

Chapter 7: CONCLUSION

Data collection does not only occur through visual observation.

Observation is a matter of sensory engagement – with eyes, ears, and hands – and it involves the body and listening as much as it does vision. My perspective on scientific knowledge production in the field sciences has shifted after five years of accompanying Michael and his team during fieldwork, online calls, and laboratory visits, attending to the sensory and bodily practices of their research process. By focusing on the boundaries of epistemologies and ontologies with which these field scientists engage during their work, my perception of the role of the visual shifted from it being *the* observational practice towards it being *part of* several observational practices, embedded in a wider sensory engagement. In my case study of evolutionary biologists, the visual was complemented by other sensory and bodily practices during data collection in the field. However, data collection is also guided by technologies and epistemologies that frame the act of observing. It was only during the processing and modelling of the raw data that the biologists' sensory engagement seemed to return primarily to the visual (i.e. the computer screen).

Bearing this process of filtering and transformation in mind, it is clear that the resulting '[i]mages or representations [that, i.e., the readers of scientific journals usually see] are

not snapshots or depictions of what awaits us but rather condensations or traces of multiple practices of engagement.¹ The final images are the result of a process of bodily and sensory practices, and not a simple mirroring of nature that 'awaits' the researchers in the field. What follows from this observation is that evolutionary biology appears to engage not only with *hard* facts based on visual evidence but also with several practices that could be rendered as *soft*,² as they require bodily and sensory knowledge that is hard to grasp and define. Thus, it cannot simply be formalised, but pertains to experience, practice, and virtuosity.

Given this shift from hard to soft, and the tension between the so-called *hard* (e.g. natural sciences) and *soft* (e.g. humanities) sciences, I summarise the most important insights, observations, and outcomes of my study that led to this observation. I do this regarding the natural scientific practices that, as I suggest, cannot be generalised as *soft* or *hard*, but are, instead, a process that moves between different stages of these conditions. I subsequently contextualise my observations in terms of their meaning for future development and disciplinary boundary-making, which enables me to draw on aspects that I excluded from my study and suggest topics for future research within the relevant fields. Finally, I conclude with an *Epilogue* in which I discuss a recent shift in the research practices of the evolutionary biologists I accompanied. This shift offers a new perspective on the practices of fieldwork and lays the foundation for new scientific endeavours in evolutionary biology.

¹ Barad, *Meeting the Universe Halfway*, 53.

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During one of our last interviews, Michael described his field as a rather *soft* science among the natural sciences. He argues that in physics, mathematics, and chemistry, *hard* knowledge is produced. This is because there is little doubt about certain facts, for instance, the existence of gravity. However, in the life sciences, such as evolutionary biology, the boundaries are more blurred, and the discipline is often more concerned with confirming (not proving) a hypothesis under the specific conditions of the research setting. This is also reflected in the research papers, where the possible conditions when the outcome can be considered as *true* must be discussed. Often, the storytelling plays a major role in convincing the audience (cf. Zoom interview with Michael, 24 May 2022).

Reflection on Previous Chapters

Adopting a design-informed approach in my case study provided different perspectives on the relevant scientific practices. It allowed me to attend to that which is usually invisible – the performative, processual, sensory, and embodied characteristics of the scientific process – which, as I have illustrated, usually disappear. Attending to these from both a design and an anthropological perspective allowed me to examine the scientific practices with a different focus, and redefine my understanding of design and anthropology. As suggested in the Introduction, the lens of a designer is a suitable starting point for bringing these different disciplines into the discourse. It allows one to focus on the sensory, emotional, and aesthetic aspects, thereby mediating between different ontologies and epistemologies. However, these aspects are not only limited to design discourse but are also popular in anthropology. Combining design and anthropology allows me to extend design into the field of anthropology and vice versa. Whereas anthropology provides methods and theories on the *cultural* and *social* aspects of specific practices, design focuses on the actual *practices* and *processes*. This contributes to a broader understanding of the scientific practices of my case study as cultural, social, embodied, and sensory, and instigates a discussion on the relationships between these disciplines, which seem to complement one another.

By focusing on design practices, I have brought anthropology and evolutionary biology into the discourse, despite the difference in research topics and thought styles. In both cases, design is employed as a recording practice to facilitate complexity and stabilise and transport observations. These formal-aesthetic design aspects are part of the *soft* aspects of the research processes, as they are defined by their sensory and bodily aspects, thinking in practice, and aesthetic engagement.

