

EXPERTISE IN AND AROUND ORGANIZATIONS

The Changing Constitution and
Ecology of Expertise

Edited by Kasper T. Elmholdt, Ruthanne Huising
and Elina I. Mäkinen

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RESEARCH IN THE
SOCIOLOGY OF ORGANIZATIONS

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EXPERTISE IN AND AROUND ORGANIZATIONS

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RESEARCH IN THE SOCIOLOGY OF
ORGANIZATIONS, VOLUME 97

**EXPERTISE IN AND
AROUND ORGANIZATIONS:
THE CHANGING
CONSTITUTION AND
ECOLOGY OF EXPERTISE**

EDITED BY

KASPER T. ELMHOLDT

Aalborg University, Denmark

RUTHANNE HUISING

ESSEC Business School, France

and

ELINA I. MÄKINEN

Tampere University, Finland



United Kingdom – North America – Japan
India – Malaysia – China

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INVESTOR IN PEOPLE

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ABOUT THE EDITORS

Kasper T. Elmholdt is an Associate Professor of Organization Studies and Public Administration at Aalborg University. His research focuses on the intersections of expertise, technology, work, and organization. Currently, he studies the implications of machine-learning technologies for expertise within public administrative settings in the research project “Professional Expertise in the Age of the Learning Algorithm.” He is one of the co-organizers of the Standing Working Group at EGOS on “Expertise in and Around Organizations.” He received his PhD from the Department of Management at Aarhus University.

Ruthanne Huising is a Professor at ESSEC Business School. She studies the work and professions that are central in shaping how organizational compliance with regulations, standards, and other ethical and social expectations is understood and practiced within and across organizations. She is a former Deputy Editor and Senior Editor at *Organization Science* and Founder of the *Ethnography Atelier*. She received her PhD from the Sloan School of Management at M.I.T.

Elina I. Mäkinen is a Professor of Science, Technology, and Organization at the Faculty of Management and Business at Tampere University. Her research bridges the fields of organization studies and science, technology, and society (STS). She studies institutions, work, and careers in academia. She is currently leading the Competing Imaginaries of Ethical Science (IMAGES) project, which explores ethical intensification in life sciences from the perspective of scientists who rely on animal experimentation and those who develop non-animal methods. She received her PhD in Organization Studies from Stanford University.

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ABOUT THE CONTRIBUTORS

Giada Baldessarelli is an Assistant Professor at the House of Innovation at the Stockholm School of Economics. Her research pertains to creative processes and aesthetics. She employs qualitative methods to study how material and digital artifacts influence audiences' reactions and collaborative work across expertise. She received her PhD from the École Polytechnique Fédérale de Lausanne, and her research has been published in *the Academy of Management Annals* and *the Journal of Evolutionary Economics*.

William C. Barley (PhD, Northwestern University) is an Associate Professor in the Department of Communication at the University of Illinois Urbana-Champaign. His main research interests include interdisciplinary collaboration, knowledge boundaries, knowledge representation, and scientific teamwork.

Noah A. Benjamin-Pollak is a PhD candidate in Management Science & Engineering at Stanford University. He is a member of the Center for Work, Technology, and Organization (WTO). His research focuses on how different professions interact, particularly how authority and expertise are utilized in cross-occupational contexts. His current research uses ethnographic methods to understand cross-occupational collaboration between engineers and traditional business employees. Additionally, he is focused on understanding how expertise and expert authority are built and communicated between experts and non-expert audiences.

Katharina Berr is a Doctoral Researcher at Weizenbaum Institute and Berlin University of the Arts. Her work draws on science, technology, and organization studies to explore the changing roles and expectations of scientific expertise in the digitally networked society.

Alaric Bourgoin is an Associate Professor at HEC Montreal, Canada, where he leads the CEO & Strategic Management Hub, a research center dedicated to studying the CEO job. His primary research interests include elite studies, strategy, and power, all approached through a pragmatist lens. His work has been published in journals such as the *Academy of Management Journal*, *Human Relations*, and *Organization Studies*.

Le H. Bui is a PhD Student of organizational behavior at the Desautels Faculty of Management, McGill University. Her research focuses on how organizational structures are modified across contexts and the consequences of this process for

the organizations and their employees. Most recently, she has examined these issues in the context of multinational companies.

Lisa E. Cohen is an Associate Professor of Organizational Behavior at the Desautels Faculty of Management, McGill University. She received her PhD from the University of California at Berkeley. Her research focuses on how tasks are assembled into and across jobs, the consequences of this process, and the movement of people into and out of those jobs. Most recently, she has examined these issues in the context of start-ups.

Cornelius Heimstädt is a Postdoctoral Researcher in the “BioMaterialities” research group at Humboldt University of Berlin, working at the intersection of science and technology studies (STS) and economic sociology. His research focuses on emerging practices and instruments for the valuation of environmental issues in the start-up economy. Cornelius received his PhD from the Center for the Sociology of Innovation (CSI) at the MINES Paris – PSL and worked as a postdoctoral Researcher at the French National Centre for Scientific Research (CNRS).

Maximilian Heimstädt is Professor of Business Administration at Helmut Schmidt University in Hamburg. He studies new forms of organizing in digitally networked environments, focusing on issues of transparency, accountability, and expertise. He received his PhD from Free University of Berlin and his Habilitation from Witten/Herdecke University. His work has been published in *Academy of Management Annals*, *Organization Theory*, *Management Learning*, and *Big Data & Society*, among others.

Arvind Karunakaran is an Assistant Professor of Management Science & Engineering at Stanford University. He is a member of the Center for Work, Technology, and Organization (WTO), the Stanford Technology Ventures Program (STVP), and a Faculty affiliate of the Institute for Human-Centered Artificial Intelligence (HAI). His research focuses on authority and accountability in the workplace during periods of technological and organizational/cultural change. His current research focuses on human–AI augmentation and its organizational impact. His research is published in *Administrative Science Quarterly*, *Academy of Management Journal*, *Academy of Management Annals*, *Organization Science*, and *Research Policy*. He received his PhD from MIT Sloan School of Management.

Tomi Koljonen is an Assistant Professor of Organization Theory at the University of Liverpool. He uses qualitative methods to examine work, occupations, and organizations, with particular research interests in technology, diversity and inequality, and expertise. He received his PhD from Aalto University.

Jean-Charles Leynadier is a Practitioner-Researcher and a Managing Partner in a consulting firm. After earning degrees in fundamental physics (master, Sorbonne Université UPMC) and IT (MSc, EFREI), he spent over 10 years at the French CDC national bank before transitioning to IT consulting. He worked as a Partner

at a boutique consultancy firm specializing in IT and management and later co-founded Substantiel Conseil specializing in similar domains. He completed an Executive MBA and an Executive PhD in management at PSL Université Dauphine. His PhD focused on authority formation in consulting firms, and his research examines professional service firms through actor-network and practice-oriented approaches.

Kajsa Lindberg is a Professor in of Gothenburg, Sweden. Through ethnographically inspired studies of daily work, she examines how knowledge- and technology-intensive practices are organized. Her research interests encompass material and situational aspects of organizing work, coordination and cross-disciplinary collaboration, expertise, and learning. Recent research focuses on the entanglement of digital and mechanical aspects of technologies and how the use of epistemic technologies is intertwined with the capacity to make joint judgements.

Pedro Monteiro is an Assistant Professor at Copenhagen Business School and Malmsten Early Career Scholar at Gothenburg University. His academic work explores how organizations develop, recognize, and integrate expertise, especially in technically or socially complex settings. He is particularly interested in the interplay of organizational structures and knowledge dynamics, such as how professionals specialize, collaborate, and translate new ideas into practice. He is also interested in how expertise in organizational theory relates to lay understandings and theories about organizing, especially concerning bureaucratic organization. He is also passionate about research dissemination and one of the co-founders of the Talking about Organizations Podcast.

Nicholas Occhiuto is an Assistant Professor of Sociology at Hunter College – CUNY. His work sits at the intersection of political sociology, economic sociology, work and occupations, and public policy. He received his PhD in Sociology from Yale University.

Samantha Ortiz Casillas is an ethnographer of work and organizations interested in the study of public administration and political collective action. She is Assistant Professor of Social Innovation at the NOVA School of Business and Economics and received her PhD from Emlyon Business School.

Pauli Pakarinen is an Academy Research Fellow at Aalto University. His research interests lie at the intersection of work, expertise, and professions. He uses qualitative and archival methods to examine professions and their work in complex settings saturated with information, technology, and interdependencies, such as simulation rooms, central banks, and technology companies.

Alex Preda is a Professor of Sociology at Lingnan University, Hong Kong, and Visiting Professor at King's College London. His work is situated at the intersection of science and technology studies and economic sociology, respectively. His

current projects concern venture capital valuations of AI and blockchain, and the uses of digital evidence across institutional contexts, respectively.

Elena Raviola is Torsten and Wanja Söderberg Professor in Design Management, Academy of Art and Design, and Director of Business and Design Lab, University of Gothenburg, Sweden. Her main research interest concerns the role of digital technologies in organizing professional work, theoretically developing the intersection between institutional theory and science and technology studies. She has long studied automation and AI technologies within the contexts of professional organizations, with a special interest for news organizations in Italy, France, and Sweden. Since 2022, she is leading the Nordic project Dinobord, exploring the intersection between openness and security at Nordic borders, especially in relation to digital surveillance practices performed by a variety of actors at the national borders.

Siddhant Ritwick is a Doctoral Researcher at Aalto University School of Business. His research focuses on the limits of expertise and their social implications. He also studies how digital information ecosystems affect expertise, institutions, and societal polarization. His work has been published in the *Academy of Management Review*.

Jeffrey W. Treem (PhD, Northwestern University) is the Theodore R. and Annie Laurie Sills Professor of Integrated Marketing Communications in the Medill School of Journalism, Media, Integrated Marketing Communications at Northwestern University. His research interests include communication visibility, expertise, digitalization and datafication of work, employee surveillance, and knowledge sharing.

Paula Ungureanu is Associate Professor in the Department of Sciences and Methods of Engineering at the University of Modena and Reggio Emilia. She studies how collaboration takes place at the boundaries of new forms of organization occasioned by emerging technologies such as digital ecosystems or cross-sector partnerships. Her latest projects investigate the socio-materiality of blockchains, big data, and AI and their impact on individuals' trust, collaboration, expertise, and resilience in the digital world. Her work has been published in *Organization Studies*, *Strategic Organization*, *Journal of Business Ethics*, *Academy of Management Learning and Education*, among others.

FOREWORD: RESEARCH IN THE SOCIOLOGY OF ORGANIZATIONS

Research in the Sociology of Organizations (RSO) publishes cutting-edge empirical research and theoretical papers that seek to enhance our understanding of organizations and organizing as pervasive and fundamental aspects of society and economy. We seek provocative papers that push the frontiers of current conversations, that help to revive old ones, or that incubate and develop new perspectives. Given its successes in this regard, RSO has become an impactful and indispensable fount of knowledge for scholars interested in organizational phenomena and theories. RSO is indexed and ranks highly in Scopus/SCImago as well as in the *Academic Journal Guide* published by the Chartered Association of Business schools.

As one of the most vibrant areas in the social sciences, the sociology of organizations engages a plurality of empirical and theoretical approaches to enhance our understanding of the varied imperatives and challenges that these organizations and their organizers face. Of course, there is a diversity of formal and informal organizations – from for-profit entities to nonprofits, state and public agencies, social enterprises, communal forms of organizing, non-governmental associations, trade associations, publicly traded, family owned and managed, private firms – the list goes on! Organizations, moreover, can vary dramatically in size from small entrepreneurial ventures to large multinational conglomerates to international governing bodies such as the United Nations.

Empirical topics addressed by RSO include the formation, survival, and growth of organizations; collaboration and competition between organizations; the accumulation and management of resources and legitimacy; and how organizations or organizing efforts cope with a multitude of internal and external challenges and pressures. Particular interest is growing in the complexities of contemporary organizations as they cope with changing social expectations and as they seek to address societal problems related to corporate social responsibility, inequality, corruption and wrongdoing, and the challenge of new technologies. As a result, levels of analysis reach from the individual to the organization, industry, community and field, and even the nation-state or world society. Much research is multilevel and embraces both qualitative and quantitative forms of data.

Diverse theory is employed or constructed to enhance our understanding of these topics. While anchored in the discipline of sociology and the field of management, RSO also welcomes theoretical engagement that draws on other disciplinary conversations – such as those in political science or economics, as well as work from diverse philosophical traditions. RSO scholarship has helped push forward a plethora of theoretical conversations on institutions and institutional change, networks, practice, culture, power, inequality, social movements,

categories, routines, organization design and change, configurational dynamics, and many other topics.

Each volume of RSO tends to be thematically focused on a particular empirical phenomenon (e.g., creative industries, multinational corporations, and entrepreneurship) or theoretical conversation (e.g., institutional logics, actors and agency, and microfoundations). The series publishes papers by junior as well as leading international scholars and embraces diversity on all dimensions. If you are scholar interested in organizations or organizing, I hope you find RSO to be an invaluable resource as you develop your work.

Professor Michael Lounsbury
Series Editor, *Research in the Sociology of Organizations*
Canada Research Chair in Entrepreneurship & Innovation
University of Alberta

THE CHANGING CONSTITUTION AND ECOLOGY OF EXPERTISE

Ruthanne Huising^a, Kasper T. Elmholt^b and
Elina I. Mäkinen^c

^a*ESSEC Business School, France*

^b*Aalborg University, Denmark*

^c*Tampere University, Finland*

INTRODUCTION

Expertise is a force that quietly shapes and reshapes the institutional and organizational contexts that house and leverage it. It winds its way through and around seats of power, piles of money, and pockets of violence – authorized and illicit – within societies. Traditionally, expertise has been understood as “a historically specific type of performance aimed at linking scientific knowledge with matters of public concern” (Eyal & Medvetz, 2023, p. 5). Expertise, in the sense of technical knowledge and specialized skills, was central to early theories of bureaucracy and management (Taylor, 1912; Weber, 1922), as well as in theories of the division of labor (Durkheim, 1893; Smith, 1776). Use of the term expertise in public discourse grew in the 1960s. This coincided with the increased production of specialized knowledge, the expansion of the technocratic management of the state, and the complexity and specialization of modern economies and corporations (Eyal, 2013). The centrality of expertise in the operation and governance of society is underscored and reinforced by contemporary challenges to it (Eyal, 2019).

Professions made expertise manifest in the past century and, thus, the terms profession and expert became interchangeable. Abbott (1988, p. 323) studied professions because of his broader interest in how “societies structure expertise” and identified professions as “the main way of institutionalizing expertise in

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industrialized societies.” Through an abstract, propriety knowledge system and related technical practices professions convince clients, the public, and the state that their definition and treatment are most appropriate to the problems at hand and thus they should control any interventions. While *The System of Professions* is often interpreted as a treatise on credentialled or certified professions (lawyers, physicians, accountants), Abbott argued jurisdiction is “established in the processes of actual professional work” via the capacity of knowledge systems to control problem definition within a given era and society (Abbott, 1988, p. 33). Abbott, and as many have since, examined the division of expert labor, observing competition among groups for the recognition – in very few cases the monopoly – to apply their expertise within a domain of social problems.

Professions, through their expertise, work to inject scientific knowledge and interpretation into the design and operation of large swaths of society. Beyond inter-professional competition, historically, one could argue that professions faced few other challenges. For a good part of the 20th century, professions in the Anglosphere worked in standalone practices, eluding managerial control, or in professional bureaucracies that buffered their practices from managerial interference (Barley & Tolbert, 1991). When working in groups or alone, professions self-governed within and across organizations. At the same time, clients, patients, and customers had limited rights, charters, advocates, and information that allowed them to question the work of these experts (Hughes, 1958). Acts of inference through which professions generated diagnoses, judgments, and advice were shielded from the observation and questioning of organizations, managers, and clients. The autonomy of professions to diagnose and treat could suggest trust in their expertise. Yet the relative dependence, and limited recourse of those who sought their advice suggest it may be more a matter of faith in the project of modernity (Giddens, 1990).

However, both trust in expertise and faith in modernity may be waning. Changes in the context in which expertise operates, the constitution and basis of circulating expertise, and the adjudication (deciding who qualifies as an expert) and evaluation (assessing the credibility and quality) of expertise are significant (Huising, 2023). Scientific knowledge and the abstract expertise of professions are losing standing in matters of public concern (Weingart, 2023). Although organizations and institutions have evolved to depend on myriad experts, collective trust in the conventional abstract, rationalist approaches is in decline (Eyal, 2019; Eyal & Medvetz, 2023). Inference and interventions may no longer be authorized and deferred to on the basis of their rationalist or scientific origins.

These changes have opened up realms of social problems to a plurality of incommensurable yet competing forms of expertise and to what was historically absent: the observation, questioning, and critique of expertise itself. The boundary between those historically considered experts and others is dissolving, as participation in inference and interventions is extended independent of the informational and analytical bases of inference and interventions (Collins & Evans, 2002). Alternative logics of openness and participation in matters typically deferred to those with specialized knowledge and training is where the politically left and right commune. Efforts to enhance participatory democracy, decolonize

institutions, “open” science, and decarbonize economies have contributed to this shifting ground as much as efforts to reinstate religious authority, challenge the “deep state,” undermine universities, and reinforce patriarchy. Experiential knowledge, do-it-yourself trial and error, religious conventions, cultural heritage, and celebrity status have emerged as a base of expertise (e.g., [Epstein, 1995](#); [Sheehan, 2022](#)). These alternative claims of expertise and performances are supported and diffused via diverse communication technologies, in particular social media platforms, that saturate the transactions of daily life ([Arnoldi, 2023](#); [Preda, 2023](#)). Expertise claims and performances are further complicated by the emergence and expansion of AI agents that provide output on almost any topic. Citizens, patients, and clients have the means to search for and reach whom they determine to be the appropriate expert on any given issue.

FROM THE SYSTEM OF PROFESSIONS TO THE ECOLOGY OF EXPERTISE

Retreating from the assumption that expertise is institutionalized in professions raises the question of “how forms of expertise can acquire value as public interventions” ([Eyal & Buchholz, 2010](#), p. 120; [Eyal & Levy, 2013](#), p. 225). In this way, expertise is understood more broadly as the potential to have an effect ([Eyal, 2013](#)). However, expertise as the capacity to have effect may be independent from expertise as recognized as having value. That is, virologists have the expertise to make vaccines that protect us from viruses, yet some people refuse to recognize that expertise. In contrast, astrologist’s forecasts have no predictive power, yet some people believe astrologists impart expertise. We live in a time where what constitutes and counts as expertise is fractured.

Conceptualizing expertise as a capacity for intervention or effect that competes within a complex ecology for recognition unleashes a significant new research agenda. Abbott’s idea of an ecology of actors (read broadly to include technology, networks, and other systems), competing to control the interpretation and treatment of a domain of problems remains wholly relevant to answering this question. Rather than reading Abbott through the lens of professions, it can be more productively read through the lens of expertise ([Huising, 2023](#), p. 454).

Expertise shapes – it is self-consciously interested in shaping – the ways in which we interpret, classify, and understand particular phenomenon and then take action in relation to the phenomenon.¹ This raises questions about how forms of expertise generate a context of demand and the implications for public interventions. Likewise, the supply of expertise – its basis, representations, and claims – requires examination. The “well-woven web of arguments, procedures, measurements, and institutions, all supporting each other” ([Eyal, 2019](#), p. 86), intermediaries ([Turner, 2023](#); [Waardenburg et al., 2022](#)), collective action ([Epstein, 2023](#)), and technologies ([Collins, 2018](#); [Pasquale, 2023](#)) provide crucial bases for interventions. Through what mechanisms and infrastructures do forms of expertise become accepted as appropriate in relation to social problems and needs? Further, we need to understand the adjudication processes through which interventions

are deemed expert. If expertise is no longer claimed in alignment with modernist logics, how are claims and outcomes of expertise evaluated and legitimated? How have the roles of audiences and publics changed? To capture the expanding constitution, the changing basis of circulating expertise, and the new processes through which expertise acquires value, we must expand our research agenda.

REALIST AND RELATIVIST PERSPECTIVES ON EXPERTISE

The expanded research agenda should not degrade the conversation into one in which everything is coded as expertise, and everyone becomes an expert (Collins, 2014). We need both realist and relativist studies of expertise as together they build a comprehensive understanding of how expertise is generated, applied, and recognized, and the reciprocal dynamics among these processes. By realist we mean a verified capacity to have effect developed through specialized knowledge and techniques (Abbott, 1988) acquired through deep training in a community of specialists (Collins & Evans, 2007). This includes substantive expertise (Barley, 1996) and contributory and interactional expertise (Collins & Evans, 2007). The term relativist can be understood in two ways. In the first (relativist one), expertise is understood as constructed through social processes and thus its generation, application, and recognition are vulnerable to social dynamics. This first definition relates roughly to the second wave of science studies (Collins & Evans, 2002) in which “real” expertise was shown to be subject to social forces and dependent on social consensus about the legitimacy of specific claims of expertise. In the second (relativist two), expertise is understood to be a claimed and recognized capacity that does not depend on a single social consensus. Various, incommensurable claims of expertise may be recognized as legitimate simultaneously by different communities. This definition relates roughly to the third wave of science studies (Collins & Evans, 2002) in which participation in expert domains is increasingly extended to actors who claim a range of identities, experiences, and positions as sources of expertise.

Realist and relativist “one” understandings of expertise have much in common, although this is not generally recognized, as expertise is *generated*, *applied*, and *recognized* through communities that develop processes of verification and social consensus. In contrast, relativist “two” understandings of expertise focus on the *recognition* of expertise as participation in social interventions has been extended to include anyone who claims expertise (Collins & Evans, 2019). As alternative capacities – including folk knowledge, life experience, and religious tomes – are elevated and verifiable capacities to understand physical processes are accelerated, efforts to analyze expertise as a claimed or verifiable capacity and to examine the processes through which such capacities achieve or do not achieve social consensus are important.

The COVID-19 pandemic illuminated these points. From a realist standpoint, scientific experts – such as epidemiologists, virologists, and public health officials – who relied on specialized, verifiable knowledge had the capacity to intervene (e.g., prescribing social distancing, personal protective equipment, developing vaccines,

and prescribing vaccines). Yet, a global comparison of the functioning and advice of these experts showed how their prescribed interventions were shaped by institutional, political, and economic forces. Medical and scientific advice was shown to be contingent and mutable – although with limited variation – and thus socially constructed (relativist one standpoint). Small differences in medical and scientific advice were leveraged by anti-science communities to cast doubt on the legitimacy on the advice and more generally rational, scientific approaches to dealing with viruses. At the same time, a range of actors – drawing on position, identity, or experience – claimed to have relevant expertise for dealing with a virus (relativist two standpoint). A president, skeptical of the value of social distancing and wearing masks, suggested that ultraviolet light or injecting disinfectants should be tried. A range of alternative-health practitioners prescribed essential oils, apple cider vinegar, and other household treatments. Those who experienced the virus also prescribed their treatments. This range of interventions was recognized by many as superior and preferred to medical and scientific interventions; thus, they were recognized as forms of expertise.

Unpacking both relativist and realist ontologies of expertise depends on a relational or interactional³ conception of expertise; however, “differences arise when defining interactional” and relational (Preda, 2023, pp. 35–36). Realist and relativist one conceptions of expertise understand expertise to be generated and applied relationally or interactionally. Expertise is created, learned, acknowledged, and made manifest interactionally through communities of practice (including professions and occupations) (e.g., Collins, 2014, pp. 64–65). This capacity is relationally constituted within a domain of activity. Relativist two conceptions of expertise understand expertise to be recognized and authorized via interactions with audiences of clients, patients, the public, and decision-makers. Unfortunately, a relational ontology is often conflated with relativist analyses of expertise and a substantivist ontology is conflated with a realist analysis of expertise. To examine the expansion of forms of expertise and the ecology of expertise, we depend on a relational ontology to understand how relativist and realist constitutions of expertise evolve and interweave (Pakarinen & Huising, 2025).

EXPERTISE IN AND AROUND ORGANIZATIONS

The volume is divided into two sections focusing on the changing constitution of expertise and the expanding ecology of expertise. The papers explore how understandings of expertise are evolving beyond rationalist, scientific forms of knowing and beyond professions. The epistemological, performative, and political bases of expertise are opened up. In doing so, the papers consider the changing political and technological contexts in which expertise is performed to make interventions, as well as changing notions of expert performance and intervention. Together the papers motivate new and important avenues of research.

The first section in the volume expands conceptualizations of expertise beyond domain expertise to offer new forms of expertise that undergird and facilitate domain expertise. Aesthetic expertise (Pakarinen & Baldessarelli, 2025),

decomposition expertise (Mäkinen, 2025), process expertise (Treem & Barley, 2025), institutional expertise (Ortiz Casillas, 2025), alignment expertise (Preda, 2025), and groundwork (Lindberg & Raviola, 2025) are forms of expertise that work in tandem with rationalist, scientific expertise to leverage them into an intervention. Similarly, organizations generate new forms of expertise in the context of emerging technologies. Technologies may lead to new forms or configurations of de/centralized expertise (Ungureanu, 2025) and shape how expertise is acquired and how it evolves (Cohen & Bui, 2025).

The second section begins with a provocative review that reveals how ecologies of expertise – past and present – are shaped by and shape processes of inequality (Occhiuto, 2025). It goes on to examine how the ecology of expertise has expanded to include intermediaries (Benjamin-Pollak & Karunakaran, 2025), allies (Berr, 2025), lay people (Ritwick & Koljonen, 2025), classification systems (Monteiro, 2025), algorithms (Heimstädt & Heimstädt, 2025), and clients (Elmholdt, Leynadier & Bourgoïn, 2025). This expanding ecology illustrates the various forms of expertise and actors that refract and generate what counts as a “legitimate basis for intervention” (Eyal & Buchholz, 2010, p. 128). Such an ecology highlights the multiple, often competing forms of expertise that operate in organizations and the public, challenging the scientifically and technically constituted expertise. Below we work across these volume sections and papers to synthesize their collective contributions to the enlarged, emerging research program.

BEYOND DOMAIN EXPERTISE: OBSCURED, UNDERVALUED, AND EMERGENT FORMS OF EXPERTISE

Traditionally, expertise is understood as *domain expertise* – specialized knowledge and techniques based on a canon of abstract knowledge – that ties a basis of knowing to a space of effect (Abbott, 1988). Collins and Evans (2007) call this contributory expertise: the knowledge and skills acquired through prolonged interactions with specialists in a domain that contribute to a domain of practice. Rising through the ranks – novice, advanced beginner, competence, proficiency, and finally expert – one learns abstract, practical, moral, and social notions about how to practice within and eventually contribute to a domain (c.f. Dreyfus & Dreyfus, 2005). Most studies of expertise, as well as studies of occupations and professions, draw on this notion of expertise. Labor markets, educational institutions, and organizational charts are largely organized around domain expertise. Domain or contributory expertise is thus the dominant form of expertise, understood explicitly or implicitly as the “real” expertise against which another knowledge is contrasted and understood.

Identifying new forms of expertise that are useful for conceptualizing expertise beyond domains is to walk a fine line. It entails examining and naming obscured, devalued, or emergent ways of knowing and practicing within or across domains. It avoids replicating polemic distrust in and displacement of specialized systemized ways of knowing about a domain. Elucidating new forms of expertise across

domains that resist reduction to social constructions is unabashedly part of the realist agenda. As the papers in the first section show, mitigating the complex problems related to domains, organizations, institutions, and new technologies will depend on governing through detailed, historically grounded knowledge of socio-technical systems (Bratton, 2021). At the same time, the relativist agenda appears as domain expertise is the ultimate point of reference for “alternative” articulations of expertise. To navigate this, it is crucial to recognize and categorize the diverse forms of expertise that, while often overlooked, play a vital role in complementing and enhancing domain-specific knowledge. We organize the forms of expertise presented in this collection as obscured, undervalued, and emergent. *Obscured* forms of expertise are those that cultivate, support, and extend the practice of domain expertise in ways that are often not explicitly articulated or consciously recognized by experts within the domain. Tacit components of knowing (Polanyi, 1962), knowledge that cannot be made explicit, and intuition (Bessis, 2024; Villani, 2015) are partially obscured forms of expertise in the sense that domain experts know they rely on them, but their role is rarely acknowledged. In the first section of the volume, Pakarinen and Baldessarelli introduce *aesthetic expertise*, expertise “that resides in cultivated sensory judgments that experts employ to work with and through materiality” (Pakarinen & Baldessarelli, 2025, p. 25) and Mäkinen introduces *decomposition expertise*, expertise that enables a practitioner “to break down the products of their work into individual components, assess each part, and evaluate how the components come together to form the whole” (Mäkinen, 2025, p. 46).

Pakarinen and Baldessarelli distinguish sensory sources of knowledge from tacit and embodied sources of knowledge, taking the materiality that informs, surrounds, and sustains all domains of expertise seriously. Aesthetic expertise is generated, applied, and recognized through sensory experiences. It is an elusive form of expertise that may be easy to displace or dismiss. To be methodological, to be rational, is often understood to be guided by systems of thought and practice. This perspective obscures the role of sensory experience and the materiality of expertise. Aesthetic expertise recognizes how knowledge is developed through close engagement with materials; thus, aesthetic expertise, in contrast to tacit knowledge, highlight how expertise is developed and applied as individuals engage with materials through their senses (hearing, sight, touch, smell, and taste).

Mäkinen extends the concept of professional vision (Goodwin, 1994) – how members of a profession “see and discursively articulate phenomena in their perceptual field” (Mäkinen, 2025, p. 45) – by examining how vision can be trained to deconstruct and question the practice of the profession. Observation and analysis of journal club meetings, a typical training practice in academic science, shows how early-career scientists come to see and critically evaluate the process of creating scientific knowledge (others and their own) by taking apart published scientific articles. Through this regular, collective practice, young scientists learn to identify ambiguous knowledge claims, critically deliberate on supporting visualizations and analytical tools, and then turn this critical gaze on their own research process and projects. Decomposition expertise – also recognizable to social scientists – is developed proactively, allowing emerging researchers to develop the capacity to interrogate analytical strategies, knowledge claims, and knowledge

representations. This previously unarticulated expertise feeds back into and alters the practice and production of domain expertise by creating critical taste and standards regarding knowledge production and claims.

Undervalued forms of expertise are those that, despite and possibly because of their necessary and continuous performance, are treated as subordinate to and less than domain expertise. These forms of expertise are complements to domain expertise, working in parallel to and across domain expertise. Treem and Barley, building on earlier work (Treem & Barley, 2016, 2018), considers the troubling status of *process expertise* and experts in organizations that persist in valuing domain expertise. Ortiz Casillas, writing in the context of public administration, introduces *institutional expertise* as an alternative to domain expertise and perhaps the foremost expertise of public administration. Both process and institutional expertise are invisible forms of expertise whose effect is consistently devalued in relation to domain expertise.

Process expertise is used to manage “information and communication both within and across domains but does not, in itself, represent those domains’ practices” (Treem & Barley, 2025, p. 69). This paper considers the troubling status of process expertise and experts in organizations. Despite the continued importance of information and massive growth of rich information in organizations, the ability to select, compress, and represent relevant information in serve of organizational problems remains underappreciated. Treem and Barley consider three ways – assimilation, brokerage, and commodification – through which process experts may work in relation to domain expertise and experts to alter the identity, visibility, and accessibility of their work. The paper motivates the need for more research and organizational awareness of the important, yet underappreciated role of process experts in organizations.

Understandings of the form and function of expertise in public administration (the departments and agencies tasked with planning, implementing, and evaluating public policy and regulations), revolve around the joint legacy of Weber (1978) and Wilson (1887). Ortiz Casillas argues that Weber’s view of expertise as something best produced, organized, and applied through bureaucracy, together with Wilson’s insistence that expertise should transform politically derived problems into apolitical, technocratic solutions, has generated an uneasy relationship between expertise and politics. This legacy has resulted in significant examination of the presence, absence, and implications of politics for expertise and expertise for politics. However, this focus has detracted from examining the expertise needed to “keep the lights” on in governments around the world. Beyond apolitical and professional expertise, Ortiz Casillas introduces the concept of institutional expertise: specialized knowledge of and skills developed within and about the interlocking institutions that make up the state. Most members of the public administration fulfill policymaking and administering roles that depend first and foremost on their skills working in a complex institutional system and knowing that system helps them generate, apply, and recognize expertise. This paper outlines a research agenda intended to take public administration beyond the continuous tension between expertise and politics and to examine institutional expertise as a fundamental resource in the operation and governance of societies.

Emerging forms of expertise are those needed to commensurate and stabilize (however, momentarily) an increasingly complex set of intersections among technical, administrative, material, and epistemic worlds. The intersections of these worlds are not or cannot be anticipated and designed for compatibility, thus capacities are developed to facilitate these intersections. These processes of development are focused on making an object, a technology, a process, or an organization “viable,” “workable,” “useable,” and “functioning.” The expertise is formed in relation to a new configuration of conditions that may continuously evolve, requiring the contemporaneous evolution of expertise. These same conditions can simultaneously conceal and devalue the expertise developed. Papers by Preda, Lindberg and Raviola, Ungureanu, and Cohen and Bui examine expertise – its emergence and dynamics – that contribute to commensuration, stabilization, and functioning in complex contexts.

Preda shows how the production of global market indices depends on *alignment expertise*; expertise that intersects the worlds of econometric formulae and computing machines. This is possible as software engineers and financial analysts collaborate to first purify or “clean” price and volume data, weeding out the strange, and second to purify the data even further by removing excessive data that would prohibit the machine to run smoothly or slow down or even malfunction. As Preda demonstrates, these acts of purification gradually turn indices into objects of expertise. By intersecting multiple forms of domain expertise, market indices are made of layers – the sedimentation of expertise from multiple and heterogeneous domains – that require continuous collaboration to maintain these laminations.

Lindberg and Raviola examine how experienced nurses develop the expertise needed to integrate robots into a surgical unit, making them useable. The *groundwork* necessary to make robot surgery safe and efficient depends on nurses expanding (out of necessity not organizational instruction) beyond their domain expertise to develop expertise in setting up, positioning, cleaning, and maintaining the robots. The authors show how this amalgam of forms of knowing depends on a deep material and processual awareness through which nurses develop a commitment to and capacity for attending to the robots that tends toward moral. The nurses take responsibility for the care and domestication of the robots in service of patient safety. This ethical commitment depends on creating new forms of expertise that make technology useable in a complex setting.

Although the papers by Ungureanu and Cohen and Bui range from the technological complex to the technological mundane, they demonstrate how the organizational need for expertise is dynamic and how this dynamism is experienced within the organization. Ungureanu examines how a Bitcoin community balances the ideal of decentralized participation with the periodic functional need for centralized control. This dichotomy reflects the broader struggle in the community to balance the efficiency and reliability that centralized expertise can provide with the inclusivity and resilience that decentralization promises. When the system is working, the Ethereum community visibilizes collective expertise and invisibilizes individual expertise, upholding the ideals of blockchain technology (wide consensus, better code). However, critical events require that control

be quickly centralized with individual expertise and accountability moving to the fore with the crowd offering general problem solving and monitoring (rough consensus and running code). The dynamics of shifting from maintaining routine operations to addressing critical events reveal the visibility and accountability of experts and the challenges of broad community participation.

Cohen and Bui examine how organization-specific expertise develops in relation to menial tasks in an early technology start-up and observe how developing expertise around these tasks – and staying with them – enables employees to advance in the hierarchy. The authors discuss the distinction between *core expertise* (expertise required to perform a specific task) and *produced expertise* (expertise developed through performing a task that can be applied to other tasks). This distinction problematizes a tension between how expertise is typically understood (as static and tied to specific tasks) versus the reality that performing tasks can generate new forms of expertise that extend beyond the original task, enabling new forms of work and jobs. Like scut work, doing such tasks is “a means of developing knowledge of and relations...that enhances a professional’s ability” to expand their role in the organization (Huising, 2015, p. 6). Cohen and Bui demonstrate how expertise, tasks, and jobs closely co-evolve. By pointing at the continuous interplay between tasks and the evolution of both core and produced expertise, the authors point out the importance of considering tasks in expertise development.

Looking across these newly articulated forms of expertise, we observe more than a list of flavors. There are important themes woven through them that require further empirical exploration and theorizing, suggesting future pathways for research. First, these papers unearth forms of expertise that have largely been delegitimized by organizations and scholars. Their invisibility and value become apparent when they are absent or of low quality. These dynamics are ripe for study. How does expertise that is fundamental to running our institutions become sidelined both in practice and in theory? What does this indicate about the processes and conditions that legitimize expertise? Second, these forms of expertise are embedded within and emerge from a knowledge of a complex context with significant contingencies. This does not mean that these forms of expertise are specific to one context. These forms of expertise are found across contexts despite a lack of unifying domain expertise. Abstract knowledge and related specialized practices can be material inputs, but they do not structure and guide the basis for action. Examining how expertise emerges from within and about complex organizational and institutional contexts requires more consideration. Third, because these forms of expertise are not part of managerial and professional discourse, they are not given attention (observation, tracking, and measuring). This lack of articulation and recognition has important implications for whether and how this expertise is developed, who develops it and for what reasons, and ultimately its quality and availability. Beyond examining these implications, how might observation, tracking, and measuring alter such expertise?

This section of the volume aims to encourage a more empirically grounded exploration of forms of expertise that enhance and extend domain expertise, including those that undergird the continuous functioning of organizations and institutions, and develop in response to continuously emerging configurations of

new technologies, sources and qualities of data, organizational forms, and institutional demands. Revealing, valuing, and articulating forms of expertise beyond categories of domain expertise and tacit knowledge is also likely to refine these age-old, often too-general conceptualizations.

THE EXPANDING ECOLOGY OF EXPERTISE: INTERMEDIARIES, ALLIES, LAYPEOPLE, AND AUDIENCES

The erosion of scientific authority and the emergence of alternative, sometimes competing sources of expertise, are well documented in science studies (Epstein, 1995; Jasanoff, 2003). Over the past 50 years, a series of failures (Three Mile Island, AIDS, Chernobyl, mad cow disease, the pandemic), debates (nuclear power, genetically modified food, vaccines, climate change, conspiracy theories), and controversies in scientific conduct (data fraud, plagiarism, peer review manipulation, research misconduct) have ended “scientific exceptionalism” (Weingart, 2023). The organization, operation, and claims of science have, since the 1970s, been under increasing pressure to be accountable, accessible, explainable, responsible, and relevant to the public. Such processes “leave scientific experts in a precarious constellation of forces in which their credibility based on claims to certified knowledge is challenged by claims to public legitimacy” (Weingart, 2023, p. 30).

Expertise, stemming from scientific inquiry and advances, is subject to increased public accountability, activities – including citizen science (Baudry et al., 2022), open science (Leonelli, 2023), science communication (Horst, 2022) – that have oriented and opened science to the public dialogue and participation, and to the changing media through which science is represented and scrutinized. Not only is the public “looking into” science, but they are also participating in it, shaping it, and challenging it. Matters of science and technology have stakeholders who want their perspectives or standpoints included and recognized. Deciding how and when to extend and enlarge participation in matters traditionally tended to exclusively through credentialed expertise has been discussed as the process of extension (Collins & Evans, 2002). At issue, for scholars who take a realist perspective on expertise is how extension can improve rather than degrade the constitution of expertise not reducible to social construction. At issue, for scholars who take a relativist perspective on expertise is how extension expands and orders the sources of expertise.

Studies of professions in sociology and organizational theory have focused less on societal efforts to challenge professional credibility, to politicize and question the role of professions, and to reject and replace professional control. However, professional authority is no longer a given as alternative sources and manifestations of advice giving in relation to social problems emerge (Huisin, 2023). Domain expertise is questioned by those who have taken advantage of public availability of information about and knowledge of domain expertise. As Treem and Barley note, the volume, variety, and distribution of information in the form of videos, blogs, interviews, peer-reviewed (or not) academic articles, courses,

course material, and so on available about any given domain expertise is crushing. If you are curious about shoulder surgery, a few hours or days of scrolling and reading is likely to provide enough interactional expertise (Collins & Evans, 2007) to allow you to speak confidently about conducting shoulder surgery without having stepped into a medical school. Vaguely aware of this possibility, we have not meditated on its myriad implications for who can put themselves forward as an expert and how we recognize expertise. It no longer takes privileged, physical access to a community of experts, social scientific methods, and 30 years of communication within the community to pass oneself off as a gravitational wave physicist (Giles, 2006).

The mediums through which domain expertise is available are also the channels through which those who want to increase the social and epistemic diversity of expertise share and seek recognition of expertise developed based on one's life experience or self-practice, or through epistemic travel (Huising, 2024) and trespassing (Ballantyne, 2019). DIYers (Gauntlett, 2018), celebrities (Caulfield, 2015), and influencers (Bishop, 2019) are a few examples of the increasing supply of those claiming to have the capacity to make knowledgeable and effective interventions. Claims of expertise – from outside of scientific and professional communities – and efforts to have those claims recognized as having value in interventions expand the set of actors to be studied and theorized. At the same time, those who seek expertise – patients, clients, colleagues – are more organized, informed, and agentic than in the past. Enter in the “public” who are observing the health of their sheep (Wynne, 1989), their community (Epstein, 1995), and their children (Eyal, 2013). Those who would in the past be recipients of expertise increasingly actively shape advice and interventions directly by generating hybrid forms of expertise (Epstein, 2023) or indirectly by evaluating and requiring reformulations of expertise (Chan & Hedden, 2023). Clients, patients, and advisees feel empowered to make claims on expertise.

Abbott conceptualized the expert division of labor as an ecology, one in which actors compete to attach their expertise to a set of problems, creating a dynamic system in which the success of claims of appropriate expertise “reflects as much the situation of its competitors and the system structure as it does” claims themselves (Abbott, 1988, p. 33). This dynamic ecological apparatus is theoretically powerful as it continues to capture the expert division of labor despite significant changes in the actor groups claiming expertise and the basis of these claims. The idea that the generation and application of expertise could be cordoned off or patrolled by experts, with laypeople as “a resource available for use, or an ally available for enrollment” (Epstein, 1995, p. 409), now seems quaint. Making distinctions between “experts” and “others” is fraught as the ecology contains a more complex set of relations and resulting hybridities (Epstein, 2023). As the ecology expands, the increased cacophony of claims and counterclaims (Crease, 2023), as well as the processes of evaluation, alteration, and hybridization of expertise, promise to be complicated. Increasingly we are talking, however implicitly, about the societal conditions and spaces in which needs for expertise and offerings of expertise are formed, represented, and adjudicated. This suggests a need to trace the structure and operation of the infrastructures – technologies, practices, actors, and organizations – through

which forms of expertise are developed as offerings, adjudicated as appropriate and acceptable, and evaluated and performed.

We consider the expanding ecology of expertise in the second section of the volume including the range of actors who contribute to processes of selection, variation, and retention of expertise. Occhiuto, and Benjamin-Pollak and Karunakaran examine the social processes through which certain categories of people are selected into the ecology of expertise and the reciprocal relations between the production of expertise and representations of expertise. Berr, and Ritwick and Koljonen reveal the increasing variation in participation in the ecology of expertise, complexifying our understanding of lay expertise to include allies and reluctant challengers. Papers by Monteiro, Heimstädt and Heimstädt, and Elmholdt, Leynadier, and Bourgoïn speak to how various processes of assessment, audiences for expertise, organizations, and clients reformulate and contain the territories experts can claim within the ecology. Through processes of organizing, evaluating, and editing expertise, audiences are important participants in the ecology of expertise. Thus, the papers in the second section of the volume inquire into the expanding ecology of expertise and the roles of intermediaries, allies, laypeople, and audiences.

Implicitly shrouded in notions of universalism, studies of expertise have eluded examination of the experts themselves. The first paper examines exclusionary processes within the expanding ecology of expertise. Occhiuto argues that studies of expertise largely decontextualize or conceal who the expert is in socio-economic terms, “treating experts as seemingly unaffected by or above social processes that generate or reproduce [...] inequalities” (Occhiuto, 2025, p. 223). Reading the literature on inequality with an eye to how social and economic inequalities shape the production and recognition of specialized knowledge; this paper challenges the notion that expertise can be or should be studied as unembodied or uninhabited by people in a particular historical and social context. While the literature on expertise has extensively considered the diversification of participation in matters requiring expertise, the diversification of participation in matters requiring expertise, consideration of how racist, xenophobic, sexist, and classist beliefs, and the institutionalization of these ideas in the structures and processes that contribute to producing and recognizing expertise have received limited attention. Occhiuto shows that who is considered an expert, authorized to produce, and recognized as having expertise is consequential to the constitution of expertise and the reproduction of inequality. Weaving together realist and relativist perspectives, this paper shows how social exclusion shapes epistemic exclusion and vice versa.

These socio-economic processes are institutionalized in organizations, shaping choices and decisions. Taking up Occhiuto’s call, Benjamin-Pollak and Karunakaran turn their focus to the *intermediaries* of expertise. The authors examine the inter-organizational, social processes through which a narrow, homogenous demographic become selected as public experts, reinforcing dominant cultural ideas about who can be an expert. In developing their model of expert amplification, the authors argue that the market through which scientific expertise is diffused to a general audience is shaped in significant ways by supply-side and demand-side intermediaries, leading to a skewed selection and

representation of experts to the public. First, experts themselves may opt out of participation in the public discourse, anticipating sanctions from within the expert community. Second, supply-side intermediaries (press officers, public relations, and communications specialists) selectively market a subset of willing public experts. Third, demand side intermediaries (media organizations) preferentially invite experts to perform for the public. Drawing on prior research, Benjamin-Pollak and Karunakaran suggest that these processes screen out those invested in their expert community, namely women and racialized minorities. As the drive for public engagement has increased in many universities, we can reflect on such screening processes and their criteria in our own institutions. Beyond identifying the process through which a demographic subset of experts dominates, the authors consider the consequences for the selection and representation of experts for public discourse and how expert amplification may have implications for the production and recognition of expertise.

Studies of *lay expertise* have increasingly recognized the range of actors, motives, and basis for expertise (Epstein, 1995, 2023). Lay expertise also operates in relation to scientific or professional expertise in increasingly complex, hybrid configurations (Epstein, 2023). Berr reveals that not all laypeople want to influence or challenge the scientific production and application of expertise. In a post-truth era, communities of laypeople may attempt to champion and support knowledge and advice produced through the scientific method in expert communities, leverage social media techniques to promote such expertise. A two-year digital ethnography of an online community shows how citizens supported scientific expertise and antagonized those who challenged it in the context of the Covid-19 pandemic. *Allies of expertise* did not claim to have expertise themselves instead they represented and defended scientific values, findings, and advice in on-line forums, “copying their post-truth antagonists by leveraging the logics and infrastructures of social media” (Berr, 2025, p. 272). These citizens made themselves subservient to scientific knowledge and the scientists producing it. Beyond trying to convince other laypeople to focus on scientific knowledge and advice regarding the virus, the allies went out of their way to engage those tending toward misinformation. In conceptualizing a form of public engagement with expertise, Berr’s study emphasizes how citizens have taken the work of recognizing expertise into their own hands and how the cacophony of claims across the endless expanse of the multiple social media platforms feeds these efforts.

The processes through which those seeking help, advice, counsel, or treatment search, adjudicate, and accept a claim of expertise is a relatively open frontier of research. Ritwick and Koljonen examine how patients who continue to suffer gastroesophageal reflux disease despite medical treatment turn to online communities and the alternative treatments proposed by members of these communities. The volume of both certified medical information (Mayo Clinic, NHS, etc.) and alternative ideas about how to diagnose and treat medical conditions is astounding. This information is shared, dissected, and adjudicated in online communities dedicated to a particular diagnosis or set of symptoms. A community of “sufferers” shares experiences of unmitigated pain, negative interactions, poor treatment, and disappointing prescriptions at the hands of physicians. They also

share alternative treatments and how they mix medical and lay expertise to manage their conditions. Neither medical nor lay expertise address their condition and sufferers experience a spiral of increasing anxiety. This paper reflects how we increasingly – as patients, clients, and advisees – determine our own treatment by mixing “professional expertise” with ideas and suggestions offered by others who have faced the same problems in managing a medical condition, renovating a house, or managing a financial portfolio. Where such problems are persistent, Ritwick and Koljonen show that people get caught in a spiraling dynamic in which anxiety grows as potential solutions are grasped. This study generates questions about how people work with multiple sources of information, with various epistemic foundations, to develop their own solutions to complex problems or projects. This DIY treatment can reflect a distrust in certified expertise, a need for control, overconfidence, suffering, or any number of motives and narratives. Understanding such DIY processes opens questions about conditions, responsibilities, and consequences.

Audiences play another key role in the ecology of expertise both by valuing expertise and recognizing who counts as an expert. Recognition processes are largely the domain of audiences (Abbott, 1988, pp. 60–68). However, our conceptualization of audiences often remains circumscribed to clients and patients and forms of acceptance and rejection. There are important ways in which our understanding of retention processes can expand to include a range of actors and more dynamic processes of feedback. The processes through which organizations comprehend the landscape of expertise embodied in their employees, for example, have significant implications for what is recognized, labeled, and retained as expertise. As organizations trend toward disaggregating jobs into a dynamic assignment of revolving projects, ad-hoc assignments, committees, and add-on roles, the allocation of expertise to work (vs expertise to job) becomes complex. This strategic and administrative challenge is often managed through internal platforms in which employees’ knowledge, skills, and availability are roughly represented. Monteiro considers how contemporary efforts to map expertise risk flattening, eclipsing, and marginalizing expertise. In the critique of conventional understandings of expertise, Monteiro argues that traditional systems for mapping and matching expertise often fail to capture the complexity and social nature of expertise, leading to various forms of “expertise invisibilities.” The concepts of flattening, eclipsing, and marginalizing are central to this critique. Flattening occurs when the multidimensionality of expertise is reduced to a single dimension, oversimplifying and thereby obscuring the rich interplay of skills and contextual knowledge. Eclipsing happens when some forms or versions of expertise are highlighted while others are pushed to the background, thus only partially visible, often reinforcing existing hierarchies. Marginalizing takes this a step further by actively pushing certain forms or conceptions of expertise to the fringes, often due to power dynamics or competing bodies of knowledge. Through such processes and conceptions of expertise, Monteiro argues, poor alignment between workers and tasks is likely, ultimately hampering the recognition and development of expertise.

Organizations also reformulate the expertise they offer and, thus, the expertise of the specialists that they employ in efforts to expand, attract customers,

and capture more markets. In such cases, audiences – especially clients – play an important role in recognizing claims of expertise. Heimstädt and Heimstädt examine the advent of what they call “algorithmic expert services” – expert advice generated algorithmically through a mobile app. The authors focus on an app for farmers to gain insights on problems related to agriculture and how to handle plant diseases, and explore how organizational aspirations to scale such expertise reshaped the character of the expertise diffused. In the paper, they show how organizational efforts to make agricultural expertise scalable was at odds with the experts’ preference of providing more specified, customized advice and their efforts to decrease the health and environmental externalities of agricultural practices. Tracing changes in expert advice over an eight-year period, they show how the app providers cycle through the challenge of producing scalable advice while maintaining diffusion of the expertise intended to reduce social harm. Their study points to the need to understand the organizational and technological processes through which expertise is curated, reformulated, and redacted in ways that trouble experts. Notably, the authors indicate how an audience can be complex and hold rivalry values to those aspiring to deliver expert services, which in the end may alter the expertise delivered.

Continuing the focus on audiences Elmholtz, Leynadier, and Bourgoignie hone in on the dynamic, relational nature of expertise in a study of how consultants’ expertise is both challenged and produced through interactions with clients. Because consultants and clients share overlapping knowledge, clients may shape how expertise comes to operate through consultants’ work. Based on an ethnographic study of a consultancy project, the authors analyze three practical tests through which clients assess the consultants’ expertise. Skills tests evaluate the consultants’ ability to translate abstract and specialized knowledge; results tests measure the speed, impact, and value for money of the consultants’ work; and loyalty tests assess the consultants’ adherence to the client’s authority. These three forms of evaluations allow clients to specify what they want as well as what expertise they recognize as relevant. Consultants must pass these tests by making their expertise visible while incorporating and coordinating, at times, divergent client inputs. Aligning with relational views of expertise (Pakarinen & Huising, 2025), these findings demonstrate how expertise is never taken for granted as experts must demonstrate their specialized abilities within a “relational context of the client system” (Elmholtz et al., 2025, p. 390) as well as rely on material objects in their efforts to assert their expertise. These findings are helpful for further understanding the client system’s role in the ecology of expertise.

In sum, by advancing an ecological understanding of expertise, the second section of the volume seeks to move beyond relativist versus realist perspectives and understand the heterogeneous, distributed, and infrastructural elements of expertise. Noticing the range of actors, procedures, devices, and institutions that are part of the ecology of expertise, provides important insights into how expertise is relationally conditioned within and around organizations. Notably, an ecological view highlights the structure of the broader system and the positioning of competing actors, which remains essential for understanding expertise in an ever-evolving landscape of claims to expertise and contestation.

CONCLUSION AND CAUTIONS

Woven through this essay and the papers in this volume is a research agenda focused on expanding our conceptualizations of what constitutes expertise and the ecology of expertise. We argue these expansions hold several implications for future studies of expertise. First, a significant fissure has emerged between realist observations of expertise and relativist observations of expertise. Fifty years ago, expertise was domain expertise – grounded in training in a domain of verifiable and verified knowledge and techniques – and scientists and members of professions who operated based on domain expertise were recognized as experts. Realist and relativist conceptions held together in the past. The papers in the volume suggest that the fissuring of these two – the techno-scientific basis of expertise and the recognition of this as expertise – is likely to grow in society. Domain expertise is just one source of advice and treatment among many to choose from; selected, ordered, and considered relevant to different degrees by different parties. People do and are likely to continue to recognize multiple sources of advice and treatment as expertise relevant to their problem. Changes in the public recognition of what forms of knowing count as relevant are certain to change what the public counts as knowing and knowledge. That is, as the relative role of domain expertise decreases in interventions, the status of domain expertise as expertise is likely to erode in interventions. As papers in the second section of the volume show, what is recognized as expertise and the processes and infrastructures through which this recognition occurs may not only be estranged from domain expertise but contribute to its decline. Ironically, the papers in the first section of the volume show that what is *not* recognized as expertise, are the forms of expertise that undergird, leverage, complement, and expand domain expertise. Together, the papers of the volume underscore the important relationship between realist and relativist dynamics of expertise in society.

The importance of this comprehensive agenda is highlighted by the opposing challenges to expertise observed in contemporary discourse. Those interested in reducing the role of science and technological rationalism in society narrate the relativist character of expertise to create doubt about whether there is any “real” expertise about, for example, climate change, viruses, or human origins. In contrast, those interested in maintaining or elevating the role of science and technological rationalism in society challenge the relativist character of expertise to reveal realist qualities of expertise. As the fissure between realist observations of expertise and relativist observations of expertise in society grows, the dynamics will become more complex.

The articulation and analysis of this gap, as well as related dynamics, will be central to understanding expertise. As we do this work, we should be mindful of our language, assumptions, and explications of expertise. For example, we cannot continue to conflate professions with experts. Professions exist within broader ecologies in which forms of expertise, other than domain expertise, compete as interventions. Abbott remains relevant to our understanding of ecologies of expertise; however, not all of the experts in this ecology will be professions (Huisin, 2023, p. 454). Thus, expertise rather than professions or occupations is

the focus of inquiry. We also need to reorient our focus to the alternative epistemological and political resources that fuel performances aimed at linking a form of knowing with matters of public concern. Beyond studies of professions, studies of new sources of expertise as well as obscured, undervalued, and emergent forms of domain expertise must articulate richly generation, application, and recognition of these forms of expertise. Our work is to continue identifying the changing resources, performances, and politics through which forms of knowing win and lose ground in the ecology.

Second, as the conceptual and theoretical ground shifts, we will lose our footing. Prior concepts may begin to lack relevance, losing their capacity to provide abstract narratives that help us think about and explain empirical patterns. The absence of strong middle range theory, in the age of “every paper must build a new concept,” indicates that we may be without theoretical bearings for some time. There is opportunity to build new middle range theory, but such work requires going beyond one setting, one snapshot, one analysis. As the original vision of grounded theory building proposed (Glaser & Strauss, 1967), concepts and theories are built across numerous settings and thus depend on ambitious and rich empirical projects (e.g., Barley, 1996). Doing ambitious empirical work that develops insights through working across contexts, time, and geography will be essential to grasping the changed quality, mobilization, and effects of expertise in this century. We should invigorate our methodological imagination and stimulate our sociological imagination with fresh approaches to observe, trace, and compare how expertise emerges and matters across various contexts. This may involve developing innovative methods to capture expertise in digital environments or incorporating insights from historical methodologies. By doing so, we can deepen our understanding of how expertise evolves and its impact in a rapidly changing world.

Third, as we attend to building new knowledge about expertise, we must be explicitly reflexive about how our ways of conceptualizing – our choices about how to contextualize and what to emphasize – ripple out to shape the academic and public discourse on expertise. Theoretical conversations and efforts of knowledge building should not depend on sensationalized claims about the crisis, overthrow, or death of expertise (Eyal, 2019; Nichols, 2017).³ How we perform our own expertise will have implications for how others approach and talk about expertise (Preda, 2023). We can fuel attacks on and doubts about expertise or we can generate constructive inquiry and dialog. The appropriation of Bruno Latour’s work to delegitimize science and question its authority is more than a tale of warning. Academics can lose control over ideas in sometimes spectacular ways. Latour admitted that “it felt good to put scientists down a little” but attempted to repair the effects of this “juvenile enthusiasm” for much of the last two decades of his life (de Vrieze, 2017, p. 159; Kofman, 2018). The language we choose, the explanations we put forth, and the performances we create around an evolving concept matter.

Finally, this volume includes a heterogeneous collection of efforts to create knowledge about a dynamic, complex phenomenon. Our approach has not been to ask the established “experts” on expertise to contribute, but to issue an open

call for papers and draw on our typical methods of professional sorting and evaluating of contributions. As a result, this volume features many emerging voices on expertise. Our intention is to extend participation in this conversation with the hopes of diversifying lines of thought, contexts of consideration, and intersections of literatures. We hope it is fruitful for your own lines of thinking and writing about expertise.

NOTES

1. For example, during the COVID-19 pandemic, various actor groups actively attempted to shape how the public understood the virus and influence public health actions like lockdowns, mask mandates, and vaccination campaigns (Lakoff, 2023).
2. Interactional here is not a reference to or related to Collins and Evans (2007) concept of interactional expertise. Rather, interaction and interactional should be read as social transactions (Emirbayer, 1997) – actions among interactants through which the social world and its meaning are generated, informed by the prior history of transactions that shape actions and interpretations.
3. Eyal (2019) is concerned with the ongoing “pushmi-pullyu” status of expertise and criticizes other authors for sensationalizing the status of expertise in society.

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SECTION 1

OBSCURED, UNDERVALUED, AND EMERGENT FORMS OF EXPERTISE IN ORGANIZATIONS: BEYOND DOMAIN EXPERTISE

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OF PROUST'S MADELEINES AND WHALES' SONGS: AN AESTHETIC PERSPECTIVE ON EXPERTISE

Pauli Pakarinen^a and Giada Baldessarelli^b

^aAalto University, Finland

^bHouse of Innovation, Stockholm School of Economics, Sweden

ABSTRACT

This paper explores the overlooked role of senses in generating, applying, and recognizing expertise. Drawing from scholarly work on aesthetics, we highlight the role of aesthetic knowledge in expertise – knowledge that resides in cultivated sensory judgments that experts employ to work with and through materiality. We elaborate on three ways in which aesthetic knowledge is implicated in expertise. First, sensory judgments elicit interactions between experts, artifacts and technologies within the webs of relations in which expertise is generated. Second, as experts apply expertise to cases and problems, they produce, evaluate, and manipulate artifacts and technologies relying on their senses. Third, judgments and representations of expertise are implicated in negotiations on who is an expert and which expertise is valuable. Together, these insights suggest an understanding of expertise that accounts for sensory faculties and experience as social practices intertwined with the material environment.

Keywords: Expertise; work; aesthetics; senses; materiality

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INTRODUCTION

Expertise operates and occasions effects in and through webs of social and material relations (Eyal, 2013; Latour & Woolgar, 1986; MacKenzie, 2006) as practitioners that viably claim authority via expertise (Abbott, 1988; Anteby & Holm, 2021) engage with and through materiality to accomplish work (Bailey et al., 2011; Bechky, 2021; Stigliani & Ravasi, 2012). Empirical findings suggest that sensory judgments of the material environment are inherent in how experts accomplish their tasks, diagnose and treat problems, and claim authority (see Baldessarelli et al., 2022, for a review). Practitioners in different fields approach their work and the materiality it entails, from specimens and prototypes to tools and technologies, by employing their senses—that is, hearing, sight, touch, smell, and taste (e.g., Christin & Lewis, 2021; Elias et al., 2018; Goodwin, 1994; Lynch, 1985; Rostain & Huising, 2024; Stigliani & Ravasi, 2018; Wasserman & Frenkel, 2011).

These sensory judgments constitute and are constituted through what researchers refer to as *aesthetic knowledge*, that is, a practical form of knowing that resides in sense-induced judgments vis-à-vis materiality (Strati, 1992). To illustrate, narcotics analysts in crime laboratories intuit “drugs on the basis of their smell,” firearms examiners use comparison microscopes “to make judgments based on visual cues,” and toxicologists “hear problems with their instruments” (Bechky, 2021, p. 55). Surgeons in operating rooms employ haptic, visual, and auditory cues of patients’ bodies during surgical operations (Sergeeva et al., 2020). Technicians rely on their “ability to make sense of subtle differences in the appearance of materials and the behavior of machines” (Barley, 1996, p. 425), and mathematicians follow “the feeling of mathematical beauty, of the harmony of numbers and forms, of geometric elegance” to perform their work (Poincaré, 1910, p. 331).

Despite abundant empirical evidence, these observations are overlooked, marginalized, and left anecdotal in theoretical conversations on expertise. Even when these observations are attended to, they are typically considered embodied skills pertaining to the individual (Collins & Evans, 2002). Current scholarship falls short of appreciating these observations in connection to broader contexts such as expert jobs, professions, and networks of expertise within which expertise is applied, generated, and recognized (Pakarinen & Huising, 2023). As a result, empirical evidence documenting the role of senses and aesthetic knowledge in experts’ work is sidelined in theorizations on expertise, professional authority, and expert performances beyond creative industries and occupations.

This insight motivates our paper, which aims to put aesthetics into focus in research on expertise. For instance, if a cursory touch of the wood tells a flute maker whether the quality is good (Cook & Yanow, 1993) and a glance at financial reports tells auditors whether they are satisfactory (Guénin-Paracini et al., 2014), then understanding produced through the senses is implicated in how experts enact expertise. The modernist conception of knowledge which emphasizes rationality, standardization, and universality (Scott, 1998; Weber, 1978) and simultaneously excludes local and sensual, has deterred us from acknowledging the role of senses in expertise. In this paper, we argue that, on the contrary,

the webs of relations constituting expertise entail aesthetic judgments – visual, sonic, haptic, olfactory, and gustatory – and that aesthetic knowledge is central to enacting expertise within these relations.

In what follows, we first introduce the concepts of sensory judgment and knowledge rooted in research on organizational aesthetics. We elaborate the notion of aesthetic knowledge within the broader “elusive knowledges” (Torald et al., 2018) that also encompass embodied and tacit forms of knowing. After that, to elaborate on the role of aesthetic knowledge, we detail ways in which expertise is relationally generated, applied, and recognized through the senses. We argue that attending to senses in expert work can advance our understanding of relational expertise.

AESTHETICS: AN INTRODUCTION TO ITS FOUNDATIONAL CONCEPTS

The word “aesthetics” derives from the Greek αἴσθησις (aísthēsis) and αἰσθητικός (aísthētikós), “of or for perception by the senses, perceptive.”¹ The term was first introduced in the 18th century by philosopher Baumgarten to “protest against the rationalist devaluation of sense cognition” (Gregor, 1983, p. 369). By stating that “[a]esthetics (theory of the liberal arts, doctrine of inferior knowledge, art of beautiful thinking, art of the analogous of reason) is the science of sensory knowledge” (Baumgarten, 1750, p. 2),² the philosopher sought to dignify aesthetics as an essential knowledge as deserving of examination as rational thinking.

While it originated in the mid-1700s, aesthetic knowledge gained traction in the study of organizations only in the early 1990s (Gagliardi, 2007), coinciding with a newfound awareness of the value of sensory judgments in organizational settings (e.g., Gagliardi, 1990; Strati, 1992). Since then, researchers have dedicated growing attention to aesthetics and its influence on work (Baldessarelli et al., 2022; Cattani et al., 2020). In particular, scholars have focused on two fundamental concepts – sensory judgments and aesthetic knowledge – that we describe next.

Sensory Judgments: Interacting with the Material World Through the Senses

A sensory judgment is a sense-induced response to events and interactions (Csikszentmihalyi & Robinson, 1990; Stephens, 2021; Stigliani & Ravasi, 2018). It is an immediate perception triggered as individuals interact with the material world surrounding them (Dewey, 1934). An aesthetic or sensorial judgment unfolds as an “initial perceptual hook followed by a more detached, intellectual appreciation that returns the viewer to the work with a deeper understanding” (Csikszentmihalyi & Robinson, 1990, p. 118). Put differently, sensory judgments generate immediate, visceral reactions that often evolve into secondary considerations, such as cognitive and instrumental evaluations (Rafaeli & Vilnai-Yavetz, 2004; Rindova & Petkova, 2007). To illustrate, roaming through the rooms of a museum, an art piece might catch the visitor’s attention and surprise them. They might find it shocking,

comforting, confusing, or exciting (Beyes & Steyaert, 2012). Another example is as follows, Marcel in Proust's (1914) *In Search of Lost Time* eats the crumbs of a madeleine dipped in lime blossom tea and sensorially and cognitively experiences it: "No sooner had the warm liquid mixed with the crumbs touched my palate than a shudder ran through me and I stopped, intent upon the extraordinary thing that was happening to me. An exquisite pleasure had invaded my senses, something isolated, detached, with no suggestion of its origin."

Immediate, intuitive reactions might, then, generate lasting emotional responses, symbolic associations, and logical analyses leading to further assessments (Rindova & Petkova, 2007). For example, individuals might experience shock or strong dislike when encountering disturbing views, which generate lasting meanings and propel actions (e.g., Barberá-Tomás et al., 2019; Rafaeli & Vilnai-Yavetz, 2004).

Aesthetic Knowledge: Understanding and Building the Material World Through the Senses

Informed by the role of sensory judgments, a growing body of research in organization studies has explored aesthetic knowledge in work and organizations. This research conceptualizes aesthetic knowledge as a type of practical knowing employed by experts who deliberately use their cultivated sensory judgments to carry out tasks (Gagliardi, 1990; Strati, 1992, 1999; Strati & deMontoux, 2002). Aesthetic knowledge is "acquired through the senses [and] is employed to enact day-to-day work and to infuse material artifacts and workspaces with aesthetic properties" (Baldessarelli et al., 2022, p. 235).

Aesthetic knowledge, alongside embodied and tacit forms of knowledge, makes up what Toraldo and colleagues call "elusive knowledges" (2018) – that is, knowledge that is difficult to articulate in words and epistemologically challenging to study. Even though such forms of knowledge are often used interchangeably, and we acknowledge that overlaps exist (i.e., all three depend on personal, direct involvement in a task), each has a distinct historical trajectory and a different focal interest (Table 1 summarizes the three forms of knowledge).

Embodied knowledge is lodged in the body, which is the primary means to reflect and enact realities (e.g., Meziani & Cabantous, 2020; Sele et al., 2024). Embodied knowledge is "coming from experience of the body from within," that is, from "involving bodily senses and a process of becoming aware of the body as a source of ... knowledge" (Rigg, 2018, p. 153). Embodied knowing acknowledges the "agency of flesh" (Harding et al., 2022) and, thus, treats the body as "central to the perceiving, feeling, communicating, judging, reflecting and moving" (Blanche & Feldman, 2021). In this sense, for example, when considering writing a letter, "it is knowledge in the hands, which is forthcoming only when bodily effort is made, and cannot be formulated in detachment from that effort" (Merleau-Ponty, 1945, p. 166).

Tacit knowledge, instead, is "the knowledge that we draw on in use, but is difficult to have consciousness of, or to express in language" (Hadjimichael & Tsoukas, 2019, p. 672). It allows one to be aware of a task (e.g., writing a letter)

Table 1. Classification of “elusive knowledges.”

Form of Knowledge		Definition	Focus of Research (= focus of inquiry)	References
Embodied knowledge		Knowledge acquired and used through sensing and inscribed within/on/as flesh	Bodies and somatic sensations For example, the body that perceives comfort/discomfort	<i>Foundational work:</i> Merleau-Ponty (1945) <i>Other key references:</i> Lawrence et al. (2023), Shapiro (2019), Wacquant (2015)
Tacit knowledge		Knowledge that people use in action but is difficult to have consciousness of and to put into words	Task at hand (which the person is focally aware of) For example, the words and sentences that are being written	<i>Foundational work:</i> Polanyi (1958, 1966) <i>Other key references:</i> Hadjimichael et al. (2023, 2024), Tsoukas and Hadjimichael (2019)
Aesthetic knowledge		Knowledge developed and utilized as people use their senses (i.e., hearing, sight, touch, smell, and taste) to engage with materials	Relation between senses and the materiality of the task at hand For example, the touch of the clay to shape a vase	<i>Foundational work:</i> Baumgarten (1750); see also Kant (1987) <i>Other key references:</i> Baldessarelli et al. (2022), Gagliardi (1990), Strati (1992, 1999)

*We include additional references of recently published conceptual papers that speak to management and organization scholars.

because one attends unconsciously to it *from* its subsidiary aspects (e.g., when writing a letter, one uses pen and paper, “but attending *from* them *to* that which they mean, reduces them to a subsidiary status” (Polanyi, 1967, original emphasis). As such, tacit knowing implies a process of integration, called “indwelling” (Polanyi, 1966), that goes unnoticed and is mostly inaccessible to people’s consciousness. In decision-making, such a process entails a rapid and nonconscious processing of subsidiary aspects that some scholars have called intuitive processing (Dane & Pratt, 2007; Salas et al., 2010).

Finally, aesthetic knowledge is a form of “knowledge used to construct, represent, and interpret the felt meanings and sensory experiences related to organizational life” (Hansen et al., 2007). As such, aesthetic knowledge is deliberately developed and utilized by tapping into one’s sensory capacity to produce, interpret, and work through the material environment (Gagliardi, 1990; Strati, 1992). Aesthetic knowledge, then, emerges and is employed through a process of situated sensory knowing and directs one’s attention to the relation between the senses (i.e., hearing, sight, touch, smell, and taste) and the materiality under scrutiny. Returning to the example of writing a letter, aesthetic knowing entails a deliberate awareness of the contact between the hand and the pen and the motion of the hand to write.

In a nutshell, while partly overlapping with embodied and tacit forms of knowledge, aesthetic knowledge has a distinct character in that (a) it places an explicit focus on aesthetic experiences vis-à-vis materiality, and (b) it acknowledges that the materiality of organizing has an agential role.

AESTHETIC EXPERTISE

Although the role of aesthetic knowledge in expert work has been documented in various fields, it has been primarily investigated in research on creative occupations, such as product design (Stigliani & Ravasi, 2018), fashion design (Bazin & Korica, 2021), architecture (Ewenstein & Whyte, 2007), dance (Harrison & Rouse, 2015), and visual art (Wohl, 2021). Scholars have long recognized that members of creative professions utilize aesthetic knowledge to carry out expert work, such as developing new products, art pieces, styles, and buildings and interacting with their clients and peers while doing so (Baldessarelli et al., 2022).

Yet, senses and aesthetic knowledge are implicated in how all kinds of experts construct new knowledge, diagnose and treat cases, and claim their status as experts among peers and audiences. Therefore, it is warranted to discuss aesthetic expertise as distinct from – for instance – substantial and interactional expertise (Barley, 1996; Collins et al., 2007; Sandefur, 2015). On the one hand, aesthetic expertise entails the capacity to retrieve relevant qualities of the material environment through sensory judgments that are relatively uniform among an expert community such as a profession. On the other hand, aesthetic expertise highlights the organization of social and material environment that afford such judgments and differential sensitization to the material environment. Following field theoretical approaches (Bourdieu, 1984; Martin, 2003, 2011; Sgourev et al., 2023), we claim that these two aspects are correlative.

Below, we elaborate on the aesthetic perspective to expertise by detailing the role of the senses in expert work (see Table 2 for a summary). We organize our analysis of aesthetic expertise following three critical processes that constitute relational expertise: generation, application, and recognition (Pakarinen & Huising, 2023). First, sensory judgments elicit interactions within the assemblages through which expertise is generated. Second, experts utilize their senses to concretize, evaluate, and validate expertise in and through materiality (e.g., physical and digital objects, tools, technologies, and materials). Third, aesthetic knowledge and artifacts are resources to claim membership in expert communities and authority in audience interactions. Together, these three processes highlight how senses and aesthetic knowledge enact, shape, and mediate interactions within which expertise is generated, applied, and recognized. Table 2 summarizes the three processes, which we will detail below.

Generating Expertise Through the Senses

Experts work with and through materiality to generate expertise that emerges in an interactional relationship between experts and their material surroundings.

Table 2. How Aesthetic Knowledge Informs Expertise.

Process Informed by the Senses	Generation of Expertise Through Senses	Application of Expertise Through Senses	Recognition of Expertise Through Senses
The role of aesthetic knowledge	Sensory judgments connect interactants in the webs of relations in which expertise is generated. • Artifacts and the material environment shape expertise by conveying affordances, qualities, and organization • Experts generate expertise by using their senses to relate to, draw meanings from, and modify physical and digital objects, technologies, and materials	Experts apply expertise to cases and problems by utilizing, producing, and evaluating artifacts through their senses • Experts articulate, evaluate, and modify their expertise vis-à-vis cases and problems through sensory judgments of artifacts • Experts tailor outcomes of expertise to make them intelligible for patients, clients, and audiences by deploying aesthetic knowledge	Sensory judgments are used as a resource to claim membership in expert communities and authority vis-à-vis audiences • Membership in expert communities is claimed, demarcated, and recognized through relatively uniform sensory judgments drawing from experts' aesthetic knowledge developed through socialization • Experts use representations and performances to elicit recognition of their expertise
Examples	Scientists in particle physics tracking weak neutral currents use enlargement of photographs “so that the group as a whole could judge their validity” visually (Galison, 1987, p. 187) Scientists in laboratories generate expertise by modifying materials, specimens, and organisms through and for their senses by using radioactive substances and dyes (Rheinberger, 2023)	Weather and macroeconomic forecasters apply their expertise to particular forecast by working with simulation models that they evaluate and manipulate through their senses (Daipha, 2015; Pakarinen, 2019) Engineers, architects, and designers work with and through artifacts such as blueprints and 3D-models, and prototypes as they apply their expertise to a problem or a project (Boland et al., 2007; Henderson, 1999; Stigliani & Ravasi, 2012)	Code writers and hackers use shared sensory judgments of code to demarcate their community from that of managers they work for (Case & Piñeiro, 2006) Public presentations of sensory judgments, for instance by sommeliers, help claims of expertise when they interact with guests (Bosker, 2017)

For example, practitioners use their senses to draw information from materials, samples, instruments (Barley, 1996; Barley & Bechky, 1994; Bechky, 2021) and patients, bodies, and specimens (Craciun, 2018; Timmermans, 2006). They also use their senses to produce and manipulate representations and instruments of expertise (Carlile, 2004; Kaplan, 2011; Kaplan et al., 2016). For instance, forensic scientists visualize and diagnose bodily fluids by using chemical reagents and alternative lights (Bechky, 2021). Similarly, neuroscientists modify and transform specimens (e.g., brain tissue) through different steps constituting the “sensible, palpable, and tangible, and appreciable properties” of data (Lynch, 1985, p. 59). Furthermore, experts in economics, finance, and atmospheric science use simulation models to render their otherwise invisible objects of expertise visible and tangible (Daipha, 2015; MacKenzie, 2006; Pakarinen, 2019). In carrying out different tasks, experts interact with, interpret, and modify materiality through sight, hearing, touch, taste, and smell relying on aesthetic knowledge.

As experts choose and employ apt tools and materials by using their senses, they simultaneously generate expertise on the work itself and how to best conduct it. Once again, expertise is generated through the senses. For instance, fashion designers “craft in space” through trial and error informed by sensory judgments to manipulate garments (Bazin & Korica, 2021), supermarket employees as sales experts construct what pleasing displays should look like (Endrissat et al., 2015), and building inspectors generate knowledge concerning property owners’ code violations by observing buildings and objects around (Bartram, 2021).

As aesthetic expertise is generated through the senses, its generation depends on practitioners’ engagement with materiality and their prior experiences. On the one hand, an object will convey its purpose through what *gestalt* theorists call “demand character,” famously elaborated by Koffka as follows: “A fruit says, ‘Eat me’; water says, ‘Drink me’; thunder says, ‘Fear me’” (Koffka, 1935, p. 7). Demand character, further elaborated by Gibson (1971, 1979) in his concept of “affordance,” is “neither a subjective nor an objective property,” but it “points both ways, to the environment, and the observer” (p. 129) – that is, to the interaction between the two interactants. On the other hand, however, not all artifacts spur the same web of relations in actors because the relationship between the qualities of an object and the qualities of a sensory judgment is not the same for everybody (Martin, 2011; Martin & Merriman, 2015). Actors with different social positions such as memberships in different expert communities and prior experiences not only draw different conclusions but also have qualitatively different experiences (Martin, 2011). Therefore, experiencing artifacts that animate a given expert domain is an activity shaped by mastering historically constituted expert practices (Goodwin, 1994). To illustrate, very few can perceive a philharmonic hall as having “an antiseptic sound, very weak in the bass, with little color and presence,” as the music critic Schonberg (1974) did. Similarly, only experts can understand a flute maker’s “cryptic remarks, such as, ‘It doesn’t feel right’ or ‘this bit doesn’t look quite right,’” which lead to the rework of a flute to make it perfect (Cook & Yanow, 1993, p. 380).

In summary, aesthetic expertise is generated in and through relationships between experts and their material surroundings as they experience, interpret, and act upon the web of relations that materiality affords.

Applying Expertise Through the Senses

Experts' aesthetic knowledge informs the application of expertise to cases and problems, and to materially mediated interactions with audiences. Engineers and architects, for example, employ their senses to produce designs and work with drawings, sketches, and 3D models they then use to interact with other experts and clients (Ewenstein & Whyte, 2007; Henderson, 1999). Engineers and data scientists rely on their vision to build and maintain crypto market indices and monitor them for errors, malfunctions, and "strange cases" (Preda, 2025). Haute couture textile experts from ateliers assess new fabrics for potential inclusion in the upcoming collection by "trying the textiles out, touching, modeling and 'playing' with them" (Grand, 2016). Finally, physicians' touch and patients' physical responses, such as "the withdrawal of their gaze and the tightening of... facial muscles expressions," are fundamental in diagnosing pain in medical consultation (Heath, 1989, p. 123).

As practitioners carry out their work with and through artifacts, they evaluate, calibrate, and manipulate expertise embedded in materiality through their senses. In the application of expertise, professionals employ their senses to carry out daily tasks, such as sight to calibrate raw images taken by a rover on Mars to extract trustworthy data (Vertesi, 2015) or evaluate macroeconomic forecast simulation in search of anomalies and inconsistencies (Pakarinen, 2019) or even all senses – including taste to judge the porosity of clay – while making pottery (Brown et al., 2016).

When practitioners apply their expertise to develop expert outcomes, they do this in relation to the recipients of their expertise – patients, peers, clients, and the general public – for whom experts seek to translate expertise and its outcomes understandable and valuable. Experts draw from their aesthetic knowledge to make their artifacts of expertise intelligible to relevant audiences (Anteby & Holm, 2021; Barley, 2015; Bechky, 2021). To this end, experts leverage their sensory judgments to anticipate and understand the needs and sensibilities of their audiences and infuse material outcomes with understandable and resonating properties and style (e.g., Bapuji et al., 2019; Barley, 2015; Golden & Bencherki, 2023). For example, architects and strategists craft PowerPoint presentations to visually introduce and validate an idea over alternatives across audiences (Kaplan, 2011; Stark & Paravel, 2008). Designers develop easy-to-understand prototypes to aid clients in their task of judging their designs (Stigliani & Ravasi, 2012), and atmospheric scientists produce data representations to communicate effectively with their clients (Barley, 2015).

Collectively, therefore, the application of expertise through the senses entails the deliberate use of sensory judgments to solve cases and problems, and to produce outcomes anticipating and resonating with recipients' needs, and aesthetic understandings and sensibilities.

Recognizing Expertise Through the Senses

Sensory judgments on the qualities of objects drawing from the use of aesthetic knowledge are utilized as resources to claim membership in expert communities – typically professions – and to demarcate experts from non-experts. Similarly, aesthetic knowledge and material representations of expertise are leveraged to eliciting general expert authority and recognition among audiences.

Expert communities share values, skills, and characteristics that bind members together (Abbott, 1988; Anteby et al., 2016; Cattani et al., 2013; Van Maanen & Barley, 1984). Within these communities, membership claims emerge through socialization taking place through training and participation in the core activities of the community (Kroezen et al., 2021; Van Maanen & Schein, 1977). Through training and participation, members develop relatively uniform aesthetic knowledge, as capacity, to judge what is credible and worthy (Lave & Wenger, 1991). For example, through socialization into an expert regime designed to foreground particular habits of judgment, weather forecasters become “‘intuitively’ drawn to and developing a taste for particular data and problem solutions” (Daipha, 2015, p. 96). Similarly, apprentice flute makers learn the skill by sitting at a workbench and producing flutes that they then show to experts for review (Cook & Yanow, 1993, p. 380). What’s more, through socialization, “an apprentice ... both acquires a set of skills in flutemaking and become a member of the informal quality control system that has unfalteringly maintained the style and quality of these instruments” (Cook & Yanow, 1993, p. 380).

Aesthetic expertise is, therefore, correlative to a specific social group and, hence, affords one to claim membership (Cattani et al., 2013; Martin, 2011; Wohl, 2015) and the authority to assert “right” interpretations of artifacts (Bechky, 2003). Relatively uniform sensory judgments constitute “disciplinary objectivity” that relies on “the artful application of insight that comes only with learned experience among peers” (Timmermans, 2008, p. 170). For example, in creative fields, what is described as having a “good eye” or a “strong vision” is tied to the expert community and its standards (Godart & Mears, 2009; Wohl, 2021). Through uniform sensory judgments, practitioners reveal their membership to a particular community while simultaneously demarcating group boundaries by assessing such judgments (Bourdieu, 1984; Martin & Merriman, 2015; Wohl, 2015). Citing Arendt ([1961] 2006), Wohl (2015) explains that “taste decides not only how the world is to look, but also who belongs together in it” (p. 304). Aesthetic knowledge, therefore, is implicated in how members define an “us” versus “them” (Wohl, 2015). This is also exhibited in how members engage in the public display of their membership, such as by following specific dress codes (Kachtan & Wasserman, 2015; Pratt & Rafaeli, 1997), manufacturing public performances (Preda, 2023), and creating and displaying symbols (Ravasi et al., 2019).

Alongside demarcating experts from non-experts, practitioners use aesthetic knowledge as a resource when interacting with audiences. Experts persuade audiences of their expertise by using representational artifacts (such as visual metaphors, presentations, and prototypes) that invoke particular experiences. As Latour (Latour, 1986, p. 5) emphasizes: “We need, in other words, to look at the

way in which someone convinces someone else to take up a statement, to pass it along, to make it more of a fact.” To this end, experts develop engaging and convincing representations of their work that are intended to generate recognition among audiences. Such representations go beyond the translation work necessary to interact with clients and patients; they encompass verbal and material representations meant to invoke particular sensory reactions and persuade the audience of their authority and the value of their expertise. For example, quantum physicists employ visual metaphors and analogies to communicate their expertise and even arouse awe and astonishment in the audience (Hilkamo & Granqvist, 2022), and designers utilize appealing prototypes and films to influence their clients and collaborators and to elicit recognition for their design expertise (Pakarinen, 2024). Going even further, some experts develop dramaturgical representations of their expertise to create and maintain recognition of their position as experts. For example, financial experts make a “spectacle” of their expertise on TV to ensure the audience’s recognition of their claims (Preda, 2023), while shop assistants and models must “look good and sound right,” that is, perform “aesthetic labor” to persuade clients of their expertise (Mears, 2015; Witz et al., 2003).

Collectively, aesthetic expertise correlates to the domain in which experts mutually define which sensory judgments are valid and credible. Hence, these judgments retrieve not only information about objects but about experts’ position and membership in the domain (Martin, 2011; Martin & Merriman, 2015). In addition, experts produce representational outcomes used as resources to claim recognition among external audiences and to persuade them about the value of their expertise.

CONCLUSION

We began our quest by highlighting that while studies on expert work empirically document the use of senses (Barley, 1996; Bechky, 2021; Rostain & Huising, 2024), these observations have been largely disregarded in theorizing expertise. To call for greater attention to and appreciation for the role of the senses, we introduced an aesthetic perspective to the study of expertise. We argue that attending to aesthetic expertise inherent to expert work can enrich the scholarly conversation on expertise because sensory judgments mediate and elicit the webs of interactions in which experts accomplish their tasks and claim their expertise.

To this end, we have elaborated three ways aesthetic knowledge participates in the relational generation, application, and recognition of expertise. These three ways aesthetics is implicated in expert work contribute to the research on expertise and organizational aesthetics. First and foremost, while we acknowledge that the use of senses has been reported in the empirical findings of studies on expert work, we take a step forward and elaborate on the multifaceted role of aesthetic knowledge. We disentangle aesthetic knowledge from other forms of practical knowing, that is, embodied and tacit knowledge. We also draw attention to how experts use cultivated sensory judgments vis-à-vis the material environment (e.g., physical artifacts, digital tools, technologies, and visual representations) to enact

their expertise and how such use is derived from and regulated by the expert community. Interactions and relations that make up expertise are developed and sustained through the senses by invoking particular experiences and translating them into effective representations for relevant audiences.

These insights add to the scholarly conversation on expertise by highlighting how aesthetics is entwined with expertise, from its generation to recognition, and with the effects expertise generates in society. First, we point to the importance of accounting for the sensory faculties of individuals (Strati, 2007) and connecting them to interactions and social practices constituting expertise. Second, we highlight that aesthetics is implicated in how expertise is structured, recognized, and occasions effects. This is evident in the following example, which illustrates the role of aesthetics in the network of expertise, leading to a worldwide ban on whaling. Scientists changed public experience and appreciation of whales by utilizing recordings of the “surprisingly beautiful sounds” or “singing” of whales, captured by hydrophones initially designed for detecting submarines (Payne & McVay, 1971). These recordings and experiences led to the “Save the Whales” campaign, which ultimately resulted in a ban on whaling worldwide (Burnett, 2012).

Alongside the contribution to the study of expertise, our article serves as a reminder for those interested in aesthetics (BaldeSSarelli et al., 2022; Strati, 1992; Taylor & Hansen, 2005) that cultivated sensory judgments are pivotal in different domains beyond creative professions. First, we bring to the fore the role of aesthetic knowledge in a vast range of professions that, at first glance, might seem to have little to do with the senses. In this way, we remind ourselves and others that sensory judgments are involved in the day-to-day work of scientists, engineers, technicians, physicians, and many others. Second, we connect the work on aesthetics to discussions on expertise. This body of research suggests that sensations and aesthetic knowledge are situated in social practices and relations within specific domains of expertise in which credibility and meanings are negotiated. As such, aesthetic knowledge is relational (Sgourev et al., 2023), encompassing situated material practices and the broader webs of relations among communities of experts and their audiences.

Future Research

Thus far, we have stressed the need to systematically examine how experts interact with materiality through their senses and have elaborated three ways aesthetics contributes to generating, applying, and recognizing expertise. Specifically, we believe that scholars of expertise would benefit from productive conversations with adjacent empirical and theoretical discussions. Below, we outline a research program by detailing some promising future directions.

First, we anticipate research that explores in detail the pivotal role of aesthetic expertise in expert work and that creates empirically sound and theoretically insightful links among senses, work practices, and the webs of relations in which expertise resides. For example, researchers could theorize practices and assemblages through which experts deliberately call upon their sensory judgments to manipulate, interact, and monitor materiality. Moreover, researchers

could explore how the material environment and its affordances reciprocally shape expertise. Finally, researchers could identify and theorize the relationality of aesthetic expertise both in situated expert work (Barley & Bechky, 1994) and broader ecologies of expertise (Kuriyama, 1999; Sgourev et al., 2023; Tan, 2024).

Second, beyond deepening our understanding of how aesthetics informs expert work, we must understand how different modes of embodying expertise interact with aesthetic knowledge. Especially when expertise is increasingly embodied in organizations and technologies such as models, data spaces, interfaces, and platforms, instead of groups of experts (Abbott, 1991), we must understand how sensory judgments connect, integrate, and translate expertise in these increasingly heterogeneous assemblages. For example, research suggests that as models and algorithms take on an increasingly pivotal role in the chains of inferences through which expert outcomes are produced, experts' tasks increasingly focus on validating, supervising, and translating the outcomes (Anthony, 2021; Lebovitz et al., 2022). In such tasks, experts are likely to rely increasingly on sensory assessment and judgments.

Third, the technologization and hybridization of sense-induced experiences, as well as increased attention to nonhuman ecologies, force us to reconsider what counts as sensorial. New sensor technologies, such as sensors detecting and recording motion, temperature, stress, and biometrics, as well as digital online trackers, are shifting sensing from the human realm to a configuration of humans and more-than-humans (Gabrys, 2019). For example, sensing in oceanography is changing from ship-based sensing to satellites and remotely operated or automatic vehicles (Lehman, 2018); risk assessment in policing is changing from experience-based to data-driven knowledge (Brayne, 2020); and audience metrics increasingly determine the "newsworthiness" of events and phenomena (Christin, 2018). These examples suggest that researchers should explore how material mediation (McLuhan, 1964) and more-than-human assemblages may (re-)constitute sensory judgments, thus shaping expertise.

Fourth, the questions above suggest we need to revise our methodological approaches to study expertise. An essential method to capture sensory judgments and their role in expert work is the systematic observation of practitioners' interactions with the web of relations. Yet, as the ethnographic tradition relies so much on words (Mead, 1975), we must develop new means and sensibilities to observe, record, analyze, and communicate sensory judgments around expertise. The use of audiovisual methods, such as photographs and film (video), could be valuable in capturing sensory judgments and knowledge, or at the very least, the material environment and practices in and around work and expertise (e.g., Bateson & Mead, 1942; Pink, 2007; Toraldo et al., 2018). Also, systematically examining codified representations of expertise in archives (e.g., Henderson, 1999; Kuriyama, 1999) could help researchers link experiences to broader networks and institutions of expertise. Furthermore, new computational methods and technologies, such as computer vision (Brachmann & Redies, 2017), could enable researchers to capture both representations and the employment of aesthetic expertise beyond situated settings to broader scales.

NOTES

1. <https://www.etymonline.com/word/aesthetic>
2. “Die Ästhetik (als Theorie der freien Künste, als untere Erkenntnislehre, als Kunst des schönen Denkens und als Kunst des der Vernunft analogen Denkens) ist die Wissenschaft der sinnlichen Erkenntnis” in Baumgarten (1750), *Aesthetica*, page 2.

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LEARNING TO SEE: HOW SCIENTISTS DEVELOP PROFESSIONAL VISION AND DECOMPOSITION EXPERTISE

Elina I. Mäkinen

Tampere University, Finland

ABSTRACT

Professional vision refers to the shared practices by which members of a profession see and discursively articulate phenomena in their perceptual field. Extant research has paid limited attention to how professional vision is learned. Analyzing journal club meetings in academic science, this qualitative study asks, what are the practices by which early-career scientists learn professional vision and, as part of this learning process, what expertise do they develop? The findings show, first, how scientists engage in ambiguous reporting through which they communicate an article's knowledge claims to other research group members. Next, scientists collectively engage in critical deliberation through which they identify and evaluate the article's specific components, namely, its visualizations and analytical tools. Finally, scientists engage in self-centering the critical gaze aiming to reflexively relate the components of the article with their own ongoing research. These findings contribute to professional vision and expertise research by detailing the steps through which professional vision is learned and by demonstrating how in the process decomposition expertise is developed. Decomposition expertise

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enables professionals to break down the products of their work into individual components, assess each part, and evaluate how the components come together to form the whole. In academic science, decomposition expertise is critical for recognizing questionable analytical approaches and knowledge representations, detecting mistakes and misconduct, and enhancing efforts to make important contributions to the field.

Keywords: Professional vision; expertise; representations; socialization; scientists; research groups

INTRODUCTION

The notion of professional vision was initially developed by a linguistic anthropologist, Charles Goodwin (1994), who defined it as the shared practices by which members of a profession see and articulate phenomena in their perceptual field. Professional vision thus encompasses not only the group's practices of seeing but also their vocabularies and discursive practices used in the articulation of what they see (Comi et al., 2019; Gegenfurtner et al., 2019; Goodwin, 1994; Styhre, 2011). Empirical research on professional vision has focused on identifying the practices of seeing and articulating of different communities, such as architects (Styhre, 2011), embryologists (Arman & Styhre, 2019), airport security professionals (Bassetti, 2021), and science press officers (Samuel et al., 2017). This research has shed light on how professionals use professional vision in their everyday work and in collaboration with their colleagues.

The question of how professional vision is learned, however, has received limited attention in extant research. Some scholars have studied how professionals demonstrate and explain their practices of seeing to members outside of their professional community. As a case in point, Gegenfurtner et al. (2019) analyzed how radiologists explained to education researchers how they viewed and worked with x-ray images. There are only a handful of studies that consider how new members of a profession develop professional vision within their communities (Goodwin, 1994; Grasseni, 2004; Hindmarsh et al., 2011). Findings from these few empirical studies – conducted in archeology, cattle breeding, and dentistry – suggest that professional vision is mainly learned in interactions in educational settings or in master-apprentice relationships.

Considering the extent to which experts across industries and professional domains depend on visual expertise to get their work done (Styhre, 2011; Styhre & Gluch, 2009), we have a surprisingly limited understanding of how professional vision is learned in professional communities. This is puzzling especially as professional vision is growing in importance due to heightened technological change and increasingly complex knowledge representations (Gegenfurtner et al., 2019). Therefore, we need detailed empirical studies that reveal how professional vision is developed in different contexts of work.

This study aims to advance research in this area by illustrating how members of a profession develop visual expertise required in their field of work.

The learning of any skill spreads across different work interactions, settings, and tasks. In academic science, which the present study focuses on, when novice scientists begin their PhD studies and join research groups, they gradually learn skills that are critical for becoming an expert in their field. They learn through education, mentoring, conferences, and varied research group activities, such as journal club and lab meetings. This study zooms in on journal club meetings, which are an example of a traditional, institutionalized practice through which novice scientists are socialized and educated in scientific fields. The scientists engage with the published work of other scientists and through this engagement learn to read, critique, and evaluate scientific work. Analyzing findings from such meetings, the study asks, what are the practices by which novice scientists learn professional vision, and as part of this learning process, what expertise do they acquire?

The findings show how in journal club meetings, a novice scientist first engages in *ambiguous reporting* through which they communicate to other research group members their understanding of the discussed article's knowledge claims and supporting evidence. This is followed by *critical deliberation*, where scientists work together to identify and evaluate specific components of the article, namely its visualizations and analytical tools. Finally, scientists engage in *self-centering the critical gaze* which allows them to reflexively relate the components of the article with their own research thus deepening their learning and ability to use professional vision.

Taken together, these findings contribute to professional vision and expertise research by detailing the steps through which professional vision is learned and by demonstrating how in the process a unique form of expertise is developed. *Decomposition expertise* enables professionals to break down the products of their work into individual components, assess each part, and evaluate how the components come together to form the whole. Decomposition expertise is developed within professional communities where members with varied levels of experience interact, discuss, and share their expertise in relation to the products of their work. In the context of academic science, decomposition expertise is critical for recognizing questionable analytical approaches and knowledge representations, detecting mistakes and misconduct, and enhancing efforts to make important contributions to the field.

THEORETICAL BACKGROUND

Professional Vision

Professional vision refers to a specific way of seeing that is embedded in professional identities, values, training, and everyday work experience (Goodwin, 1994, 1995; Styhre, 2010). The concept allows for analyzing “how seeing is interpersonally, materially, and epistemically mediated by tools, people, and discourse in socially organized visual practices that are lodged within particular (professional) communities” (Gegenfurtner et al., 2019, p. 281; Goodwin, 2017). Professional vision thus denotes practices of seeing and articulating meaning it should be perceived as “a socially situated activity accomplished through discursive practices”

(Comi et al., 2019, p. 93; Gegenfurtner et al., 2019; Goodwin, 1994). Accordingly, Styhre (2011, p. 254) argued that in any knowledge-intensive work, authority and jurisdiction over a field of expertise require that members of a professional community transform themselves into “speaking eyes,” meaning that they must learn “a repertoire of visual practices” as well as their accompanying vocabularies. Professional vision can also be perceived as a form of hybrid vision in the sense that it integrates different practices such as seeing and saying, as well as gesturing and manipulating visual objects (Styhre, 2010).

