

From Affect to Action

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Abstract

Reports from integrative researchers who have followed calls for socio-technical integration emphasize that the potential of interdisciplinary collaboration to inflect the social shaping of technoscience is often constrained by their liminal position. Integrative researchers tend to be positioned as either adversarial outsiders or co-opted insiders. In an attempt to navigate these dynamics, we show that attending to affective disturbances can open up possibilities for productive engagements across disciplinary divides. Drawing on the work of Helen Verran, we analyze “disconcertment” in three sociotechnical integration research studies. We develop a heuristic

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that weaves together *disconcertment*, *affective labor*, and *responsivity* to analyze the role of the body in interdisciplinary collaborations. We draw out how bodies do affective labor when generating responsivity between collaborators in moments of disconcertment. Responsive bodies can function as *sensors*, *sources*, and *processors* of disconcerting experiences of difference. We further show how attending to disconcertment can stimulate methodological choices to recognize, amplify, or minimize the difference between collaborators. Although these choices are context-dependent, each one examined generates responsivity that supports collaborators to readjust the technical in terms of the social. This analysis contributes to science and technology studies scholarship on the role of affect in successes and failures of interdisciplinary collaboration.

Keywords

interdisciplinary collaboration, affect, disconcertment, care, intervention, sociotechnical integration research

Introduction

As science policy and funding in North America and Europe have included calls for integration of the social sciences and humanities in technoscience (Fisher 2019), integrative researchers have come to report on successes and failures of their approaches to collaborative sociotechnical integration (e.g., Aircardi, Reinsborough, and Rose 2017; Doubleday and Viseu 2010; Lee et al. 2019). Fisher et al. (2015) conceptualize this type of collaboration in terms of three characteristics: it works across established sociotechnical divides, including disciplinary distinctions between humanities scholars or social scientists and natural scientists or engineers; it situates the collaborating parties in proximity to one another for mutual learning; it contributes to technoscientific practices by stimulating change in how scientists and engineers engage societal contexts. Failures to put collaborative integration into practice have been attributed to the presence of prescriptive arrangements in which disciplinary boundaries and asymmetries structure interactions between integrative researchers and their technoscientific collaborators (e.g., Rabinow and Bennett 2012; Viseu 2015).

Integrative researchers highlight the “affective costs” (Viseu 2015, 5) of navigating their positionality between the role of a distant critic who is often perceived as an adversarial “naysayer” (Balmer et al. 2015, 18), and

uncritical, submissive service that tends to transform attempts at collaboration into divisions of labor (Hackett and Rhoten 2011). Due to this liminal and precarious position as outsider/insider, most researchers remain silent on the affective disturbances of interdisciplinary collaborations (Balmer et al. 2018). Only a few have pointed at tensions that involve experiences of shame, insecurity, and ambivalence (Jönsson and Rådström 2013; Fitzgerald et al. 2014).

These unhappy affects have received increasing attention in feminist science and technology studies (STS). Feminist thinkers emphasize their transformative potential to evoke changes in thought and action (Ahmed 2010; Murphy 2015). According to Puig de la Bellacasa (2012), anxiety, sorrow, and grief “belong to an out-of-place sense of *inaccurateness*; that something does not match, does not hold together, that something could be different” (p. 212, emphasis in original). In research collaborations, unsettling emotions have been described as “fruitful parts of collaborative processes and as guides to all that we do not know” (Jönsson and Rådström 2013, 140). They are presumed to unsettle stable objects, phenomena, logics, procedures, and conceptions of the good within established paradigms because they crack open spaces for critical reflection on normalized practices.

The transformative potential of affective disturbances has recently been addressed in a proposal for generative critique in interdisciplinary collaborations (Smolka 2020). Drawing on Verran’s work on science education in postcolonial Nigeria, Smolka suggests that paying attention to “disconcertment” (Verran 2001, 5) in sociotechnical integration research (STIR; Fisher 2007) enables integrative researchers to position themselves in-between adversarial armchair critique and co-opted, uncritical service. This in-betweenness allows for the enactment of generative critique, a critique that is capable of “generating possibilities for new futures” (Verran 2001, 5) and opens up alternatives to what is hegemonic. Possibilities for change in thought and action can arise when people come together who engage with the world in different ways. Likewise, collaborators who are usually positioned differently in relation to a research object may be able to remake the object in alternative ways by drawing connections across differences (Hillersdal et al. 2020). In order to spot differences, Verran (2001) recommends attending to disconcertment, a bodily felt disruption that is experienced when our taken-for-granted assumptions are contradicted. Sensitivity to the disconcerting effects of differences can serve as a guide for openings to generative critique.

To examine Smolka's proposal, we ask: how is disconcertment experienced in integration research? Which choices do integrative researchers make in attending to disconcertment? How do disconcerting affects relate to changes in thought and action of integrative researchers and their technoscientific collaborators? In answering these questions, we seek to contribute to STS literature that unpacks the mundane realities of integration research (Doubleday and Viseu 2010; Lee et al. 2019; Prainsack et al. 2010; Shilton 2012; Viseu 2015) and, more broadly, interdisciplinary collaboration (e.g., Balmer, Bulpin, and Molyneux-Hodgson 2016; Callard and Fitzgerald 2015; Centellas, Smardon, and Fifield 2014; Klein and Marghetis 2017; Lyle 2017). We explore the possibility that disconcertment may serve as a resource for engaging collaborative difficulties that stem from solidified disciplinary boundaries, epistemological and cultural differences, and asymmetric funding provisions (Delgado and Åm 2018; Prainsack et al. 2010; Rabinow and Bennett 2012; Viseu 2015).