Despite this commonality in data-collection methodology, the role of design is reflected differently in both disciplines. In anthropology, *soft* aspects, such as the sensory and bodily immersion in the field and the visual representation thereof, are reflected as part of the methodology and formalised and conceptualised in the interpretation. In biology, these qualities are eventually filtered out to produce *hard* facts. In my case study, this sensory involvement, such as sensory alignment with the field and the Siberian jays, is performed only as a means to an end, for instance, to find and attract the birds. This difference is foremost the result of the quantitative and highly formalised approach, as opposed to a qualitative and sensory methodological approach. Again, these are the result of the historical development of the different disciplines that have resulted in almost opposing scientific world-making practices, thought styles, and meta-narratives that must be followed for the disciplines to be accepted in their respective scientific communities. Anthropology must meet the criteria of qualitative data collection and create evidence through consistency: by publishing primary data, using direct quotations, and including the role of the ethnographer in the reflections. These elements are often perceived as *objective* only in their raw state, along with the visible presence of the researcher in the results. In biology, it seems to be the other way around: only once the raw data have been processed and quantified, tidied of any subjective traces, transformed and refined, have *facts* been produced that are considered objective and robust.

Accordingly, whereas in ethnographic accounts, the audience can see first-hand visual material, such as photographs, the images in natural scientific journals are technical and formalised. Rarely can the audience of the latter see an image of the actual research subjects, such as the Siberian jays. The final images are usually small fragments ex-

tracted from the natural world, often representing highly specific aspects, and the result of a long process of *Preparing, Collecting, and Producing*, as I have illustrated.

During the research process, the evolutionary biologists, Siberian jays, boreal forests, and data-collection circumstances became increasingly invisible with each step. They developed from data collection as a situated practice, which is highly dependent on the biologists' involvement in the field and with the birds, to the processing of data that refer to the birds but are ontologically entirely detached from them and their environment. In this visual processing on computers, the biologists have also become somewhat arbitrary, as the processing and modelling can be performed by people who may have never been to Arvidsjaur.

During the practices of *Preparing* (Chapter 4), the biologists underwent what I conceptualised as situated enskillment, in which they were initiated into the fieldwork practices of the thought collective of the relevant researchers. This enskillment complemented the formal knowledge gained from their university training. As this knowledge was insufficient for fieldwork – a practice-based endeavour – this in situ enskillment was necessary. It encompassed practices of organising and preparing for fieldwork, of learning the reference system that ensures consistency in the data, and of navigating through the field and learning how to conceptualise the geography of the field. Most importantly, it involved learning how to work with the Siberian jays: how to identify and register them, and how to collect and document the relevant data.

During the practices of *Collecting* (Chapter 5), the biologists did not collect data with highly technical tools and media, as the technical appearance of the results suggest. Instead, they were engaged with their entire bodies and sensory perception in the field, particularly when attracting the birds in the different territories. They aligned themselves with their environment during wayfinding, and with the

Siberian jays when calling them. This alignment enabled them to find the birds and collect data from them. To ensure that the data collection was systematic and purposeful, and to frame their observations, the biologists used tools such as binoculars, protocols, and video recordings. By using these during fieldwork, the biologists became part of the observational apparatus that, only through the combination of *situated enskillment* and technical and epistemological *mediation*, enabled consistent data collection. I referred to this knowledge – of how to collect data in this specific study and account for relevant circumstances – as *situated mediations*, drawing on *situated enskillment*, embeddedness in discourse, and bodily and sensory practices.

After data have been collected in the field and transported to the office, the biologists, during *Producing* (Chapter 6), transformed, processed, and modelled those data, again based on situated mediations. The situated mediations in the office were also guided by specific practices, now mostly digital, which were driven by the researchers' hypothesis and epistemological interest in the data. Thus, they worked as *filtering* practices through a combination of technical tools and operations conducted by the biologists.

During this process, the traces that specified the field data and situated them in relation to the individual biologists and birds became invisible. In fact, it seems to have been the aim of the biologists to refine the data from that which situated them (e.g. autographic data such as handwriting that identified individual biologists). Through this filtering, the data became *objectified* in the sense that all their subjective, specific, and unique traces were eliminated. In this step, the biologists and the birds were not only re-located from field to office but also became less visible as *facts* began to emerge. As illustrated by Haraway's 'god trick', the biologists – except for their names on published

papers – became neutralised and located somewhere outside the research. These steps of filtering were accompanied by a shift from a bodily and sensory engagement during the practices in the field, towards visual operations on computers during data processing.