According to Goodwin (1995), professional vision is not an individual or innate skill; rather, it is based on collective agreements and acquired through training and actual practice. Professional vision is learned through education and work experience among a community of practitioners and it denotes the disciplined and standardized gaze of that community (Goodwin, 1994, 1995; Styhre, 2010). Using professional vision appropriately may sometimes require efforts from a broader community of professionals checking and assessing each other’s work, as Arman and Styhre (2019) showed in their study on embryologists and clinics working together in the context of in vitro fertilization. While professional vision highlights the collective qualities of seeing and articulating, it includes the idea that such practices can also be contested, that is, members of a group may articulate the things they see in competing ways (Comi et al., 2019; Goodwin, 1994). This is especially likely in multidisciplinary collaborative work where experts have different ways of seeing but where they seek to develop a shared professional vision to get their work done (Comi et al., 2019).

In an effort to identify practices associated with professional vision, Goodwin (1994) conducted empirical research among archeologists and court professionals. He showed how archeologists studied excavated dirt to see traces of ancient civilizations and how lawyers in court used forensic evidence to make claims as part of their defense strategy. Goodwin (1994) found that professional vision allows members of a profession to *codify* what is being inspected, for example, architects can use standardized coding schemes to analyze and make judgments about a patch of dirt. They can also use professional vision to *highlight* important aspects of what is being inspected. In their testimonies in the Rodney King trial, expert witnesses translated a video depicting the beating and while doing so, highlighted certain physical cues arguing that the police officers’ actions were within the realm of accepted professional practice. Finally, based on these practices of codifying and highlighting, members of a profession can *articulate* or *produce material representations* of what is being inspected (Goodwin, 1994).

A growing number of studies in fields such as anthropology, sociology, and education have relied on professional vision and Goodwin’s (1994) earlier findings to detail similar practices in other contexts of work (e.g., Bassetti, 2021; Gegenfurtner et al., 2019; Samuel et al., 2017). Studying science press officers, Samuel et al. (2017) discovered how these professionals articulated and produced material representations of biomedical research so that they could sell its promise and build hype as well as do so according to the standards of responsible research. In doing so, science press officers engaged in highlighting some aspects of biomedical discoveries while downplaying others. In the collaborative

accomplishment of airport security work, screeners and other security professionals working by the monitors engaged in tacitly showing and highlighting to one another objects that needed to be checked preferring embodied action over verbal interaction (Bassetti, 2021). These examples from different contexts of work demonstrate the power of professional vision, as it allows professionals to shape how objects of inspection are represented, examined, and discussed.

Learning to See

Developing professional vision is a learning process and a critical part of becoming a recognized member of a professional community. As Goodwin (2013, p. 9) noted, full members of a professional community face “the task of building new members who can be trusted to see, understand and act upon the world in relevant ways.” To learn to see like an expert, novices must go through extensive training “to be able to make credible accounts of what is seen” (Arman & Styhre, 2019, p. 385). In his ethnomethodological study on architectural education, Lymer (2009) argued that critique from full members of a professional community is one key component of how newcomers acquire expertise such as professional vision. When assessing students’ presentations of their work in the so-called critique sessions, critics “enact a set of disciplined visual practices through which architectural qualities become available for competent remark” (Lymer, 2009, p. 167). These examples highlight the collective aspect of learning professional vision, as the community is required to take part in how the skill is developed, disciplined, and maintained over time (Arman & Styhre, 2019; Hartswood et al., 2002).

Some studies have sought to advance knowledge on professional vision by analyzing it in contexts where professionals teach and explain what they see to laypeople. For example, Carlin et al. (2021) studied an astronomy education session where an astronomer at an observatory instructed a young boy and his mother to use a telescope and see sunspots against the background of the Sun. Gegenfurtner et al. (2019) in turn analyzed interactions in an interdisciplinary collaborative setting where radiologists explained to education researchers how they produced diagnoses with chest x-ray pictures. As such findings zoom in on the professionals’ attempts to explain to outsiders of their community what they see, their ability to shed light on how professional vision is actually taught and learned in professional communities is limited.

There are few studies on learning processes in settings such as apprentice relationships and classrooms, where new members of a profession encounter professional ways of seeing and articulating when interacting with full members (Goodwin, 1994; Grasseni, 2004; Hindmarsh et al., 2011). While such studies center on different practices through which professional vision is taught and learned (e.g., demonstrating, presenting, giving feedback), they all highlight the distinct roles of a newcomer and a full member (Goodwin, 1994; Grasseni, 2004; Hindmarsh et al., 2011). That is, a novice must rely on the full member to learn the professional ways of seeing and articulating which are relevant for their community.

In his study on archeologists, Goodwin (1994) demonstrated how an experienced archaeologist used tools, speech, and gestures to show to students how

they should recognize and interpret archaeologically salient phenomena in the dirt they were studying. Drawing on conversation analysis and studying how professional vision is acquired in interactions between an expert and an apprentice, Hindmarsh et al. (2011) analyzed training in dental clinics where students were working on patients that had dental problems and in the process were supervised by “demonstrators.” The students presented their thinking and working to dentists who then inspected the same patient and explained what they saw and how this “seeing” related to a proposed treatment plan. While doing so, students were looking into the patients’ mouth over the professional’s shoulder to see if they were able to see what the professional claimed to see. Grasseni (2004) studied professional vision in cattle breeding distinguishing the ways in which professional vision is learned in informal and formal settings. On family farms, cattle breeders learned to recognize cows, analyze their physical form, and assess their health in their local community and in everyday interactions with the animals. As a more institutionalized skill, breed inspectors and breed experts acquired professional vision which was associated with evaluating cows and reporting their judgment of the animal on paper or in electronic forms as part of formal cattle evaluation.

Despite these findings, we have limited understanding of the steps through which members of a profession develop professional vision within expert communities. It is important to advance research in this area as professional vision is growing in importance across knowledge-intensive industries and professional domains. Gegenfurtner et al. (2019) noted that as many professions experience heightened technological change, this will impact practices of seeing and articulating, potentially increasing ambiguity and disagreement over what experts claim to observe. These effects are already visible in academic science, where the methods and tools for creating effective knowledge representations are becoming increasingly sophisticated and complex (Dumit, 1999; Peterson, 2015; Vyas, 2013). In such contexts of expert work, it is crucial to advance our understanding of how novices acquire professional vision.

DATA AND METHODS

Research Setting

The article is based on a qualitative study of a research group in genetics, aiming to understand scientific work and communities and the training of early-career scientists. I came across the group, which focused on genomics, when conducting a larger study on transdisciplinary science in a research-intensive university in the United States. The professor, who led the group, participated in the research efforts I was studying, and in one of our conversations, I suggested it would be valuable for my work to familiarize myself with some cases of disciplinary research practice. Consequently, she welcomed me to observe her research group, which I started in January 2012 and continued to do so until the end of the year.

The research group: The group was a small, closeknit community that included the professor, a postdoctoral researcher (Bertha), and three doctoral students (Doug, Annie, and Keith). Adjacent to this core research group, there was a

handful of researchers (two doctoral researchers and two postdoctoral researchers), who participated in the group's lab meetings, but were formally advised by another professor, who had recently left the university. In addition, the group's research was supported by a lab manager and a research assistant.

This study analyzes the core research group which included the professor, Bertha, Doug, Annie, and Keith. Bertha was a postdoctoral researcher who was quite advanced in her career and looking for an academic job. The doctoral students were at different stages in their programs and thus had varied levels of expertise; one graduated during the observation period and started to look for an academic job (Doug), one was halfway through her studies (Annie), and one was doing the required lab rotations as part of the first-year studies (Keith). In their scientific work, the group of researchers sought to understand placental cell development in different species. While I often refer to them collectively as early-career scientists in the analysis, they had varied levels of experience and expertise, which also evolved during the 12 months I spent observing the research group.

Roles within the research group: Every group member had a role to play in their production of scientific knowledge. As has been described elsewhere on the organization of science labs (e.g., [Owen-Smith, 2001](#); [Rushforth & de Rijcke, 2015](#)), the professor was in charge of applying for research funds and overseeing the work of the group. As a faculty member, she was teaching, advising, attending faculty meetings, and traveling. The postdoctoral researchers focused on bench-work and analyses, writing up papers, and applying for fellowships and academic jobs. The doctoral students attended courses but were also engaged in research and finishing their PhD work. The lab manager and research assistant tried to support everyone's work by for instance ordering materials and helping with experiments and analyses. Similarly to other studies on scientific research groups (e.g., [Owen-Smith, 2001](#); [Rushforth & de Rijcke, 2015](#)), the genomics group engaged in collaborative work and co-authored publications. Traditionally the first author was the person who led the research work and often produced the main figures for a paper. The other authors contributed somewhat less, and the professor was usually the last author on the paper.

Despite these roles, the lab maintained an easygoing, low-hierarchy environment where the early-career scientists enjoyed close, informal relationships. They supported one another and frequently discussed how they could assist each other with experimental work, job talks, and grant proposal writing. They often talked about sharing data and analyses, if someone needed evidence for their work that others already had. Even their interactions with the professor seemed easygoing and I could not sense tension or fear, which are characteristics associated with high-status research groups. When I asked a doctoral student, Doug, to describe their lab culture, he told me that before joining the group, he was in another one which he described as "a very rough environment" where "micromanagement, aggressiveness, and competition" were commonly experienced. His reason for joining the genomics group related to its easygoing, low-hierarchy culture and the professor's respect for the students. He described the different lab cultures he had experienced in an interview:

For me, I thought I just couldn't see myself being there [the other lab] for very long. It was way too intense, and some advisors are very condescending and insulting towards their students. I feel like [the former adviser] didn't respect the students very much, whereas [the current adviser] was the complete opposite of that. She was completely respectful of my individuality and doing what I want.

Organization of scientific work: The research group I studied, much like other laboratory studies have shown (e.g., [Delamont & Atkinson, 2001](#); [Owen-Smith, 2001](#); [Rushforth & de Rijcke, 2015](#)), relied on varied organizational routines that structure the training of doctoral students, scientific work, and lab operations. In this context, such regularly organized activities were the lab meetings, the journal club meetings, and one-on-one meetings with the professor and the doctoral and postdoctoral researchers. The lab meetings provided an opportunity for early-career scientists to present their work-in-progress and receive feedback from other group members. The purpose of the journal club meetings was to study and debate the published research of other scholars. Finally, the one-on-one meetings with the professor provided early-career scientists the opportunity to discuss their progress in the PhD program, graduation timeline, career opportunities, publications, fellowships, and any other personal concerns they wished to raise. While I collected some data on all these organizational routines, as I explain next, the present study zooms in on journal club meetings as an important context in which professional vision is acquired.

Data Collection

Over the course of one year, I observed and audio-recorded 19 journal club meetings (in total 34 hours) and nine lab meetings (in total 14 hours). I was also allowed to observe and record four adviser–advisee meetings between the professor and the group's early-career scientists. In addition, I conducted four semi-structured interviews, each about 60 minutes, that were recorded and transcribed (professor, Bertha, Doug, and Annie) as well as several short in-situ conversations to better understand the group's work ([Hammersley & Atkinson, 2007](#)). These short interviews or conversations were not recorded and transcribed, but they were reported in the fieldnotes. Throughout the year, I had several opportunities to become familiar with the group's work, as the early-career scientists kept me informed about ongoing activities. For instance, Bertha invited me to observe her benchwork one day and introduced me to the tools, machines, and her lab book. Similarly, Doug asked me to attend his practice job talk before he graduated, as well as his dissertation defense and graduation celebration with research group members and his family.

While all these activities and events were crucial for developing an overall understanding of the group and its work, I became particularly interested in the journal club meetings. The meetings were organized every two weeks during the academic year in a small seminar room. The scientists selected and presented published papers to other group members and then engaged in discussions and debates aimed at making sense of the articles' findings. In these meetings, the process of developing professional vision through different practices caught my

attention and piqued my interest in studying these practices further. More so than the lab meetings, the journal club meetings revealed collective efforts, where everyone with varied levels of expertise was involved, to articulate what they saw in the papers and then to make inferences about it. While professional vision is acquired in different contexts of work, the journal club was an accessible setting for studying scientists' ways of seeing and articulating.

Therefore, the primary source of data includes audio-recordings, transcripts, and observation notes from 19 journal club meetings. In the findings, I draw on the other mentioned data sources (e.g., interviews, lab meetings), when they allow me to bring more nuance to the analysis. Each journal club meeting lasted for about 1 hour and 45 minutes, the length of meeting transcripts varied between 38 and 49 pages. The regular attendees were the early-career scientists – Bertha, Doug, Annie, and Keith – while the professor attended about two-thirds of the meetings. When she was present for a meeting, she did not present a paper, only engaged in debating the discussed studies. The data on the journal club meetings are supported by the published papers that were discussed in each meeting (usually two publications per meeting). The group's shared and somewhat niche research interest – placental cell development in different species – directed their choice of papers.

Data Analysis

As I had a broad aim in mind when starting to observe the work of the genomics group – wanting to study scientific work, communities, and training in disciplinary contexts – I approached the data inductively (Charmaz, 2006; Miles & Huberman, 1984; Strauss & Corbin, 1998). Although the analysis presented here developed iteratively moving between coding the data, writing analytical memos, and reading relevant literature, the analytical process consisted of three main phases.

First, I started the analytical process by listening to the meeting recordings along with reading the transcripts and observation notes to get a sense of a typical journal club meeting, that is, how was the meeting structured, what were the different activities and phases through which the meetings developed, and how different participants participated. From this, I identified three main phases: reporting (a scientist gives an account of the paper they have selected and studied), deliberation (the whole group assesses the findings and claims), and relating what was learned to one's own ongoing research (scientists discuss their own experiments and results in light of the published study). These three phases repeated from meeting to meeting and generally in the same order. Importantly, the scientists' discussions throughout these different phases were largely centered on how the analyses were conducted and how the findings were presented.

In the next analytical stage, I went through all the data again but now analyzing more carefully interactions and discussions concerned with analyses and visual representations. As I had collected the published papers, I was able to simultaneously consider the meeting discussions and the scientific papers' figures and graphs. Consequently, I was able to examine the discursive practices and the

group's conceptual vocabulary in relation to the articles and thus better develop an understanding of how professional vision is practiced and demonstrated in a natural context. I reconsidered each of the previously described three phases of the meetings by identifying, grouping, and analyzing examples from the data, where the scientists were discussing analyses and visual representations.

Over the course of the analytical process, professional vision became salient for my effort to explain and theorize the findings. I was reading on professional vision and how this expertise is learned in professional communities. As a result, the final analytical stage, which involved moving between organizing the data and reviewing the literature, redefined the practices by which professional vision is learned in journal club meetings. These practices became the main analytical categories: (1) ambiguous reporting, (2) critical deliberation, and (3) self-centering the critical gaze.

LEARNING TO SEE LIKE AN EXPERT

The findings of the study detail how professional vision is learned through three specific practices. The journal club meetings began with an individual practice of seeing, *ambiguous reporting*, where an early-career scientist independently studied a selected article and then gave an account of its knowledge claims and supporting evidence to other scientists. Next, the scientists collectively engaged in *critical deliberation*, where they learned to recognize and critique the article's components such as visualizations and analytical tools. Finally, the early-career scientists engaged in *self-centering the critical gaze*, which allowed them to reflexively relate components of the discussed article with their own research and thus find ways to advance their work. Through this learning process, scientists developed what I call *decomposition expertise*. It refers to the ability to break down the products of professional work, such as scientific articles, into individual components, assess each part, and evaluate how the components form a cohesive whole.

Ambiguous Reporting

When a scientist, either a doctoral student or a postdoctoral researcher, chose a paper to be presented and discussed, they read the study carefully with the aim of developing an understanding of its aims, methods, analyses, and conclusions. At the start of every meeting, the scientists engaged in *ambiguous reporting* giving uncertain accounts of the discussed paper's main ideas, which suggested they struggled to fully comprehend the paper's knowledge claims and supporting evidence.

For example, on her turn to present a paper, a doctoral student, Annie, had selected a paper that was published in *PNAS* (Proceedings of the National Academy of Sciences), a highly respected journal, where the authors examined embryonic stem cells, trophoblast stem cells, and extraembryonic endoderm stem cells in the mouse. Annie was a confident doctoral student about halfway through her doctoral studies, but when presenting her understanding of the paper's main point, she hesitated.

Let's see. I mean I guess what their own story is that in general you have K9 trimethyl, it's there in these undifferentiated cells, so that the extraembryonic ectoderm I think is what they consider sort of undifferentiated TS cells, and they show if there's K4 trimethyl and K9 trimethyl, but then they went to the more differentiated population. They show less K9 trimethyl, but then they show that there is like K27 trimethyl, so like it's not like K27 is not in the placenta. It just seems like it's not in these TS cells like preimplantation, but they speculate that maybe K27, you know, becomes important later on.

When giving a summary of the paper's main findings, Annie's tone was uncertain and there was hesitation in her voice. She repeatedly used expressions such as "I guess" and "I think." While she could specify *what* the authors found in the different cell lines, her account suggested it was difficult to understand the reasoning behind these findings. As such, she referred to the authors of the study by saying "their own story" and "they speculate." These hesitations suggested that the authors' efforts to support a particular "story" with certain evidence (e.g., analyses, figures) was not thoroughly convincing to Annie.

Similar tone and expressions were present when Doug, an even more experienced doctoral student than Annie, reported on a paper that analyzed cell development in human and mouse placenta. As can be seen below, expressions such as "I guess maybe" and "this paper is trying to" are present suggesting that reporting on the knowledge claims and the supporting evidence was difficult. Similarly to Annie, Doug tried to connect the reported analyses to a particular scientific narrative.

Okay, so there are these two genes, syncytin-1 and syncytin-2, that are expressed in human and in mouse placenta. They are required to queue fusion of human trophoblasts, and so instead of giant cells, or I guess maybe in addition to giant cells. The human placenta has these multi-nucleus cells called syncytiotrophoblasts and they require syncytin-1 and syncytin-2. There are all of these other endogenous retroviral elements that are also expressed in the placenta, and so this paper is trying to get out a molecular analysis and a functional analysis of two of those: NVV and NPB.

Due to these hesitations to explicate the scientific narrative of a given paper, the presenters often indicated that there was a need for the whole research group to engage in assessing the discussed article. On one such occasion, Doug addressed the group when giving an ambiguous report on the storyline of a paper that discussed insulin imprinting among wallabies.

Doug: Let's see. I guess their main thing is that imprinting, it's specific to marsupials and eutherians, so a large part of this marsupial group is just to compare the differences in imprinting between marsupials and eutherians, and try to understand what are the forces that led to its evolution. What I thought was interesting though, which I don't really understand, is the traditional view of how imprinting evolved is like parent-offspring, right. [...] A lot of the imprinting papers, they're all talking about this co-adaptation hypothesis instead of like alternative hypothesis of imprinting. Do you know about that? I don't really – it doesn't make sense to me.

Annie: I feel like it's – as best as I can explain, it's another way of saying the same thing.

Doug: But it's not like they're saying that maternal and fetal interests are – the imprinting is to drive rapid fixation of maternal and fetal, like, optimal.

Annie: Hmm. Okay.

Doug: See, it doesn't make sense to me. I don't really –

Annie: It doesn't make sense.

Here, Doug began ambiguous reporting with the expression “I guess their main thing is” followed by his understanding of the scientific narrative: “imprinting, it's specific to marsupials and eutherians, so a large part of this marsupial group is just to compare the differences in imprinting between marsupials and eutherians, and try to understand what are the forces that led to its evolution.” This account was followed by an assessment of what he found to be confusing, although interesting, concerning two evolutionary hypotheses the paper discussed. While ambiguous reporting was typically an individual practice, in the middle of his account, Doug turned to the other journal club participants asking if they were aware of these different hypotheses. Annie took part in the conversation although they both concluded that they still found the discussion of the different evolutionary hypotheses confusing.

As these examples show, first, ambiguous reporting revealed the individual practice of seeing and articulating through which scientists sought to identify the paper's scientific narrative and supporting evidence. They focused their attention on assessing the extent to which the shown evidence (e.g., analyses, figures) in the paper and its storyline matched. For instance, in the first example, Annie was able to report on the different cell lines and what they were showing, but it was difficult to specify what the authors wanted to say with the findings. Highlighting the importance of being able to connect evidence and storyline in this way, in the lab meetings, the doctoral students often asked, “what story can I tell with these figures,” referring to the analyses they were presenting. This meant that they had produced findings and developed figures but struggled to define a compelling story with this evidence for a scientific publication.

Second, these hesitations concerned with ambiguous reporting related to the complexities of the published research and the ambiguities in the relationship between the story and the evidence, more so than the inexperience of the early-career scientists. All the journal club attendees, both doctoral and postdoctoral researchers, engaged in ambiguous reporting. Nobody felt embarrassed for expressing these hesitations about how a storyline was supported by specific evidence, and there were no comments made by the professor or anyone else suggesting they thought the presenter had not studied the paper carefully enough prior to the meeting. Quite the contrary, the scientists anticipated ambiguities in the relationship between the story and the evidence. Deciphering these complexities called for journal club discussions and further analysis by the entire research group.

Critical Deliberation

The journal club was generally seen as a context in which early-career scientists learned to critique scientific work. As Doug explained in an interview:

Now the criticizing thing, I would say that's the traditional, the institutionalized reason you have journal clubs, so when we are in our first three years in grad school, we are actually required to join a journal club. Criticizing part of it is just communicating science.

Doug continued on the importance of critique after one journal club meeting, saying:

The job of the journal club is to – like even the most perfect paper ever – I mean what do you gain by just looking at a paper and being like it's so awesome? I mean you can talk about it but there's a lot to learn from criticizing it.

From the perspective of developing professional vision, critique had an important role. Consequently, I will show next how ambiguous reporting was followed by the collective practice of *critical deliberation*, which was directed at recognizing and critiquing the visual representations (e.g., figures, graphs) and the analytical tools used to create them.

Critical deliberation directed at visual representations: When engaging in critical deliberation, the scientists focused their attention on visual representations debating their meaning. This involved pointing at the visualizations, showing excitement, disappointment, or doubt, asking questions, and challenging interpretations. In the next example, the scientists discussed a video representation of findings from a paper Bertha, a postdoctoral researcher, had selected. Bertha wanted others to look at the video together with her, showing to them why she thought the findings were interesting. They were gathered around Bertha's laptop, watching and pointing at the video. The discussants in the excerpt include Bertha, the professor, and the doctoral students Doug and Annie.

Bertha: The interesting thing in this paper is, it really focused on the different parts of becoming polyploid. I'll show you the movie. The movie's not very good. What happens is if you go from 2N to 4N, you actually – so here it shows you GFP (green fluorescent protein) marks the DNA, so the stem GFP. Here it's producing two separate groups of chromosomes and there's a cleavage furrow. Then, actually, it goes back together to form one 4N cell.

Prof: Wow, no way.

Bertha: Then, after 4N, it just – so this is cells that are greater than 4N, there's no cleavage furrow. It just starts replicating and there's not this obvious mitosis.

Prof: Why would it go back together? So, it fuses together?

Doug: Does it actually separate or is it just a cleavage furrow that just disappeared?

Bertha: Yeah, so let's see. This is Movie 2. They have movies about it and so what's it going to do. So, it separates and then it goes back together, which is kinda cool.

Prof: It is really cool. Does it always go back together with its original partner or is it more promiscuous?

- Annie:* I think that they stay connected. They must.
- Prof:* Yeah, it looks like they stay connected. Their membranes must be sort of – see, look, look, look, yeah [Professor points at the screen while speaking].
- Doug:* Yeah, there's a little – some kind of junction.
- Bertha:* Yeah, but they go apart very far, I thought.
- Prof:* That's wild, isn't it?
- Annie:* I mean, you choose the video where they go the furthest.
- Doug:* Is this just a really well-known thing or is that what they're showing, is that unique?
- Bertha:* Well, this, it actually seems like this is previously known.
- Annie:* But it's never been shown so pretty. [Chuckles]
- Bertha:* Yeah. Well, there is some debate about how much cleavage formation there was, so they wanted to use this live imaging to really show that there's two distinct phases.

The scientists looked at two videos trying to see why the cell division process was missing “cleavage furrow” and instead showing cells separating and fusing back together. Bertha and the professor were excited about the visual representation, and Bertha's excitement seemed to grow when the professor showed interest in what she was presenting. They also used phrases such as “kinda cool,” “it is really cool,” and “that's wild” to describe what they saw. During this critical deliberation, we see however how the two doctoral researchers, Doug and Annie, presented competing understandings about the extent of cell separation shown in the video and the novelty of the finding. When using their professional vision to make sense of the video, the scientists seemed to come to different conclusions. Concerning cell separation, Doug saw “some kind of junction” between the cells, while Bertha argued “they go apart very far, I thought.” Annie engaged in critical deliberation raising the concern that the authors might have cherry picked a video that showed cell separation to go the furthest. Because of Doug's question concerning the novelty of the finding, Bertha explained there was an ongoing debate concerning the extent of cleavage formation, but that by using live imaging, a novel technology, the authors were able to highlight its two distinct phases. It is noteworthy that in this exchange, seniority and level of experience were not used to settle how to interpret the visualization. Moreover, the professor did not engage in settling these differences or side with any of the early-career scientists.

In another instance of critical deliberation centered on visual representations, Keith, a first-year student who was doing lab rotations and spending a semester with the research group, presented a paper focusing on the regulation of DNA replication in mammals. This was his first journal club presentation. After introducing the main point of the research, Keith went through each of the figures describing what they showed. One figure activated critical deliberation as the others were suspicious about how the figures had been created and how the authors had chosen the visual representations to be included in their paper. The doctoral

students (Annie, Doug, and Keith), the postdoctoral researcher (Bertha), and the professor took part in the conversation.

- Prof:* Oh, my goodness. They just put everything in here.
- Annie:* Well, this is early to late, goes from the middle to the edge and late to early goes from the edge to the middle. How many sites do you think they tested in order to find that figure?
- Bertha:* Ten? I'm just guessing.
- Annie:* I would guess significantly more than that.
- Keith:* You think so?
- Bertha:* Well, here they have nine regions.
- Annie:* That's a model.
- Keith:* Yeah, that's their model.
- Bertha:* Oh, okay.
- Keith:* You think they –?
- Annie:* Oh, I am 100 percent confident they cherry picked. In all of this nuclear localization stuff seeing something right at the edge versus right in the center is incredibly rare.

Keith first described what he saw happening in the figure which was followed by critical comments from the more experienced scientists. While the professor exclaimed in horror “Oh, my goodness. They just put everything in here,” Annie directed a question to the others in the room: “How many sites do you think they tested in order to find that figure?” This was to imply that the authors might have done the analyses as many times needed to get at a figure where the result looked the best. Bertha suggested a number which Annie dismissed by saying she thought the number could be much higher. Throughout this critical deliberation, Keith was somewhat astonished about the conversation turning to Annie with questions such as “You think so?” Finally, Annie made her critique explicit by stating that the authors had cherry picked the figure because it was rare to be able to show what the figure was depicting.

In this example of critical deliberation, the more experienced scientists demonstrated to Keith how to critically assess the visual representations of a published study. The possibility that scientists might work their data to create better visualizations seemed shocking to Keith. Again, assessments using professional vision were not simply related to seniority and experience, as in this interaction, Annie, more so than the professor, gave a final judgment on how the authors had most likely worked their data to arrive at particular visualizations.

Critical deliberation directed at analytical tools: In critical deliberation, it was equally important to recognize and assess the analytical tools used to create visual representations. The chosen tools were associated with how credible the results were as well with the integrity and academic standing of the authors. As shown in the next excerpt, the scientists discussed an analytical approach used in a paper Keith had presented. Doug and Annie criticized the chosen analytical approach, Lipidic Cubic Phase (LCP) crystallization, which was a method for determining cell membrane protein structure.

- Doug:* I think the LCP thing is basically a way for people to twist their data into whatever they want to see.
- Annie:* Oh, totally. It's a totally artificial test.
- Doug:* Yeah, because it's artificial thresholds.
- Annie:* You put the threshold where it needs to be in order to see something that looks kind of okay, yeah.
- Keith:* I mean it's not artificial, though, right?
- Doug:* Kind of.
- Keith:* Picking which point is, but there is actually a change over a gradient.
- Doug:* But the implications of those gradients are so loosey-goosey.
- Annie:* If they plotted the whole gradient and showed an R-squared value then maybe I would accept it, but having three classes where the boundaries are entirely ambiguous to the reader doesn't actually present useful data.
- Doug:* It's really just a broad correlation with expression patterns. How much can you really tell by how many CPs there are in a promoter? There's a lot of randomness to that as well.

Doug and Annie engaged in critical deliberation directed at LCP explaining why it should not be used in any research. Doug described the method as "a way for people to twist their data into whatever they want to see." Annie agreed saying LPC was an "artificial test" in that researchers set thresholds "where it needs to be in order to see something that looks kind of okay." Taking on the role of a more experienced scientist, Annie and Doug explained to Keith why they thought LPC should not be considered a valid analytical approach.

On another occasion the scientists criticized authors who used a "DAVID website." The Database for Annotation, Visualization and Integrated Discovery (DAVID) was an online tool for scientists, who wanted to use functional annotation tools to understand the biological meaning behind large gene lists.

- Doug:* I mean they basically – it looks like they're using a DAVID website, right?
- Bertha:* Yeah.
- Doug:* I don't think they made up that weird number.
- Annie:* No, I bet they didn't. I bet this is just how they got the data.
- Doug:* They probably just like, oh, let's learn DAVID in five minutes, and just put – we'll say our post.
- Annie:* Oh, absolutely. Absolutely. But I don't mean to belittle them.
- Doug:* No. But that's like everything that's wrong with the analysis right there.
- Annie:* Yeah, I don't understand this data, and I guess because of that, I don't trust it.

In this example, Annie and Doug, again, appeared to know more about different analytical tools and their ability to generate credible results. When discussing

what was wrong with the paper, Doug gave his interpretation of the issue: “they’re using a DAVID website, right.” Both Bertha and Annie agreed with this observation. They saw a suspicious detail in the paper and suspected the reason for it was the used functional annotation tools. Doug implied the tool was for quick and dirty analyses as it can be learned in “five minutes.” Annie then suggested she did not want to discredit the authors, but their collective assessment was that the website tool undermined the study and led them to distrust the data.

To summarize, these findings on critical deliberation directed at visual representations and analytical tools show, first, how due to the complexities associated with deciphering scientific papers, as demonstrated through ambiguous reporting, the scientists relied on critical deliberation to develop certainty in their interpretations, knowledge of different analytical tools, and the ability to identify scientific misconduct. To achieve this, the scientists had to deconstruct and critically assess the different components of the papers highlighting the need for a unique form of expertise, here defined as decomposition expertise.

Second, the collective element of critical deliberation was important because the scientists could take advantage of each other’s knowledge and expertise when trying to assess the different components of the discussed papers. As shown in the previous analysis, instances of critical deliberation were rarely solved by seniority. In this research group, Doug and Annie, the two doctoral researchers, had experience in bioinformatics and were often the ones who knew about new analytical tools appearing in scientific papers. The professor and Bertha did not have a similar skillset as their core expertise was in wet lab work. Consequently, when engaging in critical deliberation, Doug and Annie could exercise their professional vision and judgment in relation to specific visualizations and analytical tools and hence contribute to collective learning.

Self-centering the Critical Gaze

As the early-career scientists learned to recognize and assess different components of an article, they began to gradually engage in *self-centering the critical gaze*. This meant reflexively relating components of the discussed article with their own ongoing research. Self-centering the critical gaze signaled deepening learning which allowed the scientists to improve their own research practice. In fact, the more experienced the novice scientists became, the more likely they were to turn the critical gaze on themselves seeing their research through the eyes of potential reviewers and critics.

Self-centering the critical gaze marked a shift to increased reflexivity in how the early-career scientists used professional vision. In an interview, Doug, who graduated during the observation period, showcased this reflexivity by describing how his own interest in the journal club meetings was moving away from critiquing the work of other scientists to thinking about how to advance his own work.

When I read a paper, it’s like I’m not reading it thinking I’m just going to tear apart everything they do. First of all, I’m reading it just to read it, but also, the first question I ask is how I can apply this to something that I would be interested in doing, it sort of builds on your own

project. Some on the other side might say, well, then you're just taking things at face value, whatever, and I think criticizing a paper is a really valuable skill. I think that's why we may need journal clubs, but at a certain point, it's tiring, it's tiresome.

In the journal club meetings, the professor also encouraged the early-career scientists to practice such reflexivity, which involved combining the studying of scientific articles with deep reflection on how to conduct and present their own findings. Exemplifying this, in the following conversation, the professor advised Bertha by pointing out that she should reconsider her ongoing analyses and visualizations from the perspective of what they had just analyzed in the published paper.

- Prof:* In yours, remember your analyses and the big blob? After looking at all these figures, do you have more clarity on what the big blob thing is? Yours doesn't look like this, right? [Points at the screen of her laptop.]
- Bertha:* Well, that was the thing. My megakaryocytes look like this, but my trophoblast giant cells don't.
- Annie:* They are just chaotic.

After deconstructing the discussed paper and assessing its different components as part of critical deliberation, the professor focused on the paper's figures and encouraged Bertha to rethink her own findings from their perspective. This was an attempt to guide Bertha to see connections between her results and the figures they had analyzed. Bertha dismissed this as she thought her findings looked too different and did not see how the figures could help her explain the findings. Annie supported Bertha's perspective noting that in Bertha's analyses the trophoblast giant cells were acting "chaotic," and it was difficult to find patterns and meaning in them. While Bertha and Annie dismissed the professor's invitation to relate the ongoing analyses and the discussed paper's figures, this moment is an example of how developing professional vision by critiquing the work of other researchers evolved into self-centering the critical gaze which involved reflexively making connections between specific components of the article and their own work.

In addition to the professor guiding the early-career scientists toward self-centering the critical gaze, the scientists themselves expanded journal club discussions to the research they or others in the group were working on. As the scientists presented their own research in lab meetings, journal club conversations about the connections between a published study and ongoing research often referred to the lab meeting discussions. Demonstrating this, on one instance Bertha introduced a paper at the journal club saying:

What they [authors of the paper] are interested in, is similar to what Annie presented on in our lab meeting about timing of replication in certain domains. They're looking at specifically stem cells, embryonic stem cells, and so with Figure 1 they just basically describe how they do it, so it's similar to what Annie mentioned in her presentation.

This example shows how Bertha related an identified component of the published research (i.e., Figure 1) to a specific component of Annie's ongoing research presented at one lab meeting.

Similarly in the following excerpt, Bertha initiated a conversation toward the end of one journal club meeting where she compared elements of a discussed article and her own work. Bertha addressed the other scientists saying in a defeated tone that her analyses were not as conclusive as what they saw in the published research.

- Bertha:* It'd be nice if I had something that was more conclusive than this paper.
- Annie:* Well, you could find something like – you didn't make a chorion set [chorionic tissue sample test], right?
- Bertha:* Yeah, I haven't gotten my sets yet.
- Annie:* But no one else has done that kind of equivalent study?
- Bertha:* No.
- Annie:* I mean if anything, it would be good to sort of replicate this figure [pointing at a figure in the paper] with the data that you have, just for whatever, your set [job] talks or anything.

The paper they had read had sought to better characterize decidual cell ploidy and after describing their main findings, the authors were able to suggest that mitochondria played an important role in the positive regulation of decidual cell polyploidization. One of Bertha's own studies was similar, and she hoped to make a stronger and more compelling contribution. After finishing their discussion of the published article, the early-career scientists engaged in self-centering the critical gaze expanding their focus to include Bertha's research and thinking about how to advance it. To help Bertha find a way to make a stronger contribution to the field, Annie suggested a chorionic tissue sample test as a strategy to get at those more conclusive findings. Moreover, Annie encouraged Bertha by reminding that she had access to samples nobody else had potentially allowing her to make a novel contribution. After deconstructing the different elements of the published research, Annie even suggested that Bertha replicated a specific figure from the discussed paper with her own data. While Bertha was viewing her research from the perspective of the published study rather negatively, Annie identified components that would allow Bertha to improve her work which could lead to a more significant contribution to the field.

In instances in which the article under discussion was perceived as containing questionable components (i.e., visual presentations, analytical tools), self-centering the critical gaze was associated with reflecting on what elements to avoid in one's own research. In the following excerpt, Annie, Doug, and Bertha reflected on some of the papers they had recently read assessing the different components that made these publications "under-developed" and "depressing."

- Annie:* Well, we know now where we can send totally under-developed stories.
- Doug:* Yeah. [Laughter]
- Bertha:* I think of the under-developed stories in the reading recently, this one at least has a lot of – it does both RNA and protein.
- Annie:* Right!
- Bertha:* And you can – the figures, while the error bars may be large, are not as suspect as some of the other papers that we've been reading.
- Annie:* Oh, I agree that we have had a slew of sort of depressing papers recently. [Laughter]

The early-career scientists demonstrated their ability to detect those components in published articles that should be avoided in their own work. They pointed at specific analyses and figures as examples of the ways in which these publications fell short. At the same time, the realization that these were still published papers gave them some optimism for their own future research goals and led to the shared joke: “we know now where we can send totally under-developed stories.”

To summarize, after critical deliberation, self-centering the critical gaze was the next step in the process of developing professional vision. While through critical deliberation the early-career scientists learned to recognize and assess the different components of published studies, when engaging in self-centering the critical gaze, the scientists began to deepen their understanding and use of professional vision. They were reflexively relating the components of the discussed studies and their own research aiming to advance their research toward significant contributions. Taken together, the practices of critical deliberation and self-centering the critical gaze were central in the development of professional vision and, with that, decomposition expertise.

Additionally, self-centering the critical gaze appeared more common among those early-career scientists (Bertha, Doug, Annie), who had experience in publishing their research, attending conferences, and applying for academic jobs, than Keith, who was at the beginning of his PhD journey. At this stage in their careers, Bertha, Doug, and Annie had experience with peer review, were embedded in their field, and increasingly thought about their research in relation to the published studies of other scientists. For them, professional vision was informed by other members of their profession, who could be their critics, reviewers, and even competition.

DISCUSSION

This study demonstrated how members of a profession, in this case academic scientists, develop professional vision and, with that, decomposition expertise. The findings detailed three practices in the learning process. *Ambiguous reporting* showed how a scientist first studied a published paper on their own aiming to develop an understanding of its main storyline and supporting evidence and

then presenting this understanding to other scientists. *Critical deliberation* demonstrated how scientists then worked together to identify and assess specific components of the discussed article. They took advantage of each other's expertise and experience to achieve certainty in their assessment of visual representations and analytical tools. Finally, *self-centering the critical gaze* showed how scientists began to reflexively relate components of the discussed article with their own research thus deepening their learning and understanding of their field. Together, these practices revealed the steps through which scientists develop professional vision and decomposition expertise. In their line of work, decomposition expertise was critical for deconstructing products of professional work, inferring mistakes and misconduct, and advancing scientists' own work toward credible and impactful contributions.

These findings advance research on how members of a profession learn to see, first, by bringing new insight to the roles of novices and experts in the processes of teaching and learning professional vision. The few studies that have analyzed how professional vision is acquired demonstrate the ways in which an experienced professional explicitly guides a novice to see what the expert sees (Goodwin, 1994; Grasseni, 2004; Hindmarsh et al., 2011). These roles are common in apprentice relationships, classroom settings, and even in the context of everyday work. Due to this role difference, experts have been shown to engage in practices such as *demonstrating* to a student how to recognize archeologically relevant phenomena (Goodwin, 1994), or *giving direct feedback* pointing at correct and incorrect paths of action (Hindmarsh et al., 2011). In general, experienced members of a profession engage in practices such as *zooming* and *highlighting* to show to new members where they should direct their gaze and what they should see (Gegenfurtner et al., 2019).

The findings from the present study reveal a more nuanced understanding of who can be considered a competent actor capable of seeing and articulating like an expert, which also influenced the development of professional vision. The study showed everyone in the research group – no matter what their formal role was and what was their level of experience – engaging in ambiguous reporting. Moreover, instances of critical deliberation were not solved by seniority. Oftentimes, the two doctoral students, Doug and Annie, had more knowledge of the newest analytical approaches and their implications for scientific work than the postdoctoral researcher or the professor, which allowed them to authoritatively and actively engage in critical deliberation. In the journal club meetings, the most novice scientist in the group, Keith, was often mentored by these experienced doctoral researchers. This finding on the different roles may be related to how the journal clubs were organized, as they were more student-than professor-led perhaps giving novice scientists an opportunity to exert their authority. It is also possible that the lab's easygoing, low hierarchy group culture helped to create an environment, where novice scientists could more easily demonstrate their expertise without stepping on the toes of their supervisor. Further research is needed to understand how journal clubs are organized in different contexts and how this relates to practices by which professional vision is developed.

Second, the findings contribute to extant understandings of how professional vision is acquired by demonstrating that while this learning process involves both the individual practice of ambiguous reporting and the collective practice of critical deliberation, among these scientists learning to see like an expert was particularly dependent on their collective efforts. This finding aligns with prior studies on professional vision that have similarly highlighted the important role of collective practices of seeing (e.g., [Arman & Styhre, 2019](#); [Hartswood et al., 2002](#)). Yet, such studies have examined how professional vision is used by experts in their everyday work to get things done rather than how professional vision is taught and developed. The journal club meetings illuminated the dynamics of acquiring professional vision in a group setting where participants at varied career levels engaged in collectively learning and figuring out what they saw.

Third, the findings on critical deliberation and self-centering the critical gaze contribute to research on the role of critique in the process of acquiring professional vision. Extant research has shown that the expert community involved in the learning process makes sure that the student's practice is disciplined by the experts when necessary ([Arman & Styhre, 2019](#); [Goodwin, 2013](#); [Hartswood et al., 2002](#); [Lymer, 2009](#)). In the research context of the present study, the scientists or products of their work were not critiqued, instead they engaged in critical deliberation directed at the work of others, often more established scientists. However, the more involved they became in academic activities such as publishing and applying for jobs, the more likely they were to turn the critical gaze on themselves. It was as though they learned to see their own work through the eyes of potential reviewers and critics, therefore achieving something similar to what [Styhre \(2011, p. 265\)](#) discovered among architects: "the architect's gaze is always already vision informed by the vision of colleagues, clients, and other relevant groups – 'the generalized other' of the architectural field." When novice scientists developed professional vision, they began to view their professional selves and their work from the perspective of the whole expert community.

Finally, the study showed how in the process of acquiring professional vision the scientists developed decomposition expertise. Decomposition expertise is important for any field of expert work, especially those affected by technological change. It has been noted that technological change can challenge the development and application of professional vision ([Gegenfurtner et al., 2019](#)), thereby influencing the demands of decomposition expertise. As the creation processes for complex knowledge representations become more ambiguous, the need for expertise capable of breaking down and interpreting various components of work products across domains of knowledge-intensive work increases.

In academic science, the importance of developing decomposition expertise could be seen in the complexities associated with deciphering scientific papers. Decomposition expertise allowed the scientists to deconstruct and critically assess the products of scientific work and thus develop certainty in their interpretations, knowledge of different analytical tools, and the ability to identify mistakes and scientific misconduct. As the methods and tools for creating scientific visualizations are highly sophisticated and complex ([Dumit, 1999](#); [Peterson, 2015](#); [Vyas, 2013](#)), the ability to carefully dissect from published research what was done to

get at the presented results is even more critical. This was particularly important in genomics as the scientists felt that compared to other research fields, there was not a standardized way of representing findings making the assessment of published papers difficult. As Bertha said in an interview:

In genomics, this is the frontier that there's not really a standardized way to do something. Every so often, every two weeks or so, some really interesting new method of analysis would come up, and they would find something that *looks* really neat.

Therefore, decomposition expertise was necessary for scientists to identify and assess new visual representations and the analytical tools used to create them.

Furthermore, in academic science, due to continued methodological developments and pressure to publish, scholars struggle with recognizing things like data cooking and fabrication which put extra pressure on decomposition expertise and the ability of scientists to act as peer reviewers who can differentiate between “good” and “bad” research (e.g., Bornmann, 2013; Miller & Ulrich, 2022). With limited decomposition expertise, scholars run the risk of missing mistakes and instances of scientific misconduct. Such observations underscore the importance of settings, in which experts with varied levels of professional experience can exchange knowledge and gain confidence in their ability to effectively deconstruct knowledge creation processes.

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THE GROWTH OF PROCESS EXPERTISE AND THE ABSENCE OF PROCESS EXPERTS IN THE DIGITAL AGE

Jeffrey W. Treem^a and William C. Barley^b

^aNorthwestern University, USA

^bUniversity of Illinois Urbana-Champaign, USA

ABSTRACT

Multiple facets of the current social and technical environment challenge traditional orientations toward understanding both expertise and experts. Digital and informed workplaces produce contexts that necessitate workers enact process expertise, expertise that is applicable to managing information and communication both within and across domains but does not, in itself, represent those domains' practices. This essay describes the double-edged consequences of this context for would-be process experts through two objectives. First, we explicate why process expertise has become an increasingly essential source of value for contemporary organizations. Second, we describe how process expertise's dynamic and relational qualities produce challenges for legitimating individuals who enact process expertise as experts within organizational contexts. We use empirical examples to describe three dynamics by which process experts may position themselves alongside domain experts: assimilation, brokerage, and commodification. We show how each of these mechanisms produces distinct tensions associated with the identity, visibility, and accessibility of work, which delegitimize this important form of knowing. Our essay motivates a call

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for further research and policy development aimed toward understanding ways in which process experts come to be more valued by organizations.

Keywords: Process expertise; domain expertise; visibility; assimilation; brokerage; commodification

INTRODUCTION

Becoming an expert is just not the same as it used to be. Eroding public trust in experts has led some to herald the “death” of expertise (Nichols, 2017), while movements to incorporate more diverse sources of expertise into policy decisions have led to a purported “crisis” of expertise (Eyal, 2019). Amidst this uncertainty, those organizations that can instill confidence that stakeholders will have access to expert knowledge, services, and results are at a market advantage (Alvesson, 2001; Stehr & Grundmann, 2011). Yet in an environment where claims to expertise are plentiful, organizations face new challenges regarding which forms of expertise to value and how best to facilitate productive interactions among experts.

Two interrelated shifts in work and professionalization over the past several decades have disrupted how we understand organizational expertise. First, the massive visibility of information enabled by the increased use of digital tools and platforms (e.g., search engines, online databases, social media) has fueled uncertainty, equivocality, and opacity about the nature of experts and expertise in contemporary organizations (Alaimo & Kallinikos, 2022; Flyverbom, 2019; Leonardi & Treem, 2020; Reischauer & Ringel, 2023). The transaction costs of accessing and mobilizing domain knowledge decrease in environments of high information visibility. Formerly, if someone could articulate in detail the process of conducting a coronary artery bypass graft surgery, they were almost certainly a doctor (or someone who studied or wrote about doctors). Today, given a few days locating and processing information using online resources (e.g., Wikipedia), an individual could communicate with a high-level of granularity how this procedure is conducted; and even watch videos of actual surgeries (e.g., by using a repository such as YouTube) to learn the movements and language of the doctors engaged in the practice. Information that was once scarce, inaccessible, or esoteric is now widely available using digital technologies. Within this information-rich environment, the marginal value of one’s capacity to manipulate, curate, and translate information becomes more essential to workplaces.

Second, individuals and organizations are less dependent than they used to be upon ties to formal professional communities to enact expert authority (Brint, 2020; Galperin, 2020; Huising, 2014). Experts draw on abstract knowledge to assert jurisdiction over particular forms of work (Abbott, 2014); however, the purported knowledge utilized, developed, and sold by knowledge-intensive firms is often opaque and ambiguous (Alvesson, 2001). Increasingly, scholars eschew the idea of expertise as held within individuals or systems and instead conceptualize expertise as relationally constituted through networks of interactions and interactants (Edwards, 2010; Eyal, 2019; Pakarinen & Huising, forthcoming).

This view recognizes expertise as a “practical accomplishment” (Kuhn & Rennstam, 2016) that is enacted in micro-level practices, while also influenced by organizational structures, resources, and discourses that shape which forms of knowledge are valued. If as Eyal (2019, p. 19), noted, “expertise is not a thing, not a set of skills possessed by an individual or even a group, but a *historically specific way of talking*,” (emphasis in original) than it is incumbent upon scholars to reexamine the types of communication that are valued during our current epoch. We contend that this reexamination requires challenging the self-efficacious nature of experts and expertise by developing an analytic distinction between *expertise* (i.e., an individual’s practical capacity to enact a particular form of knowing) and *experts* (i.e., individuals who are assigned status and legitimacy because others perceive them as possessing valuable knowledge). More specifically, we contend that changes in modern workplaces challenge whether the *historical* ways of assigning expert status apply to the forms of expertise that are increasingly important to work.

Our prior scholarship has established that one shift within workplaces has been a growing importance of *process expertise*, which we characterize as “expertise that is applicable to managing information and communication both within and across domains but does not, in itself, represent those domains’ practices” (Treem & Barley, 2016, 2018). We exclusively center the orientation to information (i.e., data, texts, files) and information technologies (databases, software, computing platforms) to note that the skills, abilities, and knowledge associated with process experts are theoretically domain agnostic. An individual with knowledge of geospatial simulation tools who has been given historical weather data can likely provide a statistically credible prediction for next year’s hurricane season without a deep mastery of meteorological knowledge (putting aside for now the issue of whether that would be seen as valuable). Process expertise can exist in the form of different sub-processes: (a) operational processes related to the skilled use of information technologies; (b) curational processes related to the aggregation and consolidation of information; (c) evaluative processes related to judgments about the completeness and usefulness of information; and (d) representational processes related to abilities to display information effectively (Treem & Barley, 2016). Collectively and individually, these processes highlight the variance that workers may have in managing information in organizational contexts. Process experts, such as project managers (Monteiro, 2024), data curators (Thomer et al., 2022), and hospital transport nurses (Barley et al., 2020), may not possess a priori the kinds of domain expertise of those they work alongside, but in an era of information (over)abundance, process experts embody the unique ability to navigate, curate, and communicate information in ways that domain experts may be less equipped, or inclined, to perform.

This essay contributes to the study of expertise in organizations by first discussing the ways the contemporary information environment has shifted many of the underlying assumptions we’ve held for how one establishes expertise, who is seen as an expert, and how one communicates that expertise to establish expert status in organizations. In doing so, we posit that we have shifted into a period when traditional conceptualizations of domain expertise are less valuable than

in the past, and other forms of expertise – specifically, *process expertise* – have become more important to organizations moving forward.

Next, we consider how, despite the value of this form of knowing, those who enact process expertise are set up for a struggle to establish legitimacy as acknowledged experts in future work contexts. We argue this point through examples of three mechanisms by which process experts may position themselves relative to domain experts in contemporary workplaces: assimilation, brokerage, and com-modification. We uncover how each of these processes produces their own unique tensions to be managed by would-be process experts. In doing so, we call for future work examining how individuals and organizations may build structures and support practices that value the work of those who enact this important form of expertise.

THE UNIQUE QUALITIES AND CHALLENGES OF PROCESS EXPERTISE

What makes someone an expert? It is intuitive to conclude that experts are individuals with deep knowledge of a specific domain of practice: an expert in medicine diagnoses illnesses and treats patients; an expert painter produces masterful watercolor portraits and landscapes; or an expert civil engineer produces detailed blueprints for bridges and skyscrapers. These individuals enact what is frequently termed *domain expertise*, meaning they can actively engage in the practices associated with a specific well-defined domain. This common epistemology posits that experts are those who have high levels of domain expertise as demonstrated through achievement within a domain, experience, or situated knowledge and are evaluated by peers and arbiters engaged in similar practices. From this perspective, becoming an expert requires prolonged practice within a domain, or intensive interactions with established domain experts.

Process expertise is distinct from domain expertise in several important ways. First, process expertise is both enabled by, and dependent upon, vast amounts of visible and accessible information, almost exclusively in digital form. A consequence of this is that process work lacks the materiality associated with many other forms of work – that is, it is harder to see. Decades ago, Zuboff (1988) noted that a distinguishing aspect of information technology (IT) use, relative to physical machines, was that as IT seeks to automate or replicate human action it produced new forms of information for analysis – that is, IT *informs*. In turn, organizations have responded by developing new organizational and occupational roles such as data scientists (Zhang et al., 2020), data curators (Thomer et al., 2022), and simulation modelers (Leonardi et al., 2021) that are centered around the management of available information. Process expertise is fueled by information, and the products it produces exist in the form of representations of information. Because the work of process experts is not embodied or material in the same way many other work practices are, this work is more prone to be invisible to others in an organization (Suchman, 1995).

Second, process expertise is inherently relational with other forms of domain expertise, in that it is usually enacted with orientation to one or more specific domains of practice, but its practices do not embody specific domain knowledge (Unless you count activities like online search, manipulating databases, or speed reading as distinct domains). This is both potentially limiting and empowering. Process experts can deftly transform, analyze, and display information but are still reliant on domain experts to leverage that information in practice. For example, a data analyst in a hospital might have the unique capacity to sort through thousands of electronic medical records to determine a pattern in symptoms of emergency room patients indicating increased likelihood of subsequent respiratory problems. However, the ability to recognize this pattern only provides value if an organization has doctors or nurses who can actively identify these symptoms in situ and provide timely treatment. Inversely, unlike domain expertise, process expertise is potentially transferable across a wide variety of organizational and occupational contexts. A doctor is limited in contexts where they can practice medicine. However, if the form and structure of information is the same (i.e., coding frameworks, data architecture, statistical tests), the same data analyst above could presumably apply their process expertise in many other work contexts (e.g., legal offices, insurance adjusting, farming).

Third, process expertise is dynamic, in that its specific practices change rapidly as the platforms of an informed environment evolve. As [Collins \(2018\)](#) notes, “Most fatal of all for the idea that expertise is necessarily esoteric is that the same expertise can be esoteric at one time or place and ubiquitous at another.” For instance, [Attewell \(1992\)](#) frames the adoption of computing within organizations as a story of skill acquisition, noting that organizations initially relied on outside experts with specialized knowledge and over time experts emerged within organizations and became in-house gurus that others sought out for help. Eventually, all individuals developed enough computing skill that these specialized experts became obsolete. The erosion of process expertise is particularly likely in situations of operational process expertise where the knowledge is tied to the use of a specific technology. For example, if you were planning a long career as an expert social media consultant, and you solely specialized in work related to MySpace, Vine, Xanga, Periscope, Orkut, or del.icio.us, you are out of luck. This is not to deny that established domains of practice don’t evolve or change, but rather aspects of identity associated with domain experts are likely to be more durable than for process experts.

Fourth, work involving the use of information or structured processes is often viewed as lower-skilled, and the perception of data-focused tasks as rote, or prescriptive can obscure the immense skill and craftsmanship involved in this form of work ([Barley & Kunda, 2006](#)). For example, research on data curation work found that individual curators routinely exhibited specialized, situated skills critical to the success of projects, yet this work was rendered invisible within their respective organizations ([Thomer et al., 2022](#)). Other scholars note the marginalization of this type of process expertise as generalist work ([Woo et al., 2022](#)) and observe that coordination practices are often gendered by stereotypes about who should

perform certain forms of work (D'Ignazio & Klein, 2023; Rice, 2021). This final point gives rise to the second claim of our essay – the observation that many contemporary work arrangements seem set up to potentially prevent individuals who enact process expertise from being seen as experts within their organizations.

TENSIONS LIMITING THE EMERGENCE OF PROCESS EXPERTS IN ORGANIZATIONS

As stated in our introduction, we consider one's expertise to be distinct from one's expert status. Thus, it follows that the dynamics explaining process expertise's *value* for organizations are potentially distinct from those explaining whether individuals who enact process expertise will come to occupy expert status. Given process expertise's unique nature, it is worthwhile to explore how prior work explains how individuals with expertise attain expert status. Heimstädt et al.'s (2024) categorization of views of expertise in management scholarship is useful in demonstrating different ways experts provide value in organizational contexts and offers insights into which enactments of expertise may or may not align with attributions of expert status.

Realist perspectives view expertise as the possession of substantive knowledge or ability that others do not have, whether that be technical (i.e., how to do something), relational (i.e., who to talk to), or cultural (i.e., what appeals to different audiences). Expertise provides value because individuals who possess it have produced, and are likely to produce, a desired result. From a realist perspective, experts have value because they have extensive experience in a domain and a record of achievement. An expert's status emerges from work in an occupational role, organization, or professional field. There are two reasons that individuals with process expertise are disadvantaged from a realist perspective in terms of being valued by an organization. First, because process expertise is oriented to information, and not a specific domain, individuals will likely have fewer opportunities to demonstrate experience. There are not as many organizational roles tied to process expertise, therefore it is harder to link the work of a process expert to a distinct outcome. Second, the forms of knowledge involved in process expertise are not perceived as exclusive or esoteric in the ways domain expertise is, thus lowering the perceived value of individuals who enact this knowledge.

A constructivist perspective examines how groups of actors come to be seen as appropriate for organizational roles, tasks, and positions. Within organizations, members of groups tend to specialize in tasks over time, often creating a cycle in which specific individuals (e.g., those occupying particular occupational or professional roles) are viewed as experts in distinct tasks, clients, or topic areas. From a constructivist perspective, expertise provides organizational value because the individuals who possess it are attributed legitimacy and authority as appropriate actors to accomplish particular jobs. For some occupational roles, primarily those aligned with institutionalized professions (i.e., doctor, lawyer), expert status

results from licensure or certification necessary to engage in practice. Because the work of process expertise is not associated with a particular profession or role, the value of this work for organizations is often ambiguous. Moreover, the work of process expertise is often hidden from domain experts, or perceived as lower-skilled labor, further decreasing the likelihood that process experts would be valued in organizational settings.

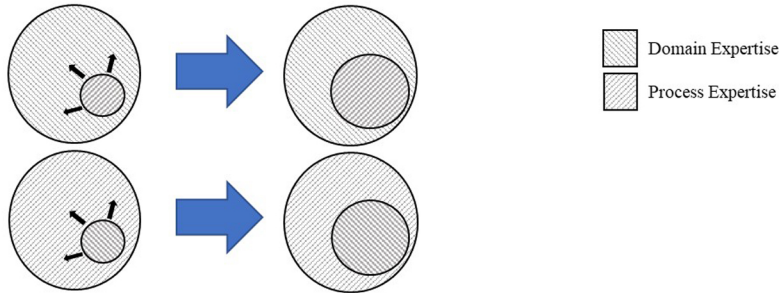
From a situationist perspective, the organizational value of an individual with expertise is that they can claim, and sustain the claim, they are an expert. Though this claim is likely to be accompanied by a variety of communicative signals indicating expert ability, it is the claim itself that matters most because it shapes how audiences behave and relate with workers. The situationist perspective centers the practical value of experts in organizations by recognizing that experts are not always those who meet set criteria, but rather often emerge as a relative attribution among available options (Bunderson, 2003; Treem, 2012). Process experts are disadvantaged here because their work does not easily produce signals that would result in attributions of exclusive knowledge or that allow others to see them engage in skilled work. It is more likely that other organizational members see the outcome of processes than the processes themselves, thus obscuring the process practices and making it harder for would-be process experts to demonstrate organizational value.

Although process expertise provides value, would-be process experts face real tensions in efforts to establish themselves as experts in organizations. Regardless of scholarly viewpoint, via a realist, constructivist, or situationist perspective, the nature of knowledge enacted via process expertise produces practical challenges undermining claims for expert status. Thus, an important avenue forward involves understanding these dynamics in more depth to understand when and how they might be overcome.

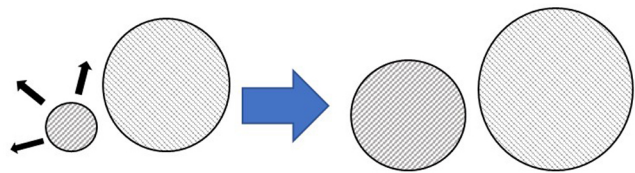
CAN PROCESS EXPERTISE FACILITATE PROCESS EXPERTS?

The preceding section demonstrated how the situated, relational, and dynamic nature of process expertise elevates practical challenges for individuals who seek to occupy expert roles through deploying this expertise. We see this as an issue of key concern for future studies of expertise and work. What mechanisms exist to potentially legitimate the role of people who enact process expertise in organizations? Given that process expertise is always positioned in relation to one or more domains, we see this question as being best answered by examining the dynamics by which would-be process experts position themselves relative to the domain experts residing within their organizational contexts. In what follows, we present three different ways that process experts might operate in organizational contexts relative to domain experts. In each scenario we note distinct tensions that process experts face in having their expertise valued. Fig. 1 provides a conceptual illustration of each dynamic we will discuss.

Scenario 1: Assimilation. Domain experts expand their own process expertise or vice versa



Scenario 2: Brokerage. Process experts work alongside domain experts



Scenario 3: Commodification. Process experts specialize to establish legitimacy

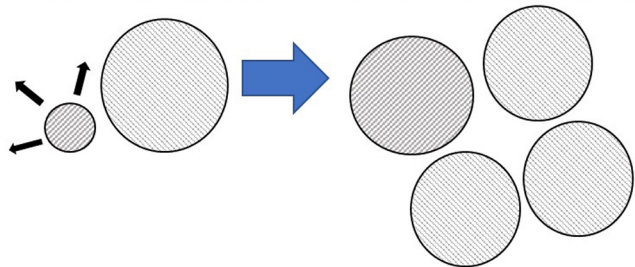


Fig. 1. Possible Relationships Between Domain Experts and Process Experts in Organizational Contexts.

*Assimilation: Domain Experts Develop Process Expertise or
Process Experts Develop Domain Expertise*

In this arrangement, a single individual is viewed as both a domain expert and a process expert. Depending upon the initial conditions, the individual either begins as a recognized domain expert and comes to be seen as a process expert, or the opposite direction of development occurs as a process expert comes to be treated as a domain expert. The distinguishing aspect of this scenario is that regardless of the initial condition, an individual can credibly sustain or develop a dual identity as a process and domain expert. [Kosterich's \(2022\)](#) research on the influx of technologists (i.e., process experts) into news organizations in the 1990s demonstrates how such a process unfolds. Early in the transition, incumbent organizational members viewed technologists as rival domain experts offering an

alternative way of working to traditional journalists. Incumbents resisted collaborating with these new employees who had different experiences and skills. Over time, technologists learned how to reframe how they communicated about their work and emphasized their role not as a unique new profession (i.e., as process experts), but as journalists themselves (i.e., domain experts) who merely sought to elevate, expand, and evolve the existing organizational expertise. Eventually, technologists became integral members of teams in news organizations and were able to not only demonstrate value to current practices but also help anticipate and evaluate changes in the news environment.

This example of technologists *assimilating* into news organizations highlights the *identity tensions* present when process experts threaten the expert status of entrenched domain experts. Assimilating to the identity of the domain experts, who already had expert authority in the organization, served to alleviate the tension but limited establishing technologists as occupying a distinct expert identity aside from journalists. This short-term benefit achieved expert status, but that expert status was linked to the individual's perceived domain expertise, not their process expertise. Organizations frequently struggle to manage relationships between individuals from different departments (Barley et al., 2012), occupational communities (Bechky, 2003), and organizational roles (Woo & Leonardi, 2018). Considering the relationship between identity and expert roles helps highlight the ways that workers can communicate and act in ways that are meaningful to identity targets – that is, groups who they seek to align themselves with. Because individuals can express multiple identities within organizations and to clients, workers have some agency in what expertise they seek to emphasize, and in turn the type of expert role they may garner (Anteby & Holm, 2021).

Yet managing identity tensions can be difficult in part because so many aspects of organizations – such as specialized roles and departments, hierarchy, and bureaucracy – create distinct boundaries that can make fluid identification difficult for people whose process expertise is specifically applicable across multiple organizational roles (Monterio, 2024). This challenge is exemplified by the increased use of data analysts by sports organizations to process information on player performance and improve individual and team outcomes. Players and coaches often resist recommendations from data analysts because many of these would-be process experts do not have experience playing or working in a sport context (i.e., domain knowledge of the specific sport). One way the Houston Astros, a Major League Baseball team, combated this issue was by having analysts develop domain knowledge of the sport through serving as coaches in the organization's development system (Roth, 2019). This included having the analysts dress in uniform, travel with the team, and be visible during practices. Over time, as analysts gained legitimacy embodying the identity of “coaches,” players became more trusting of the analysts. As with news technologists, organization members only embraced the value of process expertise (i.e., individuals' analytic skills and knowledge) when the individuals providing the knowledge successfully assimilated to the identity of a coach (i.e., an established domain expert role). This example shows that individuals with process

expertise may need to identify as a specific domain expert as a precondition to attaining expert status in organizations.

Inversely, one could imagine process expertise gaining “expert” acknowledgment if an established domain expert assimilated themselves into a new role of process expertise. However, developing process expertise from a domain-focused position both creates a burden of additional learning and represents a risk that experts will develop identities that misalign with what is valued in their domain. For instance, [Beane \(2019\)](#) studied urologist trainees who successfully engaged in unapproved process practices to acquire skills using robotic tools, what he termed “shadow learning.” However, these efforts often came at the expense of developing domain skills needed to be a general practitioner. As the surgeons developed process knowledge, they were indeed viewed as skilled in this specialized mode of work, but this specialist identity was not widely valued and therefore their job prospects were limited. If domain experts develop a process expert identity based on a specific information-based activity, task, or technology, they risk building a specialist identity that may stymie efforts for broader learning and development.

These examples demonstrate how the information-focused nature of process expertise is more likely to be valued when it is seen as consonant with the identity of established domain experts within an organization. In this scenario, the process expert is not viewed as a threat to other experts because they assimilate into a “valid” domain expert identity. However, the value of their process expertise is hidden underneath their newly attained domain expert status – technologists become “journalists,” data analysts become “coaches,” shadow learners become “surgeons” – and thus the process expertise remains invisible. Navigating multiple identities in an organizational context is difficult given structures that favor specialization. This creates a challenge for process experts to integrate and apply their distinct skills in a manner that fits within a range of behaviors deemed acceptable to existing domain experts.

Brokerage: Process Experts Work Alongside Domain Experts

In this arrangement, process experts apply their skills in a distinct role that is positioned adjacent to a domain expert with the goal of processing information to facilitate domain work. If successful in this arrangement, a process expert can free up time and resources for domain experts to focus more on primary tasks and knowledge development. Additionally, when process experts can occupy this position in relation to multiple domain experts, they can serve as brokers in organizations that facilitate information retrieval, transfer, and allocation across different parts of an organization. Finally, process experts and domain experts can engage in mutual learning as each comes to better understand each other’s practices and respective value. [Pawlowski and Robey \(2004\)](#) discuss how information technology professionals in organizations often serve as brokers of knowledge because of their varied exposure to different roles, tasks, and business problems. When successful, this scenario can be a means of establishing meaningful interdependencies among

occupational groups (Kahl et al., 2016). However, this mechanism, too, is fraught with unique challenges for establishing process experts.

An example of process experts establishing a brokerage role is provided by Barley et al.'s (2020) study of the transfers of pediatric patients among hospitals in the Midwest United States. When a patient was being considered for transfer a specialized team of nurses evaluated whether the movement was necessary and, if so, how to best facilitate a safe and expedient transport. Members of the team needed to quickly evaluate information from various sources to identify the best course of action. This process work involved interpreting patient record databases, lab results, poison control information, and hospital logistics regarding bed and ambulance availability. It also involved calling various experts at the respective hospitals to solicit and evaluate additional narratives to understand the patient's context and health. Although transport nurses did not possess the domain knowledge attributed to physicians in their hospital, their deep familiarity with the process by which children were transferred allowed them to coordinate transfers with speed and safety that these traditional domain experts readily acknowledged would have been impossible for them. When doctors legitimated the team's expertise, the physicians could focus exclusively on providing direct diagnostic treatment of patients, knowing that their job was to provide accurate and reliable information to the process experts that would coordinate other aspects of care.

For individuals with process expertise to operate as effective brokers of information, they must navigate *visibility tensions* that can limit the benefits they provide within organizations. Because the work of process expertise can be seen as routine information processing, or the labor may not be observed by domain experts (i.e., they only interact with the outputs of analysis), this work can be rendered invisible in organizations (Hatton, 2017; Nardi & Engeström, 1999; Star & Strauss, 1999). This was certainly true in the case of the transport nurses, who routinely faced challenges when interacting with physicians who were unfamiliar with their process expertise or role. When physicians had not previously worked with the transport team inquiries from the nurses were viewed as distracting, invasive, and overstepping. The new physicians discounted the nurses' evaluations and recommendations because they did not see (and thus, value) the skilled labor that went into producing those recommendations. Alternatively, physicians who had seen the work of the transport team trusted the expertise of its members and willingly provided and received relevant information.

In another example, Monterio (2024) noted how the work of project managers and coordinators at an aeronautical organization was critical to ensuring that projects progressed, but that because these individuals' work was not visible to specialist engineers these workers operated as "ghosts" despite supplying valued expertise. Another example of how the invisibility of process experts matters can be seen in Black et al.'s (2004) reinterpretation of Barley's (1986) results regarding the introduction of CTs into hospitals. They present the results as a story of expertise differences across the roles of doctors and technicians relative to operating the new technology (i.e., operational expertise, a form of process expertise) and interpreting the results (i.e., diagnostic expertise, a form of domain expertise).

When doctors and radiologists had similar levels of respective expertise they were more likely to conduct and interpret scans together and engage in mutual learning that grew levels of both forms of expertise for both roles. But in instances where there were large gaps between respective expertises, technicians conducted scans independently, and doctors interpreted scans independently, limiting opportunities for learning. These examples all show the relationship between the visibility of work and the valuing of expertise in organizations.

People with process expertise face unique challenges making their work visible, because their abilities are often expressed in processes themselves, not in the outcomes or products of those processes. We are less likely to value what we cannot see. Making the work of process experts more visible in organizations can help others see the distinct skills and abilities they can provide. This visibility into work also helps process experts serve as more effective brokers by gaining insight into what will be of greatest value to domain experts. The challenge organizations face is how to make the work of process experts visible in a manner that is neither viewed as onerous or irrelevant to existing domain experts.

*Commodification: Process Experts Establish Themselves as
Unique Service Providers*

In this arrangement, process experts are positioned as providers that domain experts seek out for their valuable services. Here process experts engage in efforts to be explicitly valued via claims their expertise is rare, exclusive, or provides uniquely valuable applications. This scenario is reflective of the challenge that professional service firms such as management consultancies, accounting firms, or marketing agencies face in selling the process expertise they provide to clients (Heusinkveld & Benders, 2005; Suddaby & Greenwood, 2001). In contexts like these, would-be experts faces tensions where they must provide enough information about their work to establish its value, but to do so in a manner that doesn't position their work as easily replicable or attainable (Bourgoin et al., 2020).

To avoid commodification diminishing the value of their expertise, process experts must navigate *accessibility tensions* that shape how work is evaluated. Accessibility tensions arise in the valuing of expert work because expertise often operates with an inherent asymmetry: we accept that non-experts may not understand the behaviors, decisions, and work of experts (Sharma, 1997). As a result, clients develop a variety of approaches to monitor and evaluate experts' work (Huisin, 2014), and workers enact tactics to project expertise, even in the absence of experience or esoteric knowledge (Bourgoin & Harvey, 2018). For instance, organizations often provide extensive documentation of services for clients to explicitly account for work. This need to have insight into what work is being done is particularly prevalent in settings where the work does not produce a distinct, material output. For example, Treem (2016) noted the extensive time and effort public relations practitioners put into reporting to clients about outreach to media members that would otherwise be unobserved. In these cases, process

experts must engage in explicit practices to make the value of their work accessible for their clientele.

An example of challenges associated with the accessibility of process experts' work can be seen in [Jensen et al.'s \(2022\)](#) study of data analysts at a healthcare organization seeking to provide services to various organizational departments. Anticipating skepticism from organizational members about their value, the analytics group developed a ticketing system that departments could use to request data services, and a visible dashboard of projects the team was currently working on. Initially, this approach led to a flood of requests for data work. Most tasks were serviced quickly and vanished from the dashboard, but complex projects took time and remained visible in the publicly accessible queue for extended periods of time. As these projects piled up, external audiences viewing the dashboard perceived two things: the analytics team appeared primarily to take on complex projects, and they seemed to take a long time to complete their work. Though the goal of the data analyst group was to demonstrate their accessibility to others in the organization, the perception was the group did not take on simple projects, and most work was delayed. This effort to increase the accessibility into the work of process experts backfired, and the analytics team dissolved in less than a year. For process experts to be seen as valuable within organizations their skills and knowledge must be viewed as both valuable and accessible, but not easily copied.

TOWARD A DEEPER UNDERSTANDING OF EXPERTISE, VALUE, AND EXPERTS

The three processes described in the different scenarios – assimilation, brokerage, and commodification – demonstrate different mechanisms by which would-be process experts might be valued in organizations. Yet the mere enactment of these mechanisms is not enough; each scenario was fraught with labor requiring would-be process experts to balance tensions that, if not managed, would lead other members of their organizations to discount, marginalize, or overlook the value of their expertise. [Table 1](#) outlines the three tensions process experts face and the associated consequences of not effectively navigating demands associated with identity, visibility, and accessibility. These tensions are not unique to would-be process experts, but we do show that the relational, situated, and dynamic nature of process expertise put its practitioners at a distinct disadvantage relative to individuals whose knowledge is aligned with established professional and occupational roles. This essay contributes to scholarship on expertise in organizations in two ways. First, we demonstrate the value of conceptually decoupling the growth of process expertise in organizations from the valuing of process experts and note how this distinction unveils very real obstacles to organizations acknowledging process experts as occupying legitimate authoritative roles. For example, despite the broad applicability of process expertise within organizational contexts more holistic ([Monteiro, 2024](#)) or generalist ([Woo et al., 2022](#)) experts are likely to be valued less than specialists whose roles are more defined. As new organizational positions and structures inherently emerge over time, the

Table 1. Tensions Faced in Valuing Process Experts in Organizations.

Tension	Consequences of Too Little	Consequences of Too Much
Identity	Expertise has indeterminate value and is not easily connected with tasks, roles, or outcomes	Specialization limits organizational value of expertise and aligns expertise with narrow roles
Visibility	Practices of expertise, and contributions of experts, are overlooked, marginalized, or discounted	Expertise is seen as burdensome, irrelevant, or an impediment to domain practices
Accessibility	Impenetrable nature of expertise obscures the potential relevance to a domain	Expertise is not seen as distinct and viewed as easily replicated or automated

identities associated with those forms of work are open to contestation regarding their scope, relevance, and value. The potential transferability of process expertise across contexts offers would-be experts’ agency in shaping their work identity, and future research should explore the choices individuals make in attempting to enact identities that will be valued in organizational contexts (e.g., [Endacott & Leonardi, 2022](#)).

Second, this work connects a constructivist perspective on expertise recognizing the enduring influence of professions, occupational roles, and domains of knowledge, with a situationist perspective focusing on how situated practices and recurrent moves of workers mediate their positions as experts. Scholars have repeatedly shown that workers engage in recurrent communicative practices to manage the ways they are perceived by different audiences from which they seek to be viewed as experts. In contexts as varied as research compliance enforcement ([Huising, 2015](#)), community health workers ([Kellogg, 2014](#)), and city planners ([Woo et al., 2022](#)) findings revealed distinct sets of work practices enacted by workers to exercise expert authority. Yet in each of these cases, the success of the practices was predicated on not challenging the existing expert authority of collaborators. Our essay shows that for process experts the path of least resistance in terms of being valued likely involves not challenging the status quo of existing organizational structures. Because process knowledge is viewed as distinct from the forms of domain knowledge that have been constructed as valuable for organizations, we posit that would-be process experts need to take on additional communicative labor to manage the very real tensions they encounter as they seek to establish legitimacy alongside domain experts.

CONCLUSION

The emergence of algorithmic occupations ([Kellogg et al., 2020](#)) and data work ([Muldoon et al., 2024](#)) offers a form of natural experiment to examine the ways process expertise might be valued by organizations in the future. Early empirical studies indicate that organizations using artificial intelligence, computational tools, and algorithmic platforms rely heavily on human workers to clean, curate, and categorize data. However, often these workers are largely invisible to others

in organizations and have been labeled as “ghost workers” (Gray & Suri, 2019). This trend highlights the importance of visibility – of both identity and practice – for organizational members relative to perceptions of expertise and status within organizations. As Flyverbom and Reinecke (2017, p. 1632) note, “If something appears, is visible and talked about, the assumption is that it must be good or important. At some point, we conflate visibility with value.” Future research must explore ways that the skills, abilities, and knowledge of process experts can become more visible within organizational contexts.

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APOLITICAL, PROFESSIONAL, OR INSTITUTIONAL: RECONCEPTUALIZING EXPERTISE IN PUBLIC ADMINISTRATION

Samantha Ortiz Casillas

Nova School of Business and Economics, Portugal

ABSTRACT

The work of public administration is important, from attending to the everyday needs of citizens to addressing complex social problems. Across organizations, a wide variety of workers design, plan, implement, manage, and evaluate the actions that make governments function. Yet, while central to governing capacity, the study of expertise in public administration has been limited and fragmented. Efforts to understand it adopt narrow definitions of expertise as professional or scientific knowledge and are driven by concerns over workers' politization, interference with political authority, and democratic will. In this essay, I map out classical and contemporary understandings of expertise in the context of public administration and propose a research agenda. I identify in the literature notions of expertise as apolitical, professional, or institutional and argue in favor of the last one. Institutional expertise refers to workers' ability to perform tasks and fulfill organizational mandates by navigating the formal and informal structures, relationships, norms, and practices that facilitate and constrain action within public administration. It explains how workers reconcile the technical, administrative, and political dimensions of government work and "keep the lights on" across

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changes and crises. I argue that looking into the political dimension of expertise, at workers below the top and behind the frontline, and at more diverse and challenging contexts, can improve our understanding of expertise in the context of public administration.

Keywords: Expertise; public administration; government work; politics; institutional expertise

INTRODUCTION

Public administration encompasses a wide variety of workers that translate laws and decisions into the policies, rules, and actions that govern the lives of people. Within their organizations, these workers address problems and oversee functions as varied and important as clean water; climate change; gender violence; regulating small and large businesses; public education; or public health. Workers across the hierarchy collectively inform, translate, plan, implement, or evaluate laws created by the legislature and the decisions of democratically elected leaders and their political appointees. While we know increasingly more about the work of those at the top (Page & Wright, 2006; Rhodes et al., 2007), in the frontline (Chang & Brewer, 2023; Lipsky, 2010), or at the periphery (Lavertu & Weimer, 2011; Marciano, 2023) of public administration, workers “in the middle” – their efforts and expertise – have received less attention (Page & Jenkins, 2005).

Expertise in the context of public administration involves the knowledge, tools, and techniques that workers employ to address the functions and challenges of government. It is key to the rise of the modern state (Heidelberg, 2024), the ability of political leaders to make decisions and navigate crises (Rutledge, 2020), and state capacity (Hanson & Sigman, 2021). Yet, efforts to understand how workers develop, share, use, and accumulate expertise within and across public organizations are limited and fragmented. Across the study of public administration, expertise refers predominantly to the use of professional or scientific knowledge (Jasanoff, 1998; Lambright & Teich, 1978; Smith, 2010) and research focuses on outside or peripheral workers like consultants (Laage-Thomsen, 2022; Lepont, 2021; Marciano, 2023; Walker, 2014), advisors, or committees (Grömping & Halpin, 2021; Jasanoff, 1998; Lavertu & Weimer, 2011) that best embody this type of expertise. Emphasis on scientific and technical knowledge excludes other types of work and support concerns over the incompatibility between expertise and political issues – like the decisions of leaders (Centeno & Silva, 2016; Fischer, 1990) and the will of the electorate (Bertsou & Caramani, 2020). While there have been recent efforts to understand the work and expertise of workers within the bureaucracy, these have focused overwhelmingly on the street-level (Arnold, 2014; Campos & Peeters, 2022; Chang & Brewer, 2023; Lipsky, 2010; Masood & Nisar, 2022; Maynard-Moody & Musheno, 2009; Zacka, 2017) rather than the office-level. Thus, the expertise of workers “in the

middle” – the less visible work that can account for the performance of government and for “keeping its lights on” across changes in leadership, policies, and ideologies – remains underexplored.

In this essay, I shed light on the expertise of the people employed below the top and behind the frontline of public administration. I argue that the study of these workers – “capable of imagining, planning, and directing large scale and long term programs for social and economic change” (Grindle, 1977, p. 400) – needs more attention. Recent research on the crisis of expertise looks at citizens’ and politician’s distrust in experts (Clarke & Newman, 2017; Collins & Evans, 2019; Eyal, 2019; Eyal & Medvetz, 2023; Reed & Reed, 2022). Part of this crisis is explained by a general lack of knowledge and appreciation of the conditions in which workers inside the bureaucracy perform tasks and how they come to produce information, advice, or policies. Related to this crisis, are also concerns about states’ declining administrative capacities brought on by populism and democratic backsliding (Bauer, 2023; Bauer et al., 2021; Bauer & Becker, 2020; Koga et al., 2023). While some research has looked into how organizations can adapt to resist and overcome threats to their work (Bersch & Lotta, 2024; Bozeman et al., 2024), research into a wider variety of workers and contexts is necessary to understand the resilience and adaptability of public administration. Indeed, understanding and adapting one’s work to the political context might be key to workers’ expertise in public administration (O’Leary, 2017, 2019). Last, but not least, continuous calls to address grand challenges and wicked problems have in part supported an increased attention into the role that expert workers can play in policymaking (Christensen, 2021; Daviter, 2019; Fjørtoft, 2022; Head & Alford, 2015). Yet, these studies tend to focus on the expertise of external advisors (Christensen, 2021), ignoring the various forms of “inside” expertise that account for organizational performance and states’ governing capacities (Hanson & Sigman, 2021; Williams, 2021).

To bring more attention to the knowledge, tools, and techniques that workers employ to address the functions and challenges of public administration, I review the literature and propose a research agenda. I first identify and describe foundational ideas on the form and function of expertise, in classical texts of public administration, and argue that they shape how we understand expertise to this day. Then, I discuss studies of expertise and expert work from the last five decades, classifying them in three categories: research that defines and studies expertise as apolitical, as professional, and as institutional. I argue that while apolitical and professional expertise restricts its study to a few types of workers, functions, and spaces, institutional expertise points to the variety of middle-level workers that inhabit public organizations and fulfill their functions. It offers the potential to explain how these workers conduct their work and navigate the formal and informal structures, relationships, norms, and practices that facilitate and constrain action within public administration. Based on this review, I propose a research agenda focused on comprehending the political dimension of expertise, looking at workers below the top and behind the frontline, and in contexts outside the Global North.

This essay contributes to the study of expertise in and around organizations and of public administration work. Expertise in the context of government has been primarily studied by disciplines like public administration and political science and marginally by sociology, management, and organization studies – where the systematic study of expertise has been thriving for some decades (Abbott, 2014; Collins & Evans, 2008; Eyal, 2013; Heimstädt et al., 2024; Pakarinen & Huising, 2023). Expanding the study of expert work to this context has the potential to enlighten the ways in which political values, ideologies, and interests shape and challenge expertise. This essay also contributes to the study of work in public administration by challenging dominant notions of expertise as instrumental or problematic. It draws attention to a greater variety of workers capable of reconciling the political, social, administrative, and technical dimensions of government work. These workers' expertise can offer clues on how to address contemporary challenges like populism, democratic backsliding, or distrust in experts. Beyond looking at how top officials make decisions or how frontline workers negotiate policy implementation, I show that we need to pay attention to the more invisible office workers that understand how government works and manage to “keep the lights on” across changes and crises.

THE FORM AND FUNCTION OF EXPERTISE IN PUBLIC ADMINISTRATION

Before discussing contemporary research on expert work, it is useful to go back to early notions of expertise, in the context of public administration, that shape how we think about it today and around the world. Two ideas on the form and function of expertise appear in foundational texts from Western Europe and the United States. One, that public organizations – in their ideal bureaucratic form – concentrate the expertise needed to govern and this concentration can threaten political leaders. Two, that expertise should be strictly technical, neutral, and apolitical to guarantee the effectiveness and efficiency of public organizations. Together, these two ideas characterize expertise in the context of public administration as important yet problematic because of its interaction with political actors and processes. They support a narrow understanding of expertise as technical knowledge that can threaten or be threatened by political power (i.e., actors, leaders, and processes). I explain each idea briefly before showing, in the following sections, how they have influenced the study of expertise for decades.

The first idea comes from the conceptualization of bureaucracy as the ideal or dominant form of organizing public administration because it allows organizations to accumulate, develop, and mobilize expertise (Farmer, 1995; Olsen, 2006; Weber, 1978; Wilson, 1887). According to Weber (1978), “bureaucracy is the means of transforming social action into rationally organized action” through its “technical superiority” (p. 987). This technical superiority comes from expertise – the result of “expert training, a functional specialization of work, and an attitude set on habitual virtuosity in the mastery of single yet methodologically integrated functions” (Weber, 1978, p. 988). Expert workers in the bureaucracy “have

specialized training and by constant practice increase their expertise” (Weber, 1978, p. 975). That is, bureaucratic workers bring with them professional training but also cultivate and develop expertise with time. This accumulation of expertise allows bureaucracies and their workers to play a central role in the administration of the state. A role that supports yet threatens political power and leadership.

In his discussion of the power position of the bureaucracy, Weber identified as a source of constant tensions the “ruler’s dependence on the bureaucracy”; because of its expertise, “the political ‘master’ always finds himself, vis-à-vis the trained official, in the position of a dilettante facing the expert” (Weber, 1978, pp. 991–993). Weber asserted that for either an absolute monarch or a democratically elected leader, “the superior knowledge of the bureaucratic expert” is a necessity and a challenge in the exercise of government (Weber, 1978, p. 993). Public bureaucracies control the information, resources, knowledge, and tools needed to govern and rulers are unwillingly reliant on these organizations and their experts to exercise their power. To cement and protect their role, bureaucracies keep their expertise a secret, protecting it from public scrutiny, competitors, foreign hostile actors, and even elected officials (Weber, 1978). Thus, bureaucracy’s ability to accumulate expertise makes public administration a necessity and a problem. Rulers need it to be formidable yet strive to contain and control its power.

The second idea that shapes understandings of expertise in public administration refers to how this work should take place in relation to politics (i.e., political parties, institutions, and actors and their partisan interests, agendas, and efforts to direct government). In *The Study of Administration*, Wilson (1887) writes on the need to improve how public organizations and workers operate, to increase their efficiency and effectiveness, and to answer to the will of society. Wilson writes that “the field of administration is a field of business” and it is only related to political life “as machinery is part of the manufactured product” (Wilson, 1887, p. 210). Through strict appointment procedures for civil servants and forms of organization and action that protect “the sanctity of public office,” administrative questions can be kept separate from political questions (Wilson, 1887, p. 210).

According to Wilson:

although politics sets the tasks for administration, it should not be suffered to manipulate its offices ... politics is the special province of the statesman, administration of the technical official ... policy does nothing without the aid of administration; but administration is not therefore politics (Wilson, 1887, p. 210).

While Weber is preoccupied with the politician’s dependency on the bureaucracy, Wilson is preoccupied with maintaining the bureaucracy pure and immune to political dynamics. Both agree on the function of expertise – to make public organizations effective and efficient in performing government tasks – yet see it as either unavoidably linked to (Weber) or necessarily separate from (Wilson) political power (i.e., actors, leaders, and processes).

Wilson envisioned a model of work and organization that is based on perfecting methods and procedures for administering government and implementing policy decisions that, although political in origin, are treated by the bureaucracy

as apolitical – that is, as instructions to be executed in the most effective and efficient way. Regardless of whether it is possible to separate the work of public administration from political actors and issues, this second idea defines expertise as the antithesis of politics: neutral, apolitical, and business-like, possessed by the technical official dealing exclusively with administrative questions.

These two central ideas in the study of public administration shape how we think about the form and function of expertise today and around the world. Expertise is developed, accumulated, and stored within public bureaucracies. This accumulation of expertise sustains leaders' capacity to govern. Yet, it also creates tensions. It makes leaders dependent on the bureaucracy, anxious about the need to control it. It raises social and scholarly concerns on how expert work should take place: responding to official decisions but isolated from the political relationships and processes that produce them. The two ideas assert the importance of expertise for the functioning of the modern state yet perceive its interaction with political actors as problematic. Next, I show how these ideas on the form and function of expertise have influenced decades of studies on the work of public administration.

REVIEW METHODS

I examine how expertise is conceptualized and studied by drawing on a synthesis of the literature that, although not exhaustive, aims to be representative of what we know about expertise and expert work in public administration. I used the Web of Science Core Collection database – one of the most comprehensive in the world – to find research articles and book papers in the past five decades (1974–2024) that refer to expertise or the work of experts in the context of public administration.¹ I restricted my search to articles from the main journals for public administration, management, sociology, and political science.² I manually reviewed the title and abstract of 123 records that resulted from this search. To focus on the expertise of workers inside – and “in the middle” – of public administration, I excluded articles that focus on outside or peripheral experts working with government (like scientific advisors, committees, expert groups, expert activists, think tanks, civil society, and task forces); organizations that provide public services but do not perform central government functions (like public hospitals and schools); articles that mention government and expertise but are not about expertise in government organizations (e.g., studies that draw on surveys of experts to discuss policy issues); and studies of expertise that do not take place in government organizations or involve government experts. In this last category, I discarded the few studies from sociology and management journals that were picked up by the search.

I reviewed all records to identify the different meanings and role of expertise in public administration and forms of expert work. In particular, I reviewed each text in light of the following questions: What role does expertise play in public administration? What does the article mean by expertise? Who are the expert workers in this study – what do they do and what do they know? And what are the challenges to expert work identified in each case? In general, I found that most discussions come

from public administration and policy journals and to a lesser extent political science journals. I also found – perhaps unsurprisingly given the search was conducted in English and using an international journal ranking – that most studies in these top journals look at the United States, the United Kingdom, and Western Europe. After reading and thinking through these texts, I decided to organize them in the way in which they conceptualize expertise: as apolitical, professional, or institutional. In the next sections, I explain what I mean by each of these labels, discuss studies, and use this review to propose a future research agenda.

EXPERTISE IN PUBLIC ADMINISTRATION

Across studies on the work and organization of public administration, expertise is understood and studied in three main ways: as apolitical, professional, or institutional. Expertise, in the first two categories, is conceptualized as technical or scientific knowledge and practices contained in selected workers, functions, or spaces. The first category asserts the politics-administration dichotomy by focusing on fears of bureaucratic power or concerns over technical neutrality. It argues that there are certain workers, functions, or spaces that must not influence or be influenced by political actors, their interests, and decisions. The second category of studies examines the compatibility between professional and public administration values and practices and the effects of employing members of professions in public organizations. Expertise is developed externally, in the professions, or as an internal yet separate product of public administration work – with its own body of knowledge, methods, and practices. Last, the third category groups efforts to understand how organizations operate and how key government functions take place, by looking at workers' expertise developed within public administration. These studies offer a richer conceptualization of expertise as encompassing technical knowledge, tools, and methods yet also the competence to navigate the complex social, administrative, and political dimensions of public organizations. I discuss the three categories of studies and use the third one as inspiration for proposing a research agenda.

Expertise as Apolitical

A large collection of studies is concerned with the (in)compatibility between politics and expertise and seek to understand how the two can coexist without compromising each other. The normative notion that politics and administration should remain separate (Wilson, 1887) has been progressively countered by many who recognize that in practice the two spheres – their processes, functions, actors, and work – interact (Demir, 2009; Svara, 2001). Yet even as this interaction is acknowledged, it is problematized. In this category, we find studies looking critically at the politization of expertise – that is, whenever political interests or pressures influence functions or work that are technical and scientific – or studies that problematize the various ways in which expert workers influence the political processes of decision-making. Through these concerns over technical neutrality

or bureaucratic power, the dichotomy between politics and administration stays alive. These studies reinforce the notion that there are certain functions – the workers that conduct them and the spaces in which they take place – that are incompatible with political interests, actors, and decisions. The key point about expertise in public administration is that it is (or should be) apolitical.

On the one hand, studies of political interference or the politization of expertise³ understand expertise as technical knowledge and tools developed through scientific methods that are possessed by trained workers and can be objectively applied to a problem or sets of problems to uncover the best solution. These studies document the ways in which political actors – most recently in the context of populism and democratic backsliding (Bauer et al., 2021) – interfere with and obstruct expert work. Attacks on expert work can involve weakening its regulatory or legal framework, budget cuts, and political appointments (Bersch & Lotta, 2024). They can also involve using political discourse to delegitimize the role of expertise in policy and decision making (Peci et al., 2023), dismantling civil service (Moynihan, 2022), or coopting expertise to mask political interests with technical criteria (Nelkin, 1979). The problem these studies identify is the threat to or reduction of spaces within public administration that are dedicated to producing scientific knowledge and evidence to inform and assist policy design and the decisions of democratically elected leaders. Without sufficient protection for these spaces from political interests and influences, the harmonious complementarity between scientific knowledge and democratic will is lost. Expertise loses its value and becomes an unreliable function of public administration.

On the other hand, looking also at the problematic relationship between politics and expertise, but from a different angle, are the literatures on technocracy (Bertsou & Caramani, 2020; Centeno, 1993; Fischer, 1990); the politics of expertise (Bovens et al., 2008; Brint, 1996; Centeno & Silva, 2016; Turner, 2013; Whitehead, 2006); bureaucratic power (Bertelli & Busuioc, 2021; Mangset & Asdal, 2019); bureaucratic politics (Allison & Halperin, 1972; Bendor & Moe, 1985); and discussions on the bureaucratic threats to democracy (Boushey & McGrath, 2017; Cook, 2018; Etzioni-Halevy, 2009; Fischer, 2009; Steven, 1994). As the labels suggest, these literatures are concerned with Weber's original observation that political leaders, parliaments, citizens, and society at large are dependent and thus subordinate to "the superior knowledge of the bureaucratic expert" (Weber, 1978, p. 993). Bureaucrats' – or technocrats' – monopoly over expertise makes them a potential threat to political leadership and democracy and the object of continuous administrative efforts to control, supervise, and make their work more transparent.

These studies also understand expertise as technical skills, specialized knowledge, and sophisticated methods yet problematize the fact that this expertise is either protected from, obscured, or not accessible to people outside the organization. Research on bureaucratic power has looked mainly at the context of policymaking (Boushey & McGrath, 2017; Centeno, 1993; Fischer, 1990, 2009) – in particular economic policy (Centeno & Silva, 2016) and policy evaluation (Bovens et al., 2008) – and at popular types of expert workers like senior civil servants (Mangset & Asdal, 2019) or foreign affairs analysts (Allison & Halperin,

1972). Across these types of work and workers, the exclusionary character of expertise makes it a problem in the context of public administration:

Expertise is treated as a kind of possession which privileges its possessors with powers that the people cannot successfully control and cannot acquire or share in (...) Expertise is a problem because it is a kind of violation of the conditions of rough equality presupposed by democratic accountability. Some activities are apparently out of the reach of democratic control ... precisely because of imbalances in knowledge (...) we are faced with the dilemma of capitulation to “rule by experts” (Turner, 2013, p. 17).

Based on this problematization of expertise, these studies look at how public workers influence decision-, policy-, and rule-making directly or indirectly. For example, by progressively redefining political questions as scientific ones to absorb them into their jurisdiction (Centeno, 1993) or through the curated representation and use of information, resources, knowledge, and tools to influence government actions (Cohen, 2013). Under this approach, expertise is a necessary yet problematic dimension of public administration whose boundaries must be continuously assessed, supervised, and controlled.

Studies on the politization of expertise and on bureaucratic power argue that the appropriate role for and form of expertise (in the functions and activities of government) is apolitical. Expert workers supply knowledge, evidence, and technical skills and methods, but they must do so without concealing or manipulating information to suit the political context (Cohen, 2013). Workers support decision-makers – political appointees or leaders – with the implementation of policies and programs but should not guard this policy expertise from their principals (Bertelli & Busuioc, 2021). Public administration organizations should continuously develop their expertise through professionalization but without threatening the authority of democratically elected leaders (Boushey & McGrath, 2017). According to this category of studies, there is a correct and incorrect use of expertise in public administration. Yet, normative thought around the form and function of expertise is not fixed. As regimes change and states face new or different challenges, “the realm of the specifically ‘political’ may either expand or contract [and]... what counts as expertise, and how much autonomy it is granted, also varies over time and space” (Whitehead, 2006, p. 119). As recent examples show, what was once under the exclusive purview of experts (e.g., climate change or vaccination) can transform into political issues contested by majority and minority interests in many parts of the world (Eyal & Medvetz, 2023).

Studies in this first category convey the idea that interactions between expert workers and political actors outside the advisor–advisee model are problematic. The relationship between expert workers and politicians is defined by the separation of “technical skills” – that is, “intellectual capabilities, most often acquired through formal educational processes, which enable an individual to collect, organize, and analyze data on specific subjects, or to employ such information in the making of decisions” – from “political skills” – that is, “the intellectual and personal attributes which make it possible for an individual to influence, mobilize, manipulate, or control other human beings” (Grindle, 1977, p. 403). While politics and administration can interact in various ways, expertise – the core of

administration work – becomes problematic if it is used to influence, mobilize, control, or manipulate the functions and decisions of public administration.

Expertise as Professional

This second group of studies considers members of professions as a vehicle of expertise in public administration. Expertise is defined, as in the prior category of studies, as specialist knowledge and tools obtained by workers through training in a profession. Setting aside questions on politics, studies in this category examine how organizations acquire – and are transformed by – expertise when employing members of a profession. Interest in the employment of professions within public administration goes back at least five decades (Mosher, 1978; Mosher & Stillman, 1977). Coinciding with sociology's interest on the rise of the power and influence of professions around the same time, scholars in public administration began looking at professions that “operate within the constraints and delegations of government” (e.g., law, economics, accounting, and applied sciences) or those “almost exclusively governmental” (e.g., military, foreign service, or city management) (Mosher & Stillman, 1977, p. 632). Since then, scholars see the employment of members of professions as an effort to make government functions more efficient or effective and focus on understanding how these workers – through their abstract theories, tools, and methods – reshape the way public administration works.

