Science & Technology Studies

2/2023

Science & Technology Studies

ISSN 2243-4690

Co-ordinating editor

Antti Silvast (Technical University of Denmark, Denmark)

Editors

Saheli Datta Burton (University College London, UK)
Ana Delgado (University of Oslo, Norway)Kathrin Eitel (Zurich University, Switzerland)
Karen Kastenhoffer (Austrian Academy of Sciences, Austria)
Ingmar Lippert (IT University of Copenhagen, Brandenburg University of Technology, Denmark/Germany)
Alexandre Mallard (Centre de Sociologie de l'Innovation, France)
Martina Merz (Alpen-Adria-Universität Klagenfurt, Austria)
Jörg Niewöhner (Humboldt-Universität zu Berlin, Germany)
Vincenzo Pavone (Spanish National Research Council, Spain)
Salla Sariola (University of Helsinki, Finland)
Alexandra Supper (Maastricht University, Netherlands)
Estrid Sørensen (Ruhr-Universität Bochum, Germany)
Mikko J. Virtanen (University of Helsinki, Finland)

Assistant editor

Heta Tarkkala (University of Helsinki, Finland)

Editorial board

Nik Brown (University of York, UK)
Miquel Domenech (Universitat Autonoma de Barcelona, Spain)
Aant Elzinga (University of Gothenburg, Sweden)
Steve Fuller (University of Warwick, UK)
Marja Häyrinen-Alastalo (University of Helsinki, Finland)
Merle Jacob (Lund University, Sweden)
Jaime Jiménez (Universidad Nacional Autonoma de Mexico)
Julie Thompson Klein (Wayne State University, USA)
Tarja Knuuttila (University of South Carolina, USA)
Shantha Liyange (University of Technology Sydney, Australia)
Roy MacLeod (University of Sydney, Australia)
Reijo Miettinen (University of Helsinki, Finland)
Mika Nieminen (VTT Technical Research Centre of Finland, Finland)
Ismael Rafols (Ingenio (CSIC-UPV), Universitat Politècnica de València, Spain)
Arie Rip (University of Twente, The Netherlands)
Nils Roll-Hansen (University of Oslo, Norway)
Czarina Saloma-Akpedonu (Ateneo de Manila University, Philippines)
Londa Schiebinger (Stanford University, USA)
Matti Sintonen (University of Helsinki, Finland)
Fred Stewart (Westminster University, United Kingdom)
Juha Tuunainen (University of Oulu, Finland)
Dominique Vinck (University of Lausanne, Switzerland)
Robin Williams (University of Edinburgh, UK)
Teun Zuiderent-Jerak (Linköping University, Sweden)

Open access & copyright information

The journal is Open Access, and is freely available anywhere in the world. The journal does not charge Author Processing Charges (APCs), meaning that the journal is free to publish at every stage. The further use of the articles published in Science & Technology Studies is governed by the Creative Commons Attribution 4.0 International License (CC BY 4.0), which further supports free dissemination of knowledge (see: https://creativecommons.org/licenses/by/4.0/). The copyright of articles remains with the authors but the license permits other users to read, download, copy, distribute, print, search, or link to the full texts of the published articles. Using and sharing the content is permitted as long as original materials are appropriately credited.

Science & Technology Studies

Volume 36, Issue 2, 2023

Editorial

Articles

Book reviews

Visit our web-site at

www.sciencetechnologystudies.org

Editorial

Antti Silvast
Technical University of Denmark, Denmark/ aedsi@dtu.dk

Dear Colleagues

Welcome to the second issue of *Science & Technology Studies* in 2023.

Late last year, the *Science & Technology Studies* journal issued an open call for new editors. This call created a large interest, receiving 16 applications that met the criteria in the advertisement. Interviews were held and the editorial team made a proposition of five candidates. These appointments to the editorial team were agreed between the Finnish Association for Science and Technology Studies and the EASST Council.

Please join me in giving a warm welcome to our new editors, who are:

- Ana Delgado, University of Oslo, Norway
- Kathrin Eitel, University of Zurich, Switzerland
- Karen Kastenhofer, Austrian Academy of Sciences, Austria
- Ingmar Lippert, Goethe University Frankfurt, Germany
- Mikko J. Virtanen, University of Helsinki, Finland

We are very happy to be joined by these highly competent scholars from different STS hubs in Europe and look forward to working closely with you in the following years.

With the new editors and the journal filling 35 years this year, the editorial team is in the process of introducing new developments. We have divided our work into four topic areas:

1. Collaboration and outreach with other STS networks and journals.
2. Development of potential new formats for papers that we accept in the journal beyond the currently existing formats.
3. Updating the author guidelines and requirements for research papers – particularly as it comes to how papers advance STS debates and reflect on how their knowledge is produced via doing of methods and data.
4. Updating the design of the website and use of social media.

These topics are now work-in-progress by dedicated teams, and more updates will follow during the year.

In the last issue of this year, *Science & Technology Studies* celebrates its 35 years anniversary, and the editors will develop a look back into the history of the journal. Thus, the last editorial of this year will offer an overview to this end.

I wish you a pleasant reading of this issue.

Yours sincerely,
Antti Silvast

Fieldwork in the Anthropocene: On the Possibilities of Analogical Thinking between Nature and Society

Tanja Bogusz

Center for Sustainable Society Research, Hamburg University, Germany/
tanja.bogusz@uni-hamburg.de

Abstract

Interdisciplinary sensitivity takes into account the epistemic upheaval of the Anthropocene. However, the still fragmented academic organization between nature and society counteracts intellectual progress. The paper explores the possibilities of enhancing collaboration between biology and sociology by providing an empirical reflection of common methodological grounds. Building on practice theory, pragmatism, science studies and sociocultural anthropology, I discuss current nature–society relationships through an ethnography of a taxonomist's laboratory, followed up by a biodiversity expedition in Papua New Guinea. I address analogical thinking as a device for interdisciplinary collaboration through four modes of fieldwork enrollment: Ontological, disciplinary, transdisciplinary and experimental. The paper concludes with two arguments: Firstly, fieldwork could engender new knowledge in between differing epistemic cultures and, secondly, an analogical fieldwork approach based on the interrelatedness of experience, trial and cooperation facilitates promising pathways for sustainable futures of inquiry.

Keywords: Anthropocene, Biodiversity, Experimentalism, Pragmatism, Social Theory

Introduction

The planetary climate crisis and biodiversity loss have engendered many effects on the organization and understanding of knowledge practices. A considerable body of social and natural scientists agree that the 'Anthropocene' might replace, in the long run, 'modernity' as the core concept for the description of contemporary eco-societies (Folke et al., 2020). Some scholars from the human sciences criticize the holistic connotation of the term 'Anthropocene,' which blames humanity as such for the Earth's devastation – and not, for instance, particular extractive practices linked to the emergence of Western capitalism (Moore, 2017). Others contest its explanatory power, or usefulness to overcome the epistemic dichotomy between 'nature' and 'society' (Hornborg, 2017). While these criticisms contain powerful arguments, it is, however, hard to find a convincing alternative when seeking common grounds to realize problem-oriented interdisciplinary collaboration with natural scientists – which is the theme of the present paper. As a consequence, the terms 'nature' and 'society' stand here for two denoted research objects that have been conventionally separated by modern science (Felt et. al., 2013: 521ff).

While this separation has been fruitful for the sophistication of both the natural and the social sciences, it has also spawned their profound epistemic incommensurateness. Facing the urgent need for what Tsing and colleagues call 'pragmatic radical hope' in times of profound eco-social uncertainty, the Anthropocene invites "collaboration across multiple registers of knowledge and being" (Tsing et al., 2019: 193). Hence, while using the term 'Anthropocene,' I do so by embracing, with others, its experimental "event-character" (Haraway 2015: 160; James, 1976) for the transformation of interdisciplinary knowledge (Blok and Bruun Jensen, 2019). The Anthropocene event corresponds to a longstanding critique, particularly voiced within the humanities, against the epistemic dualism between 'nature' and 'society' as clearly distinguishable objects of research for either the natural or the social sciences.

However, when adopting the Anthropocene for interdisciplinary research, it will remain a 'poisoned gift' to the human sciences (Latour, 2014) if the effective entanglement of nature and society for which it stands remains unnoticed on the level of practical knowledge exploration. The 'practice' and 'pragmatic turns' by the turn of the millennium have indeed been reshaped through the unsettling of the dualism of 'nature' and 'culture' (Blok and Bruun Jensen, 2019; Descola, 1996, 2013). Science and technology studies (STS) researchers have eventually shifted their approaches from the observation *of* toward collaboration *with* the natural sciences (Bieler et al., 2020). The STS' longstanding training in observing and accounting other's scientific practices put them in an advantageous position "to actually work within and through interdisciplinary research projects" (Fitzgerald et al., 2014: 702).

Consequently, today, and even more facing the COVID-19 pandemic, an experimental sensitivity takes into account the epistemic upheaval of the Anthropocene event. However, collaboration across disciplines which are traditionally far alienated from each other remains a fundamental challenging task. This is especially the case within research settings, where human-environmental problems are processed primarily from the perspective of the natural sciences, with social scientists joining in later (Balmer et al., 2015): Firstly, because an already settled problem defines its own solutions, while other options tend to be marginalized (Dewey, 2008: 255ff.), and, secondly, because of the given epistemic and power inequality between the natural and the social sciences. Social scientists are frequently assigned to certain "roles," such as the "representative of the public" or "the critic" (Balmer et. al., 2015) but seldom as scientists with an equally valid research account, corresponding analytical models and agendas, let alone as a veritable "co-producer of knowledge" (Balmer et al., 2015: 9). How could STS collaborative research in the Anthropocene achieve such a more co-productive epistemic positionality?

There is, of course, not only one answer to such a vast question. Some classical STS accounts have developed reflections on how to enhance interdisciplinary research through, for instance, a pragmatist "cooperation without consensus" approach (Star, 1993), or through the distribution and adaption of different modes of expertise and their potential to foster cooperation between science and public issues (Collins and Evans, 2002; Marres, 2012). Recent debates turn around the idea of enhanced reflexivity on researchers' organizational positionalities and their mutual epistemic entanglements (Freeth and Vilsmaier, 2020; Marguin et al., 2021). However, my paper takes a slightly different perspective, combining pragmatism with enhanced reflexivity. It refers to the ideas of collaboration and mutual learning not as *add-ons* to interdisciplinarity. Rather, by insisting on *methodological similarities* from within the natural and the social sciences (Barry and Born, 2011), it carves out *analogical thinking through fieldwork*.

In the paper, I will develop this argument through some insights into a study on the works of a group of French taxonomists on the topic of biodiversity loss. My inquiry started in 2011/12 at the Muséum national d'histoire naturelle (MNHN) in Paris, followed by a two-month observation of a large biodiversity expedition in Papua New Guinea (PNG) in 2012 (La planète revisitée 2013), and a short stay at a workshop of the expedition's data assessment section in Besse, France, in 2013. The paper starts with a brief overview of the debate on the Anthropocene event and its effects on the social and natural sciences. I then present four modes of analogical thinking, explored in four sections: ontological, disciplinary, transdisciplinary, and experimental.

During my stays with the taxonomists in 2011-2013, analogical thinking was, however, not at the core of my inquiry. Instead, it resulted from recently revisiting my fieldnotes in order to explore their use for the development of interdisciplinary methodologies. The paper accounts for this process of rethinking and reorganizing my material. While situating analogical thinking within the theoretical framework of pragmatism and experimentalism, I discuss it as a heuristic for possible future collaborations with naturalists in the Anthropocene. However, the paper is notably limited to a conceptual framework. To date, I have neither done a systematic analysis of my material, nor adopted this heuristic. Both of these tasks are currently set up in a project dedicated to the exploration of a joint natural and social scientific 'field sciences' approach. The paper traces back the origins of this approach and explains why I see potential in it.

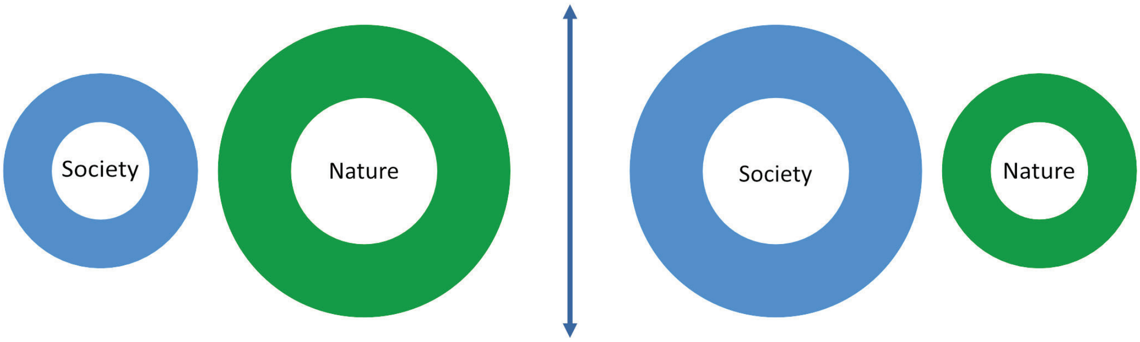
Ontological enrollment through the Anthropocene event: Challenges for the natural and the social sciences

Before inviting the reader to join me in the empirical grounds of my experimental journey, I will address the recent transformation of the natural and the social sciences through a brief sketch of the Anthropocene event. World society had become aware of the alarming planetary limits of the modern exploitation of nature by the end of the 20th century. Human's modern degradation of nature, it turned out, impacts nature's fate more than ever, and much more than evolution could handle. Geologists named this epochal shift the 'Anthropocene,' where "humankind has become a global geological force in its own right" (Steffen et al., 2011: 843), assuming that "earth systems are seen to be decidedly 'post-natural'" (Brown, 2019: 107). This 'post-naturalism' has been assessed, along with climate change, through "the sixth extinction" of the Earth's biodiversity (Kolbert, 2014). The UN Conference on Environment and Development in Rio de Janeiro in 1992 was the first transnational convention to introduce the idea of saving and conserving terrestrial and marine biodiversity in the public sphere. Transnational, academic, and public attempts to improve global biodiversity assessment and, simultaneously, mitigate biodiversity loss, understood as a planetary core effect of the Anthropocene, have accelerated on a formerly unknown scale since the turn of the millennium.

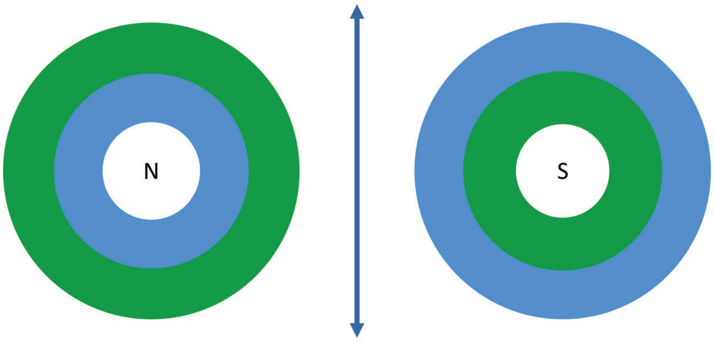
Critiques in the human sciences, however, are concerned with the holistic take of the term 'Anthropocene,' blaming it for depoliticizing the unequal distribution and allocation of responsibilities, and the globally disparate power relations regarding the causes of nature's dramatic state (Moore, 2017; Hornborg, 2017). Yet, the success of the term within STS research on environmental-human relations consists of creating a productive starting point toward interdisciplinary collaboration with natural scientists (Haraway, 2015; Tsing et al, 2019). Therefore, I use the 'Anthropocene' as a tool which allows for an experimental integration of epistemic heterogeneity, or, in other words, as a conceptual opportunity to organize joint explorations together with natural scientists. It could be understood, following Donna Haraway (2015: 160), more as an "event than an epoch", thereby supporting the pragmatist assumption of the epistemic productivity of 'events' as the interruption of habits (Mead, 1929: 87ff.). This "ecological disruption" (Blok and Bruun Jensen, 2019: 1197) of the difference between 'nature' and 'society' which is taken for granted, here understood as the conventional baselines for the respective research domains of *either* the natural *or* the social sciences where echoed, for instance, through semantic transformation. To give but one example, 'biodiversity,' formerly a purely scientific term, transgressed the boundaries of biological research on life's inventory on Earth and became a normative and, thus, a societal issue (Robin, 2011: 26). However, this ontological shift did not affect language alone. Instead, it transformed the academic positionalities for modern natural sciences and the social sciences on a more basic level.

The use of the term 'analogy' seems appropriate here. Stemming from biology, analogy embraces a structural resemblance between two entities; a resemblance which originates, however, in different histories. In contrast to homology – a term Pierre Bourdieu (2001) frequently employed in his theory of the field – it is not the structure itself that facilitates the resemblance but the way in which resemblance is enacted. Transposed to the natural and the social sciences, the analogy lies in their respective ontological, yet differently enacted, transformation. As suggested above, I define 'ontological transformation' here as an interruption of disciplinary *habits* (Dewey, 2008: 38) regarding their opposed epistemologies, where either nature included all but the human, or, vice versa, society included all but nature. Within this transformation, thus, the respective disciplinary ontologies shift from their mere dualist positionalities toward what Andrew Pickering (2009) called "ontological contingency". Ontology, as a term, here refers thus generally to a mode of existence as a reference point for either the social, or the natural sciences

Figure 1 gives a schematical account of the ontological transition between modernity and the 'Anthropocene event': Throughout the modern division of academic labor, 'nature' (in green) has described the sole research object of the natural sciences, based on the epistemic exclusion of 'the social' (in blue). And, *vice versa*, 'society' had described the sole research object of the social sciences, based on the ontological exclusion of 'nature' (Fig. 1a). Regarding the Anthropocene, this distinction gets fuzzy: 'Society' is enrolled within the natural sciences to understand nature's fate; yet, alternatively, for the social sciences, 'nature' is enrolled as an integral part of society's foundation (Fig. 1b). Michel Callon (1999: 74) defined enrollment as "a device by which a set of interrelated roles is defined and attributed to actors who accept them." Despite the fact that the actors described here – the disciplines – are still separated on the academic level of knowledge organization – expressed through the blue vertical arrow in between – their respective, yet analogical transformation within the two grand disciplinary families expresses what I call 'ontological enrollment':



1a. Modern Division of Labor between the Natural and the Social Sciences



1b. Ontological Enrollment through the Anthropocene Event

Figures 1a and 1b. Ontological analogies between the natural and social sciences

While biologists and physicians provide the empirical data to assess the scope and the sources for climate change and biodiversity loss, impacted notably through human societies, many social scientists today have integrated nature and non-humans into society. Consequently, the modern division of labor between nature and society underwent an analogical "enrollment" through the global critique of the consequences of the Anthropocene. Scientific and public awareness of these consequences are, thus, cocreated through ontological contingency. The Nagoya-protocol, being part of the Convention of Biological diversity (CBD) and coming into force in 2014, gives a striking example. It underlined the importance of the mutual benefit for scientific research arising from conservation strategies, "by strengthening the ability of [indigenous and local, T.B.] communities to benefit of the use of their knowledge, innovations and practices" (Secretariat of the CBD, 2011: 1).

If analogical enrollment can be observed on the level of ontology, analogy still does not mean symmetry. The epistemic boundaries between the natural sciences and the human sciences not only remain rather robust, they also tend to increase unequal funding, demarcated disciplinary training and often ineffective inter-governmental action. They engender "trials of strength" (Callon, 1999: 74), often being rather obstructive for mutual learning (Billi et al., 2019: 312). It is one of the core problems, as Rebekah Brown and colleagues (2015: 315) put it, that "so many well-meaning attempts at interdisciplinary collaboration fail to deliver tangible outcomes". However, the COVID-19 pandemic teaches us that interdisciplinarity today requires dialoguing epistemic cultures to foster "preparedness" (Keck and Lynteris, 2018). "Preparedness," in the sense of proactive engagement with unknown Anthropocenic futures, experiments throughout cross-disciplinary collaborations, which are generally based on *heterogeneous ontologies* (Keck and Lynteris, 2018: 10). This is hard work because it requires time, resources, and curiosity. In other words, where symmetry is scarcely available, the possibility of analogical thinking *between* disciplinary borders invites experimental enactment. Yet, according to Philippe Descola, such "analogism," either cosmological or scientific, could be comprehended as a consequence of "dissatisfaction," "bringing together through an operation of thought that which was previously separate" (Descola, 2013: 202). Analogical thinking, hence, "nurtures the hope of weaving […] heterogeneous elements into a web of meaningful affinities and attractions […]" (Descola, 2013: 202). In the human-environmental cosmologies Descola describes, this web is based on ontological continuity between, for instance, micro and macro events. In a slight difference to this, interdisciplinary analogical thinking between the natural and the social sciences results from their respective, yet, contingent resonances within the Anthropocene. In the following, I will take a closer look at such a resonance within a group of marine taxonomists. For semantic clarification, I use inter- and transdisciplinarity as follows: Interdisciplinarity consists of the collaboration between two or more different academic disciplines. Transdisciplinarity focuses on the integration of non-academic knowledge and experience. Cross-disciplinarity usually equals interdisciplinarity ('across' or 'between' disciplines), though it might potentially go beyond academia and integrate non-academic experiences, practices and knowledge as well.

Enacting disciplinary enrollment: Marine taxonomy in a museum's lab

My query regarding the disciplinary effects of the Anthropocene started in 2011 from the angle of the natural sciences. I chose the Parisian National Museum of Natural History (MNHN), one of the world's leading natural history institutions, as a site. I wanted to understand how the ecological crisis and the political charge of conservation strategies impacted the everyday work and the ontological configuration of nature as a research object for biologists. Embracing the consequences of their findings for society implied, in my first suggestion, a twofold ontological shift, firstly, of their very objects of inquiry and, secondly, of the accountability of these objects in terms of sustainable knowledge and conservation governance. How do biologists experience their disciplinary 'enrollment' through society? How do they deal with it?