Furthermore, our efforts to capture the fleeting nature of disconcertment contribute to the "affective turn" (Kerr and Garforth 2015, 3) in STS—a renewed interest in affective entanglements and embodied ways of knowing in science (Collins 2010; Fitzgerald 2013; Myers 2012; Pickersgill 2012) dating back to Max Weber, Ludwig Fleck, and Robert Merton (Barbalet 2002; Parker and Hackett 2014). By characterizing the nature and effects of disconcertment, we seek to advance ongoing discussions on the methodological and analytical relevance of affects in research and interdisciplinary collaboration (Boix Mansilla, Lamont, and Sato 2015; Fitzgerald et al. 2014; Griffin, Bränström-Öhman, and Kalman 2013; Hillersdal et al. 2020; Parker and Hackett 2012).

For this purpose, we analyze disconcertment in three projects in STIR including collaborations with neuroscientists, scientists working on 3D biomanufacturing, and engineers in a nanotechnology laboratory. After briefly presenting the STIR approach and elaborating on disconcertment, we analyze vignettes from our STIR studies by means of a heuristic. The heuristic is a provisional tool that helps us think of disconcertment as a form of responsivity (Myers and Dumit 2011; Rosa 2016). Responsivity emerges among interdisciplinary collaborators who become increasingly sensitive to how researchers from other disciplines think, talk, and behave. Sensing and responding to differences may be disconcerting, but engaging with disconcertment becomes easier with practice, what we refer to as "affective labor" (Myers 2012, 49). Collaborators practice "using their bodies as sensors, sources, and processors" (Poldner, Branzei, and Steyaert 2019, 152) to see relations between differences, which facilitates more reflexive

sociotechnical integration. The examples of dealing with disconcertment through affective labor show different choices in tapping the body as sensor, source, and processor that are not mutually exclusive and can appear in different sequences of interaction with the same collaborators. We illustrate how collaborators learn “to move with and be moved by” (Myers 2012, 177) other bodies in order to enable generative critique in integration research.

STIR

The concept “sociotechnical integration” refers to a phenomenon assumed to commonly take place in technoscientific practice; it denotes “any activity whereby technical experts take into account the societal dimensions of their work as an integral part of that work” (Fisher 2019, 1139). STIR is a collaborative method that aims to both observe and intervene into this phenomenon. The collaborative process embeds a social science or humanities scholar, often from STS, in a technoscientific space to conduct dialogue that supports reflection by illuminating integration in real time. Whether such reflection occurs and leads to practical modulations of the technoscientific workflow thus become empirical questions. These questions are important both for understanding expert capacities to shape technoscience and for informing institutional policies and design.

A typical STIR study is designed as a twelve-week project during which the “embedded” (Fisher and Mahajan 2010, 216) scholar conducts regular exercises with one or more technoscientific collaborators that are guided by a decision protocol (Fisher 2018). The protocol approaches decisions using four conceptual components—opportunity, considerations, alternatives, outcomes—and includes questions meant to unpack socioethical dimensions of technoscientific practices (Fisher 2007). Regular use of the protocol tends to facilitate collaborative inquiry by stimulating socioethical reflection on technoscientific practices. The embedded scholar guides the STIR exercises and uses participant observation in the technoscientific space, desk research, and additional interviews as resources for both observation and engagement.

The empirical material is analyzed through the lens of midstream modulation, a framework that helps capture the unfolding of learning and socio-material change over time (Fisher and Schuurbiens 2013). Midstream modulation relates the gradual alteration of technoscientific processes to scientists’ and engineers’ ongoing reflective interactions with their broader social contexts. Three analytical categories serve to capture this gradual

alteration: “de facto modulation” (socioethical dimensions play an implicit role in technoscientific practices), “reflexive modulation” (heightened awareness of de facto modulation in real time), and “deliberate modulation” (changes in practice in response to reflexive modulation). Midstream modulation may pass sequentially from de facto, over reflexive, to deliberate modulation in a few moments or over the course of an entire STIR study (p. 100).

Published STIR studies have not extensively discussed the role of affect in collaborative sociotechnical integration (see Conley [2014] for an exception). Embedded scholars are supposed to be alert to their collaborators’ feelings (Fisher 2018), but their own implication in the affective fabric of socioethical reflection, technoscientific practice, and collaborative actions has remained underexposed. In our STIR studies, a focus on affect was not a premise of doing research. However, we took “side notes” on our affects and the manifestations of affects we observed among and in interactions with our collaborators. These “side notes” and other empirical material fed into writing and analyzing vignettes that illustrate how attending to affect, more specifically disconcertment, informed collaborative actions and deliberate modulations in our STIR studies.

Disconcertment

Postcolonial STS scholar Verran (2001) describes moments of disconcertment as fairly common but often overlooked “fleeting experience[s]” (p. 5) that grow from “seeing certainty disrupted” (Verran 1999, 141) and that may open avenues for thinking and doing things differently. Verran says that certainty is disrupted when different metaphysics or epistemologies meet. This can occur in the encounter of different knowledge traditions, such as Nigerian versus English practices of counting (Verran 1999), the Western assumption of a single, ordered cosmos versus the acosmotic view of a totality of things without order in classical Chinese philosophy (Law and Lin 2011), and an anthropological, relational understanding of pain versus pain as a result of biological processes in the biomedical sciences (Hillersdal et al. 2020).