The employment of professions fulfills operational requirements and technical mandates of public organizations. For example, accountants work across government organizations in basic functions like internal management, procuring goods and services, auditing, and contract negotiations. They also perform special government functions like taxation, public budgeting, regulation, and accountability (Morse, 1978). Some technical mandates call for the employment of professions like civil or aeronautical engineers (Schott, 1978) and environmental or agricultural scientists (Lambright & Teich, 1978). Besides employing members of professions, public administration can also be a source of new professions that can travel outside its boundaries. For example, mental health professionals (Feldman, 1978), foreign affairs officials (Bacchus, 1977), and urban planners (Baer, 1977) – or government-specific specializations within existing professions like city managers (Stillman, 1977) and school administrators (Mosher, 1977). Examining the close relationship between professions and public administration has led researchers to look at the ways in which these workers support or transform government functions.

The employment of members of professions within public administration transforms the practices and processes of organizations. Besides the use of specialized knowledge and methods, organizations are shaped by the professions' “own particularized view of the world and of the agency's role and mission in it” (Wollan, 1978, p. 107). For example, in the case of policymaking, the employment of natural and social scientists was found to alter “the cognitive frameworks and shared operating assumptions within the policy planning organization” (Bunker, 1978, p. 224; Fischer, 2009). “Thinking like a lawyer” shapes how policies (Wollan, 1978,

p. 105) and regulations (Macey, 1998) are made, influencing their design, discourse, goals, and instruments. Unlike outside committees and expert advisors, when employed within the bureaucracy, the expertise of professions becomes an inherent part of how organizations collect and process information, make decisions, design policies, and oversee their implementation. This influence over how organizations function sparks concerns. Particularly because professions are constituted around a set of values and standards that might contradict or change values traditionally associated with public administration (Nalbandian & Edwards, 1983).

One of the issues that has received most attention is the large-scale employment of economists and their ability to influence and shape policies, administrative reforms, and the way of thinking about and addressing social issues in general (see Babb, 2004; Davies, 2011; Hallett & Gougherty, 2024; Keren, 1993; Popp Berman, 2017, 2022; Rhoads, 1978). The influence of economists in public administration is partially attributed to the success with which they have led efforts to transform or “modernize” states (Babb, 2004; Keren, 1993) and adapted theories, tools, and methods to analyze and evaluate policy alternatives (Dror, 1967; Rhoads, 1978). The influence of this profession in public administration has had lasting consequences because of its ability to shape rationality (i.e., ways of thinking about social issues) and institutionalize economic tools, methods, and standards in decision making and the design of interventions (Popp Berman, 2022). For example, across regulatory agencies and policymaking organizations, it is considered standard to use tools like benefit–cost analysis, forecasting models, and insights from behavioral economics (Boardman et al., 1993; Cranor & Finkel, 2018; de Campos, 2022; OECD, 2017; Shapiro & Morrall, 2012; Sunstein, 2014). Even beyond the boundaries of the profession, economic thinking became part of the standard training that public affairs and management students receive before joining the public service (Hallett & Gougherty, 2024).

Looking at the professions employed across organizations is one way to improve our understanding of expertise in public administration. While this category of research only looks at workers that can be identified as members of an established profession, these workers play an important part below the top and behind the frontline of organizations. Like scholars acknowledged five decades ago (Mosher & Stillman, 1977), professions and government shape each other in various ways and there are many professions that need greater attention. In recent years, studies in this line of research have focused mostly on economists or natural scientists in advisory roles, leaving many of the other professions that inhabit public administration underexplored. While we have learned about how professions shape public administration processes and functions, it is also important to learn how the administrative and political dynamics inside organizations reshape the work of professions. I elaborate on potential lines of research in the final part of this essay.

Expertise as Institutional

The last category of studies examines what I call institutional expertise. It refers to workers’ ability to perform tasks and fulfill mandates by navigating the formal

and informal structures, relationships, norms, and practices that facilitate and constrain action within public administration. Unlike the previous two groups that define expertise as exclusively specialist knowledge and tools linked to professional training, these studies examine the expertise that workers develop, through experience and practice, on the inner workings of government. Institutional expertise is close to Weber's notion of bureaucratic expertise, involving specialization and "habitual virtuosity" around a particular function (Weber, 1978, p. 988). Yet, it refers not only to mastering technical tools and methods but also the knowledge, relationships, formal and informal procedures and practices, and political sensitivity necessary to fulfill organizational mandates. Institutional expertise is an opportunity to appreciate "the value-laden and relational nature of knowledge and expertise, showing how its formation is endogenous to political processes" (Slayton & Clark-Ginsberg, 2018). It shows how workers simultaneously react to the social, administrative, political, and technical conditions of their organization and how they reconcile multiple and at times competing demands through their work.

Because of its almost invisible character – at least in quantifiable or formal terms – and close interaction with the political context, institutional expertise is overlooked. It is not as easily identified and conceptualized as professional expertise (i.e., formally recognized outside the boundaries of public organizations). Also, it can spark concerns over technical neutrality or bureaucratic power as workers take into account and influence the politics around decisions, policies, and regulations. To illustrate what institutional expertise entails, and its importance for understanding the functioning of public organizations, I draw on studies of policymaking and bureaucratic or administrative work. These two cases offer the opportunity to explicitly and pragmatically examine the realities of government work below the top and behind the frontline. In the rest of this essay, I will argue that institutional expertise is a more fruitful line of inquiry to both expand our understanding of expertise and develop a better understanding of how public organizations function.

In recent decades, and given its importance for governing society, the work of policymaking has received significant attention. Policymaking involves problematizing social situations, discussing possible interventions, making recommendations, designing policy interventions, and planning and overseeing their implementation. It is not about "making policy" in the sense of making an authoritative decision such as passing a law or changing a budget"; it involves the work of "developing, running, or evaluating a program or scheme" (Page & Jenkins, 2005, pp. 55, 58). Policymaking is a complex phenomenon because of the diversity of organizations, workers, and dimensions it encompasses. It is conducted across a large variety of organizations and agencies within public administration, all of whom have some policy responsibility as part of their organizational mandate. Policymaking involves a wide range of workers within these organizations, most of whom operate not at the top or at the frontline but across the middle. Most importantly, policy work does not occur in a vacuum. Workers "face all manner of structural, institutional and organizational constraints, challenges and opportunities in framing, designing, implementing and

evaluating policy” and how they respond to these circumstances “is heavily conditioned by the skills, expertise, experience and creativity that they bring to their role” (Considine et al., 2014, p. 222). For these reasons, the work of policymaking is one of the most fruitful ones to understand expertise in public administration.

Policy workers, policy analysts, or policy bureaucrats have captured the attention of scholars who seek to identify and characterize them and to understand the important role they play in public administrations. Early accounts identified these workers as “experts,” “professionals,” “sometimes a specialist, sometimes a generalist” that “helps formulate solutions to problems of public policy” (Meltsner, 1976, p. 1). The role of policy analysts (Meltsner, 1975, 1976) or bureaucratic analysts (Feldman, 1989) was first understood as simply providing information to policy and decision makers on the best alternatives to design and implement a policy. Like the professional workers in the previous category, policy analysts were social or natural scientists that appreciated the opportunities for power and impact afforded by their position in government (Meltsner, 1975). Yet, as time passed and policy work became a distinctive feature of public administration, the diversity of policy workers increased, and our collective understanding of policy work became more nuanced.

Some of the most insightful research comes from rejecting the myth of the top official as the main figure in policymaking (Page, 2015) and looking “at the middle”: “where much of the detail of policy work is done” (Page & Jenkins, 2005, p. 19). Research on middle-ranking officials found that although these workers have a university education and come from disciplines as varied as sociology, public administration, business studies, biochemistry, law, economics, or linguistics, “it is not a degree that makes them specialists” (Page & Jenkins, 2005, p. 35). Their expertise comes from their job experience. This experience is not gained by staying on the same job for many years but by constantly moving across jobs involving diverse policy subjects and various aspects of the policymaking process (Page & Jenkins, 2005). While similar to Weber’s notion of expertise as coming from long-term specialization (Weber, 1978), this specialization comes not from doing a single task over a long period of time but by learning about how policies are made across diverse issues, sectors, and stages in the iterative process of policymaking. This accumulation of experience is key to institutional expertise.

Another important dimension of policy work – and institutional expertise – is the ability to combine “political and bureaucratic activities” (Page & Jenkins, 2005, p. 55). For example, Feldman’s (1989) study of bureaucratic analysts shows how producing information for policy and decision making requires as much technical knowledge as sensitivity for the political context. To address problems of uncertainty and ambiguity in policymaking, workers interpret data and frame it by taking the political context into consideration. Subsequent studies (Albæk, 1995; Cairney, 2016; Page & Jenkins, 2005) have also found that policy work entails not only producing facts and information but framing it in a way that is useful for decision makers and more likely to gain political support. The expertise of policy workers involves developing close relationships with officeholders in order to develop their political sensitivity and secure better conditions for policy

design and implementation (Batten et al., 2006). Thus, policymaking shows us how institutional expertise is not about workers' ability to maintain technical and scientific knowledge separate from political concerns. Rather, workers' expertise involves the ability to combine technical, political, and administrative dimensions in a way that makes policy design and implementation possible.

Looking more closely at this ability to do one's job and keep public organizations operational – despite a complex political environment or potentially contradicting demands – is bureaucratic or administrative work. Here, I include studies on administrative work or “knowing the rules” (Wagenaar, 2004); authoritative expertise or “knowledge and skills stemming from the experience of service in itself” (Mangset & Asdal, 2019, p. 579); and bureaucratic expertise (Liu et al., 2017). In general, these strands of research point to the expertise that workers develop, through experience and practice, related to the inner workings of government. This expertise involves knowledge, techniques, practices, and interactions that are specific to working within public administration, are necessary and transferable across organizations, and allow workers to operate in a complex and ever-changing administrative and political context. Similar to policymaking work, it involves concrete knowledge on the formal rules and processes of public administration but also the ability to navigate formal and informal norms in order to get the job done.

In his theory of “administrative work as practice,” Wagenaar (2004) draws on symbolic interactionism to examine the hidden aspects of administrative work that can account for more visible elements like decisions, reports, negotiations, procedures, rules, or structures. These are:

Effectuations, enactments of the hidden, taken-for-granted routines: the almost unthinking actions, tacit knowledge, fleeting interactions, practical judgments, self-evident understandings and background knowledge, shared meanings, and personal feelings that constitute the core of administrative work (Wagenaar, 2004, p. 643).

Institutional expertise refers to this taken-for-granted know-how that is the result of workers making sense of their context together and learning how to navigate it to fulfill their mandate. This notion of expertise allows us to appreciate the relational character of public administration work (Bartels & Turnbull, 2020) and to extend its study to all types of workers found within the bureaucracy. Workers make sense of situations collectively, they act in interaction with others to align interpretations of what is going on, and they are thus able to achieve action and cooperation despite conflicting or evolving technical, administrative, social, or political conditions (Wagenaar, 2004).

Research shows that government work requires more than knowing the rules or possessing technical or scientific knowledge and tools.

In a bureaucracy, it is presumed that the rules dominate, and the rules are a public transcript. The hidden transcript, though, is the use of the rules. In terms of the work of public administrators, they do not simply follow rules; they use rules. In doing so, they create situations rather than simply respond to them (Heidelberg, 2016, p. 736).

Across functions and levels of public administration, workers require skills and networks to circumvent everyday challenges (Liu et al., 2017). For example,

research on the work of senior civil servants shows that it takes more than professional knowledge (i.e., in economics or law) to assert their power and influence decision making. Senior workers learn specific ways of writing to get the attention of political actors, they correct and improve notes collectively, and they gain and share this expertise through the ongoing training and supervision of younger officers (Mangset & Asdal, 2019). Analysts in rulemaking also use their knowledge of the process (Balla, 2015; Potter, 2019; West, 2004), the political and administrative context, and their experience on what rules work best – or do not work at all (Heidelberg, 2016) – to influence how and what regulations are made in line with their organizational mandate. As these studies show, understanding institutional expertise requires going beyond official accounts of what organizations know and do and looking into the day-to-day work of public servants, how they establish their authority and legitimacy, and how they perform their work.

Institutional expertise – through policymaking, bureaucratic, or administrative work – shows that in order to make public administration operational, workers need to combine knowledge and skills related to the administrative, political, and technical dimensions of government. It goes beyond professional training and knowledge. It encompasses aspects of relational (Pakarinen & Huising, 2023; Sandefur, 2015) and procedural (Barley et al., 2020) expertise – knowledge on “social processes” and “communicative practices” (Barley et al., 2020, p. 62) and on “how to navigate the relationships involved in getting work done” (Sandefur, 2015, p. 911). Yet, institutional expertise is specifically about the art of government. It involves knowing how to navigate the intricate system of laws, actors, and organizations and it requires “political knowledge” – understood as “what individuals know about political systems, structures, institutions, norms, and rules as well as how politics works and what is going on in politics” (Liu et al., 2017, p. 719). Institutional expertise does not entail a “one best way” to run public organizations nor does it assume that there is one bureaucratic rationality that can be tapped into and understood. This form of expertise recognizes and adapts to the diverse and complex character of public organizations in which conflicting or contradictory forms of knowledge and control interact (Carnevale & Stivers, 2019). Unlike research under the politics and administration dichotomy, this third category understands that getting the job done requires knowing, navigating, and answering to the political context of public administration.

A FUTURE RESEARCH AGENDA

Research on the meaning, role, and challenges of expertise in public administration is limited and fragmented. On the one hand, expertise has been primarily understood as professional or scientific knowledge and practices that take place around specific mandates and functions and through dedicated spaces and workers. Outside these pockets of professional or scientific expertise, the knowledge, tools, and practices that public workers use to fulfill the various functions of public administration and address its problems and challenges

are understudied. Beyond compiling policy knowledge to make recommendations or assessing the technical criteria of subject-specific regulations, how do workers within and across public organizations generate, mobilize, accumulate, and share the expertise required to govern? On the other hand, a large focus across studies has been the clash between these selected pockets of expertise and the political context of public administration. These studies show that public administration cannot be isolated from politics and that the political context conditions and shapes government work. Yet, how do various workers experience, understand, and address the political context? How does it shape their expertise? And how do they adapt their work and fulfill their mandates – “keeping the lights on” of government – across changes in political ideologies and leadership? The ability to respond to the political context and interact with political actors, rather than remain apolitical, seems an important yet underexplored dimension of expertise in the context of public administration.

In an effort to address these limitations, I argue that we need to go beyond conceptualizing expertise as apolitical or professional and focus on understanding it as institutional. This involves a systematic study of how workers – in interaction with each other and other actors – generate, apply, and recognize the different types of knowledge, tools, and techniques necessary to address the problems and challenges (Pakarinen & Huising, 2023) of public administration. In particular, I propose expanding our study of institutional expertise in three ways. First, to study the “political” dimension of expertise – including negotiations, (re)interpretations of rules and mandates, (re)definitions of public value, or mobilizing and influencing interests and decisions –, in combination with technical and scientific knowledge and tools. Putting the politics-administration dichotomy to rest means not only acknowledging the various ways in which politics interferes with government work but also understanding workers’ efforts to deal with political issues as a key element of their expertise. Second, to go beyond selected pockets of scientific or professional expertise and understand how workers within and across bureaucratic organizations generate, apply, and recognize knowledge, tools, and techniques central to government work. This involves going below the top and behind the frontline, systematically looking at “the middle” (Page & Jenkins, 2005, p. 19), to unpack the “technical superiority” (Weber, 1978, p. 987) of public bureaucracies. Third, to expand our understanding of expertise in public administration by looking at more diverse and challenging contexts. Most research has focused on the Global North, precisely because these settings best adhere to ideal types of expertise and administration as scientific and professional. Yet, in the Global South, workers’ expertise can play a unique role in fulfilling organizational mandates amid adverse conditions. With little or no career protection (Dussauge Laguna, 2011; Kearney, 1986), patronage and clientelism (Bearfield, 2009; Oliveros, 2021), and the need to address grand challenges with limited economic and institutional resources (McDonnell, 2020), workers creatively draw on their knowledge, tools, and techniques to keep government operational. Understanding expertise across a wider variety of workers and contexts can help us understand what the work of government entails and why public organizations function the way they do.

Looking at the Political Dimension of Expertise

Expertise in the context of public administration is conditioned by the political actors, institutions, groups, and interests that shape the exercise of government. So far, the relationship between expertise and the political context of public administration has largely been examined as a problem. Concerns over technical neutrality or fears of bureaucratic power are based on the assumptions that expertise involves only technical or scientific knowledge and practices – exclusive to certain workers, functions, or spaces – and that these are incompatible with political interests, dynamics, and decisions. Yet, while these literatures address important issues on the integrity of public administration work, they limit our understanding of expertise. They recognize expertise only in relation to the use of scientific and professional knowledge and support the notion that there is one correct way of enacting expertise – one that adheres to the politics-administration dichotomy. What is missing is an understanding of how workers, as part of their expertise, use knowledge, tools, and practices to navigate the changing political context and conduct their work.

Future studies can expand our understanding of expertise by paying attention to the more “informal” or “political” aspects of public administration work – such as negotiations, (re)interpretations of rules and mandates, (re)definitions of public value, or mobilizing and influencing interests and decisions. This political dimension of expertise, understood in interaction with technical and scientific practices, can account for how officials conduct their work and how public organizations function. It can help us understand how – in constant interaction with public opinion, notions of public interests, techno-legal mandates, and the political context – workers use skills, knowledge, and methods to get the job done and keep public administration working. Going beyond the problematization of “political skills” (Grindle, 1977, p. 403) can shed light on the types of work that are instrumental in reconciling the administrative, technical, political, and social realities of public administration. It can redeem the intricacies of expert work and counter the assumption that public organizations are machines that can be tuned, through legal-administrative reforms, to protect and isolate expertise.

Based on some of the insights discussed throughout this essay, I propose that we look at expert work as continuously shaped by workers’ interpretations of the political context. Expert workers within public bureaucracies are bound by administrative rules that govern what they can and cannot do (Gailmard & Patty, 2007). Yet, they also respond to how the information and advice they produced is used and reframed (McQuade, 2016). Workers depend on the support of political actors, like politicians or legislators, for the design, implementation, and continuation of policies (Bersch & Fukuyama, 2023; Carpenter, 2001; Christensen, 1991; Heredia & Schneider, 2003). And lastly, because of the public nature of their work, they are mindful of the expectations of citizens and how their work is assessed by the public (Bechky, 2021; Karunakaran, 2024). Expert workers are constantly making sense of and negotiating the boundaries of their work and opportunities for action.

Studies have already signaled that workers use dimensions of their expertise, like technical or scientific knowledge, strategically – depending on public attention

or political disagreement over goals (Eckert, 2018; Lundin & Öberg, 2014). For example, in the context of policymaking, interactions between bureaucrats and politicians involve “expertise bargains”:

In expertise bargains, bureaucrats offer politicians some form of knowledge or skills in exchange for some degree of administrative responsibility and discretion. Yet, expertise bargains vary in the emphasis on bureaucrats’ expertise relative to their political loyalty, in the kind of knowledge bureaucrats provide (e.g., specialized expertise in economics or law, generalist skills, or political process knowledge), and in the degree of autonomy bureaucratic experts enjoy. Expertise bargains may be deeply institutionalized and persist over time, but can also break down and give way to new bargains (Christensen, 2024, p. 80).

The way officials conduct their work and fulfill organizational mandates varies as a function of the political context and while this might be problematic in some cases, it deserves attention. The ability to successfully navigate the political context might in fact account for more influential or resilient forms of expertise. Like the *técnicos* in Grindle’s studies: “dichotomized models of *técnicos* and *políticos* are inadequate to explain the reality of political and administrative processes in Latin America... it is the *técnicos* who also have political skills who are increasingly important in policy making functions” (Grindle, 1977, p. 402). Future studies should look beyond the function of policymaking to understand other ways in which expert workers perform their work in response to political and other social or administrative factors.

Besides looking into the everyday work of public administration, understanding expertise as politically constructed also entails looking at how ideologies and interests drive the development or adoption of new forms of expertise and how changes in the political context over time can affect the role and practices of expert workers. Some of the studies I discussed on the employment of professional workers within public administration already show the way political interests and ideologies support the dominant role of some professions (Keren, 1993; Popp Berman, 2017) and even the development of the profession itself, beyond the boundaries of public service (Babb, 2004; Hallett & Gougherty, 2024). Looking at other groups of workers (besides economists), it is important to acknowledge that public organizations – created with a techno-legal mandate linked to expertise – are ideological and political products. Organizations are created to enact and fulfill a mandate which responds to ideological, political, and temporary visions of the role and function of government (Bertelli, 2006). As political leadership and administrations change, the expectations of political actors and constituents on the mandate and work of these organizations might also change (Demortain, 2004). “As a result of external changes, such as a change of government or an economic crisis, political leaders may no longer see the particular knowledge and skills offered by bureaucrats as relevant for achieving salient political goals” (Christensen, 2024, p. 80). The practices, tools, knowledge, and processes used by workers can become challenged (Demortain & Borraz, 2022), and they must adapt to procure the survival of their organization.

Research looking to understand the political dimension of expertise could answer questions like how do workers understand the political context and how do they adapt their work accordingly? What is the relationship between (a group

of) workers and political leaders and how do workers manage this relationship as part of their work? Across leadership changes, how do workers perceive and adapt their work to protect their mandate and organization? What is the political context that supported the rise of a particular class of workers or function and what accounts for their demise? How do workers experience and address challenges brought on by populism and democratic backsliding? What happens when workers fail to align their work with the political vision and mandate of leaders? How do workers successfully navigate leadership changes? These and other questions can help us abandon narrow notions of expertise as exclusively scientific or professional knowledge and capture the realities of government work.

Looking Below the Top and Behind the Frontline

The study of institutional expertise requires looking within organizations to understand how expertise is developed and shared through practice, interactions, and across generations of workers. In particular, future studies should look beyond top officials and senior civil servants (Page & Wright, 1999; Rhodes et al., 2007) or frontline and street-level workers (Arnold, 2014; Campos & Peeters, 2022; Cecchini & Harrits, 2022; Chang & Brewer, 2023; Fineman, 1998; Lipsky, 2010; Masood & Nisar, 2022; Zacka, 2017) to enrich our understanding of how government works. There is an immense variety of public workers who have systematically received little attention, leaving us without theories and concepts to accurately identify and characterize the work of those “in the middle” (Camp, 1972; Page, 2015; Page & Jenkins, 2005): “those at the top make the rules, those at the bottom simply apply them, but what the people in the middle do is harder to understand, as is the mix of creativity and constraint by rules and expectations that characterizes their work” (Page & Jenkins, 2005, p. 18). This “mix of creativity and constraint” is key to advancing our understanding of institutional expertise in public administration.

While the work of top officials or frontline workers is easier to identify and define – because of the decision-making or implementation role they fulfill in the system of public administration –, workers in the middle have a much more elusive role. In some contexts, vocabulary to identify types of workers in public administration has looked at the separation between politics and administration as guide (Salazar-Morales & Lauriano, 2020). While terms like “political appointee,” “career civil servant,” or “loyalist” might help illustrate the degree of influence that politicians have over public administration work, it does not help us explore how these workers perform tasks and play a role in the operation of public organizations. The most productive efforts to look “at the middle” have occurred in relation to a specific government function, like policymaking (Camp, 1972; Page, 2015; Page & Jenkins, 2005), or to members of a particular profession (Keren, 1993; Wollan, 1978). Possible lines of inquiry for future studies are to deconstruct the different forms of work and expertise that get grouped as “policymaking” or “rulemaking,” to look beyond these two main functions and identify others, and to consider professions that have received less attention.

In the coming years, we need to substitute the notion of “middle” for a richer vocabulary that showcases the intricacies of public organizations, functions, and work. Studies should look at how, for example, techno-legal mandates are translated into specific tasks and functions within organizations – the groups of workers involved and the interactions between them. While some of this distribution of work can be inferred by looking at organizational charts, studies in institutional expertise have shown that looking closely at the day-to-day activities and dynamics of organizations can help us better understand the configuration of expertise. By looking at the office level, we can account for how the top makes decisions and how the street level executes them. Workers in the middle conduct the key functions of translating laws and decisions into rules, programs, and activities that make government a reality. Efforts to understand how workers do this will inevitably show the importance of balancing technical, political, and administrative concerns.

Expertise in the Global South

The last way in which I propose to enrich our understanding of expertise in public administration is by exploring the richness of Global South contexts. As evident by looking at the majority of studies cited in this essay, studies of work, expertise, and public administration published in the main journals of our professions have focused overwhelmingly on countries of the Global North – in particular, the United States, the United Kingdom, and selected European countries. Perhaps because countries in the Global South are further away from normative ideals of public administration – that emphasize professionalization, formalization, and strict separation with politics (Du Gay & Lopdrup Hjorth, 2024; Wilson, 1887) –, the efforts of their workers are often ignored or misunderstood. Yet, in the Global South, workers’ expertise can play a unique role in fulfilling organizational mandates amid adverse conditions.

When we look at the selected studies that take place in the Global South, it is clear that these can enrich our understanding of government work and expertise and, most importantly, on how this work makes organizations operational despite complex or hostile institutional environments (Campos & Peeters, 2022; Canales, 2011; McDonnell, 2017). A focus on work and expertise can allow us to understand how states – even without Anglo-Saxon legal systems; low inequality; high economic development; or professional bureaucracies (Berwick & Christia, 2018; Savoia & Sen, 2015) – are able to display administrative state capacities. For example, by bending rules to address the needs of citizens (Canales, 2011); creating and protecting a bureaucratic ethos based on strategic recruitment, socialization, and symbolic rewards (McDonnell, 2020); or repurposing patronage to access necessary yet scarce resources and align efforts (Torralba, 2024).

Across the world, workers face administrative, social, and political conditions that vary with their institutional context. For example, their level of autonomy vis-à-vis politicians (Balla, 1998, 2015; Bolton et al., 2016; Calvert et al., 1989; Grimes & Simmons, 1969); (lack of) protection through a civil service (Dussauge Laguna, 2011; Gailmard & Patty, 2007; Kearney, 1986; Moynihan, 2022); prevalence of patronage appointments (Hollibaugh, 2017); demands for accountability

and transparency (Bennett, 1997; Bovens et al., 2014; West, 2004); and threats from corruption or organized crime (Arellano-Gault, 2019). All of these variations will affect how expert workers conduct the functions and fulfill the mandates of their organizations. By focusing overwhelmingly on the Global North, the richness of insights afforded by these contexts is foregone.

Relevant to contemporary public administration challenges, studies in the Global South can also help us better understand how organizations and their workers are affected by, adapt to, or counteract attacks from democratically elected leaders. Populism and democratic backsliding have emerged as important topics in the resilience and future of public administrations around the world (Arellano-Gault, 2020; Bauer, 2023; Bauer & Becker, 2020; Clarke & Newman, 2017; Moynihan, 2022). Selected studies, particularly in the Global South, have begun to look at how workers respond to and adapt to these challenges. For example, a study of policymaking during Bolsonaro's government in Brazil looked at how expert workers bargain with politicians to fulfill their mandates, depending on "the nature of the attack (local or extensive), the knowledge base's and epistemic community's level of cohesion, and the advice system's degree of institutionalization" (Koga et al., 2023, p. 378). Another study, also in Brazil, examined how environmental agencies are able to resist (or not) the president's efforts to dismantle them and obstruct their work, depending on their "leaders' previous experiences and their ability to learn, adjust, and tighten their grip on the instruments of the state" (Bersch & Lotta, 2024, p. 27). When it comes to the crisis of expertise and expert work (Eyal, 2019; Eyal & Medvetz, 2023; Reed & Reed, 2022), the continuous exclusion of Global South contexts as important cases for studies comes at the risk of limiting our understanding and imagination of how workers and organizations can adapt to new and future threats.

Research on expertise in the Global South can ask how do workers develop and share the knowledge and skills necessary to navigate the administrative and political context? How dimensions of technical, scientific, or professional expertise imported from the Global North are adapted to work in more complex settings? Studies can explore variations and similarities on how workers experiencing similar challenges – like patronage or populism – conduct and adapt their work. Research can look at organizations with techno-legal mandates that have managed to survive leadership changes and fulfill their functions and at how workers expertise makes this possible. By looking at Global South contexts, studies can more successfully abandon the illusion of the politics-administration dichotomy and focus on understanding how workers combine knowledge, tools, and techniques to address the functions and challenges of government.

CONCLUSION

In this essay, and drawing from a synthesis of the literature, I have discussed the ways in which expertise and expert work have been understood by scholars in the context of public administration. I traced notions of expertise present in foundational texts for the study of public administration and explained how these

classical notions shaped our understanding of expert work – defined by its separation from politics – in the following decades. As a first effort to expand our appreciation of what expert work in the context of public administration can entail, I identified and organized empirical studies in three categories. Studies looking at the problematic relationship between politics and expertise; studies looking at the employment of members from professions; and studies on what I call institutional expertise – workers’ ability to navigate the intricate world of public administration. Using these studies as inspiration, I proposed a future research agenda that looks at the political dimension of expertise; at workers below the top and behind the frontline; and at administrations outside of the Global North. I argue that these three lines of inquiry can lead us to improve our understanding, not just of expertise, but also of how governments function and can function better.

Throughout the essay, I made the argument that we need to leave behind the politics and administration dichotomy and grasp the different ways in which these two dimensions are inextricable. This requires that we accept the claim that “politics and administration are a coherent whole that cannot be partitioned” (Tsao, 2009, p. 1021) and that the expertise of workers is part of what makes the two dimensions work in practice. Leaving the dichotomy behind can help us adopt a more holistic understanding of expertise – as involving more than the technical skills and knowledge possessed by a professionally trained group of workers. As Weber (1978) once remarked, expertise in public bureaucracies is developed, shared, and accumulated by workers that not only received professional training before joining the organization but that collectively developed a special know-how on the inner workings of government. With this essay, I invite us to consider how do workers acquire, develop, and accumulate expertise inside public administration? What kind of problems or challenges does their expertise allows them to manage or circumvent and how? How do forms of expertise in this context relate to other profession-specific forms of expertise? And what can this expertise tell us about the administrative, technical, and political dimensions of government work?

This essay contributes to the study of expertise in and around organizations by looking into a context (i.e., public administration) that has not been the focus of sociology, management, or organization studies. The richness of conditions, phenomena, and workers that is found in public administration is bound to enhance current bodies of work. The essay also contributes to the study of public administration by offering a new way in which we can better understand how government organizations work and how they can work better. Understanding how workers perform central tasks and reconcile legal, technical, administrative, and political concerns can shed light on the effectiveness of government organizations and the ways in which administrative and governmental capacities are achieved.

NOTES

1. I searched for *expertise* (and variations, like expert) in the title and across topics including *government*, *public organization*, or *public administration* (and variations).
2. Using the SCImago Journal Rank indicator, I included: Public Administration Review, Public Management Review, Public Administration, Public Personnel

Management, International Review of Administrative Sciences, Journal of Public Administration Research and Theory, American Review of Public Administration, Administration Society, Review of Public Personnel Administration, Public Performance Management Review, International Public Management Journal, Governance, Organization Studies, Policy Studies Journal, Public Policy and Administration, Journal of Policy Analysis and Management, Regulation and Governance, Policy Sciences, Organization Science, Policy Studies, British Journal of Management, Annals of the American Academy of Political and Social Science, Journal of Management Studies, Academy of Management Journal, Politics and Society, Administrative Science Quarterly, Social Forces, Social Science Quarterly, Work Employment and Society, Gestión y Política Pública, Organization, Policy and Society, American Sociological Review, Sociological Forum, American Journal of Sociology, Social Science Research, Sociological Perspectives, Academy of Management Review, Sociological Review, Work and Occupations, Academy of Management Perspectives, British Journal of Sociology, Journal of Management, and Sociological Quarterly.

3. While outside this review, this line of inquiry is also found in studies that look at political influence over outside scientific advisors or expert committees (Jasanoff, 1998; Lavertu & Weimer, 2011; Wilkinson et al., 2010) and the influence of corporations or politicians, shaping deliberations over scientific matters (Priest et al., 1984; Smith, 2010).

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PURIFYING MARKETS: ALIGNMENT EXPERTISE AND THE COLLABORATIVE PRODUCTION OF GLOBAL MARKET INDICES

Alex Preda

Lingnan University, Hong Kong

ABSTRACT

I suggest here the notion of alignment expertise as group-based sets of operations and skills that simultaneously align (1) apparently incompatible worlds, (2) different domains of knowledge, and (3) heterogeneous layers of objects of expertise. The case on which I build the argument is that of market indices. These play a key role in global markets, being illustrative for the data world we live in. Indices are regulatory, epistemic, commercial, and automated objects. These features have to be simultaneously produced and maintained. Based on ethnographic observations in a data analytics firm, I argue that market indices align two very different worlds: the mini-world of econometric formulae and the messy world of computing machines. I identify two operations, grounded in collaborations between software engineers and financial analysts, that perform this alignment: first, a purification operation sorts out price and volume data into “source of truth” and “strange,” respectively. Then, a second purification removes excessive, yet “truthful” data. I argue that these operations are anchored in coordinated expert skills of reading and writing in multiple scripts at once.

Keywords: Alignment; objects; coding; data; markets

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INTRODUCTION

I examine here alignment expertise, understood as group-based, collaborative operations through which (1) apparently incompatible worlds of formulae on paper and machines, (2) different domains of knowledge, and (3) heterogeneous layers of objects of expertise are aligned with each other. I ground the argument in an empirical examination of global market indices: used by fund managers, pension funds, investment banks, or arbitrageurs in their strategies, pointed at by politicians as signs of successful (or failed) economic policies, indices such as the Dow Jones, S&P500, FTSE, or the Nikkei have a global presence and an impact well beyond financial markets. Market indices have multiple, heterogeneous layers that depend on each other and that need to be kept aligned. This cannot be achieved without aligning two very different worlds: that of formulae on paper and that of computing machines, respectively. In its turn, this requires aligning different domains of knowledge: finance, software engineering, and data science.

Consider the following elements: (1) market indices are regulatory objects, subject to the specifications of market authorities, but also regulating markets. They enable the construction of particular instruments (e.g., ETFs, or exchange-traded funds cannot be built without indices), are intrinsic to the strategies of market actors (e.g., hedge funds, market makers), and are used to evaluate financial performance. (2) They are commercial objects, being sold by data providers (since at least the 1920s) on a subscription or ad hoc basis, for a profit. (3) They are epistemic objects, being the subject of academic and commercial research, with evolving methodologies and data. (4) They are automated objects, being produced, processed, and disseminated within global networks of data centers, computer servers, and transmission lines.

None of these laminations¹ is possible without the others: the existence of indices as regulatory objects depends on them being viable commercial, epistemic, and automated ones at the same time. Conversely, indices being commercial, epistemic, or automated objects depend on them simultaneously being regulatory objects and continuing being so. As regulatory objects, indices are well-defined instructions, with institutional force, to represent an ideal market.² As commercial objects, indices are data sold and displayed to customers within set parameters. As epistemic objects, they are econometric formulae subject to experimental modifications. As automated objects, they are data that have to be regularly generated and circulated by machines.

The puzzle is then, what operations and activities make it possible to produce objects that are all this at the same time?

In the following, I examine this question based on an ethnography of how market indices are produced and maintained. The case at hand is that of licensed crypto market indices produced and disseminated globally by a UK data analytics firm. As in traditional finance (TradFi), markets in crypto and their actors (both institutional and retail) make extensive use of indices licensed by national regulators such as the Financial Conduct Authority (FCA, UK) or the Commodities and Futures Trading Commission (CFTC, USA), indices produced and sold by specialized data providers. They are relevant not only

because of their economic consequentiality on a global scale but also because they are emblematic of the data world we live in, where expertise is heavily involved in producing consequential data.

Building, maintaining, upgrading, circulating, and selling indices require a permanent collaboration of multiple domains of knowledge, not least those of software engineers, finance professionals, and data analysts. I ground the analysis in ethnographic observations of the operations deployed collaboratively in producing market indices, combined with interviews conducted with those involved in producing and using indices.

In a first step, I examine the literature on alignment expertise, objects, operations, and collaborations, with a focus on market indices. The second step presents the data and methods. The third step analyzes the ethnographic findings with regard to expert operations and the skills supporting them. I argue that market indices are objects that align two worlds: the mini-world of econometric models and the messy, real-life world of distributed computing machines. Two operations play a key role in this alignment. I call them here Purification I and II. Purifications sort and reduce data so that they can fit both worlds concomitantly. The conclusion discusses the relevance of studying forms of expertise that produce authoritative data and reiterates the notion of alignment expertise.

ALIGNMENT EXPERTISE AND MARKET OBJECTS

In relationship to expertise, issues of alignment have been conceptualized primarily as (1) alignment of expertise or (2) alignment expertise. Alignment of expertise means ranking different expertise domains and (experts) based on claims of knowledge absorption and authority (Bunderson, 2003). Especially when it comes to the relationship between software engineering and knowledge domains such as finance, alignment of expertise has been represented as software expertise absorbing knowledge domains (Ribes et al., 2019), as adapting to the demands of domains (van der Voort et al., 2021, p. 3), or as domain knowledge adapting to pressures from software expertise (Hansen & Souleles, 2023, p. 436). Alignment expertise though is understood as task-solving operations, grounded in skilled activities, that link together (Li, 2007, p. 265) apparently disparate entities or worlds, as well as knowledge domains, in order to produce objects of expertise, with specific properties.

In the context of financial markets, objects of expertise have been conceptualised alongside at least three dimensions: boundary objects coordinate the perspectives and interests of heterogeneous participants in collaborative activities (Leigh Star & Griesemer, 1989); epistemic objects generate uncertainties and focus curiosity (Knorr Cetina, 1999); infrastructural objects support distributed activities and relationships across networks of participants (Pardo-Guerra, 2019, p. 137). What objects of expertise would do then, generally speaking, is to coordinate participants, focus their attention, and support their distributed activities. Financial markets rely on combinations of boundary, epistemic, and infrastructural objects. These combinations, together with the social relationships emerging

in their operation, are regarded as socio-technical assemblages (Borch, 2022; Callon, 1998; MacKenzie, 2009, 2021; Pardo-Guerra, 2019). Assemblages create affordances for financial action while accelerating the circulation of financial capital. While objects of expertise can be interconnected (hence the notion of socio-technical assemblage), they are usually regarded as distinct and not as laminations of one and the same artifact.

For instance, analyses of high-frequency trading, of rapidly evolving algorithms and machine learning (ML) processes in financial trading (Hansen & Borch, 2022, 2021) have rested on a distinction between infrastructural and epistemic objects. While the first designate interconnected datacenters, servers, and transmission lines supporting the operations of algorithms and ML tools, these latter are rather seen as epistemic objects that generate uncertainties, focus the curiosity, and have limited explainability.

An ML-based trading algorithm is an object of expertise with epistemic features: it might generate new uncertainties, attracts the curiosity of builders and users (having only partial explainability), and generates multiple narratives concerning its effects (Borch, 2022; Borch & Min, 2023). However, it is also an economic object that has necessitated investments, has operating costs, and is expected to produce over time a return greater than its development and operating costs. If it were to cease being profitable, a trading algorithm would be abandoned. Therefore, it would cease being an epistemic object too. We know indeed that trading algorithms have a limited lifespan and cease being used once their stop being profitable, or when they are detected by competitors.

Not only that: by definition, a trading algorithm is a set of formulae (Lepinay, 2011), but also an automated object: its working and the results it delivers are inseparable from the machine(s) it is embedded in and communicates with. While computer screens (on which its results are displayed) are treated some times as secondary objects (Nicolini et al., 2012, p. 625), in financial contexts, they are treated as primary objects that both incorporate and display “the market” (Knorr Cetina, 2003; Knorr Cetina & Bruegger, 2002). Similarly, computing machines are primary objects, as trading algorithms will be written to run on machines with specific properties. If these properties are modified, so are the outputs of the algorithm and its functioning. Donald MacKenzie (2021, p. 167) highlights that the language in which algorithms are written is chosen in such a way as to be close to the machine, in terms of physical implementation of the algorithm. When it is modified or collapses, the algorithm will cease to be a commercial object and an epistemic one. Conversely, if such an implementation becomes too expensive, the commercial character will be endangered. This points to the fact that epistemic objects cannot be entirely separated from infrastructural ones. Nor can they always be separated from commercial objects as, in financial markets at least, they are evaluated on their costs and the profits they generate. Overall, my argument is that we should consider objects of expertise not only under the angle of their connections but also as having laminated features that depend on each other.

A trading algorithm (or, for that matter, a market index) would require aligning not only the interests and perspectives of participating experts but also two very different sets of entities: abstract formulae, on the one hand, and machines that

enable the production of trades (or index numbers), on the other hand. Similarly, in order for a simulation model to produce forecast numbers, it would need to be aligned with computing machines. The formula of an algorithm cannot produce any trades without such an alignment, which is neither given, nor natural, nor unproblematic. This alignment is crucial for an algorithm (or an index) being an epistemic, commercial, and regulatory object at the same time. Aligning paper formulae with machines in such a way that trading outputs, or index numbers are regularly and continuously generated necessitates operations, understood as coordinated, iterable actions grounded in group-specific skills.

Such operations require, more often than not, collaboration across different, group-based expert activities (e.g., [Collins & Evans, 2007](#); [Collins 2018](#)). Collaborations have been treated in terms of the operations that define the participants' expertise (e.g., [Pakarinen, 2024](#), p. 22) or in terms of their impact across domains. This impact can include semantic and syntactic transfers (e.g., [Bechky, 2003](#)), expert languages that extend across or creolize domains, the dominance of one expertise over the other, or the substitution of one through the other ([Collins et al., 2010](#), p. 9). Expertise as a set of group activities is defined by (non)discursive skills and practices ([Collins et al., 2017](#), p. 777), the character and understanding of which depend on the relationships within which they are deployed ([Pakarinen & Huisig, 2023](#)). The implication here is not only (and not primarily) that expertise varies as it is displayed to different audiences ([Anteby & Holm, 2021](#); [Eyal, 2013](#)), but that expert skills (such as coding, or computing an index formula) can evolve depending not only on how expert participants relate to each other but also on how they relate to the objects of their expertise.

For the context investigated here, that would mean that the expert activities of producing and maintaining a market index are deployed within a set of interactions and relationships within groups of experts. As the index needs to align different layers (e.g., commercial, regulatory, machinic, etc.), we should expect the operations that produce indices (and the participants' understanding of their expert skills and collaborations) to be geared toward this alignment. In the following, I will examine closer the expert operations that align indices, together with the skills that support them. Before that, however, I will provide a short overview of market indices as objects of expertise.

INDICES AS OBJECTS OF EXPERTISE

Market indices have been seen as crucial in financial economics at least since the development of the capital asset pricing model in the early 1960s, as they play a significant role in estimating the risk of financial assets ([Perold, 2004](#), p. 21). Risk profiles of individual financial assets are calculated against a market benchmark (usually an index); so are excess returns on stocks against fixed income instruments ([Perold, 2004](#), p. 4). While indices such as the Dow Jones were already introduced in the late 1880s, and have their origins in financial journalism, starting in the 1920s, they became an object of econometric methodologies concerning the measurement of returns or of market fluctuations ([Hautcoeur, 2006](#)).

From the beginning, at least in the USA, market indices were produced and sold by private firms. Starting in the 1930s with the work of the Cowles Commission, indices became objects of expert collaborations: financial economists collaborated with statisticians in producing them (Hautcoeur, 2006, p. 14; Porter, 1995). Indices have remained objects of academic expertise, but also of professional expertise within financial firms: global marketplaces such as the London Stock Exchange or the Chicago Mercantile Exchange (CME) produce and sell a manifold of indices using their own trading data. Additionally, data providers (e.g., Bloomberg) produce and sell their own indices, using data feeds from different venues. We have thus indices produced on a venue's own data and indices computed using data across different venues (the kind investigated in this paper). Market indices can be the object of a private contract between a client and the provider, or they can be sold to several clients. In this latter case, regulators require that index providers disclose their methodology to the public, so that indices can be replicated, audited, and are representative of underlying market realities. Anyone following methodological specifications should be able to apply the formulae to data and obtain the same results; the way in which results have been obtained should be verifiable. Indeed, providers such as Bloomberg, CME, or the analytics firm discussed here have made their methodologies public.

The formulae for computing market indices are largely similar and consist of volume weighted averages of the last trades over a given time interval. As data coming from different venues have different latencies (i.e., arrive at different speeds at the venue computing the index), some price and volume data might come at a speed lower than the average and therefore not reflect the last trade anymore. Index formulae penalize lateness by factoring in lower weights for price data that arrive later (by a set factor) than the latest transactions observable on the exchange in question. Another penalty is assigned to price data deemed to be outliers when compared with the prices at which the same asset trades at the same time on other venues. For instance, if asset A trades on venue X at a price that is higher (or lower) by a set factor of n compared with the venues Y, Z, Q, etc., it will be assigned a lower weight in the formula. In other words, the (public) index formula is built in such a way as to weigh down price anomalies and data lateness, in order to maintain the representative character of the index. Thus, the public, licensed formula of the index aims to ensure that events happening on one exchange (high/low prices, late prices) do not impact the representation of "the market" as a reality broader than any single exchange.

DATA AND METHODS

The data analytics provider (henceforth: the firm) where I conducted ethnographic observations was based in the UK, with engineering teams in two other countries, across three different time zones. It produced and sold licensed market indices, bespoke indices, market order books, and market data. Among its clients were global investment banks, as well as a major, globally influential central bank. The index subscription was also sold to accounting and custodian firms,

and to node validators on the Ethereum blockchain. As a commercial object, the index was continuously expanding.

At the time of the fieldwork, the firm was working on new products such as analytics of social media feeds. It was in negotiations with a major Asian exchange for becoming their data analytics provider on crypto assets. The indices were sold by subscription to institutional clients. Retail clients could buy index data on an ad hoc basis. Clients could order custom-made indices that were sold only to them: this is in line with the operations of established providers, who sell both licensed and bespoke indices.

The firm collected live data feeds on the 40 most traded assets from 250 crypto exchanges worldwide. The incoming feeds were transferred into the own databases and used to compute a licensed market index that was then disseminated to subscribers and regulators. The index had to be computed continuously, as crypto markets are 24/7.

The firm had marketing, sales, finance analytics, and engineering teams working together in an open plan office on a hot desking principle – meaning that desks were assigned on a first come, first served basis. Engineers and finance analysts mixed together while working and more often than not sat at adjacent desks.

After negotiating access for more than a year, over the course of two months during 2023, I spent a full workday every week in the open plan office, sitting at a desk next to the CTO's, in the zone where finance analysts and engineers were working. As part of granting access, only handwritten notes were taken; interviewing members of the firm was conducted only during breaks. All firm members in the UK office had agreed to my presence. I conducted a total of 39 hours of observation.

I sat next to the CTO, with direct visual access to the engineering and analysts' desks. I could observe directly the interactions between software engineers and finance analysts, between engineers, and between analysts. I could observe directly Slack meetings as well, and the work processes in which both sides, separately and together, were engaged. I took onsite handwritten notes from conversations and interactions, as well as from the observed work processes. I also took handwritten notes from the oral accounts of the CTO about what engineers were doing at any given time. During breaks, I conducted interviews with: the engineers working on the index and the social media feed; the heads of index operations (twice), of order book operations (twice), of market data operations (twice); the data scientist working on the index. I transcribed the interviews in handwriting. I also conducted offsite interviews (recorded and transcribed) with the CTO and the head of index operations. In addition to the interviews conducted on- and offsite with members of the firm, I conducted, together with collaborators: interviews with 31 software engineers and 33 financial analysts involved in crypto and blockchain projects, in order to elicit accounts of the expertise involved; interviews (recorded and transcribed) with 22 crypto exchange managers, 11 market makers, and 5 OTC traders, in order to understand how indices are used in crypto trading.

While in the field, I started observing the main operations required by building and running the index. I cross checked observations against interviews in the field. I elicited in interviews rationales for the necessity of these operations. To outside

observers, these rationales are not always immediately visible in the participants' operations and have to be reconstructed based on interviews. I built categories of the work processes involved in generating market indices and assigned them to the operations performed in producing and maintaining the index. I then built categories of the types of collaborations between software engineers and finance analysts and assigned them to work processes pertaining to each operation. I built categories of work processes that required a collaboration, and work processes that did not, and of the discursive knowledge and skills involved in each (see [Table 1](#)). I cross checked the operations and skills I was observing in work processes on the ground against interviews with engineers and analysts from outside the firm. I cross checked onsite against offsite interviews and against interviews with financial engineers and analysts from outside the firm. I cross checked the self-description of the onsite participants against onsite third parties descriptions, and against self-descriptions from interviews, to see whether there were hard boundaries between these expertises, as understood by participants on the ground, and whether these boundaries could possibly shape collaborations and work processes.

MINI-WORLDS AND MESSY WORLDS

As a standard, regulators require indices to be replicable, auditable, representative of the market, robust, and stable. Any changes to the publicly available formula had to be approved and made public at least three months before they came into effect. A white paper (available in online open access) detailed the index formula, every single variable in it, the rationale for including these variables, and how every variable should be calculated. Transparency and stability of the formula were also seen as increasing the commercial success of the index and making it into a standard. The formula represented thus an officially sanctioned, expert-produced, efficient, transparent, stable mini-world ([Yonay & Breslau, 2006](#)) that included only a few variables (price, volume, time) while leaving out others (for instance, it didn't include the machines on which the index was computed and their properties).

While present at the back of their minds, the formula was rarely if ever present in collaborative discussions or other joint activities of engineers and analysts. It rarely was brought up, mostly when a client required changes and had to be rebuked by the CTO. The topics that dominated pre-announced discussions were mostly about blocks, validators, nodes, and the Ethereum chain. Spontaneous discussions centered almost exclusively on data, inputs, outputs, errors, and latencies; among themselves, the engineers talked about machines, queues, stalling, and more machines (see [Table 1](#)). Even when it came to actions and non-discursive skills, the formula didn't seem to play a role. Rather, it was seeing, reading, writing, correcting, removing, and making judgments on data that took the center stage – all actions and skills that had to be deployed in groups, not individually. Why was the formula quasi ignored?

Participants involved in producing, maintaining, and disseminating the index had to ensure that it had the above properties (replicability, auditability,

Table 1. Expert Skills and Knowledge in Producing a Market Index.

Collaboration Types	Participants	Discursive Knowledge About	Talk Topics	Non-discursive Skills	Actions
Online presentations to analysts and engineers, including those physically co-present	(All of the below, always) CTO Heads of: index, market data, order book operations Financial analysts Software engineers Data scientist	Crypto assets traded on centralized platforms and in decentralized finance The Ethereum blockchain and Ethereum accumulation at validator nodes Traditional financial assets (e.g., swaps, futures, derivatives)	Nodes Validators Rewards Sanctions Blocks Ethereum Periods Perpetual futures Asset pools	N/A	Making judgments on numbers (price, volume)
Spontaneous discussions/unexpected summons between analysts and engineers while looking and pointing at screens	(Most times either head of index or head of market data or both were part of the group) Heads of: index, market data operations Financial analysts Software engineers Data scientist	N/A	Data (price and volume) Input data Output data Errors Latency Liquidity	Writing/reading code Reading in decimal and hexadecimal scripts at once Producing numbers in two scripts at once Seeing prices	Making judgments on numbers (price, volume) Removing/modifying numbers Producing synthetic numbers
Engineers coding together on shared screens (including physical co-presence)	(Mostly CTO and other engineers) CTO Software engineers	Machines (number of cores, capacity) Machine tools	Messages Queues Machines (building) Machines (stalling and other problems) Endpoints Throttling	Writing/reading code Seeing errors in code Localizing code on screen Seeing code and machine performance at once and in relationship to each other Identifying/finding/using tools appropriate to the problem	Making judgments on machines Using tools to maintain/repair machines

representativeness, robustness, stability) at any given time, while handling uncertainties that arose in these processes. In theory, anyone could have replicated the index to check its validity. For an exact replication, however, the formula would have had to be coded on virtual machines identical with those used by providers; the machines would have had to be configured on the same server farms (keeping the same data feeds); the data specified in the methodology would have had to be obtained from trading venues and processed in the same way: the index feed would have had to be sent to clients with exactly the same latency. That is, in order to replicate the index, the efficient and transparent mini-world of the econometric formulae needed to be connected to a much messier, much less transparent world, made of virtual machines, cloud computing, data flows, and messages. This connection, or alignment had to be produced first: this was where engineers and analysts deployed their skills, and this is what they mostly talked about when they summoned each other.

The index had to deliver authoritative numbers regularly, with low latency, and not be impacted by market conditions, such as volatility. An unstable index would have oscillated too much when markets were volatile, and this was not supposed to happen. Additionally, crypto markets could be impacted by forking – that is, situations where an asset splits into two as a consequence of changes made to the blockchain protocol that generates the asset. Examples of new crypto assets created by forking are Bitcoin Gold, Bitcoin Cash, or Ethereum classic. When forking occurs, the index should incorporate the trading prices of the old asset, not of the new one, as the latter does not have enough trading history. Even worse could be situations when the index would mix prices from both assets in the calculation. The index also had to reflect a fair market – that is, a market without manipulation or errors. The formula had no variables for typing errors or for market manipulations. (It had an error term though, which could not be allowed to become too large.)

Thus, the index as continuously produced data was not required to be representative of a market with high volatility, where unexpected events such as forking occur, where traders commit errors and manipulate prices. It was required to be representative of a mini-world – a market with few anomalies, few errors, honest traders, stable, and where supply met demand quickly (deep liquidity). Periodically, regulators audited the index for these properties. Yet, this mini-world – simple, clean, efficient – was incapable of generating data on its own. In order to produce numbers, a far messier world was needed, one including an array of machines, together with engineers, analysts, and data scientists. This was not an easy task; it could not be automated. It required complex collaborative operations, supported by group activities and skills, and deployed within collaborations, to which I turn now.

PURIFICATION I: A LIBRARY OF STRANGE CASES

The firm collected price and volume data on the 40 most traded crypto assets from 250 exchanges worldwide via live feeds, with an average latency of 2 milliseconds. The data underwent a first set of operations before going into a database. From

there, it went on a UK-based virtual machine that computed the index numbers. As it was going onto the machine, the data underwent a second set of operations. Once computed, the index numbers went to subscribers and were fed back into the exchanges (see Fig. 1).³ Subscribers could see the index updating on their screens within a set period of time (e.g., every minute) specified in the contract. (A more expensive contract had a lower updating latency.) What subscribers and exchanges could see on their screens depended on: (1) the firm’s visualization (the API, or application programmable interface); (2) data ordering tools (the data library); (3) what the firm decided to send back to them (index data, or index data and meta-data); (4) how the subscribers’ machines communicated with the firm’s.

At all times, the index had to be representative not of a real market, but of a pure mini-world. Consequently, engineers and analysts engaged in purifying data of numbers that indicated real-life happenings (errors, manipulations), as much as they could.

All the operations had to be done in real time, as the live data feed arrived from a messy world: exchanges distributed around the globe, on which some traders could make errors or try to manipulate prices. None of these would have fitted the mini-world of the econometric formulae. The index data also went back to a very messy world and was dependent on key variables that were to be found nowhere in the formula: data library, API, properties of virtual machines. As the live feed arrived, the analysts, data scientists, and software engineers did not know yet which data was error, manipulation, or a genuine transaction. Errors and manipulated trades had to be filtered out. The formula also required that price data concomitantly deviating by a preset order of magnitude from at least two other exchanges is weighted down in the calculation.

Before the data went into the database, all these operations had to happen: decide which data indicates a trading error, which data indicates a market manipulation, which data should be weighted down or not. As the data scientist (with a PhD in mathematics) explained to me, there was no reliable algorithm to

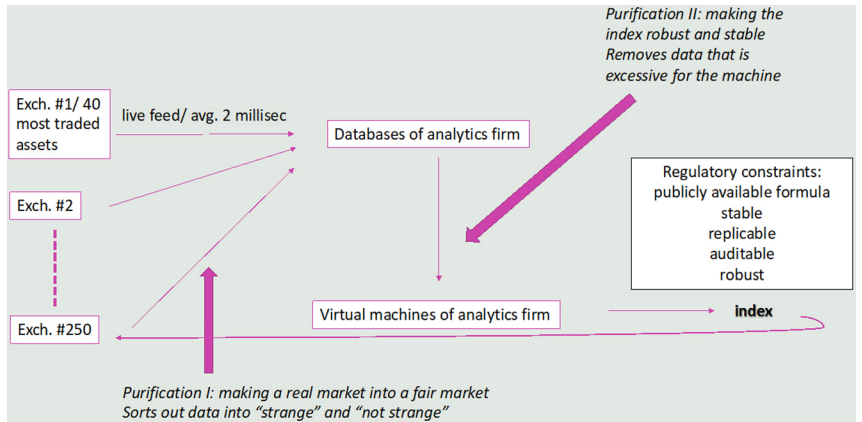


Fig. 1. How the Index Is Produced.

automatically and universally distinguish between an intentional order and an erroneous one; he could not use algorithms to automatically filter out all trading errors. Neither were all market manipulations detectable by algorithms. The detection of wash trading (one player buying and selling the same asset continuously) or of spiking the price (putting in intentionally large orders to attract other traders) requires human surveillance skills. Even if price spikes were weighted down by the formula, a manipulative one would still impact the index, bringing it further away from representing a fair market. According to the head of the order book, spoofing (placing large numbers of limit orders and then cancelling them, in order to move the price in the desired direction) could be detected only in level 3 data⁴ coming from exchanges and required the attention of data analysts.

One of the methods used by the data scientist was to go through past order books and build a catalog of, as he said, “strange cases” and then monitor the live data feed against this catalog that was augmented with new cases. Another approach was to generate synthetic errors, “spike” the data feed with them (before going into the database), and see if and how many an algorithm would detect. Both approaches required that the data scientist monitored the data feed (and removed undetected errors). Had the engineers and analysts let errors and manipulations slip into the database from which the index was calculated, the latter would have been distorted and ultimately the license would have been put in danger. They could not do this without seeing and judging first, in real time, what data is error: yesterday’s errors are not necessarily today’s ones, and even if they could write a program to filter out some expected errors, there were unexpected ones too. Neither could this filtering out be done on an individual, isolated basis, by a single engineer or analyst. In an interview previous to the fieldwork, the head of index operations complained that in the beginning engineers were putting onto the excel spreadsheet zeroes for errors, which distorted the index. She had to filter out the errors on the spreadsheet herself. This implied that seeing data as erroneous or not was not enough; one had to decide as well how to write data. “Seeing” and “writing” were key collaborative activities.

These operations, which taken together I call here purification I, are distinct from what has been termed purification of science, understood either as a demarcation operation (from other domains – see [Elam, 1999](#); [Latour, 1988](#)) or as the introduction of explicit regulatory norms ([Faulkner et al., 2006](#)). It did not consist in classifying data into “good” and “bad” categories according to a general set of criteria (this could not be done). It was a collaborative, visual evaluation of how much individual data, as it appeared on the screen, was aligned (or not) with what has been seen before, coupled with decisions about how to record data in multiple scripts.

PURIFICATION I: OBTAINING TRUTH THROUGH SEEING AND WRITING

When a transaction in a crypto asset is executed, the asset will be moved between wallets by a smart contract (i.e., a piece of code that automates the transfer without

a clearing house). If the smart contract has vulnerabilities discovered by hackers, the asset can be moved to a different wallet. This will make the transaction an invalid one – manipulations and frauds cannot be allowed into the database of the index. Engineers and analysts had to verify the authenticity of transactions – an operation for which they needed to look at the metadata associated with them. In one instance, the data scientist, together with engineers, huddled around the screen discussing how to establish the authenticity of transactions:

Data scientist [talking to engineers while all looking at the screen]: ... transaction, do you have a key value? [... points at the screen] that's not going to tell you what is exactly happening So one simple block number, so the smart contract is good, transaction is authentic, so this Ethereum, right, just checking. So you need also the logs associated with this, the input will be the function that triggered the transaction, you need these logs associations ... can you put also that hash in?

Verifying the authenticity of transactions required thus monitoring not just price and volume numbers, but also the logs showing transfers across wallets, that had to be visualized on the monitors shared by engineers and analysts.

Additionally, data arrived on the live feed with a time stamp from the original exchange and was time stamped again on arrival: as stamps did not show the same time difference for all data, engineers and analysts had to recalculate and synchronise the original time stamps on the data before it went into the index – which means that data had to be re-written too. This was a key operation, as the index was the volume weighted average of the last trades, and time stamps mattered.

On the live feed, the data was arriving in a decimal script, but was going from the database onto the machine in a hexadecimal script. For instance, one Bitcoin can be US\$26,000 in decimal script, but in hexadecimal script, it is 6,590. Analysts and engineers had to make sure that the numbers going onto the virtual machines correspond to the numbers going in and out of the database – i.e., that they see the same price or volume in two totally different strings of numbers.

Members of the index team had two or three screens on their desks: on one screen the live feed of price and volume coming from exchanges was displayed on an excel spreadsheet. On the other screen, the live feed was displayed in code (with numbers in hexadecimal script). A third screen, where present, was used to monitor data latency and the operations of the virtual machine. The index formula (written in code) had to pick up the right data in hexadecimal script and compute the index – hence the second screen, on which the price and volume were displayed in hexadecimal script.

On several occasions, the head of market data referred to the live feed (see Fig. 1) as the “source of truth” and insisted that the data they were producing had to be situated within a “tolerance range” with the “source of truth.” The latter could be taken as the source from which truth has to be extracted, but not as truth in itself. The very same head of market data said though that only “genuine market movements” should be left in the “source of truth.” This implied that the live feed was providing only the rough material that needed to be purified in such a way that nothing but true market movements and true transactions come to the fore as “the source of truth.” These true movements

were produced by the team – in the sense that they, together, decided which numbers will be the market and which will be not.

These decisions required that analysts and engineers engaged all the time in spontaneous, collaborative, and indexical seeing of “the source of truth”: regularly, during my observations, an engineer or analyst would interrupt their work, point at a screen, and summon others with the words “what is this?” or “why is this here?” Then the summoned analysts and engineers will interrupt what they were doing and huddle together and discuss, alternatively pointing at the screens, sometimes for up to an hour, deliberating on the character of the data on their screens, until they reached an agreement on the data that is right for the index. The character and the content of the discussion were entirely indexical, as the participants kept pointing at the screens, comparing the data points with yesterday’s ones, modifying codes, checking if transactions are authentic, and coordinating time stamps. Due to this indexical character, an outside observer could not very well comprehend what was going on without knowing in advance what analysts and engineers were concerned with. Interviews with the head engineer and the head of index operations revealed that they were concerned with filtering out errors, checking time stamps, checking authenticity, and ensuring that the volatility of the index remained low, as a condition of its stability.

These were spontaneous collaborations arising in the middle of work: nevertheless, invariably, analysts and engineers answered when they were summoned to come and look at the screens together and decide on the quality of their data. As they were searching for correct data in two scripts at once (decimal and hexadecimal), I would argue that, together, they developed the skill of seeing “genuine market” data, a skill that anchored their purification operations.

This could not have been achieved simultaneously, but separately, simply because this seeing had to take place in both scripts at once. I am not arguing here that engineers and analysts did not practice this seeing separately as well. However, every time they were in doubt about it, they summoned each other and responded promptly, spending considerable amounts of time discussing the data in front of them. One might argue that this skill of seeing data could have been brought in by team members who had previously worked on indices in TradFi (the emic term was non-natives). Conversely, one might argue that this skill needed to be developed exactly because many team members did not have work experience in traditional finance (i.e., they were crypto natives). If the first were true, then I should have seen non-natives teaching crypto natives how to see a “fair” index. I did not observe any such teaching. If the second were true, then I should have seen crypto natives summon non-natives to teach them how to see. I did not observe such summons either. Rather, this was an entirely interactional process, in which no reference was made by the parties to previous experiences of seeing data in TradFi.

What was Purification I then? To stay in line with the practices I have observed (that were largely inductive), I will attempt to infer a definition: Purification I was oriented toward the mini-world of the index formula. It sorted numbers that fitted the prescriptions of this mini-world, by extracting the “truth” from its source (the live feed) and confining “strange cases” to their own repository. These latter

were not simply discarded, as they had their own use as a collectively accessible memory,⁵ against which new cases could be evaluated, and as templates for generating sythetic errors. “True” numbers were re-written and made ready to go onto the machine. This combined sorting and re-writing operation was grounded in collective, indexical skills of seeing and evaluating numbers in multiple scripts at once.

PURIFICATION II: MAKING A MACHINE THE SOURCE OF TRUTH

Once Purification I extracted “genuine market movements” from the live feed – data that fit a normative model of pure markets – they were transferred from the database onto the virtual machine computing the index. This machine was situated in a much messier world than that of index formulae. The data, already purified once, had to be subjected to another set of operations so that it fits a messy world. This second set, which I call here Purification II, removed excessive, albeit pure data that could imperil the working of the virtual machine.

The index *had to be seen*, in its fairness and robustness, by subscribers on their screens. Without being visible to subscribers, it was worthless. If fairness of numbers was a matter of seeing together possible errors and manipulations, stability, robustness, and visibility depended, to a large extent, on another layer of the index: it was an automated object, located within and processed by machines. If the machines became unstable, the index became unstable too. What is more, if clients were to be able to read the index on their screens, then the numbers produced by the formula needed to fit the library (i.e., the collection of precompiled routines and scripts) and API (application programmable interface) set up by the firm, as well as the machines of the subscribers. Mismatches between numbers, library, API, and the machines of subscribers could impact the latency of the index and, potentially, its robustness.

Overall, stability, robustness, and visibility depended not only on which numbers were selected from the live feed and made into the source of truth but also on the properties of the machines producing it. These properties were not independent of the numbers being fed into machines, and on how they were fed. If too much data – that is, too many volume and price numbers were put on the machine, it took more time to calculate the index (even if “more time” meant more milliseconds). The numbers then kept accumulating and the machine began stalling. When the machine was stalling, the index lost its low latency or, even worse, could become unstable, less robust.

Another aspect was that if the numbers kept accumulating on the machine computing the index, it took more time and computing power to generate the index, which became costlier for the firm to maintain. If that were the case, the index became a less efficient commercial object, eating into the profit margins of the firm. The machine had to work efficiently – that is, producing index numbers within the specified latency but also generating a profit for the firm. If computing became too expensive, the firm started losing money on their flagship product.

During my fieldwork, on more than one occasion, the CTO and surrounding engineers were preoccupied with how to send index data to subscribers. For that, the API and the data needed to be adjusted to each other, but the API wasn't treated by engineers as entirely controllable. The index data could be sent out as it was produced; however, if the firm pushed too many updates per minute, exchanges responded by increasing the data feed coming to the firm, which would have created computational problems. Additionally, when trading activity spiked, the firm had larger incoming dataflows *and* larger outgoing dataflows and needed to compute more (which increased the cost of the index). An alternative would have been to aggregate data instead of queuing it up. Aggregating data, however, required more lines of code, slowing down computations.

The firm was operating on a cloud architecture, not a centralized database: that is, instead of a single server farm, virtual machines were configured on various servers located in the GMT zone (to avoid timestamp issues). An advantage was that machines could be reconfigured according to needs; engineers could also add more machines, as they developed more products. However, this made computing time and machine rental an important cost factor. Engineers were permanently preoccupied with maintaining the index computationally profitable, while, together with the analysts, keeping it robust, stable, and representative of a pure mini-world. In some instances, they were adopting a language of commercial efficiency to rebuke clients: during my fieldwork, the CTO of the firm was on a call with an institutional client, where he refused to modify the index, saying that not only they would lose their license, but the modification itself would cost hundreds of thousands of pounds that would need to be recouped over many months.

Engineers and analysts had to address issues of machine efficiency all the time (e.g., machines stalling, high latency, breakdowns) – after all, the index was an automated, 24/7 object, impossible to produce manually. The head of index operations, whose background was in finance, had learned how to restart a virtual machine:

So things like basic things, actually, for example, an index is not working, like I can see, like, I see the charts and I see that the prices are not updating, for example. And sometimes, a developer is not always there. For example, so we don't only work for Europe, but we also work for abroad. And we have clients in California, for example. So we have a time difference. So there was an index that broke, and we were all sleeping at, like I am in the morning, I got a call, like we need these prices, and we're not getting them. So I had to grab my laptop and start checking what was happening because yes, there is what's right, like the prices were wrong. So I had to go and maybe restart the service that was calculating that index. That's something that I wouldn't think I would have to do, right? Like, I don't know, I'm just like, I calculate the model and then pass it to a developer. But yeah, like in the end, *I'm the one that actually understands how the prices are being calculated* [my emphasis]. So maybe they call a developer, they don't realise that the price is actually wrong. So that's why they call me and I need to know this basic stuff, like how to start the calculation again, or things like that. ... So it's actually writing a script, but it's running like a Javascript that I wasn't familiar with that before. So yeah, it's going into the cloud connecting into the machine and rewriting our script. That's it.

In this excerpt, the head of index operations describes how she had to fix a problem in the middle of the night using skills that she didn't previously regard as being part of her expertise – but which she sees now as intrinsic to her understanding of price calculations. She had to connect to a virtual machine (into the

cloud) and rewrite the script so that the machine can restart and recalculate the prices. She made clear that learning how to repair a virtual machine was somehow completing her skills in seeing “fair” prices (she is the one who understands how prices are calculated):

I have to understand the whole process, because maybe we’re growing a lot. And there’s not enough people either. So it’s better if I understand it, because then I can solve all the issues. There are many things that I think at the beginning, I had no idea. And now I can go into our beautiful machine and fix it myself. But before that I had to rely on a developer.

This extends the notion of calculation from paper formula (the model) to the workings of a machine (the whole process), an extension that is not captured in regulatory instructions.

One could argue that learning to restart a virtual machine would be akin to a simple operation, such as flipping a power switch: the analogy, however, would be inaccurate, since the latter doesn’t require complex operations (going into the cloud, connecting to a machine, rewriting a script in code) and does not complete an understanding of something else (how prices are actually calculated). Flipping a switch can be done without all these operations and understandings.

In order to keep the machine working efficiently, another set of purifications had to be undertaken: extracting from the set of already produced “genuine market” data the right amount for the machine. The data had to be purified of amounts that are excessive for a messy world, even if this data is appropriate for a pure one. As the volume of data varied with market activities on the 250 exchanges, there was no way of determining in advance, by calculation for instance, how much should be purified.

During fieldwork, in the engineering area of the office “machines,” “messages,” and “real time” were the most frequently heard expressions: not only because launching new products required preparing new machines, but also because engineers had to monitor the index machine for stability and robustness. Several factors were in play here: deciding the amount of price and volume data to put on a machine so that it does not stall; deciding whether to send subscribers only index data, or data and metadata (sending out data and metadata made the message lengthier); making sure that the output data fits the API (e.g., if metadata were to be sent too, the API would have had to be adjusted); monitoring possible unforeseen market events that could jeopardize index stability. For instance, a sudden spike in trading would result in more data arriving, and more messages being sent to the index machine, making it stall. In the past, an incident had happened when a crypto coin had forked (i.e., a change had happened in the chain protocol) and, as a consequence, the index had become unstable. Engineers had to monitor for such events and take measures if the index became unstable.

Not only unforeseen events such as forking or increased trading volumes could pose a challenge for the machine but also unexplained malfunctionings. One day during my fieldwork, the machine started putting messages inside each other instead of ordering them one after each other, as they were coming. Bloated data strings slowed down computations to a point where the machine was working with a much reduced capacity.

While there was a monitoring team in a different country supposed to alert the engineers for accidents or incidents, it was ultimately the latter's task to address both kinds of issues, which could happen globally, in an unforeseen way, and 24/7. On more than one occasion, the CTO, engineers, and the head of index operations had been called at weekends, in the wee hours, because the index was not updating correctly. Hence, intervening to keep the machines stable and robust was a collaborative activity engineers engaged in all the time during fieldwork.

PURIFICATION II: FITTING MESSAGES ONTO THE MACHINE

In a previous section, I have discussed the spontaneous collaborations between analysts and software engineers who were coming together in front of the screens to see numbers that could be unfair, inauthentic, or temporally uncoordinated. I have called this purification I, a set of operations that sorted out from the live feed data that fitted a mini-world. Purification I relied on engineers and analysts collaboratively monitoring the data feed in two scripts simultaneously, and deciding whether to keep data or send it to the repository of "strange cases." This monitoring required reading and writing together in multiple scripts at once.

Purification II removed excessive, yet "fair" data that could impede the functioning of the machine. It brought together engineers deciding how to put messages on machines. A "message" was data deemed "fair," with or without metadata. Engineers cared about how many messages should be let onto the machine so that the index stays stable, robust, with a low latency, and it the machine does not stall. They had to care about how often they can update the index depending on the properties of their machine, the properties of their clients' machines, and the fit with the API and the library too. On several occasions, the CTO made statements such as "if you're on this machine, the maximum [for the frequency of updates] is every second" or asked other engineers to test the machines of their clients. For engineers, everything was "messages" and "endpoints," terms I never heard analysts using. If trading activity was high, engineers could throttle the API – that is, limit the number of requests their subscribers could make per unit of time. The CTO, however, was reluctant to throttle ad hoc too much, as the firm would have to provide a methodological explanation as to how it was being done.

Messages could be added or taken off the machine, depending on how overloaded it was. Engineers came together on Slack, sharing coding screens, and decided how many "fair" messages they should let in. During fieldwork, they sometimes worked in pairs on this task, and sometimes in groups of three or four. Even if they were physically co-present, engineers preferred to work online and share screens rather than come together huddling in front of the same screen, as I had witnessed them doing during Purification I. They usually worked with three screens: a coding screen, a Slack screen for messaging, and a screen for monitoring the performance of the machine through a series of dashboards (latency, number of messages coming in, how heavy the message load was, free capacity). Oftentimes, I observed the CTO working together with engineers on coding via

a shared code screen, while talking to and messaging his collaborators (see my screen, look at my screen!). To some extent, the setup was similar with that used by analysts and engineers for producing fair numbers, in the sense that messages were displayed in two scripts: decimal (on the machine dashboards) and hexadecimal (the coding screen).

As the volume of trading varied, engineers could not assume that they were going to get the same volume every day, and hence apply the same filtering rules. Neither could they assume that the machine will behave exactly like the day before. Deciding how many fair messages to put onto the machine was a task that had to be done anew every day. After all, the index was indeed an epistemic object: one couldn't know what the next day will bring. Not only this: sometimes, messages could be sent to the wrong place and this made the machine malfunction. Engineers had to work backward from the malfunction, find what was causing it, find the repair tools, and then find a way of repairing the machine. The following excerpt renders a situation in which messages were placed within other messages (instead of being queued up), making them more than double in size and stalling the machine:

CTO [coding with two other engineers on a shared screen]: something has happened ... it's doubling every time ... why is it doubling every time? Did somebody change something? ... oh it puts its deb file back into itself! That's what it is, that's why it doubles in size every time, 'cause it's putting itself into itself we know why [expletive] 'cause it's doubling plus 90 meg ... I don't even know where the Jenkins machine [a repair tool] is [...] I'm down to 7% usage 'cause you can't physically ... it takes time to download and not it's got physically 3 times ... poor machine ...

In collaborations with other engineers, the CTO used digital markers (usually red or green) to highlight areas of code that needed to be changed in order to reduce or augment the amount of messages on the machine. As with the collaborative work on “fair” numbers, this work was largely indexical: the CTO would circle with the marker an area of code on the shared screen and just say, “here... and here, we need to take this price and volume out.” The skill of directly seeing price and volume in lines of code was apparently shared by engineers, who never raised questions about this. With an eye to the diagrams showing machine performance, the engineers would then decide whether to add or delete messages to it. This skill of seeing was used to make a distinction between right and excessive message loads (and to intervene accordingly), crucial for keeping machines aligned with users and with the mini-world of the formula.

CONCLUSION: ALIGNMENT EXPERTISE

I have started this paper by asking, What expert operations make it possible for market indices to be generated as authoritative numbers with global impact? Authoritative numbers with constraining force are key components of economic institutions big and small. They shape economic policies at global and state level. Market indices could not be generated, maintained, and disseminated without aligning two distinct worlds, namely formulae and machines. As indices play such a role on a global scale, the question about the operations that produce them is

consequential for, among others, understanding how global markets work. In a broader perspective, indices as authoritative numbers illustrate a puzzle of our data world: how do skills-based group activities produce authoritative data?

A commonly held trope is that “algorithms produce data” – that is, that formulae that are input into machines would somehow automatically generate authoritative data. This would imply a kind of fusion between formulae and machines that leaves no place for the intervention of human, skill-based operations. My argument, however, has been that this production and display requires the alignment of two very different worlds: the pure one of (econometric) formulae, and the messy one of computing machines. This is neither given nor unproblematic, nor automatic. It is achieved by two purification operations deployed within small groups. One is the purification of numbers as “source of truth” that respects regulatory conventions: it sorts out pure from impure data, without discarding the latter (as it has its own uses) and re-writes pure data as it fits them onto machines and the other is the purification of excess, so that machines can support this source. The other operation removes the excess of pure data, adjusts its qualities to the machines processing it, and makes it fit for being displayed. These operations appear to play a key role with respect to how the constraining force of numbers is achieved, and they could not be deployed without expert skills.

Based on the above, I would submit here the notion of *alignment expertise* as encapsulating the task oriented operations that simultaneously link and coordinate: (1) apparently incompatible worlds (formulae and machines), without dissolving boundaries across worlds or knowledge domains; (2) heterogeneous layers of the object of expertise at stake (indices, in this case); (3) disparate domains of knowledge (in this case, finance and software engineering).

Operations that achieve alignments are grounded in collaborations across domains of knowledge. In order to produce “fair” numbers, engineers and financial analysts had to engage in collaborative activities that relied on indexical, coordinated skills of seeing data in multiple scripts at once and making judgments about the data. Ethnographic observations provide no evidence that such skills were simply transferred from previous activities; rather, the evidence points to them being developed jointly in repeated, spontaneous collaborations where participants summoned each other to look at the screens. At the same time, there were skills related to seeing machines at work, and seeing numbers on machines, that remained the domain of collaborations among engineers. Finally, there were skills that, at least in some cases, pertained to engineering but were learned by financial analysts: for instance, how to connect into a machine and restart it. While some critical skills were jointly produced, this was not a mix of pre-existing skills, but rather the outcome of collaborations across different domains of expertise, the boundaries of which were blurred in practice, but not entirely removed. Other critical skills, such as handling messages and machines, remained the exclusive domain of engineers.

Engineers and analysts did indeed understand the index as a commercial object too, which was made clear not only to the ethnographer but also in conversations with clients. They understood that machine time, as well as their own working time were factored in when it came to pricing the index, and they did not

hesitate to relay this to clients. A creole “cryptoindexicalese” (see [Galison, 1997](#)) was not observed on the ground, and certain terms (messages, machines) largely remained in the engineering domain. Syntactic and semantic transfers across boundaries took place, yes, but such transfers did not fully remove boundaries. As for interactional expertise ([Collins & Evans, 2007](#)), observations on the ground suggest that it was both asymmetric and limited: engineers understood more of the financial terminology than analysts understood engineering terminology, perhaps also because terms such as machines and messages were used mostly (if not exclusively) in collaborations among engineers. This being said, terms such as “real time” took a prominent place in a great deal of the conversations involving both expertise domains, perhaps also because it was of paramount importance to the index: both sides understood the importance of latency, as well as that proper “real time” could not be achieved. The argument I am making here though is that, at least in some instances, (full) interactional expertise is not needed for alignment to be successful. Key aspects of collaborations were entirely indexical and did not involve full verbalizations.

The above observations are relevant against the background of historically developed rhetorical positions according to which, as varied domains of expertise (e.g., finance, or biology) increasingly automate, they will ultimately become subordinated, if not outright absorbed (in)to the expertise of software engineering (see [Ribes et al., 2019](#)). There is little on the ground (at least in this case) that would corroborate these positions.

Another relevant trope is the “algorithms produce data”⁶ mentioned above that implies that formulae can be fused with machines and this fusion will generate data. It too ultimately excludes expert operations from the generation of data. Again, observations on the ground suggest the contrary: formulae cannot generate data without complex alignment interventions, collaboratively performed in small groups.

It is said that we live in a data world, one in which data science, or expertise plays an essential role. Understanding this world, and the normative force of data (one that goes well beyond the case of market indices) requires understanding the alignment expertise that produces and expands it.

NOTES

1. I borrow the term from Erving [Goffman \(1986 \[1974\], p. 82\)](#) to designate layered framings of an activity (or object, in my case) that depend on each other and that cannot be taken apart without the activity unravelling.

2. Since the 1970s, regulatory agencies have increasingly adopted an economics-based benchmark model of fair and robust markets, coupled with utility maximization and rational choice ([Jones, 2012, p. 129](#)).

3. The thin arrows in [Fig. 1](#) indicate the data flows between exchanges, databases, and virtual machines. The thick arrows indicate the purification interventions undertaken by analysts and engineers.

4. Level 3 data includes individual, non-aggregated order data: real time bid/ask size, quote price, size of last trades, high and low price for the day. This data level is accessed by registered market makers.

5. Natalie Heinich (2017, p. 78) notices that detected art forgeries are not destroyed but kept as a special category against which the authenticity of a painting can be evaluated.

6. A version of this argument is encapsulated in varieties of the performativity thesis, according to which formulae and models have performative power – that is, they are capable of automatically generating data that are integrated within institutions to the effect of reshaping the latter (e.g., MacKenzie et al., 2007; MacKenzie & Millo, 2003). Expertise is deployed in constructing and testing formulae, but generally formulae and machines do not need a work of alignment (but see MacKenzie, 2021).

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GROUNDWORK: EXPANDING EXPERTISE IN MAKING ROBOTS USEABLE THROUGH DOMESTICATION AND CARE

Kajsa Lindberg and Elena Raviola

University of Gothenburg, Sweden

ABSTRACT

In recent years, advanced technologies, such as robots, are increasingly being used both to replace mundane and routinized tasks and to support and enable expert work. Previous studies investigating how advanced technologies transform expert work and its organization have mainly focused on the use of technology by experts. This paper turns our gaze away from the use of technology toward the work and expertise entailed in making technology useable. Drawing upon a longitudinal in-depth study of robots in advanced medical practices, we introduce here the notion of groundwork, the highly skilled behind-the-scenes work of making and keeping the robots useable. The study illustrates the myriads of activities and the expertise needed to make and keep technologies useable so that medical procedures can be performed safely and efficiently. The groundwork is understood as a collectively-enacted process that unfolds through processes of domestication and care. This work implies the pragmatic accommodation and expansion of multiple forms of expertise and relies on deep material

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and processual awareness, which uphold a form of ethical obligation between experts and robots. Bringing the groundwork to the fore offers a new perspective on how advanced technologies become and remain useable in complex settings, such as medical practice, where expert work is key and stakes are high.

Keywords: Groundwork; domestication; care; robots; multiple forms of expertise; expansion of expertise

INTRODUCTION

Advanced technologies frequently intersect with different realms of specialized expertise (e.g., [Anthony, 2018](#); [Bailey & Barley, 2020](#); [Barley, 1986](#); [Bechky, 2003](#)). This expertise is marked by its capacity to act autonomously and exert an influence on the different facets of practice, grounded in jurisdictional authority (e.g., as discussed by [Abbott, 1988](#); [Bechky & Chung, 2018](#); [Kellogg, 2014](#)). Thus, the use of new technologies often introduces new situational factors that complicate how expertise is practiced ([Heimstädt et al., 2024](#)). Previous studies have focused on how expert work is replaced or transformed whenever new technologies are introduced. For example, the algorithmic categorization of online music platforms has replaced the work of human experts and changed music discovery ([Alaimo & Kallinikos, 2021](#)). In other outcomes, the use of diagnosing systems in health care ([Lebovitz et al., 2022](#)), autopilot programming in the software industry ([Shestakofsky, 2017](#)), and evaluating deals during legal processes ([Kronblad, 2020](#)) are all examples of how expert work is transformed using new technologies that support and enable experts in the performance of their work. Such technologies may also produce new data and information that transform the way in which experts collectively interpret and make decisions regarding how to proceed in specific situations ([Lebovitz et al., 2021](#); [Tyskbo & Sergeeva, 2022](#)).

One repeatedly researched transformation of expert work, based on advanced technologies, is the increased coordination demands on different experts ([Heimstädt et al., 2024](#)). Using technologies often requires, in fact, different groups of experts to coordinate their activities and thus tends to redistribute expertise across professional groups (e.g., [Barley, 1996](#); [Beane, 2018](#); [Edmondson et al., 2001](#); [Sergeeva et al., 2020](#)) and require different groups of experts to align their tasks and to acknowledge each other's expertise ([Lindberg et al., 2019](#)). Using new technologies may also challenge experts' "spheres of obligations" (Valentine, 2018), highlighting the status differences among them ([Anthony, 2018](#)), or it may reconfigure the occupational boundaries between groups, as well as their collaboration and expertise ([Barrett et al., 2012](#)).

While these studies make significant contributions to how expert work is organized, and how expert roles change, they mainly focus on using technology to perform expert work, as in the case of doctors using surgical robots during operations, or traders using algorithms to evaluate financial trading opportunities among other things. Yet the work and expertise involved in making technology useable is often overlooked, perhaps because this work is often performed

by occupational groups that are less visible than others. As highlighted by several scholars (Bailey et al., 2022; Pakarinen & Huising, 2025), we take here a relational perspective on expertise, allowing us to see how expertise is expanded amidst interactions between a heterogeneous assemblage of humans and non-humans, and shedding light on how technologies are domesticated and cared for in order to become and remain useable.

The paper is based on a longitudinal study of the introduction and use of two robots, namely the *surgical robot* and the *robotic X-ray*, in a surgical unit at a Swedish university hospital. In order to become useable and perform medical procedures, the robot needs to be integrated into the assemblage of medical devices and routines. In fact, Lipp (2023) stresses that robots need robot-friendly environments and constant human support. Therefore, we ask what needs to be done to make the technology useable in a complex setting like that of advanced medical care.

The study illustrates how experienced nurses play a vital role in making the robots useable so that medical procedures can be performed safely and efficiently. These ordinary and often invisible, yet simultaneous, fundamental activities unfold both before and after surgery. We thus contribute to previous studies of expertise and technology in three ways. First, the study illustrates the highly skilled behind-the-scenes work (Nardi & Engeström, 1999) of making and keeping the robots useable, which we describe as “groundwork.” By unpacking the work of domesticating and caring for the robots, we thus shift attention away from using technology in expert work toward the work of making it useable. Shifting our gaze to a place that is often treated as invisible, such the operating room (OR) empty of doctors and patients, we show the myriad activities done to make technologies useable and we highlight how this work requires multiple forms of expertise. Second, groundwork mobilizes and expands multiple forms of expertise, all simultaneously being in play and interrelated. The nurses draw upon their domain and relational expertise to integrate the robots in the medical practices by negotiating the wide range of needs within assemblage of humans and non-humans. Finally, by unpacking the process of domesticating and caring for the robot, we show how this pragmatic accommodation and expansion of multiple forms of expertise relies on *material and processual awareness*. Such awareness grounds the development of the ethical obligation on the part of the nurses toward the robots, which produces commitment and an attachment to the durability of the material assemblage.

LITERATURE REVIEW

In complex settings containing multiple expert groups, with high-risk procedures and time pressure, the introduction of new and advanced technologies, which scholars have shown to entail the transformation of expert work, often needs work in order to domesticate and care for these technologies to make them useable. Pakarinen and Huising (2025, p. 2054) emphasize that the embedding of technologies in webs of interaction depends “...on how members of professions

domesticate – attend to and tend to – these technologies.” This domestication work means caring for technologies in a similar way to something other scholars have termed the care both of and for things like robots (Denis & Pontille, 2015; Lipp, 2023).

Etymologically, domestication means to become adapted to life in a household and to make something fit for domestic life. It has been used to study how “strange” and “wild” technologies must be “housetrained” (Berker et al., 2005), describing the process by which technologies are tamed or appropriated by their users (Silverstone & Haddon, 1996). This approach, mainly used in media studies, concentrates on how new media enter household contexts, and also on the role that the media have played in the daily life of individuals (Hartmann, 2013), how people use them and, more specifically, how that use is scheduled into people’s routines, and hence also into their time structures (Haddon, 2017). Such studies have shown, for example, how information and communication technologies have been both objects in their own right and the medium through which media content has entered the home.

Another approach, driven by Norwegian STS researchers, focuses on domestication in a wider sense, including any kind of technology used in diverse settings. This approach represents a stronger focus on context and practice and entails the making of connections with other artefacts, other practices, and other people (Liste & Sørensen, 2015). Domestication processes involve the work of integrating and appropriating technologies into the user’s life, but they also involve how users attend to technologies. Domestication processes presuppose that the users of technologies “...play an active and decisive role in the construction of patterns of use and meanings in relation to technologies” (Sørensen, 2006, p. 46).

Thus, studies of domestication are concerned not just with the enactment of technology, but also how technologies become integrated into practices in ways that may result in the reproduction or transformation of existing activities, or even in new activities. This is very much in line with the argument made by Parkarinen and Huising (2023) that the future of technologies will be shaped by how experts attend and tend to these technologies, in turn being influenced by the relational complexity of work settings. If technologies are integrated into practices without members having relational expertise concerning the assemblage where work takes place, then technologies will likely be less useable or will fail. Mol et al. (2010) emphasize that technologies do not work, or fail, in and of themselves, instead being dependent on care work.

The *logic of care*, as described by Mol (2008), does not take technologies as “mere” instruments, instead acknowledging the fact that they are just as unpredictable as people. As technologies may interfere in unexpected ways with other entities and configurations, care work requires what Mol et al. (2010) describe as attuned attentiveness and adaptive tinkering. Good care thus includes “Keep[ing] a close eye on your tools, adapt[ing] them to your needs, or adapt[ing] yourself to theirs” (Mol, 2008, p. 50). In his study of a care robotics project, Lipp (2023) shows how specific settings, including other objects, were changed to accommodate robots’ needs in order to make them work at all. He found that caring for robots involves an ensemble of practices, entailing “endless tinkering, ad

hoc improvisation and a kind of localized gathering of knowledge and people” (p. 676). Another example here is Winance’s (2010) study of the testing and adapting of wheelchairs to specific needs wherein she illustrates the tinkering character of care, including, among other things, exploring, touching, adapting, and paying attention to details and changing these until a suitable arrangement is achieved. This means that care work is “...infused with experience and expertise and depends on subtle skills that may be adapted and improved along the way when they are attended to and when there is room for experimentation” (Mol et al., 2010, p. 14). Thus, technology, objects, routines, and people’s skills all have to be mutually adjusted (Mol, 2008).

Moreover, care work includes a double significance which de La Bellacasa (2011, p. 90) describes as “an everyday labour of maintenance that is also an ethical obligation: we must take care of things in order to remain responsible for their becoming.” The doings of care – maintaining, continuing and repairing (de La Bellacasa, 2011) – form a significant part of making technologies useable; however, as Denis (2019) emphasizes, also of the durability of these objects. Maintenance and repair work is characterized by interdependencies between devices (Graham & Thrift, 2007) and also involves the interaction of parts within the sociotechnical assemblage, adjusting and calibrating these to each other (Jackson, 2014). Adaptability and reparability are thus numbered among the more important requirements of technologies (de Laet & Mol, 2000).

Not all maintenance and repair work is connected with breakdowns; it also includes the mundane work of problems and malfunctioning. Thus, ongoing care of the artifacts and technologies is required, as it is difficult to foresee when something will go wrong, or what it will be (see also Denis & Pontille, 2015). In his study of an intensive care unit, Schubert (2019) shows how nurses and doctors routinely face equipment breakdowns and failures, and how they engage in situated problem-solving. To both deal with and take responsibility for material problems, they engage in prioritizing and improvising. Day-to-day routine maintenance is thus necessary in order to make the artifacts and technologies useable (Denis, 2019). During such work, the artifacts and technologies appear as fragile and transforming entities (Denis & Pontille, 2015), rather than stable ones. As Mol (2008) points out, it is important that nothing is taken as entirely fixed or entirely fluid. Thus, the taken-for-grantedness of the technology that users can rely on is the result of the attention and intervention of those doing the maintenance and care work (Denis, 2019).

Taken together, we propose to call the work of domesticating and caring for technologies “groundwork,” which we will show refers to the work and expertise entailed in making the technologies useable. Such work highlights a relational perspective of expertise which focuses on how expertise is generated and transformed amidst interactions between a heterogeneous assemblage of humans and non-humans. It underlines the fact that expertise must be understood as negotiated and recognized during interaction with others (e.g., Barbour et al., 2016; Pakarinen & Huising, 2025), being attuned to other actors’ purposes and ways of working, and mutually aligning these so that engagement continues (Edwards, 2011). In what follows, we illustrate the work of nurses in making robots useable

by means of ongoing domestication and care, as well as how these nurses used multiple forms of expertise in doing so.

METHOD

Setting

The study presented here forms part of an ongoing study of the introduction and use of imaging technologies and robots in advanced medical practices. We examine the work done by a group of nurses in relation to two different types of robots, namely a *surgical robot* and a *robotic X-ray*, at a unit called Operation X (OPX) at a Swedish university hospital. The OPX unit forms part of the new Center for Imaging and Intervention, which hosts the bulk of the hospital's imaging specialties and image-guided treatments, and also includes six ORs, used for both acute care and planned procedures, where high-risk patients suffering from severe and complex conditions are treated. This is also an R&D unit and the staff working there are involved in both developing new procedures and refining existing ones.

OPX is part of a department employing approximately 200 registered nurses and healthcare assistants specializing in surgery and anesthesiology. However, use of all the advanced technologies at this unit has led to the selection of approximately 60 nurses to work in this setting. The unit is located in a new building which is "neutral territory." The hospital started flexibly and efficiently utilizing the different robots by allowing different surgical sub-specialisms to utilize the same ORs, with the support of the same teams of nurses. This means that the doctors do not have OPX as their home turf. Thus, they come and go, but the teams of nurses stay.

The ORs are equipped with robotic X-rays (4), a surgical robot (1), and inter-operative Magnetic Resonance Imaging (1). They are almost double the size of ordinary ORs, and they also contain a huge number of other technologies, medical equipment, and devices. Before being allowed to work with the robots, all staff need to undergo training provided by the MedTech suppliers. While the doctors have attended specific training programs regarding how to use the robotic systems to perform medical procedures, the nurses are instead instructed and trained in how to prepare the robots and take care of them after procedures. As the ORs include a huge number of advanced medical technologies, and the medical procedures performed there are complex, a lot of preparation and maintenance is required to make these rooms useable, as we will show. The two robotic systems are used for different purposes, but the nurses' preparations and maintenance work are quite similar.

Data Collection

Between 2014 and 2021, the first author conducted extensive fieldwork at OPX using a combination of interviews, field observations, and shadowing (Czarniawska, 2014). The Ethics Committee for Sweden approved the study, and informed consent was obtained from the participants. The overall aim of the

study was to investigate how to organize knowledge- and technology-intensive practices in a new setting. Initially, interviews were conducted with all the groups of staff working in the ORs (healthcare assistants, registered nurses, and doctors from radiology, anesthesia, and surgery) to gain an overall understanding of their established work practices and medical specialties, as well as some insight into their views on the robots. The fieldwork has thus concerned itself with the introduction of new technology infrastructures, entailing that staff with different specializations, who had not previously shared any common practices, needed to negotiate and integrate not only new technologies and material arrangements, but also each other's established practices into their everyday work.

In the field, it immediately became clear that the nurses were playing a significant role in organizing these emerging practices. They were responsible for integrating the robots with other technologies, devices, and tools used in the advanced ORs. Even though the nurses working with the robots were among the most experienced, they had no standard operation procedures, protocols, or routines to rely on when making the robots ready for use. In this paper, we focus our attention on the work of a group of nurses assigned with the task of developing new routines for making the robots and OR ready for use.

Initially, we observed training sessions for the different staff categories in how to use the robots and their accompanying technologies, as well as workshops where registered nurses and healthcare assistants collaborated to combine their different tasks in relation to the new technologies. Supplier representatives and medical technicians were also involved in these sessions and workshops. These were also interviewed and observed during their interactions with the staff. Many activities and discussions thus concerned how to ensure that the robots were functional and to make them work in relation to all the other medical technologies and devices used in the OR. As a part of the overall study, we decided to follow a designated group of nurses working with the robots, a group that included six surgical nurses, two anesthesia nurses, and four surgical healthcare assistants, sometimes also assisted by intervention radiology nurses. They were chosen because they had shown great interest in working in this specific setting. They had extensive training in the maintenance and use of the robots and became what the suppliers of the technologies called "tech nurses." This also meant that they were responsible for training other nurses when the OPX group of nurses was expanded. Over time, the nurses developed the expertise necessary to make the robots ready for use.

During the next phase, we continued to observe the nurses in their day-to-day work. As preparations are a vital part of their advanced medical work, we shadowed them before and after their medical procedures. This work often included discussions about the technical aspects and how to position the patient on the table to make sure that the robots could work properly. As many of the medical procedures had not been standardized, this involved a lot of trial-and-error. This shadowing of the nurses and our observations of their "before and after work" allowed us a unique insight into the clinical practices, for example how they prepared, maintained, and repaired the robots, tools, and other technologies, and how they discussed and coordinated their activities. During our observations, we

took extensive fieldnotes, accounting for verbal interactions, the physical settings, and, more generally, the collective actions and interactions of the participants.