After several detours throughout the MNHN, I finally gained field access in early 2012 through a contact with a Parisian anthropologist who had already collaborated with the museum. Professor Philippe Bouchet, head of the division of marine taxonomy, part of the Institute for Systematics, Evolution and Biodiversity, received me to do a laboratory study in his division. Today, the division is part of the Unité mixte de recherche 7205, which has been called the "Institut Systématique, Évolution, Biodiversité" since 2014. The institute integrates the taxonomic research of flora and fauna of all kinds and works in close collaboration with the Université Pierre et Marie Curie (also called Paris 6) and the École Pratiques des Hautes Études in Paris. I observed notably the team of morphological, anatomic taxonomy in the laboratories of the rue Buffon for two and a half months, and included several trips to the phylogenetic laboratory in the rue Cuvier on the other side of the botanic gardens.

Taxonomy is part of evolutionary biology and zoology and, hence, a foundational science. It consists of the determination of life on Earth through qualitative, morphometric, and genetic analysis, and the classification of living beings in space, time, and number. The taxonomists at the MNHN specialized in the assessment of marine invertebrates, i.e., sea mollusks, scallops, crabs, and all kinds of spineless small water species. Marine invertebrates constitute about 90 % of all species described and have a fundamental impact on the Earth's ecology. Taxonomy represents an interesting case to study in order to understand the current disciplinary dynamics for three reasons: Firstly, taxonomy belongs to the oldest classification practices in naturalists' inquiries and in biology becoming a science – think about Darwin, Merian, Linné, and Lamarck. Secondly, taxonomy plays a key role in measuring the current dramatic loss of biodiversity and, thereby, in orienting research programs. And, thirdly, though I became aware of this only years later, taxonomy is an experience-based field science, inviting the possibility of analogical thinking between nature and society.

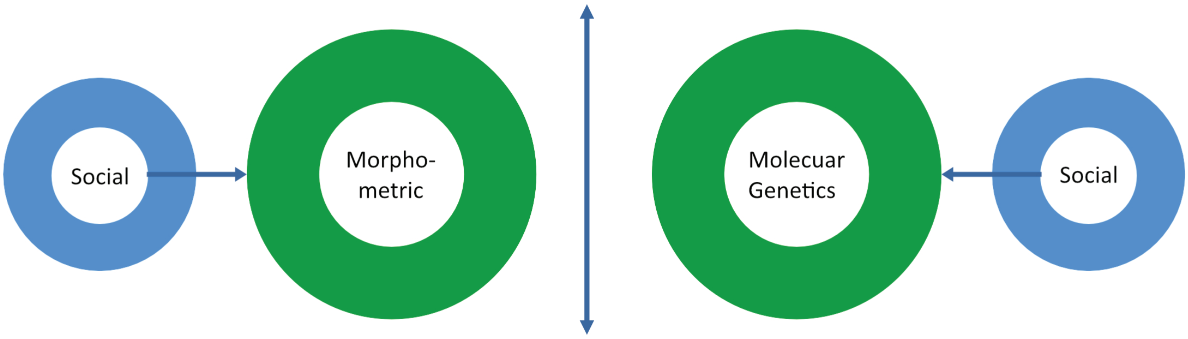
"Biodiversity – It's Us!": Methodological collaboration against fragmentation

The taxonomist's inquiry has always been, as the marine specialists told me, about the state of the art of planetary biodiversity. "Biodiversity – it's us!" they used to confirm proudly. However, taxonomic methodology today is twofold, which provides another good reason to take it as an example for the investigation of analogical thinking in the Anthropocene. Comparable to sociology, current taxonomy includes outdoor fieldwork, qualitative description, the development of quantitatively dense databases and statistical (genetic) analysis. Despite the obvious differences between biological and sociological methodologies and their different aims and scopes, both are embedded in a methodological fragmentation (Abbott, 2006: 43) between qualitative and quantitative approaches. But the shock of the "sixth great extinction" had thrown taxonomy, by the turn of the millennium, into a fundamental methodological upheaval (Waterton et al., 2013: 9). This crisis arrived nearly coincidentally with the fast overturn of the molecular revolution in the life sciences, downgrading the century-old morphological approach into an apparently outdated practice, not least because of the new awareness of taxonomists' ignorance about the state of the art of global biodiversity (Bouchet, 2006: 33; Ellis et al., 2010: 500). However, methodological fragmentation turned out to be ineffective for the sustainability of taxonomy as a science. Instead, the concern of naming "earth's species before they go extinct" (Costello et al., 2013) featured a professional ethos motivated by what Geoffrey Bowker called "the panoptic dream" to "complete" the global inventory of life (Bowker, 2000: 645).

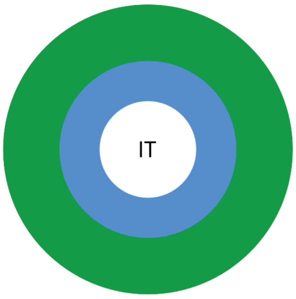
The shared commitment of the taxonomists (either in the rue Buffon or in the rue Cuvier) to methodological collaboration found its material infrastructure in the freshly established "MarBOL" curation database. MarBOL was launched in 2010 as a cooperation between the consortium for the Barcode of Life and the Census of Marine Life and had a strong impact on global marine taxonomic assessment and curation practices. In a joint paper, the authors stressed the importance of a "standardized workflow" (Puillandre et al., 2012: 397) combining new taxonomy and old collections, especially within the framework of the MNHN in Paris. This cross-methodological workflow linked the genetic databases of the rue Cuvier with the rue Buffon and spanned from fieldwork to scientific documentation through both lab facilities.

So, here was my first finding related to my previous question regarding a biologist's reaction to the ontological upheaval through the Anthropocene: The societal pressure through the global biodiversity crisis enhanced, in the case of the marine taxonomists at the MNHN, systematic collaboration between morphometric (qualitative) and molecular genetic (quantitative) approaches. Instead of increasing competition and deepening methodological fragmentation, they opted for mutual enrolment and collaboration. But collaboration as an experimental response to (the) crisis was not limited to assessment practices, as I will show in the following sections.

Figure 2 shows the dynamic of the disciplinary enrolment within the taxonomists' research practices on the level of method. While the classical morphometric analysis of species was formally separated from molecular genetics, the social pressure to sustain taxonomy's impact caused by the biodiversity crisis became virulent for both approaches (Fig. 2a). With their decision to overcome their separateness through their collaborative 'integrative taxonomy' approach, the Parisian taxonomists realized a 'disciplinary enrolment' in order to enhance their management of both the biodiversity crisis and their disciplinary crisis (Fig. 2b):



2a. Intervention of the Biodiversity Crisis Caused by Humans in two distinct Research Approaches



2b. Disciplinary Enrollment through "Integrative Taxonomy"

Figures 2a and 2b. Disciplinary enrollment within marine taxonomic practices at the MNHN

The disciplinary enrollment of biodiversity loss as a burning societal issue through the development of a collaborative methodology did not have any impact on the taxonomists' general distance toward the social sciences (see Figure 1b). This is not surprising given the robustness of the modern academic borders in academic institutions sketched above. However, during my observation post under the dusty rooftop of the lab in the rue Buffon, I began to wonder about possible modes of collaboration with the taxonomists around the topic of biodiversity loss and conversation practices in their research areas. Their disciplinary enrollment was instructive in that the idea of an effective 'external' intervention of a social/cultural-scientific approach through pathways which are alienated to their own modes of reasoning seemed now to me quite naive. But how did they approach 'society'? I witnessed, through my daily exchanges with the team, on the one hand, a certain familiarity with the fact of being observed by a social scientist. Occasional jokes while presenting me to visitors to the lab as a "spy" were accompanied by friendly smiles. They alternated with occasional pejorative remarks about sociologists as people "looking for problems." On the other hand, the team received me every day with the warm, trustful and unlimited candor for which not only scientists knew for the lab in the rue Buffon. What held these rather divergent encounters together?

Transdisciplinary enrollment: Doing biodiversity *between* nature and society

Within the museum, the taxonomists stressed their difference not only toward the social sciences, but particularly with biodiversity research typically associated with the human sciences, such as sustainable governance, public and participative sciences, or museology. Yet, this professional distance was not a sign of sociocultural distance toward non-naturalists. On the contrary, the lab in the rue Buffon was a place of enormous openness and even, in my impression, of exceptional hospitality. It was not only packed with a multitude of heterogeneous species but also with lots of people with diverse backgrounds. Colleagues, friends, amateurs, technicians, and volunteers from places throughout the world popped into the lab on a daily basis and moments of absolute silence were rare. Above all, the traditional support of amateurs regarding the museum's collections was constantly present. One staff member told me that "50 % of the mollusks collected come from high-level amateurs!" I witnessed, through the busy dynamics in the lab, a veritable example of the long history of collaboration between amateurs and natural history museums (Kohler, 2002; Lepenies, 1976; Manceron, 2015; Star and Griesemer, 1989). While most of the amateurs were retirees, their professional backgrounds ranged from lower middle- to upper-class members – there were ex-engineers, ex-school teachers and ex-ambassadors, to name but a few.

In addition to this diverse bunch of participants in the lab, I was not the first social scientist who had been received by the morphologists in the rue Buffon either. Several other sociologists and anthropologists had observed and accompanied them during previous expeditions since 2005 (Faugère, 2019). These encounters, including my own presence, were, to the best of my knowledge, based on the special convention of ethnographic fieldwork: Social scientists observe biologists and write accounts of their "laboratory lives" (Latour and Woolgar, 1986). However, was my observational approach not exactly rehearsing the good old modern ontological division of labor the Anthropocene event actually teaches us to overcome? As an ethnographer in the museum's laboratories, I started to think about a different, more 'natural' access to their activities within and beyond their workplace. Perhaps it was too obvious to be noted right away.

The Field in the Lab

Disciplinary enrollment through the integrative approach did not affect the taxonomists' methodology in such a way that they would integrate public, anthropological, or sociological knowledge on an equal footing. Nevertheless, there was striking evidence of their affinity for heterogeneous accounts based on daily enactments of transdisciplinary 'epistemic cultures' (Knorr-Cetina, 1999). This affinity was an indication of the potential possibility of analogical thinking between nature and society. Such observations turned my attention toward a more profound reflection on possible commonalities between the taxonomic enterprise in the lab and my own as a sociologist. During the time of my two-month stay in the rue Buffon, I became a part of the laboratory. Through my existence as a well-received ethnographer persona, I experienced a certain similarity between us in dealing with heterogeneous people and things. A shared 'habit,' in the sense of John Dewey (1896), which originated in a century-old and longtime slightly ignored professional kinship. Only years later, through the analysis of my fieldnotes, did I realize that this kinship had a name. It lies in the congregation characteristic of *fieldwork*, consisting of an experience-based reconfiguration of heterogeneous people, things and living beings.

However, I did not see that at the time of my laboratory study. I was trapped in my own disciplinary observatory. Nevertheless, it was impossible not to notice that the 'field' was more than an external unit in the museum's marine taxonomist workplace. 'Doing biodiversity,' under the auspices of a civic engagement for nature, did not end at the lab's walls. Fieldwork campaigns were constantly present within the lab, precisely because they constituted 'the soul' of the lab; either in the molecular systematic service in the rue Cuvier within the sequencing machines and databases, or in the rue Buffon, through the overwhelming material presence of the geographical maps, collected specimens in the trays, compartments, lots, on the tables, in the books, posters and papers, or in a funny comic strip of a little swimming individual captioned by the phrase: "Wanted – dead or alive!" I never departed from the laboratory without at least one note testifying to long and intense debates and phone calls on the planning of the next expedition. They left me astonished and fascinated about the logistical, financial, geopolitical and, not least, *cultural* complexity of taxonomists' investment in organizing the next campaign, while constantly assessing the vast stocks gained through multiple expeditions. Thomas Gieryn observed that in "some scientific specialties, knowledge claims gain legitimacy by preserving and drawing on simultaneously – and in a complementary way – the assumed distinctive virtues of both lab and field" (Gieryn, 2006: 6). This virtue was, in the case of the MNHN taxonomists, expressed through a professional fieldworker ethos, actually encompassing nature and society and their academic, ontological and epistemic differences.

This fieldworker ethos can be traced back toward the 'pre-academic' era. It originated through the historical epistemic affinities and conflicts between naturalists, anthropologists, and early pragmatists, starting with naturalists' expeditions in the colonial epoch. Throughout history, the term 'field' shifted from the natural toward the social sciences through physical immersions in the study of human-environmental relations. Franz Boas participated in a polar expedition in 'Baffin Land' in 1883/84, converting him from geography to ethnology. Danish anthropologists Kirsten and Frida Hastrup credit the zoologist Alfred C. Haddon with having "imported the term fieldwork into anthropology from zoology" (Hastrup and Hastrup, 2015: 8). Haddon's pioneering expedition to the Southwestern Pacific Torres Strait Islands in 1898/99, where naturalists and anthropologists worked together, was a core epistemic event for the creation of anthropology as a discipline (Stocking, 1983). The Torres Strait expedition promoted the three-year stay of Bronislaw Malinowski in the Trobriand Islands (1915–1918), conceived as the foundational moment for the fieldwork approach in the human sciences.

This continuity between nature and society through 'field studies' also shaped early pragmatism and sociology. Charles Peirce was a professional land surveyor before he converted to philosophy. For John Dewey, who met Boas at Columbia University in 1904, the translation of fieldwork into cultural analysis constituted, along with Darwin's evolution theory, an important background for his analogical naturalism and his theory of experience (Dewey, 1983; Bogusz, 2022; Lewis, 2001; Torres-Colón and Hobbs, 2015). Later, sociologists imported the anthropological field approach through, notably, the First Chicago School of Sociology in urban studies (Palmer, 1928) and Pierre Bourdieu's practice theory (2000, 2001).

Distancing themselves from the armchair humanities of their times and the pure ratification of social theory or statistical data today, most field researchers stress the central importance of experience. Within the human sciences, they circumvent the geopolitical and epistemic division between sociology and anthropology, supporting thereby a longstanding criticism against the consequences of colonialism for academia (Randeria, 1999). They embrace the embodied, reflexive and material encounter with inquired environments. So do biologists, actually defending their solid field approach against sole molecular assessments of nature's inventory (Fleischner et al., 2017; Rios-Saldania, 2018).

Field studies have, thus, grounded and anticipated the emergence of the natural and empirical cultural sciences since the late 19th century. Regardless of the vibrant debates on the constitution and the methodological challenges of fieldwork in the social sciences (Bourdieu, 2001; Hastrup, 2014; Marcus, 1995; Star, 1999), the historical kinship between naturalist and sociological fieldwork has been somewhat forgotten. Instead, it was the 'lab' which became a frequent topos to describe eco-social worlds and their disciplinary enactments. The 'lab topoi,' explored notably through the history of science and STS epistemics, comprises the idea of "laboratizing and de-laboratizing the world" (Guggenheim, 2011); experimentalist approaches to the interdisciplinary encounter between the natural and the social sciences through reflexive 'co-laboration' (Niewöhner, 2016); or 'real-world-labs' which promise to promote participative transdisciplinary research (Engels and Walz, 2018; Groß et al., 2005).

Some of these empiricist approaches retrace, though often rather implicitly, classical pragmatist philosophy, inspired by experience-based practical reasoning. Pragmatism for John Dewey and Charles S. Peirce consisted of the translation of laboratory logics into modes of dealing with the general challenges of humankind (Dewey, 1984; Peirce, 1997). Dewey's procedural evolutionism was particularly committed to the idea that an "experimental theory of knowledge" could learn from naturalists through analogical thinking (Dewey, 1906). Following the paths of William James' "radical empiricism" (James, 1922), Dewey aimed to provide analytical foundations to reconcile empiricism and rationalism. This reconciliation, for Dewey, would link nature and society through the heuristics of the naturalist's experiment, where ignorance and uncertainty fuel new and previously unknown terrains. However, this partly simplified transposition beyond the natural and the social sciences is of striking actuality today, where the planetary entanglement of science and society engages citizens, scholars and experts to address the environmental uncertainties of our times (Chakrabarty, 2021; Latour, 2018; Nowotny, 2016).

While the pragmatist renaissance by the end of the twentieth century helped social theory to promote actors' transformative capacities and nonhuman involvement in social enactments (Boltanski and Thévenot, 1999), the often overstated anti-structuralist gesture (Descola, 2013: 91) discarded such analogical thinking. However, the social and cultural sciences might miss opportunities to acknowledge naturalists' own experimental enactments by discharging social analysis from analogical thinking as a heuristic tool. While the 'lab' expressed a sociologist's "(cautious) welcome" of the natural sciences (Benton, 1991) through the upcoming, though partly contested, Anthropocenic framework (Lidskog and Waterton, 2016), a renaissance of 'the field' within the natural sciences is also given voice (Burt and Thompson, 2020). Geographers, botanists, geomorphologists, zoologists, and meteorologists stress the importance of qualitative description, improved sensitivity, and experiential knowledge. They counteract the overwhelming material, financial and epistemic hegemony of system analysis, molecular genetics or satellite remote sensing. Such concurring developments testify to the intriguing dynamics within the natural sciences and particularly within the domain of taxonomic biodiversity research.

Consequently, in the Parisian taxonomists' lab, where the integrative workflow standard was highly appreciated, my own observational fieldwork posture and its limits inspired a new question for me: Could taxonomists' fieldwork, similar to ethnography, pave a way to transgress the academic alienation between their research on the transformation of the environment and mine as a sociologist? I also wanted to participate in one of the lab's overseas expeditions to get a more complete view into taxonomists' *in* *situ* fieldwork practices. As chance would have it, my ethnographic journey brought me into exactly the same geographic area where Haddon had converted from zoology to ethnography. However, if I enrolled nearly the same territory, history has not only shifted from modernity to the Anthropocene but also from the colonial to the postcolonial age.

The Lab in the Field: Expedition in Papua New Guinea

Seven months after my study in the Parisian MNHN, I attended a large-scale expedition in PNG in November and December 2012. The PNG expedition was part of the campaign "Our planet reviewed. Taking a closer look on biodiversity hotspots." The campaign had started in 2006 and covered terrestrial and coastal biodiversity surveys in Vanuatu, Mozambique, Madagascar, New Caledonia and, after PNG, French Guiana. The choice of PNG was, notably, data-driven: Being part of the so-called 'coral triangle,' the taxonomists mapped PNG as a largely understudied area of planetary biodiversity and considered it notably as the planet's richest "hotspot" of marine biodiversity (Press Kit, 2012).

As a particularly intense form of fieldwork, which is comparable to an ethnologist's in-depth stays abroad, naturalists' expeditions often build on (post)colonial infrastructures (Anderson, 2002; Kohler, 2006: 7; Weber, 2019: 83), diverse knowledge cultures and conflicting modes of nature/culture problematization (Helmreich, 2009; Hornidge, 2018; Thomas, 2015). Expeditions enact 'liminal' forms of experience, being dense endeavors of work, people and logistics. They feed myths of extreme bodily and cultural investment, as well as harsh critiques of epistemic and material exploitation of non-Western people (Leshem and Pinkerton, 2019; Robben and Sluka, 2012). Simultaneously, expeditions process heterogeneous sociomaterial goods (Law, 1987), globally 'circulating references' (Latour, 1999) and, as history has shown, generate specific forms of translocal knowledge.

The expedition was based on the campus of the Divine Word University near the city of Madang, which is also the capital of Madang province on the north coast of PNG and the Bismarck Sea – one of many territorial names still reminding one of the German colonial era. As a sociologist of science, my aim was not to study PNG in general, nor the people living in the prospected research area. Instead, I sought to understand the way in which the taxonomists' integrative research into biodiversity was realized *in situ* through their involvement in a particularly located area. However, the narration of expeditions as a practice of "discovering" "unknown" territories inescapably resonated the geo-political past of PNG in a particular manner here (Communiqué de Presse, 2013). Independent from colonial power since 1975, the oceanic island-country still triggers the imaginaries of western naturalists, cultural scientists, writers and adventures (West, 2006: 2ff, 2016: 35ff.; 87ff.). Therefore, for its long history of occupation, resistance, and natural and cultural diversity, the country has also been a prominent example of the complex entanglements between global environmental governance, (post)colonialism and science (Bamford, 2002; West, 2006: 222ff, 2016: 108). Moreover, New Caledonia, a former French colony and today part of the French overseas territory in the Pacific Ocean, provided important infrastructural support for the expedition, in particular the research vessel and local scientific expertise. While these entanglements were orienting neither the naturalists nor my own sociological research at first glance, the expedition enacted, inevitably, fieldwork in the Anthropocene also through their postcolonial imprint.

The marine and terrestrial program of the PNG campaign comprised about 200 participants from over 20 countries. The marine part that I observed was composed notably by taxonomists, specialized in the research of marine invertebrates. Their goal consisted of exploring the magnitude of marine invertebrate biodiversity in the coastal zone of Madang province, the Madang lagoon and the local freshwater and delta regions. The research was supported by students from the capital City University of Papua New Guinea in Port Moresby, from Madang city (Divine Word University), some of them living in Madang province, Bougainville, Kavieng and New Britain. The students guided the scientists in the freshwater regions and dealt with for communication and translation. In return, they could participate in simple research tasks, such as sieving and sorting, and experience the general workflow of a large-scale expedition. Moreover, civic guides from Madang province also, as well as technicians, amateur naturalists and public visitors from Madang city and Madang province took part in the research activities on a daily basis.

My presence and research were financed through external funding I brought in myself. It covered boat and coastal trips to observe the taxonomists' different practices of species extraction from the waters and coastal sampling through different techniques (handpicking, brushing basket, dredging and sieving, first preparation for DNA analysis). I realized participant observation in the expedition's lab near Madang harbor, recorded the scientists' workflow, assisted in the sorting of the species, and followed them throughout water access negotiations with Papua New Guinean citizens, politicians, and nongovernmental organizations (NGOs). I had daily exchanges, breakfast, and lunch with them, and conducted a set of interviews with core representatives from the expedition's campaign and the receiving partners of the expedition.

Both morphological and molecular genetic taxonomists constituted the marine group within the expedition, thereby confirming their integrative approach not only on paper but through the shared experience of fieldwork. This infrastructural translation of the Parisian lab situation to the expedition was echoed by the large number of nonacademic support workers integrated into the everyday tasks. The Parisian museum's 'field in the lab' was now reversed to the 'lab in the field,' though this reversion correlated with an enormous increase of material and people within and outside the lab. This engendered many issues, partly exceeding the lab's concerns.