Detecting metaphysical or epistemological difference helps recognize what has so far been taken for granted; it also facilitates seeing and creating connections. This is what Verran (2011) describes as “doing difference together” (p. 422) and what Hillersdal et al. (2020) have taken up to facilitate collaboration between scholars and scientists from different disciplines who study the same research object. In meetings between anthropologists

and clinical researchers who collaborated in studying muscle soreness, staying with disconcertment in exchanges helped apprehend a shared problem and induced collaborators to explore the connections between the elements that formed their object together. By addressing connections between differences, Hillersdal et al. enacted a “generative critique” (Verran 2001, 21). Informed by Verran’s concerns about postcolonial politics, they explored “how a problem may be examined in ways that destabilize politically strategic agendas, expertise, and evidence hierarchies” (p. 13). For this purpose, paying attention to disconcertment facilitated interdisciplinary “knowledge production inherent in the concrete processes of doing connections between disciplines, people and problems” (p. 13).

Several scholars have made use of disconcertment as a bodily indicator for epistemological and metaphysical differences (Christie and Verran 2013; Jerak-Zuiderent 2013; Law and Lin 2011). Descriptions of how disconcertment feels and what indicates disconcertment in others vary. Some scholars who try to identify disconcertment in their interviewees pay attention to laughter (Jerak-Zuiderent 2013), others claim that “there wasn’t much belly laughter . . . but there was certainly disconcertment” (Law and Lin 2011, 141). Christie and Verran (2013) take on the challenge to specify disconcertment in a special edition including nine “ethnographic stories of disconcertment.” The editors invited contributors to write stories because “stories have a special ability to clarify . . . psychological and emotional states, their aesthetics and their entrenchedness as well as their searching for the new and the different” (p. 2). As emotions are notoriously difficult to record and classify, the contributors use storytelling as a creative way to give readers an impression of how disconcertment was experienced and what it can do.

Inspired by Christie and Verran’s special edition, our research aims to capture empirically the experiences and bodily manifestations of disconcertment. Similar to colleagues who have written on disconcertment, we use the terms “affects,” “emotions,” and “feelings” interchangeably in relation to disconcertment while emphasizing its embodied nature—“a sort of visceral laughter,” a “chuckling” that afflicts bodies when different knowledge systems collide (Verran 1999, 140). Following Verran and philosophers of emotions such as Colombetti (2014), we consider emotions, in particular disconcertment, as experiences with bodily symptoms. Emotions affect bodies in different ways and the affective quality of the experienced world changes accordingly (p. 123). Comparing and contrasting individual differences in bodily expressions of disconcertment with the intent of identifying patterns or recurrent variations would be a psychological project (cf. Tsai

et al. 2002) that exceeds the scope of our analysis. Instead, we describe how disconcertment manifested itself in our bodies and draw out how it gave rise to particular interactions with our collaborators. Building on the work by Hillersdal et al. (2020), we elucidate how disconcertment relates to action in interdisciplinary collaborations and how it can enrich data, analysis, and research in these collaborations. For this purpose, we develop a heuristic that serves as a provisional tool for thinking about disconcertment. It is a plausible, contingent construction of how disconcertment relates to action.

Heuristic of Disconcertment

Our analysis of disconcertment approaches it as a potential form of *responsivity*. Responsivity characterizes a particular embodied relationship that can show up in collaborations. In order for disconcertment to take such a productive form of responsivity, however, collaborators must perform the work of attention, sensitivity, and cultivation—in other words, they must perform *affective labor*. If collaborators do affective labor, their bodies can function as *sensors*, *sources*, and *processors* that can in turn facilitate responsive collaborations across disciplinary divides.

Myers and Dumit (2011) introduce *responsivity* as one among several concepts that have entered STS debates about agency distributed across bodies and materialities, such as “intra-action” (Barad 2007, 141), “ontological choreography” (Thompson 2005), and the “dance of agency” (Pickering 2012). They argue that responsivity speaks best to the affective quality of relations between bodies. This understanding of responsivity has been further developed in sociology. Rosa (2016) coins the term “resonance” to describe a meaningful relationship across people and other aspects of the world. He believes that humans seek and need resonance that connects people to other people, to their work, cherished objects, or nature. For Rosa (2018), resonance depends on responsivity: “we feel truly touched or moved by someone or something we encounter” and “we reach out and touch the other side as well” (Schiermer and Rosa 2017, 3). This process is transformative. It constitutes the person who is reaching out while constituting the world as the person encounters it. Responsivity and transformation result in a resonant two-way relationship. Resonance is the “transformative appropriation of difference” (Rosa 2018). It resembles Ver-ran’s idea of finding ways in which different systems can “‘go on together’ that are respectful of differences between them” (Singleton 2012, 424). This presupposes responsivity—the ability “to move with and be moved by”

other bodies (Myers 2012, 177). According to Myers, fostering the ability to engage in this double movement requires “affective labor” (p. 49).