The nurses also had regular meetings where they discussed their experiences regarding the procedures and how to elaborate upon both their duties and their use of the different tools and technologies. Moreover, they often discussed the challenges posed by the robots and how to solve the problems so that these could be used safely. We attended these meetings and conducted interviews afterward, asking questions about the unfolding of the procedure, use of the technology, and collaborations with other staff.

Altogether, we conducted 85 interviews as well as 230 hours of observations of meetings, workshops, and training sessions and also shadowed nurses for 48 hours doing their day-to-day work. The interviews were held at each individual's workplace, lasted between 1 and 2 hours and were recorded and transcribed. Moreover, we also engaged in informal conversations during coffee breaks and corridor meetings, giving us further insight into their work and how they solved problems. Furthermore, we also gathered documents such as the medical reports, method cards, and publications written by the medical teams. Sometimes, these texts created the input for questions and discussions during the interviews, while, on other occasions, they were referred to during meetings, after which we checked them to gain further insight into practices.

Data Analysis

Inspired by a grounded theory approach ([Charmaz, 2006](#); [Czarniawska, 2014](#)), we have engaged in an iterative process of comparing the data from different sources over time. We coded the transcribed interviews and the notes from the observations, simultaneously writing memos to track and explore both the emerging codes and the connections between them ([Charmaz, 2006](#)). The initial codes followed the sequence of activities and included preparing machines, preventing problems, protecting the robot and people, and maintaining the robots. We mapped how the nurses worked *before* surgery to make the OR and the robot useable for the specific patient and type of surgery, as well as the maintenance work done *afterward* to make the robots ready for further use. A key insight gained from the initial round of coding was that working with the robots required the nurses to put more effort into preparation and maintenance. They had to enhance their repertoire of activities, for example, by translating some activities that concerned preparing the patient and medical devices to also encompass working with robots. Some of the other aspects were new to the nurses, and they needed to interact with the product specialist and medical technicians to learn how to make the robot useable.

During our subsequent analysis, we paid special attention to the longitudinal and situated character of our data in order to examine how the nurses enhanced their expertise. We realized, in fact, that a central theme around which many codes revolved was the way in which experienced nurses performed new activities and learned new skills relating to the robot. Over time, it also became clear that the same group of nurses engaged in caring for the robots and other advanced

technologies. The codes had to do with how they used their established and situated expertise to become better at enacting the robots, for example, by being able to anticipate what happens when using the robot, to note additional aspects such as “what is different” and being flexible and ready to make adjustments in order to make the robots functional. We continued by further elaborating upon the themes and their connections with the literature on domesticating technologies and caring for things. The field material shows that domesticating and caring are ongoing and interrelated activities, which we frame as “groundwork.”

An important aspect of analyzing the data was our ongoing conversations with the participants regarding our interim findings. Via these conversations, we obtained more detailed descriptions of and reflections on using the robots in the ORs. We then compared and discussed the codes and found that these were often connected with the way in which experienced nurses expanded their expertise. The nurses developed knowledge of the whole process, coordinating with all the actors involved, to make the robots function safely. Drawing upon a relational perspective on expertise, we explored how the nurses’ expertise is expended in relation to their practices of making the robot useable and thus also ultimately taking care of it. In the following sections, we present our analysis of the field material.

GROUNDWORK: MAKING THE ROBOTS USEABLE

Making robots useable requires a significant amount of work and extensive expertise to prepare the ORs and take care of the robots so that the medical procedures can be performed safely and efficiently. The experienced nurses working at the OPX unit were very familiar with their established routines, instruments, devices, and technologies very well. Their work also requires them to be flexible and prepared for the unexpected as there is always some need for situational adjustments and adaptation, for example, if a machine suddenly fails, or if relevant information about a patient is missing. However, the nurses experience working with robots as different from, and more complex than, the technologies and devices used during traditional surgical procedures. To make robots ready for use, and to keep them useable, the nurses working in the robotic ORs engage in processes of domesticating and caring for the robot. Here, we illustrate how this ordinary and often invisible, yet fundamental, work unfolds before and after surgery.

Domesticating the Robots

The robots are installed in the ORs on a permanent basis, making the OR the home of the robot. Domesticating the robot – literally making it *domesticus* (= belonging to the house) – includes all the work it takes, and the expertise needed, to attend to the robot’s needs in relation to the physical requirements of the medical space and to integrate the robot into the room, while also adapting the nurses’ practices to serving that robot. The robots thus need to share the space with an already established assemblage of technologies, medical equipment, and devices, which all must be aligned and mutually adjusted.

The Robots and the OR

The nurses working at OPX are responsible for making the physical setting of the ORs functional. They are well-educated and experienced, having three years of general nursing education and at least one year of education and 10 years of experience within their medical specialty: anesthesiology, radiology, or surgery. The robots became pivotal in respect of their work in the ORs.

At the heart of the OR is an operating table, which is about three meters long, with devices and technologies belonging to the surgical and the anesthesiologic procedures positioned around it. Even though the robotic ORs are almost double the size of a normal OR, the space around the table, which is the sterile zone, is always cramped and needs to be negotiated as staff, devices, and technologies all need to be close to the patient. The robotic systems consist of several parts which take up considerable space.

The robotic X-ray is floor-mounted in one corner of the room (outside the sterile zone). It has a C-shaped arm which measures 130 cm in diameter and has an X-ray tube and a detector mounted on each side of the C. To produce images, it moves into the operating table, rotates around the patient and produces 3D images in real time. The C-arm has nine axes to enable precise positioning. At the side of the table (within the sterile zone) is a control module on wheels with joysticks and buttons used for maneuvering the robotic arm.

The surgical robotic system consists of three components: the console, a computing tower, and the robot, which is a four-armed surgical device. Three of the robot's arms are equipped with surgical tools, and one with a camera. The surgical robot is large (175 cm in height, 125 cm in length, 90 cm in width) and weighs approximately 500 kg; it thus takes up considerable space at the operating table. It is on wheels as it needs to be positioned at the table in different ways depending on the type of surgery that will be performed. The computing tower and the console, from which the surgeon maneuvers the robot, are positioned outside the sterile zone around the table.

Domesticating the robots, attending to the robots, and integrating them into the OR involve exploring, adjustments, and adaptations initiated by the nurses in their day-to-day interactions with the robots. This includes, as we will show, adapting the medical practice to the needs of the robot while also adapting the robot and its devices to the needs of the medical practice in general, and to the needs of the specific medical procedure and of the patient.

Making the Robots Ready for Use: Developing Material and Processual Awareness

Preparing the OR and making the robots ready for use include aligning the different needs and requirements of all the participants, humans and non-humans, in the OR. A day at OPX starts at 6.30 am with a group of nurses preparing the ORs for the medical procedures of the day. When they arrive, the ORs with the robotic systems are arranged using a generic and standard set-up to make them ready for any kind of medical procedure. The robot and the room must now be adjusted to specific needs while taking into account both different and specific

requirements, depending on the medical procedure as well as the medical condition of the patient. The surgical nurses are responsible for preparing all their tools and devices, as well as attending to all the sterility aspects of the room. The anesthesiology nurses are responsible for the technologies and devices connected with their duties, and also for patient safety issues. This is part of their training as nurses as they have lengthy experience of different kinds of surgery and different kinds of patients. However, to make the robot ready for use, they need to collaborate and adjust their practices to the needs of the robot. Preparing the OR, however, also means accommodating both the patient's and the doctor's needs in a new material setting.

The material properties of the robots and their movements during use are sources of concern when preparing the OR. The robots need more space in which to work and to avoid collision. As the robots lack the capacity to adjust or adapt their movements and actions during use, the nurses need to attend to them before surgery, trying to anticipate how the medical procedure will unfold. While preparing the room, one anesthesiology nurse describes this work thus: "My role is constantly about thinking one step ahead, about what can happen during the operation."

One of the main activities when preparing the OR is building the table. This means the nurses need to materially set up the table in different ways. Specifically, the middle part of the table is fixed and rests on a pillar, to which the electronic parts are connected. When building the table, they can add different sections, for example, a short or a long piece, depending on how the patient has to be positioned for the procedure. The table can be moved – tipping, sliding, and rotating – using a hand control. While materially setting up the table for the patient and the doctor, the nurses need to take the movements of the robot into consideration at all times. In the example below, we see how this includes the practical uncertainties and ambiguities that need to be attended to before the surgeon enters the room and surgery starts.

One morning, one surgical nurse (SN), two healthcare assistants (HA) and one anesthesia nurse (AN) were beginning the preparations for vascular surgery. The SN checked the medical records system and the specific notes made by the doctor regarding how to position the patient.

- SN: Hmm, she [the doctor] is planning to perform the procedure using central access [through the patient's armpit] on the left-hand side, so we need an extra arm-table. She asks the AN: How do you want to position the anesthesia machine?
- AN: It depends on whether we use the short or long tabletop. I can put it a bit further to the right if necessary. I think the tubes [for the gas] are long enough.
The tubes for the gas cannot be too long, otherwise the pressure of the anesthesia gas and the oxygen will drop.
- HA 1: But what about the robot?
She walks around the table and looks at the robot parked in the corner of the room.

- HA 2:* The arm-table is on the same side where the C-arm enters, when we do a rotation [the C-arm of the robot rotates around the patient], I'm not sure there will be enough space. I suggest we turn the table a bit.
- SN:* Yes, that will probably be necessary. Shall we try 45 degrees?
- AN:* Sure, I may need longer tubes though, but that's ok. Perhaps we'll also need to move the table holding the surgical tools when we use the robot.
- HA 1:* No problem. But to be sure, we can do a test run when the robotic system is started up. We don't want it colliding like it did last week...

The nurses are articulating here a material awareness of what may happen during the medical procedure by also referring to a previous case. Their work includes matching the needs of the robot with the needs of both the staff and all the other devices, in this case by adjusting the position of the table and using longer tubes. This entails anticipating the robot's movements in relation to the medical procedure to be performed, but also in relation to all the people and other devices present in the room. The nurses know the room, its equipment, and their colleagues' movements, anticipating potential complications for the patient and working with the materiality of the room in order to be ready for different interactive scenarios between things, staff, and the patient. One of the nurses describes this as follows:

Sometimes, when we've positioned the patient in a specific way we have to rearrange all the machines and devices in the room to make sure that the robot gets access [to the patient]. They [the technologies] take up a lot of space and everyone, including the robot, needs to get access to the patient. (Elsa)

Material awareness is also a recurrent aspect when preparing the surgical robot. The robot is on wheels and, depending on the kind of surgery, can be positioned at the table in various ways. The position of the surgical robot does not change during surgery. However, the four arms move as the surgeon maneuvers them using the console and they take up considerable space. One nurse explains: "The basic set-up is often the same, but *our job is to look at what's different*. We need to figure that out" (Lisa, italics added). As the nurse explains here, they need to develop a new way of looking at the space when identifying the subtle differences between each procedure. Positioning the robot is important in preventing accidents and ensuring that all the devices work properly. For example, during surgery, the surgical instruments attached to the arms of the robot are inside the patient's body and must never be touched, as any unintended movement may cause bleeding and damage to tissues.

Daniel [the supplier representative] has guided us a lot in how to position the [surgical] robot, what the distance to the patient should be, and what to think about so that it doesn't collide with other devices, or with staff working in the sterile zone. (Maria)

To create enough space to perform surgery in a safe way, the nurses adjust both the position of the patient and the position of the robot. There must be enough space for the anesthesia nurse, working close to the patient's head, and for the assistant doctor and surgical nurse, working close to the patient in the sterile zone and supporting the surgeon working via the console. All the activities conducted

prior to surgery, such as addressing specific requirements and needs and making the robot ready to use, are important as this arrangement of interdependencies does not change significantly during the medical procedure.

Making the robots useable enables the users (the doctors) to take them for granted during use, but this work is not visible to them. These activities often take 2–3 hours, something occasionally questioned by the doctors:

The doctors complain and wonder why the preparation times are so long. But it isn't fair, the work done in this room is completely different from other ORs. Elsewhere, preparations aren't such a big deal. Here, we have more technology to attend to. (Lotta)

The more complex the procedures, and the higher the risk faced by the patients, the more preparations are needed, and the nurses need to stay alert to the unexpected. Their material and processual awareness thus becomes key to making the robots useable.

Taken together, domesticating the robots involves not only the robot itself, and its mechanical workings, but also the interdependencies between the robot and everything else in the room. Making the robot useable in a significantly new material assemblage also includes knowing the contextual details of the procedures to take place in the ORs, and how to deal with unexpected and difficult situations. This ongoing work of exploring, adjusting, and adapting in order to domesticate the robots includes what [Mol et al. \(2010\)](#) describe as attuned and adaptive attentiveness, which includes paying attention to details and being ready to change these. This means that the nurses not only build on their domain-specific expertise and a material awareness; they also draw upon their substantive understanding of the process to make the robot work in the significantly new material assemblage. They thus develop not only an accurate material awareness, but also a processual awareness, which entails being able to anticipate the robot's work and its interactions with the rest of the assemblage. The work of attending to and aligning the robot with the established assemblage of devices and technologies in the ORs thus also requires an understanding of the use of the robots during the medical procedures. This includes anticipating what may happen and taking action to prevent risks while using the robots, and also to protect both people and machines. Thus, the nurses expand their expertise regarding when to adjust the needs of the robots to the needs of the other devices and staff working in the room, by drawing upon material and processual awareness. However, all the work done by the nurses to make the robots useable so that medical procedures can be performed tends to become invisible when the robots function as intended.

Caring for the Robots

The ongoing work of making the robots useable includes caring for them. The robots neither work nor fail to work due to inherent reasons; rather, they depend on activities such as maintenance and repair. Such work entails “endless tinkering, ad hoc improvisation and a kind of localized gathering of knowledge and people” ([Lipp, 2023](#), p. 676). Moreover, there are back-up devices for most of the technologies in the event of malfunctioning or failure, but not for the robots permanently installed in the rooms. Thus, even if the robots look solid and sturdy,

they should be enacted as potentially fragile entities which can break down and fail. Most of the time, it is not a matter of dramatic breakdowns, but of practical uncertainties and ambiguities that must be fixed. Caring for the robots thus includes making them ready for use, but also being responsible for their becoming and durability.

Maintaining and Repairing the Robots Through Material and Processual Awareness

After a medical procedure, the nurses follow a standard procedure of making the OR ready for further use. The OR is thoroughly cleaned and disinfected, and the instruments that have been used are sent away for sterilization. The nurses make sure that all the necessary equipment and supplies are available for the next procedure, thus also engaging in equipment maintenance. Many of the maintenance activities have been routinized, standardized, and formalized in the procedural documents used by the nurses in their day-to-day work. Expanding these activities to also include the needs of the robot requires building on the nurses' already-established domain-specific knowledge, for example, regarding sterility, and on their process expertise. However, as the robots may interfere in unexpected ways with the assemblage of other technologies, devices, and people working in the OR, maintenance work also frequently includes troubleshooting and experimentation. One such example here is the sterile draping of the robot, which caused a lot of trouble at the beginning.

During surgery, an acute situation arose whereby the patient was hemorrhaging, and the doctors had to convert this minimally invasive procedure to open surgery. After surgery, the nurses took off the wrapping and started cleaning and disinfecting the robot. It immediately became clear that the sterile draping on the robot had not protected all parts of it and that blood had seeped into its joints. One of the nurses described what happened as follows:

It was messy during surgery, with a lot of blood all over the place. Everybody was concerned about saving the patient's life and didn't think about the robot. Afterwards, when we started cleaning, we saw that the sterile wrapping hadn't fully covered the base of the robot and had been torn apart over the C-arm. There was no chance of us cleaning it and making it sterile again.//...//We had to call for Adam [the supplier's maintenance technician]. It took him almost a whole day to disassemble the robot and clean it. And we had to postpone one operation and move another one to a different operating room.

The day after this incident, while the supplier's maintenance technician was working on the robot, a group of nurses visited the OR to discuss how to avoid this happening again. In order not to compromise safety and usability, both as regards sterility requirements and in order for the robot to function properly, the supplier representative (SR), two surgical nurses (SN), and a radiology nurse (RN) discussed how to apply the sterile wrapping:

SR: The whole robot needs to be covered during procedures so that no blood will get into its joints.
He shows his suggested way of covering the robot.

- RN:* I know, but if you dress the C-arm like this, then the wrapping will prevent the arm from having the right level of flexibility when rotating. I think this wrapping is too short and too tight.
- SN 1:* Hmm, but if it is too loose, it might touch the floor and maybe the patient too [said with a gesture of resignation].
- SN 2:* But maybe we can divide the wrapping into sections and use tape to fasten them? Perhaps two parts for the c-arm and one for the rest of the robot. We actually did something similar for a patient a while ago. Do you remember, we had to use two pieces of wrapping to get it right.
- SN 1:* Yeah, that's a good idea, let's try it...
Using scissors, the nurses started to cut the wrapping into pieces and then attached them using adhesive tape. After a few failures, with pieces that were too short and attachments that were too tight or too loose, they eventually found a successful way of draping the robot in a sterile way.
- SR:* This isn't, of course, a proper solution, but it will probably work as a temporary fix (said while starting the robot and doing a test rotation around the table).
I need to discuss things with the supplier of the wrapping. If they make it bigger, then you can adjust it according to your needs using adhesive tape, without cutting it I mean.
- RN:* We probably need to write more detailed instructions for our colleagues so they understand how to do it.

They measured the different parts and wrote the sizes of these on a sheet of paper that they attached beside the computer. One nurse took photos to record the sterile wrapping so that they would remember how to do it again.

This episode illustrates how maintenance and repair work is characterized by interdependencies between devices, here the robot and the sterile wrapping. Even though it was a temporary solution, it helped the nurses to better understand the movements of the robot in relation to other requirements, such as sterility. This also highlights the practical difficulties that nurses encounter when caring for the robots. The nurses were able to manage the entanglement of high and low tech, the robotic arm and adhesive tape and plastic wrappings, thanks to their extensive experience in surgery and radiology and expertise in the robot, and the specific aspects of the robotic ORs. Drawing upon their experience and past events, together with the situation at hand, they were able to anticipate what will happen. Taken together, based on their material and processual awareness, the nurses engaged in situated problem-solving and improvisation.

Keeping the Robots Useable

The domestication and care of the robots, done jointly by the nurses before and after medical procedures, sometimes with support from the MedTech suppliers, is a prerequisite for the safe functioning of the robots during use. With time, and the expanded use of the robots, more nurses have become familiar with working

in the robotic ORs, expanding their expertise as regards being able to prepare the room and do maintenance work afterward. This work of making and keeping the robots useable relies significantly on the nurses' established and situated experiences regarding preparing the room, as well as maintenance and repair of the robots. To develop new routines, and for these to be spread to newcomers, the work and expertise of the nurses have to be stabilized.

The nurses' work also includes documenting the procedures in the OR into brief step-by-step instructions arranged into two sections. One of these describes the work procedures involved in preparing the robot, as well as the equipment used for it. The other section describes how to clean up the robot and the equipment following a medical procedure, and how to position all the robotic equipment when the room is not in use. To exemplify this, the nurses also added photos to the instructions. Detailed instructions and specifications are important means of stabilization (Denis & Pontille, 2015) and for keeping technologies useable. This also resonates with what Bowker (2008) refers to as the "memory practices," the procedures that are considered valuable and thus need to be formalized into documents and protocols to be reproduced.

Moreover, some of the most experienced nurses, who had been working with the robots right from the beginning, became fully occupied working with the robots and transferring their expertise to newcomers.

I usually say that I eat, sleep, dream, and breathe robots. I'm responsible for teaching other nurses about the robotic systems, but I also make sure that we have the right instruments in the room and that everything is prepared. (Lotta)

If the robots are not working, everything else will come to a standstill. Therefore, it is important that nurses with technical skills, who can solve problems as soon as they arise, are always present at the unit. As the unit is technology-intensive, a couple of nurses have been given the role of "tech nurse." They are among the most experienced, having worked at the department for a long time and engaged in both procuring the robots and implementing the robotic systems. They are experts in domesticating and caring for the robots and have developed an extensive material and processual awareness. They support all the robotic ORs and work with troubleshooting and maintenance. They also coordinate repairs interactively with suppliers or medical technicians. One tech nurse explains her work with the robots thus:

I'm the one you call if things go wrong, and they do so most of the time. Usually, it's small things, that we fix together. But sometimes, there are bigger things and then I have to call someone at the MTD [Medical Technology Department] or the supplier. They're often in the building so they can come quite quickly. (Charlotte)

The tech nurses are also responsible for ensuring that there are documents and instructions when it comes to handling the robotic equipment, and for ensuring that these are kept up to date. These instructions also act as guidelines for staff who lack experience of working in the robotic ORs. Thus, these standardized instructions are not only a way of prescribing the expanded expertise of the nurses working in the robotic ORs, but also of sharing the practices with a larger group and thus of contributing toward collectively expanding the expertise that

makes the robots useable. The instructions thus serve as a collective memory, resting on the joint assessments and collective judgements of the nurses. In this way, the groundwork performed in the OR also makes the robot integrated in the wider organizational context of the hospital.

Taken together, the nurses treat the robots not as single things, but as part of a complex assemblage of people, objects, and technologies that includes many different needs which change over time and new needs that may arise. Over time, the nurses develop the capacity to anticipate what will happen, taking action to prepare for this and to foresee the outcomes of current activities. Thus, the nurses taking care of the robots expand their repertoire of actions, and their domain-specific expertise, to include the robots. Their adaptability allows them to swiftly grasp problems as they occur and apply their expertise to varying situations. This means that they not only draw upon multiple forms of expertise, but also that the different forms of expertise are blended. This enhancement of the nurses' expertise, required for making the robots ready for use, was not only relational, it was also collective. Thus, groundwork is a situated practice that includes ongoing domestication and care. Without this relational expertise, the medical procedure cannot start, or it may expose the patient to risk if the robots fail to work during surgery. Thus, the taken-for-grantedness of the robot, which the doctors can rely on during surgery, is a result of the ongoing groundwork of the nurses; their attention and intervention when it comes to making and keeping the robot useable.

FORMS OF EXPERTISE AND EXPERTISE EXPANSION

In the study presented here, we have illustrated how nurses engaged in groundwork to make different kinds of robots become and remain useable during medical procedures. This kind of work is often done in “invisible” places – in our case, in an OR without doctors and patients (Nardi & Engeström, 1999). This work may be defined as routine, but as we have shown, it actually required the nurses to mobilize and expand multiple forms of expertise (see Barbour et al., 2016), which were all simultaneously at play and interrelated.

To make the robots useable, the nurses working in the ORs built on their domain specific expertise. They were highly experienced and knowledgeable within their specific domain (Barley et al., 2020) which had emerged through long-term immersion with the nursing practice (see also Benner, 1984). Their expertise included knowing about the medical condition of the patient and different medical procedures with the use of specific instruments and devices. Their work, although highly systematic and standardized, also involved ambiguous trial-and-error processes and improvised action. Thus, being flexible and prepared for the unexpected was part of the nurses' domain expertise.

The nurses working with the robots represented anesthesia, radiology, and surgery, three different medical specialties which may be described as sub-domains. This implies that the nurses had to coordinate their tasks and acknowledge each other's expertise when attending to the robots in the OR and integrating them into the medical practice. By coordinating around the technology, they expanded

their domain expertise by learning about other domains' priorities and practices and collectively finding ways to accommodate the demands of different domains operating around the robot. To attend to and care for the robots they also had to draw upon, and learn from, the supplier representatives' expertise in the robotic systems. Thus, the nurses' expertise expanded not only toward each other's medical domains, but also in relation to the technology, as they were engaging with the expertise underpinning their own specialist practice while simultaneously having the capacity to respond to and interact with others' expertise in this local practice and technology-intensive room.

This implies that the nurses draw upon their relational expertise, as they are attuned to other actors' purposes and ways of working, and mutually align these so that engagement continues (Edwards, 2011). The nurses' relational expertise is negotiated and recognized in interaction with others (e.g., Barbour et al., 2016); for example, the surgery and anesthesia nurses usually work together during surgical procedures, and part of their expertise is to be knowledgeable about, and interact with, other professionals, like doctors and hospital technicians. However, their relational expertise is also expanding, alongside the expansion of their domain-specific expertise, to perform the groundwork in robot-enabled medical practices. In fact, in the OR, the nurses' relational expertise not only involves social relationships, interactions with other people, but it also builds on a relationship between the nurses and the robots whereby these continuously influences each other.

Our study shows that the expansion of expertise – domain and relational – to perform groundwork implies the development of two types of awareness: material and processual. The nurses were developing a material awareness, which means that their relational expertise also concerns the material interdependencies and interactions in the assemblage where work takes place – including medical personnel, robots, instruments, patient, bed, and so on. This is of significance for making the technologies useable, as technologies may interfere in unexpected ways with other entities and configurations. In refining their material awareness to make the robots useable, the nurses draw upon past experiences, but, as they need to engage in situated problem-solving and experimentation in the very specific context of operation, the technology and objects in the room, the medical routines, and their nursing skills all have to be mutually adjusted (Mol, 2008).

The nurses also developed an accurate sense of timing, which we describe as processual awareness, when it came to domesticating and caring for the robot. In intertwining multiple forms of expertise, they both anticipated what would happen in the room during the medical procedures and drew upon past experiences as they remembered what had happened earlier, thus weaving together past and future in situating the usability of the robot for the specific medical procedure at hand. Over time, a fluid, almost seamless performance emerged whereby the nurses' actions reflected attunement to the situation. This also involved being able to anticipate what might happen, which involves a readiness to continually renegotiate the sequence and interplay of the interdependencies. For example, the nurses know in advance that, if they prepare the robot in a specific way, it will probably work, or that it may also create problems during and after surgery.

The nurses' domain expertise was characterized by intuitive links between seeing the salient issues in a situation and finding ways of responding to these (see also Benner et al., 2009).

Taken together, the material and processual awareness, grounding the expansion of expertise, were produced and enacted in interaction with the nurses' domain and relational expertise. The expansion of the nurses' expertise was generated, applied, and transformed amidst interactions of a heterogeneous assemblage of humans and non-humans (see also Pakarinen & Huising, 2025). The pragmatic accommodation of their domain-specific and relational expertise, as well as their material and processual awareness, helped them to establish what constitutes good practice and good judgment (see Dreyfus & Dreyfus, 2005) when making the robots ready for use. By literally manifesting what Mol (2008) articulated as "keeping a close eye on your tools" (p. 50) – a matter of material awareness – and being temporally skilled in anticipating the unexpected, learning from past experience and reading the specificities of the present – a matter of processual awareness – the nurses' domain expertise became recognized as useful and relevant by means of integration with adjacent forms of expertise (see Pakarinen & Huising, 2025, p. 2068). This expansion of expertise was necessary for the nurses to make the robots useable and maintain them as such, that is to engage in what we have called here groundwork. In the next section, we further discuss the notion of groundwork.

DISCUSSION

In this paper, we pay attention to groundwork, the work and expertise entailed in making the technologies useable. This kind of work, we claim, is important, and necessary not only for efficient and safe use of the robots but also to make use of the potential of the technologies and to integrate them into existing practices. Our study makes visible a reliance on material and process awareness while the nurses are expanding their domain and relational expertise in order to make the robots useable. The study also emphasizes how the expansion of expertise ongoing in the nurses' groundwork around the robots was highly situated in the specificities of the ORs.

Rather than being performed individually, the groundwork done in the ORs was based on a *collective* conception of the practice and the needed expertise. Making the technologies useable included jointly experimenting, adapting, and paying attention to details, and then changing these until a suitable material arrangement was achieved. Groundwork thus rested on the joint work of nurses, including assessments and judgments, to make and keep the robots useable. The nurses also critically reflected upon, and documented, their experiences, which served both to show the repertoire of options available to other nurses and reduce some of the uncertainty surrounding the use of the technologies. Once their groundwork was recognized as trustworthy, their newly generated expertise was shared with other nurses and, by means of formalization, made collective. This results in a "taken-for-grantedness" of the material assemblage that users can rely

on when using the robots during medical procedures. This taken-for-grantedness is the result of the attention and intervention of those engaging in groundwork.

Groundwork is, thus, an interactive and ongoing accomplishment that is practiced by *domesticating* and *caring* for the robots during a long process of commitment and attachment to the materiality and the processual aspects of the medical practices performed in a specific context. It entails attending to the robots' needs and integrating them into the complex setting of the advanced OR, as well as maintaining and repairing them for further use. Groundwork is thus relational in time and space and requires expertise that builds upon material and processual awareness; in other words, being able to draw on the past and anticipate the future, mutually adjusting the robots' and the experts' needs in time and space.

Domestication is concerned with the integration of technologies into practice, which has consequences for its enactment (e.g., [Liste & Sørensen, 2015](#); [Silverstone & Haddon, 1996](#)). It is an ongoing and emergent process, where the needs are changing, and new requirements arise. It thus requires an understanding of the situated and contextual aspects into which technology is being introduced. In line with [Huising and Silbey's \(2011\)](#) system managers, whose knowledge of the physical infrastructure of the organization was key to making an IT system work, the nurses' intertwining of their multiple forms of expertise during their groundwork took on a concrete and material form in terms of knowing the specific rooms in which the robots were being used, and which were being shaped by the robots. This also resonates with what [Kho et al. \(2019\)](#) found: that for physicians and nurses using telehealth, relational expertise became a new resource alongside their domain-specific expertise as regards solving complex problems. Our study, however, goes further because it shows how the work of the experts engaged in domesticating the robot, relies on a recursive relationship between nurse and robot: attending to and integrating the robot into the room while adapting the nurses' practices to serve that robot. Such expertise thus entails making connections with other artefacts, practices, and people (see also [Liste & Sørensen, 2015](#)) and constructing a relational functionality where the participants in the assemblage act or react to serve both their own and others' needs ([Bailey et al., 2022](#)). Thus, the domestication of the robots is not only performed by means of unidirectionally adapting the robots to both the room and the medical procedures, but also by means of changing the ORs and the assemblages of devices, tools, people, and technologies in that room, in order to accommodate the needs of the robot.

Caring for the robots – the maintenance and repair work – is characterized by interactions and interdependencies between the parts within the assemblage which are adjusted and calibrated to each other ([Jackson, 2019](#)). How experts care for these technologies is influenced by the relational complexity of work settings. The nurses engage in situated problem-solving, including the mundane work of problems and malfunctioning, where they deal with and take responsibility for material problems (material awareness) and, drawing upon their processual awareness, they engage in prioritizing and improvising. Such work and expertise also include experimental learning that may lead to improvements and renewal. The maintenance and repair work are done in the OR, the home of the robot, by

the nurses, instead of being separated or outsourced to others (for example, done by cleaning staff or sent away to the supplier's workshop), sometimes with support from maintenance technicians. The nurses become everyday caregivers of the robots in the robots' own home.

Taken together, groundwork is understood as a collectively-enacted process that unfolds through processes of domestication and care which are interrelated. The focus of domestication is on the relationship between the technology and the physical space and the heterogeneous assemblage of humans and non-humans. It includes the work and expertise needed to make the technologies become part of the assemblage of participants including their different needs and requirements. Care, on the other hand, has a stronger focus on the technology itself and the work and expertise needed to repair and maintain the technology. Domestication and care are not straightforward processes but ongoing and emergent, as needs of the participants in the assemblage change, and new ones may arise. The technologies are not stable entities, but open for negotiation, and "fragile" in the sense that they must be attended to and cared for in order to become and remain useable. Groundwork, including the processual and material awareness, is thus fundamental to the work of making and keeping the robots useable. This groundwork also develops an ethical obligation (de La Bellacasa, 2011) between the nurses and the robots, as the developed relationality between them produces attachment and commitment to making the assemblage of the ORs and the medical practices performed in these settings durable.

CONCLUSION

Drawing upon a longitudinal in-depth study of robots in advanced medical practices, we introduced here the notion of *groundwork*, the highly skilled behind-the-scenes work (Nardi & Engeström, 1999) of making and keeping the robots useable. Shifting our gaze to a place that is often treated as invisible, such the OR empty of doctors and patients, we show the myriads of activities and the expertise needed to make and keep technologies useable. The groundwork is understood as a collectively-enacted process that unfolds through processes of domestication and care. Bringing the groundwork to the fore offers a new perspective on how advanced technologies become and remain useable in complex settings, such as medical practice, where expert work is key and stakes are high.

First, we have turned our gaze away from looking at what happens when technologies are used, and thus need to be taken for granted, toward looking at groundwork during which the technologies are open for negotiation and not taken for granted. Groundwork is performed amidst interactions of a heterogeneous assemblage of humans and non-humans with different needs and requirements which must be considered to make the technology useable. Groundwork is thus not a straightforward process but ongoing and emergent, as needs and requirements of the participants in the assemblage change, and new ones may arise.

Second, the study illustrates how groundwork mobilizes and expands multiple forms of expertise. The nurses' domain expertise is needed to domesticate

the robots in the ORs and at the same time expanded as the nurses attune the advanced technology to the medical practices at hand. This expansion relies also on their relational expertise as the nurses interact and negotiate different needs within the assemblage.

Third, by unpacking the process of domesticating and caring for the robot, we highlight how groundwork relies on a deep *material and processual awareness* which is produced and enacted in interaction with the nurses' domain and relational expertise. The results show how the expansion of expertise grounds the development of the ethical obligation on the part of the experts toward the technologies, which produces commitment and an attachment to the durability of the material assemblage.

Finally, paying attention to groundwork may also have practical implications, as the increasing use of advanced, and expensive, technologies in expert work will probably increase the need for such work. Safe and efficient use of technology is dependent on groundwork, which is based on domain expertise and requires an extensive awareness of the material and processual aspects of the situation. Thus, an acknowledgement and re-evaluation of this highly skilled behind-the-scenes work may become more important in knowledge- and technology-intensive practices.

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RUNNING CODE OR BETTER CODE? EXPERTISE DE/CENTRALIZATION TENSIONS IN THE ETHEREUM BLOCKCHAIN ECOSYSTEM

Paula Ungureanu

University of Modena and Reggio Emilia, Italy

ABSTRACT

Blockchain is one of the most consequential innovations since the world wide web. Although blockchain is argued to remove, displace, or redistribute expertise, there is little understanding of the role of expertise in blockchain ecosystems, and more generally the expertise that fuels the development of new technologies by means of open, fluid, and heterogeneous knowledge contributions. An empirical study of the social organization of the Ethereum community, the second largest blockchain ecosystem after Bitcoin, reveals the contrasting tensions involved in setting up a system of decentralized expertise. The alternate community mantras “rough consensus, running code” and “wide consensus, better code?” suggest that the Ethereum community enacts expertise centralization and decentralization practices simultaneously to create a fragile balance between individualized accountabilities and a generalized sense of diffused participation. These practices unfold along a continuum of routine operations punctuated by critical events and are both essential for navigating the uncertainties of decentralized organizations. The study contributes to research on new forms of expertise occasioned by emerging technologies, and in particular to our understanding of blockchain expertise. The study’s relational

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perspective on expertise adds to research on the dynamics of knowledge delocalization in online communities.

Keywords: Blockchain; expertise; de/centralization; online communities; open source; platform ecosystems; Ethereum

INTRODUCTION

Emergent algorithmic technologies are strongly challenging traditional models of expertise organization to the extent that “one could go so far as to claim that the technology is the organization” (Alaimo & Kallinikos, 2021, p. 1402). How expertise is socially constructed and negotiated in decentralized ecosystems occasioned by emergent algorithmic technologies constitutes a new area of social inquiry (Dorschel, 2022; Kellogg et al., 2020; Susskind & Susskind, 2015). This study aims to bring attention to the decentralized forms of organization such as platforms, ecosystems, and open online communities occasioned by blockchain technology in order to encourage inquiry about the shift from traditional models of expertise based on human centralization to new models based on human-algorithm interdependencies.

Blockchain technology has been said to afford new models of social governance which are not reducible to traditional definitions of hierarchical organizations, networks, or even platforms (Davidson et al., 2018; Lumineau et al., 2021; Vergne, 2020; Zachariadis et al., 2019). By acting like databases distributed among peer-to-peer computer networks, blockchains enable transparent and immutable information exchanges without use of expert intermediaries such as regulators, banks, lawyers, accountants, or governments (Davidson et al., 2018; Felin & Lakhani, 2018; Notheisen et al., 2017). From that standpoint, blockchains promise to dismantle the premise that information is centralized systematically in the hands of the few and set the basis for the inalterable distribution of rights and responsibilities to the many. Thus, how blockchains organize expertise is raising novel theoretical and empirical questions.

Many contributions across various domains and disciplines coalesce around the functional definition of blockchain as a “trust machine” which has the power to replace trust between individuals with trust in algorithms (Davidson et al., 2018; Lumineau et al., 2021). In this view, the correct functioning of cryptographic rules, mathematics, and game-theoretical incentives allows the seamless operation of computational systems which limit or remove the need for human intervention. Yet like all technologies, blockchains need to be developed, maintained, and improved which ultimately requires human intervention (Lumineau et al., 2021). Recent studies (Alaimo & Kallinikos, 2021; Anthony, 2021; Glaser et al., 2021) argue that the algorithms driving new technologies take the form of a black box where the agency lies with the algorithm rather than the socio-technical relations and negotiations involved in their creation and deployment. As a result, humans are frequently considered passive actors, and their contributions to these technologies are undervalued.

In responding to calls for a more balanced approach that takes account of both human and algorithmic agency (Bailey et al., 2022; Faraj et al., 2018; Glaser et al., 2021; Kellogg et al., 2020; Susskind & Susskind, 2015), this study adopts a relational perspective of the expertise necessary for the creation and deployment of automatizing technologies such as blockchain (Pakarinen & Huising, 2023). On the one hand, the literature on online communities (OCs) such as open-source software communities and open innovation projects (Barrett et al., 2016; Faraj et al., 2016; Fürstenau et al., 2023; O'Mahony & Ferraro, 2007) documents trends related to the collectivization of knowledge and the decentralization of technical expertise which question much of our current knowledge about expert systems (Crowston & Howison, 2006; Dahlander & O'Mahony, 2011; Hippel & Krogh, 2003; Lyytinen et al., 2016; Safadi et al., 2021). Mathematician and computer programmer Eric Hughes coined the term cypherpunk in his 1993 manifesto, arguing that information technology could fuel collective and decentralized means of social liberation:

Cypherpunks write code. We know that someone has to write software to defend privacy, and since we can't get privacy unless we all do, we're going to write it. We publish our code so that our fellow Cypherpunks may practice and play with it. Our code is free for all to use, worldwide. We don't much care if you don't approve of the software we write. We know that software can't be destroyed and that a widely dispersed system can't be shut down (Hughes, 1993).

These ideas are echoed in the manifestos of many open-source communities dealing with technological developments including Bitcoin (Nakamoto, 2008), Ethereum (Buterin, 2014), blockchain, and OpenAI.¹

However, even in open-source environments, the power of experts such as computer programmers and data analysts is increasing and becoming the “invisible hand” behind algorithmic models and technologies (Burrell & Fourcade, 2021; Crowston & Howison, 2006; Dahlander & O'Mahony, 2011; Dorschel, 2022; Pachidi et al., 2021; Susskind & Susskind, 2015). For example, although OpenAI uses open-source data, the work of its in-house experts is opaque which allows it to retain control over certain tools such as Chat GPT for instance (Roose, 2023). Similarly, despite blockchain technology being largely open source, only a few programmers have the expertise to contribute to its development (Walch, 2019). Several studies have investigated “new” experts considering them as either the custodians of decentralization that ensure technological development, reliability, and accountability or threats to decentralization that are undermining the ideals of online communities (Crowston & Howison, 2006; Faraj et al., 2016, 2018; Safadi et al., 2021; Susskind & Susskind, 2015). However, despite this growing awareness of the contradictory tensions between the decentralized organization of new technology developments and the rise of new groups of experts, none of the literature adopts an integrative perspective.

In this context, the present study aims to shed light on the de/centralization tensions intrinsic to the relation between expertise and new forms of organization occasioned by emergent decentralized digital technologies. The study examines the social organization of the Ethereum community, the blockchain ecosystem second only to Bitcoin. The case of blockchain offers a unique opportunity to

study the paradoxical tensions entailed in the organization of a decentralized system of expertise. By design blockchain offers transparency and challenges traditional open-source models that combine openness with occasional closeness. However, similar to other technology, blockchain technology needs to be programmed, maintained, and implemented by human experts.

The case study in this paper provides a more comprehensive understanding of how blockchain technology is produced through the efforts of decentralized open-source communities in which elite developers play an important role. It provides a thick description of the Ethereum community's attempts to navigate the de/centralization tensions resulting from concerted efforts to extend the expert contributions from the broad community and invest "elite" experts with the power required to develop a reliable technology. The de/centralization tension manifests as ongoing alternating between two community mantras *rough consensus, running code* which alludes to expertise centralization practices, and *wide consensus, better code* which indicates the community's aspirations to achieve radical decentralization. These tensions occur along a continuum of routine organization punctuated by efforts to organize in times of crisis. The study contributes to the literature on algorithmic work and expertise in online communities. It emphasizes the need to move beyond dualistic views of de/centralized expertise and adopt a relational perspective on human intentions, algorithm production, hybrid ideologies, routine, and crisis organization.

THEORETICAL FRAMEWORK

Decentralization Tensions in Platform Organization and Online Communities

In an era of rapid technology advances, the boundaries between democratization and control of knowledge have become increasingly multifaceted (Burrell & Fourcade, 2021; Kallinikos et al., 2013; Yoo et al., 2012; Zuboff, 2019). Technology platforms and ecosystems, in particular, involve loosely coupled groups interacting without hierarchical command to develop new algorithmic technologies (Constantinides et al., 2018; Faraj et al., 2016; Gillespie, 2010; Lyytinen et al., 2016; O'Mahony & Ferraro, 2007; Shaikh & Vaast, 2016). OCs, such as open source software communities and open innovation crowds, have become pivotal for developing emergent technologies and are driving most of the organization of technology platforms (Faraj et al., 2016). They unite geographically dispersed individuals with diverse interests to collaborate on loosely coupled activities related to a technology or set of complementary technologies. Unlike traditional organizations, OCs have fluid membership, porous boundaries, and evolving roles and norms (Faraj et al., 2011). This flexibility allows dynamic flows of tacit and explicit knowledge, fostering an environment conducive to decentralization of expertise (Barrett et al., 2016; Faraj et al., 2016; Fürstenau et al., 2023; Safadi et al., 2021; Shaikh & Vaast, 2016; Von Krogh et al., 2003). It is being claimed that these new organizational forms are challenging traditional expertise structures but how and when requires deeper investigation (Susskind & Susskind, 2015). So far, studies on platform organization and

OCs observe tendencies toward both decentralization and centralization which are leading to unique tensions and dynamics.

Studies that focus on the trend toward decentralization suggest that platforms are distinctive organizational forms which differ from markets, hierarchies, or networks. [Stark and Pais \(2020\)](#) suggest that while markets contract, hierarchies command and networks collaborate, platforms co-opt. Since the term platform is “specific enough to mean something, and vague enough to work across multiple venues for multiple audiences” ([Gillespie, 2010](#), p. 349), it facilitates co-option as a form of distributed rational control distinct from the normative, technical, and bureaucratic control used by experts in the past ([Cameron & Rahman, 2022](#); [Kellogg et al., 2020](#)). For instance, blockchain platforms have enormous growth potential. Through the mobilization of heterogeneous communities of hierarchically independent actors who contribute their expertise to complementary applications the blockchain technology can be programmed to adapt to countless needs and niches beyond those anticipated by its original developers ([Davidson et al., 2018](#); [Lumineau et al., 2021](#); [Notheisen et al., 2017](#); [Zachariadis et al., 2019](#)). This decentralized approach is credited for fostering innovation and enabling a democratic approach to knowledge creation ([Barrett et al., 2016](#); [Shaikh & Vaast, 2016](#); [Tiwana et al., 2010](#); [Von Krogh et al., 2003](#)). [Priharsari and Abedin \(2022\)](#) note that although OCs are often created or managed by organizations, they remain largely autonomous. Even in sponsored communities, enforcing compliance and controlling value creation are difficult and uncertain tasks. These characteristics can be explained by several processes. Fluidity defined as the continuous evolution of rules, participants and interactions, encourages continuous inflows of new ideas and perspectives in OCs while enabling participants to shift roles as their engagement changes ([Faraj et al., 2011](#); [Lyytinen et al., 2016](#); [Priharsari & Abedin, 2022](#); [Safadi et al., 2021](#)). Transparency and openness, foundational to open-source ideology, ensure that code remains visible and accessible to everyone even during the most critical phases of development ([Diriker et al., 2023](#); [Hippel & Krogh, 2003](#); [Shaikh & Vaast, 2016](#)). Trust mechanisms such as swift trust arising from shared goals, shared values and repeated interactions, have been shown to facilitate cooperation, integration, validation, and knowledge sharing in OCs that lack traditional organizational structures ([Ren et al., 2007](#); [Von Krogh et al., 2012](#)). Digital platforms enhance these affordances by providing an infrastructure for fluid and open large-scale collaboration ([Barrett et al., 2016](#); [Constantinides et al., 2018](#); [Diriker et al., 2023](#); [Lyytinen et al., 2016](#)).

At the same time, there is a strand of work that studies centralization practices which allow individuals or subgroups to accumulate disproportionate influence in OCs ([Burrell & Fourcade, 2021](#); [Dorschel, 2022](#); [Pachidi et al., 2021](#)). Centralized expertise can result from the technical complexity of the digital technology ([Crowston & Howison, 2006](#); [Von Krogh et al., 2012](#)). According to [Burrell and Fourcade \(2021\)](#), a coding elite comprised of software developers, computer engineers, and researchers can introduce centralization practices in platform models by retaining exclusive ownership over translation of social norms into computer code either because they are the only actors that understand the code or because they own the code and are able to influence how others deploy it. In platform

organization, coding elites play a crucial role in managing knowledge contributions and maintaining code quality (Dahlander & Frederiksen, 2012; Hippel & Krogh, 2003; Levina & Arriaga, 2014). In line with the open-source ethos, individuals aspiring to become core contributors may volunteer to play informal leadership roles within the community, guiding discussions, validating knowledge, and setting collective norms (Dahlander & O'Mahony, 2011; Howison & Crowston, 2014; Levina & Arriaga, 2014; Stewart & Gosain, 2006; Von Krogh et al., 2012). To become a core contributor typically requires significant time and effort since social status must be earned through proven expertise and continuous contribution. The terms "trusted lieutenants" (Hippel & Krogh, 2003; Shaikh & Vaast, 2016) and "fiduciaries" (Walch, 2019) have been used to highlight the pivotal role of these individuals in the governance and coordination of OCs. However, some studies examine the dark side of this phenomenon. Centralized expertise, although beneficial for maintaining high standards and ensuring continuity, can lead to power imbalances and gatekeeper behaviors which stifle innovation by limiting the diversity of ideas and slowing the incorporation of novel contributions (Crowston & Howison, 2006). This can result in the establishment of elites and power networks that concentrate and obscure decision-making about technology developments (Burrell & Fourcade, 2021; Schüßler et al., 2021) and hierarchies which control less powerful and less visible digital actors (e.g., users, gig workers) (Burrell & Fourcade, 2021; Dorschel, 2022). These negative outcomes have become more problematic over recent years with the gradual shift in the contributions of OCs from hobbyist to professional and commercial and more aligned to increased corporate involvement in open source projects (Santos et al., 2013; Shaikh & Vaast, 2016; Von Krogh et al., 2012) and online crowds (Frenken & Fuenfschilling, 2020; Schüßler et al., 2021). From such perspectives, control over expertise in the fluid and digitalized capitalistic society resembles traditional forms of expertise.

Advancing the De/centralization Debate: The Role of Emerging Technologies

In sum, the interplay between de/centralization tendencies in OCs is causing unique tensions which may challenge our understanding of expertise. Decentralized expertise has been credited for fostering inclusivity and democratic creation of knowledge but can pose coordination challenges and code quality inconsistencies. Centralized expertise is seen as ensuring high technological standards but also can lead to power imbalances and gatekeeper behaviors which challenge the OC philosophy. Achieving a balance among these tensions is crucial for OC sustainability and success (Dahlander & O'Mahony, 2011; O'Mahony & Ferraro, 2007; Tiwana et al., 2010). Studies such as Safadi et al. (2021), Hemetsberger and Reinhardt (2009), and Dahlander and Frederiksen (2012) explore the origins of valuable contributions in online technological communities and highlight the frictions that emerge between core and peripheral participants. This stream of work finds that both socially embedded (core) participants and epistemically marginal (peripheral) participants contribute highly valued knowledge, and that the interplay between their roles is crucial for effective knowledge production. However, how this interplay unfolds and its consequences for OCs have so far received

limited research attention. The existing literature discusses numerous strategies for balancing de/centralization tendencies. These include boundary objects, that is, tools and structures that provide an interface between the core technology and complementary innovations allowing both stability and integration of diverse contributions (Ghazawneh & Henfridsson, 2010; Hemetsberger & Reinhardt, 2009), adaptive and multifaceted governance schemes that combine elements of autocracy, oligarchy, federation, and meritocracy (Shaikh & Henfridsson, 2017), hybrid open-closed models (Diriker et al., 2023; Hippel & Krogh, 2003), and temporary private spaces or “digital folds” which balance transparency and privacy according to the needs of the development work (Shaikh & Vaast, 2016).

However, although important these studies have some limitations. In contrast to issues such as coordination and motivation, expertise and knowledge distribution have received scant attention in research on OCs with most studies focusing either on the need for centralized expert roles or the ideals of radical knowledge decentralization but not their joint effect. This stream of work also overlooks the role of emergent technologies and the algorithmic processes underlying the structuring of OC knowledge (Bailey et al., 2022; Faraj et al., 2016). Glaser et al. (2021, p. 2) criticize the current views of algorithmic technologies as “precise recipes that specify the exact sequence of steps required to solve a problem” because they tend to minimize or exclude human intervention (Pakarinen & Huising, 2023). However, from a strictly computational and programming perspective, an algorithm implies a set of non-automatic translations from a logic component that defines what needs to be done in abstract terms, to a control component that defines how it should be done (Glaser et al., 2021). Many of these steps are performed by computer programmers, but other actors in and around OCs such as technology researchers, users, investors, auditors, and orchestrators may also shape how algorithms are produced and implemented into code (Alaimo & Kallinikos, 2021; Barrett et al., 2016). According to Faraj et al. (2016), the domestication of increasingly complex digital technologies such as artificial intelligence, blockchain, and big data is shifting the focus from the individual efforts of single contributors, such as coding elites, to the collective social practices that allow entire communities to make sense of new technologies and find a place for them in their daily interactions (Anthony, 2021; Bailey et al., 2022). This changed perspective invites renewed attention to how OC relationships shape de/centralization tendencies via the social production of algorithms. Consequently, in this context, expertise should be studied from both a substantial standpoint – where the expertise is localized and embodied, and from a relational standpoint – how this expertise is constituted and negotiated through social interactions (Alaimo & Kallinikos, 2021; Anthony, 2021; Bailey & Barley, 2020; Dorschel, 2022).

CONTEXT AND METHODS

Context Description

Ethereum is a decentralized open source digital platform founded on blockchain technology. In essence, blockchain is a public ledger which has been likened to a

long DNA chain that grows in size periodically as information about new transactions is added. These transactions are stored in blocks which are linked linearly using cryptographic hash functions allowing each block to be traced back to its the genesis block, hence the name “blockchain.” The chain is maintained by a network of nodes which verify the validity of the transactions. These transactions are added to the chain as new blocks based on consensus mechanisms which can assume various forms depending on the blockchain type (Notheisen et al., 2017). In being decentralized, immutable and transparent, blockchain dispenses with intermediaries and centralized authority and serves as a single source of truth, enabling the actors to read and write according to a common database in which all participants can trust (Buterin, 2014; Davidson et al., 2018; Felin & Lakhani, 2018).

Ethereum was co-founded in 2013 by Vitalik Buterin, a Canadian computer programmer who wanted to extend blockchain applications beyond financial payments. Ethereum is the second largest blockchain ecosystem after Bitcoin and is famous for having introduced deployment of smart contracts and decentralized applications to blockchains thereby shifting application domains from financial payments to virtually every sector of the economy (Buterin, 2014). In addition to the baseline protocol, Ethereum hosts over 50 million smart contracts² which constitute the backends for a wide range of decentralized applications that can be created and deployed by anyone with appropriate programming skills. For example, Ethereum provides a platform for decentralized finance (DeFi) applications which provide a broad array of financial services, including borrowing or lending without the need for financial intermediaries such as brokers, exchanges, or banks. It also hosts non-fungible tokens which represent digital ownership of assets and privileges.³ It controls a native cryptocurrency called Ether (ETH) which is ranked second in market capitalization value to Bitcoin. In 2022, ETH’s market capitalization was \$200 billion, 400 times its value in 2016.⁴ The Ethereum ecosystem is home to one of the most vibrant and fastest growing communities in the crypto space and includes core blockchain protocol developers, independent developers of smart contracts and decentralized applications, and the actors that make the blockchain machine “work” by providing the computation resources necessary to verify transactions (i.e., validators, stakers), cryptocurrency holders, investors, and community managers among others.⁵

To understand how expertise is socially constructed and distributed within the Ethereum community, we investigate the perceptions of and interactions among these different actors responsible for keeping alive the Ethereum platform.

Data Collection and Analysis

Data collection occurred between 2020 and 2023 and involved 65 primary source semi-structured interviews and 75 secondary source videos (e.g., online meetings, tutorials, live recordings available on YouTube) and podcasts involving Ethereum community members. Interviewees were identified through a mix of online recruiting and snowball sampling techniques. Initially, contact was made with members of the Ethereum community who were relatively active in the community’s forums and on social media. Interviewees were asked to introduce the

researchers to ecosystem stakeholders whom they knew, and thought could provide interesting insights. In addition, community managers who agreed to participate were asked to host and/or endorse the research project on the community's social media such as Reddit and Discord in order to identify and recruit new interviewees. All interviews were conducted on-line, lasted around 75 minutes on average, and were recorded and transcribed verbatim.

Archival data include 89 documents – reports, white papers and research papers, community members' blog posts, and other documents available on the Ethereum website. During data collection and analysis, the author integrated the data collection process with specific searches for critical incidents in the life of the Ethereum community. These searches used data scraping on some of Ethereum's popular Reddit channels to extract and analyze 618 community posts and 3,889 comments and searched the Lexis Nexis database for media coverage of critical incidents in a total of 430 articles. The data were imported into an integrated database on Dedoose, a web-based platform for computer-assisted qualitative analysis.

Grounded theory (Strauss & Corbin, 1990) was used to shed light on the participation of the Ethereum community in the social negotiation of blockchain expertise, alongside continuous back and forth between the various data sources and extant theory on platform organizing and expertise negotiation. This allowed development of a grounded model of the paradoxes involved in decentralized expertise in platform communities such as Ethereum. The following steps were performed iteratively: (a) open coding of interviews, podcasts, and videos including among other things types of actors and roles involved in Ethereum governance, definitions of knowledge and expertise about blockchain, definitions of expertise, roles and practices in the Ethereum ecosystem and the trust dynamics, incentives and accountability processes in place; (b) open coding of archival data to integrate and triangulate interview information on decision making processes, knowledge, roles and positions, membership, incentives, responsibilities, and accountability; (c) axial coding across data sources to identify sets of recurrent relationships between attitudes to expertise, relationships among expert roles and positions, expertise centralization and decentralization practices, and critical incidents in the life of the community; (d) further data collection and analysis of the critical incidents identified in the life of the community; (e) selective coding to generate a grounded model of the community-level practices involved in establishing a decentralized expertise system. This last step implied going back and forth between steps (c) and (d) that is axial coding of the types of actors in the ecosystem and their expertise, membership, roles, and participation based on two cardinal ecosystem conditions (i.e., routine operation and critical events) that emerged from axial coding of primary and secondary data sources (d). Specifically, as part of the selective coding process (e), I focused on the expertise practices of each type of actor, and categorized them according to whether they referred to centralization and/or decentralization tendencies, and whether they emerged from routine operations and/or during critical events. Subsequently, actors' expert practices were aggregated into two main categories "centralized" or "decentralized" – and were compared using the ecosystem condition criterion (routine operation and critical events). This exercise identified two main tensions

in the data which I labeled “rough consensus and running code” and “wide consensus and better code,” based on ethnographic evidence derived from the interviews and secondary-source videos. This provides a record of the permanent tensions characterizing Ethereum’s efforts to setup a decentralized system of expertise to govern its blockchain technology and shows how the Ethereum community oscillates between the two states that cause these tensions.

FINDINGS

The Decentralization Tensions at Ethereum

The study findings highlight the ongoing tensions in Ethereum’s efforts to establish a decentralized expertise system of blockchain governance. These tensions derive from the simultaneous practice of centralization and decentralization of expertise based on two alternative beliefs within the Ethereum community. Rough consensus and running code reflects the belief that centralizing expertise (and granting decision-making power based on expertise) in a select group of actors (e.g., core developers, researchers) is necessary for routine operations but potentially harmful for long-term survival. Wide consensus, better code encourages expert contributions from the broader community to prevent concentration of expertise (and power) among a few active and knowledgeable members. Wide consensus better code suggests that decentralizing expertise is vital for long-term survival but is difficult or potentially harmful for routine operations. The following interview extract describes this constant state of tension and the contrast between these two perspectives:

How to say this, rough consensus and running code is basically writing high quality code to make sure that Ethereum continues to be one of the most reliable systems out there, while continuing to represent the Ethereum community, or at least those directly interested to contribute ... we could also say wide consensus and better code ... more participation can lead to stronger blockchain technology and avoid centralizing decision-making in the hands of few which is not what we stand for (I12 ETH Core Developer)

Table 1 delves deeper into these tensions by providing a systematization of the centralization and decentralization practices in the ecosystem in the form of a 2×2 matrix. This matrix is based on the nature of the expertise – centralized or decentralized – being mobilized and the ecosystem conditions – routine operation or critical events. It includes four practices that explain how these tensions are managed in blockchains: invisibilizing and individualizing experts, and visibilizing and generalizing collective expertise.

In sum, **Table 1** depicts the delicate balance between individualized accountability and the need for widespread participation which explains how blockchain communities operate and navigate crises in paradoxical yet complementary ways. During routine operations, decentralization practices are more visible. The community seeks collective contributions to “better code” while individual experts such as core protocol developers or researchers operate in the shadows. However, in times of crisis, attention and accountability shift these experts – hence the need to decentralize Ethereum expertise. However, although there is a need for

Table 1. Expert Practices by Condition and Emerging De/centralization Tensions.

Nature of Expertise	Expert Practices by Condition and Emerging De/centralization Tensions		
	Routine Operation	Critical Events	Tensions
Centralized	<i>Invisibilizing individual expertise:</i> setting up a minimalist technocracy to ensure “running code”	<i>Individualizing:</i> establishing individual accountability for critical incidents	<i>Rough consensus, running code:</i> centralization as necessary for routine operation but potentially harming for long-term survival
Decentralized	<i>Visibilizing collective expertise:</i> encouraging wide community contributions to “better code”	<i>Generalizing:</i> calling for collective problem-solving and preventive monitoring	<i>Wide consensus, better code:</i> decentralization as vital for long-term survival but impossible and/or potentially harming for routine operation

decentralization to balance the risks related to centralization, in crisis situations decentralization practices can prove fragile and may collapse due to misunderstandings about roles and participation which underlines the crucial importance of central experts. In the following sections, I explore these dynamics by showing first how centralization tensions emerge in routine and critical events, and second by examining the related decentralization tensions.

Centralization Tensions: “rough consensus and running code”

During Ethereum routine operations, expertise operates in the shadows. Transactions on Ethereum’s blockchain are automatic and do not require human intervention. However, the system enabling these transactions is supervised and orchestrated by a minimal technocracy to ensure rough consensus and running code. This technical expert elite receives implied legitimacy from a wide base.

Routine Operation: Invisibilizing Individual Expertise

The Ethereum system runs on a network of interconnected computers which each use Ethereum software. The core of this blockchain is Ethereum’s virtual machine (EVM), which is a decentralized computer that executes smart contracts. The EVM ensures that smart contract code runs consistently and predictably, regardless of hardware or software differences across the network. It simplifies the blockchain underlying complexity and provides a uniform platform for running smart contracts, balancing diversity and unity within the network. The role of the EVM in the Ethereum technology and ecosystem is described on Ethereum’s website as follows:

The EVM's physical instantiation can't be described in the same way that one might point to a cloud or an ocean wave, but it does exist as one single entity maintained by thousands of connected computers running an Ethereum client. The Ethereum protocol itself exists solely for the purpose of keeping the continuous, uninterrupted, and immutable operation of this special state machine (ArchD_Doc21).

The Ethereum core protocol is the software engine that ensures the smooth functioning of the EVM. Regular updates to this protocol are essential to avoid problems and manage the impact on the ecosystem's applications. However, the decentralized and open-source nature of Ethereum means that carrying out these updates is not straightforward. Since there is no single entity that controls Ethereum, all changes must be agreed among the network participants. Protocol upgrades are introduced as new software versions which the network nodes (validators) can choose to adopt or not. An update that does not gain enough support will likely not be implemented. The stakes are high since flawed code could disrupt the entire system and cause significant financial and reputational damage. It is thus crucial that protocol upgrades are of the highest quality.

In theory, no single individual or company governs the development of the Ethereum core protocol; although upgrades can be proposed by a single entity, these subsequently are peer-reviewed by the community. However, in practice in blockchain ecosystems such as Bitcoin and Ethereum, key decisions are made by technical experts such as protocol developers, programmers, and researchers.

Table 2 presents the actors in the Ethereum ecosystem in relation to the de/centralization tensions; core developers and researchers constitute centralization patterns and software developers and programmers (dApp developers), validators, and cryptocurrency holders provide decentralized contributions. The Ethereum Foundation acts as an ecosystem orchestrator, promoting both stable governance and decentralized participation. Below I describe these actors' expertise, membership, participation, and role in the governance of Ethereum which produce centralizing forces in the Ethereum ecosystem.

Core developers: protocol custody. In the Ethereum ecosystem, an amorphous group of "core developers" (i.e., technology experts very active in the community) influence the direction of the technology through protocol custodianship which involves a mix of technocratic control and open peer-to-peer consultation. The Ethereum improvement proposal process allows anyone to suggest changes to the protocol. These proposals, which might provide enhancements or fixes, undergo thorough review and discussion by the core developers, researchers, and other stakeholders within the community. Core developers act as gatekeepers who conduct informal reviews before formal submissions to ensure proposals meet review standards. They have significant influence over final decisions and are responsible for assessing the impact on the protocol's health. They also play a prominent role in persuading the community about the benefits of any proposed changes.

Some core-developers are permanent employees of Ethereum, others have occasional or part-time collaboration contracts, rely on scholarship schemes, or work for organizations providing applications or infrastructure to the Ethereum ecosystem. It is interesting that the identity and composition of the core-developer teams is unknown. In the interviews, Ethereum members explained that the very

Table 2. Types of Actors Involved in the Ethereum Community and Their Contribution to Ethereum’s Organization as a Decentralized Platform.

Ecosystem Stakeholders	Core Developers	Researchers	Ethereum Foundation	D’app Developers	Stakers	Crypto holders & Community
Expertise tensions	<i>Centralization</i>		<i>Decentralization</i>			
Type of expertise	Protocol custody	Crypto economic advancements & ecosystem design	Ecosystem development & decentralization	Application ecosystem generation	Cryptoeconomic validation	Cryptoeconomic performance
Organizational role	Minimalist digital technocracy ensuring “running code”	Research elite advising/consulting about ecosystem future development based on esoteric knowledge (crypto economics)	Minimalist bureaucratic organization aiming at ecosystem support & decentralization; aims to reduce role/disappear with time	Broad community of complementors (developers of applications on top of the core protocol) contributing to ecosystem growth & diversification	Computation “engine” for transactions and consensus validation (i.e., blockchain transactions)	Critical mass of participants in the functioning of a decentralized ecosystem (crypto market capitalists)
Membership	Amorphous group of algorithmic experts with opaque criteria for access	Small group of experts (e.g., researchers) recruited/coopted based on reputation (academic credentials, affiliations, etc.)	Amorphous group of support staff & community developers with opaque criteria for access	Broad and heterogeneous community with open access and almost no form of organization	Broad and heterogeneous community with limited organization (community developers, discussion forums, social media groups, etc.)	Heterogeneous stakeholders keeping the system alive thanks to cryptographic and economic participation to the life of Ethereum – open access to cryptocurrency markets

(Continued)

Table 2. (Continued)

Ecosystem Stakeholders	Core Developers	Researchers	Ethereum Foundation	D'app Developers	Stakers	Crypto holders & Community
Expertise tensions	Centralization		Decentralization			
Governance	<i>Routine operation:</i> structure decision making as semi-formal processes (EIPs) & act as gatekeepers in protocol update & development <i>Critical events:</i> guide ecosystem decision through opinion making & proposed technical changes	<i>Routine operation:</i> develop reports & inform community about future developments of ecosystem functions <i>Critical events:</i> provide advice about important protocol updates & ecosystem changes	Ensure multi-stakeholder coordination and collaboration for important decisions both during ordinary practice and critical events; intention to disappear in the future to further foster decentralized governance	Limited role in ecosystem governance; can become the spotlight during critical incidents	Critical role both in routine operation & critical events; must validate any significant change of the protocol by accepting to update their software (i.e., protocol version) to proposed changes	Online voting and limited mechanisms of coordination for decision making; indirect pressure through crypto market behavior
Participation incentives	Ensure “running code” and “better code” thanks to community funding & compensation schemes (e.g., stipends, scholarships via Ethereum Foundation)	Funded by community to advise and provide scientific opinions about future economic development	Ambiguous participation incentives (i.e., ideology, reputation, community funding)	Economic remuneration based on degree of d'app adoption by the community	Capitalistic interests and incentives (maximizing earnings on staked capital) & ideology of blockchain-driven decentralization	Capitalistic interests and incentives (maximizing earnings on cryptocurrency) & ideology of blockchain-driven decentralization

concept of core developer refers to a position of prestige related to competence and expertise rather than a formal organizational role. Consequently, there is neither a fixed number of core developers nor a typical core developer profile.

Am I a core dev? I don't know (laughing) I guess I am because people say I am. So, in strict terms, a core developer is someone working on the baseline protocol, it's a very technical role. But actually, it's often more than that. There are people like (names of reputed members of the community) who are considered core devs although they lack the technical skills but are so involved and influential that when they speak a lot of guys shut up (...) I guess what really matters is how involved you are with protocol changes and how much you know Ethereum inside out. (I33, ETH Core Dev and Ex-Community Builder)

Researchers: crypto-economic advancements and ecosystem design. Ethereum also uses scholarship schemes to sponsor researchers to work on the development of new algorithms or specifications for core protocol code. These researchers are chosen based on their academic credentials and affiliations. They produce reports and provide recommendations for the community on ecosystem developments and are involved in discussions about proposed changes. Their disciplinary expertise is in cryptoeconomics, an interdisciplinary field that exploits ideas and concepts from economics, game theory, mathematics, and peer-to-peer cryptography to theorize about digital decentralized systems. According to one of our interviewees, in the Ethereum community, they are considered “very reputed assets with unique skills (...) invaluable to the future of the community,” and active efforts are made to coopt and maintain their activity in the community. In contrast to the anonymity surrounding core developers, these researchers are listed on the Ethereum website.

Debate about the need for overseers to ensure protocol changes are safe and reliable is ongoing. Even though researchers and core developers do not confirm to Ethereum's decentralization ethos, these actors are seen as crucial to ensure technology reliability and ecosystem advancement:

Am I happy that there are a bunch of dudes writing code which could potentially have an impact on everything I do here? No, because this is what centralized systems do, what if they mess up, we all bear the consequences, right? But when this thought comes to my mind I ask myself: Would I be able to write it in their place? No, sir, no (laughing). Would most of the folks that stake on Ethereum be able to do it? No, of course they wouldn't (laughing). So if I don't write it, you don't write it, and they don't write it either, what happens to this big dream we all have called Ethereum? (I13 ETH Community Builder)

During normal operations, the expertise of researchers and core developers is invisibilized. They tend not to figure in Ethereum community discussions, and many members are not clear about what they do. Nevertheless, since these experts are vital to Ethereum's operations, community members are willing to trust and respect them. The interviewees said that “they seem to know what they are doing,” and “other people agree about that as well”:

These guys are not just making things up. It takes a lot of knowledge to be able to propose a protocol change to Ethereum, Vitalik, the researchers, the core devs team (...) we wouldn't even be close to where we are without them. To be honest, I understand like 10% of what these guys are saying, maybe less, and I'm sure I'm not the only one (...) It's not ideal to have changes implemented by a limited group of people but what's the option today? (...) I trust Vitalik,

I trust the other guys because they've proven to care about Ethereum more than their self-interests. (I7 ETH Community Builder)

The above extract further exemplifies the centralization of expertise in Ethereum. On the one hand, community members recognize the importance of decentralized expertise, referring to it as the “ideal” condition. On the other hand, they recognize the need for a small group of highly knowledgeable individuals such as Vitalik Buterin and core developers on whom they can rely and whom they consider are dedicated to Ethereum’s interests.

Making Sense of Critical Events: Individualizing Core Expertise

While expertise works in the shadows during routine operations, it comes to the surface and captures the attention of the community. Hacks and thefts, controversial protocol changes, cryptocurrency market volatility, and external pressures from legislators represent typical examples of blockchain crises which cause uncertainty about the ecosystem’s future. In trying to make sense of a crisis and in acting to secure their interests, community members give visibility to the role of experts seeking for both solutions and someone to blame. In turn, by questioning aspects such as core-developers’ ethics or competence, the Ethereum community is questioning the idea of rough consensus and running code. The Ethereum 2016 DAO Hack provides a useful example of these practices.

In 2016, one year after the official launch of the first version of Ethereum’s blockchain, the ecosystem enthusiastically welcomed one of the first experiments of decentralized autonomous organizing (DAO) and one of the largest ever crowdfunding initiatives which in just 28 days raised around \$250 million (Mehar et al., 2019). The DAO project was groundbreaking and allowed people to invest in Ethereum-based startups through a decentralized organization governed by smart contracts. However, shortly after its launch, it suffered a major hack by an anonymous hacker who by exploiting a bug in the DAO smart contract code stole over \$50 million (3.6 million ETH) from the DAO asset pool (Mehar et al., 2019). This incident caused widespread panic and uncertainty within the Ethereum community and sparked a broader conversation about expertise. Since several reputable members of Ethereum’s core team, including Vitalik Buterin, had been involved in supporting or auditing the DAO project, the community held the DAO developers as well as the broader community of Ethereum researchers and developers responsible for having failed in their role of custodians. Discussions on Ethereum’s Reddit channel highlight how critical events visibilize failings and mistakes of experts and encourage the community to call for expertise to be better diffused across the ecosystem:

My question is, how much black hat testing was done on DAO code beforehand? Given the vulnerabilities discovered at the last minute, and this morning’s attack, I wonder if there was too much Utopian thinking behind the project and not enough Devil’s advocates recruited to bang on it. (C1786 r/TheDao)

The DAO hack had a dual effect on expertise de/centralization practices. On the one hand, it reinforced the need for collective vigilance of malicious events

and, thus, greater decentralization of expertise within the Ethereum ecosystem as discussed in the next section. On the other hand, it gave more power to Ethereum experts. Many community members demanded to have their money back and by asking the Ethereum experts involved in the DAO project to find a way to retrieve the stolen funds further increased their power and visibility. Some influential members of the Ethereum community such as core developers and researchers responded by proposing that the state of the Ethereum blockchain should be changed by implementing a fork which would work to reverse the system to the moment before the hack, thus nullifying the hack. Following heated debate between those who favored the intervention strategy and those who considered it incompatible with blockchain's decentralized ideology, a split occurred within the Ethereum community leading to different versions of the protocol and two separate ecosystems (Ungureanu et al., 2025). There were multiple reasons for the split but the most influential was the disagreement over the role of experts and their jurisdiction in a decentralized system (Mehar et al., 2019).

In addition to other major critical events and internal conflicts in Ethereum, threats posed by crypto volatility, continuous malicious attacks, and scams offered periodic opportunities for heated debate within the community on the role of expertise in Ethereum. The argument reached a crescendo in May 2024 when two of Ethereum stars were accused of receiving a multimillion-dollar token incentive package from a pioneering restaking protocol flagged as possibly posing a systemic risk to Ethereum (Nijkerk, 2024). In such critical moments, some experts such as core developers and researchers are made scapegoats, and others become guides about how to escape the crisis and preserve the ecosystem's integrity. Interviewees referred to their "acting as white hats fighting malicious attacks and staying vigilant" and "giving hope about the future of crypto even in crypto's darkest hours" (informants' words). For these reasons, critical incidents put the spotlight on individualized expertise in blockchain ecosystems.

Decentralization Tendencies: Wide Involvement, Better Code

While according to our interviewees the existence of expert roles is considered a "necessary harm for solid operation" it is also widely regarded as a transient situation, a "transition stage towards a system that draws closer to perfect decentralization." The belief in wide consensus, better code exemplifies Ethereum's attachment to the ideology of radical decentralization.

Although public awareness of the blockchain technology began only in 2008 through the introduction of Satoshi Nakamoto's cryptocurrency Bitcoin, it originated in the 1990s with the cypherpunk movement. This was a loosely-knit group of individuals with a shared interest in cryptography, computer science, and libertarian or socialist ideology. The group believed that advancements in cryptography and related technologies could empower individuals and promote social and political change by enhancing privacy, security, and freedom of expression in the digital world. In line with the crypto-anarchist imprinting of the blockchain movement (Swartz, 2018), Vitalik Buterin proposed Ethereum as a decentralized, incorruptible, and transparent technology capable of facilitating a wide range of

transactions between individuals without the intermediation of third parties that would give rise to a new social order (Buterin, 2014; Wood, 2014). The following sub-sections illustrate how the decentralization ideal of wide consensus, better code is supported by a great part of the Ethereum ecosystem during routine operations but falls short when put to the test by a critical event.

Routine Operation: Visibilizing Collective Expertise

In line with cypherpunk ideology, maintaining expertise decentralization is deemed vital for long-term survival but impossible and/or potentially harmful to routine operations. This tension emerged with Ethereum's continuous efforts to visibilize collective community expertise during routine operations but reliance on a small group and limited participation of the community to solve problems related to critical events. Table 2 shows that several actors contributed to the decentralization of blockchain expertise, maintaining a balance with the centralized roles and practices emphasized in the section above. These actors are stakers responsible for cryptoeconomic validation, developers generating Ethereum's vibrant ecosystem of decentralized applications, and cryptocurrency holders responsible for Ethereum's market performance. The following sub-sections illustrate how these actors swing the de/centralization pendulum during routine operation and moments of crisis.

Stakers: cryptoeconomic validation. In addition to being negatively connoted from an ideological standpoint, centralization is a condition feared by blockchain communities because of its association with technology failure. A 51% attack or a majority attack occurs when a single entity or group controls over 50% of the blockchain's computing power which grants them significant domination over the network. This dominance enables transactions to be manipulated and reordered and can allow some rewriting of parts of the blockchain. To avoid this, transactions must be validated by consensus among multiple independent computer nodes.

As already described, blockchain communities include actors who make the blockchain machine "work" by providing computational resources to verify transactions. In Ethereum, these validators are referred to as stakers because they lock up their cryptocurrency as a kind of security deposit which they then can use to validate transactions and create new blocks in the blockchain. In return, they earn rewards in the form of additional cryptocurrency. Although these actors mostly do not have the expert skills required to participate in blockchain development, their actions are vital for any advancements to Ethereum (see Table 2). First, validators can boycott any protocol change proposed by experts simply by refusing to upgrade their software; second, they represent one of the most popular threats in blockchain, the 51% attack. Consequently, most of the cryptographic and game-theoretical advancements in Ethereum proposed by experts are aimed at incentivizing validators to act virtuously and disincentivizing them from performing malicious attacks on the network. Increased decentralization is seen as the best way to prevent 51% attacks:

I think that most of these people are concerned with how much money they're making, or how much money they have to lose, rather than what the long-term consequences for Ethereum will be. So, it's important to have the right economic model in place, both in terms of incentives and sanctions, I don't know if we're there yet but we are working on it (...). (125 Community Builder, ETH Foundation)

A 51% attack requires malicious collusion among validators. However, as explained in the excerpt below, community members also referred to the possibility that core developers and researchers might intentionally introduce vulnerabilities potentially facilitating a 51% attack:

I'm not saying that core devs and researchers are going to willingly blow Ethereum up by creating cracks for a 51% attack, I mean, from day one people like Vitalik, like (names of other reputed members of the community) are doing research on how to avoid this from ever happening, I'm just saying that we all know that centralization is bad for decentralized systems, it's just the way it is, any point of centralization is theoretically a vulnerability that someone, someday, somehow, is going to take advantage of (133 ETH Staker).

As can be seen in the excerpt above, the term 51% attack is used by the community to refer to a wide range of centralization threats involving actors of the ecosystem. It constitutes a collective point of reference because it reminds the community about the importance of preventive actions such as collective vigilance and decentralization.

Ethereum Foundation: ecosystem development and decentralization: To deal with the decentralization threat, the Ethereum community works continuously to visibilize the expertise within the community. This implies encouraging expert contributions from the broad community to ensure perspectives that are diversified beyond those of expert members such as researchers or core developers. These efforts are supported by the Ethereum Foundation, a non-profit organization dedicated to financing and supporting research, development, and real-world application of Ethereum and related technologies. The Ethereum Foundation works to ensure diversity at both the core protocol level and at the application layer level.

In the case of the core protocol, to make the network stronger and more diverse, Ethereum maintains multiple open-source execution clients developed by multiple client teams using different programming languages. The Ethereum Foundation runs a fund dedicated to client teams and scholarships for researchers to work on decentralization advancements. The Ethereum Foundation contributes to ecosystem development more generally by funding or employing community builders who organize calls, competitions, and social media debates to incentivize active participation in the development of the ecosystem (see [Table 2](#)).

However, the Ethereum Foundation also represents a centralization risk. In response to this, the stated aim of the community builders and managers employed by the Ethereum Foundation is to “cease to exist one day, or at least to minimize our involvement in the community as much as possible, in the hope that alternative arrangements for stabilizing sources of expertise will emerge as we make Ethereum more decentralized” (110 ETHF). For this reason, the Ethereum Foundation limits its intervention to “only the essential or else unavoidable forms

of support, such as funding the vital development of blockchain expertise and taking care of administrative and legal issues” (I15 ETHF). Several interviewees from the Ethereum community acknowledged the inherent de/centralization tensions surrounding the Ethereum Foundation:

My sense is that the guys from the Ethereum Foundation are doing a really great job, and a necessary one too, you know? But it's like I said, even if they are, they should disappear in some years' time and leave it all in the hands of the community (...) don't get me wrong, I'm sure they're doing a better job than most of us would, but it's just not safe on the long run. This is not just something I say, they've also been publicly claiming it for some years now, they will have to disappear (...) finding a healthy balance is hard. (I7 ETH Community Builder)

dApp developers: generating the application ecosystem. In addition to core developers and researchers, blockchain expertise usually involves developers who build smart contracts and decentralized applications (i.e., dApps) on top of the core protocol. Since smart contracts execute automatically on the blockchain, how developers write smart contracts code is pivotal, and whether other experts and non-experts trust or can verify their work has a significant impact on the functioning of the entire ecosystem (Buterin, 2014; Davidson et al., 2018; Notheisen et al., 2017). In contrast to core developers, application developers are a much broader and more amorphous group of individuals who often develop applications for multiple blockchain ecosystems. While some consider them “the pulsating heart of the ecosystem” where “decentralized magic really happens” (informants' words), they are also considered less reliable and less concerned about the future of the Ethereum ecosystem compared to researchers, core developers, and the Ethereum Foundation. For instance, an Ethereum staker described dApp developers as utilitarian complementors of blockchain ecosystems rather than members of the Ethereum community with a common purpose and identity:

What these people want is to make money, as long as Ethereum allows it they will continue to bring their work here and make the system grow but as soon as something goes wrong or this platform becomes less profitable, they're gone and they won't be looking back. (I40 ETH Staker)

One core developer interviewee said that core developers sometimes scrutinize or even question dApp developers' expertise and suggested that their work might be intentionally malicious or poorly executed:

There are so many dApps out there and so many different people working on them that it's really hard to tell, I mean, some of them are scams and some of them are legit but with so little transparency the line is thin ... take into consideration that in most of these apps we never get to know who the developer was ... Many times, it's really hard to trust a project, or to actually understand if it's any good (...) What to do about it? If you read it you can clearly understand if the code is any good and the guy has any idea what he's doing (...) but not so many actually do it or, I don't know, I mean, I do it but I'm a core dev, not an average user. (I18, ETH Core Developer)

These interview extracts show that application developers within the Ethereum community may be scrutinized over their ethical integrity and code writing ability. The increasing number of community members with no programming expertise makes concerns over scams and frauds more prominent and exacerbates the

tensions between centralized and decentralized forms of monitoring of blockchain applications development. While some are in favor of trusting experts to oversee decentralized application development and identify fraudulent projects, there is a lack of consensus within the community about who should be responsible for setting and enforcing rules and standards.

Crypto holders and the broader community: cryptoeconomic performance. The interview extract cited above makes it clear that the Ethereum ecosystem also includes cryptocurrency holders and other members of the broader community. The cryptographic and economic participation of these heterogeneous stakeholders in the life of Ethereum keeps the Ethereum system alive. Although their participation in the governance of the ecosystem is limited to voting and coordination during critical events, their mobilization of capitalistic interests and incentives to maximize their earnings continuously shape the performance of Ethereum in the cryptocurrency markets which in their turn condition routine organization of the ecosystem. The attempts of the community builders of the Ethereum Foundation to increase decentralized expertise involve encouraging the active participation of the wide Ethereum base, especially in important decisions and vigilance toward potential malicious attacks. For example, as shown in the excerpt below, a group of community builders produced a series of YouTube videos to encourage the building of a strong and participatory community of Ethereum stakers around the need to fight malicious attacks:

We do these podcasts for a reason, and this is to tell you, folks, study before investing, go and see who the guy is, talk to other people in the community to understand if it's legit, ask me or [name of other community builder], write it on our forum and people will step in and give you valuable feedback, we say this all the time, get involved, stay vigilant, don't just throw your money away. (ArchD_YouTube Video 4, ETH Staking Community Builders)

This excerpt shows how community builders either independently or with the support of the Ethereum Foundation try to foster a decentralized approach to blockchain expertise, by promoting collective vigilance against malicious attacks and fostering a culture of peer reviews. The excerpt shows that this can be achieved through communications aimed at educating the wider community and providing information about possible dangers and pitfalls.

In sum, [Table 2](#) shows that the roles of the actors in the Ethereum ecosystem can be distinguished based on their attitude to the de/centralization tensions, with core developers and researchers representing centralization, and decentralized contributions coming from dApp developers, validators, and cryptocurrency holders, and the Ethereum Foundation acting as an untraditional ecosystem orchestrator that contributes to both centralization and decentralization practices.

Making Sense of Critical Events: Generalizing Collective Expertise

Although decentralization is often seen by the community as the best means to ensure long-term healthy development of the Ethereum ecosystem, critical incidents highlight the difficulties involved in implementing decentralization in routine operations. For instance, during the critical DAO hack incident, calls for

increased decentralization were confounded by the community's very limited understanding of and participation in technical decision-making during a crisis. The Ethereum community was faced with a 28-day window in which to decide whether to fork the blockchain, negate the hack, and restore the stolen funds which resulted in the decision being put to the vote. Since a significant number of community members did not vote, whether the decision to fork truly reflected what the community wanted is unclear (Ungureanu et al., 2025).

The following extracts highlight the challenges related to generalizing expertise within large and heterogeneous ecosystems such as Ethereum. A core-developer who formerly developed decentralized finance applications illustrates the de/centralization tensions in critical incidents. The crowd blames experts for system failures while experts blame the crowd for its failure to exercise the rights and responsibilities of a decentralized organization:

I started working as a developer in de-fi (decentralized finance) but I stopped as soon as I could because it was terrible (...) People coming at you all the time blaming you for losing money, it was terrible, sometimes I could not sleep at night because of the terrible messages I received (...) People are ignorant, they place their money in crypto projects they know nothing about and then take it out on the programmer. They don't understand that there is a market out there and you lose or win money because of how the project performs on the market, not because of how I wrote the code (...) security is also often brought up but sometimes people just don't know how to take care of their keys, if they get hacked they immediately blame it on the project's code vulnerability and not on their stupidity (...) In general, everyone in Ethereum wants decentralization but it is easy to forget that for decentralization to work everyone must participate, you can't just delegate when it's profitable and claim your rights when it's not. (I48, ETH Core Dev)

The above extract indicates that lack of expertise and irrational investment behaviors within blockchain communities are factors that contribute significantly to the occurrence of scams and hacks. Ethereum experts and community builders attribute this to the hype surrounding crypto investments, and the many individuals who invest in these projects without understanding the technology and the associated risks. This suggests that extending blockchain expertise to the broader community base would not be feasible.

Other critical events involving scams and fraud provide further examples of this issue. For instance, ERC-20 tokens are digital currencies built on the Ethereum blockchain, adhering to a standard set of rules for compatibility across applications. These popular tokens have been targets of countless phishing attacks, leading to continuous crypto losses. Scams exploit vulnerabilities in smart contracts and user authentication processes, often through use of fake websites or emails to trick users into revealing private keys or transferring tokens to malicious actors. Every attack sparks more debate over the responsibility of experts to guard against technology flaws versus the responsibility of the community to be better informed. A core developer said that although flaws exist in the design of ERC-20 tokens, the increased number of scams is due mainly to manipulation tactics used to trick users who interact with security systems rather than to inherent flaws in the technology.

The standard itself is flawed (...) Unfortunately, we can't require all of the [wallets] to do things in the right way, especially if the community can't agree on what is the right way. (ETH Core Dev in Yun, 2024)

However, community members blame core developers for not considering scams a high-priority issue and call for experts able to monitor, audit, and prevent faulty or malicious technologies, this way swinging the pendulum back to centralization.

In sum, critical events such as hacks, scams, and major changes highlight the conflicting role of expertise. On the one side, core developers and researchers are blamed for failures, prompting calls for more decentralization; on the other side, given the challenging task of spreading blockchain expertise to the large community, they also become the only solution to crises, or as one interviewee put it an “unavoidable harm, at least for the moment.” Thus, critical events highlight the risks and advantages of centralizing knowledge and decisions in the hands of a few capable individuals. While interventionism is necessary for short-term routine operations, the community would prefer a future Ethereum with broader participation where as one interviewee described it “many knowledgeable people participate and (...) the power belongs to all but nobody, ever really gets to hold the scepter.”

DISCUSSION

This study adds to our understanding of expertise organization in emerging digital technologies that require decentralized forms of organization. Several studies refer to the changing nature of work in the digitalized world (Bailey et al., 2022; Dorschel, 2022; Faraj et al., 2018; Pachidi et al., 2021) and the problems that arise from the use of algorithms (Burrell & Fourcade, 2021; Kellogg et al., 2020; Susskind & Susskind, 2015). The present study sheds light on the role of experts in decentralized systems such as blockchains and other digital platforms.

This research adds to the growing literature on open online communities, and in particular to work on the governance-knowledge organization nexus (Dahlander & Frederiksen, 2012; Faraj et al., 2011, 2016; Howison & Crowston, 2014; Safadi et al., 2021; Shaikh & Vaast, 2016; Von Krogh et al., 2003; Yoo et al., 2012). While blockchain has been considered a novel and disruptive technology, the present study shows that the social organization underlying blockchain technological platforms has many similarities to other OCs such as open source software (Fitzgerald, 2006; Hippel & Krogh, 2003; Shaikh & Vaast, 2016; Von Krogh et al., 2012) and open innovation (Faraj et al., 2011; Lyytinen et al., 2016; Yoo et al., 2012). This work offers an empirical examination of two blockchain theses “rough consensus and running code” which highlights centralization tendencies, and “wide consensus, better code” which highlights decentralization efforts in blockchain OCs. It was here shown that the Ethereum blockchain community engages simultaneously in expertise centralization and expertise decentralization practices. This requires a delicate balance between individualized accountability and the need for widespread participation to enable the community to navigate both routine and critical moments in paradoxical but complementary ways. Four practices explain how de/centralization tensions are managed in blockchains. During routine operation, collective expertise is visibilized while individual expertise operates in the shadows; crises reveal the

blame and responsibilities assigned to individual experts and highlight the need for more decentralization of expertise. Decentralization practices emerge as a reaction to centralization risks and are aimed at distributing expertise more widely within the Ethereum community but can collapse during crises which then require intervention of centralized experts.

The findings contribute to the literature on knowledge governance practices in OCs such as temporal bracketing, digital folds and hybrid open-closed models (Faraj et al., 2016; Safadi et al., 2021; Shaikh & Vaast, 2016). The literature suggests that open source development relies on ongoing collective coordination and governance overseen by elite developers. Many individuals may contribute sporadically but the elite plays a crucial role by providing content regularly, intervening in emergencies and safeguarding community boundaries by means of temporary closures and measures imposed to enable prompt address of critical issues. This study has highlighted the importance of critical events that punctuate routine operations in a decentralized system and suggests that de/centralization tensions can be examined fully only at their interface.

However, critical events in decentralized systems such as blockchains may have different consequences from those theorized in the OC literature.

Specifically, decentralized algorithmic technologies such as blockchain may significantly reduce the ability of elites to enact efficient bracketing practices and closure moments, fostering continuous de/centralization tensions and debates within the community. First, given the decentralized functioning of blockchain technology and the distributed nature of its consensus mechanisms, trust in experts is displaced from the transactions level (i.e., exchanges occurring on cryptography-governed platforms without third party intermediation) to the socio-technical system that enables these transactions. This involves the researchers and developers who write and audit the code through a peer-review process, and the validators who make the blockchain machine work, the holders of tokens and cryptocurrencies contributing to the growth of the ecosystem's market value, and the community builders advocating for these stakeholders' interests and organizing them into factions and coalitions. This organization differs from both more traditional organizational forms where roles and responsibilities are clearly assigned to expert participants who compete for jurisdictional power, and also from more traditional open software communities where experts are often the majority who possess the technical knowledge.

Second, as the result of blockchain hybrid ideological underpinnings, blockchain communities are shaped by constant interplay between the capitalistic goals of utility maximization, neoliberal and anarchist ideologies of decentralization, and technocratic theories of cryptoeconomic decentralization (Jacobetty & Orton-Johnson, 2022). The eclectic mix of aspirations in the Ethereum community depends on reliable technology which in turn is associated with ecosystem stability and financial performance. The community generally accepts that technology experts step in and take the lead to ensure economic and technological stability. In their turn, technology experts accept the community's investment in exchange for social status and financial incentives. However, this tacit

social contract is fragile. As soon as a critical incident occurs, the roles of experts become objects of heated public debate and their ability of experts to impose control and closure mechanisms is constrained by the mix of technocratic, economic, and ideological interests which characterize Ethereum and amplify debates about de/centralization in the event of a crisis (Ungureanu et al., 2025).

It should be noted that system decentralization is a key concern for all the actors in the blockchain ecosystem including “elites.” In his cypherpunk manifesto, Hughes (1993) describes how a blockchain system which tends toward centralization is vulnerable to failure and thus is less likely to attract and reward social, technical, and economic capital. In this view, technical failure is also likely to lead to social and economic devaluation (Davidson et al., 2018). The paradox in this is that experts holding central positions may sacrifice their reputation and ability for the sake of a better more reliable technology. From such standpoint, the value of blockchain expertise lies not so much in the ability to write the code, as in the ability to collaborate with others to write code to achieve a healthy decentralized system. For instance, although Ethereum researchers have centralized power, their mission is to identify and eliminate failure points in the system potentially caused by any type of centralization threat including expertise. Some experts recognize that they are a centralization threat and promise that in the long terms they will cease to exist for the sake of Ethereum. These evidence suggest that differently from what may happen in other open software communities, in blockchains both experts and other community members (validators, community builders, cryptocurrency owners) occupy liminal roles in the continuous struggle between de/centralization forces because of the cryptoeconomic underpinnings of blockchains – that is, the unique mix of technological, algorithmic, and economic needs and requirements. Thus, although openness and decentralization are core values for most OCs (Krishnamurthy et al., 2016; Stewart & Gosain, 2006; Von Krogh et al., 2012), in blockchains de/centralized expertise is a consequence of relational negotiations following a quasi-free market logic.

In sum, the fluid nature of blockchain communities and the wide diffusion of technical, capitalistic, and anarchist ideologies across different categories of stakeholders, mobilize and sustain the de/centralization tensions identified in this paper. Overall, these conditions call for renewed attention to the liminal role of expertise in decentralized systems. In the context of an increasingly digitalized, decentralized, and connected world where systems of expertise become progressive sociotechnical entanglements of material and non-material actants such as people debating models, cleaning training data, designing algorithms, tuning parameters, deciding on context conditions, reviewing and revising code and adapting it to constantly changing situations (Alaimo & Kallinikos, 2021; Anthony, 2021; Anthony et al., 2023; Bailey et al., 2022; Glaser et al., 2021), we also need to inquire about how expertise is socially constructed in such systems, if and how experts self-affirm and/or are recognized, legitimated and made responsible (Kolkman, 2022). The present study was intended as a first step in this fertile research field and a call for more research in this direction.

NOTES

1. The OpenAI manifesto states that: “Our mission is to ensure that artificial general intelligence benefits all of humanity. We are building safe and beneficial AGI but will also consider our mission fulfilled if our work aids others to achieve this outcome” (<https://openai.com/about/>).
2. https://dune.com/sawmon_and_natalie/smart-contracts-on-ethereum
3. <https://coinmarketcap.com/currencies/ethereum/>
4. <https://www.globaldata.com/data-insights/financial-services/ethereums-market-capitalization-history/>
5. <https://ethereum.org/en/community>

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THE COEVOLUTION OF TASKS AND EXPERTISE

Lisa E. Cohen and Le H. Bui

McGill University, Canada

ABSTRACT

How do tasks and expertise coevolve? Tasks and expertise are tightly linked and essential for the execution of work in organizations. Despite the link in the practice of tasks and expertise, scholars have yet to theorize them as coevolving. A small body of research provides evidence that by failing to treat them this way, research misses insights critical to explaining the evolving nature and future of work. To explore these dynamics, we analyze interviews and observations of people involved with the data-collection task in an early-stage startup. We trace the task's detailed movement across jobs and by doing so, observe complex dynamics between the task and associated expertise. The task moved from proto-analysts to analysts to data-entry operators and, with that, the core expertise required for the task moved across positions. In addition, doing data collection produced expertise that those in the analyst position applied in performing other tasks. In part, because it facilitated the production of expertise, analysts continued to collect data – a task that they routinely complained about doing – even after it migrated to data-entry operators. Based on these findings, we develop the distinction between core and produced expertise. We also refine our understanding of hiving-off with an alternative explanation for why menial tasks might not be hived-off. Finally, our findings enhance our understanding of the dynamics around change in jobs and task segregation.

Keywords: Tasks; expertise; coevolution; jobs; sociology of work

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INTRODUCTION

Work tasks and expertise together shape how and how well work gets done. When expertise is applied, it is always in performing tasks. When tasks are performed, that performance always draws on some form of expertise. Yet, while the two are inextricably linked in practice, scholars rarely treat them as co-evolving – that is, as reciprocally affecting each other’s evolution in a reverberating way over time. For the most part, scholars study one of these concepts at a time, consider them as co-existing without influencing each other, or, at best, examine one as subservient to the other without significant reverberations (Ericsson & Lehmann, 1996; Greenwood et al., 2019; Haerem & Rau, 2007). Furthermore, while evolutionary change is likely to occur at the level of individual tasks and the related expertise, scholars often treat these concepts in the aggregate: they discuss sets of tasks at the level of the job, organization, or occupation (e.g., Cohen, 2016); they discuss bodies of expertise as properties either of individuals who develop, maintain, and apply expertise or of a higher-order collective – for instance, occupations or organizations – where expertise is applied (Heimstädt et al., 2023). These problems are exacerbated by a tendency of each literature to discuss the focal construct – tasks or expertise – as relatively stable entities. That is, tasks themselves and configurations of tasks are considered to be managerially pre-determined (see Cohen, 2016 for a related argument). Similarly, while experts may increase their level of mastery or try to apply expertise in other domains, the core body of expertise itself changes relatively little (Chi et al., 2014; Ericsson & Lehmann, 1996; Green et al., 2019). In this paper, we shift the focus and ask how a single task and the associated expertise coevolve and examine the implications of this coevolution.

A handful of recent studies have demonstrated that examining the dynamics of tasks and expertise at a detailed level provides insights that would otherwise be missed. For instance, a study of puppeteers describes how new expertise emerges and becomes central to puppeteers as their work tasks shift with the transition from film to stage (Anteby & Holm, 2021). In a study of technology implementation in banking, Anthony (2021) shows that how employees perform tasks shapes the expertise developed differently for two groups of employees in the same job. The work was partitioned in one group: junior bankers did the data analysis, and senior bankers interpreted the results. In the other group, junior bankers did both analysis and interpretation. Consequently, only junior bankers in the second group developed the expertise needed to do data interpretation. Kahl and colleagues (2016) describe a case study where, in response to the obsolescence of one of their central tasks, members of an occupation successfully applied the expertise developed around the obsolete task to other tasks. The central story of the dynamics of tasks and expertise shown in these, and a handful of other studies, demonstrates considerable and ongoing give and take between the tasks and expertise. It also shows that failing to consider their evolution at a detailed level could create false impressions about the dynamics of work.