Biodiversity loss and the ecological crisis, though generally conceived by PNG people, clans, researchers, students, and NGOs as important global problems, were, however, not preeminent for most Madang province inhabitants. Instead, and similar to Europe and most world regions today, they were shaped through local eco-social challenges of a different scale. In Madang province, these issues consisted of overfishing, rising sea levels, land erosion and the overturn of their territorial resources by multinational mining companies. Since the establishment of the Convention of Biological Diversity (CBD) effected by the United Nations in Rio de Janeiro in 1992, these and similar topics have given rise to conflicting modes of practicing and representing environmental concerns between PNG people and scientists (Bamford, 2002; West, 2006). They rivaled with the taxonomists' desire for access and political consent by claiming a mutual trade-off in the governance of transnational biodiversity research, thereby adapting the Nagoya Protocol (Secretariat of the CBD, 2011) in their own right.

Consequently, field (or rather water) access turned out to be a central concern for the taxonomists. The unintended effects of the postcolonial infrastructure as a typical component of taxonomic knowledge gained through an expedition of naturalists (Kohler, 2006: 7) were particularly striking here. Despite the will to overcome structural and epistemic disparities between Western scientists and local people, the expedition triggered the postcolonial conjunction between Papua New Guinean customary land tenure and Western science politics: "[T]he recognition of customary landownership is located within complex matrices of colonial history, government policy and legislation, ideology, indigenous property rights and relations to land" (Weiner and Glaskin, 2006: 12). Moreover, different to any properly prepared fieldwork and quite surprisingly, a certain number of concerned customary communities were not informed by the PNG government about the researchers' arrival and survey. People were shocked to see them extracting species from their properties, seemingly without having asked for permission. Occasionally, they attacked the researchers with stones, or their findings were dropped back into the sea.

Such issues led to many public and informal gatherings, where the villages, clans, NGOs, scientists, and the expedition's leaders negotiated access. These events not only reminded me again about the analogy to ethnographic fieldwork, as access is always a critical point which can potentially yield to political conflicts. Moreover, and very similar to ethnographic fieldwork, the taxonomists were confronted with altering and formerly unknown approaches regarding their very research topic. Such incidents were especially evocative when a trial situation – for instance, a rejected water access and *in situ* ad hoc negotiations – had not been expected, or when heterogeneous ontologies of nature met. This could lead to occasional transdisciplinary enrollments linking nature and society as objects of inquiry, as I will outline next.

'Worlding'

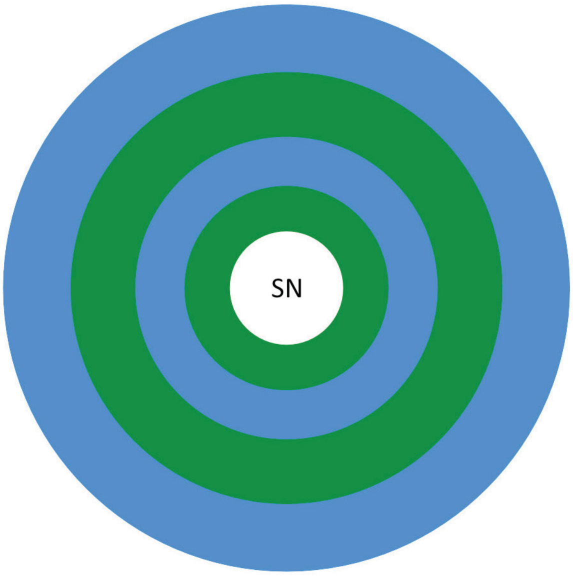
Leaving aside the marine species themselves, around which the daily marine fieldwork was organized, not only humans and sea animals were involved in such enactments. The following event was related to me one night in the lab by a French researcher who took part in it. During my presence in Madang, I did not realize its analytical potential and did not double-check the report. Although I am lacking key information, such as the local origin of participants, their language and original quotes, the event merits being recounted as it stands for a quite typical way of scientists dealing with ignorance, surprise, and adaptation during the expedition. Ignorance, surprise and adaptation belong to the core principles of fieldwork, either naturalist (Burt and Thompson, 2020: 39) or humanist (Strathern, 1999: 3). Experienced and reflected by a marine biologist, such incidences invite analogical thinking. So, here is the story.

A daily sampling boat trip took place at the coastal zone of Kananam, a region situated about 16 km to the north of Madang city, between Alexishafen and Rempi. The trip was officially confirmed by the Madang government. In the morning, a small group of biologists, together with two local guides from the rural environments of Madang province went with a motorboat in the sea. The biologist immersed themselves in the water, using the brushing basket technique, brushed samples from the seabed, collected them in a basket and sent the basket lifted with air-filled balloons up to the surface and the boat, where the local guides would take them. However, when the biologists returned to the water's surface, they became aware that the basket full of samples had disappeared. The scientist expressed his profound stupefaction when telling me the story late at night in the lab. They had searched everywhere, he told me – in the boat, on the seabed – and found nothing. To their complete astonishment and surprise, finally, the two guides explained that they had violated a local law. It turned out that the taxonomists have dived into the sacred territory of a sea goddess called 'Samalangdun.' Unfortunately, I do not possess, even after follow-up research, any information on Samalangdun and her status within the prospected era. It was reported that Samalangdun prohibited access to her waters, and, following the account of the two guides, no inhabitant of this coastal area would ever enter her domain.

Embarrassed by the deception of the researchers about the loss of their findings, the guides and the researchers wondered about finding a solution. After the lunch break, they returned to the place in the sea. The guides proposed delivering a prayer to Samalangdun asking for forgiveness. The taxonomists agreed, though they were uncertain if this could be of any use. However, after one of the two guides had delivered the prayer, the scientists went back into the water. To their complete surprise, the basket reappeared at the same place in the deep sea where it had evidently been lost some hours before. Taking note of this insoluble enigma and the compromise resulting from it, they happily brought the basket into their boat. As a consequence, they regretted not having adapted their habitat mappings to the local conservation laws. One of them wrote in the expedition's blog on the night of the event: "One thing is sure, next time, before diving into a new site, we will take notice of the local beliefs. At any rate, the cultural richness of Papua New Guinea is as diverse as its biodiversity" (Faure, 2012, translated by the author).

Following Anna Tsing, we could call this incident "worlding": "All researchers develop their work in context-making collaborations […]. Worlding is the only way to take difference seriously in a collaborative research practice" (Tsing, 2010: 49). To me, Samalangdun represented what the western culture usually knows through intergovernmental conservation laws promoted by, for instance, the United Nations. From a pragmatist angle, taking difference seriously by maintaining the possibility of acting through heterogeneous worlds confirms a basic assumption for the success of democracy (Dewey, 1956). The postcolonial moment enacted by Samalangdun and "worlding" led, thus, to a compromise between different worlds. Boltanski and Thévenot assumed that, "[i]n a compromise, people maintain an intentional proclivity towards the common good by cooperating to keep present beings relevant in different worlds, without trying to clarify the principle upon [which] their agreement is grounded" (Boltanski and Thévenot, 1999: 374). Such a compromise, or "cooperation without consensus" (Star, 1993), was a postcolonial moment, in that the top-down governmental politics on which the expedition was organized clashed with the bottom-up customary tenure in the Madang coastal area. Nevertheless, the actors involved then solved the conflict in a peaceful and respectful way. Regarding the possibility of analogical thinking and, thus, for heterogeneous collaboration, it is not primarily important why or how exactly the basket had disappeared before. What counts is the shared acceptance of the effect Samalangdun has created. As an authority transgressing the western nature-society dualism, Samalangdun (and not the taxonomists) enacted a transdisciplinary enrollment of a 'postcolonial moment' (Verran, 2002) in the Anthropocene.

I visualized the taxonomists' transdisciplinary enrolment in Figure 3. The taxonomists integrated nonacademic participants not only within their everyday museum's transdisciplinary habits but also through their fieldwork within the expedition in Papua New Guinea. Moreover, the encounter with the sea goddess Samalangdun suspended, at least temporarily, the very existence of the epistemic dichotomy between 'nature' (N = green) and 'society' (S = blue). This suspension, instead of producing a conflict, effected heterogeneous collaboration between 'society' and 'nature,' both being represented by Samalangdun. The taxonomists, the two guides, the local people of the coastal area, the goddess and the sea enacted a respective transdisciplinary enrolment through a shared postcolonial fieldwork moment:



Heterogeneous collaboration through a postcolonial moment in the Anthropocene

Figure 3. Transdisciplinary enrollment

The 'Samalangdun event,' as I named it later in my notes, expressed a core feature of fieldwork; either natural or social-scientific: Fieldwork knowledge is not acquired through an external perspective of the object of inquiry but through interactional involvement with it. It is a relational process facilitated by conflicting ontologies, epistemics and values channeled through experimental enactments. According to Dewey's classical experimentalist theory of knowledge, the taxonomists, similar to ethnographers, reconciled fieldwork experiences with disciplinary reflexivity. They experimented in their observed environments through flexible practices, adapting themselves to often unpredictable encounters. While it could be argued that the taxonomists maintained a certain naturalist universalism which is easy to criticize from a social science perspective (Boltanski and Thevenot, 1999: 364-365; Brown, 2019: 103; Faugère, 2019: 62ff.), the expedition's infrastructure, based on human and nonhuman support, allowed, despite its postcolonial features, a successful collaboration while taking difference seriously. Transdisciplinary enrollment facilitated through fieldwork enabled the taxonomists to embrace, at least occasionally, a reflexive approach vis-à-vis their own critical potential (Bieler et al. 2020: 83) toward this very universalism. 'Society,' thus, entered the taxonomists' research practices through and within fieldwork, often through contingent and unpredictable encounters which were integrated either pragmatically, or even experimentally, into their daily workflow.

I left Madang impressed and puzzled. Back at my desk at home, I tried to relate my observations to my own disciplinary positionality and approach. While seeking possible collaboration, I felt, indeed, that the 'poisoned' character of the 'gift of the Anthropocene' makes it even easier for ethnographers to remain stuck in the social science observatory. However, this, at times, awkward situation increasingly fueled my thoughts on how to leave it – while appreciating the *in situ* opportunity for "a more dialogic kind of cooperation" (Sennett, 2012: 28). Could the enrollments observed in Madang eventually contribute to a pragmatist analogical thinking *between* nature and society – that is, between biological and sociological fieldwork?

Experimental Enrolment: Toward an Analogical Field Sciences Approach

"'These are the specimens we processed during the expedition. They have been sitting in these bags for nearly one year.' Sandra shows me the bag. I am relieved to hear this because this also holds true for my fieldnotes." I wrote that observation down in October 2013, about one year after my ethnography of the expedition in PNG. In 2013, I visited the taxonomists for a short follow-up observation of a determination workshop on the expedition's findings at the biological station in Besse, near Clermont-Ferrand, which is part of the MNHN structure. From then, it took again several years until I realized that there are more similarities between taxonomy and ethnography which deserve closer attention. Collecting information translated through nonhuman beings, or language, and bringing them back home to the desk; then other tasks intervene, the collected beings are set aside, partly even forgotten. Feelings of discontent occur; even guilt, raised through the knowledge that there is a treasure "sitting in these bags," as taxonomist Sandra said, waiting to be looked at. The battle against and with the time needed to return to the bag, to open and to rediscover it … And the joy when finally exploring the material again, to re-experience being in the field and experimenting with its outcomes.

My encounters with the taxonomists before, during and after the expedition indeed again confirmed that fieldwork is 'experienced' rather than 'conducted' – a statement constantly rehearsed by anthropologists and sociologists since the classics. Moreover, experience, trial and collaboration regarding ethnographers and naturalists' encounters are impacted and enhanced by moments of uncertainty and mutual learning. This fits perfectly with the pragmatist legacy. Dewey created an ontological continuity between 'experience' and 'experiment' by stressing the entanglement between observation and object construction. His concept of democratic experimentalism was driven by the idea that political cooperation would reflect human undefeatable curiosity to discover the unknown, based on the entanglement of experience and knowledge. Thinking about this further through Richard Sennett's works on the craft of cooperation, a "cooperative mindset" is not only difficult to establish within an interdisciplinary encounter but is a fundamental democratic challenge as well: "[C]ooperation needs to be developed and deepened. This is particularly true when we are dealing with people unlike ourselves; with them, cooperation becomes a demanding effort" (Sennet, 2012: ix). This is, as I have outlined in this paper, not only true on the broader societal level, but also on the level of the academic organization and collaboration between the natural and the social sciences in the Anthropocene. Stemming on Sennett's idea of heterogeneity as a precondition for cooperation, we can distinguish the term 'collaboration', generally meaning 'cooperation / working together', from 'co-laboration'. 'Co-laboration' consists of explicitly seeking a common ground, or "a third space" between disciplines and other communities of practice (Niewöhner, 2014: 350; Bogusz and Holtappels 2021). Analogical thinking, thus, could be understood as a precondition for the development of inter- and transdisciplinary collaboration heuristics which might possibly lead to the experimental creation of third knowledge spaces.

While, for various reasons, my material kept sitting in the bag, I immersed myself the following years in a deeper study of pragmatism, neopragmatism, and their possible articulation with anthropology, social theory and STS. Consequently, the return to the empirical material presented in the paper is equally impacted through my acquaintance with the experimental perspective inherited through the pragmatist legacy. It made me sensitive to an experience-based approach that might contribute to a collaborative heuristic, although, by the time of my research, I was not focused on collaboration but on observation.

From this positionality transformation, the Parisian and PNG studies, still approximately explored to date, allow the determination of three similarities between taxonomist and ethnographic fieldwork: Firstly, they are exposed to similar contextual challenges through the current ontological reconfiguration of nature and society; secondly, they adopt experimental methodologies to sustain their research infrastructures and adjust them to their goals; and, thirdly, both taxonomist and ethnographic fieldwork enact transdisciplinary collaboration between human and nonhuman participants in particular geopolitical environments. Hence, it seems reasonable to suggest that a more systematic exploration of these similarities could pave the way for analogical thinking between nature and society and foster cross-disciplinary collaboration in the Anthropocene.

Accordingly, figure 4 shows "experimental enrolment through a shared field sciences approach". The epistemic separation between the natural (N = green) and the social sciences (S =blue) is still maintained on the level of academic knowledge organization – expressed again through the two distinct core rings. However, both of them have enrolled important epistemic features of what was formerly excluded (Fig. 2b), that is (left circles) 'society' is part of 'nature' as an object of research, and *vice versa* (right circles). They are related to each other through a shared field sciences approach, containing epistemic features of research in both disciplinary families, and through analogical thinking on the level of methodology (blue arrow), that is, through an experimental exploration of the similarities between their respective fieldwork practices and knowledge:

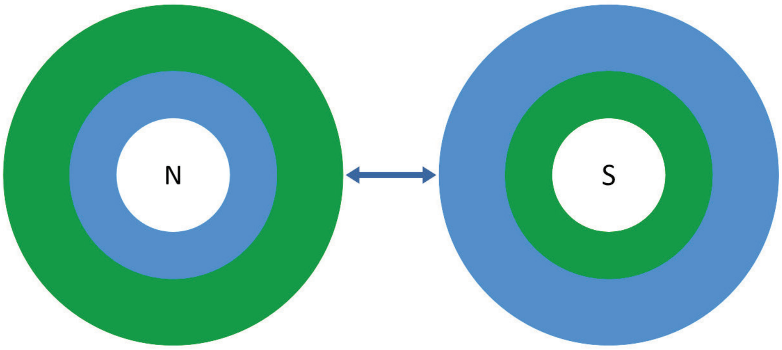


Figure 4. Experimental enrollment through a shared "field-sciences" approach

With the theoretical resurgence of classical pragmatism, fieldwork in the age of the Anthropocene points to a core epistemic continuity between nature and society as objects of inquiry, which is strikingly topical again today. While the laboratory as a metaphor for the observation and enactment of knowledge sometimes "tends to obscure rather than help to think" (Guggenheim, 2012: 15), fieldwork stems from concretely located places where naturalists and social scientists meet with heterogeneous participants. By featuring continuity between observation and object construction, 'the field' embraces alterity, difference and contingency where symmetry is unattainable. Aligning with pragmatism, science studies and the anthropology of nature, the social and cultural sciences have proliferated and innovated inter- and transdisciplinary instruments and concepts for "both observation and thought experiments" (Tsing et al., 2019: S000) which are good to think with. The analogical fieldwork heuristic outlined here allows one to set such an experimental methodological focus as a starting point for the organization of co-laborative research – thereby encouraging joint enactment with natural scientists on a more equal footing.

Conclusion

Pierre Bourdieu (1987), aiming to reconcile ethnology, sociology and philosophy, described his practice theoretical approach as the "fieldwork in philosophy". 'Fieldwork in the Anthropocene,' as I tried to demonstrate, consists of the realization of experimental collaboration in times of eco-social crisis and epistemic sensitivity. At the start of this paper, I wondered about the possibilities of analogical thinking *between* nature and society throughout the Anthropocene moment. Throughout an observation of a French team of marine taxonomists doing research on biodiversity loss, I have explored a set of arguments showing that taxonomy and ethnography are good candidates to encompass the modern disciplinary nature/society divide. This divide concerns preeminently alienated epistemic cultures and research practices. For the taxonomists, establishing a collaborative methodological workflow, negotiating field access and "worlding" constituted three fundamental modes of knowledge enrollment to sustain and advance their disciplinary impact through the Anthropocene. It is similar with ethnographic inquiry; this includes the generation and reorientation of research experiences, trial situations and heterogeneous modes of collaboration. From here, I deduced a fourth, however, still hypothetic mode of enrollment, that I named 'experimental.' An experimental field sciences approach relating taxonomist and sociologists' methodologies of fieldwork, I conclude, could provide a good starting point for collaborative encounters between nature and society as research objects.

Today, social-scientific knowledge is increasingly solicited for participation in research projects and programs driven and led by natural scientists. This has effected, especially within STS research, hopeful expectations concerning the epistemic impact of our knowledge within such settings. Yet, this hopefulness often clashes with the rather "awkward forms of 'experimental politics' that […] animate" such collaborations (Fitzgerald et al., 2014: 703ff.). The question of how to navigate, as social scientists, within natural scientific-dominated frameworks where the "understandings of 'the social' […] become the most significant force against which our work to negotiate a deeper collaboration must be orientated" (Balmer et al., 2015: 20) remains a challenging task. This is why methodology matters. Analogical thinking could encourage interdisciplinary work by combining methodological pragmatism and enhanced reflexivity with "radical hope." Such work does not exclude difference and critique – on the contrary. But my guess is that it is more challenging – and more important actually – to carve out similarities beyond heterogeneity. This is, not the least, a democratic concern in times of mounting political disparities.

Admittedly, my account presented in the paper only gives a very general idea of what "analogical thinking" beyond academic division means exactly when putting it to the empirical test. Moreover, the twist of '*analogical* thinking' in the *digital* age plays with the slight, yet ironically, self-limiting preference for methodological exploration through classical scientific craft experience as 'making and repairing,' another pragmatist '*clin d'oeil*' (Sennett, 2012). However, as the example of the Parisian taxonomists shows, fieldwork, either naturalist or ethnographic, does not exclude digital and quantified knowledge but can provide opportunities for their problem-oriented integration (Niewöhner, 2021).

The Anthropocene event is a good momentum to explore the possibilities of analogical thinking – without being naive about its epistemic limits, as well as its practical impediments. Such possibilities are, in a time of planetary ecological destruction and the global crisis of democracy, precious antidotes to the 'poisoned gift of the Anthropocene' for the human sciences still waiting to be further explored. Exchanging with taxonomists and other natural scientists while doing fieldwork in the Anthropocene provides an excellent starting point for mutual learning. By discussing methodological similarities and fieldwork experiences either in scientists' workplaces, in a rural area or during an expedition overseas, those being formerly "research subjects" for STS research, can become "epistemic partners" (Bieler et. al., 2021: 91). To be sure, such a transformation needs epistemic partners that are open "to confront, discuss, and transform the challenges and contingencies of epistemic practices" (Bieler et al., 2021: 91). Reassembling these practices could foster true collaborative research so much needed these days. Analogical thinking through fieldwork allows STS researchers, as a heuristic, to immerse themselves into the fascinating world of natural-scientific research while mentally staying on familiar methodological ground. It consists of discovering, exploring, and profiling analogies across methodological divisions where they are far from obvious. Such, still tentative, assumptions will constitute the baseline for the further development of an empirically based interdisciplinary *field science* research framework.

Acknowledgements

I am grateful to the anonymous reviewers and to the editor for their extensive feedback and helpful suggestions. This research was / is supported by Thyssen-Stiftung (AZ 50.12.0.033); Fondation de la Maison des Sciences de l'Homme (FMSH) Paris/France, German Academic Exchange Service; and Deutsche Forschungsgemeinschaft (DFG) (GZ: BO 3268/4-1). I owe a special debt to Philippe Bouchet and his team, and to the members of the biodiversity expedition of 2012–2013 to Madang, Papua New Guinea.

References

Abbott A (2006) Le chaos des disciplines. In: Boutier J, Passeron JC and Fabiani JL (eds) *Qu'est qu'une discipline?* Paris: Éditions EHESS, pp. 35-67.

Anderson W (2002) Introduction: Postcolonial technoscience. *Social Studies of Science* 32(5/6): 643-658.

Balmer AS, Calvert J, Marris C et al. (2015) Taking Roles in Interdisciplinary Collaborations: Reflections on Working in Post-ELSI Spaces in the UK Synthetic Biology Community. *Science & Technology Studies* 28(3): 3-25.

Bamford S (2002) On Being "Natural" in the Rainforest Marketplace: Science, Capitalism, and the Commodification of Biodiversity. *Social Analysis* 46 (1): 35-50.

Barry A and Born G (2011) *Interdisciplinarity. Reconfigurations of the Social and Natural Sciences*. London: Routledge.

Benton T (1991) Biology and Social Science. Why the Return of the Repressed should be given a (cautious) Welcome. *Sociology* 25 (1): 1-29.

Bieler P, Bister MD, Hauer J et al. (2020) Distributing reflexivity through co-laborative ethnography. *Journal of Contemporary Ethnography* 50(1): 77-98.