Myers borrows the concept of *affective labor* from political theory (Hardt 1999) and from feminist literature on “care work” (Federici 2012, 368) and “emotion work” (Hochschild 1979). While the former often describes invisible labor that women have been doing for millennia in domestic spaces, the latter refers to low-waged workers such as stewardesses, waitresses, and nurses whose work practices include regulating their emotional expressions. Studies on (post)colonialism and capitalist production shed light on coerced forms of care and emotion work performed by the poor, immigrant, or racialized women for privileged others (Glenn 2012; Wilson 2004). The often-gendered practice of “caring for” somebody that can be coerced or paid for must be distinguished from the affective relation of “caring about” that depends on love and passion (Puig de la Bellacasa 2017; Schrader 2015). Combining the practical and the affective dimension of care is essential for Myers’ conceptualization of affective labor. She shows that caring about molecules with affective, bodily attachment induces biologists to make enormous efforts to care for their instruments, experiments, and objects. Their affective labor gives them access to new forms of molecular life “that are perhaps less readily captured by capital” (Myers 2012, 51). Similarly, affective labor enables interdisciplinary collaborators to recognize alternative forms of taken-for-granted hegemonic objects by becoming responsive to one another.

To further specify how disconcertment can be approached as a form of responsivity, we suggest that responsive bodies can function as sensors, sources, and processors. Poldner, Branzei, and Steyaert (2019) studied these functions of bodies in constructing entrepreneurial selves over time. They introduce a tripartite framework to analyze embodied ethics. The *body as a sensor* helps detect ethical issues. Ethical issues are selected and refined by the *body as a source* through which an “assemblage of ethical fragments” (Poldner, Branzei, and Steyaert 2019, 162) is created. The body as a source defines the different fragments of ethical issues and puts them together as a bricolage in order both to make sense of their relations and to turn them into an assemblage, that is, an organized aggregate whose components can be addressed individually. With the body as a source, the fashion entrepreneurs in the study by Poldner, Branzei, and Steyaert “are not dealing with ethical issues as big issues, but they are dealing with very specific things that they pin down and use in their collections” (p. 165). The *body as a processor* puts these “very specific things,” the “ethical fragments,” together in a new way, and ends up transforming an entrepreneurial self. We draw on the

framework by Poldner, Branzei, and Steyaert to analyze how disconcerted bodies do affective labor in order to generate responsivity and facilitate interdisciplinary collaboration in our STIR studies.

Analysis of STIR Vignettes

Trying to grasp affect analytically runs the risk of reducing what is sensed and felt to empty shells. The wording of our analytical categories thus sits uncomfortably with our attention to the body and its affects. “Sensors” and “processors” remind of automatons instead of flesh. Nevertheless, we hope to provide readers with a sense of the affective situations we experienced without engaging in navel-gazing and self-indulgence. For this purpose, we present our experiences in the form of vignettes that alternate with analytical sections. We do not treat these short literary sketches as “raw data” to make sense of but as stories that are carefully crafted to illustrate how we see our STIR studies retrospectively through analytical lenses.

Theoretical distanciation made us realize how disconcertment shaped our individual STIR studies. Different reactions to moments of disconcertment illustrate different modes of becoming sensitive to the body as source, sensor, and processor. Whereas Smolka endorsed disconcertment and amplified difference, Hausstein’s example shows that she made efforts to reduce disconcertment by minimizing differences to establish the grounds for a responsive collaboration. A snapshot from Fisher’s STIR study illustrates vividly how responsivity feels in and between bodies when collaborators recognize difference and acknowledge that their collaboration entails an encounter of diverging normativities.

Amplifying Difference in Neuroscientific Clinical Research

Smolka conducted her STIR study at the biomedical research institute Cyceron located in Caen, France. The institute hosts the Silver Santé study, a European project funded by the European Commission Horizon 2020 program from 2016 to 2020 that investigates the impact of meditation on healthy aging. One part of the project is a randomized controlled clinical trial that compares the effects of meditation with those of learning the English language over a period of eighteen months in a group of 137 healthy elderly participants. From September until December 2018, Smolka joined the Silver Santé team as an embedded scholar. Being embedded allowed for participant observation and conversations with study team members. STIR

exercises were organized on a biweekly basis with two PhD students in the neurosciences, an English and a meditation instructor.

Disconcertment turned out to be a pertinent feature of doing STIR and a resource for sociotechnical integration with regard to a particular measurement task that relates to one of the Silver Santé study's focal points: investigating the effects of meditation training on emotions. To study how meditation in comparison to learning English influences emotional responses to the suffering of others, participants undergo a functional brain imaging task that involves silent video clips with either low or high emotional content of suffering. Smolka describes her experience of assisting the video task for the first time as a moment of disconcertment:

I joined a PhD student and a radiologist who administer the task in a room next door to the brain scanner in which the participant was lying. Three computer screens were blinking; two showed a range of images of the participants' brain and the other allowed us to follow the videos that were projected to the participant. After the PhD student had launched the task, I watched the videos attentively and realized that the furrow on my forehead was becoming steeper the longer I kept on watching. The videos that seemed to have high emotional content portrayed people with disabilities, dark-skinned toddlers who were malnourished, women with headscarves crying in the ruins of a city, and similar scenes filmed in African and Arab countries. I gained the impression that suffering was equated with the experience of disability and life in the Global South. As this portrayal of suffering made me feel unsettled, I bluntly pronounced my observation. The PhD student explained that these videos were selected from news and documentary material broadcasted during peak viewing hours. Moreover, the video task had been approved by an ethics committee, and it had been used in several other studies. Finally and most importantly, the majority of participants did not make any special remarks about the task.