The lack of attention to the coevolving nature of tasks and expertise is especially problematic in the current landscape, where the pace of change in work

seems to be increasing at an increasing rate; the forces of technology, regulation, globalization, and other institutional changes are continually altering what work is done and what expertise is needed to do it. Work scholars are challenged to predict how institutional and technological changes will change work itself and, in particular, the tasks and expertise associated with it. For instance, scholars struggle to anticipate how AI and other smart digital technologies will affect work. Discussions of AI and work have quickly gone from broad proclamations that AI will destroy billions of jobs to more subtle discussions of how AI will change tasks within jobs and ripple through systems of work (Hollister et al., 2024). At the same time, scholars of expertise struggle to predict the effects of a potential crisis of expertise brought on by similar factors: will technology usurp expertise; will society continue to lose faith in experts and expertise (Heimstädt et al., 2023; Huising, 2023; Pakarinen & Huising, 2023)? While rumors of the death of expertise may be greatly exaggerated (Pakarinen & Huising, 2023), rumors of impending change in expertise may not be. For instance, the tendency of expertise to be primarily institutionalized through occupations may not prevail in the changing landscape of work (Heimstädt et al., 2023; Huising, 2023; Pakarinen & Huising, 2023).

Taken together, the link between tasks and expertise, the existing evidence of their complex relationships, and the trends surrounding them suggest that we need to understand more about the coevolution of tasks and expertise. In this paper, we explore these dynamics by tracing the detailed movement of and changes in a single task – data collection – in conjunction with the related expertise across jobs in a tech-enabled startup over two years. We trace this task and expertise using data from 122 interviews and 180 hours of observations of people connected to this work.

We found that tasks and expertise coevolved and did so in response to various organizational dynamics. Following shifts in technology and the business and operational models, the task moved across jobs from proto-analysts to analysts and then to data-entry operators. With the task movement, related expertise also evolved. Some core expertise was required and applied to do data collection. For the most part, this core expertise remained constant as the task and expertise moved across jobs. However, another form of expertise emerged and evolved from doing the task. Doing data collection produced new expertise about governance practices, data quality, and more. The new expertise was applied by analysts to other tasks like training, analyses, and writing. Because of this produced expertise, analysts did not fully hive-off data collection. The coevolution had implications for the task and expertise but also for the jobs of interest, which in turn influenced employees' experiences and the ability of the company to attract and retain them.

By looking at how a single task and the associated expertise coevolved, we make contributions that might have been masked by more aggregated analysis. We provide empirical evidence of the depth of the link between the two and of how that link helps us to understand reverberating changes. We contribute to the literature on expertise with the introduction of the concepts of core and produced expertise. Our findings also have implications for the study of hiving-off

processes, explaining why complete hiving-off may be rare. Finally, we contribute to understanding of how the expertise surrounding tasks can shape the allocation of tasks to jobs.

THEORETICAL BACKGROUND

Tasks and Task Evolution

Work tasks are the minute pieces of work assembled to form a larger, more easily discernable body of work known as a job, position, or role. Since Adam Smith's (1937 [1776]) foundational discussion of the organization of pin-making tasks, scholars have engaged in a robust discussion of the effects of tasks and task arrangements on organizational and individual outcomes: e.g., efficiency, job satisfaction, control over workers, and pay (Braverman, 1974; Hackman & Oldham, 1975; Wilmers, 2020). Yet, for the most part, research has assumed that task arrangements were the deliberate and stable products of goal-directed managers responding to administrative and technological imperatives (see Burton & Beckman, 2007; Cohen, 2016; Miner, 1987 for related arguments).

A handful of scholars have more recently considered the dynamics that bring tasks into and out of jobs. One such line examines how employees craft their jobs to suit their preferences, while another related line considers how jobs might be constructed around employees (Miner, 1991; Miner & Akinsamni, 2016; Rousseau et al., 2006; Wrzesniewski & Dutton, 2001). Others have considered task allocation as an assembly process that invokes multiple actors across levels and the ties between tasks and jobs and other structures that hold them in place (Cohen, 2013, 2016). Research has also begun exploring the segregation of tasks within jobs and how the same tasks potentially have differing implications for those performing them: for instance, Chan and Anteby (2016) show differentiation in the tasks performed by people ostensibly with the same job and how that affects their career prospects. However, to our knowledge, there is only limited explicit attention to expertise in research on task evolution. When expertise is discussed in the literature on tasks, it is typically treated as an unintended byproduct.

Expertise and Expertise Evolution

Defining expertise is a complex undertaking. A recent review of expertise scholarship identified three perspectives on the study of expertise – Realist, Constructivist, and Situationist – and in each of these, the construct is defined differently, sometimes in multiple ways (Heimstädt et al., 2023). Across the varied definitions noted in this review and other studies of expertise, two central properties emerge: Expertise is based on knowledge and know-how (Pakarinen & Huising, 2023), and expertise facilitates the superior performance of experts on work tasks (DiBenigno, 2018; Ericsson & Lehmann, 1996; Eyal, 2013; Sandefur, 2015). Building from these ideas, we define expertise narrowly as the body of specialized knowledge that facilitates the execution of tasks. Like the expertise scholars who fall into the Constructivist and Situationist views of expertise identified

by Heimstädt and colleagues (2023), we examine expertise as a dynamically constructed or emergent property.

Where we differ from many past treatments of expertise is that we do not consider expertise as inherent to occupations (Abbott, 1988; Gorman & Sandefur, 2011; Pakarinen & Huising, 2023). While arguably all occupations are built around expertise, not all expertise is occupationally bounded (Abbott, 1988). Recent evidence suggests that how expertise is developed and valued is determined at the organizational level (Monteiro, 2024). Nor is it likely that in the face of tectonic shifts surrounding work, occupations will remain the only way that expertise is created and institutionalized (Huising, 2023). By considering expertise outside of occupational structures, we move away from ideas typically associated with expertise: that the knowledge at the base of expertise is somehow intellectually elevated and that this elevation allows occupations to maintain control over the expert work; that expert knowledge is recognized as superior by outsiders; that expertise like occupations transcends organizational boundaries. Our approach has the advantage of shifting the focus from the occupational members who do the work to the employees in organizations – “bounded collections of people and material, financial, and information resources” (Haveman, 2022, p. 2) – where the work is done. By doing so, we can better examine how the constellations of people and resources around a task drive expertise (Monteiro, 2024).

While our definition is narrow, it does not preclude that expertise is connected throughout a broader system. As other scholars have argued, expertise is a relational construct, one that connects those performing it with audiences, actors, and structures (Anteby & Holm, 2021; Eyal, 2013; Pakarinen & Huising, 2023). This relational system of expertise includes some factors by definition – knowledge, tasks – and many others by implication – the experts themselves, those who manage the experts, the organizations in which tasks and expertise are performed, associated rewards, and, sometimes, occupations in which these are embedded. Tasks are part of the relational network around expertise just as expertise is part of the relational network around tasks.

Expertise scholars have proposed several ways to distinguish or categorize expertise based on the level, content, or domain of that expertise. For instance, Collins and Evans (2019, p. 14) distinguish levels of expertise ranging from interactional to contributory expertise. Contributory expertise, the highest level, is the ability to recognize and adapt to contextual cues and cannot be attained by novices through rules and guidelines. Only those who reach the level of contributory expertise are truly experts who perform superior work autonomously. Expertise has also been categorized based on the content of the expertise: is it processual, relational, substantive, abstract, or contextual/relational (Barley, 1996; Pakarinen & Huising, 2023), and the degree to which it is broad or deep (Heimstädt et al., 2023). Expertise has also been described based on the specific type of work or occupation it is associated with. For instance, marketing expertise (Paşa & Shugan, 1996), information technology expertise (Haislip et al., 2021), and legal expertise (Kellogg, 2014). Notably, related to both level and content, some have treated process expertise – expertise enacted in coordinating information and communication – as a distinct form of expertise that can be applied across

specialist domains (Barley et al., 2020; Treem & Barley, 2016, 2018). We move the focus from categorizing expertise based on level, content, and domain to differentiating it based on when and how it is created relative to the task at hand.

The dominant streams of research on expertise, much like those on tasks, treat it as a relatively stable construct. Experts may change but expertise rarely does. Within this literature, scholars focus on how training, socialization, the transfer of expertise across members of occupations, and other mechanisms foster superior performance in a known body of work (Anteby et al., 2016; Carr, 2010; Dreyfus & Dreyfus, 2005; Ericsson & Lehmann, 1996). This treatment of expertise stems, in part, from the focus on expertise as the core of occupations that themselves are relatively fixed structures. Indeed, members of the system of occupations resist change both in terms of the addition and elimination of tasks and expertise (Huising, 2014, 2015; Sandholtz et al., 2019). Though dominant, the tendency to view expertise as fixed is not absolute, and when scholars break from it, they provide unambiguous evidence that there is much left to learn about expertise in relation to task dynamics.

The Coevolution of Tasks and Expertise

A handful of scholars have taken a more dynamic approach to the study of expertise and tasks, most often by examining how new problems associated with social movements, technology, regulation, and more lead to the emergence of new work tasks and new expertise that are allocated to occupations (Abbott, 1988). Similarly, evidence suggests that existing tasks and expertise may move into or out of occupations when problems arise with existing arrangements; for instance, regulations might mandate that tasks be added or removed from occupations (Huising, 2014). Higher-status occupations may hive-off tasks that are menial, codified, or otherwise less desirable to reinforce occupational status hierarchies and maintain the purity of their expertise (Abbott, 1988). For instance, Abbott (1988) described how, starting in the 1960s, doctors delegated menial tasks such as giving shots to nurses.

There are recent hints that tasks and expertise might co-evolve in ways other than moving into and out of occupations. For instance, differences in the allocation of tasks to groups within an occupation may lead to changes in expertise (Anthony, 2021; Chan & Anteby, 2016). Exogenous changes such as the introduction of new search technologies for librarians (Nelson & Irwin, 2014), the introduction of DNA profiling techniques for crime scene investigators (Bechky, 2020), and decreased demand for expertise for on-stage puppeteering (Anteby & Holm, 2021) produced variations in how core tasks are performed, consequently altering expertise.

Together, this work provides compelling evidence that tasks should be more central to the study of expertise and expertise should be more central to the study of tasks. Our review also highlights that occupations as such are not the sole driving force for this interplay between tasks and expertise. While most of the evolution discussed in this research is within and between occupations, it is patterned by organizational and even societal factors. Organizations and societies

shape who and what work people do and how they do it through choices about technology, organizational structure, and business and operational strategies. Organizations are the funnels through which broader changes come to work. This funneling, in turn, shapes what happens to tasks and expertise, suggesting potential benefits to considering these issues in contexts where occupations have less influence. Furthermore, our review of research on the evolution of tasks and expertise highlights the importance of looking at the two as dynamic and interconnected. It also highlights the value of drilling down to the level of tasks and the related expertise in examining them.

RESEARCH DESIGN

Because our study was exploratory and focused on questions concerning processes and interactions, we used qualitative methods to directly observe the phenomenon of interest and the factors identified as potentially important (Edmondson & McManus, 2007). We wanted a setting where we could observe the coevolution of expertise and tasks in an organizational context and see how multiple actors participated in and were affected by this evolution. Furthermore, because we believed that the occupational lens may limit understanding, we wanted a setting without a well-developed occupational structure. To meet these needs, we drew on an in-depth study of an early-stage startup that we call Sage.

Setting

Sage was founded in 2016 as a spin-off of Advisors, a corporate governance consultancy. Partners at Advisors identified a business opportunity: clients needed access to better data on boards of directors to meet regulatory requirements. This data was publicly available from internet sources – for example, in annual reports, disclosures, press releases, and media – but was not compiled in a single place or easily collected. To fill this gap, they created a project that later became Sage to gather and sell this data. Sage was about a year old in early 2018 with 15 employees when data collection began and peaked 18 months later with over 40 employees. The company was dissolved in 2020 following the start of COVID-19.

We focus on one specific task – data collection – and the expertise associated with it. While data collection is often dismissed as a dreaded and menial task (Cohen, 2020), it was central to Sage, a company created expressly to provide data. In the context of Sage, performing data collection involved online searches for information about boards of directors – for example, the number of directors, director independence, committee memberships, and demographics – from publicly available documents such as annual reports and press releases and entering the information into a structured database. This work was performed by people in multiple jobs in three different arrangements over time. We describe the tasks and expertise associated with this work and their movement across jobs in detail in our findings.

Data Sources

We collected data over two years through interviews, observations, and archival materials. Altogether, we conducted 122 interviews with Sage employees during multiple office visits and follow-up phone or video interviews with these employees and others who were not in the office during visits. This included the management team – CEO, CTO, Research Head, and Sales Manager – 16 full-stack developers, 12 analysts, and 9 data-entry operators (DEOs). Most individuals were interviewed on multiple occasions. [Table 1](#) provides details on the interviewees and the arrangements that each discussed.

The first author and another project member spent over 180 hours in seven periods ranging from one day to one week in the head office and three days in Sage's satellite office. As non-participant observers, the researchers interviewed subjects, attended meetings, sat in on job interviews, ate lunch with employees, joined them for after-work drinks, and observed daily interactions. The researchers were given a desk in the open-plan offices from which they observed daily activities. They typed field notes on an ongoing basis and created analytic notes afterward, which were analyzed along with interview transcripts. Meetings were recorded and the recordings were transcribed. Furthermore, we collected archival data from slide decks, emails, and job postings. Our understanding of this setting and our analysis drew from all the data.

Analysis

Our data analysis progressed through five steps ([Grodal et al., 2020](#)), moving from broad intuition about Sage to more specific insights about the coevolution of tasks and expertise. We show this progression in [Fig. 1](#) and describe it in detail below. For each step in this figure, we show specifically what form of analysis we did and what we learned that guided us to the next analytical step.

Step 1: Reviewed transcripts and field notes. Each of the authors reviewed the transcripts and field notes multiple times. Our goal in this review was to understand Sage's evolution. In our review, we noted numerous changes in work over time.

Step 2: Constructed and reviewed events timeline. To better see Sage's evolution, we created a timeline of events from Sage's creation to its death using the transcripts and field notes. We noted the movements of people in and out of the organization and the events happening around them. It became clear that much of the activity centered on three jobs – developers, analysts, and data-entry operators.

Step 3: Wrote and reviewed job summaries. We used the transcripts, notes, and timeline to write role descriptions for the three central jobs. The summaries included information on who was hired to do what work, how that work was done and changed, who interacted, and what expertise was needed. Based on these, we observed that the tasks associated with data collection and entry appeared in several arrangements across the three positions. We noted that with the shifts in arrangements, there were also shifts in expertise, in terms of its distribution across roles and the precise expertise associated with each role. Our next task was to understand more about those arrangements.

Table 1. List of People Interviewed.

Subjects	Number of Interviews	Arrangements Discussed
<i>Management team</i>		
CTO (Bertrand)	2	All
Research Head (Karie)	9	All
CEO (Seth)	5	All
Sales Manager (Elijah)	1	3rd
<i>Analysts</i>		
Grace	2	All
Corey	2	2nd–3rd
Nick	2	2nd–3rd
Violet	3	2nd–3rd
Bella	3	2nd–3rd
Raven	7	2nd–3rd
Ella	2	2nd–3rd
Rina	2	3rd
Victoria	3	3rd
Marco	4	3rd
Ethan	5	3rd
Julia	5	3rd
<i>Data-entry operators</i>		
Seema (promoted to Junior Analyst)	4	3rd
Gabriel (promoted to Junior Analyst)	4	3rd
Lacey	1	3rd
Jane	1	3rd
Cheyenne	1	3rd
Alex	1	3rd
John	1	3rd
Clive	1	3rd
Kanta	1	3rd
<i>Developers</i>		
Andy	3	All
George	3	All
Owen	4	All
Kenny	6	All
Ian	2	All
Mike	3	All
Leo	3	All
Aurelien	1	3rd
Valeria	1	3rd
Sabrina	2	3rd
Genevieve	2	3rd
Kelsey	3	3rd
Parker	2	3rd
Adrian	1	3rd
Horatio	1	3rd
Jennifer	3	3rd
<i>Other</i>		
Business Intern 1 (Sophia)	1	2nd
Business Intern 2 (Shane)	1	2nd
Business Intern 3 (Edith)	1	3rd
Senior Site Reliability Engineer (Rupert)	1	3rd
Site Manager (Christine)	1	3rd
Advisor (Duke)	1	3rd
Office Manager (Scarlet)	4	3rd
Marketing Manager (Vincent)	1	3rd
Total: 49 people	Total: 123 interviews	

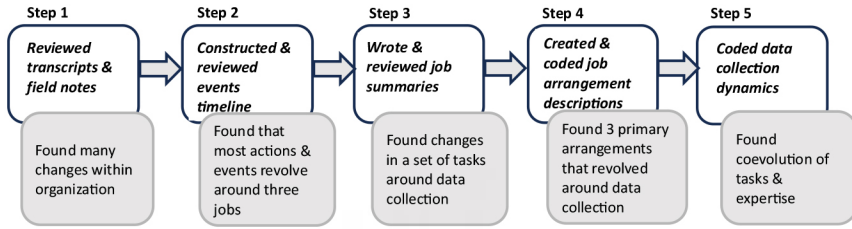


Fig. 1. Data Analysis Process.

Step 4: Created and coded job arrangement descriptions. We reviewed our analytical documents to understand more about the evolution of tasks and expertise across these arrangements. In doing this, we learned that what is commonly referred to as *data collection* included five tasks: mapping the data points that needed to be collected, collecting that data from online sources, adding data to the database, validating the data, auditing the validated data, and the training of people to perform those tasks. We then created detailed descriptions of the three primary arrangements observed, including what work was being done, by whom, what expertise was invoked, and what the intent was. Once we created these detailed descriptions, we noted that looking at the five sub-tasks here would make it difficult to see the important action. Data collection was the most central to these activities with the richest dynamics around it. It seemed to be key to understanding the coevolution of tasks and expertise.

Step 5: Coded data collection dynamics. We returned to the data and further analyzed the dynamics associated with data collection. We observed that there was expertise required to do data collection and that performing that task refined that expertise. However, we also observed that performing data collection, at times, produced other forms of expertise that, in turn, became core requirements to do still other tasks. Finally, we noted that the data-collection task and expertise were distributed across jobs and that there was further differentiation within jobs.

THE DATA-COLLECTION TASK AND EXPERTISE, AND THEIR COEVOLUTION

In this section, we describe the evolution of tasks, expertise, and jobs uncovered through our analysis. This co-evolution is depicted in [Fig. 2](#). It begins in the upper left with the various jobs where people collect data in each phase based on the core expertise brought to the positions and developed through training and practice (lower left). It then shows that doing data collection led to newly produced expertise. This produced expertise facilitated analysts performing tasks other than data collection: training, creating guidelines, and supervising. We describe each of the figure's boxes and arrows below.

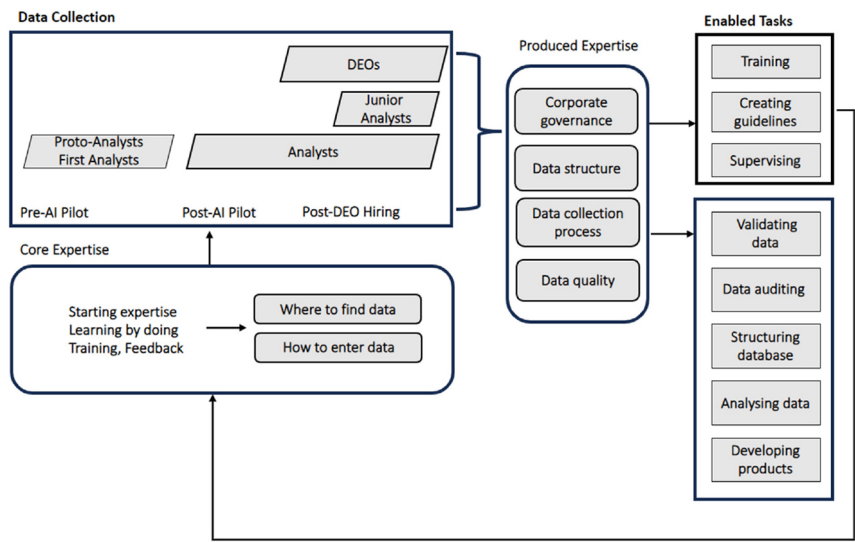


Fig. 2. Evolution of Tasks, Expertise, and Jobs.

Legend:

- The rectangles represent tasks.
- The parallelograms represent jobs.
- The rectangles with rounded corners represent expertise.
- Arrows represent time.

How the Data-collection Task Evolved

We build a foundation for our findings with a detailed description of the data-collection task. This corresponds to the box on the upper-left of Fig. 2. Across interviews, those who did manual data collection consistently described two data-collection steps: finding the data and recording it. Finding the data started with pulling information from corporate annual reports. These reports varied in comprehensiveness, and, as a consequence, how much additional digging had to be done in disclosures, press releases, and media articles. As one DEO described:

The annual reports can be anywhere from 50 to 400-something pages and, depending on the client, I have to do quite a bit of web research. And a lot of times there's just no information to be found, but I still have to keep looking until I determine that there's just no information available.

Other DEOs and analysts described their data collection similarly. Once found, the data was entered into a database – initially an Excel spreadsheet and later a bespoke database. Often, this just meant typing a number or word into a pre-defined slot. However, this step sometimes involved more. For instance, they had to calculate annual CEO compensation from monthly data or age from birthdate.

When Advisors founded Sage, they appointed a Partner as CEO and he soon asked Karie, then a newly hired intern at Advisors, to join him on the project.

Karie began manual data collection: “I joined this as an intern, which essentially meant that I was collecting all this data that we’re now collecting, just in Excel format.” She described the purpose of her data collection as going beyond simply finding and entering data; she was figuring out what data was available, what data clients might want, and what the product would be, and creating a roadmap that could be used when AI capabilities came online. She also created an Excel spreadsheet for data collection, which became the model for a bespoke database she developed with Sage’s CTO Bertrand. As Karie described it:

It became essentially working with Bertrand trying to figure out how to take these Excel files and to build something around it ... We didn’t really have any products, it was mainly me, and Bertrand still working on kind of mucking out the data ... And so, it became me and Bertrand more working on the product development.

The AI pilot aftermath. The intention at Sage’s inception had been that the data would later be scraped with AI. Toward this end, Karie and Bertrand were building an understanding of what data could be scraped from the internet. Sage’s developers would then create algorithms to collect massive quantities of data. In the meantime, Karie and other research-team members collected data manually as others at Sage worked to create algorithms. However, an AI pilot run by outside consultants produced disappointing results. It provided what Seth, the CEO, described as about five percent of the desired data at a remarkably prohibitive cost.

This pilot and the subsequent decision not to use AI as planned marked the transition to the next data collection arrangement. After this realization, the data collection and entry work continued to be performed manually by an expanding group of analysts under Karie’s direction. By this time, Sage had hired several analysts who in this period spent most of their days scouring the internet for data on bank boards of directors in much the same way their predecessors had before the failed AI pilot.

With this arrangement, data collection remained a goal, but planning for the AI transition slipped away completely, and the efforts to map data points fell primarily to Karie. The analysts’ primary focus was data collection. This was reflected by Violet, an analyst who also led analyst hiring in her description of the job to candidates she interviewed:

So, I would tell you that for the first six months, for the first month or two it will involve a lot of training, bank-specific training, and corporate governance-specific training; a lot of data collection and validation I would say for the first five or six months, which of course can be repetitive ... going through these disclosures over and over again.

When we interviewed them at the time, many of the analysts expressed concern that they were doing so much data collection. They described the task as tedious, menial, too operational, below their level of expertise, and inconsistent with their expectations of the work that they would be doing. For instance, Grace, one of the early analysts, described her experience with data collection: “So I knew that I was going to do a lot of data collection and validation ... but I have to say that after I’d done it for a few times it became really, really difficult to continue to do it because it’s such a boring task.” In describing her reasons for leaving Sage, Violet explained that she had taken an analyst job but was not doing “analyst” work.

Other analysts offered similarly negative descriptions of data collection and its fit with their qualifications.

The arrangement with analysts doing all data collection was intended to be short-lived, a stopgap measure to keep data collection progressing. Seth, the CEO, described two reasons to transition from this arrangement. First, the costs of using analysts for data collection were high. Most analysts had master's or law degrees, were based in London, and had salaries commensurate with that. Yet, as the task became more codified, it required less of the judgment and decision-making associated with the analyst position. Second, analysts' frustrations about doing data collection reinforced his belief that this was not a good long-term solution and hastened a transition to the next arrangement.

Data-entry operators. Soon after the disappointing AI pilot, Sage began developing and implementing a new data collection model. Most of it would be performed by data collection specialists, eventually called data-entry operators, in a satellite office and outsourced offshore under the supervision of analysts.

The transition to this arrangement was gradual. Sage began to search for people to do this data collection. Initially, they posted for a junior-analyst position but realized the applicants were overqualified. The concern was that, like existing analysts, they would become frustrated. Sage then posted a Data-Entry Operator (DEO) position that would be filled by employees in a lower-cost satellite office and that did not require advanced degrees. In parallel, the analysts developed a DEO training process and tested it on temporary workers in the central office. Following this, much of the data collection moved from analysts and temporary workers to the newly hired DEOs in the satellite office and an agency in India.

Even as the DEOs came online, analysts continued to collect data but for reasons other than building the database. How much they did this task varied both over time and across analysts. For instance, Ella described weeks where she spent four days collecting data and weeks where she did none. There was continued evolution in what data would be collected and how it would be recorded. Karie explained that they would collect additional years of data, information on CEO compensation, other new variables, and data on non-bank organizations. However, the essential data collection task remained the same.

Core and Produced Expertise

Through observations and interviews, we identified two distinct types of expertise associated with data collection. There was what we call *core expertise*. We use this term to refer to the expertise required to collect data. This term is not used to refer to whether the task itself – collecting data – was core to the organization. Any task would have core expertise associated with it. Furthermore, this distinction is not based on the level, breadth, depth, or occupational domain of expertise; the nature of core expertise could range widely depending on the underlying task performed.

The second type of expertise associated with data collection was what we call *produced expertise*. We use this term to refer to expertise that is developed in performing a specific task but that, unlike core expertise, is not needed to perform that task as such. It is, however, needed to perform other tasks. Like the

term core expertise, it does not indicate differences in level, breadth or depth, or occupational domain. Below, we described how each of these types of expertise evolved at Sage.

Core expertise. Through our interviews and observations, we learned that there was expertise required to do data collection, what we call core expertise, and that this remained constant across the arrangements. Whoever was collecting the data needed to know what data should be collected, where it might be found, and how it should be recorded. This expertise was produced in three main ways. First, at hiring they were screened for this expertise. They were expected to come in with some basic understanding of these elements from experience and education. Furthermore, once they start performing the data-collection task, they could augment or refine their understanding as they perform the task. Finally, they received some training on how to do this work, which varied over time as arrangements shifted.

Analysts, DEOs, and their managers described the knowledge sought at hiring for data collection. Most analysts said they were asked about their knowledge of corporate governance. For instance, Ella, an analyst hired when the second arrangement was in place, said her interview was “focused on corporate governance, you know, specific terms about corporate governance and what’s my understanding about the field.” DEOs were also asked about corporate governance knowledge, though the expectation for the level of knowledge was lower. Violet described her expectations for the DEOs: “I’m not really looking for someone who has the same sophisticated skills.” Cheyenne, one of the DEOs, recalled being asked whether she knew what corporate governance was but nothing more in-depth.

Sage used a work-sample test to assess job-skills fit. Grace, an analyst hired just before the AI pilot, described the expertise evaluated in the work-sample test she did: “It was basically going through an annual report and writing out into an Excel sheet ... And [the interviewer] just wanted to know whether I understood the contents of the executive board.” Other analysts and DEOs described the work sample test in similar ways. For instance, the DEO, Cheyenne, described her work sample as follows:

[The recruiter] sent me ... a test on how they do corporate governance data entry within their own database. And it was a spreadsheet. She sent me an annual report for a bank and a spreadsheet and said, “Fill out this spreadsheet for this board of directors...” There was a little bit of calculation for how old they were ... when they were on the board.

Analysts and DEOs also described learning more about how to do data collection after joining Sage. Through on-the-job and more formal training, interns, analysts, and DEOs learned more about what data they were meant to collect, and where to find it: for instance, CEO compensation might be available in a bank’s annual report, in the media, or through other online sources. The pattern of training, however, evolved as the work and training became more codified. In the early days, there was little formal training and guidelines. As the first person to collect data at Sage, Karie provided a model for how that expertise would be developed. When she started, she drew on expertise in data collection and corporate governance built during her master’s degree. She also had guidance from the

CEO on what was wanted but, at that point, Advisors had only general untested ideas about client preferences. As a result, her expertise was largely developed as she did the work. At this time, she provided other proto-analysts and eventually some early analysts with basic guidance on what to collect and how to collect it but, like Karie's their training was largely on the job.

By the time Sage moved into the third arrangement, the pattern of expertise development had shifted. While, for the most part, the expertise needed to do data collection was the same, the work became more codified as much of the work was shifted to the DEOs. Expertise was embedded in the collection database: for instance, the needed data points were clear; some errors were automatically flagged. Corey and Bella documenting the process and developing more formal training materials while training the temporary workers as reported by Karie in a group meeting:

Corey created the document in order to have a more standardized way of reporting and training everyone. Still, some additions and corrections need to be made. So, this is why Corey will be attending the whole week, taking notes. Bella will be training the newcomers and hopefully, we will use this for a trial for [satellite office] as well.

Over time, the training materials became more elaborate. Corey and Bella made and updated training videos that covered all aspects of data collection. Later, when those videos did not seem to fully address the questions and needs of the DEOs, another analyst, Raven, led the development of a more detailed training manual to which each analyst contributed sections on their areas of specialization:

It's huge ... It ended up being about I think 84 slides. And it's still ongoing We are in discussions with the development team, and they need to integrate that into [the database] which should be like a Wiki page so people can ... look things up, search things and I'll be primarily responsible for updating them as we grow our products.

Analysts continued to supervise and advise the DEOs. Sage also established a Slack channel where DEOs could ask questions to an on-duty analyst. The DEOs also received training and guidance in weekly group meetings. Seema, a DEO at the head office, explained: "We have these DEO meetings where we would do training and stuff and discuss any issues that they have or anything which you don't understand."

The lead analysts had regular one-on-one check-in meetings with DEOs. At the start of one of these meetings, Grace described its purpose:

The purpose of this meeting is just to have a catch-up with you on how collections are going, what our expectations are, and how you feel about them and about our coordination and collaboration, communication and getting, receiving from you some feedback and how everything works and also from our side a bit of feedback.

In that meeting, Grace and Violet discussed data collection targets and quality with the DEO and asked whether there was any help she needed. They also described the various channels that they used to get help.

Data collection, however, never became an entirely codified and straightforward process. Analysts and DEOs both described areas where they found the

work challenging and where they needed to make decisions and exercise discretion. Matthew, a DEO, put it succinctly: "Sometimes, the reality and our rules do not match." Jane, another DEO, elaborated: "You need to read through first and you need to think over because each bank's way of conveying the message and making their rules is different." Another DEO, Lacey, described variation in the difficulty of doing data collection: "So, there's easy and not so easy ... The disclosure is easy to find if it's not scanned ... Then the hard part is when it's scanned. You really have to read everything because you cannot do a search." An analyst offered a similar description of data collection challenges:

It's not as straightforward as I expected it to be ... and sometimes [the data] is not even there. So, it's kind of like trying to figure out okay, should I keep looking for this, is it somewhere hidden ... or it's just not there, they're just not disclosed.

Produced expertise. For those performing the task, data collection led to the development of additional expertise that was not directly applicable to doing data collection but that could be applied when doing other tasks. They were building what we call *produced expertise*.

The pattern through which produced expertise was created took root in Karie's early days. As she collected data, she not only refined her expertise in finding and recording data but also produced knowledge on data availability, how to orchestrate the entire data collection process, and corporate governance practices used across banks and time. This expertise did not make her better at data collection as such but allowed her to accomplish other work: for instance, creating a map of the data points that would be collected, and developing the Excel spreadsheet that would house the data and provide a model for the bespoke database. She also used this *produced expertise* to develop an initial vision for Sage's product offering.

For most analysts, before the DEOs were hired, the analysts may have been developing produced expertise but had little opportunity to apply it. One analyst, Violet, described developing additional expertise when collecting data but not having opportunities to apply it:

I would make the most of this data collection by making sure that I completely understand what we are collecting and why we are collecting it, familiarizing myself with the disclosures I believe that this is how I can get ownership of my work, this is how I can develop through my role, and this is how I can get a thorough and deep understanding of ... what corporate governance is in different jurisdictions, how banks work, what are the different risk metrics we use, why do the banks use these specific risk metrics and not others, what are the processes, what is the regulation in different jurisdictions I'm able to more substantially contribute to how our products can develop or they can diversify.

While this practice was unusual among the analysts at this time, it foreshadowed changes in data collection expertise.

Later, even as DEOs did most data collection, analysts continued to collect data although with a different intent than previously. Doing data collection allowed them to develop produced expertise, much like that Violet described above and this produced expertise, in turn, enabled them to do other tasks. For instance, Raven, the analyst who eventually led the creation of the more advanced

guidelines, described how continuing to do data collection helped her gain expertise on how to do the tasks of data analysis: “To be able to write the research reports, it is recommended to understand the various data points which we collect and so I do ... data entry.” Marco described gaining an overview of governance through data collection: “I’ve worked on the flags They highlight good or bad corporate governance practices It gives an overview of the governance structure.” Rina explained how data collection helped her write a report: “I wrote a benchmarking report ... and I could understand why we’re connecting which data points, and it gave me a better understanding.” These descriptions echoed the earlier statement by the analyst, Violet, who had described using data collection to expand her understanding: “And I very much do agree ... to be able to work as an analyst, you should have collected some data or at least familiarized yourself in the data.”

By performing the task, those collecting data learned about data quality and the overall process of collecting data and building the database. This expertise along with produced expertise on governance was applied in developing and delivering the training materials on data collection. Analysts also used their produced expertise to validate and audit data collected by others, to make improvements to the database itself like adding new data points and removing ambiguous ones; to suggest changes to the bespoke database; to inform developers what was needed; to write proposals, reports, and posts about corporate governance; to explore expanding the database to include more than banks and bank subsidiaries; to consider purchasing data and to develop a new business model around that. For instance, Raven described learning about differences in governance across organizations through data:

So, yes, it’s a similar structure [for FTSE 100 companies]. So, it’s just that when it comes to other civil firms, other industries such as emerging markets, and going into other countries like Afghanistan and other African countries, Kenya. They tend to have very limited disclosures. So, we might need to sort of weigh up the value of the data to our potential clients.

They also began to use *produced expertise* to revise the data points, removing ambiguous ones to accelerate task transfer to DEOs, and continued mapping the data points as Sage expanded to collect more companies and bank subsidiaries. Some DEOs described developing similar expertise as they did data collection. For instance, Matthew explained what he learned while collecting data: “The understanding of ... how our big corporations work, so what’s behind, and that was my focus and what I was interested in at that time.” The main distinction was that DEOs did not apply this expertise in any tasks other than data collection.

While it was primarily analysts who discussed developing and using this produced expertise, there is evidence that those in other roles also developed it. For instance, DEOs described learning about data quality, corporate governance, and more. For the most part, this expertise remained latent for the DEOs. However, as described below, some DEOs were promoted to Junior Analyst or Analyst positions based, in part, on having amassed this expertise.

Implications of Evolution for Jobs

These changes to tasks and expertise took place within specific jobs in an organization and had implications for those and, in particular, on what work people did at a collective and individual level. While the data collection task and expertise co-evolved and were shared across jobs, they were not shared equally. The tasks for which produced expertise was applied were segregated both between and within jobs. The DEOs ultimately performed much more data collection. They may have accrued some of what we call produced expertise but only those in the analyst position performed the tasks associated with that produced expertise. The main exception to this pattern was data validation done by analysts and more experienced DEOs.

Fig. 3 shows the evolution over time of the tasks done by those in each job described in the paper for each of the three arrangements and the movement of people across jobs. The headings of each box are the job titles: Proto-Analyst, Analyst, Data-Entry Operator, Junior Analyst. The list below these headings are the primary tasks performed in that period. The double-headed arrow at the bottom indicates the progression of time from the start of Sage to the failure of the AI pilot, and finally to the hiring of DEOs. The arrows after a task indicate that it moves to another job.

Evolution of the analyst job. As expertise and tasks co-evolved, the job of the analysts also evolved. As the DEOs were hired and analysts developed *produced expertise* while doing data collection, analysts began to perform the additional tasks that required this new expertise. These included the training and supervision that they did for the DEOs, analyzing data, writing reports and posts based, in part, on that data, developing the website and other marketing materials, and more. This shift to doing these new tasks was facilitated by moving data collection work from analysts to DEOs which gave analysts more time to spend on other tasks.

While all analysts developed this additional expertise, not all applied it to the same degree and to the same tasks. There was significant task segregation even within the analyst position. For instance, while to a degree all analysts trained and helped DEOs, Corey and Bella led the initial in-person training, and then Raven developed the more elaborate training materials. Another analyst focused on assessing risk. Two others were recruiting leads. One explored collecting governance data on non-banks. Others worked on marketing and developing a social media presence. Still, others did more of the tasks requiring their newly expanded governance expertise and data validation. Corey, one of the analysts initially involved in DEO training and marketing, described how his role developed:

So, I tend to pick up tasks just because I know how it's done. I know things basically which I've been doing So, I once did a leadership role in the team in terms of maybe leading some kind of content creation in terms of insights or social media and having a bit more freedom to sort of choose the type of topics that we're going to cover and produce material for.

This pattern of within-job task segregation can be traced back to the early days when Karie began collecting data and was the only one to use the knowledge to design the database and develop the product offering and continued with tasks, sometimes unrelated to data collection, added informally to specific analyst's jobs. It was formalized through an exercise where they worked through their

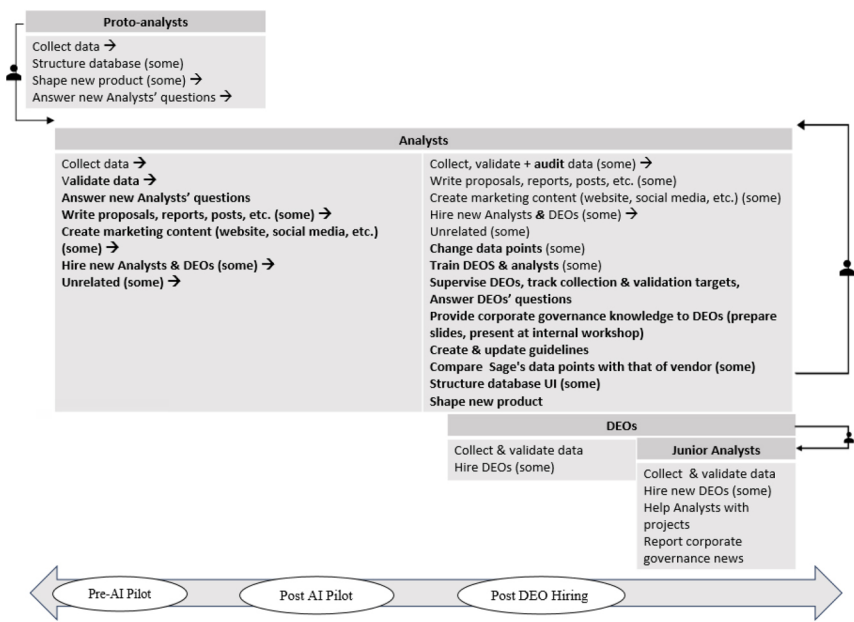


Fig. 3. Tasks Performed in Each Job for Each Arrangement.

Description: This figure shows the evolution over time of the tasks done by those in each job described in the paper and the movement of people across jobs. The headings of each box are the job titles. The lists below are the primary tasks performed under that title in that period. Bold-faced tasks are new tasks. Arrows after a task indicate it continues in the next period. The double-headed arrow at the bottom indicates the progression of time. The double-headed arrow at the bottom indicates the progression of time.

This shows that some tasks emerged within the proto-analyst positions at the start and that these tasks were carried over to the analyst position which emerged after the failed AI pilot. New tasks were added in this period and most of these tasks continued to be done by analysts even after the DEOs were hired. However, several new tasks (in bold) were added to the position, and these are the tasks enabled by produced expertise.

Legend:

- Table headings are job titles.
- The lists below headings are tasks in that job.
- The double arrow indicates time.

- Tasks in bold are new tasks.
- A small arrow after a task indicates it moves forward.
- Arrows with figureheads indicate the movement of people between jobs.

responsibilities and accountabilities. This differentiation of analysts continued and even intensified just before Sage went under. Sage began exploring an alternative business model that included purchasing data and providing clients with analyses that could be used for benchmarking. Three analysts worked on the project. Marco, an analyst involved in this project explained that the old product was “just a bunch of data points” and that the focus of the new product “would be on data analysis and then group governance in terms of collecting data ... It’s more of, what do we do with the data?”

The tasks of those analysts shifted dramatically away from data collection though their core and produced data collection expertise remained relevant. Julia, one of the analysts on this project, described her work on the project:

I’ve been doing[everything]from product design to product management, to product mock-ups We currently have a chart section where clients can benchmark themselves against their peers and we wanted to redesign that. So, I thought of the new content that should be on the page, how the tabs should be structured or what is the organization for the chart I’ve been liaising with a company that helps us do the implementation ... and, also, liaising with people from the Dev Team.

Another analyst on the project explored what data might be purchased. The analysts on this project did almost no primary data collection.

There was only limited mobility of analysts into other positions. Karie joined as an intern and became an analyst, a senior analyst, and eventually the head of research. Two became leads but left quickly. Others were given a senior designation.

Evolution of the DEO job. The evolution of the DEO job differed from the analyst job. To start, the DEOs’ orientation toward the work differed. While analysts described data collection as menial and beneath them, the DEOs described it as better than expected, involving discretion in finding and interpreting data, and making quality judgments about it. Jane, a DEO in the satellite office, compared the Sage data collection to work she had done previously:

There’s a huge difference because when I worked with [Bank] it was data operating or data entry I agree there [are] a lot of entries being made [at Sage], but you need to read through first and you need to think over because each bank’s way of conveying the message and making their rules is different. So, you need to just analyze them.

In contrast to the analyst job, the DEO job changed little. They continued to collect data and to do little else. The only other task DEOs took on was data validation once they had gained more experience with and expertise in data collection and to help with DEO hiring. One DEO imagined that eventually she might take a lead role or spend more time answering queries from other DEOs, but this never materialized. What did change for them is that the guidance they received became more structured and more tailored to what they needed, thus further codifying the work.

The level of differentiation within the job also differed. DEOs all did essentially the same thing though some were promoted to other positions within Sage. Four DEOs who differentiated themselves in performing data collection were promoted. Two DEOs in the satellite office were promoted to the analyst role in the satellite office because, as Karie explained, they “were ready.” Two other

DEOs who had started as interns in the headquarters were promoted to junior analysts and began doing additional work to assist analysts. For instance, Seema described how her work changed:

And I think now I'm more into helping different people. For example, there might be a ticket to help a [developer] ... or right now, I'm helping the Marketing department. So, I guess in terms of that, I think, a little more variation across departments It just depends on who actually has anything very important to do.

Like analysts, she became involved in training for the offshore office:

So, I was interacting a lot with Mumbai and also training them, making sure that everything was collected properly, giving them feedback. So that took, I would say 70 to 80 percent of my time I was the one who was validating all their work I was giving them feedback and answering their questions on a day-to-day basis.

We now turn to discussing the implications of these observations for research on tasks, expertise, and jobs.

DISCUSSION

We began this paper by arguing that for many reasons tasks and expertise should be studied as coevolving: the two are closely linked in practice and yet there is scarce theory or empirical research that considers them as coevolving; a small body of research hinting at their coevolution provides strong evidence that this is a serious omission; and the environment of work is ever-evolving, which means that tasks and expertise will also be changing. Knowledge of this coevolution is limited by several tendencies in the study of tasks and expertise. Expertise and tasks are most often studied in the aggregate – in occupations and jobs – and as relatively stable. Based on this, we considered tasks and expertise at a less aggregated level: for example, looking at single tasks and related expertise in a context where they are not part of highly-institutionalized occupations. We traced the task of data collection and the associated expertise across jobs and over time in a single tech-enabled startup.

We observed that this task and related expertise were redistributed and transformed at multiple junctures and that this process reverberated through the system of tasks, expertise, and jobs. At times, this coevolution was led by tasks that moved and changed. At other times, the task transformations were responses to shifts in expertise. At first glance, it might seem that the story of the coevolution of tasks and expertise ends with the movement of the data-collection task and associated expertise into the newly created DEO job. However, this co-evolution was much more complex. Not all data collection moved to DEOs, and its movement provides only a partial explanation of how the task and expertise coevolved. The analysts continued to collect data in a more limited way and with additional goals. For instance, one reason analysts continued to collect data was to gain what we call produced expertise that they could then apply to other tasks. The *produced expertise* they gained included the understanding of data availability and reliability, of

corporate governance, and this allowed them to do other tasks including structuring the database to capture this data, training, and supervising others on data collection, improving their analysis of the data, and writing reports.

In tracing this process at a detailed level, our study builds from others who have documented the more subtle ways that tasks and expertise coevolve. For instance, [Anteby and Holm \(2021\)](#) show that tasks and expertise changed when puppeteering shifted from being performed to a live audience to directors. The audience shift here was a literal one. However, there may be other important types of audience shifts. In our case, while the expertise was performed for the same individuals in the organization, that audience shifted their expectations and why they wanted it to be performed. We also build on [Anthony \(2021\)](#) who shows differences in the expertise developed and applied by junior bankers across two units: based on how they performed their tasks, some developed advanced analysis skills and others did not. In our study, we see differentiation both within jobs and across them: those performing the data collection tasks developed and applied different expertise depending on how they did it and how they applied that expertise to other tasks which was shaped both by how they did their work and by what job they were in. More generally, we build on insights from these papers and others showing the importance of looking at tasks and expertise at a more molecular level. Examining bodies of expertise and tasks aggregated to the level of occupations or jobs would have missed the details of how they changed.

We focused in this study on a particular task in a particular context. It was a task that, while seemingly menial, was central to the organization's business. The organization itself was rapidly growing with little established structure. These factors allow us to observe the coevolution without occupational influence, but it is not likely that these factors are the only ones that could account for observations of coevolution. It is hard to imagine a scenario where either tasks or expertise would change without the other also changing. It seems that doing any task requires expertise and can produce additional expertise that can be applied to other tasks and, as a result, changes in either part of the system of tasks and expertise will bring changes in the other. How this process plays out for other types of tasks and in other contexts is something that should be explored further. Specifically, one question that should be examined in future research is how this dynamic differs depending on the nature of the task being examined: for instance, what happens if the task is less central to the business model or if it is one with core expertise that is at a higher level or specific to one domain. Another question is how this might play out in more established organizations with established structures. Indeed, evidence suggests that accrual mobility and idiosyncratic jobs – phenomena that resemble what we saw – emerge even in highly bureaucratic organizations ([Miner, 1987](#); [Miner & Estler, 1985](#)).

Our findings contribute to research on expertise, on tasks, and on jobs. In the sections below, we discuss three of our more specific contributions – we introduce the concepts of core and produced expertise, elaborate on the dynamics of hiving-off, and develop understanding of the job structuring process – and offer further ideas about how scholars might expand on our work to shed light on other processes.

Core Versus Produced Expertise

One of our central contributions in this paper is to develop the distinction between task-level core and produced expertise. Core expertise is directly required to perform a specific task; produced expertise is gained by performing the focal task and applied in performing other tasks. This distinction is based, in part, on how the expertise is gained and, in part, on the relationship of the expertise to doing the task. Core expertise precedes performing the task and is applied in the performance of that task; produced expertise comes from doing the task and is applied in the performance of other tasks.

The distinction between core and produced expertise does not align with the many previous categorizations of expertise based on level, content, domain, type of task, and breadth versus depth. For instance, produced expertise differs from process expertise (Barley et al., 2020; Treem & Barley, 2016, 2018). The main difference is that produced expertise emerges from performing tasks that draw on core expertise, and so it is contingent on people continuing to do core tasks. Process expertise by contrast is the expertise that facilitates the coordination of work, which may be either core or produced as we define these terms.

Furthermore, the distinction between core and produced expertise is not based on the difficulty or level of the expertise applied. We cannot differentiate them based on whether one is simple and the other analytical. Nor is produced expertise the equivalent of Collin and Evan's (2008) contributory expertise – the ability to recognize and adapt to contextual cues that cannot be attained by novices through rules and guidelines. Like contributory expertise, all produced expertise results from doing expert tasks. However, in contrast to contributory expertise, not all produced expertise involves recognizing and adapting to contextual cues.

Finally, the distinction we make between core and produced expertise is not based on whether the task being performed is itself core or periphery. It happens that the task to which both core and produced expertise was applied in our study was core to Sage: data collection was the reason the company existed. However, this idea might apply to tasks that are not central to the organization.

Examining this phenomenon at the detailed task level allowed us to uncover the distinction between core and produced expertise. This might have been missed if we had, for instance, looked at the set of tasks done by data analysts or even the broader set of tasks around data collection and entry. Based on this distinction, we could show how it takes expertise to produce expertise. It is not a case where expertise from one domain is transferred to another (Kahl et al., 2016). Indeed, there is considerable evidence that this sort of transfer is not easily done. Instead, we see that one form of expertise allows people to perform tasks that, in turn, produce expertise that can only be applied to other tasks.

Hiving-off

Our observations also help refine understanding of hiving-off – members of an occupation pushing menial tasks to lower-status occupations (Abbott, 1988). While most of the data-entry work was moved from the analysts' job to the lower-status DEO job, there are crucial differences between what we observed and the

more typical version of the hiving-off narrative. First, we show that hiving-off is not absolute and that there are benefits to not completely hiving-off low-status tasks. Analysts continued to do data collection because it helped them to build and maintain expertise in other domains that allowed them to perform higher-status tasks. This finding builds on research pointing to the value inherent in performing tasks seen as not inherently meaningful, menial, boring, or otherwise mundane. For instance, [Huisig \(2015\)](#) documents that not hiving-off menial work helped lab technicians build relationships and eventually maintain their territory. Ranganathan and Shivaram (2002) found that woman supervisors can motivate greater productivity in women workers by engaging in scutwork. Others have documented how doing mundane work is inherent to and, in some cases, beneficial for creative work ([Bruns & Long Lingo, 2023](#); [Elsbach & Hargadon, 2006](#)). Even after doctors passed the task of giving shots to nurses, medical students continued to give shots to build their expertise ([Abbott, 1988](#)). Consistent with this, we found that continuing to perform menial tasks not only held positive implications for professional authority and task performance but also for expertise itself.

Typically, the work passed on through hiving-off is assumed to be viewed as low status and menial for both those hiving off the work and those receiving it. We show that this is not always the case: the DEOs who received the seemingly low-status data-collection task did not view it this way. This observation dovetails with recent evidence that the same work is not viewed the same way by all who do it. For instance, [Bourmault and Anteby \(2020\)](#) examined two sets of recently promoted managers in the Paris Metro – one set who had worked as station agents and one who had worked as subway drivers – and showed that in contrast to their responsibilities in their previous position, station agents viewed their new managerial tasks as a positive increase in responsibility while former subway drivers did not.

Another difference from the typical hiving-off narrative is that this was not a case where a strong occupation willfully pushed tasks to a subservient one to improve their status or their daily experience. That story fits part of what we observed: analysts did not want to do data collection. However, analysts alone could not make this happen. In large part, it was a product of organizational evolution and managerial actions: the task was always intended to be removed from their job.

This suggests several avenues for advancing understanding of hiving-off. We observed hiving-off outside of the occupational domain, but our findings suggest that more research on this phenomenon is needed even within the context of occupations. Are the dynamics we saw different from what we would see in an institutionalized occupation with more self-governance and outside regulation? Furthermore, more research is also needed to fully understand the role of the various actors in this process across contexts. We saw that hiving-off was not simply a process instigated by those doing the task which raises questions about the roles of other actors in hiving-off. To what degree do managers and other actors influence the process and in what conditions? Rather than consider that those doing the task agree about hiving-off and have the power to unilaterally move

it elsewhere, we should consider cases where those doing the task do not view it uniformly or when the targeted recipients of the hived-off task do not want it. What role do the targets of hived-off tasks play here? While we provided evidence that the DEOs offered no resistance, there is evidence that not all efforts to hive-off will be welcome or successful. For instance, when human resource professionals in one organization attempted to transfer some of the more transactional work, the targets resisted it with claims that they lacked expertise (Sandholtz et al., 2019).

How the Interplay of Tasks and Expertise Shapes Jobs

Our findings provide further insights into the forces that shape jobs – the assemblies of tasks under administrative job titles. As other research has shown, the shape of jobs is subject to influences from multiple sources at multiple levels, but this research has yet to discuss how expertise shapes job design (Cohen, 2013, 2016). We show that the interplay between tasks and expertise influences the allocation of tasks into and across jobs. When doing data collection generated *produced expertise*, analysts performed new tasks and those new tasks became a more permanent part of their jobs. It is notable, however, that the development of new expertise alone does not lead to job changes. DEOs did not take on these tasks within their current role, though a few who demonstrated this expertise were promoted. Nor were analysts able to routinely apply this expertise to new tasks before the DEOs were hired to do much of the basic data collection.

We also contribute to growing evidence that job design can occur without grand occupational influences. In our case, there were influences related to strategic and operational decisions, the failure of technology, and the dynamics across different jobs. While the preferences of those doing the work had some influence, this was not a case where the job or job holders could determine what unfolded. In other words, those doing the work did not have an overriding influence in shaping their jobs.

While occupations were not a guiding factor, our observations have implications for occupations. In our case, the coevolving dynamics of tasks and expertise shaped jobs. Given that occupations often attempt to claim tasks and expertise to build their jurisdictions and authority, it seems likely that similar dynamics could be observed in tracing detailed tasks within even highly institutionalized occupations. This, of course, could and should be explored in future research.

Implications for the Study of Work

We end this paper by connecting our detailed findings on tasks and expertise to the larger body of research on the future of work. In the face of monumental institutional changes surrounding it, the work that individuals do within jobs, occupations, and organizations is under constant revision. That means there will be fundamental changes at the level of tasks and so in expertise. We hope that our detailed observations on the coevolution of tasks and expertise can help scholars

to understand how those changes happen. They start at the minute level of the task and ripple through these larger units.

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SECTION 2

THE EXPANDING ECOLOGY OF EXPERTISE: INTERMEDIARIES, ALLIES, LAYPEOPLE, AND PRACTITIONERS

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WHO'S AN EXPERT AND WHY DOES IT MATTER?: HOW SOCIAL AND ECONOMIC INEQUALITIES SHAPE THE PRODUCTION AND RECOGNITION OF EXPERTISE

Nicholas Occhiuto

City University of New York, USA

ABSTRACT

Despite the fact that social and economic inequalities continue to be the “grand challenges” that besiege the world, the extant literature often treats experts and expertise in decontextualized way, treating experts as seemingly unaffected by or above social processes that generate or reproduce those inequalities. This review addresses this shortcoming by demonstrating two crucial pathways through which social and economic inequalities shape expertise: (1) the access to opportunities where individuals generate skills and capacities to compete in the labor market; (2) the recognition of the skills and capacities of individuals. Moreover, it considers the implications of those pathways for the reproduction of inequality before concluding with future directions for research on experts and expertise. I argue that future research on expertise would benefit from incorporating the findings from the work of scholars of racial, gender, and economic inequality to overcome the decontextualized ways in which expertise has often been explored.

Keywords: Expertise; professions; inequality; race; class; gender

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The study of experts and expertise is at a decision point. Despite the fact that social and economic inequalities are enduring social realities, the extant literature has largely treated experts and expertise as both unaffected by and unaffected of those inequalities. To elaborate, the research on expertise has largely focused on questions regarding the behavior of experts – how and why they establish and maintain boundaries (Bechky & Okhuysen, 2011; Evans, 2021; Huising, 2014, 2015; Kellogg, 2019; Kellogg et al., 2021; Lifshitz-Assaf, 2018; Sandholtz et al., 2019), how they navigate technological change (Anthony, 2021; Barley, 1986; Beane, 2019; Nelson & Irwin, 2014; Pakarinen & Huising, 2025), how they communicate and collaborate across domains (Bechky, 2003; Bruns, 2013; DiBenigno, 2020; Kellogg, 2014; Lingo & O'Mahony, 2010; Treem & Barley, 2018), how they stretch their expertise across disparate occupations (Hénaut et al., 2023; O'Mahony & Bechky, 2006). In doing so, it has largely explored expertise in a decontextualized manner and rendered the experts they study – whether they be doctors, lawyers, nurses, lab technicians, or librarians – as a monolithic category of actors. Although this abstraction allows for a level of inference and generalizability to experts in other domains, the unintended consequence of this approach has been a flattening of the diversity of experiences of actors from across racial, gender, and economic backgrounds. It has obscured the unequal social processes that influence who is included in the empirical studies of experts and has been inattentive to whether and how expertise can be a mechanism in the reproduction of economic and social inequalities. In other words, the current approach to experts and expertise often centers whiteness and masculinity, reifies elitism, and erases marginalized actors in its studies.

To avoid continuing on this path, this review will show that it is crucial for scholars of expertise to incorporate the insights from the literature on inequality that, although not identifying “expertise” explicitly as their subject of inquiry, has repeatedly demonstrated that social and economic inequalities shape both the production and recognition of specialized and tacit knowledge. It calls for a more critical analysis of who appears in empirical studies on expertise, the structures that limit the pathways for individuals from marginalized and minoritized groups to acquire specialized knowledge, and the racist, xenophobic, sexist, and classist beliefs that make it less likely for them to be recognized for the specialized knowledge they possess. It also calls for a more a critical investigation into the implications for who experts are on a micro-, meso-, and macro-level social and economic outcomes. In sum, it calls on scholars of experts and expertise to adequately consider how expertise is both the product of social and economic inequalities as well as a crucial mechanism in the reproduction of those inequalities.

This review adopts a relational approach to expertise (Anteby et al., 2016; Anteby & Holm, 2021; Eyal, 2013, 2019; Pakarinen & Huising, 2025; Sandefur, 2015),¹ which argues that the common understanding of expertise is unthinkable outside of social, cultural, political, and economic processes that make experts and the need for expertise possible (Emirbayer, 1997; Zelizer, 2012). It accounts for the social structures and institutional arrangements that engender experts. But it also accounts the cultural beliefs that imbue those structures with meaning – shaping who is deemed worthy to gain expertise and informing the biases of

who is regarded as an expert. In other words, a relational approach forces the researcher to consider the social, material, spatial, organizational, and conceptual arrangements that serve as the preconditions for experts and expertise to emerge.

The review is structured in the following manner. First, I will demonstrate how social and economic inequalities shape the unequal pathways through which specialized and tacit knowledge is attained. Second, I will show how social and economic inequalities shape the recognition expertise of individuals from marginalized and minoritized groups. Third, I will argue that these unequal pathways and differences in recognition matter and show how expertise can be a crucial mechanism in the reproduction of inequality. Finally, I will conclude with some directions for future research that incorporates findings from the literature on inequality.

INEQUALITIES SHAPE THE PRODUCTION OF EXPERTISE

Scholars of expertise have argued that individuals acquire expertise through socialization and immersion into the practices of an expert group (Collins & Evans, 2009). Through these processes, individuals build specialized knowledge, become enculturated into the norms of an occupation, and attain degrees or credentials to become a professional. Yet, the extant literature on expertise has not sufficiently grappled with the fact that these socialization and immersion processes are fundamentally shaped by economic, racial, and gendered inequalities. It has largely ignored the question of how racist, xenophobic, sexist, and classist beliefs about who is “worthy” to be invested in differentially shapes the production of specialized knowledge. In this way, the existing literature on expertise has largely un-explored: “how economic, racial, and gendered inequalities shape who gets to become an expert?” The following will highlight the empirical work that has repeatedly shown that social and economic inequalities shape the unequal access to formal and informal educational opportunities, internships, and on-the-job tasks, through which specialized and tacit knowledge is attained.

Inequalities and formal education. Formal education is one of the fundamental ways that individuals develop specialized knowledge. To become the expert doctor, the lawyer, or the librarian that appear in empirical studies, individuals are often required to accumulate degrees or certifications, which are primarily achieved through formal educational processes. As such, formal education institutions – primary and secondary schools, colleges, training programs – function as crucial sites for individuals to accumulate specialized knowledge, become enculturated to the norms and customs of a given profession, and become credentialized. Empirical work has repeatedly shown that racial, gender, and economic inequalities structure the formal educational institutions and pathways in the United States, leaving marginalized and minoritized communities less likely to become “experts” through these formal channels.

Research has shown that racial inequalities make it significantly more difficult for Black and Hispanic students to build specialized knowledge through a series of inter-locking mechanisms. First, because of racism and segregation,

Black students are less likely than their white counterparts to either attend a well-resourced public school or have the resources to attend a well-resourced private school (Logan et al., 2012; Owens, 2012, 2018). These resource differences manifest in important differences in pedagogical opportunities – such as high teacher to student ratio, limited access to gifted and talented programs, after school programs, libraries, and textbooks (Bonilla-Silva, 2001, 2006; Feagin, 2013; Omi & Winant, 2014; Wingfield & Chavez, 2020). Second, beyond funding, research has also shown how teachers and school administrators treat students differently based on their race, which also impacts students' ability to generate specialized knowledge. On the one hand, Black and Hispanic students are less likely than their white peers to be identified for higher track curriculums (Cottom, 2017). On the other hand, Black and Hispanic students are more likely to face disciplinary actions in school (Owens, 2022) – including suspensions and expulsions (Mittleman, 2018). These disciplinary actions often trigger what scholars refer to as a “downward spiral” – or, the redirection of children's trajectories away from academic achievement and toward police contact, which can derail their educational trajectory and the accumulation of formalized expertise (Kirk & Sampson, 2013). Taken together, these differences in resources and treatment from school administrators significantly impact whether and how students of color develop formalized expert knowledge.

What's more, research has shown that educational institutions shape students' enculturation processes based on their race, class, and gender. Scholars have shown that, in addition to teaching core curriculum like math, science, and social studies, schools are crucial sites of the “hidden curriculum” – defined as curriculum related to behavioral norms and interactional skills (Calarco, 2014a, 2014b). As Golann (2015) found, however, teachers vary in their teaching of the hidden curriculum according to their students' class and racial backgrounds – often emphasizing rule compliance and rote behavior with low-income minoritized students, and emphasize expression, independence, and negotiation with students from more privileged classes. This difference in teaching often helps middle-class white students interact with authorities and navigate institutions with greater ease than their working-class counterparts, which furthers their educational advantages and their potential to build formalized expert knowledge (Calarco, 2011; Khan, 2011). Moreover, because of gendered stereotypes about the potential for the production of specialized knowledge (i.e., men are better at math) and assumptions about the appropriate occupations for men and women, educators often nudge women away from subjects in science, technology, engineering, and mathematics and toward subjects like education, psychology, and social work (Legewie & DiPrete, 2014a, 2014b; Mittleman, 2022). These educational decisions ultimately influence the types of “experts” that men and women become, which become highly consequential for employment opportunities, and shape the representation of women in a given field.

Outside of the classroom, research has also demonstrated how economic inequalities shape the pathways for the production of specialized knowledge. Scholars have demonstrated that affluent parents can deploy their economic resources to advantage their children in the generation of expertise. One prominent way that

they can do this is by hiring “care workers” – or, workers that provide help develop the human capabilities of the recipient (Anteby & Occhiuto, 2020; England et al., 2002) – for their children. For example, parents can hire tutors, who help students improve their grades by providing personalized instruction and one-on-one attention, identifying areas of weakness or gaps in knowledge, and tailoring lessons to the individual needs and learning style of the student. These tutors can often also help students develop skills in other enrichment areas – such as music and language classes, as well as sports and coding boot camps – which generate cultural capital that is positively rewarded in the interview process. Moreover, because of the importance of post-secondary education in the generation of expertise, affluent parents often hire care workers to assist their children in the college school admission processes. Identifying the emergence of an “admission industrial complex” (Liu, 2011), scholars have noted the increase in expensive standardized test prep classes and one-on-one tutoring, which offer students test-taking strategies, practice tests, and coaching on time management, stress reduction, and content mastery. In addition to tutors, scholars have also noted the growing number of “education agents,” which help students apply to colleges and universities (Chen, 2021). Tiffany Huang (2023), for example, showed how affluent parents are increasingly contracting independent educational consultants to guide their children through the complicated and often opaque college application process, which includes help with how to craft an identity – in the form of personal statements, short essays, letters of recommendation, and interviews – in the context of an increasingly “holistic review” in admissions. These admissions-related behaviors enable students to accrue the credentials and send high-status signals that colleges and universities seek, leading to greater college and graduate school outcomes for wealthier students.

Most of the literature on expertise has focused on the actions of those individuals who have already reached professional status – how they establish and maintain professional boundaries, how they navigate technological change, how they communicate and collaborate across domains, or how they stretch their expertise across occupations. It is crucial to recognize, however, that one’s professional status is the product of an educational journey, which is differentially structured by institutions that individuals traverse. In this section, I highlighted the important research has shown that individuals from marginalized and economically disadvantaged communities face significant structural disadvantages in the pursuit of formal education. These disadvantages shape their ability to acquire formalized expertise, become professionals, and perform expert labor. In other words, these inequalities shape the processes of expertise generation, impacting who can become an expert and act in their professional status.

Inequalities in informal education. Of course, not all expertise is generated through these formal education processes. Scholars of expertise have called our attention to the emergence of “amateur expertise” (Croideu & Kim, 2018) – or the ability of individuals to develop skills and capacities through either informal social relations or “do-it-yourself technologies.”² Yet, like formal education, empirical work has also demonstrated that the ability to generate this “amateur expertise” is also highly stratified by race, class, and gender.

First, in terms of informal social relations, scholars have shown that parents and guardians are often the primary mechanisms for the generation of “amateur expertise” (Coleman, 1988). Yet, because parents and guardians vary considerably in their human and temporal capital – often determined by their class – there is variation in their ability to produce amateur expertise to their children. For example, parents with specialized knowledge can help develop skills in children on subjects outside of the school settings. Moreover, salaried workers with regular work schedules can take planned time off of work (without fear of not getting paid) to take their children to enrichment activities that can cultivate interests and spark enthusiasm in their children in various hobbies, which can become the source of amateur expertise. Additionally, parents and guardians also often influence the types of specialized knowledge they develop. Scholars have shown that occupational pursuits (i.e., lawyers, doctors, professors) are often passed down through generations (Bui & Miller, 2017). One example is what has come to be colloquially called the “nepo baby” – or, the children of famous actors or musicians who become famous actors and musicians. And, while some this generational inheritance may be attributed to referral networks, research also suggests that one of the crucial mechanisms of professional development may also be the “hidden curriculum” passed down by parents about a given occupation – or, rather, fine grain information that parents can provide their children about those professional pursuits. This information and exposure to help children build tacit knowledge about what to expect from a profession, normative frameworks for behavior, and how to interact with other professionals in the field.

Second, with respect to utilizing “do-it-yourself” technologies, research also suggests that individuals from marginalized and economically disadvantaged backgrounds often face high opportunity costs in their pursuits of building “amateur expertise.” For example, a recent survey from the [Bureau of Labor Statistics \(2024\)](#) revealed that over 5% of Americans work multiple formal jobs in an attempt to “make ends meet.” This number increases for Black Americans (6%), generally, and even more for Black women, in particular (6.4%). We see clearly this trend with the rise of the gig economy, which has become a “side-hustle” social safety net for many Americans (Cameron, 2022; Ravenelle, 2023). What’s more, research has shown that workers in low-wage jobs rarely have control over their work schedules (Williams & Connell, 2010).³ This means that, for low-income individuals working multiple jobs with variable work schedules, it can be difficult to find consistent and predictable time to utilize the readily available technologies that produce “do-it-yourself” skill generation. Moreover, a recent survey reported that 73% of American workers reported having some type of responsibility to care for loved ones (Fuller & Raman, 2019), which can also impact the pursuit of “amateur expertise.” People often need care most when they are least able to pay for that care (England et al., 2002). As a result, those who are not in a financial position to hire care worker must take on what scholars refer to as the “second shift” – or, the unpaid household and childcare duties that follow the day’s paid work (Hoschild, 1989). Importantly, reflecting the burdens for those who sit at the intersection of economic and gender inequalities, scholars have shown that the burden of this form of labor is often taken on by women.

An [Oxfam International study \(2024\)](#) found that women and girls undertake more than three-quarters of this largely invisible and unpaid care work in the world – carrying out 12.5 billion hours of unpaid care work every day.⁴ Similar to working multiple formal jobs, this second shift of care work makes it difficult for individuals (and largely women) to find consistent and predictable time to generate amateur expertise.

As new technologies have become widely available to the layperson, the exclusive grip of professions has weakened, leading to the emergence and growing acceptance of non-professional or “amateur expertise.” Yet, research has repeatedly shown that individuals from marginalized and economically disadvantaged backgrounds face significant social and opportunity costs in pursuing this non-formal pathway to specialized knowledge. As a result, despite the growth of amateur expertise, research suggests that this emergent pathway to expertise generation is not available for all individuals.

Inequalities and the workplace. Beyond both formal and informal education pathways, workers have also been shown to generate expertise within the workplace. Through exposure and socialization to workplace practices, workers gain crucial organizational- and field-level contributory expertise – or, the ability to contribute to the organization or field in which the expertise pertains ([Collins & Evans, 2009](#)) – and build the tacit knowledge that is often required to excel in a profession.

One increasingly prevalent within-workplace site for exposure and socialization is the internship. Described as a “work-based learning” system, internships have become a common as part of the training of workers in nearly every sector of the U.S. economy – from tech and banking to politics and the creative industries ([Frenette, 2013](#); [Shade & Jacobson, 2015](#); [Siebert & Wilson, 2013](#)).⁵ Although internships are highly valued, a survey conducted by the National Association of Colleges and Employers found that paid internships are more likely to result job offers and higher starting salaries ([Collins, 2020](#)).⁶ That same survey found that racial/ethnic minorities, women, and first-generation students were all found to be underrepresented in paid internships. Thus, despite its crucial cite for socialization and enculturation, this pathway to expertise generation is not available for all students.⁷

Other prevalent within-workplace sites for the generation of expertise are day-to-day work tasks. Through task assignment, workers gain exposure to novel techniques, are trained in new skill building exercises, and have opportunities to become further enculturated to the norms and customs of an organization. Yet, research has shown how racial and gender inequalities also shape these socialization pathways. For example, scholars have shown that challenging assignments often disproportionately go to men, even though women expressed equal desire for them ([Ammerman & Groysberg, 2021](#)). Through these differences in task assignments, men are often disproportionally allowed to build crucial skills and capacities on the job (i.e., become experts within that organization). This difference in within-workplace expertise generation differentially advantages men – both in their ability to advance within the organization as well as signal expertise to other organizations.

What's more, the production of within-organizational expertise often relies on relationships within a place of work. Mentorship relationships have been shown to be particularly important for people navigating a new organization – as they are become crucial sources of social support and generating a sense of personal belonging within an organization (Podolny & Baron, 1997). Yet, the allocation of mentorship time and effort is also deeply raced and gendered. Rivera (2012), for example, describes how race, gender, class, and notions of “cultural fit” shape who gets to be a part of which conversation within organizations and the communication between workers outside of office hours – as women and people of color are less likely to be invited to social events with the highest-ranking people in their office.

In sum, while scholars of expertise have identified a series of pathways through which individuals acquire specialized knowledge – through formal educational institutions, informal skill development, and on-site enculturation processes – they have not yet sufficiently considered how racial, gender, and class-based inequalities shape opportunities and access to those pathways. Attention to how marginalized and minoritized communities face systematic disadvantage across the various pathways through which expertise is developed, helps us see who is able to gain employment, to have a higher starting salary, to get promoted, or to move across organizations. Crucially, for the purposes of this review, these unequal pathways also influence who appears in our studies. Without recognizing these representational differences and considering their implications what we observe in the field, there will be challenges for understating what inferences can be made from our research and the generalizability of our findings.

Still, we know that individuals from marginalized and economically disadvantaged communities regularly overcome these structural obstacles to acquire expert and tacit knowledge and develop skills and capacities to perform challenging tasks. In other words, we know that many individuals have the requisite specialized knowledge to make a claim to being an expert. The next section will show how the skills and abilities of non-white, non-cisgendered, non-male, non-heterosexual individuals are often discounted or go unrecognized, further compounding their disadvantage in being an “expert.”

INEQUALITIES SHAPE THE RECOGNITION OF EXPERTISE

Scholars adopting a relational approach to expertise have shown that having skills and capacities to perform a task is necessary but not sufficient to be an “expert.” To be an “expert” also requires that those skills and capacities be recognized by others. For example, Anteby and Holm (2021) argue that expertise requires particular audiences to recognize their specialized knowledge. Similarly, Pakarinen and Huising (2025) argue that expertise is generated applied and recognized within interactions. And, Croidieu and Kim (2018) argue that for expertise to be perceived as legitimate, other actors in the field must recognize them as authorities. In short, relational scholars have argued that to be an expert is to have an audience recognize you as an expert.⁸

Yet, the literature on expertise has not adequately grappled with the vast research that has documented that, because of racism, sexism, xenophobia, and anti-LGBTQI+ sentiment, the skills and abilities of non-white, non-cisgendered, non-male, non-heterosexual individuals are often discounted by audiences such as employers, venture capitalists, and society at large. In this way, extant literature has largely ignored the question: “how do economic, racial, and gendered inequalities shape who is recognized as an expert?” This section will highlight how these inequalities shape the recognition expertise in the job application and interview processes, on-job recognition and venture funding, as well as the recognition of expertise in professions more broadly.

Inequalities and formal job applications. The resume is a critical site where individuals make claims regarding their expertise – that is, they signal that they have specialized knowledge to perform a task as either an employee or an independent contractor. This claim is then either accepted or rejected by an audience – in this case, a potential employer – which is revealed in the form of a call-back, job interview, or job offer.

Research has repeatedly shown that individuals with identical resumes (i.e., identical claims to expertise) get different responses from employers based on their race, gender, class, and sexual orientation. For example, in her groundbreaking work, Devah Pager (2003) found that when identical resumes were sent to Milwaukee employers, the resumes of white men received more call backs from employers than their Black counterparts – even if the white man had a criminal history. A subsequent series of audit studies have reinforced these findings, repeatedly showing that the race of applicants matters for how their credentials are perceived by employers (Bertrand & Mullainathan, 2004; Gaddis, 2015; Mobasseri, 2019). To further illustrate this point, research has shown that, when applicants “whiten” their resumes – or rather, conceal, or downplay racial cues on a job application to avoid discrimination and increase the chance of getting a callback for an interview – they do receive greater callbacks rates (Kang et al., 2016). And, in addition to race, scholars utilizing an audit study design have also demonstrated that the gender (Botelho & Abraham, 2017; Lucas et al., 2021), sexual orientation (Pedulla, 2014; Tilcsik, 2011), and social class (Rivera & Tilcsik, 2016) all shape whether and how employers recognize the expertise of applicants.

Recent empirical work also highlighted how the job application process has become increasingly algorithmic, which make the audience for claims to expertise machine-learning algorithms. Optimistic commentators have speculated whether and how these machine learning technologies could assist human resource departments in eliminating these biases in recognition of expertise. However, as scholars like Peter Capelli (2019) have noted, hiring algorithms are backward looking, necessarily basing their candidate recommendations on data from the past. And, because the people who have been hired and promoted in the past are largely white, cis-gendered, heterosexual males (for all of the reasons discussed in this review), the algorithm often suggests candidates that reproduce those inequalities. More perniciously, without a recognition of how inequalities permeate the production and recognition of specialized knowledge, the AI-recommended candidates can often appear as more “objective” choices, devoid of bias, and determined on the basis of “merit” alone.

Scholars of expertise have argued that being an expert requires the recognition from others of that expertise. Yet, I showed how identical claims to expertise are evaluated differentially by audiences based on the race, class, gender, and sexual orientation of those who make the claim to expertise. That is, despite similar signals of expert knowledge, those from marginalized or minoritized communities are often significantly less likely to have their expertise recognized by audiences, which has significant impacts for who gets to be recognized as an expert and appear in empirical case studies.

Inequalities and informal job referrals. Of course, not all claims to expertise are made formally. Scholars have shown that, in addition to the more formalized claims to expertise that individuals make on a resume, the job application process also contains informal claims to expertise (Lucas et al., 2021). Employers often receive claims for a given candidates' expertise through referrals from their social networks (i.e., informal recommendations from alters such as former colleagues, classmates, co-workers, and family). And, research has shown that candidates who receive these informal claims to expertise are often given more attention and received more positively by employers than those that come through the formal application channels.

However, we know that racial and gender inequalities inform whether and how those informal claims to expertise are made. With respect to racial inequalities, Sandra Smith (2005) demonstrated that low-income Black Americans are often less likely to receive job referrals than their white counterparts. Pushing back against claims that Black Americans suffer from low social capital, Smith shows that structures of racism and oppression lead to concerns over the potential for stigma by association for poor performing candidates. As such, the potential referrers withhold their referrals, as they may be jeopardizing their own reputations in the eyes of employers thus, negatively affecting their already-tenuous labor market prospects. With respect to gender inequalities, Lucas and co-authors (2021) have shown that male candidates are more likely to get referrals than candidates who are women. The authors argue that because of a prevalence of men in many jobs, male candidates tend to "fit" the mental representation of who belongs in a given job and are more likely to be recommended for the role compared to women. Taken together, similar to the formal job application, research suggests that racial and gender inequalities in the informal referral market also differentially inform the perception of job candidates' expertise.

Inequalities and job interviews. The job interview is another critical site where individual makes a claim to their expertise, which is then accepted or rejected by potential employers (in the form of a second interview or job offer). Here, too, scholars have demonstrated that economic, racial, and gender inequalities shape whose expertise is recognized. For example, a series of studies have shown that the expertise of women was under-recognized in the interview process. In their study of orchestras, Goldin and Rouse (2000) documented that the expert performances of women candidates were discounted in auditions.⁹ More recently, Rivera and Tilcsik (2016) argued that, the expertise of women is often discounted because of the negative stereotype that portrays them as less committed to full-time and intensive careers than men. Beyond gender, in

her ethnography, [Rivera \(2012\)](#) found that elite recruiters were more likely to recognize the expertise of interviewees if they shared affluent economic and cultural backgrounds (i.e., extracurricular/leisure pursuits, experiences, and self-presentation styles). In this way, research has shown that, despite similar claims to expertise, the claims of women and those from disadvantaged backgrounds are less likely to have their claims recognized by an audience.

Inequalities and job evaluations. Day-to-day work tasks are routine sites where workers make claims to their expertise. Through the constant mundane performances of applying their knowledge to work tasks, workers demonstrate their specialized knowledge and expert capacities ([Anteby & Holm, 2021](#); [Huising, 2015](#)). Racial and gender inequalities have been shown to impact how employers evaluate employees who make similar displays of competence.

Take performance evaluations, for example, which have become ubiquitous in contemporary organizations ([Castilla, 2008](#)). Research has shown performance evaluations often reflect significant bias against individuals from marginalized and minoritized groups ([Correll et al., 2020](#); [Rivera & Tilcsik, 2019](#)). For example, [Elvira and Town \(2001\)](#) found that Black employees often receive lower job performance ratings than their white counterparts for similar work. And, numerous studies have revealed that women often receive significantly lower performance ratings than men, even when their behaviors or skill levels are identical. Managers have been shown to discount women's skills, giving them less credit for their performance ([Castilla, 2008](#)). To compound this, women are significantly less likely to be described as likable, able, exceptional performers, geniuses, "stars," or "superstars" even when their qualifications, performance, and behaviors are identical ([Bian et al., 2017](#); [Leslie et al., 2015](#); [Ridgeway, 2011](#)).¹⁰ In their work, [Ammerman and Groysberg \(2021\)](#) also demonstrated that there is a gender-based double standard in assessing the time it takes for a worker to make a decision. For example, should a woman take time to ponder a problem, she may be seen as having "analysis paralysis," whereas a man is often deemed thoughtful and thorough for similar behavior.

Beyond performance evaluations, research also suggests evaluations of workers in the same position are also informed by racial and ethnic inequalities. For example, in her recent work on racialized expertise, [Portocarrero \(2023\)](#) found that the attribution of a worker's expertise in diversity, equity, and inclusion (DEI) was informed by a worker's ethnoracial background. She finds that while minority workers' expertise is recognized as racialized, white workers DEI expertise is recognized as administrative, which leads to a difference in task allocation (i.e., whether the worker was assigned peripheral or core tasks in the workplace), and the job content of DEI workers.

These differences in evaluations also inform the behaviors of marginalized workers in the workplace, which also impact how employers interpret the expertise of workers. For example, gendered evaluations of expertise lead to a series of "binds" for women workers, which have negative impacts on their performance. In her work, [Feldberg \(2022\)](#) found that women managers often attempt to disprove negative stereotypes of gendered expertise by performing more tasks in front of subordinates (i.e., supervisory tasks "on the floor" of the store), forgoing

attention to other tasks that are less public but no less important to being effective managers (i.e., planning tasks in the office of the store). This “task bind” ultimately undermines the profitability of women managers’ departments, which can impact the perceptions of expertise. Other work suggests that women also suffer from a “double bind,” whereby if they demonstrate confidence in their skills and abilities (i.e., authoritativeness, decisiveness, and directness), they are characterized as difficult to work with or temperamental, but, if when they act in accordance with traditional gender norms, exhibiting warmth and a communal orientation, they’re often seen as less skilled or capable than their male counterparts (Ammerman & Groysberg, 2021).

Inequalities in entrepreneurial funding. Of course, claims to expertise are not just made by would-be employees. They are also made by would-be employers, in the form of entrepreneurs. Like the job application process, research has demonstrated that entrepreneurs make claims to their expertise throughout the venture funding process – through pitch competitions and emails, and in the board-rooms of a venture funds. Through this process, entrepreneurs make claims to would-be investors that they have the unique skills and abilities to exploit market opportunities, generate growth, and maximize returns.

Research has documented an underrepresentation of minoritized and marginalized founders among the population of funded ventures. For example, scholars have noted that there is a significant gender “funding gap” (Kanze et al., 2018). That is, despite the fact nearly 40 percent of all privately held companies in the United States are founded by women, only 2 percent of U.S. venture capital financing is allocated to women founders. Moreover, scholars have also documented a significant racial funding gap (Younkin & Kuppaswamy, 2018). Across these studies, the common finding is that, despite similar claims to entrepreneurial expertise, minoritized and marginalized founders face a relational discounting of their expertise by largely white-male venture capitalists – with investors assuming that women and Black founders are disproportionately likely to fail, to grow slowly, or to be undervalued by potential acquirers (Balachandra et al., 2013; Brooks et al., 2014; Kanze et al., 2018).

Given that financial resources are a crucial factor for both the success and growth prospects of new ventures, this difference in the recognition of entrepreneurial expertise (and subsequent funding) has a significant impact on the viability of ventures with minoritized and marginalized founders. As I will address in greater detail below, this difference has been shown to have downstream impacts on the representation of upper echelons of organizations as well as internal organizational processes (i.e., hiring, evaluation, and promotion).

Inequalities and occupational status. Shifting levels of analysis, in addition to structuring the recognition of expertise of individuals from marginalized groups, scholars have shown how inequalities also shape whether and how the expertise of occupations is recognized. Empirical work has shown that different types of expertise are evaluated differently by audience, which reflects existing inequalities. For example, the expertise contained within occupations that are coded as “female” have been shown to be devalued in the contemporary economy. The prevailing account that explains this phenomenon is devaluation theory, or the

widespread cultural belief that women's work is inherently less valuable (England, 1992). One way to observe this devaluation is through discrepancy in wages across occupations. Professions that are predominately occupied by women are often paid less than professions predominately occupied by men (Magnusson, 2009; Weeden, 2002). And, repeated studies have identified occupational segregation – or, the concentration of men and women in different occupations – as a major source of the gender pay gap (Budig, 2002; Kilbourne et al., 1994; Mandel & Semyonov, 2014). Another way to observe this differential evaluation of expertise is in the status or prestige afforded different occupations. Occupations with larger shares of women often occupy lower occupational prestige (García-Mainar et al., 2018; Valentino, 2020). Moreover, when occupations experience a larger inflow of women workers – meaning that they feminize – this translating into a lower status (Busch, 2018).

Most of the literature on expertise has generally assumed that experts are treated equally by audiences. That is, by referring to different professions as “experts” – that is, librarians, lawyers, SWAT team members – scholars have largely ignored an occupational hierarchy. A relational approach to expertise allows for us to see that skills and capacities cannot be flattened under the categorical umbrella of “expert.” This approach forces us to recognize that there are differences in the recognition of expertise contained within occupations – with some being recognized as containing more or less expertise.

In sum, while scholars of expertise have argued that being an “expert” requires an audience recognize you as an expert – through processes such as job applications, interview processes, and job evaluations – they have not sufficiently considered how racial, gender, and class-based inequalities make it such that the expertise of marginalized and economically disadvantaged individuals often go unrecognized or is discounted. Drawing on literature on inequality, I have shown how marginalized and minoritized communities face systematic disadvantage in recognition of expertise throughout the occupational life cycle – from job application and interview through job evaluations – which impacts their ability to gain employment, have a higher starting salary, get promoted, and move across organizations. Moreover, it has documented both that the entrepreneurial expertise of marginalized and minoritized communities is often discounted, and that the perception of expertise contained within occupations – impacting the success of start-ups from marginalized communities, and the status of professions.

The next section will show how these differences in the production and recognition of expertise generate unequal distribution of “experts” in organizations, which functions as a crucial mechanism for the re-production of inequality at an individual-, organizational-, and societal-level.

EXPERTISE AND REPRODUCTION OF INEQUALITY

Scholars of expertise have argued that organizations regularly hire experts to help them solve pressing problems. As such, experts often occupy privileged positions within organizations and are trusted to make decisions within and

on-the-behalf-of organizations. Yet, the literature on expertise has not adequately grappled with the implications of who those organizations differentially hire, who differentially occupies those privileged positions, and who is trusted to make decisions on behalf of organizations for the reproduction of inequality. In this way, extant literature has largely ignored the question: “how and why does it matter who experts are?” In this section, I will examine the consequences of these unequal processes and highlight how expertise can be a crucial mechanism in the reproduction of inequality.

Expertise as a mechanism for the reproduction of inequality. The inequalities that shape the production and recognition of expertise also shape who is hired by organizations to solve pressing problems, who comes to occupy privileged positions, and who is trusted to make decisions within and on-the-behalf-of organizations. In other words, these inequalities shape the unequal distribution of individuals in the upper echelons of organizations.

Because of systemic racial, gender, and economic inequality, those who sit atop organizations as “experts” (i.e., those who have been differentially given the opportunities to build expert knowledge and have that knowledge recognized throughout the career path) are largely white men. As such, the upper echelons of organizations are often non-representative of the communities they work in, with, and for, which have important implications for the reproduction of inequality.

The significant disparity in the gender and racial composition in the upper echelons of organizations is easy to observe. For example, of the firms in the S&P 500, women occupy a mere 8.2% of the CEO positions (He & Whited, 2023). Beyond CEO, women hold just 11.8% of the roughly 15,000 C-suite roles (Chiang et al., 2024).¹¹ Other research has similarly documented that men are 2.5 times more likely than women to be executives in the top leadership teams (Lieberman, 2023). Moreover, Black CEOs make up just 1.6% of all Fortune 500 CEOs. And, highlighting the need to take an intersectional approach to exploring glass ceilings, a report documented that there was only 1 Black female CEO in the whole of the Fortune 500 (Harper, 2023).

The disparity in “experts” in upper echelons also extends to political offices in the United States. A recent report from Pew showed that Congress remains less diverse than the nation as a whole (Schaeffer, 2023).¹² Moreover, the share of women in Congress remains far below their share in the country as a whole (28% vs 51%).¹³ And, these disparities can be observed beyond just lawmakers. A Joint Center for Political and Economic Studies report on racial diversity of staff in the U.S. House of Representatives showed that although people of color account for 40 percent of the U.S. population, but only 18 percent of all top House staff (Brenson, 2022).¹⁴

But, what do these disparities in the composition of our “experts” in organizations mean for the reproduction of inequality? In what follows, I will show that who is relationally decided to be worthy to be trained or recognized, contracted with or employed, promoted or valorized as “experts” matter for the how inequality is reproduced at an individual-, organizational-, and societal-level.

Expertise and the reproduction of inequality at an individual level. At an individual-level, experts – those who are hired, and promoted up corporate ladders –

are often higher paid than their non-expert counterparts and can transform those economic advantages into pathways for the further production and recognition of specialized knowledge. As I mentioned above, economically advantaged individuals are better situated to hire care workers (daycare for children, in-home nurse practitioners for sick loved ones), which allows them to compound their own personal labor market advantages and generate the inter-generational reproduction of expert inequality.

Expertise and the reproduction of inequality at an organizational level. At an organizational level, experts in the upper echelons of organizations have been shown to shape organizational culture, which help re-produce racial, gender, and economic inequalities.¹⁵ This happens through a series of inter-locking mechanisms.

In terms of the production of expertise, experts in primary and secondary schools are the principals, super-intendents, and school boards that structure the unequal educational institutions and pathways that I identified above. These experts differentially allocate resources, differentially identify students for higher track curriculums or teach the hidden curriculum, suspend, expel, or call the cops on students, and nudge young women to take on non-stem courses. Non-diverse experts within organizations are more likely to assign challenging work tasks to men rather than women, further disadvantaging them in the production of specialized knowledge.

In terms of the recognition of expertise, individuals in upper echelons make hiring decisions, differentially give performance evaluations, make decisions about task assignment that allow for workers to generate and perform expertise. As I outlined above, organizations with non-diverse upper echelons are less likely to call-back, hire, promote, or contract with minoritized and marginalized communities due to a failure to recognize their claims to expertise. These experts are also the ones who are less likely to offer paid internships to students from disadvantaged backgrounds. They are also less likely to invest or re-invest in DEI initiatives and are more likely to decouple those initiatives from practices that would lead their intended goal.

Third, non-diverse management teams are also more likely to create hostile working environments for marginalized individuals working within the organization, which also shapes both the production and recognition of expertise within organizations. For example, scholars have shown that sexual harassment flourishes in organizations where men dominate in management and women have little power (Dobbin & Kalev, 2017). Male-dominated management teams have been found to tolerate, sanction, or even expect sexualized treatment of women employees, which can lead to a culture of complicity. We saw the prevalence of this complicity most famously with the emergence of the #MeToo movement, and the narratives from women depicting decades of sexual harassment and abuse that expert heads of organizations participated in or overlooked. Hostile work environments impact the production of expertise through the assignment of work tasks, and inform the behaviors of women workers, which impacts how employers interpret their expertise.

Fourth, experts in upper echelons of organizations also impact how their organizations treat external stakeholders. For example, an abundance of research

has shown how racism in the upper echelons of police departments produced an era of mass incarceration that derailed the production of specialized expertise in generations in communities of color throughout the United States (Kohler-Hausmann, 2013; Western & Muller, 2013; Western & Wildeman, 2009). More recently, scholars have noted the problematic rise of predictive policing algorithms and facial recognition technology, leading scholars and activists to warn that these technologies will likely lead to more racial profiling and more false arrests (Buolamwini & Gebru, 2018; Crockford, 2020).¹⁶

Finally, the unequal representation in the make-up of “experts” in the upper echelons of organizations informs the perception of what “good” or “qualified” candidates look like. These unequal labor market outcomes – for example, experts that are overwhelmingly white, male, cis-gendered, economically advantaged – help produce and reinforce racial and gender biases in candidate assessments, and help further over learned stereotypes that then lead to the reproduction of those inequalities. I outlined some of the implications for this representational difference above – with respect to algorithmic recognition of expertise and informal referrals.

Expertise and the reproduction of inequality at a societal level. At a societal level, the non-diverse body of experts that populate fields such as politics, journalism, media shape the structures that generate disadvantages in the production and recognition of expertise. Take politics, for example. The non-diverse experts that make up the upper echelons of the political arena in the United States – elected officials, regulators, lobbyists, staffers, political strategists – routinely make political and legislative decisions that directly impact the potential for individuals to build and be recognized for their expertise (Gowayed, 2022).

On the production side, empirical work has shown that the decisions of “expert” policy makers structure many of the unequal formal educational pathways outlined above – that is, state allocation of school resources, access to early childhood education, school lunches, student–teacher ratio, teacher salary, free community college, pell grant allotment, etc. Moreover, these expert policy makers routinely make decisions that fundamentally structure the economic lives of middle- and working-class individuals, impacting their or their children’s ability to generate expertise. Policies regarding issues such as universal basic income, universal healthcare, unemployment insurance, welfare policy, mental health facilities, arcane drug laws, and anti-homeless initiatives all impact (financially and temporally) middle- and working-class individuals’ ability to credentialize themselves through formal education or build “amateur” expertise.¹⁷ They also make legislative decisions that impact immigration status of individuals, which can impact their ability to go to school, access financial aid, grants, or scholarships, or work in the formal economy.

On the recognition side, experts in the political arena also make crucial decisions with respect to the differential recognition of expertise. One crucial example of such policies is race-based affirmative action in hiring and school admissions. Designed to overcome discrimination in the evaluation of candidates, scholars have argued that race-based affirmative action is one mechanism through which racial and ethnic diversity can come to be perceived as positive and important for organizations (Warikoo & De Novais, 2015).

Beyond politics, experts in media organizations also crucially shape how individuals are represented, which inform the whether and how individuals from marginalized and minoritized groups are recognized as experts. Indeed, scholars have argued that biases – over-learned mental associations about groups (such as African Americans) with concepts and stereotypes like inferiority or danger – are often generated through media consumption (Onyeador et al., 2021).

One crucial cite where media experts shape biases and stereotypes is in the field of journalism. Scholars have long cited the issue of diversity and inclusion in the profession of journalism and have questioned how marginalized and minorities communities are represented in the media (Jackson, 2020). A recent example was the disparate journalistic depictions of refugees from Syria and Ukraine. Research documented that newspapers were more likely to humanize Ukrainian refugees than Syrian refugees and to frame Syrian refugees as threats and aggressors (el-Nawawy & Elmasry, 2024). The narratives and framings that emerge from these experts help shape popular opinion on matters from immigration and education to policing and healthcare, which ultimately inform the types of public policy enacted on these issues.

Another crucial cite where experts in media shape biases and stereotypes are in the fields of film and TV. A series of studies from USC Media, Diversity, & Social Change Initiative have highlighted how the largely while male experts in film (directors, and executive producers) often center the voices and lived experiences of cis-gendered, white, men in film (Smith et al., 2016). For example, they show that, only 16% the top-grossing movies of 2022 featured Black characters in proportional representation. They also show similar failings with respect to Hispanic, Asian, Native Hawaiian/Pacific Islanders communities. With respect to gender, one famous measure of unequal representation is the Bechdel Test – a measure of whether a movie features at least two female characters who have a conversation about something other than a man. A study examining 1,794 movies released from 1970 to 2013 revealed that only half would pass the Bechdel Test (Hickey et al., 2017). This discrepancy in representation was also revealed in the wake of the #OscarSoWhite movement of 2015, which was a movement that responded to academy awarding all 20 acting nominations to white actors for two consecutive years (Ugwu, 2020).¹⁸ Importantly, these difference in depiction – proportional representation on screen, the types of roles that marginalized actors are given, the number and types of speaking roles assigned – all help to inform social-level biases and reinforce existing stereotypes, which impacts the recognition of expertise, outlined above.

In sum, while scholars have argued that experts assist organizations solve pressing problems, they have not sufficiently considered how the decisions made by those experts can be a crucial mechanism in the reproduction of inequality. Drawing on literature on inequality, this section highlighted how who is relationally determined to be worthy to be trained or recognized, contracted with or employed, promoted or valorized as “experts” in those decision-making processes matter for the how inequality is reproduced at an individual-, organizational-, and societal level. By demonstrating the unequal outcomes of expert decision makers, section highlights the need to critically analyze the implications of our

research beyond the organizations we study and the professionals that we attempt to generalize to. Instead, it suggests the need to consider how the experts we study sit at critical positions for decision making that shape who is recognized as an expert and reproduce existing social and economic inequalities.

FUTURE DIRECTIONS FOR RESEARCH ON EXPERTISE

So, what does this all mean for the study of expertise? In their classic work on research design, [King et al. \(1994\)](#) argue that all research projects should pose a question that is “important” in the real world in addition to making a contribution to a scholarly literature. What the previous three sections highlighted was that critically examining how social inequalities shape the production and recognition of expertise satisfy both criteria.

Racial, gender, and economic inequalities matter. The goal of this review is to raise awareness to the fact that extant studies of expertise often center whiteness and maleness by default, reifies elitism, and erases marginalized actors. It seeks to nudge the scholarly community on experts and expertise into deliberative cognition in their research design and analysis and incorporate the realities of these inequalities in their research. It calls on researchers to move toward turning our empirical research into actionable insights to frame and tackle these inequalities.

Crucially, this means that variables like race, class, and gender cannot and should not be treated as merely “additives” to studies of experts and expertise ([Reyes, 2022](#)). Drawing on a relational approach to expertise, I argue that a more complete study of expertise requires a critical examination of the social, cultural, political, and economic processes that make experts and the need for expertise possible. Studying experts and expertise in this way means accounting for the social structures and institutional arrangements that differentially engender experts, and the inequalities that imbue those structures with meaning – shaping who deemed worthy to gain expertise and informing the biases of who is regarded as an expert. Moreover, it requires a critical examination of the implications that experts have for the reproduction of those inequalities. This means that scholars of expertise must actively read outside what is traditionally seen as the field of expertise and engage with the vast scholarship that demonstrates how racial, gender, and economic inequalities shape both who gets to be an expert as well as whose specialized knowledge is listened to and whose skills are recognized.