Billi M, Blanco G and Urquiza A (2019) What is the 'Social' in Climate Change Research? A Case Study on Scientific Representations from Chile. *Minerva* 57: 293-315.

Blok A and Bruun Jensen C (2019) The Anthropocene event in social theory: On ways of problematizing nonhuman materiality differently. *The Sociological Review* 67(6): 1195-1211.

Bogusz T (2022) *Experimentalism and Sociology. From Crisis to Experience*. Cham: Springer Nature.

Bogusz T and Holtappels M (2021) Third Knowledge Spaces between Nature and Society. A Dialogue. *Historical Social Research* 46 (2): 264-286.

Boltanski L and Thévenot L (1999) The sociology of critical capacity. *European Journal of Social Theory* 2(3): 359-377.

Bouchet P (2006) The magnitude of biodiversity. In: Duarte CM (ed) *The Exploration of Marine Biodiversity. Scientific and Technological Challenges.* Bilbao: Fundación BBVA, 31-62.

Bourdieu P (1987) Fieldwork in philosophy. In: *In Other Words. Essays towards a Reflexive Sociology*. Stanford: Stanford University Press, pp. 3-32.

Bourdieu P (2000) *Esquisse d'une théorie de la pratique. Précédé de trois études d'ethnologie kabyle*. Paris: Seuil.

Bourdieu P (2001) *Science de la science et réflexivité*. Paris: Raisons d'agir.

Bowker GC (2000) Biodiversity datadiversity. *Social Studies of Science* 30(5): 643-683.

Brown B (2019) From critique to experiment? Rethinking political ecology in the Anthropocene. In: Bridge T and McCarthy J (eds) *The Routledge Handbook of Political Ecology.* London: Routledge, pp. 102-114.

Brown R, Deletic A and Wong T (2015) How to catalyse collaboration. *Nature* 525: 315-317.

Burt T and Thompson D (2020) *Curious about Nature. A Passion for Fieldwork*. Cambridge. Cambridge University Press.

Callon M (1999) Some elements of a sociology of translation. Domestication of the scallops and the fishermen of Saint Brieuc Bay. In: Biagioli M (ed) *The Science Studies Reader*. London: Routledge, pp. 67-83.

Chakrabarty D (2021) *The Climate of History in a Planetary Age*. Chicago: Chicago University Press.

Collins H and Evans E (2002) The third wave of science studies: Studies of experience and expertise. *Social Studies of Science* 32: 235-296.

Communiqué de Presse (2013): *Retour de l'expédition Papouasie Nouvelle Guinée. Premier bilan*. February 27th. Edited by Agence Observatoire, Agence Buzz District, Muséum national d'histoire naturelle and the Institut de recherche pour le développement (IRD) / French National Research Institut for Sustainable Development.

Costello M, May RM and Stork NE (2013) Can we name Earth species before they go extinct? *Science* 339 (6118): 413-416.

Descola P (1996) Constructing natures. Symbolic ecology and social practice. In Descola P and Pálsson G (eds) *Nature and Society. Anthropological Perspectives*. London: Routledge, pp. 82-102.

Descola P (2013) *Beyond Nature and Culture.* Chicago: Chicago University Press.

Dewey J (1896) The reflex arc concept in psychology. *The Psychological Review* III (4): 355-370.

Dewey J (1906) The experimental theory of knowledge. In: Boydston JA (ed) *The Middle Works (1899–1924), Volume 3*. Carbondale and Edwardsville: Southern Illinois University Press, pp. 107-127.

Dewey J (1956) *The Public and Its Problems*. Athens, OH: Swallo Press and Ohio University Press.

Dewey J (1983) *Experience and Nature*, *The Later Works of John Dewey, 1925-53*, vol. 1 (LW 1). In: Boydston, JA (ed) Carbondale & Edwardsville: Southern Illinois University Press.

Dewey J (1984) *The Quest for Certainty. A Study of the Relation of Knowledge and Action*, *The Later Works of J. Dewey, 1925-53*, vol. 4 (LW 4). In: Boydston JA (ed) Carbondale & Edwardsville: Southern Illinois University Press.

Dewey J (2008) *Logic: The Theory of Inquiry*, *The Later Works of J. Dewey, 1925-53*, vol. 12 (LW 12). In: Boydston JA (ed) Carbondale & Edwardsville: Southern Illinois University Press.

Ellis R, Waterton C and Wynne B (2010) Taxonomy, biodiversity and their publics in twenty-first-century DNA-barcoding. *Public Understanding of Science* 19 (4): 497-512.

Engels A and Walz K (2018) Dealing with multiperspectivity in real-world laboratories. Experiences from the transdisciplinary research project Urban Transformation Laboratories. *Gaia* 27(S1): 39-45.

Faugère E (2019) *Le making-of des grandes expéditions. Anthropologie des sciences de terrain*. Marseille. Éditions la Discussion.

Faure B (2012) Il ne faut pas fâcher les dieux de l'océan. Expeditions blog "La planete revisitee", posted December 28, 2012. Available at: http://blog-preprod-v2.laplaneterevisitee.org/index.php?q=Baptiste+Faure (accessed 25 March 2021).

Felt U, Igelsböck J and Schikowitz A (2013) Growing Into What? The (Un-)disciplined Socialisation of Early Stage Researchers in Transdisciplinary Research'. *Higher Education* 65(4): 511-524.

Fitzgerald D, Littlefield MM, Knudsen KJ et al. (2014) Ambivalence, equivocation and the politics of experimental knowledge: A transdisciplinary neuroscience encounter. *Social Studies of Science* 44(5): 701-721. DOI: 10.1177/0306312714531473

Fleischner TL, Espinoza RE and Gerrish G (2017) Teaching biology in the field: Importance, challenges, and solutions. *BioScience* 67(6): 558–567.

Folke C, Polasky S, Rockström J et al. (2021) Our future in the Anthropocene biosphere. *Ambio* 50: 834–869. Available at: https://link.springer.com/content/pdf/10.1007/s13280-021-01544-8.pdf (accessed 23 March 2021).

Freeth R and Villsmaier U (2020) Researching Collaborative Interdisciplinary Teams: Practices and Principles for Navigating Researcher Positionality. *Science & Technology Studies* 33 (3): 57-72.

Gieryn TF (2006) City as truth spot. Laboratories and field sites in urban studies. *Social Studies of Science* 36(1): 5-38.

Groß M, Hoffmann-Riem H and Krohn W (2005) *Realexperimente. Ökologische Gestaltungsprozesse in der Wissensgesellschaft*. Bielefeld: transcript.

Guggenheim M (2012) Laboratizing and de-laboratizing the world: Changing sociological concepts for places of knowledge production. *History of the Human Sciences* 25(1): 99-118.

Haraway D (2015) Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin. *Environmental Humanities* 6: 159-165.

Hastrup K (2014) Comparing climate worlds. Theorising across ethnographic fields. In: Greschke H and Tischler J (eds) *Grounding Global Climate Change*. Wiesbaden: Springer VS, 139-154.

Hastrup K and Hastrup F (2015) Waterworlds at large. In: Hastrup K and Hastrup F (eds) *Waterworlds. Anthropology in Fluid Environments*. New York: Berghahn Books, pp. 1-22.

Helmreich S (2009) *Alien Ocean. Anthropological Voyages in Microbial Seas*. Berkeley: University of California Press.

Hornborg A (2017) Artifacts have consequences, not agency. Toward a critical theory of global environmental history. *European Journal of Social Theory* 20 (1): 95-110.

Hornidge AK (2018) A research vessel: Heterotopia, boundary place, and pluriverse of epistemes. In: Poferl A and Pfadenhauer M (eds) *Wissenrelationen*. Weinheim: Beltz Juventa, pp. 430-441.

James W (1922) *Essays in Radical Empiricism*. New York: Longmans, Green & Co.

James W (1976): Does 'consciousness' exist? In: *William James: Essays in Radical Empiricism*. Cambridge, Massachusetts and London: Harvard University Press, pp. 3-19.

Keck F and Lynteris C (2018) Zoonosis. Prospects and challenges for medical anthropology. *Medicine Anthropology Theory* 5(3): 1-14.

Knorr-Cetina K (1999) *Epistemic Cultures: How the Sciences Make Knowledge*. Harvard: Harvard University Press.

Kohler RE (2002) *Landscapes and Labscapes. Exploring the Lab-Field-Border in Biology*. Chicago: Chicago University Press.

Kohler RE (2006) *All Creatures. Naturalists, Collectors, and Biodiversity, 1850-1950*. Princeton: Princeton University Press.

Kolbert E (2014) *The Sixth Extinction. An Unnatural History*. New York: Henry Holbert and Co.

La planéte revisitée (2013) *Retour de l'expédition Papouasie-Nouvelle-Guinée. Premier bilan*. Museúm national d'histoire naturelle.

Latour B (1999) Circulating reference. Sampling the soil in the Amazon Forest. In: Latour B (ed) *Pandora's Hope.* Cambridge, Mass.: Harvard University Press, pp. 24-79.

Latour B (2014) Anthropology at the Time of the Anthropocene – a Personal view on what is to be studied. Distinguished Lecture at the American Association of Anthropologists, Washington, December 2014. Available at: http://www.bruno-latour.fr/sites/default/files/139-AAA-Washington.pdf (accessed 18 March 2021).

Latour B (2018) *Down to Earth. Politics in the New Climatic Regime*. London: Polity Press.

Latour B and Woolgar S (1986) *Laboratory Life. The Construction of Scientific Facts*. Princeton, N.J: Princeton University Press.

Law J (1987) Technology and heterogeneous engineering. The case of Portuguese expansion. In: Bijker W, Hughes T and Pinch T (eds) *The Social Construction of Technological Systems.* Cambridge, Massachusetts: MIT Press, pp. 111-134.

Lepenies W (1976) *Das Ende der Naturgeschichte*. München: Hanser.

Leshem N and Pinkerton A (2019) Rethinking expeditions. On critical expeditionary practice. *Progress in Human Geography* 43(3): 496-514.

Lewis HS (2001) Boas, Darwin, science, and anthropology. *Current Anthropology* 42(3): 381–406.

Lidskog R and Waterton C (2016) Anthropocene – a cautious welcome from environmental sociology? *Environmental Sociology* 2(4): 395-406.

Manceron V (2015) "Avant que la nature meure"… inventorier. Le cas des naturalistes amateurs en Angleterre. *Ethnologie française* 45(1): 31-43.

Marcus GE (1995) Ethnography in/of the world system: The emergence of multi-sited ethnography. *Annual Review of Anthropology* 24(1): 95-117.

Marguin S, Haus J, Heinrich AJ, Kahl A, Schendzielorz C and Singh A (eds) (2021) Positionality Reloaded: Debating the Dimensions of Reflexivity in the Relationship Between Science and Society. Special issue. *Historical Social Research / Historische Sozialforschung* 46(2).

Marres N (2012) *Material Participation. Technology, Environment and the Everyday Publics*. London: Palgrave Macmillan.

Mead GH (1929) A Pragmatic Theory of Truth. In: Mead GH (ed) *Studies in the Nature of Truth.* Berkeley: University of California Press, pp. 65-88.

Moore J (2017) The Capitalocene, Part I: On the nature and origins of our ecological crisis. *The Journal of Peasant Studies* 44 (3): 594–630.

Niewöhner J (2014) Perspektiven der Infrastrukturforschung: care-ful, relational, ko-laborativ. In: Lengersdorfer D and Wiesner M (eds) *Schlüsselwerke der Science and Technology* Studies, Wiesbaden: Springer VS, pp. 341-352.

Niewöhner J (2016) Co-laborative anthropology: Crafting reflexivities experimentally [The Finnish translation of this piece has been published in: Jouhki J and Steel T (eds) Etnologinen tulkinta ja analyysi: kohti avoimempaa tutkimusprosessia. Helsinki: Suomen kansatieteilijöiden yhdistys Ethnos ry, pp. 81-125.

Niewöhner J (2021) Making Evidence in the Future Perfect: Provincialising Climate Impact Science in the Quest for More-Than-Human Liveability. *Historical Social Research* 46(2): 35-58.

Nowotny H (2016) *The Cunning of Uncertainty*. London: Wiley.

Palmer V (1928) *Field Studies in Sociology. A Students Manual*. Chicago: Chicago University Press.

Peirce CS (1997) *Pragmatism as a Principle and Method of Right Thinking.* Edited by Turisi PA. Albany, NY: State University of New York Press.

Pickering A (2009) Science, Contingency, and Ontology. Conference paper, Conference *on 'Science as it could have been: Perspectives on the contingent/inevitable aspects of scientific practice,' Fondation des Treilles*, Tourtour, France, 31 Aug-4 Sept 2009. Available at: https://ore.exeter.ac.uk/repository/bitstream/handle/10036/81575/lesT-240609.pdf;sequence=1, (accessed 10 May 2022).

Press Kit (2012) *Our Planet Reviewed. Taking a Closer Look on Biodiversity Hotspots. Expedition Papua New Guinea 2012-2013*. Pro Natura International, Muséum National d'Histoire Naturelle, Institut de Recherche pour le Développement.

Puillandre N, Bouchet P, Boisselier MC et al. (2012) New taxonomy and old collections: Integrating DNA-barcoding into the collection curation process. *Molecular Ecology Resources* 12(3): 396–402.

Randeria S (1999) Jenseits von Soziologie und soziokultureller Anthropologie. Zur Ortsbestimmung der nichtwestlichen Welt in einer zukünftigen Sozialtheorie. *Soziale Welt* 50(4): 373-382.

Rios-Saldania A, Delibes-Mateos M and Ferreira CC (2018) Are fieldwork studies being relegated to second place in conservation science? *Global Ecology and Conservation* 14: e00389.

Robben A and Sluka J (eds) (2012) *Ethnographic Fieldwork: An Anthropological Reader,* Hoboken, NJ: Wiley-Blackwell.

Robin L (2011) The Rise of the Idea of Biodiversity: Crises, Responses, and Expertise. In: Granjou C and Mauz I (eds): Special Issue "Les promesses de la biodiversité", *Quaderni – Communication, Technologies, Pouvoir,* Paris: Éditions de la Maison des sciences de l'homme, pp. 25-37.

Secretariat of the Convention on Biological Diversity (2011) *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. Text and Annex*. Montréal, Quebec. United Nations Environmental Programme. Available at: https://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf, (accessed 24 March 2021).

Sennett R (2012) *Together. The Rituals, Pleasures and Politics of Cooperation*. London: Penguin.

Star SL (1993) Cooperation without Consensus in Scientific Problem Solving: Dynamics of Closure in Open Systems. In: Easterbrook S (ed) CSCW: *Cooperation or Conflict? Computer Supported Cooperative Work*, Springer: London, pp. 93-106.

Star SL (1999) The ethnography of infrastructure. *American Behavioral Scientist* 43(3): 377-391.

Star SL and Griesemer J (1989) Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science* 19(3): 387-420.

Steffen W, Grinevald J, Crutzen P et. al. (2011): The Anthropocene: conceptual and historical perspectives. *Philosophical Transactions of the Royal Society* 369: 842-867.

Stocking GW (ed) (1983) *Observers Observed. Essays on Ethnographic Fieldwork*. Madison: University of Wisconsin.

Strathern M (1999) *Property, Substance and Effect. Anthropological Essays on Persons and Things*. London, etc.: The Athlone Press.

Thomas M (ed) (2015) *Expedition into Empire. Exploratory Journeys and the Making of the Modern World*. London: Routledge.

Torres-Colón G and Hobbs CA (2015) The intertwining of culture and nature: Franz Boas, John Dewey, and Deweyan strands of American anthropology. *Journal of the History of Ideas* 76(1): 139–162.

Tsing A (2010) Worlding the Matsutake diaspora. Or, can actor–network theory experiment with holism? In: Ton O and Bubandt N (eds) *Experiments in Holism*. Oxford, UK: Wiley-Blackwell, pp. 47-66.

Tsing A, Matthews AS and Bubandt N (2019) Patchy Anthropocene. Landscape structure, multispecies history, and the retooling of anthropology: An introduction to supplement 20. *Current Anthropology* 60(S20): S187-S197.

Verran H (2002) A postcolonial moment in science studies. *Social Studies of Science* 32(5-6): 729-762.

Waterton C, Ellis R and Wynne B (2013) *Barcoding Nature. Shifting Cultures of Taxonomy in an Age of Biodiversity Loss*. London & New York: Routledge.

Weber A (2019) Collecting Colonial Nature. European Naturalists and the Netherlands Indies in the Early Nineteenth Century. *BMGN — Low Countries Historical Review* 134 (3): 72-95.

Weiner JF and Glaskin K (eds) (2006) *Customary Land Tenure and Registration in Papua New Guinea and Australia: Anthropological Perspectives*. Canberra: ANUE Press.

West P (2006) *Conservation is our Government Now. The Politics of Ecology in Papua New Guinea,* Durham & London: Duke University Press.

West P (2016) *Dispossession and the Environment. Rhetoric and Inequality in Papua New Guinea*. New York: Columbia University Press.

Technological Expectations and the Making of Europe

Jens Hälterlein
Department of Media Studies, Paderborn University, Germany/
jens.haelterlein@upb.de

Abstract

In a case study approach, the paper traces how technological expectations have been influential in the creation of European institutions, R&D programmes and regulatory instruments and how they have contributed to processes of European integration. The first case study shows how the promises of a coming 'Atomic Age' have been mobilized to support the foundation of the European Atomic Energy Community and, thus, contributed to European integration in the post-WW2 era. The second case study analyses how the security stream within the EU's framework programmes for R&D is shaped by the promise of 'technosecurity' and enacts the normative claim of the EU's security integration in the post-Cold War era. The third case study analyses how the EU's AI strategy and AI act articulate the vision of a 'human-centric AI' and how this vision is related to the EU's current attempt to restore citizens' trust in times of crisis.

Keywords: Europe, Technological Expectations, Nuclear Power, Security Technologies, Artificial Intelligence

Introduction

The future of the 'European project' has frequently been addressed as a question of developing and regulating new and emerging technologies that are at once praised as a driver of progress and seen as a major source of problems. In the post-WW2 era, nuclear power fuelled the hope to replace all other power sources and ultimately lead Europe into an age of peace and prosperity. In its weaponized form, however, it became an existential threat to Europe being a likely battlefield of a nuclear war. In the post-Cold War era, digital infrastructures and Information and Communication Technologies (ICTs) became the lifelines of Europe's high-tech societies and at the same time a source of their susceptibility to cyberattacks, natural disasters, major accidents and highly contagious diseases. Recently, Artificial Intelligence (AI) has been imagined as a panacea for all kinds of societal grand challenges and as a multifaceted threat to the fundamental rights and even lives of the citizens of the European Union (EU).

In order to take advantage of the opportunities, these technologies create and control the risks they entail, their development and regulation have become problems that a European government and politics have to address. As they mobilized and legitimized activities and resources they contributed to the formation of governance of science, technology and innovation (ST&I) on a European level (Barry, 2001). However, the fears and promises associated with these technologies not only sparked the definition of rules and undertaking of measures to push ahead innovation or restrict their use. They also functioned as a crucial component of endeavours to advance the 'European project'. Within these endeavours, technologies became 'Europe-building tools', instruments of connection either creating unifying themes for national policies or new challenges that could only be addressed collectively.

The purpose of this paper is to acknowledge how European integration after WW2 was and is connected to technologies that figure both as objects of political intervention and as media for the construction of a political community. In a case study approach, the paper traces how technological expectations have been influential in the creation of European institutions, R&D programmes and regulatory instruments and how they have contributed to processes of European integration. The first case study shows how the promises of a coming 'Atomic Age' have been mobilized to support the foundation of the European Atomic Energy Community (EURATOM) and, thus, contributed to European integration in the post-WW2 era. The second case study analyses how the security stream within the EU's framework programmes for R&D is shaped by the promise of 'technosecurity' and enacts these promises in a way that reflects the normative claim of the EU's security integration in the post-Cold War era. The third case study analyses how the EU's AI strategy and AI act articulate the vision of a 'human-centric AI' and how this vision is related to the EU's current attempt to restore citizens' trust in times of crisis. The following section discusses the two relevant research strands on the topic and presents the central findings of the paper.

Connecting technological expectations and European integration in a historical case study approach

Expectations in science and technology have been studied under various terms such as technoscientific promises, technophobia, guiding visions ('leitbilder'), and (sociotechnical) imaginaries (for an overview, see: Konrad et al., 2017). These expectations can have a range of effects in the context of R&D, ST&I policies and public engagement. By promising future economic success, they can attract investments from private and public actors (Beckert, 2013). They can serve as epistemic orientation and coordination in heterogeneous innovation networks by pre-selecting design options and synchronizing expectations (Fujimura, 2003). They influence the acceptance or rejection of technologies among users and the general public (Brown et al., 2000). And they legitimize or delegitimize the actions of public authorities such as the funding of national R&D programmes, investments in material infrastructures and legislative initiatives (Jasanoff and Kim, 2009). While technological expectations and their effects have been studied in numerous contexts and with various scopes, their role in the creation of political communities and the imagination of nationhood has received comparatively little attention, especially with regard to the European project (see, for instance: European Commission and Directorate-General for Research and Innovation, 2007 and Mager, 2017).

Investigating the technological dimension of European integration places this paper in the tradition of another research strand. Scholarship on the history of technology[1] has shown that transnational infrastructures, material networks and the circulation of knowledge and artefacts have shaped European identities in a bottom-up "hidden integration" process starting in the 1850s (Misa and Schot, 2005: 2). Moreover, it has been proposed to view certain technology developments and large-scale technological projects "as a set of Europe-building practices in which specific concepts and visions of Europe became embedded in particular designs for artefacts and systems" (Misa and Schot, 2005: 9). This research strand investigates the co-production of technology and Europe by means of what Gabrielle Hecht (1998: 15) has labelled *technopolitics*: "the strategic practice of designing or using technology to constitute, embody, or enact political goals". While scholarship from the history of technology has focussed on the technopolitics of producing, standardizing and using technologies, infrastructures, products and expertise, the technopolitics of mobilizing and addressing expectations in science and technology has received far less attention.

Connecting both research strands, this paper presents three cases that exemplify how technological expectations have shaped European integration processes after WW2.