This scene repeated itself several times whenever Smolka assisted the video task over the course of her STIR study. PhD students stressed that the most important ethical aspect of their work was "taking care of participants," making sure that they felt "accompanied" and "at ease." As scientists often have multiple demands placed upon them, they commonly ensure that the norms and standards of their laboratory are followed (including care for participants) before reflecting upon every possible ethical aspect of their work (cf. Brosnan et al. 2013). Acting in accordance with their professional responsibilities toward study participants, the ethical aspects that the PhD

student prioritized differed from what unsettled Smolka. Her disconcerted body led Smolka to recognize *de facto* modulation in how researchers engaged in socioethical aspects of their work. Smolka made this observation because she repeatedly confronted her collaborators with her unsettlement about the video task. By amplifying disconcerted situations and interactions, she managed to use her body as a sensor to detect different disciplinary responsibilities in the neurosciences and social sciences.

Sensing difference induced Smolka to continue inquiring into the video task by bringing it up in STIR exercises and conversations with Silver Santé team members. Her disconcerted body served as a source to continue discussing the task, patch different issues together, and reflect on how these could be addressed. A recurring theme in these discussions was bias, which generally denotes a disproportionate weight in favor or against one thing, person, or group compared with another. It is a major concern for researchers because it impedes them from measuring what they intend to measure. When Smolka raised the narrow representation of suffering as disability and life in the Global South in conversations with neuroscientists from the Silver Santé team, they acknowledged it could be a form of bias. They explained that a bias in the archived news and documentary material from which the video clips were selected could be considered as a bias in the task. They further suggested that including additional video clips in the task that showed suffering in other contexts and degrees could counterbalance this bias.

This episode beginning with Smolka's confrontation and leading to an ongoing discussion of biases elicited a reflexive modulation: reflections on the presence of biases and how these could be counterbalanced. In the collaborative process, what was initially experienced bodily as an ethical concern was eventually transformed into an epistemological question and problem-solving quest. This modulation, however, induced in Smolka a new experience of disconcertment:

I experienced apprehension because the socio-ethical aspects of technological practice that I had intended to investigate seemed to dissolve into epistemological questions about how to design a study task. I was worried that this shift was moving my research participants away from the topical focus on ethics practices that was supposed to guide my research.

Only after the STIR study had ended, Smolka could process her experience. Reexamining the transcripts of the final STIR exercises she had conducted with the PhD students, she noticed that both of them referred to a

socioethical aspect of their work that they had not mentioned at the beginning of the regular STIR exercises. They said that *ethics were in their data*. If potential biases are not made explicit, “what we do here serves nothing,” a PhD student said. Another PhD student summarized this as follows: “If we are conscious of the limits of our reference frames and of our methods, our results can contribute a stone to the building.” Therefore, he emphasized that it was necessary to continuously ask: “Is this the best way to proceed? Are there other ways to do this? You see, for me, this is an ethical discussion.” Neuroscientists emphasized that finding answers to these questions would be particularly relevant as soon as they started with the data analysis: “these are complex data, but an analysis with precaution can nevertheless produce nice results.”

While rereading these transcripts, Smolka’s body functioned as a processor and put different fragments—her ethical concern and the scientists’ epistemological concern—together in a new way:

Reading the transcripts of these conversations made me burst into liberating laughter. I realized that our collaboration on identifying biases has enhanced sociotechnical integration all along because it has contributed to taking into account the ethical dimensions of scientists’ work as an integral part of their work.

Throughout and after her STIR study, Smolka’s body served as a sensor, source, and processor, which allowed her to acknowledge a *de facto* modulation (ethics only relate to the treatment of study participants), a reflexive modulation (ethics are also in the data and relate to recognizing potential biases), and a deliberate modulation (potential biases will be taken into account in the data analysis). This modulation sequence could be captured because Smolka chose to amplify her disconcerting experience of difference. If she had chosen to suppress or ignore her disconcertment, Smolka and her collaborators would likely not have made connections between the video task as an ethical and as an epistemological object. Their collaboration would have been less revealing, and its dynamics would have been less responsive.

The amplification of difference resulted in responsivity. According to Rosa, only something that is “utterly *different* can actually speak to us in its own voice” (Schiermer and Rosa 2017, 4). Responsivity depends on hearing someone else’s voice and discerning one’s own voice. For this purpose, it helps to actively heighten differences, here, the difference between perceptions of what counts as relevant ethical aspects of scientific study design.

Smolka's sense of difference informed her choice to repeatedly confront her collaborators with her concerns about the video task, which, in turn, fueled her and her collaborators' sense of difference. The amplification of difference stands in a dialectical relationship with responsivity. Smolka and her collaborators became mutually responsive to one another over the course of their ongoing and evolving interactions and discussions, which Smolka recognized later as sociotechnical integration.

Minimizing Difference in Engineering Sciences

Responsivity presupposes difference, but if there is constant opposition or contradiction, responsivity is impossible. To establish a condition between consonance and dissonance that allows for responsivity (Rosa 2018), Hausstein made continuous efforts to minimize the difference between her and her collaborators. Juxtaposing Hausstein's STIR study as one that tried to minimize difference with Smolka's STIR study characterized by an amplification of difference underlines that there are multiple ways to deal with disconcertment in collaboration. Thinking about the body as sensor, source, and processor facilitates grasping these multiple relations between affects and collaborative actions.