CONCLUSION

The literature on expertise has exploded over the last 20 years. While most of the literature has focused on the performances of experts – how and why they establish and maintain boundaries around their skills and capacities, how they navigate technological change, how they communicate and collaborate across domains, the various levels and types of expertise – this review highlighted how social and economic inequalities shape the relational processes

of expertise (i.e., the production and recognition of expertise). Given recent events – growing income inequality, a climate crisis, a global pandemic, and mainstream attention on #BlackLivesMatter and racial injustice – scholars are increasingly centering race, class, gender, disability, and empire in their research (Reyes, 2022). It is time that scholars of expertise do the same.

NOTES

1. As Pakarinen and Huising (2025) outline, relational approaches are most clearly understood in general terms when contrasted with substantialist approaches, which see the social world as composed of stable and preformed entities that act either independently through “self-action” or through “inter-action” with other fixed entities to create effects. A relational approach, by contrast, argues that entities cannot be identified or have meaning except through their relationship to the action and other interactants they connect with.

2. Because this review is concerned with the specialized knowledge that generates labor-market returns, the status much of the amateur is outside of its purview. This can include what has been termed the “skills of the unskilled” – interpersonal, technical, and work experiences that are often held by minoritized people and immigrants that are discounted as low-status or irrelevant (Hagan et al., 2015). A key skill for instance, like how to navigate an informal market, or the acquisition of an informal apprenticeship can be hard to translate into formal recognition.

3. In fact, several studies have shown that in many low-wage jobs, the days and times of an employee's work schedule are posted each week, which may vary from week to week, and for which an employee has little input (Williams, 2006).

4. For reference, when valued at minimum wage, that same report finds that this care work would represent a contribution to the global economy of at least \$10.8 trillion a year – or, more than three times the size of the global tech industry.

5. More than 50% of employees at tech companies like Apple, IBM, Google, and Facebook had internship experience prior to employment, over 80% for accounting firms, and approaches 90% for Congressional staffers (Ravishankar, 2021).

6. This survey revealed that while students with unpaid internships are slightly more likely to receive a job offer than those who did not have an internship, those with unpaid internships actually have a lower median starting salary.

7. This difference in outcomes has led scholars to call for abolishing unpaid internships – to narrow class and racial divides (Jones, 2020). It has also prompted the emergence of advocacy organizations, such as Pay Your Interns, which work to ensure all students have equitable access to professional career paths through the implementation of paid internships throughout the United States.

8. Of course, in a sense, the accumulation of any specialized and tacit knowledge is a function of relational recognition, as I outlined in the previous section. That is, to build specialized and tacit knowledge requires an audience to recognize you as who is worthy of being invested in – economically, temporally, and socially.

9. They found that introducing blind auditions marked it 50% more likely that a woman advanced to the final audition. They argue that introducing the blind audition led to a surge in the number of women being offered positions in orchestras.

10. Recent findings suggest a pathway to address this bias. In his study, Castilla (2015) found that increasing accountability and transparency into a company's performance-reward system can have beneficial outcomes for marginalized workers. He found that before accountability and transparency procedures were introduced, there was an observed gap in the distribution of performance-based rewards – whereby women, ethnic minorities, and non-U.S.-born employees received lower monetary rewards compared with U.S.-born white – and the adoption of accountability and transparency procedures reduced that pay gap.

11. This number was down from down from 12.2% the year before.

12. Non-Hispanic White Americans account for 75% of voting members in the new Congress, which is considerably more than their 59% share of the U.S. population.

13. These findings are consistent in State Houses across the United States. The Center for American Women in Politics found that women represent 32.9% of seats in State Legislatures.

14. The study found that Congressional Black Caucus members are responsible for 80 percent (four of the five) of Black staff directors hired to full committees in the U.S. House.

15. In advancing the problematic “business case” for diversity, data also suggests there is a positive financial impact to building diverse and inclusive organizations. Recent studies have highlighted the increased likelihood for above average financial performance of more diverse organizations by race and gender (Ely & Thomas, 2020)

16. The bias in facial recognition software has also been shown to impact workers. For example, Uber drivers have filed lawsuits in the UK, alleging that they were illegally deactivated due to a mismatched facial recognition (Booth, 2021). And Uber drivers in India have similarly accused Uber’s facial recognition software of costing them work (Bansal, 2022). This inability to work, or inconsistency in work schedule, limits the economic potential of drivers, which has downstream impacts on the production of both formal and informal expertise, as well as the potential for intergenerational production of specialized knowledge.

17. Most government unemployment benefits focus almost exclusively on workers’ pauses from the labor market. As a result, they often crucially neglect to support workers as they pivot or shift industries (Gowayed, 2022).

18. A report released by the LA times revealed that the “expert” voting body to the Academy awards was 94% Caucasian, 77% male and had a median age for 62 (Horn et al., 2012).

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EXPERT AUTHORITY AND THE PUBLIC SPHERE: MEDIA INTERMEDIARIES, PROFESSIONAL NORM VIOLATION, AND THE MARKET FOR EXPERTISE

Noah A. Benjamin-Pollak and Arvind Karunakaran

Stanford University, USA

ABSTRACT

We examine the social processes that shape the market for expertise in the public sphere. Specifically, we develop a model of expert amplification to examine the role of professional norms and media intermediaries in skewing the selection and representation of experts to the public. Our model of expert amplification unpacks three interrelated processes: anticipatory selecting-out, a process where experts opt out of public discourse due to the anticipated penalties for professional norm violation; selective promotion, a process where supply-side intermediaries such as press officers, talent agents, public relations, and other communications specialists act to market a subset of experts to the media; and preferential selection, a process where demand-side intermediaries (e.g., media organizations) decide which subset of experts should be invited to their platform to discuss topics that are of interest and relevance to the public. Together,

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we examine how these processes amplify a certain demographic subset of experts over others in a cumulative manner and what the consequences are for the selection and representation of experts to the public and to the legitimacy of expert authority, more generally.

Keywords: Expertise; expert authority; professional norm violation; intermediaries; media organizations; expertise dissemination

The process by which expertise is disseminated beyond the professions that produce it is becoming an important area of focus in the social sciences (Ekström, 2016; Eyal, 2019). This process, which we call the market for expertise in the public sphere, is complex, with multiple heterogeneous categories of participants (Eyal, 2019; Heimstädt et al., 2023; McLuhan, 2017; Postman, 2005; Preda, 2023). Gaining a better understanding of the practices and behaviors of under-explored participants in this market for expertise – such as the intermediaries who repack-age expertise for public consumption and other actors, such as publicists, who help experts¹ get their work before a broader audience – will help improve our understanding of expertise and expert authority in the public sphere (Childress, 2017; Menon, 2017; Zavyalova et al., 2017).

Toward that end, this paper combines insights from the sociology of professions and organizational sociology to understand the impact of the actions of third parties (i.e., neither experts nor the public) on the functioning of the market for expertise (Eyal, 2022). We argue that the processes through which the market for expertise for public consumption is assembled shape the type of experts selected and represented in the public sphere. Specifically, we examine the processes that shape the supply of and demand for expertise in the public sphere and elaborate on how such processes lead to a demographically skewed market for expertise. Together, we refer to these processes as *expert amplification*.

In particular, our model focuses on the role that media intermediaries, in conjunction with the anticipatory avoidance of professional norm violations by experts, play in contributing to the processes of expert amplification (Abbott, 1981, 1988; Childress, 2017; Spencer, 1970; Weber et al., 2004; Zuckerman, 2017).² Expert amplification is constituted by three interrelated processes that significantly impact the functioning and demographic makeup of the market for expertise in the public sphere: *anticipatory selecting-out*, a process where experts opt out of public discourse due to the anticipated penalties for professional norm violation; *selective promotion*, a process by which supply-side intermediaries such as talent agents, press officers, public relations functionaries, and other communications professionals act to market a subset of experts to the media; and *preferential selection*, a process where demand-side intermediaries such as media organizations decide which subset of experts should be featured on their platforms to discuss topics that are of interest to the public. These intermediaries have more influence on the public discourse than was previously considered and

have a role similar to that of cultural gatekeepers in creative industries (Childress, 2017; Godart et al., 2023). In particular, due to their ability to pick between a broad pool of experts and to significantly constrain the behavior of these experts, understanding how intermediaries make decisions is vital to understanding the operation of the market for expertise and discerning their impact on the selection and representation of experts to the public.

This article focuses on supply- and demand-side intermediaries' roles in the expert amplification process. These intermediaries have their own goals and incentives that push them to want to work with some experts but not others. The experts these intermediaries find appealing are more likely to become part of the public discourse. However, experts are not equally appealing to intermediaries (Macharia, 2020). The goals and incentives of intermediaries significantly skew the sex, race, and age distribution of amplified experts.

Additionally, research shows that third-party evaluations of experts can impact perceptions of them and their behaviors (Botelho & Gertsberg, 2022). Studies have also shown that intermediaries can influence "in-house" experts, causing them to drift from a more professional to a more public-friendly style of communication (Ekström, 2016). Additionally, some experts are changing their focus from the professional realm to the public discourse, intending to significantly engage with the public and impact issues they care about. These ideas suggest that rather than being confined to influencing the public discourse by impacting the makeup of the subset of amplified experts, the effects of expert amplification can reverberate both downstream and upstream, changing how experts talk about their work and potentially shaping the structure and direction of their research (Demortain, 2023; Ekström, 2016; Magee & Galinsky, 2008; Menon, 2017; Zavyalova et al., 2012, 2017).

Notably, these skews in the demographic makeup of public experts are seen in many different places (Macharia, 2020). In the United Kingdom, four male experts appeared on flagship television and radio programs for every female expert (Howell & Singer, 2017). In Canada, both women and racialized minorities are underrepresented as expert sources on public affairs television, and racialized minority women are even more underrepresented (Cukier et al., 2019). Around the world, the severe underrepresentation of female experts in media barely changed between 1995 and 2015 (Macharia, 2020). Put simply, as the most agentic participants in a transaction that significantly influences the public discourse on important topics, the preferences of intermediaries – particularly demand-side intermediaries in the media – matter. Because our theoretical model accounts for the actions of media intermediaries such as journalists, bookers (for television and radio programs), and communications professionals, this research extends prior work on the dissemination of expertise and helps us better explain the functioning of the marketplace for expertise (Abbott, 1988; Lamont, 2018; Preda, 2023) and how it produces severe representation and recognition gaps between different groups of experts (Lamont, 2018). We elaborate on these processes below.

ROLE OF MEDIA INTERMEDIARIES IN SHAPING THE SELECTION AND REPRESENTATION OF EXPERTS TO THE PUBLIC

Scholars have generally conceptualized experts (e.g., scientists, doctors, lawyers, etc.) as agentic individuals whose decisions are the primary factor in shaping the structure and composition of the market for expertise in the public sphere (Heimstädt et al., 2023; Preda, 2023). However, most experts lack the time and skillsets to command public attention through communication channels such as their websites. Relatedly, practitioners and the public are generally uninterested in expertise that is intended for a professional audience (e.g., scientists within a research field), such as scientific articles or judicial decisions. Basically, if expertise is packaged for consumption by specific audiences, people outside of those audiences will largely ignore it (Barracough, 2004; Demortain, 2023; Singleton-Green, 2010; Tapp, 2005). Because of this gap, experts usually interact with the public indirectly. Most commonly, these interactions occur through media organizations, such as *CNN* and the *New York Times*, which repackage expertise for public consumption. We view these media organizations as *demand-side intermediaries* in the market for expertise. However, these organizations have different goals and incentives from experts and the public, creating an alignment problem.

At the same time, experts cannot decide the terms of their interactions with demand-side intermediaries. Instead, demand-side intermediaries generally insist on controlling interactions on platforms they own in areas such as length, general content, and format (Hartman, 1984). Additionally, experts usually lack the skillset, contacts, and time to pursue media appearances. Since public appearances, though often encouraged by employers (e.g., universities), are not typically considered by them in annual reviews, evaluations for entry into partnerships (e.g., law, finance, consulting), or by academic tenure committees, there is a significant opportunity cost to pursuing them. Due to these factors, many interactions between experts and media organizations are mediated by *supply-side intermediaries* such as communications and public relations professionals. Because these supply-side intermediaries do not typically work for the experts directly (instead, the expert's employer, such as universities and scientific labs in industry, typically hires them), they act according to their own interests and incentives. Consequently, the incentives of these supply-side intermediaries play an important role in shaping the market for expertise. Most of these professionals represent numerous experts, such as the employees of a law firm, an entire faculty/department, or all the authors signed to a publisher. Since they can choose between such a large and heterogeneous group of experts and lack the time to work with more than a small percentage, they have significant choices regarding whom they want to represent. Because of these factors, communications professionals are focused on their own interests, which are more aligned with their employer's interests than the interests of the experts they represent at a particular moment in time. We argue that these processes skew the demographic makeup of successful participants in the public market for expertise.

A MODEL OF EXPERT AMPLIFICATION

Fig. 1 illustrates our model of the supply-side and demand-side processes that shape *expert amplification* in the market for expertise.

As we describe in the model, the universal set of experts is every expert working on a specific topic. These experts are influenced by professional purity norms, affecting which of them *anticipatorily select-out* and thus represented in the public sphere, and which experts *select-in* to participate in public discourse (Abbott, 1981, 1988; Zuckerman, 2017). Those who select-in can go in one of two directions. First, they can be represented by supply-side intermediaries, such as communications professionals, who *selectively promote* them to media organizations. Second, they can be *preferentially selected* to speak to the public on a particular platform by demand-side intermediaries (i.e., media organizations) based on their own economic incentives, such as increasing viewership metrics (e.g., Television ratings, YouTube views, etc.) or generating attention for the intermediary on social media.

Additionally, some experts are not selected by either group of intermediaries. These experts must attract public attention independently, which is often challenging because they lack the relevant skillset or platform to do so.

Finally, we call the sub-set of experts who make public appearances *amplified experts* and argue that they occupy a privileged position in the market for expertise relative to their unamplified peers. Because of the incentives of the demand-side intermediaries who act as gatekeepers for public appearances on their platforms, when an expert is amplified, they are significantly more likely to make *further* public appearances than their unamplified colleagues. This acts as a reinforcing dynamic in our model, reverberating upward from the public to affect intermediaries and experts (as indicated by the double-ended *amplify* arrow) (Demortain, 2023; Magee & Galinsky, 2008).

Our model has two main types of consequences: those that affect experts' authority and those that impact the market for expertise and its participants. In terms of

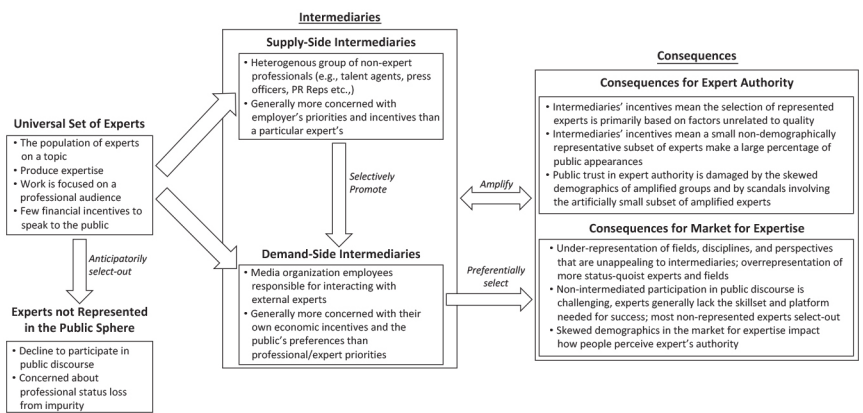


Fig. 1. Supply-side and Demand-side Processes that Shape the Market for Expertise in the Public Sphere.

expert authority, because of the incentives of intermediaries to represent experts who have had successful public appearances and possess credentials and public reputations, amplified experts tend to have more professional experience. However, they are significantly less diverse than selected-in experts, who are, in turn, significantly less diverse than the universal set of experts. This fact also means that the artificially limited pool of amplified experts sees an outsized impact on public trust when there is a scandal. These demographics of amplified experts mean that more amplified experts tend to be status-quoits. Additionally, non-represented experts are very likely to select-out due to difficulties navigating the market for expertise.

Finally, the skewed demographics of the market for expertise significantly impact the public's perceptions of expert authority. Put simply, intermediaries in the public market for expertise *preferentially select* and *selectively promote* a subset of experts and ignore others for reasons unrelated to inherent quality. Their collective decisions often have an impact that runs counter to the public's interest in getting the most accurate information (instead of the information that happens to be delivered by the experts most appealing to intermediaries). We further elaborate on our model below.

SUPPLY-SIDE PROCESSES: NORM VIOLATION, ANTICIPATORY SELECTING-OUT, AND SELECTIVE PROMOTION

We start by unpacking our arguments on the supply-side processes that determine which experts select-in versus anticipatorily select-out of the public discourse on topics related to their expertise. We will then discuss the role of *selective promotion* by supply-side intermediaries in shaping the market for expertise. These supply-side processes significantly influence which experts are amplified to the public and which ones are not, significantly impacting the public's trust/distrust in experts and expert authority more broadly.

Research on the sociology of professions explains how professional status and norm violations work inside and outside of professions (Abbott, 1981, 1988). Abbott (1981), for instance, examines the fundamental misalignment between public and professional status rankings. According to him, while public status is obtained through communicating with the public and attempting to solve public problems, intraprofessional status is obtained through maintaining professional purity, which implies minimizing contact with the public and their problems. The gap between these two paths to attaining status, as Abbott (1981) argues, is typically irreconcilable. Therefore, certain members of a profession prioritize maintaining their intraprofessional status over the desire to speak with the public. This choice means that some experts in professions seek to minimize violations of the "purity norm" within their profession (Zuckerman, 2017). This decision, in turn, limits their motivation to appear in the public sphere and disseminate knowledge that could speak to – and even potentially address – the problems confronted by the public. This phenomenon significantly impacts the demographic makeup of the subset of experts participating in public discourse.

Abbott (1981) further discusses how public and intraprofessional status hierarchies function in law and medicine. He starts by noting the inherent disconnect between the public and professional status hierarchies in medicine. The public admires frontline professionals who treat patients, distrusts “political doctors” in the American Medical Association, and ignores researchers because they “don’t care about people.” However, within the profession, researchers have high status, whereas frontline professionals such as family doctors and general practitioners do not. These professionals lose and gain status with their peers primarily based upon their “degree of contact with non-order” (Abbott, 1981, 1988). Abbott further discusses a similar phenomenon in law where the public highly regards criminal defense lawyers, while the legal profession views them as having lower-status in the professional hierarchy. Conversely, the professionally high-status securities, tax, and patent lawyers are reviled by the public and considered agents of corporate interests.

We use the term *anticipatory selecting-out* to describe the process of deciding not to appear in the public sphere due to concerns about the negative consequences of one’s appearance (e.g., being viewed by colleagues as “not serious scholars” who break professional norms). In other words, anticipatory selecting-out occurs when experts remove themselves from participating in public discourse in anticipation of intraprofessional status loss and other penalties related to professional norm violation. Such anticipatory selecting-out limits the diversity of experts available to disseminate scientific knowledge to a broader audience and shape public discourse on scientific consensus.

Zuckerman (2017), further building upon Abbott (1981), offers additional insights into the consequences of professional boundary crossing. These insights help expand our understanding of the processes skewing the demographics of the subset of experts participating in public discourse. An important insight from Zuckerman (2017) is that boundary crossing is less likely to negatively affect high-status professionals and can instead enhance their status. Since high-status professionals have demonstrated their competence and commitment to their professional peers (and to their field, more generally), boundary crossing can enhance their professional status because it can potentially benefit the profession. Professional peers’ understanding of their competence and commitment means that their boundary crossing and speaking with the public are interpreted as being in the profession’s interest (e.g., expanding its scope and jurisdiction, working toward securing more funding) rather than risk devaluing the profession’s credentials or softening its jurisdictional boundaries.

Nonetheless, the intraprofessional status loss and related penalties for purity norm violation are often perceived by experts as being applied unevenly based on nominal characteristics such as the experts’ gender, race, and professional tenure (Botelho & Gertsberg, 2022; Magee & Galinsky, 2008). These perceived differences, in turn, influence experts’ decisions around potentially norm-violating actions. For example, the tenure and seniority of experts (e.g., for influential professionals such as tenured professors and partners at law firms) can act to mitigate intraprofessional status loss and other associated career impacts of professional purity norm violations. In contrast, relatively lower-status professionals (such as

legal associates, medical residents, postdoctoral fellows, and early-career faculty) find it difficult to mitigate the penalties for purity norm violation, consequently being more likely to anticipatorily select-out from the public market for expertise. In addition, since experts who are women and racial/ethnic minorities believe they are likely to be penalized more severely for purity norm violations due to existing conscious and unconscious biases (e.g., perceived as “not committed to their discipline,” “not serious scholars,” etc.), they are incentivized to anticipatorily select-out to preempt such penalties. These perceived – and likely actual – consequences for purity norm violation demographically skew the subset of experts who select-in to participate in public discourse (Abbott, 1981; Zuckerman, 2017).

These perceptions of differential consequences for purity norm violation also drive much of the race, sex, and tenure-based differences in the rates at which experts select-in versus anticipatorily select-out of public discourse. Because there are potential benefits to one’s profession from speaking to the public that may balance out the negatives of categorical impurity and boundary crossing, the degree of professional censure for these purity norm violations is often influenced by how one’s peers interpret the motivations behind their public appearances. This interpretation of motivations is a salient mechanism driving race-, sex-, and tenure-based differences in perceived consequences for purity norm violation.³

Tenure and professional stature/seniority most likely significantly impact these processes. As noted by Zuckerman (2017), purity norm violations by higher-status experts (e.g., tenured and more experienced scientists) are more likely to be interpreted positively as attempts to expand the jurisdiction of a profession. This effect occurs because seniority is interpreted as evidence of a more significant commitment to the profession compared to less senior experts. Likewise, attributions of existing stereotypes in interpreting the motivations of public appearances by female versus male experts – that is, being driven by negative traits such as vanity for women versus an array of more prosocial traits, such as outreach and expanding the field’s influence, for men (Howell & Singer, 2017; Moss-Racusin & Rudman, 2010; Smith & Huntoon, 2014) – also drive the differences in consequences for purity norm violation between these groups. We believe that negative interpretations of behavior based on racial stereotypes could be a similar mechanism behind race-based differences in perceived consequences for professional purity norm violation.

Relatedly, the expert’s profession matters as well. Professions such as finance, law, and political science that are more regularly in communication with the public and/or have more of a revolving door between academia, government, and industry may have lower levels of consequences for purity norm violation. Conversely, other professions that are more removed from the public tend to have greater consequences – both perceived and actual – for purity norm violation. More generally, due to the perceived differences in the consequences for purity norm violation, experts select-out at different rates, shaping their availability and representation in the public sphere.

In addition, the professional socialization of these experts further reinforces these processes (e.g., senior professionals advising junior colleagues to avoid such

purity norm violations). Relatedly, the ambiguity and complexity of the incentive structures for participation in public discourse highly advantage more informed and networked experts who can better evaluate the mixed signals from their peers and employers (Butler et al., 2015).

All of these supply-side processes result in a significantly smaller subset of experts participating in public discourse due to anticipatory selecting-out. Nonetheless, even among those willing to participate in public discourse, actual participation rates are unequal because supply-side intermediaries influence such rates through selective promotion.

Supply-side intermediaries are heterogeneous groups of communications professionals that represent many experts in interactions with extra-professional groups such as the media and the public. These communications professionals, such as talent agents, press officers, public relations functionaries, and publicists, are generally more skilled at communication with the media. However, a lot of their power comes from experts intentionally selecting-out of communicating with demand-side intermediaries due to a lack of comfort, time, or skillsets. Because of this lack of experience and skillsets, experts who try to gain the attention of demand-side intermediaries without the assistance of supply-side intermediaries are typically unsuccessful. Instead, supply-side intermediaries usually facilitate or handle unsolicited communications with demand-side intermediaries.

However, these supply-side intermediaries have their own independent set of goals and incentives. They generally are not directly employed by the expert but by the expert's employer. Thus, supply-side intermediaries are incentivized to enhance the status of their employer rather than aiding the experts. For instance, supply-side intermediaries are disincentivized from selectively promoting publicly controversial experts and projects. Supply-side intermediaries represent the entire subset of selected-in experts at their employer, so they will spend the most time and effort promoting those experts they perceive as likely to benefit themselves and their employer most significantly through their conversations with the public. The most common benefits envisioned are either increased attention and reputation or monetary benefits (e.g., attracting future clients, increasing alumni donations, or increasing book sales). Additionally, organizations provide their own internal contexts, with an ability to subtly influence over time the sorts of expertise that are valued. This is especially true of individuals moving from one organizational context to another, such as academics moving from their home department's lab and classroom to their institution's press office (Anteby & Holm, 2021).

How might a supply-side intermediary interact with the subset of available experts to decide whom to selectively promote? An expert might go to a supply-side intermediary and ask them to promote a particular topic or piece of expertise. Alternatively, a supply-side intermediary can get a request from a demand-side intermediary (i.e., news media organizations) for an expert in a particular subject and then be able to promote someone of their choosing from the available experts at their employer. Alternatively, the demand-side intermediary may request a particular expert, in which case the supply-side intermediary would facilitate that contact. Finally, a supply-side intermediary can decide to promote a piece of expertise they hear about from a third party, such as an administrator or donor,

on their own initiative. Regardless, the supply-side intermediary has significant agency because they can usually choose whom to promote from the selected-in experts at their employer and how much energy to expend on that promotion.

The agentic power of supply-side intermediaries to decide which experts to selectively promote significantly impacts which experts are successful in gaining public attention. Despite the dynamics of anticipatory selecting-out, there are a large number of experts who are interested in speaking to the public and a variety of different press outlets that can facilitate such interactions. Deciding which outlet to approach is challenging and time-consuming, and there are not that many supply-side intermediaries around. However, because promotion is the focus of their duties, supply-side intermediaries gain expertise in their role, such as an understanding of what outlets are easiest to approach and which ones are not worth their time, an understanding of what is and is not newsworthy, and other knowledge that helps them evaluate what expertise is worth the effort of promoting. However, it is challenging for experts to gain similar competency in what is a side duty, something that is unlikely to significantly benefit them in their main profession.

Supply-side intermediaries' choices of which experts to selectively promote skew the demographics of the subset of amplified experts because they are incentivized in several ways: First, to promote higher-status experts and disciplines within their workplace. Second, to promote experts and disciplines that garner more public attention. Third, to promote experts that align with demand-side intermediaries' incentives because their relationships with demand-side intermediaries are more important to them. Finally, they are incentivized to promote experts they have previously engaged with and know are "easy to work with," both for themselves and their media contacts on the demand-side. These biases combine to make supply-side intermediaries and their promotion tactics an additional force in amplifying a subset of experts over others. The subset of experts is skewed in favor of tenure (because more tenured experts are likely to appeal to demand-side intermediaries), status within their own organization, and in favor of higher-status areas – both in terms of public and interprofessional status – of expertise over lower-status areas.

These supply-side processes make the subset of promoted and amplified experts more status-quoist and less diverse. Additionally, the lack of diversity within the subset of promoted and amplified experts increases the risk of public disregard for expertise and expert authority. It also means there is more significant damage to trust in experts when one of the relatively few public experts is implicated in a scandal (Adut, 2008).

DEMAND-SIDE PROCESSES: ROLE OF MEDIA ORGANIZATIONS

While supply-side processes significantly affect the market for expertise, the most significant underexplored impacts come from demand-side intermediaries (i.e., media organizations such as *CNN*, *Wall Street Journal*, and *The New York*

Times). They have a more significant impact because most experts wishing to disseminate their expertise to the public must utilize demand-side intermediaries, whereas experts can bypass supply-side intermediaries and still appear before the public on intermediated platforms. Experts attempting to bypass demand-side intermediaries and disseminate knowledge through their primary channels (e.g., channels controlled by themselves or their employers) tend to be ignored by a public that demands interaction on its own terms (Abbott, 1981, 1988; Arnoldi, 2007; Heimstädt et al., 2023; Zuckerman, 2017). Relatedly, experts who attempt to relate to the public using professional vehicles such as legal decisions or academic journal articles are also likely to be ignored.

In that regard, *preferential selection* by demand-side intermediaries plays an important role (Roulet & Clemente, 2018; Zavyalova et al., 2017). Demand-side intermediaries such as media organizations select experts to appear on their platforms according to their own goals and incentives. Specifically, they tend to economize on information processing costs and use heuristics such as which experts are “good-on-TV” or “quotable.” These heuristics create a dynamic that reinforces the demographic skews from the supply-side processes of anticipatory selecting-out and selective promotion. Because they control the primary platforms for disseminating expertise to the public, demand-side intermediaries play the most significant role in selecting and representing experts in the public sphere.

Moreover, there is a significant gap between discussions in scientific literature and discussions that are understandable and interesting to the public. The public requires experts to meet them on their terms (Abbott, 1988; Zuckerman, 2017). Therefore, demand-side intermediaries serve an important role in giving experts and their work a public audience in return for shaping their work for better public consumption and using their time to discuss issues of interest to the public. For the demand-side intermediary, an expert who is not primarily discussing things of interest to the public is not economically valuable. Additionally, experts who are not compelling or informative to the public in terms of how they discuss their area of expertise are also not valuable. Finally, experts who do not comply with the format requirements – such as operating within the time requirements of a T.V. news segment and not using too much technical jargon – of the media they are trying to appear on are also not valuable. In most cases, experts that are not valuable to demand-side intermediaries are not allowed to appear on their platforms. This gatekeeping role, granted in return for bringing a large audience to the experts, gives the demand-side intermediaries a substantial role in shaping the selection and representation of experts to the public (Boczkowski, 2010).

These organizations can set the terms by which experts interact with a public audience who otherwise would be unable or unwilling to evaluate the range of expert opinions on a given topic. Additionally, while experts can directly interact with the public, the public is largely uninterested in these un-mediated interactions. Because of these demand-side processes, which experts are preferentially selected by demand-side intermediaries and which ones are not, meaningfully impact the content and direction of public discourse. Demand-side intermediaries’ selection criteria for these mediated interactions are influenced by several factors that skew the subset of amplified experts. In this paper, we will generally

discuss the context of television, but similar dynamics likely play out in other media contexts involving intermediaries such as radio, newspapers, podcasts, and other media (Lamont, 2018).

A TV newscast is our specific context. For local and lower-budget national newscasts, a producer is generally responsible for selecting experts in addition to their other duties. Only a few programs, like national morning shows (i.e., *Good Morning America*) and national news programs (i.e., ‘*Sunday Shows*’), are likely to have an employee (a “booker,” in industry parlance) solely dedicated to selecting guests. Also, some of the hosts on shows like NBC’s *Today* prefer to select their own experts. Finally, some focused outlets have shared dedicated bookers across multiple shows (Hartman, 1984).

What dynamics drive the preferential selection process for demand-side intermediaries? We believe that four main factors explain the preferential selection process: (1) time constraints and information costs (i.e., the speed of events and cost in employee hours often means the availability and prior vetting are primary factors in expert selection, driving *repeat-bookings*), (2) information deficits (i.e., demand-side intermediaries cannot evaluate expertise well), (3) medium constraints (i.e., the skills needed to be successful on television have little overlap with the skills needed for success in an expert occupation such as academia or law), and (4) desire for exclusivity (i.e., television shows prefer novel views on a topic rather than people who have already talked with a competitor⁴).

An employee of the demand-side intermediary preferentially selecting experts likely has a film and video production background and little to no formal training in evaluating experts. Their selection process, especially for the same-day selections driven by the news cycle, is based heavily on the availability and “who can put a complete thought about that topic into a reasonably short and interesting statement” (Hartman, 1984; see also Josephson, 2021). Availability is by far the most important criterion. The news cycle moves fast, and demand-side intermediaries generally need a quote or interview within a few hours, far too little time to find and evaluate a new expert on a topic, especially when they lack the skill-set to evaluate experts and because many experts will say no due to anticipatory selecting-out. As Josephson (2021) reflects on these dynamics: “who is available? This is the true reality of booking. For day-of-air bookings, you do not always get the perfect guest—you get the guest who is available at the exact moment your busy correspondent is also available” (Josephson, 2021). Additionally, extensive vetting may not be possible, and a producer’s ability to correctly evaluate and differentiate experts within a profession is minimal. These factors combine to create an environment with significant incentives toward conservatism in expert selection. Therefore, demand-side intermediaries tend to preferentially select the same experts repeatedly, often referred to as repeat-booking.

Additionally, the time pressure of the news cycle often interacts with the desire to get a different expert than your competitors. Outside of the most competitive bookings (such as newsworthy celebrities or politicians), demand-side intermediaries will not book experts who have appeared on a competitor recently (Hartman, 1984). This desire for exclusivity is one of the reasons that new experts are preferentially selected.

The other significant incentive driving demand-side intermediaries' preferential selections is reducing information processing costs. This incentive is influential in several different ways. First, search costs are much lower for repeat-bookings because demand-side intermediaries know that the expert has been vetted and is willing to speak to the media (Abbott, 1981, 1988; Zuckerman, 2017). Finding a new expert, in contrast, will likely require vetting and contacting a number of experts before finding a suitable expert who is available. Going with someone new also risks selecting an expert who is not "good-on-TV." In addition, repeat-bookings are generally either local to the area (where the experts can be brought into the studio) or are known to be able to appear remotely without technical difficulties. Delays and other technical difficulties on live television are highly problematic; therefore, demand-side intermediaries are incentivized to reduce the risk of such problems by repeat-booking the same set of experts. Supply- and demand-side intermediaries' accounts that we read told us that repeat-bookings were the default choice and represented the overwhelming majority of expert appearances. The incentive to repeat-book is one of the significant factors in the expert amplification process. Finally, a repeat-booking has a known ability to function competently within the television format and potentially is known to be "good-on-TV." Being good-on-TV for experts involves the ability to disseminate complex technical information to the public in a charismatic manner (Arnoldi, 2007; Hartman, 1984; Josephson, 2021). Put even more simply, for an expert, being "good-on-TV" means being credible and engaging to the audience when discussing your subject of expertise (in print media, there is a similar phenomenon around "being quotable"). While "being good-on-TV" sounds simple, it is actually quite challenging for experts and depends significantly on the subject being discussed. Experts who are "good-on-TV" are willing to engage the public on their own terms rather than comply with their professions' norms. To be "good-on-TV," experts need to avoid using professional jargon and explain issues in a simple manner to an audience with very different levels of knowledge than those the experts are used to interacting with. They also need to speak less formally than they are used to and answer questions in a different format. Finally, the time format for T.V. is incredibly brief, with the aired portions of interviews sometimes being under a minute and almost always under 5 minutes. The need to speak in a non-ordered way to be "good-on-TV" drives anticipatory selecting-out and skews the demographics of amplified experts.

In comparison, being not "good-on-TV" is easy to understand. Lacking comfort with the format, it should be the default for most academic experts. This lack of comfort could result in heavy use of jargon and qualifiers (e.g., "it depends"), explanations that are unintelligible to the average member of the public, and, worst of all, a lack of preparedness for the brief time window of a T.V. segment. The average T.V. newscast is ~22 minutes (with eight minutes of commercials). Given the requirements for traffic, weather, sports, top stories, and other segments, giving expert interviewees more than a few minutes to speak is usually impossible. Additionally, as discussed above, to get the experience needed to be "good-on-TV," it helps to already be "good-on-TV." Given all of these factors, experts known to be "good-on-TV" are more likely to be preferentially selected than those who are not good-on-TV.

Demand-side intermediaries in the print media have a similar preferential selection dynamic to being “good-on-TV” called “being quotable.” The dynamics around quotable sources are nearly identical. Once print journalists find a quotable expert, they preferentially select them as a background source or quote whenever they cover their topic of expertise. Fundamentally, these relationships are based on trust, with the journalists trusting a small list of “go-to people.” They gravitate toward big names because they grant a quote gravitas and instant credibility with their audience. But, more importantly, once they have someone whose expertise they trust and who produces good quotes, they will go back to them repeatedly. While a journalist might want more sources or to differentiate and diversify their sourcing pool, doing so is difficult due to time pressures as well as the challenge of evaluating expertise outside of their area of core competency.

From the supply-side intermediaries’ perspective, while they may try to push specific experts, those experts still have to be competent in the media context (i.e., quotable or “good-on-TV”). Their ability to promote an expert who does not possess those qualities is minimal.

There is another factor that influences repeat-bookings: experts’ location. The ability to meet in person for an interview, especially on visual media, is helpful. Especially prior to the pandemic, producers were wary of remote appearances due to concerns about technical difficulties. For example, shows in New York would look for New Yorkers who could come into the studio or be interviewed at their homes or offices by an employee. More rural local news broadcasts would often look to nearby universities for experts. University affiliation is also highly salient. Local news broadcasts would often preferentially select experts from nearby universities due to their audience credibility. Similarly, national broadcasts look for experts with nationally relevant credentials, such as affiliations with well-known firms, important government agencies, or top universities.

In addition, repeatedly booked experts gain greater visibility in the public sphere, enabling them to accrue public status as an authority on a topic or subject. However, the public’s conception of an expert’s area of expertise is often significantly broader than that of their fellow experts. In other words, someone the public sees as a “Russia Expert” could be a political scientist with expertise in USSR-USA nuclear disarmament talks. However, this fact may not stop them from being asked about and opining on a tangentially related topic, such as Vladimir Putin’s 2022 invasion of Ukraine. This is the sort of purity norm violation many experts worry about, causing anticipatory selecting-out. While there is a floor regarding what the public and media will accept as adequate credentials to appear on T.V. and speak with authority on a topic, that floor is relatively low (e.g., a professional degree or doctorate in a related field). This floor is especially low compared to what fellow experts would consider expertise within a profession. This low floor for expertise combines with dynamics of preferential selection – such as availability – to incentivize repeat-booking of the same expert on a variety of tangentially related topics. Relatedly, experts who worry about purity norm violations and are not preferentially selected may be more likely to

anticipatorily select-out in response to this kind of norm-violating discourse in their area of expertise.

The low floor for credentials also helps us understand who is allowed to spread scientific misinformation through the media. For example, television networks generally do not allow totally uncredentialed guests to participate in important medical debates such as the effectiveness of vaccines (outside of public figures such as politicians and celebrities). Instead, they bring on people who may practice in an unrelated area but have publicly relevant credentials. For example, a guest's M.D. or PhD significantly protects the network from criticism, and the public generally lacks the sophistication to understand that, say, an emergency medicine specialist lacks sufficient expertise in immunology to credibly discuss vaccine science in a professional context. These factors help explain why experts regularly question orthodoxies on TV that they would be considered unqualified to debate professionally. Relatedly, this low credential floor may be part of what is inspiring lay people to participate in science outside of institutional norms and ideals as allies of expertise (Berr, 2024).

Many experts who wish to avoid the penalties for purity norm violation need to speak at a level of depth that does not fit within the structure of a newscast that would invite them. Additionally, this level of depth is not necessarily appreciated or desired by the demand-side intermediary or its audience. At the same time, using simplified explanations when communicating with the public can constitute a violation of professional purity norms, potentially resulting in intraprofessional status loss, especially for some experts who are women and racialized minorities and perceive greater negative consequences for professional norm violations, and thus tend to anticipatorily select-out of the subset of available experts (Abbott, 1981, 1988; Eyal, 2022). This anticipatory selecting-out of experts unwilling to speak in the manner required by demand-side intermediaries and the public skews the demographics of amplified experts in favor of experts who face lower penalties for non-order.

Together, these factors combine to create a reinforcing dynamic where demand-side intermediaries face significant incentives to select the same experts repeatedly (Magee & Galinsky, 2008). Thus, the demographics of the preferentially selected subset of experts are increasingly out of touch with a rapidly diversifying population of experts. As experts leave their professions due to factors such as retirement, the media slowly selects new experts. If new experts do well in their initial public appearances, they will be promoted and preferentially selected more frequently through repeat-booking (when their topic becomes newsworthy, when a preferred expert is busy, etc.). Thus, the subset of amplified experts does change, but this process is very slow and tends to favor the status-quo, skewing toward conservatism and characterized by a lack of both epistemic and demographic diversity (Lamont, 2018). Relatedly, the underrepresentation of female experts in media barely changed between 1995 and 2015 despite significant increases in gender diversity within the universal set of experts (e.g., in universities and industry research labs) and presumably within the subset of experts selecting-in (Macharia, 2020; Zhou & Gao, 2021).

CONSEQUENCES, LIMITATIONS, AND FUTURE DIRECTIONS

Adding *selective-promotion* and *preferential selection* to our model significantly improves our understanding of the public market for expertise (Abbott, 1981, 1988; Eyal, 2022; Heimstädt et al., 2023). Demand-side intermediaries in the media and supply-side intermediaries such as communications professionals are influencing the selection and representation of expertise in the public sphere in hitherto understudied ways, with significant implications for the legitimacy of expert authority in the “hearts and minds” of the public. The incentives that drive intermediaries’ decision-making, such as the desire to repeat-book, and the desire to preferentially select experts who are “good-on-TV” or “quotable” significantly skew which experts speak to the public.

Similarly, the incentives that drive the decision-making of intermediaries have significant impacts on who discusses important topics, how those topics are discussed, and ultimately the composition of the subset of amplified experts (Abbott, 1981, 1988; Ekström, 2016; Menon, 2017; Zavyalova et al., 2017). The inefficiencies imposed by supply- and demand-side intermediaries on the market for expertise are not purely theoretical problems. They have significant real-world implications. Due to the dynamics causing experts to be selectively promoted, preferentially selected, and ultimately amplified at different rates, public discussion of topics underrepresents diverse perspectives relative to their representation in the universal set of experts.

Additionally, amplified experts are, on average, significantly older than the universal set of experts and the subset of experts that have selected-in, meaning the viewpoints the public hears are more status-quoist, and the product of a more limited set of circumstances and backgrounds. Relatedly, an increasingly diverse public is further alienated by discussions between a subset of experts who are significantly “older, whiter, and male” and thus unrepresentative of the demographic composition of the public (Macharia, 2020). Ultimately, this makes the perspectives the public hears from experts more homogenous and potentially risks damaging the public’s trust in expertise and expert authority.

To elaborate, supply- and demand-side intermediaries play an important role in amplifying experts stratified along the dimensions of seniority, race, and gender. Their clear preferences for experts they have worked with before, who are more senior, and who are from influential institutions/professions means that the subset of experts who regularly interact with the media is older, whiter, and more male than the universal set of experts. These skewed demographics have significant implications for the public’s trust in experts and expert authority, especially among groups that are less represented in the subset of amplified experts (Huising, 2015; Menon, 2017). Ultimately, these groups are being denied representation to participate and shape the public discourse. This underrepresentation is not just a problem in the present. Because of the seniority skew and reinforcing dynamics of expert amplification, people who select-out in the present may significantly diminish their ability to become amplified in the future (Magee & Galinsky, 2008). Additionally, while the broader public is

being denied the ideas and perspectives of these under-amplified experts, the public is likely also being overexposed to amplified groups of experts and their dated theories and conservatism in ideas.

Additionally, scandals involving the relatively few amplified experts damage public trust in this artificially small subset of experts. Furthermore, the overrepresentation of certain academic disciplines and the underrepresentation of others limits the perspectives the public gets. Experts who fail to secure representation from intermediaries generally lack the skillset and platform needed to meaningfully participate in public discourse. This means that the preferences and incentives of intermediaries are potentially the most significant factor influencing public discussions on topics they know little about.

Notably, these processes do not amplify worse experts at the expense of better ones or vice versa; rather, because participants are acting according to incentives that are unrelated to underlying expert quality, they produce results that are not correlated with quality. So rather than producing a higher-quality subset of amplified experts or a lower-quality subset of amplified experts – in comparison to the universal set of experts – expert amplification produces a subset of amplified experts of varying quality because it amplifies experts based upon factors that are uncorrelated with quality. This has significant consequences, especially as the public finds it difficult to make accurate, independent evaluations of expert quality and instead uses a variety of shortcuts, such as popularity and the endorsements of intermediaries (Benjamin-Pollak & Karunakaran, in preparation), for evaluating quality.

The conceptual nature of this paper imposes a number of limitations. First, our mechanism is based on perceptions of negative consequences for actions driving behavior based upon the work on professional status and purity norms theorized by Abbott (1981) in his classic work on status and strain in professions. The core idea is that *belief* in the potential negative consequences of violating professional norms is sufficient to drive the “selecting-out” behavior of experts. Relatedly, given the focus of the paper on purity norms and norm violations, we chose to focus on certain types of communication with the public at the expense of others for clarity in our theorizing and simplicity of our model. This is especially true on the supply-side, where there are a large number of potential pathways and roles that can be involved in the process of expert amplification. In our view, whether something goes through a press officer, a publicist, someone employed by an academic department, a law firm, or a publisher does not majorly impact the theoretical processes at play. Additionally, we believe that while the incentives of these people can differ based on their professional role and affiliation, the impact of the gap in incentives between supply-side intermediaries and experts remains similar as long as the gap persists. Ultimately, we are more focused on these misalignments of incentives rather than the specific incentives of any participant.

One of the most significant alternative pathways for expertise dissemination is social media. As an alternative pathway for expertise, social media is not differentiated enough to be worth splitting off and discussing separately from the primary processes of this paper. We believe that these pathways for speaking with the public work similarly to the one outlined in this paper. Being successful at social

media for an expert generally involves treating it more like a job (in terms of lack of topic control and time investment). Ironically, the more like a job it becomes, the less direct expertise they can produce and the more they have to source from other experts. The more “professional” they become in social media, the more they should be treated like an intermediary due to a similar set of behavioral incentives that begin to affect them. For scientists interested in participating in a non-intermediated fashion, this is a “superstar market” where one person may get a lot of attention, but the vast majority do not (Rosen, 1981). Conversely, just because an expert such as a scientist is a social media celebrity does not mean they are also professionally respected. As scholarship has repeatedly shown, public and professional status are often misaligned with each other (Abbott, 1981, 1988). Additionally, the recent migration of many scientists from X (formerly Twitter) to other social networks such as Threads and Bluesky has further fragmented this communication channel.

To summarize, there can be other pathways through which expert amplification can happen. We are focusing on what we view as the most common and theoretically relevant pathway. While media presence is an important element of the market for expertise in the public sphere, it is only one element. Integrating the works of scholars looking at public understanding and public trust in science is an important direction for future research (Gauchat, 2012; Horst et al., 2016).

CONCLUSION

Examining the supply- and demand-side processes in the public market for expertise, and focusing on the role that intermediaries on the supply- and demand-side play in shaping the selection, representation, and amplification of experts in the public sphere, is of vital importance to understanding the public’s rising distrust in experts and expert authority (Ekström, 2016; Huising, 2015, 2024; Menon, 2017; Preda, 2023) – what scholars refer to as the “crisis of expertise” (Eyal, 2019, 2022). Skews due to which experts are penalized for their professional norm violations, which ones are not, which experts are amplified by intermediaries, and which ones are not impact not only the representation of experts in the public sphere, but also which perspectives and topics get discussed and become part of the public discourse, ultimately damaging expert authority with a public that is increasingly alienated from the experts they see in the media. Together, these supply-side and demand-side processes influence the content and structure of critical debates about “matters of concern” (Latour, 2004) that are societally relevant and important, thus shaping the public discourse and contributing to public’s increasing distrust of expertise and expert authority (Eyal, 2019; Heimstädt et al., 2023).

NOTES

1. For the purposes of this paper, when we talk about experts we are discussing individuals with a specific, valuable skillset operating within professions organized around that

skillset – for example, doctors, lawyers, or scientists. But our level of analysis is slightly more specific, meaning we believe that these phenomena are occurring in professions such as epidemiology, securities law, and low-temperature physics.

2. Note that our model is based upon the anticipatory avoidance of specific behaviors by individuals due to their perceptions of receiving negative consequences for those behaviors as they are believed to violate professional norms. The logic here is that differing views about the negative consequences will drive variation in the rates of anticipatory avoidance (e.g., [Abbott, 1981](#)).

3. While the discussion of why selection based upon demographic characteristics skews the demographics of amplified experts and why it matters will mostly take place below as we explore the impacts of demand-side intermediaries, we think it may be useful to briefly summarize these arguments here to avoid confusion. While a process that privileges high-status experts having negative impacts seems counterintuitive, it does have two significant downsides. First, while amplification selects for high-status actors, it does not select for the quality or appropriateness of expertise. In fact, while amplification is not necessarily correlated with expertise quality (selecting on other criteria), the process is actually misaligned with expertise appropriateness because lower-status experts will refuse to cross professional boundaries due to worries about professional norm violation and impurity, but higher-status ones do not have the same perceived penalties for impurity. Rather than looking for the best expert to speak on a topic within a professional context, intermediaries instead select for public status because their audience have a relatively poor understanding of professional expertise and its boundaries. For example, inviting Anthony Fauci to talk about infectious diseases (his specialty) is appropriate, but bringing him on to discuss psychiatry or mental health issues would be a disservice to the public despite his high status.

4. Note that for the purposes of our paper, there are three types of experts that we will not be discussing because other dynamics drive their selection: retained experts, competitive expert selections, and government officials. Retained experts, meaning experts paid a substantial fee to appear regularly for a media organization, are governed by different dynamics due to being compensated and contracted. Competitive expert selections, people who are in demand by the media that they have near-total agency in terms of their appearances, are also governed by different dynamics and uncommon among professional experts (usually only senior politicians and major celebrities fall under this category). Finally, when government officials appear as experts, there is often some sort of quid pro-quo, either implied or actual, for future access or a negotiation about which government employee is supplied, differentiating this from other types of expert selection ([Hartman, 1984](#)).

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ALLIES OF EXPERTISE: HOW LAYPEOPLE DEFEND THE EPISTEMIC AUTHORITY OF SCIENCE ONLINE

Katharina Berr

Weizenbaum Institute, Germany

ABSTRACT

Social media is often perceived as a particularly hostile environment for established expertise. Instead of following the advice of scientists or other established experts, there is a fear that laypeople may turn to alternative claims from online communities, influencers, or even populists and conspiracy theorists. However, this study demonstrates that laypeople not only circumvent or challenge the epistemic authority of established expertise online, they also engage in ways aiming to uphold it. Drawing on a two-year digital ethnography of an online community organized in the context of the Covid-19 pandemic, I conceptualize such engagement as that of allies of expertise. When taking on this role, laypeople perceive the epistemic authority of established expertise as threatened and defend it against post-truth phenomena on social media platforms. Thereby, they aim to convince others to favor scientific expertise over alternative claims when informing their opinions and decisions. With this concept I contribute to expertise scholarship, especially to understandings of a crisis of expertise.

Keywords: Crisis of expertise; public engagement with science; social media; post-truth; Covid-19; digital ethnography

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With the internet it seems that anyone can pass as an expert. At least this is a prominent concern in discussions about a “post-truth era” (D’Ancona, 2017, p. 2) or the “death of expertise” (Nichols, 2017). Social media in particular seems to enable laypeople¹ to circumvent or challenge established expertise² and draw on alternative claims instead. This may be authentic advice from social media influencers (Arnoldi, 2023; Larrson Heidenblad & Nilsson, 2023), the lived experiences of online communities (Au et al., 2022; Ritwick & Koljonen, 2025), conspiracy theories (Bauer et al., 2023; Harambam et al., 2022), or populist narratives (Collins et al., 2020; Mede & Schäfer, 2020). Scholars of expertise have discussed these concerns – somewhat less alarmist than those over its death – as a “crisis of expertise” (Eyal, 2019; Heimstädt et al., 2024; Reed & Reed, 2022). They regard the internet and social media not as causing this crisis, but as a “multiplier” (Eyal, 2019, p. 83). Competing claims to expertise become increasingly visible online and the question of whose advice to follow becomes more and more difficult to answer.

However, the internet and social media not only contribute to a proliferation of alternative claims to expertise. Recent phenomena suggest that they also enable counteractions. For example, following the 2016 election of Trump as US president and the Brexit vote in the UK as landmark events for a “post-truth era” (D’Ancona, 2017, p. 2), laypeople mobilized online to join scientists in so-called science marches (Riesch et al., 2021). In a similar vein, public scientists who advocated Covid-19 measures such as vaccination, face masks, or social distancing were not only at risk of being harassed but were also celebrated on social media. Some were even treated like celebrities (Joubert et al., 2023). While these phenomena suggest that laypeople not only challenge but also support the epistemic authority of established expertise online, less is known about the mechanisms of such engagement. This study therefore asks how lay engagement that aims to uphold rather than challenge the epistemic authority of established expertise online can be conceptualized.

To examine this research question, I draw on a two-year digital ethnography of an online community organized in the context of the Covid-19 pandemic. Focusing on how this community defines its own role in relation to scientific experts (as subservient) and post-truth actors (as antagonistic), I demonstrate how laypeople become what I term *allies of expertise*. When taking on this role, laypeople perceive the epistemic authority of science in society as threatened and in need of support. Thus, they defend (what they regard as) scientific expertise against (what they regard as) post-truth phenomena. Contrary to previously studied forms of lay engagement with science, such as citizen science (Baudry et al., 2022) or lay expertise (Epstein, 1995, 2023), *allies of expertise* do not claim insight into or participation in expert work. Instead, they see their role in reproducing scientific virtues such as objectivity, facticity, and rationality in online debates. However, they are not only following role models from the world of science, but are also copying their post-truth antagonists by leveraging the logics and infrastructures of social media. Their goal is to make scientific expertise as visible as alternative claims and to ultimately convince other laypeople that scientific expertise is the most credible and reliable knowledge to inform their opinions and decisions.

This study contributes to the academic discourse on a “crisis of expertise” (Eyal, 2019; Heimstädt et al., 2024; Reed & Reed, 2022). It illustrates how laypeople on social media not only drive such a crisis forward by circumventing or challenging established expertise in favor of alternative claims. As *allies of expertise*, they perceive such alternative claims as deliberately eroding trust in established expertise and organize themselves to counteract this. Their engagement can contribute to solving this crisis by making established expertise more visible and bolstering its epistemic authority in sometimes confusing and contested online debates. At the same time, their engagement bears the risk of reproducing idealized and “pure” (Shapin, 2010) images of science that the realities of expert work, especially at the science-policy interface, might not be able to fulfill.

THEORETICAL BACKGROUND

At the heart of many post-truth discourses are binary notions of a “valued objective realm of facts, science and reason,” on the one hand, and a “dangerous subjective realm of emotion, ideology and irrationality” (Harambam et al., 2022, p. 787), on the other hand (see also Eyal, 2019; Meyer & Quattrone, 2021). Observers fear that laypeople might reject the former and fall prey to the latter; that they might, for example, bypass the expertise of professional scientists in favor of misinformation, conspiracy theories or science denialism (D’Ancona, 2017; Nichols, 2017). The internet and social media are regarded as breeding grounds for such – to stick with post-truth vocabulary – “fake” or “alternative” claims to expertise. Concerns about a “death of expertise” (Nichols, 2017) even suggest that laypeople might reject established expertise altogether and, with seemingly infinite information at their disposal, resort to their own judgments.

Scholars of expertise can add nuance to these post-truth concerns. Instead of diagnosing an assault on a capital-s science or the demise of a once rational society, they see a “crisis of expertise” (Eyal, 2019; Heimstädt et al., 2024; Reed & Reed, 2022). This crisis can be explained not only by a mistrust of experts but also by their unprecedented role in shaping public opinion and political decisions. Following this line of scholarship, the internet and social media are not regarded as causing this crisis, but as introducing novel dynamics to the public recognition of expertise. On social media in particular, competing claims to expertise are becoming increasingly visible, making the question of the most credible and reliable ones more and more contentious (Eyal, 2019; Eyal & Medvetz, 2023; Knight & Tsoukas, 2019). In other words, the question of who is ascribed epistemic authority and gets “to diagnose and treat a class of problems” (Huising, 2023, p. 455) becomes increasingly difficult to answer. But what does this mean for established expertise online?

Previous research has identified various ways in which laypeople can circumvent or challenge the epistemic authority of established expertise on social media. Key figures in this context are influencers. Previously, traditional gatekeepers like

academic or media institutions held sway over publicly recognizing knowledge as expertise, usually by drawing on formal credentials or affiliations. On the one hand, social media influencers, especially those with large followings, can now take on this gatekeeping role and endorse alternative claims to expertise (Arnoldi, 2023; Weingart, 2023). On the other hand, logics of social media influencing such as algorithmic visibility, self-branding, or rhetorics of authenticity seem to be influencing lay expectations toward performances of expertise more generally (Bishop, 2023; Hund, 2023). For example, research on so-called “finfluencers” argues that ordinary retail investors are recognized as financial experts by giving emotional and entertaining stock market advice (Guan, 2023) or presenting themselves as more relatable and independent than “greedy bank advisors” (Larrson Heidenblad & Nilsson, 2023, p. 115).

Another way in which the epistemic authority of established expertise is challenged online is the collective mobilization of and knowledge exchange between lay experts (Epstein, 1995, 2023). For example, Au et al. (2022) show how Long Covid patients who feel dismissed by medical experts turn to the lived experiences shared in an online forum. In an adjacent study, Au and Eyal (2022) illustrate how patients use these online communities to develop hybrid knowledges from experiential and established expertise, which they hope will not only result in credibility among their peers but will also make them more likely to be heard by medical professionals. While such active lay engagement with established expertise generally corresponds to the ideal of democratizing science (Weingart et al., 2021), it can be understood as undermining established expertise if it deviates too far from professional standards and regulation (Mayes, 2024). For example, Ritwick and Koljonen (2025) illustrate how laypeople share alternative therapies for chronic illness in an online forum; in this way, unreliable or even dangerous claims are presented as an alternative to established expertise.

Moreover, alternative claims to expertise can be intended to cast doubt on established expertise and frame it as stemming from an intellectual elite that has lost touch with “the will of the people” (Collins et al., 2020). Research on such “science-related populism” (Mede & Schäfer, 2020) or conspiracism (Akrich & Cochoy, 2023; Harambam et al., 2022) shows that such rejections of established expertise are often not rejections of scientific epistemologies per se. Populists and conspiracy theorists accuse the “scientific establishment” (Eyal & Medvetz, 2023, pp. 6–7) of being corrupted by financial or political motives, and thus of being unable to meet its own epistemic and ethical standards. This observation also offers an explanation as to why populist narratives or conspiracy theories are often presented in seemingly scientific forms. For example, Panofsky and Donovan (2019) report how laypeople discuss the quasi-scientific practice of genetic ancestry testing on an online forum to further their white nationalist agenda. Bauer et al. (2023) show how laypeople draw on a controversial study from a scientific pre-print server to spread Covid-19-related conspiracies on social media, even though scientists had already rejected the study for not meeting scientific standards.

From social media influencing to lay expert online communities, to populism and conspiracism – existing research can help us understand the different ways in which laypeople circumvent and challenge the epistemic authority of established

expertise online. However, few scholars have observed that there are also ways in which laypeople support established expertise. The internet and social media seem to function as a “multiplier” (Eyal, 2019, p. 83) in this context, too. For example, in reaction to the presidential election of Trump in the USA and the Brexit vote in the UK, people in various countries mobilized on social media to join political protests. Scientists and lay “sympathizers” (Riesch et al., 2021, p. 46) then took to the streets and marched against “populist knowledge practices” (Stephens et al., 2022, p. 212). Similar forms of lay engagement became evident during the Covid-19 pandemic when some public scientists gained large followings online and were even treated like celebrities (Joubert et al., 2023). Laypeople also supported scientific expertise in private on- and offline conversations. For example, as a New York Times article proposed, by looking for guidance on “how to talk to friends and family who share conspiracy theories” (Warzel, 2020). Moreover, the phrase “follow the science” became a popular “slogan” (Fisher, 2022) or “mantra” (Safford et al., 2021, p. 1) to publicly express support for evidence-based Covid-19 measures (Bozeman, 2022).

So far, empirical examples like these have rarely been discussed as belonging to one phenomenon. However, it is important to not only examine how laypeople challenge, but also how they support the epistemic authority of established expertise online. I argue that gaining a better understanding of such engagement allows for more nuanced views on post-truth concerns and lay perceptions of expertise. With these insights, established experts like public scientists might be better equipped to navigate both social media environments and a “crisis of expertise” (Eyal, 2019; Heimstädt et al., 2024; Reed & Reed, 2022). This study therefore asks how lay engagement that aims to uphold rather than challenge the epistemic authority of established expertise online can be conceptualized.

METHODS

Empirical Setting

To examine this research question, this study draws on a two-year digital ethnography of an online community that was organized in the context of the Covid-19 pandemic. The community comprises seven German-speaking Facebook groups, all of which were founded between March and November 2020 (see Table 1).

At the heart of the community are the two largest groups, named after German scientist Christian Drosten: *Drosten Ultras* and *Team Drosten*.³ At the time of my fieldwork, Drosten was (and continues to be) the director of the Institute of Virology at Charité Berlin, where his research focuses on emerging viruses. During the Covid-19 pandemic, he acted as a policy advisor and science communicator. He was both celebrated and attacked for this engagement as a public expert (Joubert et al., 2023; Kupferschmidt, 2020). During our interview, an admin revealed the reasoning behind their group name: “We are soccer nerds. And just like the ultras fans do for soccer, we want to set the mood for science” (Interviewee A). The peculiar combination of the Drosten name and sports fandom (“Ultras,” “Team”) was supposed to draw in more members.

Table 1. Overview of the Online Community
(Sorted According to Group Size).

	Group Name	Founded	Members (as of March 2023)	Accessibility
1	Team Drosten	May 2020	40,663	Public, visible
2	Drosten Ultras	May 2020	7,442	Public, visible
3	Covid-19 Science	August 2020	3,162	Public, visible
4	Stop Conspiratards	October 2020	2,489	Public, visible
5	How to Deal with Conspiratards Online	May 2020	1,644	Private, visible
6	Support the Real Expert	November 2020	928	Private, visible
7	Stop the Spread	March 2020	820	Private, hidden

Excerpts from the Facebook group descriptions further suggest that the community takes Drosten as a role model, for example: “the Drosten name stands for intelligent expertise, political integrity and good communication. These should also be the guidelines of our group” (Group 1). But while his name featured prominently, the groups’ content extended more generally to the current state of the pandemic, scientific advancements, or policy measures. Members usually posted links to content from other websites (news media, blogs, rarely also preprint servers), accompanied by their own summaries, interpretations, or questions. The administrative teams needed to approve each post before it was published in the feed and opened to discussion. Over the course of the pandemic, they also created stricter rules about what to share with the community: they discouraged posts about lived experiences (e.g., about falling ill, or challenges of parenting during a pandemic), moral questions (e.g., visiting elderly relatives, or leaving the home with common cold symptoms), or provocative content (e.g., mocking conspiracy theories). These rules aimed at making the large number of posts manageable, but more importantly, at focusing the groups on scientific expertise instead of anecdotal evidence.

The other five adjacent groups were recommended to me during interviews. For example, the group *Stop Conspiratards*⁴ was founded so that members could continue posting emotional or provocative reactions to post-truth phenomena without disturbing factual discussions in other groups of the community. In contrast, the group *Covid-19 Science* aims to provide a space for sharing and discussing scientific expertise with a higher level of complexity and more factual tonality than the two largest groups. Additionally, I was invited to the group *Stop the Spread*. Here, members built their own repository of Covid-19 information. Or in their own words: “this group is a place to gather information so we can have factual discussions outside” (Group 7). To do so, they added links to scientific and journalistic sources, which were diligently sorted according to the most discussed and controversial topics (e.g., “masks as containment measure,” “long covid,” or “vaccines”). Whenever members wanted to inform themselves – or more importantly, others – they could draw from this shared library. The group *How to Deal with Conspiratards Online* also supported its members with knowledge about algorithmic visibility and other social media logics that would allow

them to make scientific expertise just as, or even more visible on the platform than content they considered as belonging to post-truth phenomena. Finally, I gained access to a group called *Support the Real Expert*. The group prominently featured a scientist who, similar to Drosten, became a public figure in the Covid-19 pandemic in Germany. However, this scientist was accused of misusing his expert status to spread misinformation about health risks and vaccinations. Individual scientists and science institutions publicly distanced themselves and discredited him as a “bad expert” (Sweet & Giffort, 2021). The group *Support the Real Expert* was explained to me as a so-called honeypot (Interviewee H), a trap to lure in, educate and mock those who supported said scientist.

I understood these seven groups as belonging to one online community, as their administrative teams (consisting of admins and moderators) either overlapped or were connected “behind the scenes.” In our interviews, many admins and moderators explained how they took on multiple roles across groups (e.g., the admin of one group would also be listed as moderator in another group), or depending on their resources, took on different responsibilities throughout the pandemic (e.g., they would focus their engagement on one group later on). They also emphasized how the individual groups complemented each other.

Data Collection

In January 2021, a post from the group *Drosten Ultras* appeared on my private Facebook feed. Drawn in by the peculiar combination of German virologist Christian Drosten and the association with sports fandom, I requested membership. Retrospectively, this was my entry to the digital field site. Instead of sampling and analyzing individual posts or comments, however, I chose a digital ethnographic approach (Kozinets, 2019; Pink et al., 2016). This allowed me to gain deeper insight into why and how this community had decided to organize in support of scientific expertise and how they themselves experienced this form of engagement. In line with this approach, the boundaries of my field site were largely informed by the administrative teams of the community. By working in this way, I followed the tradition of “multi-sited ethnography” (Marcus, 1995), which encourages ethnographers to leave it up to research subjects whether a study is about a “particular bounded place or about networks of diverse connections” (Hine, 2009, p. 8). Moreover, I followed the idea of “digital flows” (Markham & Gammelby, 2017, p. 451), meaning that I focused my research on what my interviewees deemed most relevant to the community, or reacted to “hunches and clues” (Markham & Gammelby, 2017, p. 459) gleaned from my observations. Ten months into my field work, I had joined all seven groups relevant to this study. I decided to exclude other groups from my research focus because they did not fit the research question. For example, I excluded Covid-19 and Long Covid patient groups that were used to exchange experiences about the illness and its treatments, or a lack thereof.

Sometimes, the community’s practices spilled over into the offline world, for example, when members attended protest marches to stress the necessity of Covid-19 measures in between lockdowns. While my research focuses on the community’s

online activities, I was able to capture some of these practices since they were often reported on and shared in the Facebook groups. In total, the field work lasted for two years with approximately 10 hours per month, during which I took screenshots from the groups' feeds, wrote field notes about my observations, and conducted 24 interviews with members of all seven administrative teams lasting an average of 45 minutes. I de-identified screenshots, interview transcripts, and notes before entering them into the research software MAXQDA, where the data was coded.

When first contacting admins and moderators through the private messenger on Facebook, some were hesitant to speak with me since they had previously experienced hate speech and trolling on the platform. They agreed to interviews only after I had proven my status as a doctoral researcher (e.g., by sending a link to my research profile on my employer's website). To cater to the interviewees' individual preferences (e.g., in terms of privacy or digital literacy), the interviews were conducted via different video and audio call tools. As requested by the interviewees, the conversations were either recorded or substituted with written notes. I obtained verbal consent for these recordings or notes, and to use the contents of our conversations for scientific analysis and reports. Most conversations were followed up with a Facebook friend request and so continued throughout the field work via the private messenger function. I decided to observe but not participate in interactions in the group feeds (e.g., by liking, reacting, commenting, or posting), to disturb the group dynamics as little as possible.

Ethical considerations have been incorporated into the research process throughout and were based on methodological literature and existing guidelines (e.g., [AoIR, 2020](#)). Especially challenging in the context of observing large online communities is the so-called "consent gap" ([Kozinets, 2019](#), p. 173). Although social media users publicly share information online, they might not agree to this information being used for research. However, disclosing my role as a researcher through public posts in the group feeds would have carried risks. For one thing, since I presented myself on the platform with my full name, I would also have been exposed to the risk of being harassed by social media users with anti-science attitudes. Moreover, public posts would have been searchable via the platform and would have linked me to the groups I was researching; the pseudonymization could easily have been circumvented, therefore, by searching for my name on the platform. Thus, and in line with considerations about "ambiguous consent" ([Roulet et al., 2017](#)), I decided to accept this state of covert observation vis-à-vis the group members with whom I did not interact, and instead prioritized the confidentiality of the admins and moderators I interviewed and whose interactions in the feeds I observed most closely.

Data Analysis

Following an exploratory and inductive research approach, the data analysis was carried out in a highly iterative process. For clarity, it is described here in three steps. The first step comprised exploratory open coding, guided by a general interest in what appeared to be a peculiar form of science fandom. In sports fandom, being an "ultra" means going beyond what a normal fan would do in support of their team.

In soccer, for example, ultras fans are often associated with provocative chants, pyrotechnics, or even violence (Doidge et al., 2020). To better understand what it means to be a “Drosten Ultra” or member of “Team Drosten,” therefore, I focused a first round of open coding on those practices that the community engaged in to support science on social media during the Covid-19 pandemic. Those were labeled, for example: celebrating public scientists, sharing science communication content, debunking misinformation, or mocking conspiracy theories.

The second step entailed the clustering of open codes into broader analytical categories. By drawing on relational mapping (Clarke et al., 2022), I first examined how the community made sense of its own role in relation to scientific experts (as subservient) and post-truth phenomena (as antagonistic). Assigning the open codes to either one of these analytical categories allowed me to subsequently compare and contrast practices in the service of science with practices to counter post-truth phenomena. Interestingly, this led to the observation that the community adopted practices from both their scientific role models and their post-truth antagonists. On the one hand, members of the community reproduced virtues that they attributed to science such as objectivity, facticity, and rationality in online debates. On the other hand, they copied practices from their post-truth antagonists with the goal of leveraging social media infrastructures and logics equally skillfully.

In a third step, and drawing on observations from the digital field site, I applied the conceptual lens of “allyship” to my data. This term is commonly used in the context of social justice causes to describe people who express solidarity and support for marginalized groups that they themselves do not belong to (Dabiri, 2021; Sumerau et al., 2021). This support often becomes visible in social media environments (Clark, 2019; Liu et al., 2024). On Facebook, people regularly use profile filters (i.e., designed frames with symbols or text to add to a profile picture) to declare their allyship (e.g., for Black Lives Matter, or queer rights). They also did so in the context of the Covid-19 pandemic, for example, to demonstrate their support for vaccinations. Viewing the data through the conceptual lens of allyship unveiled additional layers of meaning. While it appears counterintuitive to understand established or scientific expertise as marginalized, during the Covid-19 pandemic and especially in social media environments, the community perceived it as being drowned out by post-truth phenomena. Much like allies in the context of social justice causes, they wanted to lend their voices to science in order to make its expertise heard. This highlights that in addition to an expression of fandom toward individual scientists, the community regards its engagement as politically motivated mobilization for the role of science in society.

FINDINGS

Based on the empirical case of this study, I came to understand laypeople that aim to uphold instead of challenge the epistemic authority of established expertise online as *allies of expertise*. To conceptualize their engagement, I first examine how *allies* come to understand their role in relation to scientific experts (as subservient) and post-truth actors (as antagonistic). For both relational categories,

I then identify practices via which they orient themselves toward their role models from the world of science but also toward their post-truth antagonists. As a result, I argue that the engagement of *allies of expertise* must be understood as being both in the service of science and to counter post-truth phenomena. I support these findings with illustrative examples from my interviews and ethnographic observations.

Lay Engagement in the Service of Science

Allies of expertise engage independently from scientific experts or science institutions, but put themselves in the service of science. In their role, they signal their epistemic subservience to scientific experts. Thus, they refrain from making their own claims to expertise or to participation in expert work. Instead, they orient their practices to their scientific role models and aim to reproduce virtues that are commonly associated with science – objectivity, facticity, and rationality – in otherwise confusing and contested online debates. Through these efforts, they also construct a shared understanding of science and its desired role in society.

Epistemic subservience to scientific experts. “Science is the basis for democracy. Without it, we would live like in the Middle Ages, but instead we had the Enlightenment. We could not have fought the pandemic without science” (Interviewee K). This is what a group admin told me when asked about the role of science in society. There was consensus in the community that when it comes to solving societal challenges – from the pandemic to climate change, to global migration and wars – both individual and political decisions ought to be guided by scientific evidence. While they perceive and acknowledge certain limits of science, such as its inherent provisional quality and uncertainties, or a lack of engaging communication skills in many scientific experts, they were generally convinced of the epistemic superiority of scientific expertise against other ways of knowing. As a moderator emphasized: “a scientist is, after all, a scientist. They are the ones who know something and not the ones who believe something. I think that we should put more trust in them” (Interviewee J).

In the context of the Covid-19 pandemic, the community prides itself on recognizing and putting trust in scientific expertise rather than falling prey to post-truth phenomena. At the same time, however, its members continuously emphasize limits to their own knowledge and skills. “Knowing one’s place” outside of expert domains is crucial to them. This epistemic subservience to scientists is reflected in group descriptions such as: “we are no experts. [...] We rely here on the wisdom of the many, surely risking a certain ‘swarm stupidity’” (Group 7). Members of the community also signal this stance to each other, especially when sharing sources or information that they are unsure about. As in this case, where a member links to a blog post about Covid-19 transmission: “those who know me, know that I only share what is based on secure knowledge. That’s why I ask for your help in assessing this. It sounds correct, but I am not an expert” (Group 2). This rhetoric also matches the self-ascribed tasks of the administrative teams. A moderator described their tasks to me as “lots of fact checking – not on a subject level, I can’t fact check any scientific results – but I can check the sources”

(Interviewee S). They thereby clearly distinguished their expertise in media literacy from scientific expertise.

The community does, however, host people with relevant, even scientific, expertise. In the context of their engagement as *allies of expertise*, however, even they are careful to make no claims to expertise for themselves. For example, Interviewee E is well-known within the community for sharing and interpreting scientific expertise at a high level. During our interview, they disclosed their professional background to me: they used to hold an academic position in the life sciences before switching to a corporate career. On Facebook, however, they act under a pseudonym and no longer state their profession. This is to protect themselves from being targeted with hate speech or trolling from post-truth supporters, but also because they feel uncomfortable in light of the community's expectations toward their expertise. I observed this in the following exchange in a comment section:

- Member A: With [Interviewee E], the entire knowledge of science is available to the group. Many thanks to [Interviewee E].
- Interviewee E: Thank you dear [Member A], but this is not correct. [...] I am not a virologist [...] 😊 I don't hold the entire knowledge of science either, even if I feel flattered, of course 🙏
- Member A: Thank you for your explanation, which only reaffirms your expertise. But maybe you feel like addressing something fundamental about the topic to us in a post?
- Interviewee E: With reluctance. I prefer science to be in the foreground instead of scientists.
- Member A: I meant something basic about the Corona pandemic, the connections between climate, environment, health and pandemic. Without any scientists. It would be interesting to hear the interdependencies explained not only by politicians.
- Interviewee E: I prefer to leave that to the experts and those who are researching it. Of course, I am happy to support the interpretation of the studies where I can.

In this exchange, Member A voices their gratitude for Interviewee E's engagement in the group. In doing so, however, they exaggerate their knowledge and skills as holding "the entire knowledge of science." When Interviewee E rectifies the matter of their competencies and points out the limits of their knowledge, this is met with favor by other members of the community including Member A. This exchange illustrates how epistemic subservience is valued and rewarded within the community.

The value of epistemic subservience for the community becomes especially evident when members overestimate their knowledge or skills. For example, one moderator voiced criticism about group members engaging with scientific preprints: "if some civil engineer thinks he can listen to a podcast, which is without question excellent [note: they are referring to a science communication podcast by Christian Drosten], to then hang around on preprint servers and properly evaluate that, that's not how the world works. I think that's disastrous" (Interviewee G).

While preprints are in fact publicly accessible, they were rarely discussed by laypeople before the pandemic. With the great need for information about the virus, vaccinations, or policy measures, some of the related preprints found their way into media reports or social media (Bauer et al., 2023). Interviewee G considers it problematic to open up this typically inner-scientific practice of reviewing preliminary scientific work to the public. From their perspective, laypeople should not be involved in it. Declaring scientific knowledge production and evaluation as an exclusive expert domain further emphasizes the community's epistemic subservience to scientists.

Reproducing scientific virtues in online debate. Although members of the community regard epistemic practices such as scientific knowledge production or evaluation as exclusive expert domains, they strongly orient their engagement toward what they deem as scientific virtues. This becomes evident in their critical assessment of new information, in diligently maintained repositories, or discussion rules aiming toward rational deliberation. In group descriptions, these practices are often framed as similar to science communication: for example, as “sharing scientific and socially relevant information around the SARS-CoV2-pandemic and Covid-19” (Group 3), or as presenting “data, facts, study results [in an] up-to-date, rational, concise and understandable way for laypeople” (Group 1).

Within its groups, the community aims to provide a space for respectful and rational debate “on a higher level than typical for social media” (Group 1). They are thereby able to meet the informational needs of many of their members, who regularly voice their gratitude in posts and comments, for example, for “scientific information on the development of the pandemic,” or “the (non-political) assessment of scientific facts” (Group 1). Some groups are specifically strict about adhering to this idea of scientific practices and virtues. For example, the group *Covid-19 Science* is known within the community for its high level of complexity and factual tonality. Its administrative team has created a sophisticated filing system for Covid-19-related research, along with a set of rules for its compliance. This is by design. As one of the admins notes: “we are too factual to trigger anyone emotionally” (Interviewee E). By focusing on the dissemination of scientific expertise and refraining from more emotional or personal posts, they also aim to avoid attention and trolling from post-truth supporters. A group admin of *Stop the Spread* makes a similar statement about how they adapt their behavior within the community, but can also depart from the ideas of rational deliberation in broader online discourse. They say: “I also mock people online, for example, when I come across a post from Bullshittistan, but in *Stop the Spread*, I try to be factual” (Interviewee K).

Not all groups and members follow this example. But while groups and members have different views on how strictly they ought to separate science from politics, factual information from personal experiences, or rational deliberation from humorous and emotional engagement, they do agree that there are clear boundaries to be drawn. The community thus constructs a shared understanding of science, which allows the groups to work together despite their different approaches.

Lay Engagement to Counter Post-Truth Phenomena

Allies of expertise not only hold common understandings about science and its desired role in society, they also recognize a common enemy in post-truth phenomena. Notably, they not only orient their practices on role models from the world of science but also copy practices they observe in their post-truth antagonists. These entail practices to “game” the platform and gain algorithmic visibility (Petre et al., 2019) so that they can make scientific expertise just as, or even more visible on the platform than conspiracism and misinformation. However, some members go so far as to copy practices like trolling or incivility that might also increase social media engagement, but are actually at odds with the scientific virtues they aim to defend.

Antagonizing post-truth actors. When I first applied for membership in the group *Drosten Ultras*, the following text appeared on the screen: “no admission without an answer. Why are we called Drosten Ultras?”. There were two answers to choose from: “because we are sleep sheep listening to Merkel, and parrot everything from Bill Gates,” or, “because we consider Prof. Dr. Drosten to be a very competent doctor who explains the situation very calmly.” When asked about this clearly satirical application process, the group admin explained to me that it is important to take a stand against “conspiratards and populists” (Interviewee A). This illustrates that aside from disseminating scientific expertise and reproducing scientific virtues in online debate, the community also pursues another goal. It mobilizes against the commonly perceived enemy of post-truth phenomena.

In the context of the Covid-19 pandemic, the community perceives phenomena such as misinformation or conspiracism as threats to individual and public health. But more than that, the people I observed and interviewed were worried about a general decline in facticity, rationality, or objectivity in public discourse. They feared that trust in scientific expertise was being deliberately eroded by post-truth actors, and with it the possibility for rational deliberation and decision-making. In many conversations, it became clear that these concerns were not limited to the Covid-19 pandemic. Such was the case with this moderator, who said:

The pandemic was only a case of the infodemic. It's not quite scientifically defined, but the UN is already talking about it, saying that an overload of information, both correct and incorrect information, means that suddenly everything or nothing appears credible anymore and people lose the plot. That was Trump's strategy in his [note: first] legislative period (Interviewee S)

Prior to founding the online community, admins and moderators had observed how well post-truth actors appeared to be networked and organized on social media platforms. For example, when asked why they put time and effort into the community, one moderator referred to such post-truth actors: “I believe that so many people simply want to enrich themselves with such topics, want to pursue their own political or other goals, and that you have to stand up to them” (Interviewee J).

Copying practices to gain algorithmic visibility. In their mission to combat an “infodemic” and the deliberate attacks on scientific expertise online, the community is often confronted with the limits of adhering to practices such as

disseminating factual information or encouraging rational deliberation. Group discussions regularly turned to the question whether post-truth supporters could be convinced otherwise by adhering to scientific virtues alone. As this member shares in a comment, for example: “I don’t think that you can get the extreme conspiratards to think rationally. My nerves and time are too valuable for that. Two years of arguments, facts and science have so far achieved nothing with them, on the contrary” (Group 4). Others respond to this frustration by emphasizing the impact that the community can have on those who have not yet fallen prey to post-truth. By setting up most groups as publicly visible and disseminating scientific expertise outside of their groups as well, the administrative teams hope to inform the “movable middle” (Buerger, 2021), like those who are still on the fence about getting vaccinated. This is also reflected in a quote by a group admin:

We wanted the groups to be publicly visible so that everyone can read our information. But we do not want any conspiratards in here. So, we check every profile before admitting them. If someone has previously spread misinformation, [...] no chance (Interviewee A)

Members of the community perceive social media as a particularly hostile environment for scientific expertise, but also post-truth actors as being better at leveraging social media logics and infrastructures for their agendas. While some groups set up barriers (e.g., obligatory membership requests, or checking profiles) to protect themselves from being “infiltrated” (Interviewee A) by post-truth actors, others leverage their knowledge about digital infrastructures and algorithmic visibility with the goal of drowning out post-truth voices in online discourse.

The group *How to Deal with Conspiratards Online* is especially notable in this regard. On the one hand, this group provides epistemic resources (e.g., links to science communication content) that can be used in debates with post-truth supporters. On the other hand, the group draws on knowledge about community guidelines and blocked accounts, or strategies to optimize the visibility of posts and comments. For example, when coming across misinformation or conspiracy theories elsewhere on social media, members can link to these digital places (e.g., Twitter threads, Facebook comment sections), so that others can join them there in counterspeech. Interviewee K shared some of their insights on how to interact in ways that would promote the best visibility. They also reveal that they have observed similar practices in post-truth supporters and have copied them, since: “you shouldn’t write too long, and very early, with high frequency, that way you can increase reach and get triple digit likes sometimes.” This illustrates how the community aims to be as networked and organized as their antagonists and thus, to be able to make scientific expertise just as, or even more visible on the platform.

These observations further suggest that the community perceives their post-truth antagonists as better equipped at leveraging platform infrastructures and logics. In efforts to “beat them at their own game,” parts of the community not only adopt strategies to optimize the algorithmic visibility of their own posts and comments. They also copy practices, such as trolling or incivility, that are

strongly in conflict with what they regard as scientific virtues and would be considered inappropriate for scientists themselves. Most notably, I observed a scheme to troll supporters of a discredited public scientist. The scientific community had publicly accused this scientist of spreading Covid-19-related misinformation through social media and popular science books. During one of my interviews, I learned about a group called *Support the Real Expert*. The purpose of the group is to mock and lecture those who continue to support this discredited scientist. The debates in the group's comment sections are heated and oftentimes offensive. Members advise each other to "go back to elementary school and learn to read," or ask offending questions, such as: "if less-educated populations are less likely to get vaccinated, does that mean the stupid ones will die out in the long run?" (Group 6).

When I get in touch with a member of the administrative team of *Support the Real Expert*, they tell me that it is their mission "to show the people how dangerous their behavior and that of their 'gods' [note: they are referring here to scientists misusing their expert status to make alternative claims] is to democracy" (Interviewee N). Another interviewee supports what I learned about the group's mission, but also seems uncomfortable in their answer: "You could think of it under the heading 'honey pot'. It was founded [...] with the goal of getting as many conspiracy theorists in there as possible" (Interviewee H). When asked about their motives – will they then disseminate scientific expertise there? – they admit, "Yes, it's to share scientific expertise, but also to make fun of people" (Interviewee H).

Based on these observations, the community not only reproduces scientific virtues in online debates but also defends the epistemic authority of science by less virtuous means if this is deemed necessary. When practices such as fact-checking, evidence-based arguments or rational deliberation appear to be futile in convincing others of scientific expertise, some members of the community even resort to uncivil practices. A moderator reconciled such tensions by describing the community as "an unholy alliance pursuing the right goal" (Interviewee S). In other words: The end of defending science against post-truth phenomena appears to justify even incivil means.

DISCUSSION

This study contributes to scholarship concerning a "crisis of expertise" (Eyal, 2019; Heimstädt et al., 2024; Reed & Reed, 2022), and in particular to the question of how this crisis can unfold in social media environments. While existing research has focused largely on how laypeople circumvent or challenge the epistemic authority of established expertise online (see, e.g., Au et al., 2022; Bauer et al., 2023; Larrson Heidenblad & Nilsson, 2023), this study shows that there are also forms of engagement that aim to uphold it. When taking on the role of what I term *allies of expertise*, laypeople perceive established expertise as being drowned out by widely shared "alternative" or "fake" claims to expertise. To counteract this, they disseminate and defend (what they regard as) established

expertise against (what they regard as) post-truth phenomena. *Allies of expertise* can contribute to solving said crisis by making established expertise more visible and bolstering its epistemic authority in often confusing and contested online debates.

However, this form of lay engagement also bears risks. The question that comes to mind: When becoming *allies of expertise*, what kinds of expertise do laypeople consider worth defending, and what means do they use to do so? In the empirical case of this study, the online community constructs a shared understanding of science that builds on virtues such as objectivity, facticity, and rationality as well as their strict separation from experiences, emotions, and values. They orient their engagement toward this understanding but regularly experience the limits of fighting misinformation or conspiracism with, for example, fact-checking, evidence-based arguments or rational deliberation. Some then resort to less “virtuous” practices that are at odds with this understanding of science – and would not be deemed appropriate for scientists themselves.

With its understanding of science and the practices members choose to engage in, the online community echoes popular post-truth concerns and their often binary notions of fact versus fake, evidence versus experience, or science versus ideology (D’Ancona, 2017; Nichols, 2017). Existing work drawing on the social studies of science has criticized such binary notions for misrepresenting the realities of scientific work, the knowledge it produces, and what it can achieve at the science-policy interface. In this line of thought, scholars emphasize how scientific knowledge production can be regarded as inherently political (Meyer & Quattrone, 2021) and how in questions of expertise, facts and values are often “inextricably entangled” (Eyal, 2019, p. 76; see also Harambam et al., 2022). Moreover, while such binary notions fail to represent the realities of any type of scientific work, historically they have especially disadvantaged expertise from the social sciences and humanities, which as so called “soft” sciences were often (and continue to be) ascribed less epistemic authority (Lewis et al., 2023; Shapin, 2022). This is also mirrored in the online community’s understanding of science, which draws on practices and virtues that are generally associated with “hard” sciences: quantitative and statistical methods, controlled experiments, objectivity, or value neutrality (Shapin, 2022). Thus, *allies of expertise* run the risk of reproducing monolithic and “pure” (Shapin, 2010) images of science that might not match the realities of expert work and the diversity of established expertise.

A further risk in the engagement of *allies of expertise* lies in their subservience to scientific experts and the clear-cut boundaries they draw in lay-expert relations. They thereby contradict existing efforts to promote trust in science and established expertise, where academic literature as well as science policy programs have long emphasized the need to open up the work of experts and invite public engagement and participation (Weingart et al., 2021). In line with this call, studies on citizen science (Baudry et al., 2022) or lay expertise (Epstein, 1995, 2023) have documented how laypeople aim to contribute to expert work, often at great effort and expense. While Epstein (1995) warned fellow scholars to understand laypeople as “a resource available for use, or an ally available for enrollment”

(p. 409), this study shows how laypeople take on such a role of their own accord. They signal their epistemic subservience to scientists (for similar observations, see [Mayes, 2024](#); [Wenninger & Dickel, 2019](#)) and regard epistemic practices such as scientific knowledge production and evaluation as exclusive expert domains. This conflicts with ideals of democratizing science ([Weingart et al., 2021](#)). Moreover, previous work has warned of the negative effects of a “deference to scientific authority” ([Howell et al., 2020](#); [Post et al., 2021](#)), that is, the belief that matters concerning science and technology ought to be decided upon by experts and not through democratic processes. *Allies* run the risk of ascribing a role to experts that cannot be fulfilled – and is not desirable in the context of public deliberation or political decision-making.

In summary, this study conceptualizes the lay engagement of *allies of expertise* who aim to uphold the epistemic authority of established expertise in online debates. However, it also suggests that *allies*’ service to science can turn into a disservice. By building their engagement on idealized images of science and subservient lay-expert relations, they run the risk of reproducing false expectations that the realities of expert work and knowledge might not be able to fulfill. It is important to note that this conceptualization of *allies of expertise* is based on qualitative insights from the Covid-19 pandemic. The unprecedented role of scientific expertise and the prevalence of post-truth concerns in everyday life during that time most likely contributed to this specific manifestation of allyship. However, similar phenomena observed in earlier work (see [Riesch et al., 2021](#); [Stephens et al., 2022](#)) suggest that the concept is applicable and insightful beyond the context of the Covid-19 pandemic. Future research ought to investigate in which other on- and offline contexts laypeople take on the role of *allies of expertise*, what types of expertise they consider worth defending, and what means they use to do so. On a more practical note, this study can also provide an opportunity to reflect on how to create and communicate public images that better reflect the realities and diversity of science and expertise in society.

NOTES

1. I speak of laypeople to describe a role that is realized when people are dependent on or draw on (what they recognize as) expertise in everyday contexts. I apply the term to make an analytically necessary distinction between experts and non-experts, while also being aware of its shortcomings in describing more complex lay-expert hybrids and relations (for further discussion, see [Epstein, 2023](#)).

2. I understand established expertise as knowledge that is recognized and endorsed by the traditional institutions of science, media, and politics.

3. I have assigned pseudonyms to all groups. However, the two largest groups whose names allude to German scientist Christian Drosten as well as sports fandom (“Ultras,” “Team”) could only be de-identified to a limited extent. Maintaining these allusions was crucial for a comprehensive understanding of the empirical setting. I further protected the privacy of admins, moderators, and members by assigning them pseudonyms and refraining from providing further details about them, such as binary-gendered pronouns or other demographic information. The translation into English provides a further layer of de-identification.

4. “Conspiratards” is a derogatory term for conspiracy theorists, made up of the words “conspiracy” and “tard.” It is used here as a non-literal translation of the German term used in the empirical case. For reasons of pseudonymization, I will refrain from stating the original term.

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ENTER THE SPIRAL: THE ADVERSE CONSEQUENCES OF PROFESSIONAL AND LAY EXPERTISE FOR SUFFERERS' LIVED EXPERIENCES

Siddhant Ritwick and Tomi Koljonen

*Aalto University, Finland
University of Liverpool, UK*

ABSTRACT

While professional expertise is often the first recourse for diagnosing and treating personal problems, it cannot always satisfactorily solve them. In such instances, lay expertise can often complement professional knowledge and practices. Due to easily accessible digital platforms, it is increasingly common for people to utilize both professional and lay expertise to solve problems. This warrants further examination of how utilizing both professional and lay expertise co-constitute the lived experiences of sufferers. To answer this question, we qualitatively studied a prominent online community dedicated to reflux disease. We found that, in many cases, both professional and lay expertise proved inadequate in alleviating suffering. The nature of the symptoms faced by the sufferers, the subsequent dependence on and failure of professional and lay expertise to satisfactorily solve the problems led sufferers to experience what we call the spiral. The process of spiraling exemplifies how the sufferers engage with diverse forms of expertise and how this in turn shapes their lived experiences.

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By developing this notion, we contribute to the literature on expertise by showing the combined effects of both professional and lay expertise on the sufferers' lived experience. Our study also highlights the limitations to the complementarity of professional and lay expertise, as well as the potential harms of engaging with lay expertise.

Keywords: Expertise; professions; lay expertise; clients; online communities; suffering

Unable to work, I ended up spending the better part of two months lying in the hammock in my tiny backyard. I could no longer tolerate food with strong flavors, so I subsisted on brown rice, lentils, steamed vegetables and small amounts of chicken breast. At some point, my wedding band slipped off my thinning fingers, lost without my realizing it. One evening, my 10-year-old daughter, the eldest of my three children, burst into tears and said, "I just want you to get better!" (Velasquez-Manoff, 2023)

Science and medicine have turned many previously severe diseases into solvable problems (Greenwood, 2008). However, many health problems – such as the recent example of long-Covid-19 (Au et al., 2022) – remain difficult to diagnose and treat. Many of us have a family member or a friend who is dealing with a longstanding health issue that seems to defy treatments or even diagnosis. Such issues can cause utmost suffering for individuals and their loved ones – as the New York Times science journalist's long-term experiences with gastrointestinal issues show.

Professional expertise, the abstract knowledge held and practiced by credentialed experts (Abbott, 1988) – is often the first recourse in such situations. However, professional expertise may, on occasion, fail to solve clients' problems or meet sufferers' expectations. For example, doctors may be unable to diagnose and treat sufferers' symptoms (Bradley, 2021) or professional expertise might be unreachable due to long wait times or high cost (Siciliani et al., 2014). On other occasions, patients feel alienated by professionals who discount emotional needs (Pilnick & Dingwall, 2011).

In such situations, sufferers can turn to lay expertise to address their concerns (Epstein, 1995). Lay expertise is a collection of hybrid knowledges and practices disseminated and utilized by non-credentialed people in a given issue domain (e.g., HIV/AIDS advocacy). This hybridity originates from lay expertise's diverse knowledge bases, values, personal experiences, and interaction spaces – all of which usually contrast with professional expertise (Epstein, 2023). Prior work has identified several benefits to lay expertise, including its ability to complement professional expertise by filling knowledge gaps through the articulation of sufferers' problems (Au & Eyal, 2021; Eyal, 2013). Lay communities can also provide emotional support and identity for members by acknowledging their experiences and interests (Borkman, 1976; McReynolds-Pérez, 2017; Rabeharisoa et al., 2014).

While this previous work has helped us understand the relations between sufferers and professionals, and sufferers and lay expertise, there has been much less attention to sufferers' lived experiences in relation to *both* forms of expertise. However, there are several reasons why these experiences would be important to

understand. First, when individuals face personal problems that require expertise, they often engage with both professional and lay expertise simultaneously or sequentially (Au & Eyal, 2021; Kraschnewski et al., 2014). However, even when it highlights lived experience at all, the literature on expertise mostly considers lived experience in relation to different forms of expertise in isolation. Second, lay expertise is increasingly accessible through online lay communities organized around shared concerns (Akrich, 2010; Hardey, 1999; Kempner & Bailey, 2019). These lay communities can potentially mediate the influence of professional expertise on lived experience. Finally, while popular depictions of online communities sometimes point to the problematic nature of these groups (Dooley & Ueno, 2022; McAllen, 2024), to date, the academic literature has often focused on the nature of lay expertise itself and its epistemological tensions with professional expertise (e.g., Croidieu & Kim, 2018; Wynne, 1996). We thus know less about the potential “dark side” of engaging with lay knowledge for individual sufferers. Therefore, it is important to understand *how utilizing professional and lay expertise co-constitutes the lived experiences of sufferers?*

To answer this question, we conducted an inductive archival study of an online community dedicated to reflux disease. Drawing on the work of philosopher Ian Hacking (1995), our analysis reveals a process we call *spiraling* that characterizes how the sufferers engage with diverse forms of expertise and how this shapes their lived experiences. In *entering the spiral* phase, sufferers first experience enduring and painful symptoms and a dependence on expertise, raising anxiety about their situation. In the next phase, *deepening the spiral*, the sufferers depend heavily on medical experts. When professional expertise yields little relief, the next phase, *expanding the spiral*, follows, wherein sufferers turn heavily to online lay expert communities for solutions. While these communities acknowledge their suffering, they also offer sufferers perplexing advice, further contributing to adverse experiences of the sufferers. Our study contributes to the literature on expertise by showing how the combined adverse effects of both professional and lay expertise on the sufferers contribute to their experience of a *spiral*. Furthermore, we explicate the boundaries to the complementarity of professional and lay expertise, and the limitations of lay expertise.

The implications of professional and lay expertise for the lived experience of sufferers: Individuals grappling with a variety of problems often seek assistance from professionals (e.g., doctors, priests, and therapists) who draw on their professional expertise to solve these problems (Abbott, 1988; Freidson, 2001). However, professional expertise does not always provide satisfactory solutions. For instance, professionals may not have the knowledge needed to solve sufferers’ problems or they fail to meet people’s emotional needs (Bouchard et al., 2023).

Dissatisfied individuals can then seek solutions through lay expertise (Arksey, 1994; Barker, 2008), a term often invoked, but surprisingly, rarely defined. Usually, it refers to “outsider” knowledge and participation in a domain of professional or scientific expertise (Epstein, 1995; Wynne, 1996). Lay expertise is defined by its structural position, knowledge bases, values, and collectivity (Epstein, 2023). First, it is practiced, initiated, and advanced by relative outsiders beyond the traditional boundaries of established professions or science (see Gieryn, 1983).