The case studies primarily draw on in-depth analysis of European policy documents – statements, reports, communications, treaties, and legal texts. All of them are publicly available via online repositories. These documents are the result of complex negotiation procedures between various actors which are, however, outside the scope of this paper. In addition, the case studies integrate research findings on various individual aspects of the topics that have been produced in STS and adjacent disciplines. Even though the aim of this paper is not to produce a comprehensive account of the history of European integration, the insights it provides go beyond the individual cases. Together, the three cases display shifting strategies to advance European integration and different meanings of the European project. But they also display a constant preoccupation of European government and politics with the problems technology poses and with the potential benefits it promises. Moreover, the paper reveals recurrent themes that prevail throughout the cases: the security-technology-nexus, the problem of constructing a single market for technologies and the need to address their potential dual-use. Combining historical and contemporary cases, thus, enables us to reflect the simultaneity of continuity and discontinuity in the making of Europe.

The 'Atomic Age' - nuclear power and European integration in the post-WW2 era

The end of WW2 not only marked a rupture in European history but also heralded the 'Atomic Age'. Advancement in harnessing the power of atoms created new, ambivalent relationships among science, technology and society. On the one hand, these advancements led to the development of nuclear weapons whose destructive power has been demonstrated to the world with the bombings of Hiroshima and Nagasaki. These events not only led to the unconditional surrender of Japan but were also catalysts for a 'Cold War' arms race that culminated in the antagonistic conflict of two superpowers equipped with weapon arsenals of unprecedented destructiveness. The notion of 'nuclear exceptionalism' was cultivated to indicate both the exceptional nature of this human creation and the exceptional global power of the U.S. and the Soviet Union (Hecht, 2006). Consequently, the decision to build or possess nuclear weapons may not only follow security and defence considerations but also serve the symbolic purpose of demonstrating national strength and greatness. Becoming a nuclear weapon state, thus, shapes and is shaped by a state's national identity (Sagan, 1996). For anti-nuclear activists and engaged scientists, however, the mere possibility of a first (or pre-emptive) strike carried out by one of the nuclear powers, no matter how likely or unlikely, revealed that technoscience is producing risks of vital scope. The dystopian imaginary of a 'nuclear apocalypse' that could consume all life on the planet stood as a symbol of a society that creates the powers of its annihilation. It sparked the creation of popular culture, mobilized nuclear disarmament movements and led to the implementation of nuclear civil defence systems in the U.S., the Soviet Union and almost all countries of Western Europe (Cronqvist et al., 2022). On the other hand, the peaceful use of nuclear power was celebrated as the solution to the problem of securing a sufficient energy supply for the growing national economies. The origins of this promise can be traced back to the early days of research on radioactivity (Weart, 2012). After WW2, the U.S.' Atoms for Peace campaign, as well as international conferences, science exhibitions and media representations publicly promoted nuclear power as the ultimate solution to future energy problems (Spiering, 2011; Trischler and Bud, 2018). Nuclear energy was expected to replace all other power sources and ultimately lead to an age of peace and prosperity for humankind since it would "provide the power needed to desalinate water for the thirsty, irrigate deserts for the hungry, and fuel interstellar travel deep into outer space." (Sovacool, 2011: 259) The imaginary of a coming 'Atomic Age' as a desirable future equated the peaceful use of nuclear power with progress and modernity per se. It sparked the imagination of inventors and policymakers alike, leading to the development of food irradiation and nuclear medicine and legitimizing research funding for the development of nuclear-powered cars and aircraft.

For the two superpowers as well as many countries both in Europe and on the 'nuclear periphery', the development and regulation of nuclear energy offered the possibility to secure economic progress, demonstrate technological prowess, and present themselves as guided by rational, scientific means (Hecht, 1998, 2006; Jasanoff and Kim, 2009; Kaijser, 2021; Richers et al., 2018; Welsh, 2000). At the same time, developing or being in the possession of nuclear weapons became the ultimate signature of the geopolitical status of a nation (Hecht, 2006). For the making and shaping of Europe, 'nuclear identity' has been no less important. The promises of a coming Atomic Age influenced the articulation of a vision of Europe that rested on the classical modern understanding of progress as a marker of the ties between science and the state. It portrayed a „European government that was based on the advanced areas of scientific research and justified by the increasing economic demands of science." (Barry and Walters, 2003: 310) This entanglement of Big Science with early post-WW2 politics was different from the one in the U.S., the Soviet Union, the U.K. and France where publicly funded nuclear research was connected to both, nuclear energy and nuclear weapons development (Hecht, 1998; Holloway, 1994; Krige, 2016; Rhodes, 1988; Richers et al., 2018; Welsh, 2000). By drawing a dividing line between the military and the civil use of the atom, between the utopian and the dystopian elements of the 'Atomic Age', European integration was envisioned as a result of cooperation in the nuclear energy sector only.

Due to the geopolitical constellation that placed Europe at the centre of the "Cold War' it was widely expected that the continent would be turned into a battlefield in case of a clash of the two superpowers (Spiering, 2011: 171). Therefore, nuclear deterrence played a fundamental role in keeping peace and preserving stability on the continent. As part of the North Atlantic Treaty Organisation (NATO) strategy of Western defence integration and nuclear deterrence policy, both land- and air-based delivery systems of the U.S. Army were deployed in the U.K., France, Belgium, Germany, the Netherlands, and Italy since the 1950s. For most of the European NATO members, nuclear deterrence rested on the U.S. (except for Britain and France). Only two Western European states successfully developed their own nuclear deterrent – Britain in 1952 and France in 1960. While the British nuclear programme benefited strongly from U.S. aid and consequently led to a status where its nuclear forces were fully integrated into the nuclear defence strategy of the NATO, France used its nuclear weapons (the 'force de frappe') to gain the ability to distance itself from NATO and to defend France even if the U.S. refused to assist in the event of a Soviet nuclear attack or invasion. On the contrary, an integrated deterrence under the collective control of Western Europe (as a result of the 'Europeanisation' of the French nuclear deterrence) never became a real option (Sauer, 2020).[2] This dependency in the field of nuclear deterrence was symptomatic of the failure of European security and defence integration during the 'Cold War'. In 1954, an early attempt to create a European Political Community (EPC) – envisioned as a combination of the existing European Coal and Steel Community (ECSC) and the proposed European Defence Community (EDC) – failed after the French National Assembly refused to ratify the Treaty establishing the EDC which proposed the creation of a European army at the disposal of the EDC.

However, already in June 1955, the foreign ministers of the six member-states of the ECSC proposed „to take a new step on the road of European construction" (Commission of the European Communities, 1955: 2) through both 'horizontal' integration by establishing a common market and 'vertical' integration in the transport and energy sector. Besides securing the supply of conventional energy, one of the objectives defined in the *Messina Declaration* was the „development of atomic energy for peaceful purposes" which "will very soon open up the prospect of a new industrial revolution beyond comparison with that of the last hundred years" (Commission of the European Communities, 1955: 2). Here, the *Messina Declaration* used the high expectations regarding nuclear energy to call for a collective endeavour. This endeavour, however, would necessarily imply a transfer of power from the nation states to a new European institution: Sectoral integration in the field of nuclear energy would require „the creation of a joint organization to which will be assigned the responsibility and the means to secure the peaceful development of Atomic Energy“ (Commission of the European Communities, 1955: 2). With the creation of the *European Organization for Nuclear Research* (CERN) in 1953 and the *European Atomic Energy Society* (EAES) in 1954, two joint organizations had already been established. However, the missions of both organizations were limited to research cooperation. While the CERN was supposed to create a European laboratory for basic research in nuclear and particle physics, the EAES was supposed to facilitate exchange on civil nuclear energy research by organizing meetings for scientists and engineers working in the field (European Atomic Energy Society, 1954). The objectives of nuclear energy integration as envisioned in the *Messina Declaration* and the *Spaak Report* (Comité intergouvernemental créé par la conférence de Messine, 1956) would go beyond research cooperation and would also include common investments and joint ventures, the centralized supply of the member states with ores and nuclear fuel, a common market for materials, tools and special equipment, and a new European organization with exclusive competences in nuclear energy matters and far-reaching supervisory powers.[3] This new organization would operate under the name *European Atomic Energy Community* (EURATOM).

There was ample reason to believe in the success of this endeavour. Being a technology under development, nuclear energy was perceived as an unregulated field of S&T policy (Barry and Walters, 2003: 309). Thus, there was hope that common efforts in the nuclear energy sector would not have to deal with established national interests and could gain the benefits of collaboration in scale. Moreover, in its nascent stage, EURATOM was strongly supported by the U.S. since a regional organization for the promotion of civilian nuclear power in Europe was perceived as a focal point for the extension of the "Atoms for Peace" program beyond research.[4] In the eyes of the State Department and the Secretary of State John Foster Dulles, "nuclear science and technology provided the material infrastructure that would help bind the U.S.'s continental allies together" (Krige, 2008: 7). A second important assumption in favour of sectoral integration in the nuclear energy field was that necessary investments in infrastructure (including a steady supply with raw materials) and technology of nuclear R&D were so cost-intensive that they exceeded the financial capabilities of medium and small states of Western Europe. Therefore, the pooling of financial resources, industrial capacities and varied skills seemed to be the only way to let the promises of the peaceful use of the atom come true. This argument was first brought up in a report for the OEEC, commissioned in early 1954 and published in June 1955. The report predicted that „[n]uclear energy gives Europe the possibility of having an abundant supply of power at steadily decreasing cost in 15 or 20 years' time“ (Armand, 1955). However, „as many Member countries do not seem to dispose of the means required for carrying out a nuclear programme and there are a great many technical problems the solution of which will call for a co-ordinated effort backed by the mobilised industrial potential of all Member countries.“ (Armand, 1955) Finally, a third factor played into the hands of those political forces in favour of a collective effort in nuclear energy production: the perceived scarcity of fossil fuels at that time. In October 1956, the Ministers of Foreign Affairs of the six ECSC member states commissioned a report "on the amounts of nuclear energy which can be produced in the near future in the six EURATOM countries, and the means to be employed for this purpose“ (Armand et al., 1957: 13). The report entitled *A Target for EURATOM* highlighted the lack of significant coal deposits in Europe as well as the extent to which the ECSC countries were already dependent on oil from the Middle East. Moreover, it anticipated a growing need for energy over the next few years as requirements would double in ten years and treble in twenty. Therefore, any interruption of oil supplies would imply tremendous risks. Accordingly, the report recommended the replacement of power stations running on coal and oil and the creation of a nuclear sector producing competitively priced electricity:

> if our countries, guided and stimulated by EURATOM, make the necessary effort they will in future command - as the New World does now - abundant and cheap energy supplies, enabling them to enter boldly into the atomic era. (Armand et al., 1957: 17)

With the Treaty of Rome, signed in March 1957, EURATOM was established along with the EEC. Re-articulating the promises of the 'Atomic Age', the preamble of the Treaty establishing EURATOM states "that nuclear energy represents an essential resource for the development and invigoration of industry and will permit the advancement of the cause of peace" (EURATOM, 1958). The promise of energy security, however, was attached to a vision of Europe as the preamble expresses the conviction "that only a joint effort undertaken without delay can offer the prospect of achievements commensurate with the creative capacities of their countries" (EURATOM, 1958). Accordingly, the primary tasks of the nuclear energy community are "to contribute to the raising of the standard of living in the Member States […] by creating the conditions necessary for the speedy establishment and growth of nuclear industries" (EURATOM, 1958: 13). In order to perform this task, the Community shall undertake actions to ensure a regular and equitable supply of raw materials as well as commercial outlets and access to the best technical facilities (Article 2). For the former action, a EURATOM Supplies Agency (ESA) was to be created that would own and control the supply of all fissile materials in the Community. For the latter action, the Community shall create a common market for special materials and ensure free movement of capital for investment and freedom of employment for specialists in the nuclear energy sector. Furthermore, the Community is to "promote research and ensure the dissemination of technical information" (Article 2). Besides the promotion of nuclear research in the Member states, community research and training programmes and *Joint Nuclear Research Centre* were to be set up (Articles 4 and 8).

While the primary mission of EURATOM was the promotion of a nuclear industry within the Community, its secondary mission was the regulation of this industry. Accordingly, the Treaty defines measures by which the risks associated with the peaceful use of the atom should be governed. On the one hand, the Community declared to satisfy itself that "ores, source materials and special fissile materials are not diverted from their intended uses as declared by the users" (Article 77). The Treaty introduces a system of safeguards designed to ensure that civil nuclear material is not diverted for military purposes. However, the Treaty neither prohibits nor explicitly permits the possession of nuclear weapons. This was a sine qua non for the inclusion of France which was pursuing its nuclear weapons program at that time and threatened a veto if the treaty would include such a prohibition clause. On the other hand, EURATOM aimed to establish and apply uniform safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.

At the time of its adoption, EURATOM was seen as a progressive and charitable endeavour centred on promoting the collective development of a civil nuclear industry in Europe. However, while the CERN is acclaimed to be the model of successful European cooperation (Lalli, 2021; Mobach and Felt, 2022), this is not the case with EURATOM which is widely considered to have failed (Wolf, 2011) mainly for three reasons. Firstly, EURATOM wasn't able to coordinate national efforts in nuclear R&D. Eventually, national interests prevailed and the member states used higher funds for their national nuclear energy programs than they made available to EURATOM (Commission of the European Communities, 1968: 13). Secondly, contrary to the pessimistic forecasts preceding the EURATOM Treaty, global oil reserves proved to be sufficient due to the discovery of new deposits in the Global South, the expansion of production in the Soviet Union, and offshore production in the North Sea. Thirdly, the promises of a coming 'Atomic Age" lost their persuasiveness with nuclear energy increasingly being problematized both in terms of the possibility of nuclear accidents with disastrous consequences and in terms of the risks deriving from the handling and storage of nuclear waste.

The historical relevance of EURATOM, however, should not only be judged by its failure to create an integrated European nuclear industry. EURATOM embodied a vision of the European project that highlighted sectoral integration in the field of nuclear energy production as a necessary complementary approach to the project of a common market since an adequate supply of energy was imperative to sustain economic growth and political stability (Krige, 2006). In the period preceding the ratification of the Treaty of Rome, it was widely believed that EURATOM "held the greatest promise of success, while the EEC negotiations faltered" (European Parliament, 2002: 12). Moreover, the pairing of the two European Communities is considered as a "crucial factor in initially persuading and eventually convincing a sceptical French Government to engage with European integration after the embittering experience of the aborted European Defence Community" (European Parliament, 2002: VII). Therefore, the political radiance of EURATOM has been no less than the one of the CERN and other Big Science collaborations in Europe (Cramer, 2020). At a time when the 'Atomic Age' could still be understood in a positive, futuristic sense and a European identity was (even more than it is today) a fragile construct, the promises of a collective endeavour in nuclear energy production became a catalyst for European integration after WW2.

'Technosecurity' - European security research and security integration in the post-9/11 era

While the EURATOM treaty is still in force and nuclear energy is accounting for about one-fourth of the electricity produced in the EU, the promise of nuclear power to provide the ultimate means for peace and security has become even more controversial in the aftermath of the 1986 Chornobyl and the 2011 Fukushima disasters. With regard to the EU's objective to reach climate neutrality by 2050, most member states classify nuclear power as a 'clean energy' while some strictly oppose this view. The fear of Europe becoming a nuclear battlefield, on the other hand, lost ground after the fall of the iron curtain while at the same time a new imaginary of (in)security emerged that runs contrary to the categorical distinction between domestic and military security. The security of Western nation-states and their populations no longer appeared to be threatened by a clearly identifiable military enemy, but by a heterogeneous spectrum of threats, ranging from terrorism to transnational organized crime, large-scale disasters, illegal migration, and the spread of viruses throughout physical and virtual space. These multi-faceted, dynamic factors are seen as globalized insecurities of an increasingly globalised world, in which the circulation of people, goods, information and risks does not stop at national borders (Beck, 1998). Therefore, the post-Cold War security policies are addressing the ambiguity of the technological constitution of a physical and virtual network society (Dillon, 2002): digital infrastructures and Information and Communication Technologies (ICTs) are considered to be the lifelines of high-tech societies and at the same time a source of their susceptibility to cyberattacks, natural disasters, major accidents and highly contagious diseases (van der Vleuten et al., 2013). As 'vital systems" they simultaneously foster new forms of vulnerability (Lakoff and Collier, 2010). Moreover, they enabled the formation of international terror networks. The same line of thinking applies to the technoscientific achievements of modernity in general. They are treated as both, targets that need protection and veritable threats to security. As Langdon Winner has put it: "The horror of the World Trade Centre attack was that the power of two wonders of modern technology – the skyscraper and the jet airliner – came crashing together causing the carefully contained power of both systems to be released in catastrophic explosion, inferno and collapse." (Winner, 2004: 166)

At the same time, however, technologization is praised as the new silver bullet for security issues (Aas et al., 2009; Ceyhan, 2008; Marx, 2001). Legitimized by the sheer complexity, diversity and interconnectedness of tasks – such as fighting terrorist networks, organized crime and illegal migration, cybersecurity, public health, disaster management, and critical infrastructure protection – and driven by the technoscientific promises of a growing security industry, the use of advanced technologies is becoming (or is supposed to become) a key element of security practices in various contexts. According to this new "technosecurity paradigm" (Mattelart, 2010: 137), there seem to be technological fixes for all security issues: facial recognition that identifies search-listed criminals and terrorists in real-time (Möllers and Hälterlein, 2013), body scanners and other sensory devices that detect weapons and dangerous substances at airports (Leese, 2015); satellite images and biometric passports that enable efficient border management; software that forecasts places and times of future crimes (Hälterlein, 2021); ICTs that enable efficient coordination of emergency and crisis response activities (Hälterlein et al., 2017) etc. In terms of security, technology, thus, is a double-edged sword: its omnipresence in western societies is considered to be one of the main causes of insecurity. At the same time, the deployment of security technologies is promoted as the ultimate solution for security authorities "to address our present problems and fears" (Bigo and Carrera, 2005: 3).

However, the promise of 'technosecurity' not only had an effect on security work but created new impulses to European integration as well. Already through the Maastricht Treaty of 1992, the Member States of the EU agreed on cross-border operational cooperation in dealing with their internal security challenges, consisting of judicial cooperation in criminal matters and cooperation of law-enforcement and border-management agencies. With the Amsterdam Treaty of 1997, security measures were grouped under the heading of the *area of freedom, security and justice* (AFSJ) "in which the free movement of persons is ensured in conjunction with appropriate measures with respect to external border controls, asylum, immigration and the prevention and combating of crime" (European Union, 1997: Article 1(5)). However, in face of the common threats and challenges „of the dynamic and global twenty-first century" (Council of the European Union, 2010: 3–4) that are „cross-border and cross-sectoral" and therefore „go beyond our national, bilateral or regional capability" (Council of the European Union, 2010: 3–4), a more integrated approach was deemed necessary. Under the umbrella of the AFSJ, a new type of cooperative policy activity at the European level emerged in the post-9/11 era that „crosses sectoral boundaries, draws in a number of governmental and societal actors, and comprises a variety of institutional venues" (Boin et al., 2006).

To a large extent, this cooperative security policy is shaped by the promise of 'technosecurity'. Driven by the expectation that technological measures would provide security in the EU, numerous databases and information-sharing systems have been implemented: the European Dactyloscopy (EURODAC) in 2003, the Europol Information System (EIS) and the Customs Information System (CIS) in 2010, the European Criminal Records Information System (ECRIS) in 2012, and the European Border Surveillance System (EUROSUR) in 2013. While the implementation of these systems aims at integration and interoperability of national security practices through digital technologies and data infrastructures, a strong focus has been placed on fostering innovation by including civil security research in the Joint Research and Development Programme of the European Commission. Due to its exclusively civilian nature, the European Security Research Programme (ESRP) does not include direct funding for defence and military technology. Yet, it enables funding for dual-use technology that can be applied for both civilian and military purposes.

First steps towards establishing the ESRP as a new field of European security cooperation were taken with the creation of the *Group of Personalities on Security Research* in 2003, the *European Security Research Advisory Board* in 2005[5] and the launch of the *Preparatory Action on Security Research* in 2004. Eventually, security research was implemented within the 7th Framework Programme for Research, Technological Development and Demonstration (FP7) in 2007 with a proportional budget of EUR 1.25 billion. The Security theme of FP7 was conceived as a mission-oriented programme, addressing four main security challenges: Security of citizens, Security of infrastructures and utilities, Intelligent surveillance and border security, and Restoring security and safety in case of crisis (European Commission, 2015: 1). Since then, funding has increased continuously in terms of budget and scope. In the 2014 to 2020 period, the Horizon 2020 programme has allocated some EUR 2 billion to its 'Secure Societies' pillar which is about 50% of all public financing for security research in the EU. Research and innovation are carried out by consortia projects that enact a cross-border collaboration of policy-makers, security practitioners, the security industry and academia or by the EC's Joint Research Centre (JRC). The majority of the hundreds of projects that have been funded under the European Commission's Preparatory Action for Security Research, FP7 and Horizon 2020 focused on technical solutions "needed by those on the front line who must deal with terrorism, cybercrime, firearms, human trafficking and natural disasters." (European Commission, 2018d: 27)

Several arguments have been put forward justifying the ESRP instead of exclusively relying on national R&D programmes of EU member states or even non-EU providers. Firstly, pooling resources at the EU level is expected to generate added value, since it „facilitates finding solutions much faster and more efficiently compared to what can be done at national level." (European Commission, 2017: 29–30). EU funding for cross-border collaboration would generate synergies by breaking down the fragmentation across Europe's security sector and national markets. For European transnational corporations, there are high barriers to EU-wide market entry since the market for security products does not function as a 'single' EU market yet. It is fragmented into national markets with nation-specific demands driven by the nation-specific requirements of the respective public authorities, technical standards, and public procurement rules. This makes economic growth and market expansion difficult for the European security industry (European Commission, 2004). The problem of constructing a single market has been virulent in debates on European Integration during the 1980s and 1990s. Against the backdrop of cross-border security threats, market fragmentation is perceived as a source of vulnerability that has to be tackled. Therefore, establishing "a better functioning Internal European Market for security technologies" (European Commission, 2012: 3) through EU-wide standards and harmonized certification schemes is one of the main objectives both of the EU's security industry policy and the security research pillar of the framework programmes. In the same vein, the security research programme strongly supports the interoperability of the technological solutions and tools to be delivered, and specific intellectual property rights rules for security research as well as pre-commercial procurement. These measures are deemed to play a crucial role in creating a single market for security products and enabling Europe's security industry to create economies of scale, thereby contributing to the improvement of both Europe's security and the competitiveness of its security industry in global export markets (European Security Research and Innovation Forum, 2009).