Hausstein's study was part of a larger publicly funded collaborative project that aims at developing new technologies for scalable 3D additive manufacturing at the molecular scale while paying attention to both scientific excellence and societal relevance. Between January and March 2019, Hausstein conducted STIR exercises weekly with a PhD student in physics, every two weeks with a postdoctoral bioengineer, and monthly with a PhD material scientist.

At the beginning of the STIR study, the mutual lack of the other's disciplinary knowledge contributed to disconcertment among collaborators. Hausstein's body served as a sensor for her own and her collaborators' feelings of disconcertment:

I was not sure about the legitimacy of my agenda of sociotechnical integration (would it work at all?). I could sense that my agenda was putting them on a spot in an area they felt unfamiliar with and uncomfortable. My feeling was that this could be overly pharisaic, stealing their precious time. What would possibly justify my intention to collaborate if on their side this collaboration was upon request, causing discomfort because they had to move their consideration to fields that they felt unfamiliar with and not personally responsible for, and having to detect and admit conceptual blind spots? And how

about my own blind spots and lack of knowledge on my side? Would I have the capacity to understand only parts of their research, even the fundamental research question they were trying to explain again and again?

Hausstein's disconcertment does not only indicate an epistemological difference—apprehending blind spots in the other's area of disciplinary expertise—but it also points at an ethical difference. Whereas Hausstein, according to her social science background, expected reflections on societal and ethical implications of future applications of research, her collaborators stated that they did not feel directly and personally responsible for any such implications. Performing familiar patterns of boundary work (Calvert 2006), more than once researchers emphasized that they were doing basic research and were not directly concerned with applications of the technology that could result from their research. The detection of difference led to the recognition of a *de facto* modulation pattern: social dimensions of research did not extend beyond the scientific community.

Instead of amplifying difference, for instance, by repeatedly asking about the broader societal effects of her collaborators' research, Hausstein decided to limit questions on outcomes and to accept the fact that, for her collaborators, in their current situation, the "social" was not within the scope of their expertise. Nevertheless, her body as a source probed difference:

Although I did not insist on asking who might care what they chose to do in their work over and over, being content with seeing the realm of effects ending at the boundaries of their scientific community, it was that just by being a social scientist coming to meet them I was raising expectations. Their perception of my role and my pure presence would cause disturbance, question their system of orientation and normality. And it would also question my own system.

Hausstein's physical presence as a social scientist in a technoscientific space was generative of reflexive modulations. It created a heightened sense of awareness among collaborators regarding their perceptions of normality, normativity, and systems of orientation. Moreover, Hausstein's presence stimulated debates about the scope and limit of personal responsibility for research applications, a topic that had not been on her collaborators' agenda before.

The unsettling experience of questioning what had so far been taken for granted induced Hausstein to use her body as a processor of difference:

In order to deal with this divergence and to create feelings of nearness, I was trying to overcome perceptions of difference by “othering myself.” Being empathic with my collaborators’ concerns and attentively sensing their unease as well as mine led me to alter my body, movements, and gestures: lowering a pronounced different habitus and status (clothes, appearance, movement in space, way of speaking, use of jargon), reducing the use of media (paper, pen, notebook, cell phone), finding different ways to secure data, listening and rephrasing what has been explained, insisting on understanding what has been explained, trying to help find solutions instead of judging, challenging, or confronting. I realized that my actions were received with certain thoughts, intentions, and emotions in the perception of my collaborators, of which some were not intended by me. This partly unsettled me and, following my disconcertment, I tried to adapt to THEIR concerns and to partly reposition mine, in order to establish a level of interaction where modulations would be possible.

The body as a processor transformed Hausstein over the course of her STIR study. She was *moved by* her and her collaborators’ disconcertment, which made her alter her ingrained social scientist habitus to *move with* her collaborators. She engaged in affective labor to be responsive to their concerns. This affective labor was reciprocated by the researchers.

I could see that the reason for the researchers’ disconcertment was mainly the unspoken doubt “what this is all good for” and an uncertain sense of their capacity to understand my research interest in order to be able to contribute to my research goals in a meaningful way according to their competences. Often they asked me if their answers were “correct” or if they should reply otherwise. Over the course of the study and weeks of familiarizing with each other, the ground for trust, mutual learning, and valuing the expertise of the other was opening up.

Hausstein and the researchers involved in her STIR study changed their behavior to respond to one another. Hausstein prioritized the researchers’ concerns over her own and the researchers made efforts to contribute meaningfully to Hausstein’s research goals. Affective labor generated responsiveness, which made a reflexive modulation (recognizing that normality and normativity depend on disciplinary systems of orientation) pass to a deliberate modulation (reciprocity across disciplinary divides). Without alertness to disconcertment, researchers’ initial resistance to social science questions, methods, and habitus may have remained a hidden obstacle to responsive interactions and their generative outcomes. For Hausstein, minimizing the

difference by using her body as a processor was crucial for developing responsivity. Responsivity made it possible to move together in a collaborative project in which initial mutual intimidations vanished, trust was established, and connections between people from different disciplines could flourish.