In this final step, the implicit knowledge, involvement of the biologists with fieldwork, and their situated practices in Arvidsjaur have become redundant. The scientific papers affirm the traditional concept of objectivity as a visual construction of facts with a written account that meets the criteria of the standardised rhetoric, as they dominate the natural sciences, thus often rendering the information inaccessible to a wider audience. The result is a great leap from Siberian jays who live near Arvidsjaur to their reduced representation as evidence of a hypothesis in a scientific journal. They are presented as though the scientists have observed them from an outside perspective. However, as has become evident through my research, the biologists had to become entangled with the environment and the subjects they studied to collect data. From this perspective, they are situated within their research and not outside it. Thus, objectivity, in resonance with ecofeminist perspectives, must be understood as situated, as a partial perspective, and as something that must be conceptualised in relation to the practical engagements required by the field.

In this text, I have aimed to reveal the messiness of the environment – the natural world itself – in which the biologists are immersed with their entire bodies and senses, and from which the scientific *facts* stem. Rather than presenting clean, visually organised results of scientific work independent from the process of production, I have returned the natural world to the conversation by examining, complexifying, and entangling the Siberian jays, the evolutionary biologists, and the boreal forests, and revealing how they are intertwined. In this sense, I

have attended to the issue of human entanglement and its situatedness within the natural world during data collection, which forms the basis for producing scientific facts.

In so doing, I have introduced two concepts that have allowed me to merge methods from both disciplines – anthropology and evolutionary biology – with the aim of overcoming the polarisation of the hard and soft sciences to reveal a wider range of conditions that may be neither hard nor soft. First, combining the ethnographic method of participant observation with the biological method of behavioural observation as *participant behavioural observation* allowed me to question the observational roles and instances that researchers from both fields assume. This concept helped to reveal that which is methodologically invisible – the gaps – in biology, by emphasising how the biologists engage with the natural world during observation. It allowed me to point out that evolutionary biologists should acknowledge the necessity of their temporary participation in the world of their research subjects to collect data. This could be an opportunity for them to reconsider their methodological approaches and engage with the public on a more accessible level.

Second, I introduced the concept of a *multimodal thick description* that borrows its meaning from the ethnographic concept of a thick description. However, I expanded it beyond text and included different modalities as they have become visible throughout my ethnographic project. I am aware of the limitations of publishing raw data in natural scientific journals. Nevertheless, I would like to call for more research in the field of STS and anthropology that reveals the modalities of scientific knowledge production, as in my case study, thereby bridging this gap. In particular, this could be done beyond the role of the visual, thus offering transparency and mediating between the (natural) sciences and the public.

Although I suggest that biology could learn from social anthropological methodology, I conclude by proposing that this learning is reciprocal. As Tsing has suggested, anthropologists could learn the method of *direct observation* from the natural sciences to address the challenges of the Anthropocene.³ Direct observation, as the name implies, directly attends to the non-human world without humans (the biologists in my case study) as the mediators to explain *their* world to other humans. This could be one approach by which to avoid further anthropocentric worldviews in the sciences, given that they seem to be continuously perpetuated in both the *hard* and *soft* sciences. I did not manage to avoid this within the scope of this text; however, I did attempt to address it.

In light of the above, it was my aim to reintroduce the biologists, birds, and research conditions into the scientific discourse. By attending to the autographic data, I aimed to make the human and non-human actors of scientific knowledge production visible and offer a basis for reflection beyond the quantification and technical modelling of data. Rather than *flattening* the results, I have attempted to produce a multimodal thick description of the epistemologies and ontologies that enable scientific knowledge production. By enriching the data with the archival material that caught my attention as a designer, and by using an ethnographic methodology, I have attempted to overcome the gaps in the representation of scientific results by revealing the conditions and relationships that are part of the natural scientific undertaking of knowledge production.

In so doing, I have resituated the biologists as researchers and the Siberian jays not just as research subjects but as living animals within the study. I did this based on the observation that during the steps of *filtering*, the situatedness of the biologists also diminished along with a loss of complexity in the data. The individual biologists were visible

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Tsing, 'When the Things We Study Respond to Each Other', 228.

in the raw data and could be identified as the authors of data. However, as the data were processed into a digital format, the authors increasingly disappeared, moving towards a generic scientific *we*. In addition to this, the data that first occupied physical and tangible spaces in material data carriers such as field notebooks, datasheets, blood and feather samples, and SD cards became more intangible *ex situ* through their transfer and filtration into Excel sheets. Once filtered, data can be shared via email (as Michael often did), multiplied on several hard drives as backups, transported on USB flash drives, and circulated among scientific peers. The scientific results circulate as papers in journals all around the world, becoming increasingly detached from their origin in the boreal forests.