Secondly, integrating security research in its Joint Research and Development Programme enabled the Commission „to define the technological capabilities required by the Union to carry out its common internal security policy, and to define the priorities in that area" (Citi, 2014: 136). It underpinned the EU's claims in the highly sensitive area of security where nation-states are particularly hesitant to give up their prerogative of having the main responsibility for providing security to their citizens. As part of this agenda setting, the Commission has set the requirement for research projects to take into account that security technologies "might directly or indirectly concern fundamental rights, such as the rights for respect for private and family life, protection of personal data, privacy or human dignity" (European Commission, 2012, 2014). Such an infringement of rights may lead to a lack of acceptance which is framed as the "societal dimension" (European Commission, 2012: 4) of security technologies. This societal dimension is associated with the risks of wasted investment in technology development and the need to rely on less controversial products which may not entirely fulfil security requirements (European Commission, 2012: 5). In order to address this problem, the European Commission calls for a "better integration of the societal dimension, by thoroughly assessing social impacts including impacts on fundamental rights, and by creating mechanisms to test the societal impact during the R&D phase" (European Commission, 2012: 5). Consequently, for all Horizon 2020 security research projects, an ethics review and a societal impact assessment (SIA) has become mandatory (European Commission, 2013).[6] Under the ELSA label (Hilgartner et al., 2017), research into **e**thical, **l**egal and **s**ocietal **a**spects of security technologies has been conducted either as part of R&D projects or within projects with a general focus on the "societal dimension" of security technologies. The concerns, identified by these "screening[s] of a project's ethical implications" (European Commission, 2016b: 26) are then to be translated into technological requirements. This translation process that first and foremost ensures compliance with data protection legislation by addressing privacy impacts of security technologies proactively, is summarized under the concept "privacy by design". According to this concept, technologies should be designed with privacy in mind from the outset of the innovation process, integrating privacy-enhancing features, most prominently so-called Privacy-Enhancing Technologies (PETs), into systems design. Ultimately, this approach would enable measures to prevent a lack of acceptance of security products.

Driven by the promise of 'technosecurity', the joint development of security technologies was used the drive forward European security integration: on the one hand by establishing a single market for security products by creating harmonized standards and schemes for security technologies and procurement processes, on the other hand by ensuring the interoperability of technological innovations that enable security practitioners from different Member States and EU organisations to operate together effectively. Hence, the ESRP underpins and enacts the vision of a 'Security Union' that has been articulated in the context of the renewed Internal Security Strategy of 2015 (European Commission, 2015). In a 'Security Union', the member states would agree on a shared responsibility and "move beyond the concept of cooperating to protect national internal security to the idea of protecting the collective security of the Union as a whole" (European Commission, 2016a: 2).

Moreover, a specific normative claim of the EU's security policy is inscribed into the operations and outputs of security research. Through the assessment of societal impacts at an early stage and the design-in of identified privacy implications, security research is supposed to create the means to push the boundaries of the so-called trade-off between security and privacy (Pavone and Degli Esposti, 2012) and offer a way out of the dilemma to choose between "effective intrusiveness and non-intrusive inefficiency" (Bigo and Jaendeboz, 2010: 6). The EU's internal security policy, hence, reflects and performs the dictum that security and respect for fundamental rights including privacy are not to be seen as conflicting aims, "but consistent and complementary policy objectives". (European Commission, 2015: 3) Against the backdrop of the vision of Europe as a union based on values (European Union, 2007, Article 2), the promise of 'technosecurity' nourish the promise of the AFSJ "that law enforcement measures, on the one hand, and measures to safeguard individual rights, the rule of law and international protection rules, on the other, go hand in hand in the same direction and are mutually reinforce" (European Council, 2010: 4). However, as the ongoing deadly events on Europe's external borders demonstrate in a terrifying manner, this area is a highly restricted area where security integration correlates with the exclusion of those human beings labelled as illegal.

A 'human-centric AI' – the EU's approach to building up trust in times of its crisis

The promise of 'technosecurity' continues to play a crucial role in Europe's internal security policy and its current R&D framework programme "Horizon Europe" (2021 – 2027). This is not likely to change with the Covid-19 pandemic as it has demonstrated the vulnerability of an interconnected world where infection dynamics take the speed of international mobility and put the security of citizens, the management of borders and the protection of critical infrastructures at the top of political agendas. Given the persuasiveness of technological solutions, digital contact tracing, computer simulations of propagation scenarios and syndromic surveillance systems are at the forefront of the fight against the spread of the virus. However, the pandemic has also fed into the current hype of AI and the imaginative powers it unfolds. AI is not only used to analyse the virus' genetic information and its mutations as well as to develop and test vaccines. It is also expected to provide the means to prevent future pandemics by predicting outbreaks based on the real-time analysis of vast amounts of heterogeneous data.

AI has always evoked diverse scientific, artistic and political visions. Utopian imaginaries of social progress through AI (Minsky, 1986; Moravec, 1995) contrast with dystopian imaginaries of AI as the hubris of the human mind (Weizenbaum, 1976). One of the currently most virulent AI-related fears is surely the one of AI as a 'job killer', given the possibility that advancements in AI-based production systems will lead to mass unemployment. Moreover, AI is under public scrutiny for causing deadly car accidents, enabling more invasive surveillance of citizens, more powerful cyberattacks on critical infrastructures, reproducing or even reinforcing discrimination in various societal contexts and being used to manipulate political opinion. Furthermore, the *Campaign to Stop Killer Robots* has demanded an international ban on lethal autonomous weapon systems (LAWs). At the same time, AI is praised as a key technology that enhances our capabilities to deal with societal grand challenges, for example by improving healthcare and cybersecurity, enabling a more sustainable economy, a cleaner and safer mobility, a more efficient food system and a smarter crisis management. Moreover, robots and other "smart machines" could replace difficult, dirty, dull or dangerous tasks in the context of care work, manufacturing, policing and emergency response. These technoscientific promises of AI have been initially articulated by private tech companies and other actors who are directly involved with the development and implementation of these technologies.

Recent advances in the AI-subfield of machine learning that is already used in many real-life applications, however, have made AI a matter of concern not only for futurist thinking, criticism or marketing but also for policymaking. In the past few years, many governments and supranational organisations published strategy papers in which they present their visions of the future development, application and regulation of AI. In 2016, the US presented their *National Artificial Intelligence Research and Development Strategic Plan* defining the government's role predominantly as a facilitator of innovation. The *National Artificial Intelligence Initiative* of 2019 emphasised the importance of continued U.S. leadership in AI R&D. China, on the contrary, plans to use a state-driven development model as part of its *Next-Generation Artificial Intelligence Plan*, which was presented in 2017 and sets the goal to become the global leader in the field of AI by 2030.

The EU entered into the policy field in 2017 with the European Parliament's Committee on Legal Affairs' resolution on *Civil Law Rules on Robotics* (European Parliament, 2017). Besides recommending several legislative initiatives, the resolution also calls on the European Commission to establish ethical guidelines to be respected in the development, programming and use of robots and AI. The European Commission soon took action by presenting a set of ethical principles for the development of *Artificial Intelligence, Robotics and 'Autonomous' Systems* (European Commission et al., 2018), its strategy *AI for Europe* (European Commission, 2018a) and the *Coordinated Plan on Artificial Intelligence* (European Commission, 2018b, 2018c) in 2018. In its strategy, the European Commission articulates the vision of a 'human-centric AI' as it claims to use the „power of AI at the service of human progress" and to benefit „people and society as a whole" (European Commission, 2018a). Instead of manipulating or replacing people and threatening their fundamental rights or even lives, AI should improve the lives of EU citizens through innovations in sectors such as health, farming, education, employment, energy, transport and security. In order "to make the most of the opportunities offered by AI and to address the new challenges that it brings" (European Commission, 2018a), the Commission calls for a joint effort of the member states to ensure that Europe remains competitive in the global market for AI applications, that no one is left behind in the digital transformation, and that AI technologies are based on values and fundamental rights and therefore can be trusted. Through these objectives, the Commission not only aligns its policy goals with its vision of a 'human-centric AI' but also re-imagines the EU as a political space that provides for the well-being of its citizens and the protection of their fundamental rights. This version of the European Project is particularly important in the face of Europe's current crisis of legitimacy which is not least a crisis of trust (Wilde, 2021). In the early phases of European integration, citizens' trust was primarily connected to the promise of keeping peace and stability on the continent. Today, public trust in the institutions of the EU is, among other factors, challenged by the ongoing digitalization of European societies and its present or possible future impact on the living conditions of Europe's citizens (Bakardjieva Engelbrekt et al., 2019). As many surveys show, privacy intrusions made possible by the extensive use of digital technologies and digital data gathering have led to an erosion of trust which can hit both public and private actors (Wright, 2020). For instance, a survey of 27.000 Europeans found that 59% of those surveyed do not trust their governments who might be regularly capturing large amounts of data on citizens for surveillance purposes (Friedewald et al., 2017). The commitment to developing "trustworthy AI" (European Commission, 2018b: 4), hence, can be understood as a reaction to the EU's 'crisis of trust' by issuing a mission statement that is to re-strengthen citizen's trust in technoscientific progress and the political institutions that aim to govern it.

This mission, however, goes beyond the EU as the Commission puts the Union in a global pioneering role: "The EU can lead the way in developing and using AI for good and for all, building on its values and its strengths." (European Commission, 2018a). The ambition to become the "world-leading region for developing and deploying cutting-edge, ethical and secure AI" (European Commission, 2018c: 1) is framed as a matter of global responsibility. Thereby, its approach to AI is presented as a third way between the unrestrained, market-driven way of the U.S., where (big) tech companies play the central role in R&D and the lack of privacy regulations and data protection enables extensive (consumer) surveillance, and the way of China, where a strong state is the driving force of a coordinated R&D with the overall goal to maintain social harmony and to enable behaviour control. Given the market dominance and expansive strategies of big U.S. tech companies on the one hand and China's endeavour to gain global leadership by means of technology policy, on the other hand, dependency in the AI sector means dependency on actors whose approaches to govern the disruptive potentials and shape the future of AI would differ significantly from the one of the EU. Against the backdrop of the threat scenarios of an AI-powered surveillance capitalism and an AI-powered surveillance state, public trust *in* and acceptance *of* AI is seen as a long-term competitive advantage for the European economy, since they are a prerequisite for the uptake and embedding of AI in society. Achieving a competitive edge through trust, however, would require to effectively manage the risks of AI, "for example in the areas of safety and liability, security (criminal use or attacks), bias and discrimination." (European Commission, 2018a). In the face of these risks, the Commission sets out the essential components of a 'European approach to AI' that not only fosters innovation but also consolidates ethical and legal regulation.

The innovation pillar of this approach aims to "boost the EU's technological and industrial capacity and AI uptake across the economy" (European Commission, 2018a). Given its strategic importance for the competitiveness of the European economy, the EU's ability to deal with societal grand challenges and the aim to regain trust in its institutions, AI has been classified as one of the critical technology areas in which the European Commission strives to achieve 'technological sovereignty' which president Ursula von der Leyen defines as "the capability that Europe must have to make its own choices, based on its own values, respecting its own rules" (von der Leyen, 2019). This essentially means that the EU should not be dependent on AI-based products and services produced *in* or provided *by* companies outside the EU – particularly those from the U.S. and China.

The regulatory pillar of the 'European approach to AI' aims to create an "appropriate ethical and legal framework" (European Commission, 2018a) in line with the Charter of Fundamental Rights and the five ethical principles defined by the European Group on Ethics in Science and New Technologies (European Commission et al., 2018), namely: human dignity, autonomy, responsibility, data protection/privacy, and sustainability. Concerning ethics, the Commission's AI strategy refers to existing normative concepts, such as *explainable AI* and *responsible AI*. The task of developing a solid ethical framework, however, has been delegated to an independent High-Level Expert Group on Artificial Intelligence (AI HLEG).

The AI HLEG presented its ethics guidelines in April 2019, stating that a *trustworthy AI* is lawful, ethical and robust. The AI HLEG states that both technical and non-technical methods can be used for achieving the trustworthiness of an AI application and describes a variety of these non-technical methods such as codes of conduct, standardization, certification and stakeholder participation (High-level Group on Artificial Intelligence, 2019: 22–23). The European Commission, however, highlights technical methods as key principles of their approach to a trustworthy AI and particularly elaborates on so-called 'ethics by design' (European Commission, 2018c: 8). In the terminology of the Commission and the AI HLEG, *ethics by design* stands as an extension of *privacy-by-design* and refers to the implementation of ethical and legal principles since the beginning of the design process. Understood as a method, 'ethics by design' helps to realize the ethically and legally compliant development of AI-based systems by creating "precise and explicit links between the abstract principles which the system is required to respect and the specific implementation decisions" (High-level Group on Artificial Intelligence, 2019: 21). In this rationale, 'ethics by design' constitutes a central feature of a trustworthy AI. If institutionalized ethics is to be understood as a soft regulatory tool for the governance of technology-induced risks (Tallacchini, 2009), the design-in of anticipated ethical implications is to be seen as the subsequent technological hardening of this soft tool.

An essential part of the regulatory pillar, however, remains 'hard' law. In the white paper *On Artificial Intelligence - A European approach to excellence and trust* (European Commission, 2020) and the *Proposal for a Regulation laying down harmonised rules on artificial intelligence* (European Commission, 2021) the European Commission elaborates on mandatory legal requirements that take into account the key requirements of a trustworthy AI as set out by the AI HLEG. Together with the ethical guidelines, these legal requirements constitute the regulatory framework for AI. Besides the main objective to promote trust among citizens, the framework is expected to facilitate the formation of a single market for AI applications and, thus, strengthen the competitiveness of Europe's industry, since the investment *in* and market uptake *of* AI requires legal certainty. Divergent national legislations, on the contrary, are likely to create market fragmentation and obstacles for European companies. Thus, the framework first and foremost has to ensure that „AI systems placed on the Union market and used are safe and respect existing law on fundamental rights and Union values", but at the same time it should not „unduly constraining or hindering technological development or otherwise disproportionately increasing the cost of placing AI solutions on the market" (European Commission, 2021: 3). To guarantee this proportionality, the framework sets out a risk-based approach that differentiates between those AI applications that are to be classified as an unacceptable risk, high risk, and low or minimal risk. The mandatory legal requirements only legally apply to those AI applications classified as high risk. In these cases, a conformity assessment and certification process are necessary before an AI application can be put on the market. For low or minimal risk applications only voluntary codes of conduct are envisioned. Certain AI practices, however, are prohibited as "contravening Union values" (European Commission, 2021: 3), for instance, if they are used to manipulate persons through subliminal techniques, for general social scoring and for video surveillance of public spaces. For the latter, however, certain types of criminal investigations where the public interest outweighs the risks are defined as exceptions (European Commission, 2021: 43–44). Moreover, it is stated that the regulation does not apply to AI systems "developed or used exclusively for military purposes" (European Commission, 2021: 39). This reserve takes into account the ongoing controversy between those EU members who are advocating for inaction and those who willing to ban LAWS (Barbé and Badell, 2020). In terms of addressing the high-risks of AI, the EU's regulatory approach clearly enacts the global ambitions of the EU. On the one hand, it implicitly addresses the criticisms of China's notorious Social Scoring System and invasive sales strategies of big U.S. tech companies by classifying these practices as "unacceptable". On the other hand, it defines exceptions *from* and applicability *of* legal constraints in such a way that leveraging

AI for civil security and defence measures will still be possible.

The articulation of the vision of a "human-centric AI" and the measures that have been put in place according to this vision are to be seen as a form of acceptance politics (Barben, 2010) since the EU's regulatory framework is supposed to build up trust and, thus, provide the foundation for the uptake of AI in society: while ethical expert groups would produce trustworthy policy recommendations and engineers would use ethics by design methods to develop trustworthy technology, institutionalized risk assessment, mandatory legal requirements for high-risk applications, and the prohibition of certain, 'unacceptable' AI practices would ensure that EU citizens will have to deal with trustworthy AI only. In economic terms, the 'European approach to AI' is a unique selling position that serves the competitiveness of Europe's economy and helps to fulfil the EU's ambition to become a global player in AI. The purpose of this approach, however, goes beyond legitimizing the complementarity of innovation and regulation, of economics and ethics. Against the backdrop of a diverse spectrum of AI-related fears and AI-related promises, the endeavour to promote public trust in AI becomes deeply intertwined with the endeavour to restore trust in the EU in times of its crisis.

Conclusion

It has been shown how technological expectations have been influential in the creation of European institutions, R&D programmes and regulatory instruments and how they have contributed to processes of European integration. By drawing attention to these links between the formation of a European government and politics on the one side and the problems certain technologies pose and the potential benefits they promise on the other side, the paper addresses the making of Europe as a 'multiply imagined community' (Jasanoff, 2005: 10) based on various technoscientific promises: The promise of nuclear energy was used to promote the creation of a supranational union that would provide for everlasting economic growth and security in its member states. The promise of 'technosecurity' has shaped the EU's joint R&D programme according to the vision of a 'Security Union' where the actors involved agree on a shared responsibility for protecting European citizens in compliance with their fundamental rights. And the vision of a 'human-centric AI' is mobilized to re-imagine the EU as a political space that provides for the well-being of its citizens and the protection of their fundamental rights.

Throughout these processes of re-imaging the European project, however, a few recurrent themes for a European government and politics emerged. One of them is the problem of constructing a single market. The pairing of the two European Communities – EURATOM and the EEC – highlighted the joint endeavour in nuclear energy as a necessary complementary approach to the project of a common market. Funding for cross-border collaboration under the ESPR is expected to break down the fragmentation across Europe's security sector and create a single market for security products. The EU's regulatory framework is expected to facilitate the formation of a single market for AI applications since the investment *in* and market uptake *of* AI requires legal certainty.

Another recurrent theme is the security-technology-nexus. The development of a nuclear industry was considered to be of strategic value with regard to energy security and thus imperative to sustain economic growth and political stability on the continent. The development of advanced technologies and tools is considered to be an adequate solution to deal with a heterogeneous spectrum of security threats and, hence, became the main objective of the EU's security research. The development of trustworthy AI applications is considered to serve the aim of mitigating the risks posed both by an AI-based surveillance capitalism and an AI-based surveillance state.

Furthermore, boundary work to navigate between the civil and the military use of technologies is pervasive. In the case of nuclear power, an artificial distinction is established between the promises and the fears associated with the technology. Consequently, engagement with Big Science cooperation is exclusively connected to nuclear energy whereas the option of developing a common nuclear bomb was never seriously considered. Boundary work is also salient in

EURATOM's system of nuclear safeguards that were installed to ensure that civil nuclear material is not diverted for military purposes. In the case of security technologies, the threats they are expected to protect against blur the boundary between civil and military security. This is reflected within European security research by promoting dual-use R&D despite the declared exclusive civil nature of funding. In the case of AI, the combination of innovation and ethics would ensure that AI is only used for the common good. Therefore, the use of LAWs is addressed on the level of soft law but excluded from the regulatory proposal of the European Commission in order to avoid establishing strict boundaries for future applications.

The paper has covered wide historical ground and uncovered general connections. Such an exercise has its limits in terms of its level of detail and differentiation. But it can nonetheless be of value for both technology-oriented histories and 'standard' political histories of European integration.

Acknowledgements

I am grateful to the anonymous reviewers and to the editor for their extensive feedback and helpful suggestions. This research was supported by Fritz Thyssen Foundation (AZ 10.20.1.015SO).

References

Aas KF, Gundhus HO and Lomell HM (eds) (2009) *Technologies of inSecurity: The surveillance of everyday life*. Abingdon England: Routledge-Cavendish.

Armand L (1955) *Some Aspects of the European Energy Problem: Suggestions for Collective Action.* Report prepared for the Organisation for European Co-Operation, June 1955.

Armand L, Etzel F and Giordani F (1957) *A Target for EURATOM*. Report to the governments of the six Member States of the European Coal and Steel Community, May 1957.

Bakardjieva Engelbrekt A, Bremberg N, Michalski A and Oxelheim L(2019) Trust in the European Union: What Is It and How Does It Matter? In: Bakardjieva Engelbrekt A, Bremberg N, Michalski A and Oxelheim L (eds) *Trust in the European Union in Challenging Times:*.Cham: Springer International Publishing, pp. 1–22.

Barbé E and Badell D (2020) The European Union and Lethal Autonomous Weapons Systems: United in Diversity? In: Johansson-Nogués E, Vlaskamp MC and Barbé E (eds) *European Union Contested.* Cham: Springer International Publishing, pp. 133–152.

Barben D (2010) Analyzing acceptance politics: Towards an epistemological shift in the public understanding of science and technology. *Public Understanding of Science* 19(3): 274–292.

Barry A (2001) *Political machines: Governing a technological society*. London: Athlone Press.

Barry A and Walters W (2003) From EURATOM to "Complex Systems": Technology and European Government. *Alternatives: Global, Local, Political* 28(3): 305–329.

Beck U (1998) *World risk society*. Cambridge, Massachusetts: Polity Press.

Beckert J (2013) Imagined futures: Fictional expectations in the economy. *Theory and Society* 42(3): 219–240.

Bigo D and Carrera S (2005) From New York to Madrid: technology as the ultra-solution to the permanent state of fear and emergency in the EU. *CEPS Commentary*, CEPS, Brussels, April.

Bigo D and Jaendeboz J (2010) The EU and the European Security Industry: Questioning the 'Public-Private Dialogue'. *IN: EX Policy Brief* (5).

Boin A, Ekengren M and Rhinard M (2006) Protecting the Union: Analysing an Emerging Policy Space. *Journal of European Integration* 28(5): 405–421.

Brown N, Rappert B and Webster A (eds) (2000) *Contested futures: A sociology of prospective techno-science*. London, New York: Routledge Taylor & Francis Group.