Second, lay knowledge is characterized by epistemic hybridity (Epstein, 2023), as it appropriates professionals' primary source knowledge (Collins & Evans, 2007; Epstein, 1995), as well as anecdotes, alternative, and experiential knowledge (Broom & Tovey, 2008; McReynolds-Pérez, 2017). Third, actors engaged in lay expertise may align with professionals on values such as "health," but their priorities are often more personal and urgent (think of a cancer patient versus a cancer researcher). Finally, while lay expertise may draw from individuals' lived experiences, it is constructed in lay communities that range from activist movements (Epstein, 1995) and patient organizations (Rabeharisoa & Callon, 2004) to online communities (Foster, 2016). These collectives are tied together by members' shared experiences and identities (Allsop et al., 2004; Epstein, 2008), rather than shared socialization or institutional credentials – the hallmarks of professional expertise.

Yet, despite important differences, professional and lay expertise are not polar opposites. As Epstein (2023, p. 82) remarks "most of the empirical work on lay expertise speaks to its hybrid character and indicates that lay expertise in practice traverses the boundary between official knowledge and its multiple 'others,' rather than being located purely on the 'alternative' side of the divide."

Lay expertise can draw on professional knowledge, while professional expertise can similarly use patients' experiential knowledge or common sense.

Lay expertise fulfills several roles: it offers emotional support (Radin, 2006), generates experiential knowledge rooted in personal experiences with similar conditions (Borkman, 1976), and helps in navigating established institutions (Foster, 2016). Lay expertise can also contribute to the scientific process (Epstein, 1995) by interpreting and challenging professional norms (Barker, 2008; Wynne, 1996). Lay community members also engage in fact-gathering, data collection, analysis, interpretation, and treatment that do not necessarily adhere to standard professional practices (Campbell, 2021; Hardey, 1999).

However, while the literature has helped us understand the relationship between sufferers and professional experts, on the one hand, or sufferers and lay experts, on the other hand, there has been much less work on the combined effects of sufferers' engagement with professional and lay expertise. Instead, the literature has often focused on portraying relationships between professional and lay expertise as a political, jurisdictional, or epistemological struggle (Brante, 1988; Eyal, 2019; Kendall & Freidson, 1976) while paying less attention to sufferers' actual lived experiences as a result of engagement with expertise.

There are several important motivations to pursue this knowledge. First, individuals rarely engage with either professional or lay expertise exclusively (Kraschnewski et al., 2014). As Epstein (2023) notes, the boundary between the two is often porous, with lay experts gathering, interpreting, and disseminating professional knowledge, while at the same time, institutionalized professionals also complement their domain expertise with experiential knowledge. For instance, during the Covid-19 pandemic, online community members were recipients of both official public health messages and the interpretations of lay experts (Au & Eyal, 2021). In many contemporary cases then, simultaneous, or sequential engagement with both professional and lay expertise is the norm rather than the

exception. However, the literature on expertise often considers lived experience in relation to different forms of expertise in isolation.

This leads us to our second motivation: the increased accessibility of lay expertise through online communities. Affordances of technologies such as discussion platforms, smart devices, and wi-fi make lay communities prevalent and accessible (Brady et al., 2016). In healthcare, websites, blogs, and online communities have emerged around a variety of issues (Akrich, 2010; Kempner & Bailey, 2019). Instead of locally and culturally bounded advocacy groups, these new kinds of communities offer knowledge and collectivity without formal organization or the goal of mobilization (Foster, 2016). The accessibility of these communities is in stark contrast to professional expertise, which is often limited by economic, availability, or geographic constraints.

Finally, while there is some reporting on the “dark side” of such online lay communities (Dooley & Ueno, 2022; McAllen, 2024), their potential downsides to participants’ lived experiences have rarely garnered much attention within the broader expertise literature. We thus know little about the potential “dark side” of engaging with lay knowledge for individual sufferers. Therefore, we ask, *how does utilizing professional and lay expertise co-constitute the lived experiences of sufferers?*

To theorize our case, we draw inspiration from the notion of *looping* (Hacking, 1995), which describes how medical diagnosis and patient identities shape each other. This theory suggests that after a medical diagnosis is made and a patient is labeled, this label “loops” back to constitute the patient’s identity. We expand on the notion of looping by formulating the notion of *spiraling*. In our case, the initial loop originates from the nature of the sufferers’ symptoms and the dependence on professional expertise. This, in turn, generates anxiety, creating the *anxious self*. We elaborate on the idea of looping by adding in the third dimension, *depth*, which converts the two-dimensional loop into a three-dimensional spiral. This added dimension of depth is created by the prolonged dependence on professional and lay expertise, and the subsequent failure of both to provide adequate relief to sufferers, resulting in the experience of what we call *spiraling*.

METHODS AND DATA

Research Setting

We examine our research question in the context of online communities dedicated to reflux diseases: GERD (Gastroesophageal reflux disease) and LPR (Laryngopharyngeal reflux). Typical symptoms of reflux disease include regurgitation, dysphagia, burning in the throat and chest, inflammation of vocal cords, postnasal drip, excessive mucus, lump in throat sensation, burping, indigestion, and asthma (see, e.g., Maret-Ouda et al., 2020). Estimates of the diseases’ population-level prevalence range from 9% to 30% (IFFGDAAdmin, 2021). Reflux diseases differ from many others, as they are, on the other hand, not immediately life-threatening (compare cancer) or radically novel (compare Covid-19). This means there is sometimes a lack of urgent acknowledgment and

interest in the disease. On the other hand, reflux symptoms can be severe (compare minor headaches) and long-lasting (compare common cold), which means they can represent a significant shift in the lives of sufferers.

Standard treatments for treating reflux disease include PPIs (Proton pump inhibitors), H2 blockers (Histamine receptor antagonists), and antacids as well as lifestyle modifications (Gyawali & Fass, 2018). Diagnostic tests including endoscopies, Ph-impedance testing, and manometry can be used (Maret-Ouda et al., 2020).

The online communities we studied were founded in the late 2000s and have thousands of members. These communities provide sufferers with information, suggestions, and community. Sufferers often post about their problems and ask for help on topics including diagnosis, treatment, and diet. They also narrate their experiences with medical experts and lay experts alike. The posts are detailed and temporally arranged with terms such as “2 months ago” and “last week.” The lay experts respond to the sufferers’ queries with their own experiences and advice. The posts remain publicly archived on the platform and are available to anyone. While those who find complete relief may leave the forum, many continue to post because they are still suffering despite following guidance from both professional and lay experts. These communities are ideal settings to study our research question since the posts cover the expanse of how sufferers experience the confluence of the disease, and engagements with professional and lay expertise as they search for the elusive relief. Altogether, then, this setting is like many health communities (Epstein, 2008) where shared experiences of pain and suffering bring people together (Allsop et al., 2004; Packard et al., 2004).

Before proceeding, we would like to clarify the difference between “sufferers” and “lay experts.” Individual users in the online community can take different roles at different times. A person can act as a lay expert and advise on a problem while still struggling with the same problem. Also, there is variation in sufferers’ experience and knowledge. Following, Epstein (2023), we do not claim that at a given moment someone is an expert or not.

As the literature on lay expertise would suggest (Epstein, 2023), in our case, lay and professional expertise are not entirely in opposition. Lay experts often draw on professional expertise, as they might discuss – if often critically – gold standard medical practices (Jones & Podolsky, 2015) or less established, emerging treatments proposed by medical professionals. Conversely, professionals may also draw on “clinical experience” of what works for patients (Kahrilas, 2008, p. 1701) or lay knowledge about managing the disease (Ahuja & Ahuja, 2019), and not only systematically collected scientific evidence.

Data Collection and Analysis

We describe data collection² and analysis altogether, as the relation between these two processes was highly iterative. Our data consists of archival materials from a prominent online community for reflux disease that has over 75,000 registered members and, potentially, numerous unregistered users. The online community is open and does not require an invitation or registration to access. The platform provides guidelines and has human and automatic moderation.³ The users have

pseudonyms, but may at times state their age, gender, and location (e.g., “M,39, Atlanta” stands for male, aged 39, living in Atlanta). One interesting observation was that many of the sufferers reported being in their 20s or early 30s, while the average reflux patient is often of middle or advanced age (Lee et al., 2007).

Data collection took approximately 6 months, from April 2022 to September 2022. The data were posted between January 2017 and September 2022 and are primarily text in the form of threaded posts. Each post is timestamped and has temporal guideposts, aiding in understanding the narrative of unfolding events and experiences of the original posters and responders. First, at the beginning of data collection, the first author used the platform’s sorting features, such as “top” and “most commented” posts, to filter the posts. These posts are high in engagement, reflected by the number of comments and upvotes (i.e., likes) they have received. The first author continued initial data collection until reaching the first point of saturation (Glaser & Strauss, 1967), that is, the same types of discussions started reoccurring with no qualitatively different ones appearing. This resulted in a sample of 206 threads.

We initially analyzed the data inductively (Charmaz, 2009). The first author began the analysis by closely reading these texts and open-coding a sample of the posts, searching for emerging patterns. The second author joined the project at this stage to develop data collection and analysis. During initial coding, we observed two interesting patterns. First, sufferers consistently wrote about how persistent their symptoms were as well as their reliance on expertise to solve this issue. We coded examples of these patterns “Encountering painful and long-lasting symptoms” and “Needing to rely on professional expertise.” Second, they described their experiences of engaging with professional and lay expertise and their effects on their lived experience. We focused further data collection and analysis on understanding how the lived experience of the sufferers changed as they engaged with different forms of expertise.

With this focus and emerging categories of professional and lay expertise in mind, the first author collected another 172 threads that provided insight into the sufferers’ experience of their disease and engagement with the two forms of expertise, leading to a sample of 378 threads. While there are posts about positive outcomes, they were rare, and many users wondered if there were success stories at all. Since most of the posts on the forum were about unresolved suffering, we focused on these cases. While the prevalence of negative posts is a boundary condition of our data,⁴ it is also its strength as it provides focused data on how lay expertise, especially through easily accessible online communities, can harm sufferers.

As we continued to analyze the sample, we inductively identified the dimensions through which lived experience is constituted – by the interplay between symptoms, and engagements with medical, and lay expertise. Having settled on key themes, we then moved to focused coding of our empirical materials to uncover additional subthemes, dimensions, and relations between concepts (Emerson et al., 2011). In the case of professional expertise, we noticed that people initially trusted the medical experts for a solution to their suffering, but interestingly, medical experts inadvertently added to the anxiety of the sufferers in two significant ways: first, by conveying the message “You are not sick” and second,

by stating “There is nothing more we can do.” We categorized these instances as “dismissing suffering” and “failing to treat” by doctors. For instances of lay expertise, we coded them thematically too, for example when lay experts said: “I understand what you are going through.” We coded this as “validating suffering.” Regarding lay experts’ diagnosis and treatment suggestions, we found the advice was characterized by a broad variety of suggestions and heated debate on many topics. We coded this as “perplexing with advice.”

Our data analysis revealed that sufferers’ experiences generally followed a certain temporal sequence. We divided the temporal sequence into phases based on the specific nature of the lived experience and the type of expertise with which sufferers were primarily engaged with in each phase. In the first phase, our analysis showed that the mixture of painful symptoms and desperate search for expertise is characterized by experiences of anxiety among sufferers. We labeled this lived experience the “anxious self.” Overall, we call this temporal beginning of the spiral “entering the spiral.” Furthermore, our analysis showed us that in the second temporal phase, the sufferers were dependent on professional expertise to solve their problems, but the medical professionals were often unable to provide satisfactory relief and rejected the existence of suffering. We labeled this phase as “deepening the spiral.” We noticed that after these experiences with professional expertise, sufferers often turned to lay expertise for a solution, initiating the next phase, which we call the “Expansion of the spiral.” Members of the online community readily acknowledge their suffering, but, at the same time, often provide idiosyncratic and contradictory advice. As a result, sufferers reported being bewildered by lay expertise. Finally, we went back to our empirical materials to better understand the consequences of experiencing the spiral. Following similar analytical procedures as before, found three common responses to experiencing the spiral, which we call “resigning,” “adapting,” and “mistaking.” [Table 1](#) provides additional empirical data for each analytical category.

Entering the Spiral: The Symptoms of the Disease and Needing to Rely on Expertise Construct the Anxious Self

Individuals’ engagement with the disease starts with the onset of symptoms. In the following, we describe how sufferers – people who are affected by an illness discussing it in the online communities – describe the painful and long-lasting nature of these symptoms on the online forum, as well as how they contribute to a shift in their identity into what we call the anxious self.

Encountering Painful and Long-lasting Symptoms

In many of the posts on the online forum, the sufferers described experiencing painful symptoms that persist throughout the day, as the following post describes:

The initial weeks of this turmoil were pure hell. I couldn’t eat, I couldn’t sleep, and I had burning in my mouth, throat, ears, and nose 24/7. I want to die just to stop the burning (...) feels like something is “tearing” into my stomach (...) I eat, I suffer. If I don’t eat, I suffer. I’m being bullied by my body.

Table 1. Empirical Findings and Representative Data.

Entering the Spiral

Encountering painful and long-lasting symptoms

“14 months ago, I lived normally, then I developed reflux. Gasping for air every waking moment. I can’t exercise anymore, as it makes shortness of breath 10 times worse. I can’t concentrate on anything anymore. Endlessly gasping and yawning. I only relief when I’m sleeping.”

Needing to rely on professional expertise

“I lose hope. I have suffered from reflux for two years now. My problem continues. I have pain in my throat and difficulty speaking. I don’t know what to do anymore and if I really want to continue. My mental health is dire. I don’t want to suffer anymore. I feel that nothing will change and that I will end up dying because of this disease”

Painful, long-lasting symptoms and needing to rely on expertise give rise to the anxious self.

“I have been on the NHS waiting list for 14 months now waiting to be seen and do not have the money to go private. Today I called and they said it was another 10 weeks until I will be seen (...) I feel like the long-term ingesting of a high dose of omeprazole, the lack of NHS appointments, and my own reckless behavior have put me between a rock and a hard place.”

Deepening the Spiral

Dismissing suffering

“It’s so frustrating dealing with doctors who just say, ‘Take the antacids for 4 weeks then we’ll see what to do next’. They don’t even do a diagnostic test before it. They don’t medicate someone suspect of having high blood pressure without first checking their blood pressure, would they? They look at me like as if my life hasn’t been disintegrating before my eyes. They think that I’m young and otherwise healthy, so it shouldn’t be a problem for me. Why the callousness? I suffer just as much as a 60-year-old with this.”

Failing to treat

“I just had a half-wrap fundoplication surgery which didn’t ease my symptoms and feel very depressed. Still waiting for a follow-up appointment and in an insane amount of pain”

Dismissing suffering and failing to treat intensify the anxious self

“My doctors dismiss me completely. They behave as if nothing is wrong and tell me to breathe deeply and sleep well. As if that is going to solve my problems. They just don’t understand what I am going through. It’s so frustrating !!!!!!!”

Expanding the Spiral

Validating suffering

“As I said, I’m not a doctor. But as a human, I can understand the human side of this suffering.”
 “Wow, I felt every word you said. I was at my lowest point too.”

Perplexing with advice

“No one talks to a diabetic and says ‘don’t follow Doctor’s advice! You need to eat a lot of sugars to supersaturate your body and improve insulin production thereby making your body more insulin sensitive! It worked for me and my aunt – don’t give your money to big pharma! No one with a functioning brain would advise that.”

Validating suffering and perplexing with advice contribute to the expansion of the anxious self

“I’d be ok with following the standard advice if there was some fucking consistency! ‘Oh, don’t eat acidic foods’ – ‘Oh no, actually, you need to acidify your stomach to digest your food (Funny thing about PPIs’ if they cause rebound acidity, then wouldn’t that be what the ‘low acid’ crowd want?)’, ‘Take this PPI to treat the symptom (oh BTW it won’t actually heal your LES so good luck dealing with that without surgery).’

Such descriptions of the lived experience of sickness – drawing on dramatic imagery, “something is tearing into my stomach” – are common on the online forum. The second feature of the disease is that, for many sufferers, the symptoms are long-lasting. The following post captures this problem:

I hate this disease. I have suffered from reflux for two years now. My symptoms persist. I have pain in my throat, and difficulty speaking sometimes. My mental health is terrible. I fear that nothing will change, and I will end up dying due to this disease. I'm really trying to not cry as I type all this.

The person reports being afflicted with the condition for “two years now,” yet the problem “persists.” They are exasperated and end up catastrophizing.

Needing to Rely on Professional Expertise

After trying to manage the situation by themselves, the sufferers conclude that they need professional help:

I have so much pain every day. It doesn't matter what digestive enzymes or what I take or what I eat, I end up eating a lot of Tums a day (...) I know I need to see a GI specialist now. This is fucking hell.

When the symptoms have not abated after trying over-the-counter remedies, sufferers desperately seek professional expertise.

Painful, Long-lasting Symptoms and Needing to Rely on Expertise Give Rise to the Anxious Self

Following the sudden onset of the painful symptoms of the disease, it's not surprising that sufferers report fundamental changes to their identity. We call the identity that arises from the experiences with the disease and dependence on expertise, *the anxious self*. The following post captures these altering changes and the experience of anxiety:

Life was so good just 8 months ago. I could do and eat anything. Now I'm on house arrest. I can't socialize. I can't eat. I have never been so depressed (...) I can't believe I went from a happy-go-lucky bourbon drinker and steak eater to a guy holding his chest due to stabbing pain. What is the end game? I dread this might never be cured. I was a healthy social guy now I am a social pariah.

Identities such as “bourbon drinker and steak eater” have been substituted by “house arrest” and “stabbing pain.” The identity of a “healthy fit social guy” has been replaced by the one of “a social pariah.” Similarly, the user who saw themselves being bullied by the disease observed how they were “turning into a very grouchy and depressed person.” These profound changes induce considerable anxiety about the future, with sufferers asking themselves and fellow community members: “What is the end game.” In addition to the symptoms themselves, the reliance on expertise, their lack of accessibility, and the fear of bad news become sources of stress:

Due to the COVID situation, my doctor has informed me that ENTs are not currently available. I am very stressed about the possibility of developing cancer since it will take at least six more months for me to see an ENT.

Here, the sufferer is unable to access an ENT (specialist for ear, nose, and throat), giving rise to fears of the condition progressing. Additionally, when anticipating a meeting with professional experts, sufferers may feel nervous about potential procedures such as MRI scans.

In sum, the painful and long-lasting symptoms, and needing to rely on professional expertise—including their inaccessibility and potential for adverse findings—contribute to experiences of anxiety for sufferers. An anxious self is created by the apprehensions over the open questions of when, how, by whom, and *if* the condition will be cured. Following these experiences, the sufferers depend heavily, at first, on doctors and their medical expertise for help.

*Deepening the Spiral: Experiences with Medical Expertise
Intensify the Anxious Self*

However, sufferers often report that doctors and medical expertise fail to solve their symptoms. Two patterns are prevalent. First, medical experts fail to provide relational expertise as they often do not recognize the suffering of clients. Second—on many occasions—treatments based on medical expertise fail to alleviate the symptoms. These two experiences and the continued experience with symptoms contribute to intensifying the anxious self.

Dismissing Suffering

First, sufferers often share how doctors trivialize their experience and symptoms. Clients are denied the “patient” label and, thus, legitimacy, as shown by this post:

The doctors are so infuriating. My gastroenterologist didn't even think that my burning mouth is a problem. It is my biggest complaint. I explained to him every time I saw him (...) Asshole didn't think that the thing driving me crazy was important enough to add to my notes.

The frustration of the person toward the doctor is clear—“asshole”—as the doctor fails to see the “biggest complaint” as a problem. Sufferers report medical experts disregarding concerns for a variety of reasons. One sufferer explained how they were denied diagnostic tests because of being “young.”

Failing to Treat

On other occasions, sufferers receive recognition for their symptoms and treatments. They describe taking multiple drugs prescribed by their doctors. However, on many occasions, they also report that medical treatments are failing to manage their condition or even trigger side effects:

I am taking 80 mg of famotidine (...) it doesn't work. I stay up for over 24 hours (...) I am constantly bloated, constipated, agitated, and I keep burping up food. On my last hospital visit, I was prescribed pantoprazole 40 mg, but it only made me gassy and caused diarrhea.

Such difficulties in finding a treatment often persist alongside long-lasting symptoms, as sufferers report having the condition for several years, often experimenting with combinations of treatments without qualitative improvement:

I've had Gerd all my life. I don't get why PPIs and H2 blockers are the only medications. Antacids and OTC meds are useless placebos. They don't do a thing. I don't get it, why do so

many doctors keep throwing these medicines at you and expect them to cure everything? (...) The medicines have nasty side effects too.

The sufferers often portray doctors as experts who “throw those types of medicines at you.” But as one sufferer puts it, expert treatments run out over time: “Doctors say they can’t do anything for me [anymore].” In sum, the solutions of professional expertise fail many of these people. Users experience doctors as dismissing pain, and their treatments fail to cure the condition.

Dismissing Suffering and Failing to Treat Intensify the Anxious Self

Sufferers feel that doctors have let them down by dismissing their suffering and giving up on treating them. For example, a sufferer narrates how their concerns were outright ignored by a doctor:

I saw my doctor again, sure that it was GERD. I was hoping they’d be doing tests to check my esophagus. The doctor came in and quickly and said “You don’t look sick. Maybe you need more sleep” (...) What the hell? I felt so disrespected.

Doctors’ dismissal makes the sufferers feel “disrespected.” Such treatment from experts who are supposed to help them not spurn them plunges sufferers deeper into anxiety. Patients chafe at the invalidation from doctors, who think that their suffering “is all in the head.”

The contrast between the suffering and the dismissal by doctors produces frustration. When the treatments fail to produce relief, the sufferers’ anxieties often deepen. In the following post, the sufferer has tried a variety of medicines and lifestyle interventions:

It has been a year since this began. I’ve tried PPIs, all sorts of blood tests, ultrasound, antibiotics, rifaximin, dietary changes, probiotics, and sleeping sitting upright. I even spent 2 months in the hospital with a feeding tube in my stomach (...) every day I’m suffering from burning in my throat (...) I want to live so much, but I really feel can’t do this anymore.

The treatments and tests do not work for many sufferers, who are exasperated with the failure of professional expertise – especially if they feel gaslighted and abandoned.

Expanding the Spiral: Experiences with Lay Expertise Expand the Anxious Self

When medical experts fail them, the sufferers lean more heavily on the advice from other members of the online lay community. However, engagement with the lay community comes with a new complication. On the one hand, the lay community validates the experiences of sufferers as sick individuals. On the other, it provides perplexing advice on diagnosis and treatment, which often do little to alleviate the suffering.

Validating Suffering

While the medical experts often failed to acknowledge the suffering of the people, the lay experts in the online communities provided sympathy and recognition of the suffering. Here, a sufferer who posted about their symptoms and the

difficulties caused by them gets several validating responses from members of the online community:

- a) I'm going through the exact issue!
- b) I felt the same things. I have spent hundreds of hours on research too.
- c) My symptoms also came out of nowhere last month. I'm so confused like you.
- d) I know. It infuriates me too that doctors don't know shit.

Validation takes many forms, from shared experiences of similar symptoms to not being taken seriously by society or doctors. This validation is often welcome: "I get so much support from you people. Doctors did not take me seriously and I thought I was going crazy. But after coming here I feel seen and heard for the first time. I know I am not crazy." Interactions between sufferers and the lay community are, however, not limited to expressions of empathy, but include advice regarding diagnosis and treatment.

Perplexing with Advice

Unlike doctors, lay experts are not bound by clear epistemic boundaries but offer multiple diagnoses and treatment suggestions. The sheer range of suggestions and the lack of organizing epistemic rules make it difficult for sufferers to know what suggestions to engage with and whom to trust. This problem is exemplified by responses to a post where a person asks for help:

- 1) Get tested for h pylori, SIBO, candida, etc.
- 2) This may not be reflux or vocal cord dysfunction. It may be air hunger.
- 3) It's a vagus nerve issue.
- 4) Gluten Intolerance? Perhaps have your stool tested?
- 5) Go get a bravo test or a manometry test
- 6) This may be sleep apnea
- 7) Go see an allergist

This pattern, wherein a single discussion thread the range of possible diagnoses and suggestions ranges from a food allergy to bacterial infection and new diagnostic tests repeats itself often. This range makes it difficult for the sufferers to navigate the information and implement any suggestions. In addition, lay experts' treatment suggestions can be incoherent, as shown by this (partial) list of treatments offered to a user:

- 1) Dgl licorice, slippery elm & d-limonene have been good friends.
- 2) Exercise, drink coconut water, hot showers, no spicy food, and probiotics.
- 3) Probiotics can work wonders.
- 4) I take B-complex. I eat red meat, vitamin C.
- 5) Stay alive. My GERD symptoms reduced merely because my body aged.

- 6) Get on anti-depressants they've helped me.
- 7) For me, I have said goodbye to coffee and spicy food.

Here, users suggest treatments ranging from warm showers to acupuncture, all within a single thread. Furthermore, lay experts' treatment suggestions can be contradictory since what helped one person is often interpreted negatively by others:

I see people around here telling each other to drink ACV for their reflux. What the hell is wrong with such people? I recently had 4 months of PPIs. Now I have my singing voice back and eat without fearing how it's going to mess up my throat. Don't take my word on this. Read the medical literature yourself.

"ACV (apple cider vinegar)," a popular alternative therapy, is attacked by a user who leverages medical and experiential knowledge as evidence. In response, another user extolls the virtues of ACV:

It is a good thing to share your story, but to dismiss other options based on your experience is shortsighted. I've had reflux for 8 years now. But so far, my best success is on ACV. Doctors and PPIs have failed me.

This sufferer calls the stance of the previous post "short-sighted" as they have had a different experience, providing evidence on the effectiveness of ACV while citing the original posts suggested treatment – and the gold standard – PPIs (Proton Pump Inhibitors) as a failure.

Validating Suffering and Perplexing with Advice Contribute to the Expansion of the Anxious Self

While the doctors often disregarded the sufferers' troubles, lay experts provided validation and sympathy for the sufferers. As the following post shows, these interactions encourage sufferers to trust lay community members:

Doctors have done shit for me; they just dismiss my pain. But here I finally find the support and understanding I desperately needed. It's a relief to know that I am not alone. I read your suggestions and will try them soon.

However, sufferers soon see that online community advice is riddled with complications and experience frustration in wading through this information. This contributes to the worsening of their anxiety:

The information is all over the place: A) GERD is from too much acid. No, it's from too little acid. B) ACV will help – No, it won't. Are you crazy? C) PPIs are the best treatment – No, they are dangerous drugs. D) Eat these foods./ARGH! NEVER EAT THAT! Don't eat these foods – PSSH! These foods are fine. Don't listen to those people. E) This expert is great – No, he or she is a quack; this other expert is whom you should listen to. F) This diet is the best – No, it's rubbish, you'll be sorry, try this one instead. G) This supplement is the best – No, never take that one! Try these instead!

The conflicts between epistemic positions are incommensurable ("this is the best thing," "Argh! Never eat that!") and accompanied by fearmongering from different camps ("You will be sorry if you try this," "never try this," "this is

dangerous”). This results in further anxiety as sufferers are unable to figure out what to do:

How do you go through so much information and find what is right for you? I have been trying to know the best diet for many months (...) I just get frustrated trying to make sense of it all.

This inability to choose between the conflicting suggestions feeds anxiety. This is because of the fear that choosing the wrong treatments can worsen their condition: “It’s scary because this is something that can easily turn into cancer if it’s not well controlled, but the process of trying to successfully treat it, is causing more damage.” Due to the idiosyncratic variety of lay advice, sufferers try different diagnostic tests and speculative treatments, only to spend a lot of time, money, and effort for no tangible benefits. In the following post, a sufferer describes the actions they have taken – many on the advice of the online community – and their consequences:

I visited 15 medical specialists – ENTs, GIs, Allergists, etc. I spent a lot of money on testing – Barium X-ray, pulmonary function, manometry, upper endoscopy, EKG, blood panel, etc. An insane dietary plan – Paleo, vegan, vegetarian, keto, Mediterranean, intermittent fasting, etc. I tried blanket fixes or snake oil – Reflux Reboot, Fast Tract Diet. They did nothing. Antibiotics did nothing. Prednisone – Did nothing. Lansoprazole (PPI) – Certainly, didn’t fix me (...) Nexium (PPI) – This really messed me up! Allergy medications – did nothing, Lexapro (SSRI) – did a little to help. Wellbutrin – Did nothing, Ginger – nothing. Throat coat tea – nothing, Gaviscon Advance – fucked me up!

Sufferers end up chasing multiple diagnoses and treatment possibilities to no avail. Ultimately, the benefits of being understood by the online community members wear off while the suffering remains. This drives up the anxiety about their condition and their future after they realize that lay expertise is failing them.

Similar to sufferers’ diminishing trust in professional expertise, sufferers lose trust in lay expertise after being confused by the community advice:

Don’t spend time in online communities, get off these places. I know many of you are here a lot of times. You even feel it’s doing good to you. But seriously (...) stop looking for the cure (...) It won’t happen. This hope keeps you trapped.

At this point, many sufferers recognize that searching for the “cure” from doctors or the internet online communities keeps them in an unhealthy “trap” of hope. In conclusion, after undergoing spiraling, the sufferers are disillusioned and distrustful of the capacity of expertise to solve their symptoms.

Coda: After the Spiral?

Is there an end to the *spiral*? Sufferers often exchange their experiences of coping with their symptoms, prompted by posts such as: “Since when have you been dueling with this? I’ve been dealing with this devilish disease for three years, but it feels like forever.” We observe three broad categories of responses in the community: *resigning*, *adapting*, and *mistaking*.

In *resigning*, people have been disappointed in their search for relief. They are particularly surprised at how modern medicine can fail to treat a simple reflux disease, as articulated in the following post:

With all the advances in modern medicine, you'd think they'd be able to come up with more effective treatments for Gerd. No diet, lifestyle change, or medication (or combination of medications) suggested to me by any medical professional in the over 2 decades since I've been alive has done shit for me, no matter what I do, it's always a matter of time before I'm choking and regurgitating on disgusting burning stomach acid.

People such as this sufferer have been experiencing reflux for extended periods, trying out different professional solutions with no significant improvement in their situation.

Alternatively, when *adapting*, depending on the severity of the day-to-day symptoms, sufferers learn to live with their condition, having better and worse days in the process. They try to give hope to others by highlighting the capability of sufferers to adapt:

The human brain can adapt to a lot. GERD sucks and is a crappy thing to get used to but hell some people go blind or lose their hearing and their new life becomes more normal every day. Eventually it'll just become a new lifestyle and you'll adapt.

This narrative emphasizes that sufferers will get used to the new "lifestyle" with time. Another post echoes a similar sentiment of good and bad "streaks," where further suffering will have to be stoically absorbed: "(...) as time goes on you will have good streaks and bad streaks. Right now, I'm on a bad streak and can't really eat anything without feeling like crap."

Finally, some people claim to find a solution that works for them, after having tried many things over a long period of time. They post about how they found a "miracle cure":

I started taking TCAs (tricyclic antidepressants) like Amitriptyline. They are antidepressants, but they are often used for nerve pain. It was like night and day. My symptoms receded more and more, and I couldn't believe it. Honestly, typing this sounds like some sort of infomercial for a miracle cure. I can't stress enough how relieved I was, after two years of absolute hell.

But often, such reports of a "cure" are temporary. For example, the same person later writes that their "cure" became unusable:

Amitriptyline worked, but due to side effects I switched over to Nortriptyline (...) Nortriptyline did an excellent job of masking my symptoms, but after trying some trigger foods I realized I wasn't healed.

Here, after long-term usage, the sufferer comes to the realization that either they cannot continue with the "cure" or that it was simply masking their symptoms. Other sufferers also report similar experiences of temporary relief only to relapse later with other pharmaceutical agents or invasive surgery like the Nissen fundoplication. We call this narrative *mistaking*, as the sufferers often find relief only to later realize its temporariness.⁵

While there are different responses that sufferers have depending on the severity of symptoms and personal circumstances, generally, they become distrustful and disillusioned with both professional and lay expertise. Sufferers emphasize self-reliance and self-advocacy in solving their problems; they should not "just hand themselves over to the experts and hope that they will take care of everything," but rather, "Advocate for yourself and do your own research." They are skeptical

of both professional and lay expertise and find it difficult to immediately say that someone is “right or wrong.” Therefore, after experiencing the spiral, people are critical of any advice they receive and preach caution toward experts of all stripes:

I can’t tell you if your doctor is right or wrong (...) The mechanism of action for your reflux may not be the same as everyone else’s (...) and if you see someone selling a book, an app, a magical diet plan or exercise regiment, idk!!! Just be skeptical of the asshats that will steer you wrong.

DISCUSSION

This article examines the lived experiences of sufferers as they engage with professional and lay expertise. In doing so, it also sheds light on the important but understudied limits of expertise – particularly when it comes to lay expertise. To understand how the interplay of sufferers’ experience and engagement with expertise unfolds, we developed the notion of *spiraling* (see Fig. 1). This notion elucidates how the symptoms of sufferers, their subsequent dependence, and engagement with both professional and lay expertise shape their lived experience. In particular, our analysis provides a nuanced understanding of the distinct ways in which different forms of expertise shape sufferers’ experiences. We also shed light on the boundaries of expertise, specifically on the “dark side” of lay expertise. Next, we discuss these theoretical contributions in more detail.

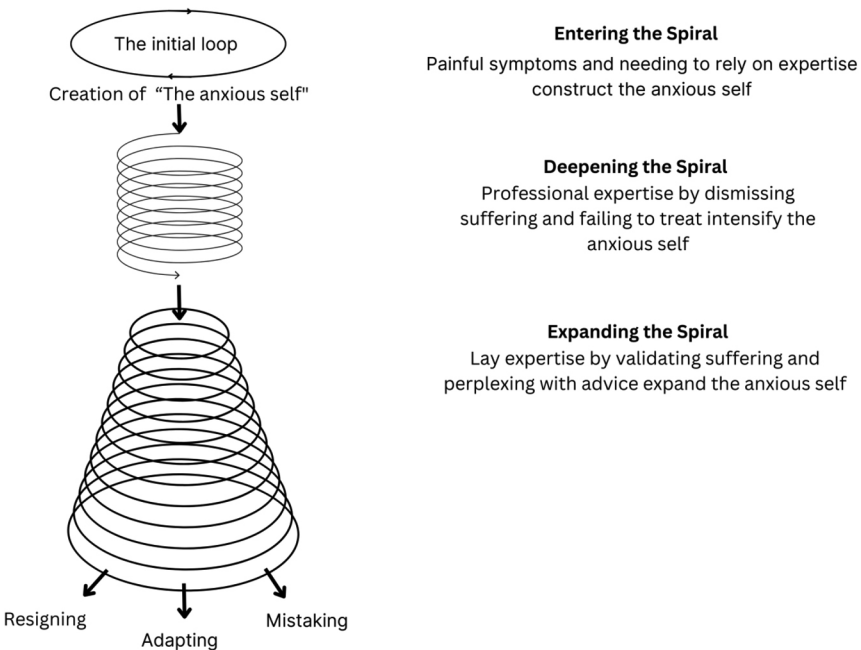


Fig. 1. The Spiral: The Co-constitution of Lived Experience Through Engagement with Expertise.

Theoretical Contributions

First, we advance our understanding of expertise by examining how laypeople utilize different types of expertise and how their lived experiences are shaped by their engagement with these various forms of expertise. Today, many people routinely engage with different forms of expertise sequentially or simultaneously (Hardey, 1999; Van Riel et al., 2017). Online communities in particular have become popular places for those seeking help and knowledge of any kind, largely due to their ubiquity and accessibility (Akrich, 2010; Au & Eyal, 2021). While the existing literature on expertise occasionally documents sufferers' experiences and perceptions, it rarely focuses on explicitly theorizing these experiences. Instead, the literature has examined issues such as how lay expertise helps sufferers in different ways (Campbell, 2021; Foster, 2016; Radin, 2006), how online platforms have changed the relationship between sufferers and professional expertise (Broom, 2005; Hardey, 1999; Trehan & Daluiski, 2016), and the incorporation of lay expertise into professional expertise (Callard & Perego, 2021; Epstein, 1995; Eyal, 2013).

Our research bridges this gap by examining sufferers who experience failure of both professional and lay expertise. This perspective is underrepresented in the literature, which often centers on sufferers' triumphs or disappointments with professional expertise (Bud, 2007; Fraser, 2021; Greenwood, 2008) or their positive experiences with lay expertise (Epstein, 1995; Petersen et al., 2020; Radin, 2006). However, such research gives us an incomplete picture of expertise and client experiences, since many personal problems remain unsolved or persist for extended periods (Charmaz, 2000; Sosnowy, 2014).

Our research suggests that individuals' engagement with both professional and lay expertise in an attempt to address their problems can actually exacerbate their anxiety. We conceptualize this lived experience as a spiral. To theorize individuals' experiences, we draw inspiration from and extend the concept of looping (Hacking, 1995, 2007). In cases such as ours, a loop can be initiated by the presence of an intractable problem that leads to a desperate search for a solution and reliance on expertise. The spiral begins as individuals become increasingly anxious about the persistence of their symptoms, their inability to access expertise, and their fear of unfavorable outcomes. While sufferers expect professional expertise to alleviate their suffering, they often fail to have their problems resolved or their emotional needs met. Thus, the spiral deepens as sufferers are let down by professional expertise. Sufferers' engagement with lay expertise may initially begin on a positive note, as sufferers may feel validated by it. However, because lay expertise is not bound by standards of evidence, the suggestions offered are numerous, difficult to understand, idiosyncratic, and often contradictory. Worse such advice often fails to provide relief, thereby contributing to the expansion of the spiraling. After experiencing the spiral, we suggest that there are broadly three types of responses that sufferers may have to their predicament: resigning, adapting, and mistaking. Going through the spiral gives rise to sufferer's skepticism regarding both professional and lay expertise, and they appear to be more self-reliant and less trusting of expertise.

We suggest such spiraling might be most likely to happen in the case of sticky and intense problems where professional or lay expertise do not have definitive tools and understandings to provide adequate relief. For example, in the field of healthcare, it can occur in cases of addiction (alcoholism, drug addiction), mental illness, chronic illness, new diseases such as long-Covid-19, and under-diagnosed women's health conditions (Au et al., 2022; Cho et al., 2019; Koob & Le Moal, 2001; Moore, 2014). More broadly, personal problems in areas ranging from law and taxation to house renovation and personal finance could have the potential for spiraling.

Second, our study contributes to understanding the dynamics between professional and lay expertise as well as the limits of expertise. The literature has shown the complementary nature of professional and lay expertise, for example, AIDS sufferers who wanted early access to potentially life-saving treatments were helped by lay activism (Epstein, 1995). Lay expertise can also contribute to knowledge when appropriate professional expertise is lacking (Wynne, 1996) and provide experiential, moral, and emotional support that professional expertise may fail to deliver (Radin, 2006; Rushforth et al., 2021; Schrock et al., 2004). In our case, sufferers engage with professional and lay expertise but are often let down by *both*. Our research shows that instead of being mutually beneficial, professional and lay expertise can be mutually detrimental and have compounded negative implications for sufferers. We emphasize the importance of future research in this area to determine how professional and lay expertise fails in myriad ways and what the consequences are for those who seek expertise. Knowing the limits and harms of expertise will allow us to potentially minimize suffering by possibly filling the gaps in the dispersion and consumption of professional and lay expertise. When considering the limits of expertise, it is important to acknowledge that there will always be cases where expertise fails (Buckwalter, 2016; Dismukes et al., 2007). Similar to our case, medical professionals can often face challenges in adequately addressing common diseases, leading to patient distress. Sometimes they deal with this inadequacy by gaslighting patients' lived experiences, shutting them out, or connecting symptoms to anxiety or hypochondria (Au et al., 2022; Fraser, 2021). This can result in patients feeling invalidated or ignored, fostering mistrust toward experts, and potentially leading to abandoning expertise. To retain trust, we suggest that professionals need to acknowledge their limitations, manage expectations, and develop behavioral skills (Hawley, 2015; Teutsch, 2003) to ensure patients feel acknowledged and understood. Recognizing and validating patient suffering, regardless of diagnosis (or the lack of one), could broaden the scope of expertise and mitigate its limitations by keeping patients engaged. Additionally, professionals can improve patient care by being transparent about the limitations and potential inefficacy of standard treatments, thereby setting expectations upfront to prevent further distress when treatments fail. Finally, engaging with online community discussions can provide insight into patient experiences and how sufferers use online resources and lay expertise. This knowledge can help professionals communicate more effectively with patients, build trust, and even prevent harmful self-diagnosis and treatments (Teutsch, 2003).

Even without a cure, professionals can alleviate suffering by empathizing with patients, recognizing their suffering, maintaining open communication, and helping them navigate their health issues. This is how the spiral could be made more tolerable.

Third, we also contribute to understanding the potential dark side of lay expertise by demonstrating how engaging with lay expertise can be detrimental to sufferers. To date, the critical views of lay expertise have been mostly focused on the ways lay actors encroach on professional jurisdictions or how lay knowledge might “dilute” institutionalized expertise (Collins et al., 2023; Prior, 2003). However, understanding the possible limits of lay expertise is important because of the increasing ubiquity and normalization of engagement with it (Epstein, 2023; Hardey, 1999; Kerr et al., 1998; Lamas et al., 2016).

Unlike professional expertise with defined epistemic boundaries and established practices (Abbott, 1988; Freidson, 2001), lay expertise lacks such constraints. While the broad spectrum of alternative practices, personal experiences, idiosyncratic perspectives, and values can be the strength of lay expertise (Bains, 2008; Campbell, 2021), our findings show this “mix” can also have consequences for sufferers. Specifically, the detriment to sufferers begins, counterintuitively, when lay expertise initially provides validation and recognition to sufferers (Callard & Perego, 2021; Radin, 2006). This leads the sufferers to seek help on core professional tasks, such as diagnosis and treatment, from lay experts who offer contradictory advice that significantly diverges from professional standards (Akrich, 2010; Pols, 2014; Wezyk et al., 2023). These suggestions may rely on idiosyncratic, personal experiences, making them difficult to make sense of and costly to act upon. As our findings show, such suggestions often fail to provide relief to sufferers and end up adding to the misery. Therefore, the very things that make lay expertise valuable to sufferers, such as their validation of the suffering and the broad collection of knowledge based on personal experience and research, are the same things that can harm sufferers. These findings contrast with previous literature on advice seeking in online health communities, where sufferers find many positive benefits, including emotional support, community, tacit, and explicit knowledge in such communities that give them dignity, legitimacy, and a voice (Akrich, 2010; Au & Eyal, 2021; Foster, 2016).

Finally, our findings may provide an interesting lens for exploring the so-called “crisis of expertise” (Eyal, 2019; Heimstädt et al., 2024; Nichols, 2017). This phenomenon that captures the increasing – and to an extent, prevalent – distrust of science in the general public, is often seen as a macro-sociological phenomenon. Here, scrutiny and denial of expert advice are primarily driven by forces such as polarization (Reed & Reed, 2023), populism (Brubaker, 2017), or politicization of science (Eyal, 2019). However, such sweeping forces should also be grounded in understanding “what people do, say and think in the actual flow of momentary experiences” (Collins, 1981, p. 984). Looking at the narratives of sufferers’ experiences suggests that the broader mistrust of expertise can be rooted in the suffering of individuals and negative interactions with professional expertise which are then onward mediated by engagement with lay communities. Modern online lay communities bolstered by algorithmic

recommendations (see [Seaver, 2022](#)) might be particularly powerful breeding grounds for macro-narratives that challenge credentialed expertise since they allow people with similar experiences and emotional registers ([Collins, 1981](#)) to come together. Notably, they can do so with less regard for time and space compared to traditional forms of lay activism that were more geographically and culturally bounded (e.g., [Wynne, 1996](#)). However, as our study focuses explicitly on sufferers' experiences, we suggest further research is needed to understand the connections between lay communities and the crisis of expertise.

It's important to note that online community moderation plays a pivotal role in shaping the discourse within these communities ([Roose, 2024](#)). While moderation can uphold institutional positions, it may inadvertently suppress discussions on experimental and alternative practices ([Au & Eyal, 2021](#); [Campbell, 2021](#)). This highlights the double-edged sword of moderation: it can both protect and limit. On one hand, unregulated forums can become breeding grounds for harmful advice and misinformation ([Scheufele & Krause, 2019](#)). On the other hand, moderation could stifle dialog and peer support, potentially driving users to seek out less restrictive platforms ([McAllen, 2024](#)). Overly restrictive platforms may deprive users, many of whom are not bad faith actors, but individuals facing genuine problems, of validation, hope, and potential solutions. Therefore, the challenge lies in striking a balance between regulation and freedom of expression. Thus, future research should explore the effects of moderation, especially the nuanced pros and cons, not based on normative ideals, but on users' experiences. Ultimately, we believe the goal should be to create online spaces that are safe while being conducive to the free exchange of ideas.

In summary, our research expands the understanding of expertise and its impact on those who engage with it, shedding light on the complexities, complementarities, and detrimental aspects of different expertise forms. We examined the lived experiences of sufferers, especially when expertise fails, providing theoretical underpinnings for this critical aspect of expertise engagement. Our findings also challenge the prevailing narrative of lay expertise and emphasize the need to consider the boundaries of expertise, including the dark sides of lay expertise.

NOTES

1. The [Oxford English dictionary \(2023\)](#) defines a "sufferer" as someone "One who suffers pain, tribulation, injury, wrong, loss, etc.; one who suffers from disease or ill health." We use the term to describe the users of the platform who discuss their illness. We do not call them patients since the sufferers can be denied this categorization or may inconsistently engage with healthcare professionals. Our understanding of suffering is further inspired by social theorist Andrew [Sayer \(2011\)](#), who writes (p. 42): "A key characteristic of pain and suffering is that they are not merely states of being, but of frustrated becoming, or continuous yearning for relief and escape."

2. The users of the platform are not "participants" of our study and data is naturally occurring archival data. We obtained ethics approval for the research project from an institutional ethics review board.

3. The community has guidelines about appropriate conduct on the platform. Low effort, gruesome, or promotional posts are highly frowned upon. Instead, detailed narratives and

constructive exchanges are promoted. While the new moderation rules say that no alternative medicine or diagnosis posts are allowed, such posts are rampant. The lay experts usually qualify their advice with (e.g., “I am not a doctor, and this is just my experience so take it with a grain of salt”) to dodge responsibility or moderation.

4. We do not seek to make any epidemiological claims about reflux disease. Rather, in line with a lot of sociological and anthropological research in health and illness, we seek to illuminate the experiences on those (often marginalized) groups that do not experience having their needs met.

5. We do not mean to claim no sufferers find permanent relief. However, mistaking is a common experience of sufferers after the spiral and may eventually lead to other pathways such as adapting or resigning.

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HIDING IN PLAIN SIGHT: EXPERTISE (IN)VISIBILITIES AND (MIS)MATCHES IN MODERN ORGANIZATIONAL STRUCTURES

Pedro Monteiro

Copenhagen Business School, Denmark

ABSTRACT

The changing nature of work and organizing makes matching individuals to tasks an increasing challenge. Consequently, there is a growing interest in mapping a workforce's expertise to manage it more strategically. Yet, systems for mapping and matching are often based on an individualist view of expertise. Drawing on research on knowledge and professional work, this paper foregrounds a social view of expertise, showing how multiple forms, diverse versions, and varying conceptions of expertise coexist as bundles. The paper discusses how mapping systems that overlook the plural, multidimensional, and dynamic properties of knowledge create expertise invisibilities – flattening, eclipsing, and marginalizing it – and can thus generate mismatches between workers and tasks. By showing that invisibility and incompetence are important dimensions in expertise dynamics, this paper contributes to research on expertise development, recognition, and mobilization. Furthermore, it suggests that beyond the debate on a potential crisis of expertise in society, at the workplace level, competent expert work hinges on organizational structures that appropriately make expertise visible and align it with tasks.

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INTRODUCTION

Identifying available expertise and leveraging it appropriately in the workplace presents a mounting strategic challenge. Organizations increasingly hire specialists in various domains, leading to a growing volume and variety of knowledge (Barley et al., 2018; Blackler et al., 1993; Monteiro, 2024). Moreover, the dynamic nature of work today, with rapid technological changes and evolving jobs, makes it harder to align expertise and tasks effectively (Barley et al., 2017; Burton et al., 2016; Rogiers & Collings, 2024) (see also Cohen & Bui, 2025). Yet, developing an understanding of the expertise available within an organization is the basis for a range of strategies and processes, including facilitating knowledge sharing and designing mentorship and succession plans (Grant, 1996; O'Dell & Grayson, 1998; Ribeiro, 2013). It is also essential to match people to tasks and balance specialized personnel across departments and projects (Weller et al., 2019). From scientific management to contemporary economic research, we know that developing a productive workforce hinges on “creating better matches between the present labor pool and specialized jobs in the firm” (Minni, 2023, p. 4).

Traditionally, the alignment of expertise and work was achieved through the design of an organization's structure. Jobs are organized in hierarchies, representing not just a progression of responsibilities but also of competence. The organizing principle behind these systems is that positions higher on the hierarchy have a broader oversight and are staffed by individuals with a deeper expertise in a particular domain (Monteiro & Adler, 2022; Weber, 1978). Beyond being vertical hierarchies, individuals also move across organizations through internal labor markets. This occurs either via managers “slotting” them into jobs (Piore, 1971) or through more market-oriented process, such as responding to posted positions (Keller, 2018).

In reality, organizations do not always live up to such ideals, and ongoing changes suggest that linearity of positions and expertise can no longer be assumed. Recent analyses indicate that disaggregation, or the unbundling of “formal job roles into discrete job elements like projects or tasks, and matching these with the knowledge, skills, and abilities of employees in the internal labor market, has become more common” (Rogiers & Collings, 2024, p. 177). In addition to performing the core tasks of a job, individuals often take up add-on roles (e.g., change agents), move between teams (e.g., cross-functional product teams), and work on transient assignments (e.g., a sustainability task force). Technological change can also leave individuals with “positional expertise” due to formal rank or social status while lacking the “effective expertise” to perform work that has been reconfigured (Beane & Anthony, 2023).

Concerns about misalignments leading to incompetent performance have long been encapsulated in the Peter principle, a tongue-in-cheek idea that individuals

are promoted up a hierarchy to their level of incompetence (Benson et al., 2019; Peter & Hull, 1969). Yet, the current challenge for organizations is a broader one: instead of *whether* tasks and competence remain aligned as individuals progress in a hierarchy, the question is *how* they can be continually aligned? Human resource management scholars have started to discuss this question, albeit indirectly, as part of an emerging debate on internal talent marketplaces and related systems for mapping skills and facilitating ongoing matching between individuals and tasks (e.g., Ammerman et al., 2023; Jooss et al., 2023; Weller et al., 2019). The literature, however, does not fully consider that expertise is a complex resource, one that is difficult to identify before it can be mobilized.

Conversely, the growing debate on expertise in and around organizations (Heimstädt et al., 2024), and related scholarship on knowledge work (Barley et al., 2018; Blackler, 1995) and professional work (Anteby et al., 2016; Gorman & Sandefur, 2011), have explored the unique challenges of identifying and mobilizing expert knowledge. Yet, in most of this literature, the division of labor in the workplace is understood as stable. Individuals appear as “pre-matched” to specific tasks. Scholars focus on experts’ ability to craft and adjust to tasks rather than exploring how they are assigned to them in the first place. Questions, therefore, usually revolve around how individuals drop, maintain, or perform particular tasks, collaborate with others, generate authority vis-à-vis clients, etc. (DiBenigno, 2019; Evans & Silbey, 2022; Huising, 2015; Sandholtz et al., 2019). Missing here, however, is an appreciation for the effort, work systems, and managers involved in mapping and matching expertise to specific tasks.

This is unfortunate because the processes for mapping and matching affect expertise dynamics. For example, how individuals are mapped impacts their visibility and status in the workplace. This can, in turn, influence their ability to secure work that enables them to develop expertise and specialize, thus affecting their access to resources and career progression (Monteiro, 2024). Mismatches can also generate incompetent performances, which may compromise organizational outcomes. Furthermore, while previous literature assumes that occupations are stable bundles of skills directly connected to tasks, professionals increasingly span many domains (Hénaut et al., 2023), and more fine-grained indicators for knowledge – such as specialties or skills – may better explain workers’ profiles and labor dynamics today (Deming & Kahn, 2018; Labussière & Bol, 2024; Marinescu & Wolthoff, 2020).

This conceptual paper aims to bridge conversations and expand the jurisdiction of expertise scholarship. Specifically, it focuses on systems used to map the expertise of professionals or knowledge workers, that is, individuals who leverage abstract, specialized bodies of knowledge as a primary input for their work (e.g., engineers, consultants, scientists, designers, lawyers, etc.). I start by outlining the general features of these systems, such as skills maps, highlighting the individualist assumptions about knowledge commonly embedded in them. Then, leveraging research on expertise and related areas, I describe how a social view highlights the plural, multidimensional, and dynamic properties of expert knowledge. Specifically, it shows how the relationship between individuals and expertise is not one-to-one but rather, one-to-many. That is, multiple forms of expertise

coexist, and there can be diverse versions and varying conceptions of the same expertise. However, mapping systems usually struggle to capture such richness, thus creating invisibilities that flatten, eclipse, and marginalize it.

By expanding the realm of expertise research, this paper suggests that how individuals are mapped and matched can impact their ability to develop expertise; and that issues in mapping can generate invisibilities, affecting expertise recognition. Furthermore, mismatches can prevent organizations from mobilizing expertise and lead to incompetent performance. This implies that beyond discussing the general status of experts in society, represented by the debate on the crisis of expertise, it is also important to examine how organizations make expertise (in) visible and (mis)match it to work.

MAPPING AND MATCHING EXPERTISE

Mapping refers to any system that makes knowledge more explicit – identifying and visualizing it. Such systems may include employee profiles listing specialties, directories with keywords related to knowledge domains, and common representations of workforce talent (e.g., skills maps or competency matrices). Mapping can be based on various criteria. Some focus on skills directly related to jobs (e.g., programming in JAVA for software developers), while others concentrate on knowledge domains and specialties (e.g., software programming, architecture, testing) or more general competencies (e.g., problem-solving, analytical thinking). In this paper, I use ‘mapping expertise’ to describe systems that identify individuals’ ability to perform work based on their mastery of specialized knowledge (i.e., their expertise).

Regardless of the criteria used for mapping, the common goal of these systems is to help identify “detailed information about the employee’s qualifications, experiences, and expertise” (Bibi et al., 2021, p. 2). Some systems are built with the explicit goal of matching employees to tasks; others are general platforms meant to be consulted for various purposes, such as knowledge sharing, facilitating mentorship programs, or supporting succession planning. Systems for mapping expertise exist at many levels, including large-scale ones focused on a national or cross-national labor market used for statistical purposes and to inform employment and human capital strategies (e.g., special visa programs for specialists in specific domains) (Markowitsch & Plaimauer, 2009). In this paper, I focus on systems related to organizations and their employees.

Matching involves assigning individuals across tasks, jobs, projects, etc. More specifically, it refers here to matching the demand and supply of expertise in the workplace, with the assumption that proficiency is a key criterion for matches. Thus, mapping supports matching as a meta-knowledge of “who knows what” is essential in matches to ensure that work is carried out competently. Such meta-knowledge of “who knows what” can be implicit, especially in smaller organizations and organizations with a stable workforce that interacts frequently. In these cases, people develop a “transactive memory” about the expertise of colleagues with whom they work (Brandon & Hollingshead, 2004; Ren & Argote, 2011).

The organizational structure also traditionally provides cues about a person's abilities. In principle, the higher the position in a hierarchy, the higher the level of expertise in a particular domain, and the more complex the tasks assigned to these individuals.

However, ensuring that proficient individuals competently carry out tasks proves increasingly elusive. The changing nature of work has brought growing specialization and distribution across space and time, making it harder to oversee the expertise panorama within an organization. Moreover, matching becomes more complex as new ways of organizing make the link between people and tasks more disaggregated and dynamic. For example, in less hierarchical organizations, such as holacratic organizations, tasks continually move across roles and individuals (Lee, 2024), and in some settings, individuals may even self-assign independently to tasks (Raveendran et al., 2022).

Digital technologies are not just changing how people work (Barley et al., 2017) but also creating new tasks or bringing new skill requirements for carrying out established tasks (Pakarinen & Huising, 2023). Careers and employment relations continue to evolve, with mobility within and across organizations becoming increasingly prevalent and uncoupled from preset career tracks (Dokko & Chudzikowski, 2020; Ray, 2024). In light of these changes, industry commentators predict an “evolution from the hierarchical model where you work your way up the pyramid to ... [an] organization where people work on multiple projects, move from role to role, and embrace job sharing” (Maurer, 2021), making it increasingly difficult to determine which expertise is required for which job.

In response to this changing landscape, mapping systems have emerged to help clarify the available and required expertise within an organization. These systems do not assume that tasks and expertise can be rank-ordered in a typical hierarchy. Rather, they aim to help distinguish individuals' proficiency in knowledge domains, specialties, skills, etc., across and regardless of their current job. The popularity of mapping systems is fueled by trends such as HR or people analytics (Leonardi & Contractor, 2018) and the popular idea of internal talent marketplaces (Cappelli, 2008), which “infer[] the skills you have and then matches you to jobs for which you have the relevant skills or are a near match” (Field et al., 2022, p. 2).

More broadly, mapping systems are associated with a presumed shift from a job-based to a skill-based organization where employees are categorized and (ideally) valued based on their skills or potential to contribute to various projects and tasks. In these settings, work is organized according to a “flexible and dynamic deployment of employees' competencies, rather than on task-related and pre-defined sets of qualifications, as traditionally has been the case” (Soderquist et al., 2010, p. 326).

Regardless of trends and labels, there is a clear drive to make a workforce's expertise more visible in order to secure optimum fit between employees and work tasks. At least, this is the promise of a host of vendors, consultants, and evangelists in this area and the hope of organizations that use such systems. The US Army, for example, has developed Green Pages, a system “to capture accurate, granular, and timely information on every officer and every duty position” (Colarusso & Lyle, 2014, p. 75). This mapping system utilizes profiles built by

employees featuring their skills that inform matches based on job profiles created by units that detail the required talents (Bukowski et al., 2014, p. 8). Similarly, though more reliant on automatization (Clegg, 2017), IBM's Blue Matching uses algorithms and related technologies that "recommend internal job opportunities to employees, tailored to their qualifications and aspirations" (Kiron & Spindel, 2020, p. 9) inferred from "employees' skills, current job role and pay grade, performance ratings, location preferences, as well as other internal digital footprints" (Broecke, 2023, p. 18).

Mapping and matching systems are expected to benefit employees by helping them find opportunities relevant to their current interests and abilities, as well as aspirations around continuous learning and career progression. Indeed, advocates for such systems claim they help employees find meaningful work within their organization, thus reducing turnover and attrition. The expected benefits for organizations include gaining agility and efficiency, as these systems reveal hidden pools of knowledge and enable organizations to move specialists dynamically. Such systems are also expected to support human capital or knowledge management strategies, such as forecasting future skill needs and upskilling the workforce accordingly. Finally, systems for mapping and matching expertise have been associated with diversity and inclusion goals, as positions are filled based on skills, regardless of formal certificates and similar traditional expertise markers.

How mapping and matching systems are implemented is understood as an important factor in mediating their benefits. In particular, adjustments to the organizational context are seen as fundamental: "What makes talent marketplaces work well is when somebody asks what the component parts of this role are and where might I find those in the organization" (Field et al., 2022, p. 3). Industry debates recognize issues such as missing or inaccurate information, potential biases in how expertise is described, and a lack of harmonious language for expertise across roles and departments. In this paper, however, I examine a more fundamental problem: the often-unexamined assumptions about knowledge embedded in these systems.

FROM AN INDIVIDUAL TO A SOCIAL VIEW OF EXPERTISE

Systems for mapping and matching expertise are often based on an individualist view. More specifically, the assumption underpinning these systems and related industry discourse is that expertise is a static, easily identifiable "thing" attached to individuals. Expertise is understood as decontextualized and homogenous – such as uniform, unidimensional skills that can be easily identified and cataloged independently of work contexts. The emphasis is thus on "capturing" and quantifying skills as if they were artifacts in an inventory or words in an index. Beyond debates in industry, such a view is also present in some academic literature on mapping and matching in operations or human resources research (e.g., Jooss et al., 2023; Shah et al., 2020).

For example, skills maps – a common way to map expertise – center on "individuals viewed as independent of the social and task-specific context in which

[work] performance occurs” even though “skill level is a characteristic not only of a person but also of a context” (Le Deist & Winterton, 2005, p. 30). While some consideration is given to potential differences in how skills are understood and defined, the expectation is that this can be resolved by creating standardized definitions and levels of proficiency. Yet, differences in skills and their combination might actually underpin unique professional specialties, organization-specific knowledge, or idiosyncratic expertise pertinent to particular contexts and goals. Similarly, while it is understood that linking skills to jobs may not be straightforward, there is little appreciation for the fact that skills are not static, but rather stretch and change across tasks, departments, projects, etc. Indeed, extending and molding skills across organizational settings is an expertise in its own right (more on this below).

This individualist view of expertise echoes assumptions about knowledge that see it as a possession (Newell et al., 2009). The implicit idea is that individuals “have” specific skills reflecting cognitive capacities that are more or less unfettered from and homogeneous across contexts – independent from people’s understanding of them. That is, expertise is “conceptualized as an intellectual possession, mental achievement, or cognitive state performed [and] examined as independent of and extractible from the people, places, processes, and objects through which it is performed” (Pakarinen & Huising, 2023, p. 2). Such an oversimplified view fails to reflect the social ways in which expertise is developed, recognized, and mobilized in the workplace.

In contrast, some literature on knowledge and professional work offers an alternative view (Blackler et al., 1993; Gorman & Sandefur, 2011; Nicolini et al., 2003b). Specifically, it suggests that expertise and how it is applied to specific tasks is a social process: it is constituted through social interactions and shaped by the history and context of its enactment. This reflects a view of knowledge as situated in practice rather than a property of individuals, highlighting that knowledge is not a single, uniform “thing,” and that language, tools, relations, and similar social elements are part and parcel of how it is enacted (Nicolini, 2011; Nicolini et al., 2003b).

Adapting and integrating knowledge is a key aspect of proficient knowledge or professional work. Tellingly, research has shown that experts are better than novices not just at carrying out a particular task but also at adapting to contextual cues to ensure superior task performance (Collins & Evans, 2007; Pakarinen & Huising, 2023). Additionally, experts often draw on multiple skills and bodies of knowledge to accomplish their work. The alchemy through which they may combine these is a central characteristic of expert performance; as is the ability to skillfully draw distinctions to leverage common resources in ways appropriate for the goal at hand (Dreyfus & Dreyfus, 2005). For example, for product managers, familiarity with various technical and administrative bodies of knowledge (Hodgson et al., 2011) might enable them to aptly adjust their work depending on the context (e.g., planning at different levels of detail or according to distinctive priorities depending on a project’s technical complexity).

In this section, I explore the challenges posed by the social nature of expertise for mapping systems. Specifically, I show how a social view highlights that

expertise comprises bundles of multiple forms of knowledge. It also highlights the implicit or emic understandings specialists share beyond any general descriptors of their knowledge. Such focus on shared understandings, however, should not distract us from the existence of pluralism, including potential divergent and competing versions and conceptions of expertise.

Multiple Forms of Expertise

Skills maps, competence matrices, or similar systems often assume variation in quantity rather than type of expertise. Yet, what may appear as a single, independent skill in a typical map can actually hide multiple and potentially intersecting skills. That is, multiple forms of expertise often coexist, influencing each other. For example, lawyers do not just require knowledge of legal codes to perform their work; they also require knowledge of practical matters, from IT systems to court rules, filing deadlines, and legal documentation requirements (Sandefur, 2015).

There are many sources for such a multiplicity of expertise. For one, there are many types of knowledge beyond explicit knowledge, such as tacit or embodied knowledge (Blackler, 1995) (see also Pakarinen & Baldessarelli, 2025). Similarly, in addition to domain expertise – knowledge about a specific field or subject area – research has pointed out the relevance of forms of expertise often devalued, such as process expertise, which refers to proficiency in methods and processes that can be applied across different domains (Treem & Barley, 2016).

Furthermore, the social nature of expertise suggests that context is not just a dimension of expertise. Knowledge of context and the ability to adjust to it is also a form of expertise. Reference to this form of expertise is hinted at in the literature through many terms, for example, situated expertise (Sandholtz et al., 2019), contextual knowledge (Barley, 1996), or more expansively, knowledge about the network of relations in which experts operate (Pakarinen & Huising, 2023). Similarly, it also reflects the idea of firm-specific skills: knowledge about “formal processes and informal routines used to do the work, about how to work with specific colleagues, the tools and technologies required on the job” (Bidwell, 2011, p. 373).

Aptly blending expertises—used deliberately here in the plural—is a hallmark of competent knowledge or professional work. For example, product engineers leverage technical knowledge and knowledge of characteristics of specific work settings (e.g., R&D vs technical support departments) or goals (e.g., pre-certification vs post-certification phases) to accomplish their work. By knowing the main deliverables and priorities in different departments and phases of product development, they can better prioritize specific objectives and work at a particular pace (Monteiro, 2024).

Diverse Versions of Expertise

Technological advancements, growing specialization, and diversity of roles challenge the notion of a single and common knowledge core required for competence in a particular job. Moreover, the contemporary world is characterized by a high volume of easily accessible information and growing social fragmentation. Thus, we find multiplicity across and differences within a particular knowledge domain or

form of expertise as well. In short, there are often diverse and sometimes competing versions of the same expertise. For example, project managers can access knowledge related to different institutes and certificates (PRINCE2 vs PMP) with a unique breadth of topics and emphasis on distinctive skills (Karaman & Kurt, 2015).

Diverse versions of expertise can stem from different bodies of knowledge, that is, collections of information, theories, and methodologies that make up a particular domain, which may be defined by professional associations (such as project management ones). Besides, similar to how expertise is enacted differently across work contexts, knowledge production also reflects distinctive socio-cultural contexts. For example, different experiences of industrialization and practical conceptions among intellectual elites crystallized into diverse versions of economics (Fourcade, 2009). Finally, diverse versions of expertise can reflect distinctive intellectual traditions, schools of thought, or paradigms. For example, opposing legal traditions in a court (e.g., textualism vs intentionalism), evolving aesthetic schools of thought in architecture (e.g., neoclassicism, brutalism, deconstructivism), or distinctive paradigms in social sciences (e.g., positivism, constructivism, critical theory).

Various versions of expertise continue to emerge as new ideas, discoveries, or changing conditions shuffle the content and boundaries of knowledge domains. For example, sustainable or green versions of expertise have emerged in technical and scientific work in light of concerns about climate change (Howard-Grenville & Carlile, 2006; Howard-Grenville et al., 2017); social movements have fueled new, more patient-centered care paradigms in medicine (Valentine et al., 2023); digital social media have enabled the emergence and popularity of indie economic ideas (Helgadóttir & Grosen, 2024); and digitalization can create new regimes of knowing that value predictive power based on new technologies that challenge traditional forms of knowing based on situated judgment in customer-facing work (Pachidi et al., 2021).

Diverse versions of expertise shape professional performance. Even when specialists mobilize similar methods and tools in comparable settings, they may work differently due to their experience with distinctive traditions or bodies of knowledge. For example, psychoanalysts following different schools of thought – such as Freudian, Jungian, or Lacanian – practice similar activities (e.g., dream interpretation) and structure the care process (e.g., duration and structure of session) differently according to unique views of the self, the nature of psychological issues, and the goals of therapy (Elliott, 2017; Wallerstein, 1988).

Varying Conceptions of Expertise

There are also varying conceptions of a single expertise. These are more subtle than multiple versions and relate to different emic understandings among similar specialists. For example, corporate lawyers within the same organization and specialty might carry out similar tasks and reference similar bodies of knowledge but engage differently with clients, peers, support staff, and tools, depending on how they understand and enact the work of managing legal risks (Sandberg & Pinnington, 2009).

Varying conceptions can reflect individual characteristics (e.g., training and career stage), work conditions (e.g., peers, clients, work demands), social factors (e.g., culture and popular discourses), or a combination of these. For example, varying conceptions of nursing in hospitals may emphasize maternal care of patients based on feminized representations of the profession or a more “nurse-as-customer-service-agent” conception that aligns with healthcare paradigms aimed at cost efficiency and patient empowerment (DiBenigno, 2022).

Conceptions are also dynamic, reflecting the dynamic nature of expertise itself, which morphs as individuals work across different settings and with diverse coworkers. Work contexts not only shape the way experts carry out their work but also influence how they understand and conceptualize their own expertise. For example, artists might foreground some aspects of their expertise over others, trying to achieve “believability” when performing live on stage versus focusing more pragmatically on delivering on cue when working on TV sets that involve a range of production constraints besides artistic expression (Anteby & Holm, 2021).

Changing conceptions are most visible in the career progression of professionals. As experts progress, they become better not only at performing the same tasks but at performing them differently. For example, engineers progress from understanding engine design and optimization as aimed at achieving optimum results according to preset technical criteria to, more holistically, considering engine performance vis-à-vis broader goals, such as expectations of car users in which the engine is to be installed (Sandberg, 2000). Such progression, however, is not given, nor is it linear. There can be different conceptions of expertise across proficiency levels (Dall’Alba & Sandberg, 1996).

HOW MAPPING CREATES EXPERTISE INVISIBILITIES

Whether and which expertise is visible is a matter of definition. A classic example is the skills related to the work of particular groups, such as “women’s work” (Acker, 1990; Star & Strauss, 1999), historically invisible due to the assumption that these skills were nothing more than a general, “natural” ability. Furthermore, every map is a distortion that not only represents expertise but also shapes how it is seen and understood. Indeed, classifications and labels for expertise reveal as much as conceal and may reinforce status hierarchies (Monteiro, 2024).

Despite interest in mapping and matching expertise, consideration is rarely given to how these systems make expertise visible – or not. The reigning idea is that, at worst, these systems make certain specialties, skills, knowledge domains, etc., invisible by not mapping them. However, depending on design and implementation, maps can make certain expertise wholly or partially invisible. The multidimensional, plural, and dynamic quality of expertise outlined above poses additional challenges to attempts to map it. For example, by illustrating that there is not just a range of skills but also a range *within* a skill. However, such variety is rarely captured in mapping systems.

This section outlines invisibilities produced by mapping systems that stem from the social characteristics of expertise. In contrast to invisibilities related to a

complete absence from mapping systems, whereby expertise is ghosted (Monteiro, 2024), these are more subtle, indirect invisibilities. The first, *flattening expertise*, relates to overlooking the multiple forms and dimensions of expertise. The second, *eclipsing expertise*, reflects hierarchies of visibility whereby some forms or versions of expertise are visible while others remain obscure. Finally, *marginalizing expertise* happens when some expertise versions or conceptions dominate over others, which are pushed to the fringes or even suppressed. While marginalization echoes peripheralization between distinctive specialist communities, it refers to dynamics within a single domain (Mäkinen, 2022).

Flattening Expertise

Flattening is a form of invisibility created when expertise is mapped unidimensionally, such as when skills are mapped as independent of each other. In reality, various forms of expertise intersect, and professionals often combine bodies of knowledge to perform tasks competently – especially in unique niches characterized by rare or idiosyncratic combinations of expertise (Ban et al., 2016; Seabrooke, 2014). Moreover, the ability to modulate one's skills according to context distinguishes the performance of proficient experts. Yet, when skills are presented as independent of each other, the result is a flattened picture of expertise.

Flattening is common in relation to the contextual dimension of expertise, or more specifically, the contextual changes expertise undergoes in practice. Some systems explicitly reference contextual knowledge of unique systems, routines, and demands of different departments; or attempt to map “soft skills,” that is, those used to interrelate, communicate, and work together. Yet, they generally neglect that domain and contextual knowledge interact. For example, technical specialists may change how they present an analysis depending on the constraints and resources of a project.

Flattening is particularly visible in the case of professionals working in complex settings involving various technologies and specialists, such as in healthcare. While there is a general expectation of competent performance in such settings, the expertise related to context can often be flattened. For example, “floating” programs aim to move nurses across different areas based on staff needs (Gobis, 2001). Yet, when “floating” between different wards or units, nurses may lack familiarity with certain elements – such as the staff in those settings, knowledge of how to work well with them, the codes needed to get supplies, and the particular kinds of patients there. Such lack of contextual knowledge may, in turn, “place patients at risk ... cause delays ... reduce[] time for patient care and create[] perceptions of disorganization ... [and] raise questions about the nurse's credibility” (Ahmed et al., 2023, p. 903).

Flattening is a form of invisibility that is particularly concerning for roles or professionals that bring together multiple skills or bodies of knowledge. Such is the case for product managers with technical and administrative mandates, as well as professionals developing knowledge around new tasks or problems. For example, scientists championing the emergence of sustainable practices

(Howard-Grenville et al., 2017) or aeronautical engineers designing new digital tools for pilots (Monteiro, 2024). In these cases, overlooking the intersection of bodies of knowledge or the blending of skills can mean neglecting experts with a particular ability to work across domains or at the forefront of a specific domain.

Eclipsing Expertise

Eclipsing happens when maps feature some forms or versions of expertise more prominently while omitting or only coarsely featuring others. Instead of being rendered completely invisible, expertise is overshadowed, present but only in a secondary or peripheral position. This may stem from criteria underpinning maps that (implicitly) privilege certain expertise over other, such as by focusing on expertise domains while eclipsing the expertise to coordinate and connect such domains (process expertise) or knowledge related to workplace characteristics (contextual knowledge). Eclipsing can also reflect a more legitimate expertise version defining the skills, abilities, or knowledge to be mapped in a way that privileges a dominant paradigm.

Eclipsing is particularly evident when expertise is mapped with only partially relevant categories. For example, terms related to a project management body of knowledge (e.g., PMBOK) may be used to map the skills of managers coordinating technical projects, thus eclipsing expertise pertaining to technical bodies of knowledge (e.g., systems engineering) (Monteiro, 2017). More subtly, expertise can be eclipsed by being mapped in coarse, generic ways. For example, in technical and highly specialized settings, it is common for “soft” or “non-technical” skills to be eclipsed despite their importance for safety operations (McCulloch et al., 2009). Such eclipsing means that they are not mapped “in sufficient detail so that they can be taught and reliably assessed” (Reader et al., 2006, p. 558).

As maps foreground some expertise and eclipse other, they reinforce status rankings. Indeed, eclipsed expertise is often related to low-status groups or expertise viewed as subordinate to another. For example, classifications in service jobs tend to be based on discrete tasks and usually poorly specify the skills related to awareness, interaction management, and coordination required for effectively performing the work. This thus reinforces the idea that these are “non-skilled” jobs (Hampson et al., 2009). Eclipsing is also common for forms of expertise that are less “objective” and harder to individuate – such as holistic expertise in specialized settings (Bechky, 2020) – or neatly fit into categories – such as idiosyncratic specialties (Monteiro, 2024).

Marginalizing Expertise

Versions and conceptions of expertise are marginalized when one is not only privileged to the detriment of another, as in eclipsing, but when there is also a more pronounced element of dominance. This is most common in the case of competing bodies of knowledge within a single domain where one seems to prevail over another, thus dictating which expertise is mapped. Marginalization is more salient for fragmented domains where specialists struggle for resources. For example, in medicine, some versions of expertise related to mainstream knowledge and the

prevailing curative paradigm might be given more importance and allocated more resources while alternative or holistic domains are marginalized. More mundanely, specialists representing distinctive training or traditions that coexist in the workplace may define categories and terms for mapping in a way that pushes to the fringes or even erases other versions of expertise.

Marginalization may reflect the emergence of different versions of expertise within a domain, such as when a subset of specialists promotes new techniques or frameworks (Mørk et al., 2010), thus redefining which skills are relevant to be mapped. Marginalization may also be a byproduct of social change – such as novel conceptions of expertise brought by new generations vis-à-vis incumbents in a profession (Nicolini & Roe, 2014) – that makes established categorizations of skills obsolete. More indirectly, marginalization may also happen incrementally following changes in staff within an organization. For example, individuals with a particular type of expertise may substitute one another, such as psychologists substituting activists in social or non-profit organizations who bring clinical skills and more individualist understandings to the work, thus marginalizing more social and political understandings (Zilber, 2002). In such cases, enduring labels for expertise may end up describing different forms or versions of expertise.

Expertise is also marginalized when it is misaligned to the context in which it is mobilized, such as when professionals trained in a particular paradigm or with experience in a specific setting move to a new one. This can be seen in the example of migrants with knowledge and broader experience marginalized by (national) accreditation systems or classifications with different, inbuilt expectations regarding proficiency (Diedrich et al., 2011). Similarly, marginalizing may occur in the aftermath of mergers and acquisitions, bringing together distinctive versions or conceptions of expertise (Faraj & Sayegh, 2017), such as medical staff joining a hospital in which existing work systems wither their unique contextual knowledge, traditions, or care paradigms.

Finally, marginalization may be nested into power struggles. That is, manipulating mapping can be a way to erode the legitimacy of versions and conceptions of expertise. For example, as part of colonial domination, western expertise marginalized Indigenous medical knowledge by changing classifications and restricting the “official definitions of medical expertise, toward a reliance exclusively on formal qualifications rather than experientially acquired and inherited skills to demarcate legitimate therapeutic knowledge” (Lambert, 2012, p. 1029). Indeed, controlling the categories and general vocabulary related to expertise is a way to establish domination through marginalization.

DISCUSSION

This paper addresses the challenges surrounding mapping and matching expertise, specifically, the difficulty in rendering expertise visible due to its multidimensional, plural, and dynamic nature. As the structuring of work in organizations changes and jobs become disaggregated and distributed (Barley et al., 2017; Burton et al., 2016; Rogiers & Collings, 2024), aligning expertise and work grows

in both importance and difficulty. In response, organizations increasingly use mapping systems to gain a more refined understanding of a workforce's expertise and better match individuals across tasks, committees, projects, or assignments. Yet, underpinning these systems and the discourse of their champions is often an individualist view of expertise that sees knowledge as homogenous and static.

Leveraging previous literature on knowledge and professional work, this paper articulates a social view that foregrounds the various forms, versions, and conceptions of expertise that dynamically coexist, intersect, and potentially even clash as they are enacted. That is, specialists may bring distinct bodies of knowledge together in unique ways, understand the same issues according to different orientations, and continually shift how they conceive of and leverage what they know. This makes expertise a complex resource and attempts to map it can end up creating invisibilities – flattening, eclipsing, or marginalizing it.

While mapping and matching may appear to be mundane organizational affairs, understanding them holds promise for expanding the current debate on expertise. We often assume that individuals within organizations have the required expertise to accomplish their work, and researchers usually focus on individuals with widely recognized expertise. However, this paper takes a step back, shifting the conversation to *whether* and *which* expertise is present and visible. In doing so, the paper opens new vistas, foregrounding the role of mapping and matching on expertise development, invisibilities in expertise recognition, and incompetence in expertise mobilization.

Mapping, Matching, and Expertise Development

Expertise is typically developed through sustained engagement in increasingly specialized tasks. Traditionally, such learning processes followed socially structured pathways and formally organized careers (Gherardi et al., 1998; Rothman & Perrucci, 1970). Yet, as jobs and careers change and become more dynamic, individuals must craft opportunities to continue learning and remain up to date (Beane, 2019; Hénaut et al., 2023; O'Mahony & Bechky, 2006). Therefore, examining individuals' strategies for being matched with tasks that provide opportunities to consolidate and refine their expertise is important. We may expect that people may “hoard” tasks or actively seek out assignments to enhance expertise or even to boost status and resources (Wilmers, 2020).

Such strategies may be particularly salient and perhaps more developed in dynamic work settings. As people routinely cycle through tasks, they may face the additional challenge of maintaining awareness of work opportunities that fit their knowledge and career strategies – and avoiding tasks that hold limited interest and enrichment for them. Politicking around matching may also become prevalent in such settings. Individuals may attempt to join high-profile projects or take up prestigious assignments that provide visibility, chances for career progression, and access to resources.

If mapping becomes more common and consequential, workers may also attempt to influence how their expertise is represented – and made (in)visible – to secure specific work and learning opportunities. For example, by lobbying for

labels, taxonomies, or systems that privilege certain forms, versions, or conceptions of expertise—especially those associated with material gains. Or alternatively by making one's expertise less visible to avoid being assigned to undesirable work (e.g., tasks for which there are limited learning opportunities) or to maintain a desirable level of autonomy and discretion (Star & Strauss, 1999).

In work settings where professionals are confronted with considerable transient or temporary tasks, being able to work across contexts – with different colleagues, work systems, and time horizons – might become a type of expertise in itself. Aside from knowledge about different contexts, individuals may also develop an ability to adjust to multiple contexts or “learn to learn” rapidly. This is already evident among professionals who constantly work across projects and take up work that largely fits within their previous experience while introducing some novel elements that extend their expertise in a new direction (O'Mahony & Bechky, 2006). It is also common among individuals who work across settings and projects, such as in the creative industries (Anteby & Holm, 2021; Smith & Autio, 2022). In light of the changing nature of work, this form of adaptive expertise is likely to become increasingly relevant even within more traditional organizational settings.

Invisibility and Expertise Recognition

Expertise corresponds not just to the existence of specialized knowledge, but also its recognition. Thus, individuals and groups continually struggle to demonstrate the relevance of their knowledge for specific problems vis-à-vis peers, clients, and audiences (Abbott, 1988; Heimstädt et al., 2024). Yet, underpinning recognition are questions around invisibility, given that knowledge is not easily observable (Hadjimichael & Tsoukas, 2019). Indeed, it is common for individuals to have a limited understanding of what colleagues or specialists in general know. Thus, the complexity of some expertise domains – including their multidimensionality, plurality, and dynamism – may easily go unrecognized, especially among laypeople. In turn, how expertise is visible can affect access to the benefits associated with recognition (Monteiro et al., 2024). For example, concealing or making expertise invisible can serve as an “objective” way to justify reduced compensation or assign a lower place in a hierarchy (Hampson & Junior, 2005).

Previous research has considered how individuals aim to strategically make expertise visible, alerting us to the potential decoupling of an individual's actual ability and its social recognition (see also Treem & Barley, 2025). For example, individuals may manipulate information in knowledge management platforms, thus leading “others to believe that they are experts in certain areas in which they really have limited knowledge, or that they are not experts in areas in which their knowledge is actually quite expansive” (Leonardi & Treem, 2012, p. 38). Complementing this debate on the political games individuals play with systems for managing knowledge, this paper shows how these very systems may privilege some types or versions of expertise over others. That is, besides some forms of deception to influence visibility, there are also politics embedded in the very systems to map expertise.

Invisibilities may also be produced in social processes through which individuals (fail to) connect to taxonomies and labels mapping expertise. Specifically,

how individuals represent and narrate their expertise may shape whether and which expertise is visible (Barley et al., 2016; Ewick & Silbey, 2003; Fine, 1996). Extant research suggests that people with similar skills may describe their expertise differently depending on their background. For example, they can emphasize their lived experience instead of technical skills or credentials relevant to a job (Portocarrero, 2023). Furthermore, different settings may feature idiosyncratic vocabularies or categories, making some expertise more or less visible and relevant (Monteiro, 2024). Finally, national regulations and classifications may implicitly privilege some forms or versions of expertise (Diedrich et al., 2011).

Invisibility can (unintentionally) reproduce power dynamics across groups and individuals, including inequalities (see Occhiuto, 2025). For example, racialized, gendered, and ethnocentric assumptions about what constitutes expertise may prevent the recognition of the skills of migrants, women, people of color, and other minority groups (Cardador, 2017; Chan & Anteby, 2016; Diedrich et al., 2011; Warhurst et al., 2017). That is, “the recognition of skill/capacity can be driven by ascriptive considerations that have little to do with actual capacities, and even when capacities are recognized they sometimes go unrewarded for the same reasons” (Osterman et al., 2022, p. 1349).

To be sure, debates on the political or socially constructed nature of skills are not new (Warhurst et al., 2017). For example, the gendering of tasks has long been seen as contributing to the devaluing of women’s work, especially when it involves care and emotional labor (Acker, 1990; Wharton, 2009). Yet, the creation and popularization of mapping systems for expertise raise new questions about how they may reproduce or even augment inequalities in recognition and access to resources. Indeed, countries increasingly use classifications of skills to prioritize migration and power digital systems for employment search (IOM, 2019; Markowitsch & Plaimauer, 2009). Thus, invisibilities can impact one’s career prospects, and mismatches can lead to “brain waste” on a large scale in society (Mattoo et al., 2008).

Incompetence and Expertise Mobilization

Expertise mobilization refers to how individuals deploy knowledge into practice (Nicolini et al., 2003a; Pakarinen & Huising, 2023). While focusing on how expertise is mobilized, prior research has overlooked the more basic questions of whether and which expertise is applied to tasks. Attending to this is particularly important because, as this paper suggests, organizations may struggle to exploit the knowledge of their employees due to the challenges invisibilities pose for matching expertise to tasks. When individuals are assigned to work that they cannot perform competently, such poor matching can lead to ineffective performance, ultimately reducing organizational efficiency and threatening survival. In the long term, organizations may develop employees’ abilities and redress knowledge gaps in key areas (e.g., via training or hiring). However, in the short term, organizations and managers face challenges in ascertaining the most appropriate specialist for some work. For example, navigating competing demands between assigning tasks to junior employees to develop expertise or to senior ones who

are already proficient in it; or trade-offs between selecting a readily available individual versus the most proficient one.

Considering mapping and matching complexities also raises new questions about the sources and meaning of (in)competence. Specifically, this paper suggests that what is routinely understood as incompetence might be, in reality, the product of a system that generates invisibilities and mismatches. That is, incompetence is a multifaceted outcome that depends on how available knowledge is made visible – e.g., how people narrate what they know or which taxonomies and assumptions are encoded in systems; and the (changing) characteristics of the work at hand – e.g., which expertise is needed for assignments or the number and kind of assignments. While the role of organizational structures in producing incompetence (Peter & Hull, 1969) or obscuring knowledge (Vaughan, 1999) has long been foreseen, this paper suggests that instances of unqualified or simply flawed expert performances may become more common, given the complexities of mapping and matching expertise.

The topic of incompetent experts has been discussed in relation to claims of charlatanism toward competitors in inter-professional struggles (Abbott, 1988). These may be particularly prevalent among professionals mobilizing non-mainstream knowledge (Heimstädt et al., 2024). Yet, this paper suggests that some forms of incompetence might not be only a feature of individuals and groups or claims surrounding them but also rooted in how individuals are positioned in an organization and the work assigned to them. This richer comprehension of incompetence also provides a new window into contemporary debates on the so-called crisis of expertise, where expertise pervasiveness in society is accompanied by growing skepticism and mistrust toward experts and expert knowledge (Eyal, 2019; Reed & Reed, 2022).

The expansion of expertise, coupled with changes in the organization of work, has created practical problems around which specialists should perform which tasks or speak on which issues. For example, a committee for designing corporate sustainability policies may involve different specialist domains, forms of expertise, and conceptions of sustainability policies (see on the multiplicity of approaches to sustainability in organizations Lounsbury, 2001; Sandhu & Kulik, 2019). Therefore, we would do well to focus not just on the social arrangements that make the expert performance of a task possible (Eyal, 2013) but also on the organizational structures that make expertise (in)visible and (mis)match it to a given task.

BOUNDARY CONDITIONS AND FUTURE RESEARCH

While this paper focuses on systems for mapping expertise, various processes enable the identification of the expertise available in an organization. Specifically, social interactions are particularly relevant in allowing individuals to understand “who knows what” by fostering a transactive memory (Ren & Argote, 2011). Yet, such understandings might be more or less shared; and experts might have distinctive mental maps of which expertise is available and relevant to tasks (Brandon & Hollingshead, 2004; Nicolini, 1999). Thus, examining the co-constitution and

potential (mis)alignments between implicit “folk” maps and those featured in formal systems would be promising. This may reveal, for example, the prevalence of invisibilities and the benefits of mapping vis-à-vis its costs and alternatives.

How expertise is mapped is also increasingly important for online labor platforms (e.g., Upwork), where labels for skills and competencies are central to the matching process between workers and clients. Furthermore, the growing popularity of online professional profiles, such as LinkedIn, has made how expertise is visible particularly consequential for career advancement and opportunities. Interestingly, current research suggests the existence of substantial heterogeneity in skill content within occupations (Labussière & Bol, 2024) – a potential result of the prevalence of gig and project-based work that may lead professionals to pick up new skills as their career progresses (Hénaut et al., 2023). Focusing on how expertise is mapped in online platforms can help us understand how visible the diversity and dynamism of expertise might be and its potential implications for career processes and job mobility.

Finally, understanding the limits of systems for mapping expertise invites us to consider the role of other factors beyond them, most notably, the role of managers (Foss & Klein, 2022). As technological and organizational changes reconfigure work, managers must develop (new) skills to evaluate specialists’ knowledge and fit for tasks. This raises questions about matching responsibilities between managers and specialists. While managers may better understand task characteristics, specialists may better know their skills. Interestingly, employees report in industry surveys that securing pertinent opportunities for developing skills is highly dependent on their managers (Cantrell et al., 2022), and recent academic research suggests that “good managers facilitate the discovery of workers’ aptitudes... which results in workers finding positions that are better matched to their skills” (Minni, 2023, p. 5).

CONCLUSION

This paper is grounded in a long tradition of scholarship drawing on ideas about knowledge to enrich assumptions in emerging debates on strategic, technological, and administrative systems to manage expertise. The foundational insights emerged from the realization that “information technology inspired but cannot deliver knowledge management” (McDermott, 1999). Accordingly, research and practice contrasted the limits of codification and knowledge databases – built on the assumption that knowledge is a “thing” that exists external to individuals who can capture, store, and transmit it – to a view of knowledge as a social process (Newell et al., 2009; Nicolini, 2011; Nicolini et al., 2003b).

Subsequently, researchers examined how an information processing perspective has underpinned the strategic debate and elided semantic and political barriers to knowledge sharing (Bechky, 2003; Carlile, 2004); and how ideas on competence prevalent in human resource systems were rooted in an individualist and decontextualized view of learning and career progression (Lelebina & Gand, 2018; Sandberg, 2000). Recently, in light of technological changes,

scholars pointed out how evaluations of AI tools privilege a focus on the know-what of professionals (explicit and codified aspects of knowledge) instead of their know-how (accumulated expertise, rooted in situated, social, and tacit practices) (Lebovitz et al., 2021); and, more generally, how a substantialist view of expertise underpins debates about the impact of algorithms and similar digital technologies on professional work (Pakarinen & Huising, 2023).

This paper continues this tradition. Advancing a more social view of expertise may enable organizations to understand better the available expertise in their workforce, such as the unique skills related to their work context or idiosyncratic employee profiles that synthesize knowledge in unique ways. It also suggests that unlike the objective process cast by the veneer of (new) technologies and their promoters, mapping and matching expertise actually requires many considerations in light of the plural, multidimensional, and dynamic nature of expertise and its relation to work.

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ALGORITHMIC EXPERT SERVICES: WHEN EXPERT VALUES MEET SCALABILITY THINKING

Cornelius Heimstädt^a and Maximilian Heimstädt^b

^aHumboldt University of Berlin, Germany

^bHelmut Schmidt University, Germany

ABSTRACT

Individuals who search for expert advice can now obtain it through algorithmic expert services. Expert advice is generated by an algorithmic system and provided over a digital interface. Human experts disappear from direct interaction with clients, but instead orchestrate the algorithmic generation of expert advice from the back office of these services. Algorithmic expert services are often associated with the hope of making expert advice available to a large number of clients in a profitable way. However, this expectation is challenged by research on the role of shared expert values in and around organizations. In this study, we therefore explore how human experts in the back office of algorithmic expert services deal with tensions between their expert values and the imperative of scaling. Empirically, we draw on ethnographic material from a startup developing an algorithmic expert service for agriculture. We find that the human experts in the back office experience tension between their core value (i.e., reducing the environmental damages caused by pesticides) and managerial demands to maximize the app's user retention. The experts navigate this tension by constantly experimenting with new representations of advice in the app's interface, a process in which they repeatedly embrace their

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core value while simultaneously reinterpreting it, until they eventually find a way of representing advice that accommodates both their core value and the monopolistic tendencies of digital capitalism. Our study thus contributes to debates about whether expert advice can be scaled up by organizations using algorithmic means, and the role of values therein.

Keywords: Agriculture; algorithms; ethnography; expert services; expert values; scaling

In many areas of life, people experience situations where they feel the need to solicit expert advice. Until recently, this advice has mainly been provided either by individual experts or through expert organizations (Heimstädt et al., 2024). This study focuses on an emerging mode of organizing expert advice, which we refer to as *algorithmic expert services*. When engaging with an algorithmic expert service, clients receive algorithmically generated advice via a mobile app or other digital interface. In recent years, algorithmic expert services have gained ground in fields such as legal advice (Hydén, 2020), pastoral care (Young, 2022), cultural taste (Sachs, 2020), mental health (Birk & Samuel, 2020), and even regarding agricultural problems with plant diseases (Heimstädt, 2022) – the latter being the empirical context of this study. With algorithmic expert services, the advice is not provided in the interaction between human expert and client (Pakarinen & Huising, 2023). However, the human experts are not taken out of the loop completely. Instead, their work is moved to the back office, where they develop and maintain the algorithmic expert service. This new mode of organizing expert advice has sparked the imagination of a wide range of actors – from policy makers to investors: thanks to their seemingly smooth and limitless scalability, algorithmic expert services not only appear to be able to serve clients who previously had little access to traditional expert advice, but also to do so in an economically viable way.

However, these high hopes turn into a conundrum once we compare them against existing research on the role of values in expert advice and the development of digital services. Experts acquire their expert values through a process of socialization into expert communities (Anteby, 2013; Becker et al., 1961). The acquired values, which they share with other members of these communities, subsequently help them to provide reliable and responsible advice (Bechky, 2011; Van Maanen & Barley, 1984). More specifically, the experts' shared values set them rigid constraints on the kind of advice they can give with a clear conscience. In direct interaction with clients, experts can often anticipate potential conflicts regarding their values and circumvent them preventively (Chan & Hedden, 2023). In the back office of algorithmic expert services, their shared values also help experts to provide expert advice (Sachs, 2020). However, as expert advice is delivered to clients via a digital interface, the human experts have little opportunity to directly discern value conflicts with individual clients and find tactics to circumvent them (Pakarinen & Huising, 2023). This challenge for back office experts

is exacerbated by a dynamic of digital services that Pfothenhauer and colleagues (2023, p. 1) describe as “scalability thinking.” In developing digital services, the argument goes, organizations have the primary goal of attracting as many users as possible and keeping their attention through the most “captivating” (Seaver, 2019) design. Developers of such digital services are therefore forced to constantly adapt the output of the system in order to scale as quickly as possible. It is to be expected that this problem of creating scalability is even thornier for experts designing algorithmic expert services than it is for generalist software developers designing digital services that do not claim to be expert, such as music recommender systems. This is due to the fact that experts, by virtue of their belonging to expert communities, have less leeway when it comes to providing algorithmic recommendations, since they have to ensure that these recommendations are in line with the values of these communities. In this study, we therefore explore how human experts in the back office of algorithmic expert services deal with tensions between their expert values and scalability thinking.

We explored this question through a case study of the German startup FLORA and its algorithmic expert service, the mobile app PHYTØ (both pseudonyms). PHYTØ offers agricultural expert advice to small-scale farmers. Farmers can upload photos of their diseased plants to the app, which uses an image processing algorithm to diagnose the plant diseases depicted in these photos. If the app was able to make a diagnosis, another algorithm provides expert advice to the farmers on treatment and prevention of the disease. Using ethnographic and archival material, we analyzed how the human experts in the app’s back office (e.g., biologists, agronomists, and geographers) repeatedly modified the algorithmic system and its representation of advice over a period of 8 years. During this period, we identified several moments in which the experts received demands from FLORA’s management to make the app more scalable, that is, to modify its expert advice in a way that would increase the number and engagement of users on the app. These demands posed a challenge for the developers as they were not willing to provide advice that would deviate from their core expert value (i.e., the reduction of environmental damage caused by agricultural pesticide use) even though it might resonate strongly with users. We found that the experts navigated this challenge by repeatedly embracing their core value (i.e., claiming that their actions reduce the environmental damage caused by agricultural pesticide use) while simultaneously reinterpreting how this core value should guide their work on the algorithmic system – reinterpretations that materialized over time in different representations of advice in the app’s interface. These cycles of embracing their core value and reinterpreting it eventually enabled the back office experts to fulfill the management’s demands for scalability and at the same time maintain their group’s core value.

With our study, we show that when expert advice is delivered algorithmically and through a digital interface, it is not possible – as is often claimed – for the human experts who develop these algorithms to respond to the situated needs of each individual client. Rather, from the back office, the respective experts engage in a process of experimentation, gradually testing different representations of advice through the app’s interface on the whole or larger parts of their user base until they find one that fits both their expert values *and* their management’s

demand for scalability. Furthermore, we show that a power imbalance can be observed in this process of experimentation, manifested in the fact that scalability thinking seems to shape the expert values at stake more than the other way round. In other words, scalability thinking distorts the way in which experts interpret their core value and, consequently, represent their advice in the interface of algorithmic expert services. In our case study, this distortion of the experts' core value was reflected in a gradual convergence of their interpretation of what it means to reduce pesticides with what it means for the agrochemical industry to reduce pesticides. Algorithmic expert services thus satisfy users' need for expert advice, but seem to have only a limited capacity to induce profound socio-ecological transformations (e.g., toward more sustainable agricultural systems).

Based on these findings, it seems plausible that the proliferation of algorithmic expert services leads to a massification of expert advice, in the sense that people who previously had little or no access to expert advice can now be served. While this algorithmically generated advice may be scientifically valid, it is still qualitatively different from the more situational and, at best, industry-independent advice of human experts who engage with farmers on a face-to-face basis (Fabregas et al., 2019). Our results therefore suggest that the massification of expert advice through algorithmic expert services leads to a client-related segmentation of expert advice (see Abbott, 1988), with affluent clients benefiting from the more situationally appropriate advice of human experts and less affluent clients being served by the more generic advice of algorithmic expert services.