Recognizing Difference in Nanotechnology Engineering

Responsivity also contributed to opening up the possibility for Fisher's STIR study in the Thermal and Nanotechnology Laboratory (TNL) in the department of mechanical engineering at the University of Colorado in Boulder. The study (Fisher 2007) started in spring 2006 after Fisher had conducted participant observation, interviews, and archival research on TNL's activities for three years (Fisher and Mahajan 2010). Shortly before, Fisher formally presented his research design and study rationale to the TNL research group. Fisher's vivid memory of this event provides a sense of what disconcertment feels like in the body and when detecting it in other bodies. Moreover, it depicts how affective labor on one's own bodily responses to a moment of disconcertment can sharpen sensitivity toward the affects experienced by other bodies and enable responsivity.

As I told my laboratory hosts, peers, research participants, and collaborators, the decision protocol exercises were designed to specify how social and technical considerations interact in research activities by mapping the components of research decisions in real time. They had heard me using phrases such as sociotechnical integration and midstream modulation, but now I had developed these into what I thought were coherent conceptual frameworks for conducting empirical research. I fielded one question after another, confidently expounding on my research design and demonstrating that, so far at least, no one in the lab was able to point out a major flaw or unwarranted assumption—a cultural practice in the lab that I had grown used to and that usually indicated that an idea was not yet ready for testing.

And then it happened. A senior researcher asked how I could be sure the experiment I was envisioning really would reveal possibilities for midstream modulation as opposed to “midstream manipulation” as he put it. For a moment, I stopped breathing, narrowed my eyes, and felt my neck tense up in response to what I took as an unfair and uninformed challenge. In an instant, as I rapidly scanned the variety of reasons I could offer as proof that what I had designed was not likely to “manipulate” my research participants (some of whom might very well be drawn from members of the audience),

and as I readied myself for a defense of my method, I noticed the lingering grin on the questioner's face and what appeared to mischief in his smile. This led me to pause and take a breath, which in turn allowed me to start sensing my environment, taking it in visually and auditorily. I suddenly realized there was playfulness in the challenge and that some engineers in the room were suppressing laughter. I somehow felt that to defend my design would have ignored their need to find humor in the situation, placing my insecurities over theirs. I smiled back and relaxed my body, signaling that I was not going to mount a defense, and simultaneously confident that there were no substantive critiques of my proposed research design. The room erupted with laughter, and I joined in the comic relief. As the room became quiet again and the smiles melted back into readiness to hear my answer, it was clear that the question had served a dual purpose: to express the lab researchers' own collective apprehension of me as "other" (after all, I was proposing to engage with the societal aspects of their practices, which they clearly felt some ambivalence about) and to test my ability to withstand their credibility test. In a moment I sensed that we were afraid of each other, and I believe that my willingness to sense and acknowledge their expression of this (even at my own expense) signaled to them that I would treat future moments of disconcertment with the same empathetic stance, even as I stood by the integrity of my research.

In this snapshot, Fisher's bodily experience of disconcertment tensed up his eyes, shoulders, and lungs. His body as sensor displeasingly experienced a difference that he at first thought emerged from what counted as "good research" in engineering versus the norms, standards, methods, and knowledge recognized in the humanities and social sciences. However, instead of addressing, probing, or even confronting this difference, Fisher used his body to process the difference by breathing and relaxing. He realized that the engineers were just as insecure as he himself because neither of them knew what it would entail in practice to engage in STIR. Fisher sensed the affective state of the engineers and let it affect his own state: their laughter moved his body to laugh, too, as much at himself (having reflexively recognized his own defensiveness) as with them. Fisher's laughter signaled his recognition, acknowledgment, and appreciation of the authentic expression of the engineers' disconcertment and that mutual understanding despite differences could be possible.

At the end of the vignette, Fisher remembers feeling confident that he would be able to approach future moments of disconcertment in a similarly empathetic manner. His confidence indicates that responsiveness can be

cultivated so that feeling and responding to other bodies becomes a collaborative practice. This practice can in turn open up sociotechnical integration to a greater variety of considerations through reflection and deliberation.

Elsewhere, Fisher documents modulations that took place in the STIR study that ensued (e.g., Fisher 2007; Fisher and Mahajan 2010). Changes in thought and action included a heightened awareness of environmental and societal aspects of carbon nanotube synthesis (reflexive modulation), which led to the usage of a more environmentally benign catalyst (deliberate modulation). Fisher's collaborators came to see and approach the more familiar technical in terms of the initially disorienting social. One collaborator acknowledged that his project on carbon nanotube synthesis "could have been a whole different thing" (Fisher 2007, 163) had he not continuously opened his decision-making processes to engagement.

Fisher's capacity to become responsive in moments of disconcertment contributed to these collaborative outcomes. If he had insisted on the validity of his method and on his social science expertise when engineers challenged his credibility, failing to recognize the affective source of their resistance, he would have come across as an adversarial critic, too far removed from the issues at hand. On the other hand, if he had simply remained compliant and not dared to speak up, refraining from asking, at times, critical questions in interaction with engineers, he would have deviated from the decision protocol and missed opportunities to productively disrupt the practices he was observing. As responsivity, especially if nourished by sustained affective labor, helps circumvent the pitfalls of armchair critique and uncritical subordination, it becomes an opener for alternative forms of sociotechnical integration.