Ceyhan A (2008) Technologization of Security: Management of Uncertainty and Risk in the Age of Biometrics. *Surveillance and Society* 5(2): 102–123.

Citi M (2014) Revisiting Creeping Competences in the EU: The Case of Security R&D Policy. *Journal of European Integration* 36(2): 135–151.

Comité intergouvernemental créé par la conférence de Messine (1956) *Rapport des chefs de délégation aux ministres des affaires etrangères*. Spaak report, April 1956.

Commission of the European Communities (1955) *The Messina Declaration*. Available at: https://www.cvce.eu/obj/resolution_adopted_by_the_foreign_ministers_of_the_ecsc_member_states_messina_1_to_3_june_1955-en-d1086bae-0c13-4a00-8608-73c75ce54fad.html (accessed 28 October 2022).

Commission of the European Communities (1968) *Survey of the nuclear policy of the European Community*. Report to the Council of the European Union, Octobre 1968.

Council of the European Union (2010) *Draft Internal Security Strategy for the European Union: Towards a European Security Model*. March 2010.

Cramer KC (2020) *A Political History of Big Science*. Cham: Springer International Publishing.

Cronqvist M, Farbøl R and Sylvest C (2022) *Cold War Civil Defence in Western Europe*. Cham: Springer International Publishing.

Dillon M (2002) Network Society, Network-centric Warfare and the State of Emergency. *Theory, Culture & Society* 19(4): 71–79.

Egeland K and Pelopidas B (2021) European nuclear weapons? Zombie debates and nuclear realities. *European Security* 30(2): 237–258.

EURATOM (1958) *Treaty establishing the European Atomic Energy Community*.

European Atomic Energy Society (1954) *Nature* 174(4423): 251–252.

European Commission (2004) *Research for a Secure Europe*. Report of the Group of Personalities in the field of Security Research, March 2004.

European Commission (2012) *Security Industrial Policy: Action Plan for an innovative and competitive Security Industry*. Communication to the European Parliament, the Council and the European Economic and Social Committee, July 2012.

European Commission (2013) *HORIZON 2020. Work Programme 2014 – 2015. 14. Secure societies – Protecting freedom and security of Europe and its citizens.* Decembre 2013.

European Commission (2014) *Ethics of security and surveillance technologies: Opinion No. 28 of the European Group on Ethics in Science and New Technologies*.

European Commission (2015) *The European Agenda on Security*. Communication to the European Parliament, the Council and the European Economic and Social Committee and the Committee of the Regions, April 2015.

European Commission (2016a) *Delivering on the European Agenda on Security to fight against terrorism and pave the the way towards an effective and genuine Security Union*. Communication to the European Parliament, the European Council and the Council, April 2016.

European Commission (2016b) *Security Research: Future-bound to protect our society*. August 2016.

European Commission (2017) *LAB – FAB – APP: Investing in the European future we want*. Report of the independent High Level Group on maximising the impact of EU Research & Innovation Programmes, July 2017.

European Commission (2018a) *Artificial Intelligence for Europe*. Communication to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, April 2018.

European Commission (2018b) *Coordinated Plan on Artificial Intelligence*. Communication to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, Decembre 2018.

European Commission (2018c) *Coordinated Plan on Artificial Intelligence: Annex*. Communication to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, Decembre 2018.

European Commission (2018d) *From Research to Security Union*. March 2018.

European Commission (2020) *White Paper on Artificial Intelligence: A European approach to excellence and trust*. February 2020.

European Commission (2021) *Proposal for a Regulation laying down harmonised rules on artificial intelligence*. April 2021.

European Commission and Directorate-General for Research and Innovation (2007) *Taking European knowledge society seriously*. Report of the Expert Group on Science and Governance to the Science, Economy and Society Directorate, Directorate-General for Research, European Commission, January 2007.

European Commission, Directorate-General for Research and Innovation and European Group on Ethics in Science and New Technologies (2018) *Statement on artificial intelligence, robotics and 'autonomous' systems Brussels, 9 March 2018*. Publications Office.

European Council (2010) *Stockholm Programme: An open and secure Europe serving and protecting citizens*. May 2010.

European Parliament (2002) *The European Parliament and the Euratom Treaty: past, present and future*. Decembre 2001.

European Parliament (2017) *Report with recommendations to the Commission on Civil Law Rules on Robotics*. January 2017.

European Security Research and Innovation Forum (2009) *ESRIF Final Report*. Decembre 2009

European Union (1997) Treaty of Amsterdam Amending the Treaty on European Union, The Treaties Establishing the European Communities and Related Acts. Available at: https://eur-lex.europa.eu/eli/treaty/ams/sign (accessed 28 October 2022).

European Union (2007) Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community. Available at: https://eur-lex.europa.eu/eli/treaty/lis/sign (accessed 28 October 2022).

Friedewald M, Burgess JP, *Čas* J, Bellanova R and Peissl W (2017) *Surveillance, Privacy and Security*. New York: Routledge.

Fujimura J (2003) Future imaginaries: genome scientists as sociocultural entrepreneurs. In: Goodman AH, Heath D and Lindee MSL (eds) *Genetic nature/culture: Anthropology and science beyond the two-culture divide*. Berkeley: University of California Press, pp. 176–195.

Hälterlein J (2021) Epistemologies of predictive policing: Mathematical social science, social physics and machine learning. *Big Data & Society* 8(1): 205395172110031.

Hälterlein J, Madsen L, Schuchardt A, Peperhove R and Gerhold L (2018) Integrating Volunteers in Emergency Response: A Strategy for Increased Resilience Within German Civil Security Research. In: Fekete A and Fiedrich F (eds) *Urban Disaster Resilience and Security: Addressing Risks in Societies*. Basel: Springer International Publishing, pp. 113–128.

Hecht G (1998) *The radiance of France: Nuclear power and national identity after World War II*. Cambridge, Mass: MIT Press.

Hecht G (2006) Nuclear Ontologies. *Constellations* 13(3): 320–331.

High-level Group on Artificial Intelligence (2019) *Ethics Guidelines for trustworthy AI*. April 2019.

Hilgartner S, Prainsack B and Hurlbut JB (2017) Ethics as Governance in Genomics and Beyond. In: Felt U, Fouché R, Miller CA and Smith-Doerr L (eds) *The handbook of science and technology studies.* Cambridge, Massachusetts, London, England: The MIT Press, pp. 823–851.

Holloway D (1994) *Stalin and the bomb: The Soviet Union and atomic energy, 1939 - 1956*. New Haven: Yale Univ. Press.

Jasanoff S (2005) *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton: Princeton University Press.

Jasanoff S and Kim S-H (2009) Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea. *Minerva* 47(2): 119–146.

Kaijser A (2021) *Engaging the Atom: The History of Nuclear Energy and Society in Europe from the 1950s to the Present*. Morgantown: West Virginia University Press.

Konrad K, van Lente H, Groves CJ and Selin C (2017) Performing and Governing the Future in Science and Technology. In: Felt U, Fouché R, Miller CA and Smith-Doerr L (eds) *The handbook of science and technology studies.* Cambridge, Massachusetts, London, England: The MIT Press, pp. 465–493.

Krige J (2006) Atoms for Peace, Scientific Internationalism, and Scientific Intelligence. *Osiris* 21(1): 161–181.

Krige J (2008) The Peaceful Atom as Political Weapon: Euratom and American Foreign Policy in the Late 1950s. *Historical Studies in the Natural Sciences* 38(1): 5–44.

Krige J (2016) *Sharing knowledge, shaping Europe: U.S. technological collaboration and nonproliferation*. Cambridge, MA, London: The MIT Press.

Lakoff A and Collier SJ (2010) Infrastructure and Event: The Political Technology of Preparedness. In: Braun B and Whatmore S (eds) *Political matter: Technoscience, democracy, and public life*. Minneapolis: University of Minnesota Press, pp. 243–266.

Lalli R (2021) Crafting Europe from CERN to Dubna: Physics as diplomacy in the foundation of the European Physical Society. *Centaurus* 63(1): 103–131.

Leese M (2015) 'We were taken by surprise': Body Scanners, Technology Adjustment, and the Eradication of Failure. *Critical Studies on Security* 3: 269–282.

Leese M, Lidén K and Nikolova B (2019) Putting critique to work: Ethics in EU security research. *Security Dialogue* 50(1): 59–76.

Mager A (2017) Search engine imaginary: Visions and values in the co-production of search technology and Europe. *Social Studies of Science* 47(2): 240–262.

Marx GT (2001) Technology and social control: The search for the illusive silver bullet. In: Smelser NJ and Baltes PB (eds) *International encyclopedia of the social & behavioral sciences.* Amsterdam, Boston, Heidelberg, London: Elsevier, pp. 15506–15512.

Mattelart A (2010) *The Globalization of Surveillance*. Hoboken, NJ: Wiley.

Minsky M (1986) *The society of mind*. New York: Simon and Schuster.

Misa TJ and Schot J (2005) Introduction. *History and Technology* 21(1): 1–19.

Mobach K and Felt U (2022) On the Entanglement of Science and Europe at CERN: The Temporal Dynamics of a Coproductive Relationship. *Science as Culture*: 1–26.

Möllers N and Hälterlein J (2013) Privacy issues in public discourse: the case of "smart" CCTV in Germany. *Innovation: The European Journal of Social Science Research* 26(1-2): 57–70.

Moravec H (1995) *Mind children: The future of robot and human intelligence*. Cambridge: Harvard University Press.

Nieburg HL (1963) EURATOM: A Study in Coalition Politics. *World Politics* 15(4): 597–622.

Pavone V and Degli Esposti S (2012) Public assessment of new surveillance-oriented security technologies: Beyond the trade-off between privacy and security. *Public Understanding of Science* 21(5): 556–572.

Rhodes R (1988) *The making of the atomic bomb*. London: Penguin Books.

Richers J, Lüscher F and Guth S (2018) Nuclear Technopolitics in the Soviet Union and Beyond – An Introduction. *Jahrbücher für Geschichte Osteuropas* 66(1): 3.

Sagan SD (1996) Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb. *International Security* 21(3): 54.

Sauer T (2020) Power and Nuclear Weapons: The Case of the European Union. *Journal for Peace and Nuclear Disarmament* 3(1): 41–59.

Sovacool BK (2011) *Contesting the Future of Nuclear Power*. Singapore: WORLD SCIENTIFIC.

Spiering M (2011) Atoms for Europe. In: Spiering M and Wintle M (eds) *European identity and the Second World War*. Basingstoke: Palgrave Macmillan, pp. 171–185.

Tallacchini M (2009) Governing by Values. EU Ethics: Soft Tool, Hard Effects. *Minerva* 47(3): 281–306.

Trischler H and Bud R (2018) Public technology: nuclear energy in Europe. *History and Technology* 34(3-4): 187–212.

van der Vleuten E, Högselius P, Hommels A and Kaijser A (2013) Europe's Critical Infrastructure and its Vulnerabilities: Promises, Problems, Paradoxes. In: Högselius P, Hommels A, Kaijser A and van der Vleuten E (eds) *The Making of Europe's Critical Infrastructure: Common Connections and Shared Vulnerabilities*. Basingstoke: Palgrave Macmillan, pp. 3–19.

von der Leyen U (2019) *A Union that strives for more: My agenda for Europe*. Political Guidelines for the next European Commission 2019-2024. Octobre 2019.

Weart SR (2012) *The rise of nuclear fear*. Cambridge, Mass: Harvard University Press.

Weizenbaum J (1976) *Computer power and human reason*. San Francisco: Freeman.

Welsh I (2000) *Mobilising modernity: The nuclear moment*. London and New York: Routledge.

Wilde P de (2021) Rebound? The Short- and Long-Term Effects of Crises on Public Support and Trust in European Governance. In: Riddervold M, Trondal J and Newsome A (eds) *The Palgrave Handbook of EU Crises*. Cham: Springer International Publishing, pp. 667–683.

Winner L (2004) Trust and terror: the vulnerability of complex socio-technical systems. *Science as Culture* 13(2): 155–172.

Wolf S (2011) Euratom Before the Court: A Political Theory of Legal Non-Integration. *European Integration Online Papers* 15(10).

Wright D (2020) Privacy and trust at risk in surveillance societies. In: European Commission (ed) *Trust at Risk: Implications for EU Policies and Institutions*. Report of the Expert Group "Trust at Risk? Foresight on the Medium-Term Implications for European Research and Innovation Policies (TRUSTFORESIGHT). Luxembourg, pp. 48–68.

Notes

1 See for instance the Tensions of Europe Research Network; https://www.tensionsofeurope.eu/

2 In 1957, the French government approached Germany and Italy with the proposal for a joint development and production of nuclear weapons, resulting in a trilateral agreement in 1958. However, the endeavour ground to a halt following the rise to power of Charles de Gaulle later in 1958, who strongly opposed German access to nuclear weapons (Egeland and Pelopidas, 2021).

3 An alternative for transnational collaboration in the field of nuclear energy was established with the European Nuclear Energy Agency (ENEA), organized under the auspices of the OEEC and formally established in December 1957. The ENEA was a more loosely structured institutional framework and should not involve the pooling of resources nor should it restrict the national sovereignty of its members in any way. (Nieburg, 1963: 597).

4 The U.K., on the contrary, after having participated in the preparatory phase of the treaty negotiations, decided to step back and to work through the OEEC in which it played a leading role.

5 Both groups comprised EU commissioners, selected security scholars, national defence ministers from member states and the CEOs of most of the largest European security industry corporations.

6 For a detailed analysis and critique of the ethics review process within the ESRP see: (Leese et al., 2019: 63–66).

Risk and Uncertainty in Telecare:
The Case of the Finnish 'Elsi'

Joni Jaakola
University of Turku, Finland / jomijaa@utu.fi

Abstract

In recent decades, technologically mediated 'telecare' solutions have become popular for making the care of ageing populations more efficient, productive and targeted in times of economic austerity and care deficits. While telecare has been implemented in care work, caring has increasingly become a practice of managing risks. This paper draws on ethnographic research on the telecare solution 'Elsi' in a Finnish care home setting and examines telecare as a form of risk management. The 'Elsi' telecare system is based on information gathered from floor sensors and alarms caused by different events, such as falls. The argument is that telecare practices deal in many ways with 'uncertainty work' that produces uncertain knowledge, uncertain entities and uncertain values. Furthermore, these uncertainties produce additional work, which creates more duties for the care worker.

Keywords: Care work, Risk, Telecare, Uncertainty work

Introduction

Transcending a fearful vision of "care turned cold" (Pols, 2012: 11), new health care advances have highlighted the promises of technology to improve health, provide a seamless service, empower individuals and encourage the independence of patients (Mort et al., 2009a). 'Telecare' is a prominent new care technology. Broadly speaking, telecare refers to monitoring devices (e.g., phones, alarms, sensors, pendants and video connections) and other information and communication technologies that help people live and age independently at home and support their physical and emotional abilities (Callén et al., 2009; Draper and Sorell, 2013; Milligan et al., 2011; Roberts et al., 2012). Rather than being a particular technological solution, telecare refers to a broad sociotechnical arrangement (López Gómez, 2015) that consists of different devices, professionals, organisations, institutions and policies that share the goal of providing 'caring at a distance' (Pols, 2012). In home telecare, for example, a range of personal and institutional, and formal and informal resources are mobilised, including not only nurses but also relatives, neighbours and social and emergency services (López and Domènech, 2008a).

In health care policies and the welfare technology industry, telecare is rallied as a way to improve the independence, autonomy and connectedness of ageing individuals (Kim et al., 2017; Sánchez-Criado et al., 2014), free the caregiver from certain tasks and responsibilities (Callén et al., 2009) and provide a means to solve the 'problem' of the ageing population that can result in rising health care costs (Kim et al., 2017; Mort et al., 2013a, 2013b; Pritchard and Brittain, 2015). The literature, especially in science and technology studies (STS), has addressed how telecare does not solve problems, but rather enacts particular problems (Pols, 2010). Telecare involves the practice of shaping care, what caring is and how daily life changes for the elderly when telecare is introduced (Pols, 2012; Schillmeier and Domènech, 2010). Telecare has been shown to reshape family and care relationships and identities and to form a new topology of care (Milligan et al., 2010; Mort et al., 2009a). When introduced into homes, telecare can reconfigure the home as a hospital-like site of diagnosis and monitoring for the elderly (Milligan et al., 2011; Mort et al., 2009b; Neven, 2015; Oudshoorn, 2011).

Telecare has also increased the amount of hidden and unrecognised work. Telecare has not resulted in a reduction in work, as promised by care policies and telecare technology providers, but, rather, a shift in relationships and responsibilities (Milligan et al., 2011; Mort et al., 2013a, 2013b) and a reconfiguration of care work and its challenges (Roberts et al., 2012). Telecare implementation has increased both the workload of nurses and the responsibilities of patients (Oudshoorn, 2008, 2011; Pols, 2010; Pritchard and Brittain, 2015; Tirado et al., 2009).

Simultaneously, telecare has increasingly transformed caring into a form of risk management. Research that has conceptualised telecare as risk management have shown that continual surveillance and monitoring are justified on the basis of providing security and safety for the subjects of telecare (Grosen and Hansen, 2021; López, 2010; Mortenson et al., 2015). Telecare as a form of risk management puts the focus on discovering risks, reducing risks and creating risk profiles that easily become the object of care (López, 2010). For example, people with dementia may have a 'risk of disorientation', which means that this risk needs to be taken into account by monitoring and assessing the person's movements (Tirado et al., 2009). Furthermore, the risk of falling is predicted because falling can increase functional decline, morbidity, mortality, nursing home admissions and costs (Draper and Sorell, 2013; Kim et al., 2017).

Uncertainty and indeterminacy are central to telecare's operations (Milligan et al., 2011; Roberts et al., 2012). The research on telecare as risk management recognises that "security is a way of bringing uncertainty into the production of order" (López, 2010: 50) and that "uncertainty is vital to delivering immediate care" (López and Domènech, 2008b: 673). Still, uncertainty has remained underdeveloped as a theoretical concept. Instead, the emphasis has been on prediction – forecasting and precaution – and governing through calculation. Uncertainties, then, become something to detect, manage or erase.

I address this gap by approaching risk management in telecare as 'uncertainty work' (Moreira et al., 2009; Pickersgill, 2011, 2020), that is, as a form of work where uncertainties cannot be avoided, but rather, are used as a resource that is linked to creativity and innovation. I examine ethnographically how uncertainty is one of the key features in the use of telecare. My research questions are straightforward: How is telecare used in care work? And what are the outcomes of telecare use? My research material consists of observations and interviews collected during ethnographic fieldwork in a Finnish care home outfitted with the 'Elsi' telecare system, which functions based on information gathered from floor sensors and alarms caused by different events, such as falls. The article contributes to research recognising telecare as a form of risk management by showing how working with 'Elsi' creates epistemological, ontological and ethical uncertainties that are connected to ways of knowing, to the enactment of new and unforeseen risks and to addressing ethical issues.

This paper proceeds as follows. In the first section, the concept of uncertainty work is presented in detail followed by a discussion of methods. Here, I also outline the characteristics of telecare technology when introduced to institutional care settings instead of private homes. Then, I analyse the epistemological, ontological and ethical outcomes of uncertainty work. Before concluding, I briefly discuss how uncertainty work is connected to the increase in work for care workers in telecare.

Uncertainty work

The concept of uncertainty is highly relevant in medical sociology and STS. Uncertainty is central to any health care practice (Cribb, 2020; Mackintosh and Armstrong 2020; Strauss et al., 1985), and it has been approached as a theoretical concept, empirical phenomenon and human experience (Fox, 1980). Indeed, the concept of uncertainty has many meanings, ranging from an 'affective state' of individuals (Pickersgill, 2020: 85) to a characteristic of the organisation of institutions, systems and infrastructures. In STS, Star (1985, 1989) identified four different sources of uncertainty in scientific work; namely, taxonomic, diagnostic, organisational and technical. Taxonomic uncertainty deals with developing classification systems. Diagnostic uncertainty is related to the application of these systems. Organisational (or political) uncertainty is about creating or maintaining the division of labour, and technical uncertainty comes from instruments and materials that create uncertainty. However, this classification also puts the emphasis on the management of epistemological contingencies and indeterminacy. In contrast, the concept of uncertainty work has captured the productivity of uncertainty, and has emphasised the importance of ontological and ethical uncertainties in addition to epistemological ones.

The concept of uncertainty work builds on the idea that uncertainty is a practical accomplishment. It has been shown that uncertainty work is a mundane and pervasive feature of scientific work and a routinised feature of knowledge production characterised by indeterminacy (Pickersgill, 2011). Uncertainty work produces new epistemological standards, practices and conventions that become "endogenous requirements for ongoing knowledge production, innovation and clinical work rather than forms of external control" (Moreira et al., 2009: 666). However, uncertainty work is not only epistemological, but also ontological, and epistemological and ontological uncertainties mutually structure each other. For example, Pickersgill (2011) has shown how the epistemological uncertainties related to diagnostic tools also co-structure what mental disorders are in an ontological sense. The production of uncertainty is not a reversal, but a constituent of knowledge and entities (Moreira et al., 2009), a precondition for action and a positive and internal force of organisation and constituting order.

In addition, uncertainty work has normative dimensions and in this way, becomes a form of ethics. When *knowing* and *being* become uncertain, value judgements, moral tensions and normative assumptions come to the fore and must be considered (Mackintosh and Armstrong, 2020; Pickersgill, 2020). In short, with the concept of uncertainty work, it is possible to see the production of uncertainty as a constituent of knowledge, entities and ethics. Thus, the concept of uncertainty work is helpful for examining telecare as a form of risk management beyond the emphasis on prediction and the Finland based telecare system 'Elsi' provides an appropriate lens to illustrate uncertainty work in practice.