In the remainder of this article, we first review existing research on expert values and the development of algorithmic expert services. We then describe the specifics of the empirical case at the center of our analysis – an algorithmic expert service in the field of agricultural extension – and the methods of data collection and analysis that we used to examine it. This is followed by a description of our analytical results, structured around three phases that make up the development of the algorithmic expert service PHYTØ. Building on this, our article closes with a discussion that further reflects on the theoretical and political implications of our findings.

THEORETICAL BACKGROUND

More than in other forms of work, the activities of experts are shaped by the shared values of the expert community of which they are a member (Bechky, 2011; Van Maanen & Barley, 1984). Experts take on these values in a long process of socialization into such a community (Anteby, 2013; Becker et al., 1961). The close connection to the values of their community helps experts to carry out their work conscientiously and consistently, even in the face of external pressure or criticism. For example, in her study of a crime laboratory, Bechky (2020) shows how a group of experts – firearms examiners – mobilized their shared values in order to defend themselves against the political demand for a reform of their expert practices.

For some time now, there has also been research investigating the extent to which shared values might not always be helpful but can also cause problems in the everyday work of experts (Augustine, 2021; Huising, 2015). A typical source of problems is when the values of experts come into conflict with the values and goals of important stakeholders such as clients or superiors. Previous research has examined these conflicts and how they are dealt with, particularly in direct, personal interactions. For example, Chan and Hedden (2023) show that the core values of career counselors in business schools often diverge from the values of the students who seek their advice. In order not to risk complaints to the school's management, experts try to anticipate value conflicts and situationally adapt their expert advice. Similarly, DiBenigno (2020) describes conflicts between mental health experts and their military superiors in the U.S. Army. In order for military superiors to accept the work of mental health experts, the experts deliberately signal that their values are aligned with the values of the military (e.g., by participating in strenuous exercises).

Expert values also play an important role for the new phenomenon of algorithmic expert services. Contrary to the image that many of these service providers convey to the outside world, algorithmic expert services do not completely take the human experts out of the loop. Instead, human expert work is shifted from direct interaction with clients seeking help to the back office of the algorithmic expert service. Here, the human experts work continuously but largely invisibly on the development and maintenance of the computational systems that deliver algorithmic expert advice to the clients' digital devices (Jaton, 2021; Justesen & Plesner, 2024). Previous research on algorithmic expert services has shown how the values of back office experts have helped them accomplish their tasks. When problems occur, these are primarily "normal, natural troubles" (Bittner & Garfinkel, 1967, p. 187) that arise from the routines of everyday work and do not call the experts' core values into question. For example, Sachs (2020) studied the work of art history experts in the back office of an algorithmic service that helps users to develop their taste in art. She describes how the experts use their shared values to classify artworks and artists. In particular, these shared values help the experts to understand and resolve "breakdowns" (p. 1693) in which the algorithmic system produces what they consider to be incorrect expert advice.

So far, however, little is known about the extent to which the values of back office experts can lead to more substantial conflicts with important stakeholders. One source of these conflicts, which is specific to algorithmic (in contrast to human) expert services, is what Pfotenhauer and colleagues (2022, p. 4) describe as the "scalability zeitgeist." An insatiable "appetite for scaling and monopoly," the authors argue, can be seen as the "key ordering logic of current initiatives in innovation and public policy" (pp. 3–4). According to this ordering logic, the most important thing for the commercial success of a digital innovation is to gain a large number of users quickly. The viability of the business model and the actual satisfaction of user needs become secondary to scaling. In the development of digital products and services, the quest for scalability means that development is never complete, but that experiments are constantly being carried out to see which features and changes will keep more users engaged for longer (Marres & Stark, 2020; Rahman et al., 2023).

Seaver (2019) provides a particularly vivid description of the scalability zeitgeist in his study on the developers of algorithmic services for recommending music. He describes how the developers make it their goal to develop systems for “getting people hooked” (p. 3), although they are aware that the “retention” of users is not synonymous with their “satisfaction” (p. 11; see also Pronzato, 2023).

Since the experts in the back office of algorithmic expert services have no direct interaction with clients, it is a great challenge for them to identify and adapt their advice to the needs of individual users (see Pakarinen & Huising, 2023). In addition, many of the algorithmic expert services we see today are organized as profit-oriented companies. It therefore seems very likely that these companies are strongly influenced by scalability thinking. Back office experts in these companies are thus confronted with the requirement to continuously experiment with the algorithmic expert advice in order to make it as captivating as possible. At the same time, the shared values of the back office experts provide them with rigid constraints on the kind of advice they can give with a clear conscience. To better understand this state of affairs, this study examines how human experts in the back office of an algorithmic expert service deal with tensions between their expert values and the scalability imperative often associated with digital innovation.

METHODS

Agricultural Extension as Expert Service

Agricultural extension – broadly understood as the transfer of knowledge and technology from agricultural science to agricultural practitioners – is a centuries-old form of expert service. As such, it plays a central role in improving productivity and, more recently, other dimensions of agricultural systems (e.g., sustainability) by supporting farmers with expert advice. From the mid-19th century to the end of the 20th century, agricultural extension agents worked almost exclusively for the state. They usually had a high level of academic training (e.g., in agronomy, biology, or chemistry) and enjoyed high social prestige. Contemporary sociological studies also describe how extension agents mobilize the materiality of farms to convince farmers of certain products or procedures (Henke, 2008; Le Velly & Goulet, 2015), for example, by measuring nitrate levels in the soil to persuade farmers to use less fertilizer. These credentials and abilities helped, and still help, human extension agents to establish expert authority over farmers and induce behavioral changes. With this in mind, historians and anthropologists studying agricultural extension attribute the emergence of contemporary productivist agriculture in large part to the ongoing modernization efforts of extension agents (Jas, 2005; Scott, 1998).

However, this state-funded model of agricultural extension was inevitably associated with high costs for the respective governments. As a result, state agricultural extension services have come under increasing criticism for failing to reach all farmers in need of advice. In response to such criticisms, as of the early 1990s, the field of agricultural extension started to become privatized (Labarthe & Laurent, 2013) – a trend that also took hold in developing countries (Feder et al., 2011). By generating

new incentives for innovation, the partial privatization of the agricultural extension sector provided an important breeding ground for the emergence of mobile (and eventually algorithmic) extension services such as the one at the center of this study.

In the mid-2000s, companies began to develop agricultural extension services based on classic cell phones – a development that can be viewed as the first wave of mobile agricultural extension services. These companies set out to leverage the increasing penetration of cell phones in rural areas to create new markets for the sale of information services. These companies oftentimes motivated their business activities with a critical assessment of traditional extension services: As they put it, most in-person agricultural expert advice (especially in poor countries) was of low quality (e.g., “biased,” “unscientific,” “outdated”) or simply nonexistent. In view of this situation, they went on to argue, mobile advisory services would permit the delivery of science-based expert advice to a wide audience in a cost-efficient way. In contrast to the lofty promises of these companies, both development scholars (Baumüller, 2017) and anthropologists (Stone, 2011) documented that these companies often had difficulties providing effective extension services. Reasons for this were, for example, that farmers did not see the advice of these companies as expert advice, that farmers did not want to pay for the offered services, or that the companies were unable to properly monitor the effect of their services at a distance.

With the proliferation of smartphones in ever more rural areas around the world, the market for mobile agricultural extension services gained new momentum. As an example, in a 2019 *Science* article, economists Fabregas et al. (2019) pointed out that “[m]obile technologies, particularly smartphones, have the potential to bring sophisticated science-based agricultural advice to smallholder farmers to improve productivity” (p. 1). To explain this enthusiasm: The key difference between cell phone-based and smartphone-based extension services is that the latter typically deploy algorithms to transform data that is collected with the help of the smartphone into expert advice. This novelty of smartphone-based mobile extension is reflected in a semantic shift that often accompanies these algorithmic expert services: Mobile extension services for cell phones were mainly portrayed as new means of delivering the advice of human experts to their clients. The providers of mobile extension services for smartphones, however, frequently promote their algorithms as experts in their own right – a typical hallmark of what we refer to as algorithmic expert services.

An Algorithmic Expert Service for Agricultural Extension: The Case of PHYTØ

The algorithmic expert service at the center of this article is the smartphone app PHYTØ which is developed by the German startup FLORA. The app’s expert service consists of diagnosing plant damages based on digital images of symptoms and providing advice on treatment and prevention (see Heimstädt, 2023a). At the time of writing, PHYTØ covers 500 different plant damages on 30 different crops and has been downloaded about 15 million times. The vast majority of PHYTØ clients are located in India, where conditions for the provision of smartphone-based agricultural extension are particularly favorable (see Heimstädt,

2023b): well-developed mobile internet, high smartphone coverage in rural areas, relatively inexpensive mobile data, many smallholder farmers (potential clients), and strong political support for digital agriculture. Given this regional focus, FLORA is headquartered in Germany and additionally operates two regional offices in India.

As is typical for algorithmic expert services, FLORA portrays PHYTØ as a replacement for human experts, as this can be seen as one of the unique selling points of these services. This is very clear in public accounts by or about the startup, where the app is variously described as “digital plant expert,” “mobile crop doctor,” “digital expert in your pocket,” “crop doctor app,” or “pocket agronomist.” However, also typical of algorithmic expert services, on closer examination, it becomes clear that FLORA does not completely take human experts out of the loop. Instead, the work of these experts is shifted to the back office and delivered to clients via a digital interface.

Data Collection and Analysis

To investigate this problem, we mobilize data from the first author’s doctoral dissertation in which he reconstructed the development of FLORA from the startup’s foundation in 2014 to the year 2022 (Heimstädt, 2022). Ethnographic data collection took place between 2018 and 2022. In order to reconstruct the development of the startup, this ethnographic data collection involved three different data sources. One important data source was observational data from the startup’s offices in Germany and in India, as well as from accompanying the startup’s staff during various field trips. Another data source was interviews with the startup’s staff and users of the app. A third data source was archival data (e.g., business plans, pitch decks, onboarding documents, and press articles) which, in addition to retrospective interviews, were particularly important for reconstructing the development of the startup before 2018.

For this study, we analyzed the parts of this larger data set which provide information about the work of the so called plant team, a group of back office experts made up of staff with academic backgrounds in fields providing them with plant expertise, such as biology, agronomy, or geography. The overall task of the plant team is to prepare the plant-related expert advice that PHYTØ displays to its users and to find the best way to display this advice to the app’s clients after a successful algorithmic diagnosis.

Our analytical process consisted of three phases. In the first phase, we openly coded the data with the broad intention to understand how the members of the plant team prepare the expert advice to be provided to farmers by the app. From this, we learned that over the lifespan of the startup, the plant team experimented with very different approaches to providing expert advice. We understood that the team sometimes discontinued advisory features of the app and – more often – added new or reconfigured existing ones. In the second phase, we looked more closely at the way the plant team explained and motivated these changes. During this phase, we learned that for the members of the plant team, the approach to providing expert advice is closely linked to one of their core values, namely

reducing the environmental damage caused by agricultural pesticide use. At the same time, their approach to providing advice is also shaped by their regular exposure to management demands for better scalability of advice. In the third phase, we divided our data into three “temporal brackets” (Langley, 1999) in order to better understand the “trial of strength” (Latour, 1987, p. 78) between expert value and scalability thinking, and how the outcome of this trial materialized in the app’s algorithmic expert advice at different points in time. As a result, we found that each temporal bracket is characterized by a different interpretation of the plant team’s core value, and a resulting materialization of that interpretation in how the app represents its algorithmically delivered advice. Specifically, in the first bracket, the app’s representation of advice revolves around “home remedies,” in the second around “personalized advice,” and in the third around “the right pesticides.” To better understand, compare, and contrast these brackets, we used a set of guiding questions: What characterized the representation of expert advice provided by the plant team in each bracket? How does the representation of expert advice in each bracket express the core value of the plant team? How does the representation of expert advice in each bracket respond to management’s demand for scalability? At the end of this phase, we were able to reconstruct how exactly the expert advice of the app changed over time, and how the tension between expert values and scalability has shaped this change process.

FINDINGS

Replacing Pesticides Through Home Remedies

During my earlier fieldwork visits to the FLORA offices, I occasionally picked up the term “home remedies” in the plant team’s conversations.¹ As I could not quite grasp the meaning of this term, one day I took the team’s lead plant pathologist aside and asked him to clarify. He explained to me, that since the beginning of the app home remedies constituted a key component of the expert advice that the plant team prepared and deployed in the app. Loosely rooted in discourses around organic farming, his team used the term home remedies to refer to do-it-yourself mixtures of non-chemical ingredients that they assumed clients would have at home or could easily obtain, such as horsetail broth or soap solution. This was nothing unusual, I was further explained, even the Food and Agriculture Organization of the United Nations (FAO) would recommend home remedies in regions where agricultural inputs were difficult to obtain. In technical terms, to promote home remedies, FLORA designed the app so that after a successful diagnosis, clients would be directed to an encyclopedia entry prepared by the plant team. This encyclopedia entry, created by copying and slightly editing parts of text from scientific literature, was intended to provide users with all the information they needed about the treatment of the diagnosed disease.

In developing this way of representing advice, the plant team was guided by a shared expert value: PHYTØ’s advice should reduce the environmental damage caused by agricultural pesticide use. In the view of the plant team, their recommendations for home remedies were a promising way of putting this value

into practice, as they believed that these treatment suggestions would discourage farmers from using chemical pesticides. In an interview for a gardening blog from that time, one of the co-founders of FLORA summarized this idea as follows: “By publicizing ecological alternatives to chemical plant protection products via the app, everyone can contribute to a more environmentally friendly approach to plant diseases.” A TV report from 2015 featuring PHYTØ gives a more concrete impression of how the plant team initially envisioned these ecological alternatives: The report features three amateur gardeners who are jointly testing PHYTØ in a small kitchen garden. Accompanied by the camera, the three gardeners discover that one of their zucchini plants is infested with an unknown pest. With the help of information provided by PHYTØ, they arrive at the diagnosis that the zucchini is infested by spider mites. Once this diagnosis is established, one of the gardeners goes on to read out the “biological advice” that the app recommends as a treatment, namely that they should apply “garlic tea.” Subsequently, the voice of the narrator of the report steps in to clarify the advantages of this treatment: “Most of what you need can be found in every household. In no time at all, Sina [the gardener] has a remedy ready to chase the troublemakers away from the zucchini. Very important, without chemicals!”

However, putting their core value of reducing pesticide use into practice was not the only concern shaping the work of the plant team at the time. Back then, the founders of FLORA received a grant from the German government for scientific spin-offs, which provided them with both financial support and coaching sessions for future entrepreneurs. Through this coaching, the FLORA team learned that in order to attract funding for the further development of the app, they needed to demonstrate to potential investors that their innovation was valuable. They also learnt that, as PHYTØ was still in its early stages, it was not yet expected that they would be able to present a profitable business model for this purpose. Instead, they were made aware that metrics such as user numbers and “user retention” were important sources of information for potential investors at this stage in order to assess the future value of the app. This expectation was also passed on to the plant team, who were optimistic that their advice on home remedies would be able to meet it. In particular, the plant team believed that potential clients would see a cost advantage in home remedies over chemical pesticides – as they would have to pay little or nothing for their ingredients – which in turn would turn many of them into regular PHYTØ users. As one member of the plant team put it: “These things work perfectly at almost no cost. And that’s the important thing.”

Yet, despite this strong initial focus of PHYTØ on home remedies, the plant team did not completely exclude chemical pesticides from the app’s advice. More specifically, the plant team decided against completely excluding chemical pesticides from the app’s expert advice, as they feared that the app’s advice might otherwise put off users who were very accustomed to using these substances. Instead, they presented the provision of advice on chemical pesticides as a means of attracting as many clients as possible in order to gradually guide them toward the use of home remedies. A vivid example of this reasoning is the following quote in which the head of the plant team explains what consequences could be expected if they did not provide content on chemical pesticides:

We're losing the opportunity to pull people who swear by chemical treatment or who do it because that's the way they have always done it, onto "the right side," in quotation marks.

As this quote illustrates, the decision to include chemical pesticides in the app's advice must also be interpreted as a response to management's demand to the plant team to fill the app with expert advice that would help to scale up PHYTØ's user base. The quote highlights that at this stage the plant team saw chemical pesticides as fundamentally at odds with their expert value of reducing environmental damage caused by agricultural pesticide use. However, they justified the recommendation of these substances as a necessary intermediate step in realizing their expert value by convincing clients of home remedies – an ambiguous configuration of expert advice the plant team could live with.

However, much to the disappointment of the FLORA management, and contrary to the expectations of the plant team, farmers were not very receptive to PHYTØ's home remedy-based advice. This was evident, among other things, in a metric that FLORA's experts referred to as "user retention," which measures the amount of time users spend scrolling and clicking through the app. As this metric demonstrated, despite the plant team's best efforts to create scientifically sound encyclopedia entries on home remedies and other treatments, users did not really engage with the app, that is, they did not read its expert advice. One of PHYTØ's developers, who worked intensively on the app's representation of expert advice, summarized the realization at the time as follows:

We cannot be like Wikipedia, like we have been doing so far, like: "Here you go this is the information, read it and make up your mind after you read it." We need to be more actionable.

Hence, the fact that farmers did not read PHYTØ's expert advice represented a challenge in the plant team's thinking about the provision of expert advice in at least two ways. First, farmers' lack of interest in PHYTØ's expert advice meant that the app did not induce the hoped-for behavioral changes and thus failed to realize the plant team's expert value of reducing environmental damage caused by agricultural pesticides. Second, the unsatisfactory use of PHYTØ jeopardized the financial basis for the continued existence of the app, as it compromised FLORA's anticipated ability to raise funds to develop the app further. As a result of this educationally and financially dissatisfying use of PHYTØ, the plant team eventually began to conceive of a different, "more actionable" way of representing advice in the app.

Reducing Pesticides Through Personalized Advice

A few months after the disappointment over the home remedies, I had the opportunity to sit in on a meeting in which members of the plant team outlined their progress in developing the new way of representing advice in PHYTØ. The core of this new way of representing advice, as the presenters made clear, should be "personalized" recommendations for improved farming practices. The redesign of PHYTØ was therefore meant as an expansion of the advice given to users following a successful diagnosis, in that it included not only treatment recommendations, but also recommendations for agricultural practices to be carried out throughout

the growing cycle. Examples of advice on such practices include advice on how to best select seeds, water one's crops, or plow one's field in order to minimize the use of pesticides. Technically, the provision of this way of representing advice was to be achieved by redesigning the app so that it would request additional data from clients (e.g., climate zone, cultivated crops, sowing date) in order to subsequently provide them with recommendations tailored to this data. As described in an onboarding document for new employees, this advice should no longer be presented to clients in the form of lengthy encyclopedia-like entries, but in the form of short, illustrated texts called "events." Furthermore, the document specifies that "[i]n a cropping cycle from about 3 to 4 months" clients should be provided with "30 to 40 events for each crop." So rather than providing clients with all the expert advice on their chosen crops at once, the plant team sought to improve the user retention of the app by delivering the advice in small chunks throughout the growing season.

Although this second way of representing PHYTØ's advice was very different from the plant team's representation of expert advice in the first phase, they still felt that it was in line with their core expert value of reducing the environmental damage caused by agricultural pesticide use. In justifying how PHYTØ's reconfigured representation of advice would help to realize this value, the plant team regularly drew a link between their advisory efforts and current debates on "precision agriculture." This means that during this phase, in line with broader precision agriculture discourses, the plant team regularly emphasized that the app's personalized advice should help ensure that clients only apply fertilizers and pesticides "where they are needed, and when they are needed" (Bongiovanni & Lowenberg-DeBoer, 2004, p. 359). Hence, in contrast to the home remedy phase, the focus of the plant team in this phase was no longer on preventing users from using chemical pesticides by showing them alternatives to these substances, but on making their pesticide use more efficient. The plant team thus distanced itself from the relatively strong opposition to chemical pesticides that had characterized the first phase; whereas in the first phase, chemical pesticides were seen as an undesirable intermediate step to bind clients to home remedies, in the second phase, they were seen as a legitimate treatment, provided they were used in moderate doses.

In order to achieve this, the plant team planned that the advice of PHYTØ should be displayed to clients at an ideal moment in the growing cycle (e.g., an event dealing with weed control, at a time when it is advisable from an agronomic point of view to engage in this practice). For this, the app was redesigned to collect two additional types of data from its clients. For one, data about the sowing or planting date of their crops. For another, it was designed in such a way that it could deduce the climate zone in which users operated from their geolocations. Next, using the sowing or planting date provided by a given client and average climate zone-specific growth rates for the crops selected by that client, the feature was designed to calculate the approximate growth stage (e.g., seedling, tillering, stem extension) that the client's crop should be in at a given point in time after the provided sowing or planting date. As a hypothetical example, it might be recorded in the app that it is advisable to perform weed control on corn in the stem extension stage. Accordingly, the app would send users events related to chemical or biological weed control as soon as it had concluded via the method

specified above that the corn plants of the corresponding client should now be in the stem extension stage.

In addition to reducing the negative environmental impact of their clients' practices, the plant team envisioned that their increased efforts to personalize PHYTØ's advice would also increase their clients' productivity. Specifically, they assumed that PHYTØ's personalized advice would optimize their clients' pesticide use so that the same or even a higher yield could be achieved with fewer pesticides. As with the home remedies before, they assumed that this would lead to increased earnings and cost savings on the part of clients, which would entice farmers to use the app and thus contribute to its scaling.

Even though the plant team put a lot of work into the development of PHYTØ's personalized advice, the advice did not perform as expected. To the continued disappointment of FLORA's management, as with the home remedies before, user numbers and user retention remained low. This prompted the FLORA team to send a crew consisting of members of the plant team and several UX researchers to India – the country where most PHYTØ users were located – to find out in face-to-face interactions with farmers why users did not engage with the app. As one of the UX researchers summarized in an interview, they realized on the trip that with their personalized advice, instead of increasing PHYTØ's user retention, they were “losing the user.” One important reason for this, which they identified on the trip, was that the intended personalization of PHYTØ's advice did not work as expected. More specifically, FLORA found that it was more difficult than originally anticipated to determine the growth stage of their clients' crops, as well as other environmental factors, at a distance, that is, via a digital interface. In the following quote, a long-standing member of the plant team sums up the increased complexity brought about by FLORA's aim to provide its clients with personalized advice:

When you deal with a disease, it's a one-factor thing. You take a picture, you have a disease, you apply your treatment [...]. The [new representation of advice] is a multi-factor [problem]. You have the soil, you have the watering, you have the nutrients, you have, you know, a lot of management things.

This increased complexity resulted in allegedly personalized advice being displayed to clients at inappropriate times in the growing cycle, causing them to lose interest in the app. As a result, the developers saw the expert status they claimed for the app in jeopardy. This was a problem for the plant team, as it prevented them from realizing their expert value, but more importantly for FLORA's current and potential investors, as it reduced the future value of the application. In view of this twofold problem, the plant team eventually decided to stop working on advice in the form of personalized recommendations for agricultural practices and to focus on the development of a new advisory feature in which concise pesticide recommendations should play a much more important role.

Ranking the Right Pesticides

During my visit to one of the FLORA offices in India, a group of FLORA employees from Germany happened to be traveling to the same office. To my

surprise, one of the reasons for their visit was that they wanted to conduct interviews with the owners of small pesticide shops in the vicinity of the FLORA office. However, as I was busy at the time collecting data regarding FLORA's interaction with farmers, I did not pay much attention to these interviews. It was only a few weeks later, during another visit to the German FLORA office, that I found out that the interviews with the pesticide dealers were intended to examine the feasibility of a possible business model for PHYTØ. This business model envisaged turning PHYTØ into a platform for brokering pesticide sales between farmers, pesticide dealers, and pesticide manufacturers – a business model that went hand in hand with a new representation of advice that the plant team prepared in the back office of the startup. This new representation of advice was intended to guide clients to choose “the right pesticides” among the many different ones available on the market. To this end, PHYTØ was redesigned so that, following a successful diagnosis, it would provide clients with lists of both chemical and (where available) biological pesticides. In the next step, clients were asked to select the pesticide that best suited their needs from these lists. Hence, in this phase, the plant team moved away from the more prescriptive advice in the form of recommendations for home remedies or allegedly personalized recommendations for agricultural practices that had characterized the previous phases and took a less prescriptive approach by offering clients a range of biological and chemical pesticides from which to choose.

Despite this much greater endorsement of chemical pesticides compared to earlier phases, the plant team continued to believe that their work on the app would help to put into practice their core value of reducing environmental damage caused by agricultural pesticide use. To substantiate this claim, the plant team began to adopt a particular framing of Indian farmers. This framing consisted of portraying the pesticide use of their actual and potential clients as fundamentally flawed. The classic examples they gave to illustrate this flawed nature were that farmers would usually mix many different pesticides irresponsibly, would use poor quality pesticides (e.g., adulterated pesticides), or simply use the wrong pesticides. The plant team therefore argued that if they were able to dissuade farmers from these flawed practices, they would already be making a contribution to reducing the environmental impact of agriculture. An illustrative example of this way of thinking is the following quote from a member of the plant team:

Indian farmers don't need us to make wrong decisions, they are making wrong decisions the whole time. We are here to improve a chaotic situation. So, like, if you are in the chaos, there are not many things that you can do wrong.

It was against the background of this framing that the plant team viewed its expert task of identifying the right pesticides for a given plant disease. As was regularly emphasized in interviews with members of the plant team, identifying the right pesticides was a multi-step process. It began with a review of country-specific regulatory documents to gain an overview of the products registered in India. However, given the large number of pesticides registered in India, a second step taken by the plant team to further narrow down the list of pesticides to be recommended by PHYTØ was to subject this initial selection to additional

regulatory frameworks from countries, regions, or organizations whose approach to pesticides the startup considered to be more stringent. In other words, the plant team saw their expert work as using PHYTØ's advice to enforce external pesticide-related regulatory frameworks in India. Finally, as a third step in compiling PHYTØ's pesticide lists, the FLORA team asked local experts – for example, agricultural extension workers or professors – to further narrow down the lists of pesticides that the startup had compiled. In this process, the experts were given a fairly free hand, meaning that FLORA did not have a highly formalized process according to which the experts were to select the pesticides to be recommended by the app. Rather, they were asked to use their professional experience to determine which pesticides would work well in the countries or regions for which they were responsible.

This selection process often resulted in the plant team considering not one, but several pesticides as recommendable for treating a particular plant disease. However, the problem with this approach of recommending several pesticides was that the experts of the plant team considered some of the listed pesticides to be more recommendable than others (e.g., because they were less toxic). With this in mind, the plant team began to rank the pesticide lists that PHYTØ displayed to clients, so that pesticides they considered more recommendable were displayed higher up and pesticides they considered less recommendable were displayed lower down. In other words, they were trying to nudge their clients to use the pesticides they thought were most appropriate, without excluding pesticides they thought were less than ideal but still “right” for the job. The strategy of presenting the app's pesticide recommendations in the form of rankings must therefore also be seen as a strategy through which the plant team subtly expressed its core value. A vivid example of this is the following quote, in which the head of the plant team expresses his team's strong support for biopesticides, while at the same time expressing his concern “not to exclude anyone” by not recommending chemical pesticides:

We said: Hey, we always try to present the biological ones a little more prominently, that is, to put them in the first place, for example, and still show the whole range of treatment options, from preventive to biological to chemical, so as not to exclude anyone.

Apart from the realization of their expert values, the fact that the plant team issued ranked lists of pesticides rather than individual, unambiguous pesticide recommendations must also be interpreted as a direct response to the imperative of scalability with which the plant team was confronted. PHYTØ's new platform business model envisioned that after a successful diagnosis, clients would be referred to pesticide dealers near their farms, who would then sell the pesticides that clients had chosen from the app's lists to those clients. This transaction was to be free for farmers and pesticide retailers and monetized through commissions that FLORA planned to collect on the additional pesticide sales generated by the app's recommendations for agrochemical companies. In this business model, the lists created by the plant team represented a means of scaling up PHYTØ's user base in two respects. On the one hand, the lists should help to increase the number of PHYTØ users, as they no longer recommended home remedies or personalized

advice regarding agricultural practices, which were far removed from the everyday practices of farmers in India, but pesticides that were already an integral part of their everyday practices. On the other hand, the lists were intended to help scale up PHYTØ's user numbers by not privileging one pesticide manufacturer but offering many manufacturers a platform to sell their products, thus turning the app into a single gateway to all sorts of pesticides.

This third way of representing PHYTØ's expert advice ultimately proved to be successful in the eyes of the plant team *and* FLORA's management. An initial sign of success was a substantial increase in the number of PHYTØ users and pesticide sales brokered through the app. Even greater proof of this success, in the eyes of FLORA's management and the broader startup world, was the fact that the startup was acquired by the major distributor of agrochemicals and fertilizers AGRO-TRADE [a pseudonym] in 2023. In a press release following the acquisition, AGRO-TRADE's Head of Corporate Development explicitly pointed out that PHYTØ bridges the gap between scalability and positive environmental impact.

We are proud to partner with PHYTØ, which already serves nearly six million farmers in India. With AGRO-TRADE's global network, we will grow PHYTØ's presence to support more farmers. At the same time, AGRO-TRADE expands its agricultural technology capabilities digital technology to reduce resource use in agriculture and especially the misuse of crop protection products

As this press release shows, the plant team's latest interpretation of their core value perfectly matched the agrochemical distributors' interpretation of how agricultural pesticide use should be transformed. So, it is fair to say that the app's way of representing expert advice has changed drastically since its early days when it used to recommend garlic tea and other home remedies to give farmers an alternative to the agrochemical industry. Curiously, however, the core value of the plant team's experts – reducing the negative environmental impact of agricultural pesticide use – has remained the same.

DISCUSSION AND FUTURE RESEARCH

The objective of this study was to analyze how human experts in the back office of an algorithmic expert service deal with tensions between their expert values and the imperative of scaling. We explored this question through a case study of the agricultural algorithmic expert service PHYTØ. We found that the experts developing PHYTØ operated in a constant state of tension between their core value of reducing the environmental damage caused by the use of pesticides in agriculture and the demands of the startup's management to develop advice that is appealing to the greatest number of users – demands rooted in investor-induced scalability thinking. Our findings show that the experts navigated this tension by repeatedly embracing their core value (i.e., emphasizing their intention to reduce environmental damage caused by agricultural pesticide use), while simultaneously changing their interpretation of this core value and its subsequent translation into corresponding representations of advice in the app's interface. The

result of these cycles of embracing and reinterpreting was to find a way of providing algorithmically mediated expert advice that would reconcile the plant team's core value and management's demand for scalability. In more detail, our results identify three phases. In each of these phases, the back office experts tested a different way of representing their algorithmic expert service *in vivo*, by exposing it to real users. In the first two phases, the representations of advice (one centered on "home remedies" and one on "personalized advice") resulting from the interpretation and reinterpretation of the plant team's core value failed these tests, leading the experts to reconsider. It was only in the third phase that the plant team's reinterpretation of their core value – now centered on brokering sales of "the right pesticides" – led to a representation of PHYTØ's advice that satisfied management's demands for scalability. In summary, then, FLORA's experts navigated the tension between their expert value and their management's scalability thinking by performing what might be referred to as moral acrobatics, maintaining outward adherence to their core value while bending the interpretation of that value to justify their companies' efforts.

As such, our study contributes to the debate on how shared values shape the work of experts in and around organizations (Bechky, 2011; Van Maanen & Barley, 1984), and in particular to the question how experts can handle value conflicts with key stakeholders (Chan & Hedden, 2023; DiBenigno, 2020). In one sense, the problem faced by the plant team is similar to the problems faced by the experts studied by Chan and Hedden (2023) and DiBenigno (2020), in that in all cases the expert communities analyzed are confronted with powerful clients who (in part) seem not to share their core values. However, it is also quite different because, to use the terminology proposed by Chan and Hedden (2023), FLORA's experts must "discern" their clients' values through a digital interface, without face-to-face interaction, and can only "modulate" their value enactments through adaptations of that interface.

Going even further, the question arises as to whether it is even appropriate to speak of manifest value conflicts in the case of FLORA. This is due to the fact that most of what the plant team discerns as the values of their clients is mediated by metrics and does not result from situated interactions with these clients. Based on the information they have, the plant team cannot be sure that the reason why certain farmers have stopped using PHYTØ or never used it in the first place is because of value conflicts. However, the plant team's reinterpretations of their core value suggest that experts working from the back office may easily interpret metric results such as low user retention as value conflicts and adjust their services accordingly. Furthermore, the case of PHYTØ shows that experts who develop and maintain algorithmic expert services from the back office have great difficulty in taking into account the values of individual clients. Rather than precisely discerning the values of individual clients and modulating their services accordingly, it shows that the experts in the back offices of algorithmic expert services can only respond to anticipated value conflicts by making quite generalized changes to their representations of advice in the interface of their digital service. In short, the ability of experts who develop algorithmic expert services to discern their clients' values currently seems very limited, and their mechanisms for modulating their

values, and thus their services, based on this limited knowledge of their clients' values currently seem rather crude.

The alleged conflict of values between experts and users is not the only conflict of values that has shaped the development of PHYTØ. Even more influential, perhaps, was the conflict between the plant team's core value and the values of another powerful stakeholder group, FLORA's management and, by extension, FLORA's investors, which manifested itself in the scalability imperative under which the plant team was constantly operating. Our analysis of the case of FLORA thus provides an insightful contribution to the discussion of whether expert advice can be scaled using algorithmic technologies. An important contribution to this debate comes from [Pakarinen and Huising \(2023\)](#), who argue that algorithmic technologies cannot scale expert advice because human experts will always be needed to adapt the outputs of algorithms to the situated needs of clients – a problem they refer to as the “translation challenge” (p. 15). Our findings shed a slightly different light on the debate by showing that the use of algorithmic technologies can actually help to make expert advice available to a wider audience. There is no denying that, in just a few years, the developers of FLORA have succeeded in providing “almost six million farmers” with a particular kind of expert advice, namely advice on “the right pesticides.”

However, and more in line with [Pakarinen and Huising's \(2023\)](#) argument, our findings also suggest that this act of making expert advice available to a wider audience simultaneously affects the quality of the expert advice offered. More specifically, it seems that the proliferation of algorithmic expert services such as PHYTØ are contributing to what we call a massification of expert advice. This means, on the one hand, that a hitherto underserved mass of clients is provided with advice that can still be considered expert advice, for example, because it is factually correct or because it conforms to the conventions of certain expert groups (e.g., in-house chemists in the agricultural industry). On the other hand, compared to advice from human experts, this expert advice is very likely to be less adapted to the situational needs of individual clients and thus of lower quality. Moreover, in line with this neglect of clients' situated needs, the massification of expert advice also means that it may seem increasingly rational to providers of such advice to recommend products and procedures that do not require much recognition of situated needs. In the case of FLORA, this was clearly demonstrated by the gradual approximation of PHYTØ's representation of advice to the standardized products and associated procedures of the agrochemical industry, that is, by the intertwining of PHYTØ with the “thinking infrastructures” ([Kornberger et al., 2019](#)) of global pesticide markets (e.g., toxicity standards).

Given that algorithmic expert services are often targeted at populations that would not otherwise have access to expert advice, for example, because they cannot afford it or because it is not available in their region of the world (see [Fabregas et al., 2019](#)), it is likely that the proliferation of these services will lead to a client-side stratification of expert advice in society (see [Abbott, 1988](#)). This stratification consists of wealthy clients or clients born in a certain region of the world, benefiting from the situated and ideally more independent advice of human experts, while the rest of the world's population (assuming they have access to digital

devices) receives the probably correct but certainly less situated and often less independent advice of algorithmic expert services. This stratification can occur both within a country or region of the global North and between countries of the global North and the global South, thus perpetuating or reinforcing historical patterns of inequality. Overall, this insight casts serious doubt on the claim made by many proponents of algorithmic expert services that these technologies can “democratize” the provision of expert advice.

Our investigation of an algorithmic expert service offers many avenues for future research, three of which shall be highlighted here as particularly promising. First, it seems important to analyze algorithmic expert services not only in their development, but also in their use. This line of work could address questions such as: How do clients integrate algorithmic expert services into their everyday work or private life? What practical problems arise in the process? What unintended forms of use arise? Second, it seems fruitful to analyze algorithmic expert services in other areas of society in order to identify similarities and differences to their use in agriculture. Possible areas of interest include dating advice, financial advice, or medical advice. Third, it seems crucial to understand the relationship between the providers of algorithmic expert services and the established experts challenged by them. Will the emergence of algorithmic expert services lead to a further differentiation or transformation of the work of human experts? Are new forms of collaboration emerging? These are just some of the questions that should help us to better understand how algorithmic expert services will contribute to the transformation of expert work in and around organizations.

NOTE

1. The results are written from the perspective of the first author, who carried out the data collection on his own.

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EXPERTISE PUT TO THE TEST: HOW CLIENTS CONTINUALLY ASSESS THE WORTH OF MANAGEMENT CONSULTANTS

Kasper T. Elmholdt^a, Jean-Charles Leynadier^b and
Alaric Bourgoin^c

^aAalborg University, Denmark

^bSubstantiel Conseil, France

^cHEC Montreal, Canada

ABSTRACT

Clients hire management consultants as experts to tackle complex problems and legitimize decisions. However, the expertise of these consultants often sparks debate. While consultants may seek to prove the distinctiveness and relevance of their expertise, clients must continually evaluate the value of consultants' expertise in treating their problems. This study examines the dynamic and contested nature of expertise in consultant–client relationships by exploring the practical tests through which clients assess and recognize consultants' expertise as distinct and valuable in addressing their concerns. Based on an ethnographic study of a four-month consultancy project involving a team of consultants at a large energy company, we identify three distinct forms of tests – skill tests, results tests, and loyalty tests. These tests are used by clients to evaluate consultants' expertise and in turn influence how consultants approach clients' problems and conduct their

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work. Our study advances a relational perspective on expertise, emphasizing the client's role and the consultants' ability to handle distinct tests. We conclude by discussing the implications for studies of expertise and management consulting.

Keywords: Expertise; management consulting; experts; clients; tests; ethnography; objects

INTRODUCTION

Organizations rely on experts such as management consultants to address technical challenges, drive innovation, and justify difficult decisions (Barley & Kunda, 2011; Chong, 2018; Waisberg & Nelson, 2018). The consultants' expertise is often seen as crucial, exploiting knowledge asymmetries between them and their clients (Sharma, 1997; Von Nordenflycht, 2010) to solve problems and perform highly specialized tasks (Stehr & Grundmann, 2011). However, while consultants are regarded as experts, the substance and nature of their expertise remain a subject of debate. Some scholars argue that consultants' expertise is more about perception and rhetorical strategies than genuine knowledge (Alvesson, 1993, p. 1004) or that it is often derived from signaling their affiliation with prestigious firms rather than true competence (Armbrüster, 2006; Mazzucato & Collington, 2023).

Amidst this debate, another critical dimension of consultants' expertise emerges – their dependency on clients to enact their expertise. Consultancy work is inherently client-dependent, establishing clients as crucial partners in recognizing and authorizing consultants' expertise (Elmholt et al., 2024; Hughes, 1963; Treem, 2016). Clients may hold differing values regarding consultants (Chan & Hedden, 2023), and research suggests that consultancy services are consistently customized to meet the specific expectations of clients, with consultants' expertise recognized as capable of achieving objectives on the client's behalf (Bourgoin & Harvey, 2018). This underscores a critical dimension of consultants' work: “developing close relationships with clients to find out what is most important to them” and demonstrating their value (Chong, 2018, p. 139), thereby highlighting the relational nature of their expertise (Bourgoin et al., 2020).

Given the relational and context-dependent nature of consultancy work, one challenge that emerges is how clients evaluate and recognize consultants' expertise. When clients hire consultants, they often grapple with determining the credibility and worth of the consultants' expertise, making the evaluation of expertise a key concern (O'Mahoney et al., 2013). Armbrüster (2006) points out that the absence of professional standards in management consulting complicates determining qualified consultants. Additionally, clients may be capable of using methods similar to those of consultants and possess comparable knowledge, which can challenge consultants' expert authority (Sturdy et al., 2015). Clients might discover that consultants' knowledge not only overlaps but also contradicts their domain and contextual expertise, potentially leading to confrontations (Mosonyi et al., 2020; Sturdy & Wright, 2011). Therefore, clients often assess consultancy expertise and seek to align understandings through a tendering process, comparing how

consultancies articulate their value proposition for the assignment (O'Mahoney et al., 2013). They may also routinely scrutinize and challenge the work of consultants throughout the assignment, looking for cues that something is amiss or that consultants are aptly fulfilling their expert roles (Bourgoin & Harvey, 2018). We propose that these evaluations, whether known to the consultants or not, serve as tests of their distinct expertise and capability to meet the client's demands – essentially assessing the consultant's worth (Marres & Stark, 2020).

Existing literature highlights a gap in how the tension between consultants' professed expertise and clients' evaluations is addressed, particularly the client's actions and influence, which are often overlooked in consulting research (Mosonyi et al., 2020; Treem, 2016). Prior studies show that clients' evaluations play a pivotal role in commodifying consultancy expertise (O'Mahoney et al., 2013) and, more broadly, in how clients may challenge experts' control through conflicting values (Chan & Hedden, 2023) or intensely problematizing and thereby undermining experts' authority (Huising, 2014). However, these dynamics have scarcely been explored in client-dependent settings such as consultancy, leaving unanswered questions about how clients recognize expertise and influence consultants' work. We investigate how clients test consultants' expertise beyond formal tendering processes, focusing on the practical and contextual challenges in everyday interactions around which forms of expertise are deemed relevant. Additionally, we explore the generative effects of these tests, which delineate the dynamics between client and consultant and collaboratively influence the outcomes of consultancy engagements.

To better understand these dynamics, we draw on pragmatic sociology and the sociological literature on testing (Boltanski & Thévenot, 2006; Marres & Stark, 2020). This body of work underscores that tests – designed to assess the validity of an argument or practice within a framework of established values, thereby determining its worth – are integral to social interactions. In consulting, clients may employ various practices and repertoires to assess the value of services and recognize certain forms of expertise over others. As such, the organization of expertise between consultants and their clients may be less clear-cut than often assumed (Sturdy & Wright, 2011), and through a focus on tests, we highlight expertise as a relational accomplishment, constantly subject to client challenges.

Empirically, we report from an ethnographic study conducted during a four-month consultancy assignment involving a team of six consultants and a partner tasked with the high-stakes redesign and integration of an innovative business unit at a large energy company. A distinctive aspect of our study is the active involvement of one of the authors as a full-time participant within the assignment, providing access to internal dynamics typically hidden from external observers (Bourgoin et al., 2020; Sturdy & Wright, 2011). This insider perspective allowed us to directly observe and analyze how clients continually challenge the work of consultants and how these challenges subsequently influence their relationships and the enactment of consultants' expertise.

Building on this, we identify three distinct types of tests through which clients evaluate consultants' expertise: skill tests that assess the consultants' ability to translate technical knowledge; results tests that measure the speed and impact of

their work; and loyalty tests that gauge the consultants' adherence to the client's authority. We examine how these tests are executed through various sub-practices and illustrate how clients leverage them to assert their influence and align consultants' interests with their own. Our study delves into the dynamics of expertise in consultancy work, advancing a relational view of expertise (Pakarinen & Huising, 2025; Treem, 2016). Furthermore, we offer new insights into the debate over the tension between professionalism and commercialism in consulting expertise by revealing how these tests intersect within consulting practices (O'Mahoney et al., 2013; Stein, 2020).

BACKGROUND LITERATURE: THE ROLE OF CLIENTS IN TESTING CONSULTANTS' EXPERTISE

Unpacking Consultants' Expertise: The Limits of Cognitivist and Institutional Views

Expertise in management consulting is often viewed from a cognitive perspective, suggesting that consultants possess highly specialized technical and esoteric knowledge primarily drawn from their domain experience. This knowledge enables them to diagnose problems and offer "objective" assessments in various contexts (Creplet et al., 2001; Hayes & Westrup, 2014). Such expertise involves recognizing patterns and processing information at an abstract level to solve problems (Heimstädt et al., 2024), often employing quasi-scientific methods (Berglund & Werr, 2000) and tools recently driven by advancements in data science and artificial intelligence (Dell'Acqua et al., 2023).

However, this cognitive view of consultancy expertise is frequently challenged. The managerial expertise involved is deeply contextual, integrating various types of knowledge (Simon, 2019; Visscher et al., 2018) and heavily reliant on navigating complex interpersonal dynamics (Morris & Empson, 1998). Moreover, the idea that consultants' expertise is esoteric – beyond the grasp of non-experts – is debatable, as many corporate managers use similar methods, blurring the lines of who is the expert (Smith, 2009; Treem, 2016; Von Nordenflycht, 2010). Some of the more outspoken scholars opposing the cognitive superior view are critical theorists of consulting (Alvesson, 1993; Clark & Salaman, 1998). Challenging consultants' knowledge base as "weak," ambiguous, and fragmented, they emphasize instead the symbolic nature of consultants' expertise, suggesting that "claims of expertise and superior rationality" are pervasive in consultancy work, where "being perceived as an expert is then more crucial than being one" (Alvesson, 1993, p. 1004). This, in turn, leads consultants to resort to persuasion tactics such as jargon, storytelling, and management fads to shape clients' perceptions of their expertise (Clark & Salaman, 1998).

Given the ambiguity surrounding the knowledge base of management consultants, another perspective suggests that what truly matters is the institution that confers upon professionals the mantle of legitimate expertise (McKenna, 2006). From this institutional standpoint, consultants as experts "are born of and reified by immersion in professional groups" (Treem, 2012, p. 25), and they may

be attributed expert status through affiliation with prestigious firms and education at elite universities (Armbrüster, 2006; Ho, 2009). Yet, this viewpoint has also drawn criticism, as scholars argue that consultants lack the institutional support seen in more established professions, including credentials, standardized training, or licensing requirements (McKenna, 2006). Furthermore, if consultants self-designate as professionals and leverage the moral legitimacy of their profession or organization to assert expertise, this can lead to a circular understanding of expertise, where “experts produce knowledge that establishes their own authority as true” (Bourgoin et al., 2020, p. 1136).

A central point of debate is that both the cognitive and institutional approaches treat expertise in an “actor-oriented way” as something consultants possess (Treem, 2012, p. 25). Whether the consultant is seen as having superior knowledge or mastering legitimate practices sanctioned by professions, they remain the primary source of expertise. The client and its influence are notably absent from this discussion: at best, they are viewed as recipients of external knowledge to be integrated into their organization; at worst, as passive and easily swayed by persuasion tactics and legitimation strategies (Bourgoin & Harvey, 2018; Sturdy & Wright, 2011). Yet, it has also been stressed that clients that clients negotiate with consultants regarding what constitutes relevant expertise in various contexts, shaping how expertise operates through consultants’ work (Elmholdt et al., 2024; Hughes, 1963; Waisberg & Nelson, 2018).

Taking the Client into Account Through a Relational View of Expertise

Rather than focusing solely on an actor-centric view of expertise, other studies suggest that consultancy work can be viewed as inherently transactional and client-oriented nature makes their expertise inherently “relational” (Bourgoin et al., 2020). A relational understanding of expertise considers its enactment within a “relational context” that involves other professionals, colleagues, clients, and objects – highlighting expertise as an interactive, situated accomplishment (Chan & Hedden, 2023; Edwards, 2010; Pakarinen & Huising, 2025). For example, Edwards (2010) emphasizes that expertise involves leveraging relationships with various stakeholders to create shared meaning and solve problems. Similarly, other scholars argue that expertise – as opposed to experts – emerges from networks that connect diverse “actors, devices, concepts, institutional and spatial arrangements” (Eyal & Pok, 2015, p. 38), all brought together to accomplish specific tasks (Pakarinen & Huising, 2025; Eyal, 2013). Hence, expertise exists and gains authority at the “interface” of various forms of specialized knowledge (e.g., technical, bureaucratic) and the “(political, legal) decision-making” context (Eyal & Medvetz, 2023, p. 5). This perspective is especially relevant in consulting, where understanding the client’s unique situational demands — and securing their cooperation and recognition of expertise — is crucial for completing the consultancy task.

In line with these ideas, studies have investigated the various relational activities in which consultants and professional experts engage to enact their expertise (Bourgoin & Harvey, 2018; Elmholdt & Elmholdt, 2017; Treem, 2016). For instance, Huising (2015) examines how health and safety experts establish

their authority by engaging in “scut work”: routine maintenance tasks that help build strong relationships and facilitate client cooperation. In a study of public relations consultants, Treem (2016) details how they establish themselves as experts in understanding clients, processing information, and effectively communicating results – skills that involve creating varied representations to demonstrate the value of their expertise. Bourgoin and Harvey (2018) suggest that consultants often face a “learning–credibility tension”: they must project expertise while simultaneously learning the specifics of a client’s situation. To overcome this challenge, consultants become “professionals of relevance,” engaging in activities that resonate with clients to achieve the maximum impact in the minimum time. These studies, in turn, suggest that consultants enact their expertise through a variety of artifacts and metrological networks, including aesthetic tools, slide decks, and other visualizations to boost their visibility and credibility (Bourgoin & Harvey, 2018; Elmholt et al., 2018; Treem, 2016).

Maintaining expertise in client interactions is essential, as clients often challenge or contest expert advice, prompting experts to modify their practices to retain their status (Chan & Hedden, 2023; Hughes, 1963; Huising, 2015). A divergence in values between clients and the professionals they engage may necessitate a discerning adjustment of values (Chan & Hedden, 2023), prompting these professionals to consider new strategies (Bourmault & Anteby, 2023). Clients who demand specific services can challenge consultants and restrict the scope of expertise deemed relevant and valuable (Sandholtz et al., 2019). Additionally, they may erode the autonomy of professional experts by critically examining their advice and undermining established practices (Huising, 2014).

A relational view on expertise underscores that it is not an attribute of the individual consultant but a relational accomplishment that is contextually situated and materially embedded, with clients playing a crucial role. Despite this shift in focus, empirical studies on expertise in consultant–client interactions are still scarce, highlighting the need for more comprehensive investigations (Mosonyi et al., 2020; Sturdy & Wright, 2011). Additionally, while many studies focus on the communicative and relational practices through which consultants engage clients, they rarely examine how clients interact with the ambiguous and overlapping knowledge base of consultants and actively influence their work. Echoing this viewpoint, Treem (2016) suggests that research would benefit from better incorporating clients’ perspectives, as they are often the primary judges of expertise.

Investigating Expertise in Consultant-Client Interactions through Tests

To better understand how expertise comes to operate in consultant–client interactions, we engage with pragmatic sociology and the sociology of testing (Marres & Stark, 2020). This body of literature highlights the critical role of various evaluations – both overt and subtle – in social interactions, as they reveal discrepancies between actual conditions and expected standards (Boltanski & Thévenot, 2006; Hutter & Stark, 2015; Marres & Stark, 2020). A test is characterized as an assessment of value within an established “order of worth” (Boltanski & Thévenot, 2006). This emphasis on testing supports the idea that what is recognized as

expertise – and, by extension, the expert – is never definitively established. Instead, experts and the strength of their expertise are continually tested as they face opposition and must adapt to persevere (Boltanski & Chiapello, 2006, p. 321). Thus, we propose that a consultant's relationship with a client involves a continuous series of tests that value different forms of expertise against each other and sort out what forms are appropriate for the task.

According to Boltanski and Thévenot (2006), tests establish an interpretive principle of worth, validating one's capability to achieve the desired objective (see also Carr, 2010). This perspective introduces various criteria for assessing expertise in different social contexts (Boltanski & Thévenot, 2006). The authors delineate six primary “orders of worth” that provide common frameworks for evaluation: *inspired*, *domestic*, *fame*, *civic*, *market*, and *industrial*. Each order aids in understanding how value is attributed to individuals and actions based on specific principles, relying on distinct objects and signs for recognition. For instance, in a consultant-client relationship, reference to a “market” order might be indicated through signs like profitability, with objects such as “shareholder value” and competitive bids playing crucial roles in task evaluation (Chong, 2018). Conversely, reference to an “industrial” order could be characterized by technical expertise and specialization, focusing on objects like plans and methods, while a “domestic” order might emphasize proximity and deference to authority, with confidential information serving as a pivotal element (Boltanski & Thévenot, 2006).

Tests in consultant-client interactions are not always conducted through formal evaluations but are frequently woven into daily practices, linked to networks of tools and actors, and expressed through the discourses and rhetorical strategies used to sway opinions on a particular viewpoint (Bourgoin et al., 2020). Clients may subject consultants to continuous scrutiny by critically analyzing their methodologies, observing their interactions with team members and other experts, and monitoring their performance throughout each project phase. This underscores why tests are multifaceted, often embedded in complex trajectories that may expose conflicts within consultant-client relationships. Multiple orders of worth can coexist in the same social context, complicating the enactment of expertise. For instance, a consultant might be commended for the creativity of their approach yet simultaneously face criticism for its lack of operability, highlighting the conflicting orders at play. Thus, focusing on tests involves addressing practical situations with tangible objects, where the actors' capabilities and actions to achieve a pertinent task are either challenged or proven.

These tests, as described here, are generative; through the ongoing testing and adjustment of consultants' work, knowledge is created, and the intervention is refined, highlighting how a focus on testing may contribute to relational perspectives on expertise. A consultant might propose an idea to a client, who could then challenge the consultant's intervention through questioning or scrutiny, weighing the robustness of their approach against specific knowledge and values. This relational emphasis on tests illustrates how clients recognize certain forms of expertise – and, by extension, what counts as relevant contributions in consultancy – using specific objects, goals, or concerns as interpretive principles. At the same time, consultants engage in a similar process.

RESEARCH METHOD AND SETTING

To investigate how expertise is evaluated and recognized through tests in client-consultant interactions, we adopted an ethnographic approach that captures workplace dynamics from an insider's standpoint (Barley & Kunda, 2001; Bartunek & Louis, 1996). Specifically, the second author gathered data while serving as a Partner at a consulting firm called Delta Consulting (all names including names of case companies are anonymized in the text). His participation in a three-year professional doctorate program enabled this dual role, allowing him to pursue advanced education while fulfilling his professional responsibilities. This deep immersion in the field proved valuable, as studying client-consultant interactions – which are typically secretive and high-stakes – is challenging (Sturdy & Wright, 2011). Moreover, since tests are embedded in daily interactions and can be quite disruptive, maintaining an external observer's perspective might have skewed our understanding of the phenomenon under study. The Partner status of the second author is particularly interesting – a rarity since ethnographic studies usually involve junior consultants (Bourgoin et al., 2020; Stenger, 2018).

This type of research, however, presents a significant “involvement paradox” (Langley & Klag, 2019) – the need for researchers to immerse themselves deeply in the field to understand it, yet maintain enough distance to analyze it and minimize biases. To address the risk of becoming overly embedded into the field, or “going native,” we developed an original insider-outsider research design (Bartunek & Louis, 1996). In this approach, the other two authors on the team stayed entirely outside the field, adopting a critical perspective on the events recounted and challenging the second author through iterative coding cycles. This methodology enabled us to balance “personal involvement and professional distance” (Anteby, 2013) and facilitated theory-building from the analysis of micro-interactions. To effectively capture the dual role of the second author as both participant and analyst, we consistently highlight his presence in the narrative under the pseudonym “Henri.” This approach acknowledges his contributions while clearly distinguishing between his roles within the research context.

Our case study centers on a four-month consultancy assignment between Delta, a mid-size French IT consulting firm, and Arago Corp, a leading French conglomerate in the energy sector. Delta comprises about 60 consultants for a turnover of approximately USD 15 million. Specializing in information systems (IS) management and strategy, Delta supports executives, particularly CIOs, in designing and managing IS and associated managerial structures. With over 100,000 employees, Arago primarily produces and distributes energy, especially from fossil fuels. Arago Corp was a significant client for Delta, representing nearly 15% of its annual turnover.

The assignment's main objective was to help Arago integrate a newly acquired company, InnoSub, dedicated to developing innovative digital services for customer loyalty programs, such as digital payment cards and fleet monitoring systems. These digital services were deemed strategic to bolster Arago's traditional product lineup amid the company's shift toward renewable energy sources. The services operated under separate organizational structures, some managed by

InnoSub and others by Arago's IT department, each following different operating models. This fragmentation led to slow development and operational inefficiencies. An initial attempt to implement agile methodologies failed to improve the situation, necessitating further restructuring. Delta was tasked with addressing these challenges through three main objectives: (1) conceive and design a structure to manage the new digital services; (2) integrate the newly acquired company; and (3) design systems and agile workflows to ensure the efficient rollout of the digital services across the company.

This case is particularly well suited for studying how consultants' expertise is tested and recognized by clients, as the assignment unfolded in a highly challenging environment for several reasons. First, the expertise required was broad and diverse, encompassing IT methodologies and managerial and strategic knowledge, which must be applied across various sites, including headquarters and operational units. Second, the consultants were working alongside internal teams, many highly trained in agile methodologies, challenging the perceived uniqueness of the consultants' expertise. Third, the client system was notably precarious, involving three key clients who were significantly misaligned.

Initially, the project involved two "primary" clients who assigned Delta (Schein, 1997): Claude, a Business Director, who managed the digital services from a product portfolio perspective, and Benoit, the CIO, responsible for the IT oversight of digital services. Despite an appearance of collaboration, the teams involved were poorly coordinated and often blamed each other for past failures. As the assignment progressed, a third key client emerged: Alfi, whom Claude appointed as the director of InnoSub midway through the assignment. His involvement introduced additional challenges; Alfi had neither requested Delta's support nor chosen Henri for the assignment, and his vision for the project diverged from Claude's. As a newly appointed client, Alfi intended to maximize value from what he considered "overpriced" consultancy, compelling the consultants to meet his stringent expectations.

Despite the extensive scope of the assignment, Claude, who was the main "paying" client, had hired Delta for its boutique size, arguably to retain close control in the context of integrating and designing InnoSub and its services, which meant reshuffling roles and responsibilities. Delta dedicated a team of six consultants to the project: a senior Partner who focused on the commercial relationship, Henri as the Partner on site, Carine as a consulting manager leading the assignment with Henri, and three consultants, one of whom specialized in agile methods, another in IT architecture, and one junior. Claude had previously worked with Delta and built a trusting relationship with the senior partner, but he did not know Henri.

Data Collection

We focused on the Arago assignment for data collection as the second author considered it a standard project in scope and expertise, and he was deeply involved in its execution. As the partner in charge, Henri dedicated two to three days per week to the assignment, working closely with Carine. His responsibilities included daily supervision of the consulting team, managing the client relationship on site,

ensuring the work's quality, and overseeing daily operations. Henri's colleagues in Delta and clients in Arago Corp were aware of his research activities from the start. Yet, none had a personal or organizational stake in the research outcomes. Henri was granted full access and consent from all the participants, provided he did not use recording devices and maintained complete anonymity of the research results. Essentially, Henri's clients treated him as a typical professional consultant. He billed at the same rate, worked the same hours, and underwent performance evaluations by the client and the firm, adhering to the same standards as other consultants.

The second author gathered empirical data from January to June 2019, utilizing a variety of sources. These included observations in formal and informal settings, interviews, and field documents, with observations being the primary source. He extensively interacted with the client through emails, phone calls, and multiple meetings during the sales process. Leading most of the steering committee meetings and client workshops – approximately 30 – he also attended additional workshops that called for his expertise. As a practitioner, the second author engaged in numerous informal conversations that doubled as “ethnographic interviews” (Spradley, 1979), combining personal exchanges with descriptive and structural inquiries. He documented these interactions meticulously, resulting in 462 pages of notes that served as both a practical record and research material. These notes were supplemented by a wide array of field documents, including Excel templates, PowerPoint presentations, memos, deliverables, and internal documents, creating a comprehensive data corpus for analysis. As a partner, he frequently discussed client challenges with consultants, enriching the insights into the expertise tests faced by the participants.

Data Analysis

The second author entered the field aiming to examine the work dynamics and authority challenges of a consultant holding a Partner role. Although experienced as a consultant, he was relatively new to the Partner position. Upon commencing the assignment, his primary concern was to assert his and Delta Consulting's expertise to the clients, as he felt that his expert authority was continually questioned despite his senior position. Consequently, he began to meticulously focus on instances of clients challenging his expertise.

While the idiosyncratic nature of ethnographic research data is evident, we ensured its robustness through triangulation and collective judgment to provide an account of events that could inform broader analyses (Lecompte & Goetz, 1982). The data analysis unfolded in three main phases, guided by an abductive approach that involved a pragmatic oscillation between surprising empirical observations and theoretical conjectures from existing literature (Golden-Biddle, 2020). This analysis was a collaborative effort, with the authors continuously engaging with the empirical data through the lens of theoretical questions.

In the first data analysis phase, the second author constructed a detailed narrative of descriptive vignettes that captured events and interactions. This narrative consistently highlighted how Henri's and Delta's expertise was challenged as

it manifested in various forms, such as advocating for specific methods, delivering strategic insights, effective positioning, managing client demands, advancing tasks, and navigating resistance during coordination efforts. In the second analysis phase, the three authors employed open coding techniques to examine the actions of consultants and clients, drawing inspiration from prior research on management consulting (e.g., Schein, 1997; Sturdy & Wright, 2011). We coded the different client types (Schein, 1997), the ways each client challenged the consultants (Bourgoin et al., 2020), and the types of expertise at play in their interactions (e.g., consultants' understanding of the organization, consultants' ability to deliver on time). In the third phase, the research team became increasingly aware that client evaluations of consultants' expertise were influenced by diverse repertoires, including values, practices, and tools, which shifted situationally. This observation prompted us to explore the sociology of valuation and testing more deeply, adopting it as a framework to analyze the data further. Inspired by Boltanski and Thévenot (2006), we especially coded the practices through which clients conducted these tests and how the consultants responded. This approach helped us identify roughly 30 distinct testing practices. We recognized that the various tests could be linked to specific interpretive principles that assessed the consultants' ability to achieve desired outcomes for the client (Boltanski & Thévenot, 2006). Initially, we categorized references to "market values," "industrial values," and "domestic values" as predominant frameworks for evaluating consultants. However, following further engagement with the literature and our empirical data, we refined these categories, adjusted our analyses, and clustered the tests around three core themes: testing skills, testing results, and testing loyalty. We did so with a bottom-up theorizing ambition and because we found that the original orders of worth overlapped in our case (Boltanski & Thévenot, 2006). This refined analysis led to developing our constructs and testing practices, which were progressively substantiated and illustrated, and we could discern the three most salient practices in each category.

In what follows, we focus on identifying and substantiating the tests of expertise that consultants encounter, delving into various clients' practices. At the end of each empirical section, we offer a more analytical summary of the results.

FINDINGS: PUTTING EXPERTISE TO THE TEST IN MANAGEMENT CONSULTING

Our results explore how clients assess consultants' expertise through three distinct types of tests: (1) *testing skills*, which challenges consultants to translate their specialized knowledge to specific contexts; (2) *testing results*, where clients engage third parties to evaluate the cost-effectiveness of the consultants' outputs, ensuring value for money; and (3) *testing loyalty*, involving clients' efforts to bind consultants to their authority systems, verifying that they can effectively advance their position. These tests are integral to recognizing consultancy expertise and connecting consultants' work to the client. Table 1 summarizes these tests and how they were carried on throughout the assignment.

Table 1. Tests of Expertise in Client–Consultant Relationship.

	Testing Skills	Testing Results	Testing Loyalty
Triggers for testing	When consultants’ knowledge is in question	When consultants’ productivity and value for money is in question	When consultants’ alignment of interest is in question
Focus of testing	Consultants’ ability to translate specialized knowledge in context	Consultants’ ability to be efficient and deliver value for money	Consultants’ ability to defer to the client’s authority to advance their position
Testing practices	• Probing for situational adaptation • Probing for insights • Probing for global understanding	• Monitoring deliverables • Monitoring change impact • Monitoring contractual promises	• Asking consultants to pick a side • Asking consultants to take a low stance • Asking for reassurance
Expertise recognized through	Signs of relevance	Signs of efficiency	Signs of commitment

Testing Skills: Challenging Consultants to Translate Specialized Knowledge

Management consultants often claim to possess specialized knowledge, which enables them to enhance the functioning of their clients’ organizations. Delta’s partners claimed a diverse set of skills relevant to the Arago project, including “deep expertise in agile methodologies” for developing digital services and work-flows. They also claimed to possess managerial knowledge crucial for the reorgan-izing InnoSub, along with a more “strategic” understanding of digital strategy portfolios (DOC¹, 02/2019).

However, the Arago case revealed that the clients were not only well-versed and competent in these areas but also asserted a critical capacity regarding the consulting expertise offered. As Claude expressed during a pre-sale meeting:

I know that consultants are great at spotting opportunities to make money, but what I really want to know is whether their expertise will be directly useful to me. (FN, CM, Feb 2019)

His statement underscored a persistent concern: the *relevance* of the consult-ant’s knowledge to the organizational context. In this line, the clients were adam-ant about testing the consultants’ knowledge – whether technical, managerial, or strategic – by challenging their effective adaptation to specific circumstances. This was accomplished through three specific testing practices.

Probing for situational adaptation: One critical area of more “technical” knowl-edge required for the project was agile methodologies, particularly the SAFe and Scrum frameworks. Both Benoit and Claude, engineers trained in these method-ologies, had observed their implementation in the project, yielding mixed results. This set the stage for an “underlying competition in agile expertise” (FN, IC, January 2019), as a Delta consultant put it early in the assignment.

Both clients resolved to ascertain that Delta consultants not only “really knew agile methods” but could “effectively integrate agile methods into Arago’s context, which means IT, business, and start-up teams alike” (FN, CM, February 2019).

To achieve this, they employed a probing technique: instead of merely seeking generic advice, Benoit and Claude started by articulating their own conceptual understanding of the methodologies, as well as their contextual perspective, and challenged the consultants to assess and respond to their views critically. This approach allowed them to demonstrate their own mastery of agile methods to maintain control over conceptual definitions and evaluate the consultants' ability to expand upon these views.

For instance, before the project began, Benoit, the CIO, arranged a preliminary meeting with Henri, during which he delved into technical specifics, making extensive use of jargon:

Benoit: I want to discuss “product mode” and “at scale.” You can interpret these methods in many ways. My approach involves dividing teams into functional squads to define and execute function blocks. Do you follow what I’m saying? What do you think of that? (FN, CM, January 2019)

At the end of the meeting, Benoit asked the consultants for a presentation on “implementing this product-oriented approach in an IT environment with specifics for each type of team,” which Henri and his team willingly agreed to provide. In their subsequent encounters, Claude specifically challenged the consultants' understanding of the “product owner role,” stressing the need for adaptation: “I want to know whether you can align the method with our context” (Claude, CM, February 2019). Drawing on his experience, he challenged them to tailor their presentation to reflect his perspective “by specifying the ‘responsibility’ instead of the ‘power’ of the product owner in your presentation” (Ibid). Despite the consultants' view that Scrum and SAFe typically grant team members significant decision-making authority, Claude argued that Arago's context – where mid-managers were seen as too inexperienced for major decisions – did not support such delegation. Again, Henri, and his team recognized the input, and in their subsequent encounters with both Benoit and Claude, Delta consultants emphasized that “agile methodologies are merely one tool among many,” downplaying strict adherence to agility in favor of identifying local organizational dysfunctions, which they detailed thoroughly (FN, CM, February 2019).

Probing for insights: Arago clients were also particularly concerned with the consultants' ability to navigate the relational dynamics among the IT department, product teams, and the newly established subsidiary. In turn, Claude and Benoit frequently challenged the consultants to provide what they referred to as “managerial assessments of the situation” (FN, CM, March 2019). These assessments aimed to generate *insights* – contextual yet profound understandings of the underlying nature of a situation or problem, derived from a combination of experience, observation, and analysis. These insights were often shared through informal conversations, where consultants were asked for their “professional opinions” on specific individuals or events. For instance, in the first days of the assignment, Claude said to Henri:

I want to hear your thoughts on the dynamics within and between the teams. Just give me your insights (FN, IC, March 2019).

Claude's directive was straightforward: he expected the consultants to quickly provide their own appraisal of the tension between his team and the IT department, as both groups would need to collaborate with InnoSub.

In the first week, Delta's team conducted a series of interviews with members of the various teams, focusing on obtaining "insider knowledge and nuggets of information," as a consultant put it (FN, IC, March 2019). These insights were primarily gathered through discussions with employees, who provided their assessments of the situation. These conversations added pieces to the puzzle in quick succession: one IT manager in Benoit's unit criticized Claude for being too authoritative, while a product owner from InnoSub expressed confusion over the disorganized use of project management tools: "It feels like a traditional project disguised as an agile one with just a Kanban overlay" (FN, ITW, 2019). Meanwhile, a InnoSub manager praised the thoroughness of the change process criticized Benoit and Claude's teams for lacking process maturity and a proper understanding of their unit. Some of these remarks suggested that team members viewed Claude as overly authoritative and believed that he had contributed to the tensions among his own product team, the IT department, and InnoSub.

When reporting insights, Henri aimed to balance accurate reflections from staff conversations with sensitivity to the political context. Claude meticulously scrutinized these assessments, demanding references and verbatim quotations and urging the consultants to probe deeper. "What makes you say that?" he asked. "I'm skeptical about feedback from a subsidiary that struggles to manage its own roadmap with 40 clients" (FN, IC, April 2019). As the consultants responded to Claude's critiques, they continuously refined their insights, bridging the gap between his feedback and their own understanding.

Probing for global understanding: During the assignment, the clients actively challenged a final aspect of the consultants' skills, which they referred to as their "strategic abilities." Strategy is a cornerstone of consulting services and a field where most firms, including Delta, claim expertise. However, it was intriguing how the clients assessed the consultants' strategic expertise by challenging them to demonstrate their understanding of Arago's broader environment and their ability to link the specific assignment to the organization's overall objectives.

Prior to the assignment, another consulting firm had been dismissed because, as Claude explained, "It failed to grasp the strategic context fully" (FN, CM, February 2019). Henri therefore understood that Claude's expectations regarding strategy extended beyond standard strategic frameworks and models; instead, the clients required a comprehensive understanding of other assignments at Arago beyond the scope of their own project. Additionally, Claude emphasized that consultants should "align their actions within the assignment with the broader goals and challenges of the organization" (FN, CM, February 2019).

Reflecting this approach, during the sales process, Claude initiated discussions about company-wide objectives and developments. For instance, in one early meeting, Claude asked the consultants whether their work could be related to the broader trajectory:

- Claude: What do you think of the group's digital master plan? I mean, from a strategic perspective.
- Henri: Well... we could take some cues from the German approach to digital services.
- Claude: [smiling] Exactly. Did you see Arago Corp's acquisition back in 2018?
- Henri: Yeah [...] And it's definitely going to help gradually shift Arago Corp's core business toward renewable energy. I think the digital services will be a crucial part of that transformation.
- Claude: Exactly. That's why the general manager is pushing me to roll out those services faster – they're a big part of our company's vision (FN, CM, February 2019).

This exchange highlights the client's efforts to test the consultants' ability to align their work with the company's broader objectives. Claude often engaged the consultants in this manner, urging them to connect their advice on role-structuring at InnoSub with the organization's strategic goal to shift toward renewable energy. This, in turn, compelled Henri and his team to continuously seek external information about group companies, including their priorities and contextual pressures, as well as other assignments in various departments. This was also a way to anchor the consultants' advice within a broader client system and demonstrate how their "recommendations would impact not only Claude and Benoit but also the entire executive team and the other subsidiaries," as one manager explained (FN, ITW, March 2019).

In summary, testing skills occurred when the utility of the consultants' knowledge was uncertain and scrutinized for effectiveness, reflecting a common principle of relevance (Boltanski & Thévenot, 2006). The clients probed for signs of *relevance*: the capacity to situationally adapt more formal and abstract methods, offer deeply informed insights, or link the assignment to a broader organizational context. These probing techniques illustrate how clients and consultants continuously negotiate what constitutes knowledge in each situation, acknowledging that traditional managerial and strategic approaches must be translated and accommodated to align with the client system's internal dynamics, the organization's contextual pressures, and its broader environment. In doing so, clients recognized the specialized knowledge of the Delta consultants and leveraged their own to challenge the consultants' work. The consultants had to prove their relevance by translating their specialized expertise and integrating it with the client's knowledge and context.

Testing Results: Challenging Consultants to Deliver "value for money"

Consulting services may be intangible, but consultants commit to delivering tangible results. At Arago, Delta emphasized its proficiency in completing tasks and delivering outputs – a cornerstone of fulfilling their assignment. This emphasis stemmed from clients' expectations, especially since Arago had access to various consulting firms and routinely compared their performance to optimize costs. Benoit underscored this point in a meeting with Claude, stressing "the need for

services to justify costs and deliver tangible value for money” (FN, CM, April 2019). Similarly, Alfi emphasized the importance of closely monitoring schedules to ensure efficient resource allocation and timely progress. Consequently, a series of tests assessed signs of efficiency as a means of recognizing the consultants’ expertise. These tests used diverse methods, often involving third parties, or focusing on artifacts and other tangible aspects of the assignment. Notably, clients utilized three distinct testing practices: monitoring deliverables, monitoring the changes’ impact, and monitoring these results against contractual “promises.”

Monitoring deliverables: From the outset, Claude established a clear metric for success: the rapid and precise production of documents that would capture the nuances of the new operational model for digital services. “I want to ensure we’re making rapid progress in the right direction,” he stressed in an early meeting (FN, CM, February 2019). Delta was expected to grasp the urgency immediately, given that a significant portion of the assignment had to be completed within four months. Consequently, clients insisted on stringent oversight of document production to ensure project success.

Two document types drew particular attention: timesheets with workload management schedules, and technical deliverables. Alfi meticulously tracked the consultants’ timesheets to monitor any changes in workload and priorities. He requested a weekly meeting with Henri to review how much time was dedicated to each task and the associated deliverables. Claude and Benoit, for their part, diligently monitored technical deliverables, frequently requesting specific documents for evaluation and feedback, such as drafts outlining job roles, process flows, and roadmaps of upcoming workshops. They consistently emphasized the importance of complete transparency and responsiveness; as Claude emphasized, “Delta’s ability to keep us informed and demonstrate progress is critical” (EM, March 2019). Monitoring document progress implied accessing shared folders to check the progress of deliverables in real time. Clients could add brief comments or questions directly in the documents or via email, posing queries such as, “When will you solve this?” (EM, March 2019). They were especially interested in the ongoing development of the agile governance structure, which was subject to thorough scrutiny.

Alfi took his oversight of technical documents a step further by requiring prior approval for every document before it was distributed. He occasionally shared these documents with other consultancies working with Arago, facilitating cross-evaluation. During interactions with the consulting team, he dropped several hints about this process, using the implied threat of substitution. For instance, during a discussion about the governance structure, he told a consultant:

I’ve sent your draft over to MajorConsultingCorp, and they were kinda surprised at how slowly things are moving and that it’s all about the problems and barriers in the new structure [...] Can you put together a more finalized version for the upcoming executive meeting to show some progress? (FN, CM, April 2019).

The Delta consultants were acutely aware of the pervasive monitoring, which they worried undermined their position as trusted advisors. Nevertheless, the consulting team claimed to understand the importance of enhancing the visibility of their deliverables. Reflecting on this, a Delta manager commented, “These

deliverables are crucial in showcasing our expertise, demonstrating tangible results that go beyond mere paperwork to practical documents used in real scenarios” (ITW, June 2019). The consultants thus aimed to not only comply with the client’s wishes but also to signal their distinctive contribution in responding to the tests.

Monitoring change impact: Clients were also keen on testing “change impact” as another critical aspect of the consultants’ expertise in delivering results. Alfi repeatedly stated that “the objective wasn’t solely to generate polished reports, but to ensure the new structure was effectively integrated” (FN, CM, May 2019), with teams fully embracing it. In this line, all three clients collectively emphasized that the assignment’s success rested on how smoothly employees transitioned into new roles and embraced the revised organizational structure. Monitoring this implied assessing how much the organization’s processes had evolved as a result of the consultants’ interventions.

The clients conducted this test by informally probing their teams for feedback on the consultants’ work, how they reacted to it, and what changes had been made to their specific processes or workflows. This feedback loop created an informal network of evaluators who observed the consultants’ actions and reported their observations to their superiors. This process involved cross-evaluation “from the entire client system on which parts of our work were worth implementing” (FN, TM, April 2019), as one consultant described it. Claude reminded the consultants in this line that “every Arago employee they interacted with was effectively a client. Dissatisfied employees could influence their superiors’ perception of the consultants’ value” (FN, CM, April 2019).

An illustrative example of this collective evaluation of change impact occurred when Alfi convened employees from various levels to evaluate the consultants’ proposed structure during formal workshops. He collected feedback after each session and often used this feedback to critique the consultants’ work during steering committee meetings. For instance, in one such meeting, Alfi asserted: “The employees did not appreciate your input; they found it useless and without content. I don’t see how the structure has moved forward at all” (FN, April 2019). Positive feedback, on the other hand, signaled acceptance of the proposed changes. In response, Henri and his team acknowledged the need to address each employee’s concerns and collaborate on implementation guidelines to foster progress within their respective teams. Once again, a consultant emphasized the significance of “making results visible” (FN, TM, April 2019) – this time through the practical adoption of changes by the employees themselves.

Monitoring contractual promises: A final way clients tested consultants’ results was by continually comparing their “performance” to the commitments outlined in the contract. Claude referred to these contractual commitments as “promises,” detailing the specific goals, resources, and deliverables Delta pledged to achieve within the project’s scope. Some of these goals were less factual than others, such as the document’s stated aim of a “well-balanced structure that met the highest standards and was accepted by all shareholders” (DOC, February 2019). During a presale meeting, Benoit highlighted the necessity of clearly defining and focusing on specific objectives: “I want you to make realistic commitments. Ultimately, we will judge you based on the promises you make in this proposal” (FN, CM, January 2019).

Benoit, Claude, and Alfi consistently referred to the contract as a framework to challenge expected results throughout the assignment. Although consultants are theoretically shielded from market pressures once the contract is signed, clients at Arago continually reintroduced these pressures to challenge the team's expertise. This was particularly evident when clients scrutinized the expertise engaged, using the contract as a reference point. For example, in the following excerpt, Delta's expertise and staffing on the assignment are discussed:

- Claude: You promised me an expert project manager, but the consultant you sent wasn't up to par. [...] I'm not paying top dollar for a junior, that wasn't what was promised [...].
- Alfi: The Partner [Henri] must be on this. That's what I'm paying you for... I won't start discussing [a potential follow-up assignment] until you deliver according to the contract on this one (FN, CM, June 2019).

As this excerpt shows, keeping "promises" was also critical for securing future assignments with Arago. Alfi frequently reminded the consultants of this, hinting at the possibility of engaging another consulting firm if expectations were unmet.

The contract's role as a benchmark for expected results came to the fore when the pace of change fell short of the clients' expectations. For instance, the consultants were also keenly aware of Alfi's dissatisfaction with progress, which they openly discussed, using the contract as a reference point. For instance, Carine noted: "While Alfi keeps pointing to the promises in the contract, we've got to remember there are limits to what's included in the agreed scope. Sure, it's crucial to deliver on our commitments, but it's just as important to recognize and address any tasks that fall outside that scope" (FN, TM, June 2019). Articulating this sensitivity to tasks beyond the original contract became critical for the Delta consultants, as it underscored the uniqueness of their work.

In summary, testing results typically occurred when clients questioned the consultants' value for money, leveraging external competition and using signs of efficiency as a reference (Boltanski & Thévenot, 2006). At Arago, clients continually sought proof of the consultants' ability to deliver tangible or intangible results promptly and according to their contractual commitments. These monitoring techniques subjected the consultants to intense market pressures, and the scrutiny of results did more to commodify their expertise than any other test. Delta saw this as restrictive and exclusionary; the team often considered that they had been reduced to mere "pairs of hands" or interim workers at risk of being replaced rather than valued for their unique expertise. As a result, Delta sought to signal their contribution and distinctive expertise, positioning themselves as more than just interchangeable labor.

Testing Loyalty: Binding Consultants to the Client's Authority

In the Arago case, assessing consultants' skills and results was crucial, but loyalty was equally significant for clients. As Claude pointed out in a pre-sale meeting,

an understanding of Arago's "political context" was pivotal in the firm's decision to choose Delta over its competitors:

Some outside consultants might not really get how our local units work, which is crucial for this task. We can't talk about everything openly because of some internal disagreements at Arago, so I need to know I can trust you (FN, IC, February 2019).

An essential part of these loyalty tests, typically informal, is the consultant's ability to sense when to demonstrate fidelity by aligning with the client's perspective, regardless of other factors, and to take proactive action to support that perspective. Here, consultants' expertise is recognized not only through demonstrations of relevance and efficiency, but also through signs of commitment, including trustworthiness, closeness, and deference to the client's authority. Building a strong rapport, in turn, helps the consultant identify what matters most to the client, which is integral to the consultant's expertise. At Arago, loyalty was assessed through various testing practices such as asking consultants to "pick a side" during rivalries among clients, to take a lower position willingly, and to offer the client reassurance.

Asking consultants to "pick a side": When consultants pledge loyalty to a specific client within the organization, they commit to a particular course of action, often navigating conflicting interests to demonstrate their allegiance. This ability to pick a side without explicit guidance proved crucial throughout the Arago assignment. Calls for allegiance were often implicit, conveyed through subtle cues such as probing silences and loaded pauses, typically during discreet one-on-one conversations.

Early in the assignment, it became evident that internal political struggles were emerging between Claude and Benoit. Both clients were trying to align Delta with their respective viewpoints, as Benoit articulated:

You need to help the business see the IT department's perspective [...]. We need Claude and his managers to get this together. They're saying we failed to stabilize the application, but the truth is, they made bad choices by buying the wrong software and picking the wrong integrator. We're just dealing with the fallout from their mistakes (FN, IC, March 2019).

On the other hand, Claude frequently criticized Benoit's approach to digital services and dismissed any attempts by Delta to introduce him to the IT department's view. Instead, he insisted that Delta reaffirm their allegiance to his side:

Claude: We can't fully grasp the extent of the problem, either technically or in our ability to develop digital services at the required speed. Twice, Benoit pushed us to rebuild the IT architecture, but we have no results to show for it. [Pause. Look for the consultant's approval]

Senior Partner: Our team will put pressure on the IT department and challenge them to meet expectations.

Claude: That sounds good, and in that case, I'm sure we can work together. (FN, IC, February 2019).

The consultants were acutely aware of the rivalry between key clients. They openly weighed the risks associated with aligning with a potentially losing side, which could tarnish Delta's reputation within Arago. Given Claude's status, which the senior partner described as "Delta's historical client" (FN, IC, January 2019), the team remained committed to supporting him. Yet, as Carine, the Delta consulting manager on site, nuanced: "Still, we need to indirectly advance the IT department's views since they line up with ours, even if we don't come right out and say it" (Ibid).

The consultants' allegiance was also tested indirectly through their choice of recommendations and wording in deliverables. For example, in the draft of the new organizational structure, Claude questioned whether a "specific workflow" would secure his role as "final decision-maker" (FN, IC, April 2019). This suggested that the consulting team would have to prioritize his authority over that of the IT executives – a point they enshrined in the subsequent version of the document. As a consultant mentioned: "I realized from the beginning that this was a crucial concern for Claude, and since it makes sense from a business perspective, I don't see why we would risk antagonizing him over it" (FN, IC, April 2019).

Asking consultants to take a low stance: Another way clients' gauged consultants' loyalty was by requiring them to subordinate themselves, thereby reinforcing the client's authority publicly. At Arago, this dynamic was especially noticeable in interactions with Alfi. As the appointed director of InnoSub, Alfi frequently asserted his authority over the consultants, whom he had not hired, to establish his new leadership role. The consultants, in turn, were expected to defer to him as a demonstration of their loyalty. For instance, shortly after assuming his position, Alfi convened a meeting with key InnoSub managers and the consulting team. During this session, he openly criticized Henri's team, accusing them of focusing on their own priorities:

Alfi:	I feel like you haven't been working closely enough with our team, right? [glancing at InnoSub team members]
InnoSub Employee:	We've had some productive sessions with the consultants...
Alfi:	[interrupting] But your work [looking at Henri] is too theoretical. We're a startup, not an established company like Arago. You need to get hands-on and analyze our situation more closely.
Henri:	You're right, Alfi. We're committed to supporting your team and can certainly adjust our approach to offer more practical guidance.
Alfi:	Exactly. I just need to see more integration and less distance in our efforts (FN, CM, May 2019).

This kind of public reprimand to put consultants back in line, using InnoSub employees as an approval tier, became a regular occurrence. Despite Henri's close relationship with Claude, who had appointed Alfi, the consultant ensured that his

team never challenged Alfi's assertive displays of authority. Instead, they politely accepted his public criticisms. This approach was framed as a way to fulfill their service role and strengthen their relationship with the young director. While the consultants were eager to address the issue, Carine explained during a debriefing: "It's all part of the game; nobody is naïve, especially not Claude or InnoSub teams. Alfi needs to assert his authority as the new boss, and if that means we show compliance to support him, then that's perfectly fine" (FN, TM, May 2019).

Claude, for his part, would also use a similar approach to implicitly remind the consultants of the chain of command, especially when challenged on substantive issues related to the new structure. For instance, during a client meeting with several internal employees, a consultant presented Delta's suggestion for restructuring InnoSub. When Claude realized that it differed starkly from his own plan, he intervened:

- Claude: We're not going over this again. Our goal isn't to confuse people. What you're suggesting wasn't in the first draft I gave you. I'm sticking with that.
- Henri: Claude, we're not trying to challenge your plan.
- Consultant: Absolutely, we're completely on board with your vision.
- Claude: Alright then, but we need to stick to the draft (FN, CM, March 2019).

A few minutes later, Henri reiterated his commitment to Claude's plan, to which Claude replied that what mattered most now was ensuring that "Delta can publicly confirm that the consulting team is fully aligned with this approach" (Ibid).

Asking for reassurance: A final approach for assessing consultants' loyalty involves clients initiating personal conversations to seek reassurance on a more intimate level. This requires consultants to explicitly show care, maintain confidentiality with privileged information, and demonstrate genuine concern for the client's position. This approach reflects broader client expectations that consultants can cultivate trust-based relationships.

In the Arago Case, Claude would assert his authority quite directly on certain occasions, yet at other times, he could also display a form of vulnerability. During private conversations, for instance, he confided in Henri about his doubts, personal challenges with the project, and the pressures from upper management. For instance, regarding the tensions surrounding accepting the new structure and feedback from teams that he could sometimes seem too authoritative, Claude remarked, "I attempted to close this negotiation earlier, but I haven't succeeded, and I realize I'm in a critical situation" (FN, IC, May 2019). Trading in intimacy, Henri entered a more personal dialogue to explain his perceptions of the risks to Claude's position and how they could be mitigated, reassuring him of his unwavering support. Following this, Henri and his team established back channels with several executives, addressing what they perceived as Claude's excessive exposure and lack of support from top management for the project. These efforts yielded positive results and eventually came to Claude's attention, prompting him to say, "I realize that you've been campaigning for me [...] and that none of our

conversations have leaked to the IT department [...] I appreciate you having my back. It means a lot" (FN, IC, May 2019).

InnoSub employees also shared more intimate concerns and vulnerabilities:

- Employee: It feels like this reorg is just being pushed down from the top. We're worried about losing our autonomy, and the teams we've worked hard to build.
- Henri: I get where you're coming from. I'm here to make sure we handle this transition smoothly while keeping your autonomy intact [...].
- Employee: I don't know, Henri... Finding my place at Arago Corp seems tough [...] and it feels like we've been left out in the cold. I know you care about keeping us motivated [...].
- Henri: I hear you [...]. We're really focused on understanding what you all need [...]. We're here to build a place where everyone can succeed (FN, CM, April 2019).

Once again, the consulting team took the initiative to carry the employees' perspectives, ensuring that personal discussions remained confidential. Claude recognized that Henri and his team had taken on the role of "buffer" in the field. Following this, he increased his communication with the teams to provide clearer insights into the project and involve them in the process. While InnoSub employees still had reservations about their positions, they acknowledged that "a common ground had been established" and that speaking with Henri had "eased their concerns, as it felt good to have someone who genuinely cared and could offer a form of reassurance" (FN, CM, April 2019).

In summary, loyalty tests occurred when clients focused on the consultant's willingness to support their authority and interests, referencing principles of trust and commitment (Boltanski & Thévenot, 2006). At Arago Corp, such tests typically involved clients asking consultants to choose sides, take a low stance when necessary, and offer reassurances when they felt vulnerable. The informal nature of these tests is critical; it compels consultants to actively show that they are not self-serving but are instead committed to the client's agenda. This implicit expectation also recognizes the consultant's expertise as a matter of navigating social and political dynamics to align closely with the client's objectives. By conducting these tests, clients emphasize loyalty as a cornerstone of the consulting relationship and strive to elicit deep commitment from the consultants. Consequently, consultants often had to synthesize or align competing knowledge and interests within loyalty tests.

DISCUSSION AND CONTRIBUTIONS

This study investigates how clients influence consultants' work by continually putting their expertise to the test, showing that consultants must repeatedly secure recognition of that expertise from diverse clients in order to sustain their work. Our research highlights clients' tests as a critical mechanism for manifesting the forms

of expertise that are recognized as relevant. We specifically observed skill tests, where the consultants had to prove the ability to translate abstract and specialized knowledge while incorporating organizational insights. Furthermore, results tests that measured the speed and impact of their work (or value for money), requiring consultants to show their efficiency and effectiveness while remaining distinct and avoiding being reduced to mere “pairs of hands.” Finally, loyalty tests assessed the consultants’ deference to the client’s authority, where they had to prove commitment by navigating and incorporating even conflicting views. By focusing on these tests, our study contributes to the literature on relational views of expertise, underscoring objects’ role in enacting expertise and offering new insights into the tensions between professionalism and commercialism in consulting work.

A relational view of expertise in client-dependent work: Contrasting cognitive views of consultancy expertise, our study aligns with perspectives that challenge the esoteric, specialized, and codified knowledge of management consultants, highlighting expertise at the interface of various forms of knowledge and actors (Bourgoin et al., 2020; Eyal & Medvetz, 2023; Treem, 2016; Waisberg & Nelson, 2018). Our findings reveal that clients, possessing overlapping knowledge and capable of many of the same methods as consultants, place great value on consultants’ situated ability to accommodate their knowledge. As we observed in our case, the recognition of relevant expertise depended greatly on the client, and there was considerable variation within the client system. Furthermore, as previous studies have suggested (e.g., Smith, 2009; Sturdy et al., 2009; Treem, 2016), a critical part of the consultants’ work in our study was to incorporate and synthesize clients’ diverse knowledge while signaling their own distinctive expertise by tailoring and extending it –thus balancing the need to legitimate existing knowledges with the delivery of newness. In this line, Treem (2016) asserts that consultants are experts in understanding clients, processing information, and communicating results, all of which require various representations of knowledge. Bourgoin and Harvey (2018) describe consultants as “professionals of relevance” who achieve significant impacts by engaging with client systems to generate knowledge outputs swiftly. Expanding on these findings, we demonstrate that clients recognize these skills, emphasizing situational relevance, internal insights, and integration with the broader organizational context. Our findings highlight how different clients – shaped by diverse priorities and organizational contexts – recognize and value consultancy expertise in distinct ways, emphasizing not only technical skills but also cost-efficiency and commitment to their specific interests.

This does not suggest that such expertise is any less “real” or “valuable,” nor that self-endowed legitimization strategies or rhetorical tactics solely drive it, as some institutional or critical perspectives might imply (e.g., Alvesson, 1993). While such perspectives often portray clients as passive participants (Elmholdt et al., 2024; Sturdy & Wright, 2011), our analysis emphasizes their active role in scrutinizing consultants’ expertise and challenging their authority, making each attempt at justification a trial. This dynamic may arise partly because the consulting firm in our study is not a major market player (Armbrüster, 2006). However, it still highlights the clients’ agency in shaping consultants’ work by continuously

requesting them to incorporate their knowledge. Hence, consultants must demonstrate their specialized abilities (e.g., to translate abstract knowledge) within the relational context of the client system, and continually secure the client's recognition of their expertise in order to sustain their work. This finding aligns with relational views of expertise (Pakarinen & Huising, 2025), seeing it as an interactive and situated accomplishment that leverages client relationships to achieve collective goals.

Our analysis further advances the relational view by demonstrating how tests act as a generative mechanism in the client–consultant relationship that provides contextual cues to the consultants about what is important to the client. We suggest that expertise in consultancy work encompasses a set of characteristics that establish a consultant's value to clients through various tests. The ability to adeptly handle these tests is vital to consultancy work. These tests define the actors, roles, and relationships crucial to what constitutes expertise, relying on shared principles that validate specific actions. By exploring the nuances of skills, results, and loyalty tests in consulting, our study shows how clients use routine evaluations to detect misalignments between the services delivered and established normative standards. As this paper discusses, tests serve as challenges posed by clients and the environment, questioning “prescribed roles and trajectories” through specific interpretive principles (Marres & Stark, 2020, p. 438). Thus, tests profile consultancy services and make relevant forms of expertise manifest.

Previous research on relational expertise has focused on how clients may resist consultants' authority by indirectly questioning their practices (Chan & Hedden, 2023; Huising, 2014). Although our study observes similar dynamics, especially during loyalty tests, it deepens the understanding of this dynamic: clients shape how consultants' expertise comes to operate through tests that prompt the inclusion of additional perspectives. Consequently, consultants must accommodate such tests by continually adjusting their actions to align with collective knowledge – or “what others might offer” (Edwards, 2011, p. 33) – suitable for the context. This approach supports understanding expertise as enacted through interaction and through coordinating divergent interests and objectives. Tests reveal key relational and contextual dynamics, and passing these tests may be crucial for consultants to maintain credibility while learning the specifics of their assignment (Bourgoin & Harvey, 2018).

Accomplishing relational expertise through objects: Our study contributes to research on the relationship between expertise and objects (Cetina, 1999; Pakarinen & Huising, 2025; Preda, 2025), emphasizing how epistemic objects such as models, graphs, and tools are essential to the enactment of consultancy expertise (Bourgoin & Harvey, 2018; Elmholt et al., 2018; Kaplan, 2011). We detail how different types of tests – each with its specific repertoire of values – rely on distinct networks of objects: skill tests focus on technical reports and materializing methods and models, whereas results tests target contractual documents and timesheets. These objects make consultants' expertise tangible through representations (Treem, 2016) and precipitate tensions and resolutions between consultants and clients. Those objects thus mediate the consultant's expertise, and they emerge as experts by representing them (see also Carr, 2010). For example,

skill tests often involve ongoing critiques of technical concepts and subsequent iterations, while results tests use contractual agreements as benchmarks. By making consultancy services tangible, these documents serve as proof of value and expose the advice to falsifiability and criticism. Overall, our research highlights objects' critical role in not only recognizing, applying, or generating relational expertise but also challenging expertise within professional and organizational contexts. These objects materialize the intangible and abstract aspects of expertise in management consulting, anchoring it in forms that facilitate evaluation, contestation, and coproduction between consultants and their clients.

Professional and commercial dimensions of consultancy expertise: Our research further deepens the understanding of the tension between commercialism and professionalism in consultancy expertise – a theme extensively discussed in the literature (Bogdanich & Forsythe, 2022; O'Mahoney et al., 2013; Stein, 2020). Previous studies often portray consultants and their expertise as commodities in a market for solutions (Mazzucato & Collington, 2023; Stein, 2017), where the focus on market dynamics conflicts with duties tied to professional integrity. As noted by Bogdanich and Forsythe (2022), although McKinsey once regarded the term “commercial” as practically profane, consultants today are increasingly viewed as commodifying and commercializing their expertise through standardized services (see also Stein, 2020). Our findings suggest that consultants not only commercialize their expertise but also that clients play a critical role in this process. Through results-oriented tests, clients seek market and competitive awareness among consultants. Our research indicates that while consultants strive to accommodate client demands, they approach these market-oriented principles cautiously. They may even attempt to resist what could threaten to erode their distinctive expertise and reduce them to mere “pairs of hands” – notably during the results test – by emphasizing their unique contributions. These insights from the level of work could nuance critical views of consulting (Mazzucato & Collington, 2023) by highlighting clients' joint role in influencing consultants' work toward serving narrow interests, tailoring conclusions to meet their demands, or even making exaggerated promises.

Boundary Conditions and Concluding Remarks

It is crucial to assess how the findings of this study apply specifically to our case conditions, considering aspects such as the technical complexity of the assignment, the nature of the service, competitive bidding influences, the client's role and expertise, the consulting firm's legitimacy, and the political context. These elements serve as boundary conditions for our analysis. We may imagine situations where consultants' expertise and authority become undermined through tests (c.f. Huising, 2014). We expect that different client types – ranging from citizens interacting with public administrators to consumers buying new technology and patients visiting doctors – may apply or adapt the identified tests based on their specific contexts and needs. Whatever these tests may be, however, “the nature of the bargain between those who receive a service and those who give it” (Hughes, 1958, p. 83) will remain pivotal, and influence experts' work. Therefore,

exploring how clients put expertise to the test in various professional settings with differing levels of knowledge overlap, how experts respond to these tests, and the resulting outcomes – such as legitimating or innovating existing knowledge – warrants further research.

NOTE

1. We use abbreviations throughout the findings to describe data sources: DOC refers to archival data, FN to field notes, ITW to interviews, EM to email, and setting: CM to client meeting, IC to informal conversations, TM for Delta team meeting.

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