Conclusion

In excerpts from the three individual STIR studies considered above, we analyze our own and our collaborators' experiences of disconcertment, showing how these informed methodological choices, which in turn contributed to collaborative action and interdisciplinary outcomes. We show how our own experiences of disconcertment were neither extraneous nor distracting phenomena but rather played central roles in our attempts at collaborative sociotechnical integration. While our comparative account here emphasizes similarity in both the nature and origin of our disconcerting experiences, our choices in response to these experiences differed considerably. Smolka chose to *amplify* difference through repeatedly confronting

her collaborators, Hausstein chose to *minimize* difference through incrementally reconsidering her own habitus in relation to that of her collaborators, and Fisher chose to *recognize* difference through symbolically acknowledging his otherness. A fuller account of the social, cultural, historical, geographical, and political contexts behind these choices and how they fit into the larger context of each study—for instance, with regard to gender and age (cf. Conley 2014)—is beyond the scope of the current investigation. Rather, we emphasize here that these choices were made within a methodological frame of interdisciplinary collaboration. In each case, our choices resulted in responsivity and generated alternative possibilities for sociotechnical integration.

Describing and analyzing our intimate experiences of disconcertment helps illuminate the role of affect in integration research and interdisciplinary collaboration in at least four ways. First, it allows us to respond to recent calls in STS for having a closer look at our own research practices to scrutinize how we generate and configure our data (Lippert and Douglas-Jones 2019). We have displayed scenes of what integrative researchers actually do in technoscientific spaces to foreground how embodied, affective experiences shaped collaborative processes and outcomes. Tracing how each of us experienced and, thus, enacted STIR in different ways reveals some of the subtle yet consequential choices that polished presentations of methods in articles and textbooks do not account for. While our analysis highlights how affects factor into the collaborative generation of STIR data, future studies could further unpack the STIR method by shedding light on ambivalences and troubles in applying its analytical categories to collaborative practices (cf. Lippert and Mewes 2019).

Second, we contribute to recent discussions on the analytical relevance of studying affect in STS research (e.g., Balmer, Bulpin, and Molyneux-Hodgson 2016; Smolka, Janssen, and Ghergu 2020; Steinert and Roeser 2020). We combine theoretical insights from postcolonial studies, feminist epistemology, organizational studies, sociology, and STS to develop a heuristic that provides resources for analyzing disconcertment. The heuristic's value resides largely in that it allows us to interpret our empirical observations to illustrate how the body plays an important role in collaborative interdisciplinary research choices, interactions, and developments. While the heuristic applies to and is descriptive of each of the cases presented here, it does not prescribe what choices embedded scholars or other integrative researchers should make. Rather, it serves to analytically present different modes of dealing with disconcertment in interdisciplinary collaboration. These modes do not constitute a monolithic strategy for long-term repeated

interactions, but refer to possible ways of handling difference through affective labor.

Third, affective labor, disconcertment, and responsivity emerge as important yet understudied aspects of interdisciplinarity that may prove informative in understanding stories of both success and failure in attempts at collaborative sociotechnical integration. Failures in interdisciplinary collaborations have been attributed to traditional knowledge hierarchies, prescriptive arrangements, and deep-seated power imbalances, which position integrative researchers as either critical outsiders or co-opted insiders (e.g., Rabinow and Bennett 2012). These dynamics can make it challenging to notice and address epistemological, methodological, ethical, and other differences between collaborators. Here, we have explored the effects of observing and engaging with the affective substrates that can underlie these differences. In doing so, we have shown that moments of disconcertment can be approached as “values levers” (Shilton 2012) that enable the opening of technical practices and workflows to more diverse considerations and to alternative responses. Instead of allowing these moments to go unnoticed, embedded scholars can view them as collaborative resources for opening new conversations that are sensitive to different value systems and wider social values.

We further emphasize that mobilizing disconcertment as a collaborative resource requires bodies to do affective labor. Affective labor helps integrative researchers to navigate their liminal position by establishing responsive relationships with their collaborators. In doing affective labor, the body can detect, probe, and process disconcerting moments in which hegemonic ways of doing research become destabilized. The body plays an essential role in creating a responsive relation among collaborators that is neither overly distant nor co-opted. Responsivity opens up a space between these two poles where research objects, disciplinary boundaries, and conceptions of “good” research can be remade in the encounter of different disciplinary cultures. To develop bodily skills that foster responsivity, we suggest that integrative researchers could draw on practices developed in joint projects by movement practitioners, anthropologists, and artists (e.g., Andersen and Høbye 2019; Vermeulen and Scholtes 2020). These practices might help further sensitize and calibrate the body as an instrument for STIR.

Finally, we follow Myers (2012) in suggesting that affective labor has the potential to unsettle dominant ways of seeing and approaching the world. This potential lies in the combination of affective labor as “caring for” and “caring about” the openness of our collaborators’ research practices to more diverse forms of inquiry. This type of voluntary care work is a

condition for generative critique and it proceeds through open-ended inquiry. It differs from the type of enforced care for outreach and educational activities that maintain the status quo and that integrative researchers are frequently charged with (Viseu 2015). Affective labor involves simultaneously caring about the socially robust emergence of technoscientific trajectories as well as responsive forms of interdisciplinary collaboration, which cannot be enforced or scripted in advance.

Our STIR studies indicate that the potential of affective labor and responsiveness to generate behavioral change, that is, deliberate modulation, should not be underestimated. Affect-oriented integration research is not only a symbol of evolving efforts to institutionalize the social shaping of technoscience; it also has concrete effects on cultural and material practices—practices that may otherwise reproduce traditional, prescriptive arrangements in interdisciplinary collaborations and technoscience. In choosing to engage with the disconcerting aspects of our collaborations, we hope to point to the resources for generative critique that come with this challenging terrain.

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