Contextualisation and Outlook

These paradigms of scientifically representing – and thus also producing – worlds, must be reflected on and questioned to meet the challenges of the twenty-first century (climate crisis, mass extinction, and political and global instability), which are accompanied by a detached human–non-human relationship and a mistrust of the sciences. As plant ecologist and citizen of the Potawatomi Nation, Robin Wall Kimmerer,⁴ states:

[S]cientists are one of their [the stories of the natural world] translators and carry a larger responsibility for conveying their stories to the world. And yet scientists mostly convey these stories in a language that excludes readers. Conventions for efficiency and pre-

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As distinguished Teaching Professor and Director of the Center for Native Peoples and the Environment at the State University of New York College of Environmental Science and Forestry, Robin Wall Kimmerer belongs to the thought collective of natural scientists. She is also a member of the Citizen Potawatomi Nation, a Native American people. She thus embodies the thought style, traditional knowledge, and Indigenous cultural practices of the Potawatomi. In this sense, she is a good example of bringing together two different kinds of worldmaking practices, namely scientific ones and spiritual-sensory ones, which reveal different human–nature relationships without pitting them against each other.

cision make reading scientific papers very difficult for the rest of the world and if the truth be known for us [scientists] as well.⁵

Given these urgencies, a shift is demanded in the relationships between the human and natural worlds, and, as Kimmerer states, scientists have the knowledge and ability to mediate these relationships. The technopositivist image of the natural sciences as a discipline that has *control* over nature based on technical manipulations no longer holds. This view must shift to one of the natural sciences having the ability to highlight entanglements, uncertainties, and complexities. It seems more necessary than ever to question the relationship between the human and non-human. However, to arrive at a more democratic relationship between these worlds, the narratives on nature must be conveyed in a more accessible way. This could be achieved through a transversal dialogue across disciplines where design and anthropology function as mediators to facilitate change.

One approach could be to reveal how scientists engage with the natural world prior to the production of facts. Attention to sensory and bodily engagement, implicit knowledge, visual skill, and situated training reveals the aspects that disappear during the research process. I have illustrated how, in the *softness* of evolutionary biology research, a different human–non-human relationship from that which is usually represented in scientific journals becomes visible. This relationship includes the sensory and the spiritual, as well as a responsibility for and fascination with the natural world. Attending to these allows for new narratives of the natural world. To echo Kimmerer: ‘For what good is knowing unless it is coupled with caring?’⁶

Within the scope of this research, I have focused on the practices of knowledge production of *one* case study by examining the overall research process. The next step would be

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Kimmerer, *Braiding Sweetgrass*, 345.

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Ibid.

to conduct similar research with other cases to understand differences and similarities. Indeed, several sub-topics arose throughout my study that I suggest as topics for future research. Having embarked on my research endeavour from a design perspective, I began by focusing on the visual. However, throughout the process, the role of other senses became prominent. One aspect was the auditory alignment between biologists and birds, which I was able to study only to a limited extent within the scope of this project. Studying this aspect further could contribute to rearranging the hierarchy of the senses and re-evaluating other senses beyond the visual when discussing and developing scientific methods. While the auditory modality has recently entered the discourse in the social and cultural sciences, taking the auditory practices of the biologists more seriously could be one approach by which to broaden biological methods and arrive at new insights.

The role of forest management, which appears to be progressing further and shifting every year – affecting the study site and the behaviour of the birds – would be another topic worth investigating. Against the backdrop of the Anthropocene, I find the conflicting interests of the biologists (who aim to protect the natural world they are studying) and those eradicating it for profit, particularly interesting. The conflict is revealing of the research conditions and offers insights into global power relations and the politics underpinning the climate crisis. Given the changes to the study site associated with both forest management and climate change, it would also be important to further investigate how these developments have influenced the research and the questions posed by the biologists.

Within the scope of this project, I was able to reflect on and reveal my own practices as an ethnographer only partly. Nevertheless, I have still attempted to consider these aspects within the short ‘patches’, as I called them. It would be a worthy pursuit to attend more specifically to the sen-

sory and bodily practices of data collection in ethnography, and to my own methods of data collection, developing a more in-depth account of them. Thus, I suggest developing more accounts in STS on the practices of knowledge production in the *soft* sciences.

