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

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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 archaeologists 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 profession 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 multinucleus 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 polyploidy 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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REFERENCES

Arman, R., & Styhre, A. (2019). Inspecting life: Professional vision in assisted reproduction technology. *Cognition, Technology & Work*, *21*(3), 383–396.

Bassetti, C. (2021). The tacit dimension of expertise: Professional vision at work in airport security. *Discourse Studies*, *23*(5), 598–615.

Bornmann, L. (2013). Research misconduct – Definitions, manifestations and extent. *Publications*, *1*(3), 87–98.

Carlin, A. P., Marques, J. B., & Moutinho, R. (2021). Seeing by proxy: Specifying "professional vision". *Learning, Culture and Social Interaction*, *30*(A), 100532.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative research*. Sage.

Comi, A., Jaradat, S., & Whyte, J. (2019). Constructing shared professional vision in design work: The role of visual objects and their material mediation. *Design Studies*, *64*, 90–123.

Delamont, S., & Atkinson, P. (2001). Doctoring uncertainty: Mastering craft knowledge. *Social Studies of Science*, *31*(1), 87–107.

Dumit, J. (1999). Objective brains, prejudicial images. *Science in Context*, *12*(1), 173–201.

Gegenfurtner, A., Lehtinen, E., Helle, L., Nivala, M., Svedström, E., & Säljö, R. (2019). Learning to see like an expert: On the practices of professional vision and visual expertise. *International Journal of Educational Research*, *98*, 280–291.

Goodwin, C. (1994). Professional vision. *American Anthropologist*, *96*(3), 606–633.
Goodwin, C. (1995). Seeing in depth. *Social Studies of Science*, *25*(2), 237–274.
Goodwin, C. (2013). The co-operative, transformative organization of human action and knowledge. *Journal of Pragmatics*, *46*(1), 8–23.
Goodwin, C. (2017). *Co-operative action*. Cambridge University Press.
Grasseni, C. (2004). Skilled vision. An Apprenticeship in breeding aesthetics. *Social Anthropology*, *12*(1), 41–55.
Hammersley, M., & Atkinson, P. (2007). *Ethnography: Principles in practice*. Routledge.
Hartswood, M., Procter, R., Rouncefield, M., & Slack, R. (2002). Performance management in breast screening: A case study of professional vision. *Cognition, Technology & Work*, *4*(2), 91–100.
Hindmarsh, J., Reynolds, P., & Dunne, S. (2011). Exhibiting understanding: The body in apprenticeship. *Journal of Pragmatics*, *43*(2), 489–503.
Lymer, G. (2009). Demonstrating professional vision: The work of critique in architectural education. *Mind, Culture, and Activity*, *16*(2), 145–171.
Miles, M. B., & Huberman, A. M. (1984). *Qualitative data analysis: A sourcebook of new methods*. Sage.
Miller, J., & Ulrich, R. (2022). Optimizing research output: How can psychological research methods be improved? *Annual Review of Psychology*, *73*(1), 691–718.
Owen-Smith, J. (2001). Managing laboratory work through skepticism: Processes of evaluation and control. *American Sociological Review*, *66*(3), 427–452.
Peterson, D. (2015). All that is solid: Bench-building at the frontiers of two experimental sciences. *American Sociological Review*, *80*(6), 1201–1225.
Rushforth, A., & de Rijcke, S. (2015). Accounting for impact? The journal impact factor and the making of biomedical research in the Netherlands. *Minerva*, *53*(2), 117–139.
Samuel, G., Williams, C., & Gardner, J. (2017). UK science press officers, professional vision and the generation of expectations. *Public Understanding of Science*, *26*(1), 55–69.
Strauss, A., & Corbin, J. (1998). *Basics of qualitative research. Techniques and procedures for developing grounded theory*. Sage.
Styhre, A. (2010). Knowledge work and practices of seeing: Epistemologies of the eye, gaze, and professional vision. *Culture and Organization*, *16*(4), 361–376.
Styhre, A. (2011). The architect's gaze: The maintenance of collective professional vision in the work of the architect. *Culture and Organization*, *17*(4), 253–269.
Styhre, A., & Gluch, P. (2009). Visual representations and knowledge-intensive work: The case of architect work. *Vine*, *39*(2), 108–124.
Vyas, D. (2013). Ethnographic notes on visualization practices in tissue engineering research. *Cognition, Technology & Work*, *15*, 373–388.