The 'Elsi' telecare system

Elsi' is an example of 'ambient assisted living' (AAL) technology embedded in Finland's social care infrastructure (Doughty et al., 1996). AAL is designed for people with cognitive impairments and is used "to detect potentially problematic changes in health or activity" (Mortenson et al., 2015: 514). The phrasing 'potentially problematic' already hints at the direction of risk management, of controlling potential, not actual, events. Indeed, "AAL is ultimately about the management of risk" (Mortenson et al., 2015: 526). 'Elsi' consists of floor sensors, mobile phones for the nurses and a computer interface. 'Elsi' can produce an alarm when someone falls down, gets out of bed, enters the toilet, has stayed in the toilet for "too long" or enters or leaves their room. The floor panels function with the same logic as smart phone touch screens; the pressure detected by the panels is translated from electro-physical information to human behaviour (Grosen and Hansen, 2021).

The research material was gathered through ethnographic fieldwork in a Finnish public care home accustomed to telecare where the majority of residents had been diagnosed with dementia. As such, Finland's care provisioning provides a good example of how the promises of telecare have been executed. According to Finland's

Ministry of Economic Affairs and Employment (2015), telecare is the most important care technology for a rapidly ageing population and this paper's ethnographic study provides a useful method for examining how risks and uncertainties are managed in everyday *care* practices (Hillman et al., 2013).

The data gathered consisted of twenty semi-structured interviews with care workers and field notes from participant observations over three weeks in 2019, and some in 2020. Interviews were semi-structured covering themes ranging from the joys and difficulties of care work to the use of new technologies as part of the work. The participants were between 20 and 65 years old and had up to 40 years of experience in care work. Interviews usually lasted 30–60 minutes. The field material was gathered during the test period of a socially assistive robot (see Jaakola, 2020). Even though three weeks is a short period for an ethnographic study, I spent up to six hours per day at the unit and participated in daily life there. In this way, I had the opportunity to compare what was said during the interviews with what was happening in the care home from my perspective and to explore the indeterminacy of telecare's usage. All the interviewee names have been anonymised.

At the care home, a heterogeneous 'shifting ensemble' of "multiple humans and more-than-humans, environments and technologies, politics and practices" (Gabrys, 2019: 723) characterises 'Elsi'. This ensemble includes the users of 'Elsi', pendants for some of the residents, cameras, motion detectors, a 'safe word' system for the staff, wireless internet networks and a private security company patrolling the area. Politically, the 'Elsi' ensemble enforces the logic of austerity politics that frame high costs, personnel shortages and the lack of other resources in care provision as problems and telecare technology as the solution. The company that promotes 'Elsi' promises the provision of "Safety – security – savings" (MariCare, 2020, Home section).

'Elsi''s use in a care home unit is a practical example of how telecare is interwoven with 'hands-on' care (Roberts et al., 2012). In an assisted living facility that provides full-time support, there is no one centre where the residents are monitored, which is the usual case with home telecare. Instead, the nurses were usually responsible for five residents each (overall, there were usually nine care workers for 45 residents) and received alarms on their mobile phones based on the residents' actions. In this case, the residents themselves were usually unaware of the technology, which became clear during the analysis.

Telecare involves epistemological, ontological and ethical uncertainty work. In the following, I first analyse the practical and often tacit knowledge that is needed to manage risks with 'Elsi'. Second, I focus on the ontological consequences of epistemological uncertainty work. Third, I discuss the ethical dimension of uncertainty work.

Epistemological uncertainty work: 'Knowing everything' and 'knowing without knowing'

"Uncertainty related knowledge is constituted, negotiated, institutionalised and continually redefined" (Mackintosh and Armstrong, 2020: 5). These facets of uncertain knowledge are evident in the epistemological work needed to operate 'Elsi'. This work is not a straightforward process of receiving and responding to alarms, but rather, emphasises the methods of investigating the truth behind the alarms. The alarms produced by 'Elsi' need to be interpreted, explained and negotiated before action is taken. This is an important distinction from home telecare, where a call centre operator could code the call coming from a telecare customer (López et al., 2010). With 'Elsi', the coding is more automated according to particular thresholds – the nurses answering the alarms, then, are interpreting pre-existing codes, not doing the coding themselves. In this section, I analyse the epistemological uncertainty work that is needed to identify false alarms and dismiss them. This epistemological uncertainty work leads to contradictions, mainly to ways of knowing termed 'knowing everything' and 'knowing without knowing'.

How nurses identify false alarms is one example of how responding to alarms is also about questioning them (López and Domènech, 2008b: 670). Not all alarms are 'true'; that is, they transmit information that does not correlate with actual events.

A mobile phone could send a fall alert, but the pressure detected by the floor panels may come from something other than a resident who has fallen.

> One night, a fall alarm came, and I ran [to the resident's room]. The resident looked at me, surprised, [asking] 'What is it?' No one had fallen. (Sofia)

Sometimes, the alarm does not result in help provision, but in puzzled residents. The workers stressed that although false alarms occurred, they were not common or a problem. However, reactions to false alarms are central when evaluating how telecare works through epistemological uncertainty. Not knowing whether an alarm is true or not is not always a problem, but rather, a resource for working with telecare. Furthermore, undermining ambiguities and anomalies and rendering them unimportant are important facets of uncertainty work (Pickersgill, 2011). False alarms are not an error to eliminate. This would not be the case if prediction was the goal of risk management – to predict a risky event, one has to erase uncertainties. However, this was not the case with 'Elsi'.

The nurses have a trait that technology does not, which practical nurse Eila described succinctly as *flexibility*. The workers developed different strategies to determine whether an alarm was false or not. They could also explain what caused false alarms and why. These strategies are examples of epistemological uncertainty work and highlight the importance of improvisation in telecare (López et al., 2010; López and Domènech, 2008b). First, some rooms were said to be more likely to cause false alarms.

> One room causes a fall alarm almost daily, even though the resident has not fallen […] Today, everyone received the fall alarm, and then one [nurse] remarked, 'Same thing every morning; no one has fallen'. (Liisa)

A practical nurse named Liisa described a scenario familiar to her: fall alarms caused by something other than a fallen resident. This was because the floor panels were installed in certain ways in particular rooms. However, it was not only 'rooms' that could cause false alarms; certain kinds of residents living and moving in these rooms also triggered the alarms. Miranda, another practical nurse, noted:

> We have this […] lady [and] every time she comes – she is big – and walks on the floor, a fall alarm is raised, but she hasn't fallen. (Miranda)

According to Miranda, it was the resident's large size that caused false alarms. This differs greatly from how 'Elsi' should work: not raising an alarm for heavy patients but for risky events. The epistemological uncertainty work in which the nurses discuss and interpret the meaning of alarms, especially the 'unusual' alarms, is an example of triangulation (López et al., 2010), of relating one's own experiences with those of other nurses. Triangulation produces the logic of not reacting to falls instantly or, at least, questioning them based on the room or resident causing the alarm. With triangulation, goals and solutions, such as reacting quickly to falls, are not solely mediated using technology; working with 'Elsi' creates new problems, which lead to new strategies for solving these problems.

Alarms can be dismissed when they are identified as erroneous. However, it became clear during the fieldwork that many other alarms were dismissed. When there are insufficient resources to interpret and respond to all of the alarms – even the critical ones – the nurses have to develop different strategies for separating important and unimportant information. In these situations, some alarms became background noise, even a disturbance, especially during the daytime, when I usually visited the unit. The workers did not always respond to the often-constant alerts on their mobile phones. During an interview with Johanna, she apologised for the continuously 'tinkling' phone. I was surprised because I had thought that alarms were more important than research interviews and should not be dismissed. However, Liisa clarified that it was not always possible to check whether there was something wrong when working with the residents.

> This ['Elsi'] tinkles all the time […], and sometimes, when you're working, you can't even look [at the phone] if there's really an emergency. (Liisa)

Sometimes, other work got in the way of using 'Elsi'. It was obvious that the information gathered by the floor sensors did not always lead to a reaction. There were simply not enough resources to respond to all the alarms at all times. However, it was hard to completely ignore the alarms because they continued ringing as long as no one responded to them. Thus, coping with the constant alarms became tacit knowledge. Dismissing alarms became part of the overall practices of the unit – only quick reactions to falls, which created a distinctive 'vibrating' alarm, were emphasised by the workers and management.

One way to conceptualise the soundscape of continuous alerts and how it relates to the epistemological uncertainty work is with 'refrains'. Refrains are rhythmic series that create a sense of place, familiarity and security, a 'limited pocket of organization' in the midst of fragility and insecurity (Brown and Capdevila, 1999: 36; see also Deleuze and Guattari, 1988). Refrains, such as the rhythmic beeping of the 'Elsi' application, link certain soundscapes to particular events, create chaos from order and paradoxically, order from chaos. In this sense, the constant noise created by the 'Elsi' applications is simultaneously a nuisance but also a precondition for creating order. Considering the resident's weight and false alarms as unproblematic are examples of how refrains create security. Overall, the refrains exemplified two epistemological principles at the unit: 'knowing everything' and 'knowing without knowing'.

The constant beeping of 'Elsi' kept the nurses updated on risky events, such as residents rising in bed. One of the nurses, Nina, stressed how this made it possible to 'know everything' with 'Elsi'.

> [The residents] usually wonder, 'How did you get here?' 'How did you know that I was awake?' [I reply] 'I know everything' (laughs). (Nina)

'Knowing everything' led the nurse to be content, even humorous, as she laughed during the interview. According to Nina, the nurses knew what was going on with the residents and how to care for them before the residents themselves knew that something was wrong. Still, the ability to know everything was somewhat exaggerated. One of the practical nurses, Katariina, explained that knowing through 'Elsi' was not enough:

> I go through all the rooms before the night shift because I don't know whether the TVs are on, if the windows are open or if the customer is in the right position in bed, without any food trays in the way […] and then we also have a 'silent round' at 12 pm. (Katariina)

'Elsi' did not gather data from all of the potentially risky objects, such as food trays, and Katariina and other nurses performed rounds before the night shift to check whether everything was alright. This is an important distinction from Grosen and Hansen's (2021) research on floor monitoring. While that study showed that the care workers' interpretation of needs transformed to following signals from the monitoring system rather than the use of senses (smell, sight, hearing and touch) or 'doing rounds', it is precisely these senses and sensibilities that 'Elsi' calls into action. In a sense, using 'Elsi' doubles the surveillance to include the sensors of 'Elsi' and the senses of the care worker – the sensors are not reliable enough to replace the senses of the worker.

The epistemological practice of 'knowing without knowing' highlights that it is not the gathering of data but the interpretation of it that is crucial with 'Elsi'. As discussed above, alarms could not always be responded to instantly when laborious tasks were being performed.

> I had a fall alarm at 8 o'clock, but I was bathing another resident. [The resident causing the alarm] had dropped something on the floor. (Emily)

Emily has a tactic of 'knowing without knowing'. She 'knows' that the alarm is false without checking or triangulation. The fall alarm was, without hesitation, interpreted as "something" falling on the floor. This was a convenient interpretation for Emily – she could not respond to the alarm because she was working with another resident. This kind of rationalisation could also be called ignorant: for me, a researcher who was an outsider to care work and unfamiliar with many of its premises, the claims of everything being alright and the alarm being erroneous seemed unconvincing. More important, however, is what enables this interpretation: the possibility of false alarms and dismissing them, the refrains and triangulation that stabilise this work routine and thus, ‘knowing without knowing’. The usual refrains create familiarity and security, and it is more likely that everything is going well with the resident than that they actually need help.

‘Knowing without knowing’ is not really knowing but guessing or betting, which are valid epistemological strategies with ‘Elsi’. The epistemological uncertainties do not erode the ability to work, but instead, render it possible. However, uncertainty work with telecare is not only about identifying true and false risks with epistemological know-how; it also comprises ontological constitution work that creates risky entities.

Ontological uncertainty work: ‘Ad hoc’ and ‘ghost’ entities

Epistemological uncertainty work is not only about reflecting on existing entities, but is also about bringing them into being (Pickersgill, 2020). In this view, the ontological status of an entity – a risky object, for example – is always an accomplishment. In the previous section, ‘knowing everything’ produced risks that were unknown for the residents themselves, such as rising in bed, and risks suggested by false alarms proved to be non-existent, which was the case when ‘Elsi’ alerted the fall of a resident who was actually resting in bed. In this section, I explore this kind of ontological uncertainty in more detail, focusing on how entities are inevitably constituted with ‘Elsi’.

The uncertainty work that is needed to manage false alarms does not end with checking in with residents to know whether they have fallen or not. The alarms are not simply true or false; rather, they enact new ontologies. In this way, false alarms are not forms of misrecognition (by the workers or by the floor sensors) or problems with technology or interpretation, but they create new risks. This phenomenon is familiar with home telecare: the call centre operators know that not all events are predictable and, therefore, create new risk codes while monitoring the actions of telecare customers (López et al., 2010: 80).

In addition to checking false alarms as routine and dismissing them, a popular view was that the imperative to always check what caused a false alarm was more important than the alarm being erroneous. For Ethan, a practical nurse working in the unit, an alarm was always an alarm:

> When an alarm comes, you must go and look [for what caused it]. That is the idea; something has happened. If a glass falls down, it can break and explode [and cause something else] […] An alarm is an alarm. (Ethan)

For me, it seemed odd and vague that falling glass could be a risk that called for a quick response. The approach seemed random. The uncertainty that comes with the possibility of false alarms is not a technological problem to fix or erase; rather, uncertainty is something to embrace. Although the users of ‘Elsi’ highlighted the importance of preventing and detecting falls, the alarms also created new risks. It was more important to respond to the alarm unconditionally than to rationalise what might have caused it. ‘Something’, an exploding glass perhaps, was always a risk, according to Ethan.

I call these new risky objects ad hoc entities. They are ad hoc, temporal and “specific to the situation” in two ways. First, ad hoc entities are not recognised on the MariCare company web pages that advertise ‘Elsi’ as important. They are also not usually identified as risk factors for the older population in a broader sense. Instead, ad hoc entities are produced and enacted when working with ‘Elsi’. Second, ad hoc entities lose their properties, such as being risks and posing possible danger or harm, rather quickly. If a glass has not exploded, it is just a glass, after all. Still, there is a possibility that the false risk lingers. Ad hoc entities can, in this sense, become ‘ghosts’. I will examine these forms of ontology shortly after clarifying some aspects of working with ad hoc entities.

Why does ontological uncertainty not lead to insecurity? One answer stems from the ways in which new ad hoc entities do not diminish, but enable work through uncertainty. In fact, ad hoc entities are quite usable and practical. When no alarm can, in practice, be false, the ad hoc entities solve the often-awkward problem of uncertainty. Ad hoc entities justify quick reactions to risks that sometimes turn out to be non-existent. In contrast, quick reactions to something that does not exist can seem unreasonable. Hence, Ethan explained why 'Elsi' is a good technology, despite it sometimes being unpredictable. Here, again, uncertainty is a resource, not an obstacle or problem.

'Ghosts', which ad hoc entities can easily become, emphasise how uncertainty cannot be solved with 'Elsi'. There are situations with 'Elsi' that produce unclear ontological outcomes. This is especially true with false alarms. When I asked Johanna whether the false alarms were a nuisance, she replied with a firm 'Yes!' and continued:

> Sometimes, the alarms come late. You can have a toilet alarm, but when you go to check the situation [right away], the customer has already left the toilet. Sometimes, there are delays. (Johanna)

Similarly, 'Elsi' sometimes sent alerts for toilet visits from rooms where the resident could not possibly visit the toilet alone:

> Sometimes, at night especially, there are these situations, like some years ago, when it ['Elsi'] can send an alert for a toilet visit in a room where the customer is incapable of moving. I don't know if [breeze from] an open window could have caused the alarm. However, the windows are seldom open if it's not summer. (Eila)

In the above situations, an entity of a resident entering the toilet and causing possible danger to their wellbeing is produced while using 'Elsi'. However, when the information translated by the sensors is delayed or when it is impossible for the resident to be in the toilet, these entities become uncertain.

Eila remembered clearly a scenario from years ago and tried to find explanations and reasons for the ontological uncertainty – they seemed to haunt her still. Maybe the fact that these alarms were produced during night shifts when she was the sole nurse on the floor highlighted the haunting aspect. The uncertainty with these kinds of alarms leads me to term the enacted entities 'ghosts'. Uncertain ontologies cannot simply be dismissed by workers. Instead, ontological uncertainty haunts them. 'Ghost' entities are both present and absent. 'Elsi''s beeping indicates the presence of someone in the toilet, but the employee is puzzled when there is no one there.

The example of 'ghosts' emphasises how the possibility of a resident being in risk becomes something not a danger or a threat, per se, but something more ambivalent. Therefore, it would be misleading to perceive falls, toilet visits or other risks as either predictable events or non-events. 'Ghosts', instead, linger between these two states. They are not really there but still have real consequences. Previous research has shown that telecare broadens, directs and limits the gaze of the care worker and creates 'zones of visibility and invisibility' (Grosen and Hansen, 2021: 259). In terms of ontological uncertainty work, however, it is unclear what is (in)visible.

The ways in which these 'ghost' entities haunt the workers indicate that it is not easy to live and work with ontological uncertainty. Although the workers smoothly switch between different ways of knowing, ontological uncertainty work also produces frustration.

> They [the false alarms] are annoying because, of course, when a fall alarm comes, you leave quite rapidly [to check the situation]. And when you notice that it was only the cleaner [who forgot to turn the floor sensors off] […] of course, it's a bit irritating […] but technology is technology and doesn't always work that way [as planned]. (Helena)

"An alarm is an alarm" for Ethan and "technology is technology" for Helena. These common sense reasonings stress that uncertainty is, if not explicitly positive, at least a central element and a mundane feature of working with 'Elsi' and something to accept in spite of the occasional frustration and irritation. The ethical uncertainty work with 'Elsi' further emphasises the centrality of uncertainty as a resource.

Ethical uncertainty work and the value of immediacy

In addition to privacy (Grosen and Hansen, 2021; Kamphof, 2017; López et al., 2010) and autonomy (López and Domènech, 2008a; López Gómez, 2015), immediacy has been shown to be an important value in telecare practices (López and Domènech, 2008b). Valuing immediacy turned out to be central for working with ‘Elsi’ as well. At the care home, ethical uncertainty work was needed to value immediacy while dealing with epistemological and ontological uncertainties. In this section, I mainly focus on three characteristics of these negotiations: speed, responsiveness and hurry.

Caring that relies on risk management values speed in performing *care* (Hillman et al., 2013). This was the case with ‘Elsi’. However, telecare solutions that provide quick and responsive care can create a conflict of values between immediacy and privacy (Grosen and Hansen, 2021). At the unit, alarms could hamper privacy when there was no clear reason to be alarmed, which was the case with false alarms. This was something that worried Bess, one of the workers, who pictured herself as one of the residents during the interview.

> I’m only moving in my bed and it [‘Elsi’] ‘beeps’ that I have fallen and alerts all the nurses even though I would like to be [alone]. [‘Elsi’] is good, but it also annuls privacy. (Bess)

How is the conflict between immediacy and privacy solved at the unit? An answer might stem from the ad hoc and ’ghost’ entities discussed above. An important distinction from ‘trotting’, a metaphor that implies running around without a clear destination, is how ‘Elsi’ makes the more precise allocation of work possible:

> When we are faster, we can prevent possible dangers. […] If [‘Elsi’] alerts a fall, we can react quickly and know where to go. (Johanna)
> [‘Elsi’] has changed the [working atmosphere] to a more secure one; you don’t have to trot around anymore. (Susanna)

Responsiveness secures immediate care. This might sound paradoxical when the possibilities of dismissing alarms and false alarms with the enactment of ad hoc and ‘ghost’ entities are taken into account. However, it is precisely the diversity of possible reactions to alarms and the ontological outcomes of this that justify fast responses to alarms, also the false ones, and the possible privacy intrusion, when it turns out that there was no reason to be alerted. There is no need to run around when one ‘knows everything’ or ‘knows without knowing’ what is going on and who needs help.

However, reacting to the alarms quickly and unconditionally also produced friction. This was evidenced during an interview with Nina.

> Again, the mobile phone constantly receives alerts throughout the interview. Nina reacts only to the last, vibrating, alarm […]. Someone has fallen. Nina specifies that the resident must have fallen because she has taken ‘drugs’ today (some strong medicine, I suppose). At first, however, Nina thinks that the alarm came from a nearby room, where a man starts to moan and yell. Nina does not go to check the situation in this room, but goes to help her ‘own’ resident. About ten minutes later, another nurse goes to check the situation in the nearby room. (Fieldnote)

Although Nina heard groaning from the nearby room, she responded to ‘Elsi’’s alarms. As previously mentioned, one nurse was usually responsible for five residents during (daytime) shifts, and these residents were specified in the nurses’ mobile phones. There was no rule about caring only for one’s assigned residents, but still, ‘Elsi’ seemed to promote this kind of routine. Based on the previous sections, however, it was clear that the alarm could have been false. In contrast to ‘Elsi’’s beeping, the sounds of the nearby resident moaning were very real. Still, the vibrating phone decided who was given priority, and the resident close by received help later. Nina did not question this ‘order’ and did not even seem to recognise it.

Why was the fall alarm responded to much more quickly than the noises coming from the nearby room? One answer might stem from the way in which ‘Elsi’ could be used to supervise not only the residents but also the nurses. The reaction times to fall alarms were sometimes supervised by management. This established omnipresent surveillance. As the nurses did not know when and how information on their actions was gathered, it was better for them to work as if they were always being watched (cf. Foucault, 1977; López, 2010). Indeed, it was sometimes the fear of constant surveillance that made caring more immediate with ‘Elsi’.

> Yeah, it is good that somebody keeps an eye on [the nurses] and that people have this kind of fear that somebody is watching (laughs). You must react [to the fall alarm]. (Liisa)

Valuing immediacy while caring with 'Elsi' – while also possibly being "kind of afraid" – often meant hurrying for the care workers. The interviewees had mixed feelings about hurrying. For some, "a little bit of hurry" was a good thing – it kept the worker alert and prevented them from "hanging around at the office" too much – but for Anneli, the feelings of hurry were frustrating.

> Well, the constant lack of time is frustrating, whether it is real or made up. Nevertheless, I often have the feeling that I don't have time to do everything I want to do [at work]. […] Of course, you can affect the feelings of hurry […] by having the patience to stop at least for a little while and [not] think about the next task. (Anneli)

Interestingly, Anneli blamed herself for not remembering to stop and take a break every now and then. The hurry may have not even been "real" but "made up" by the worker. In this reasoning, it is the worker's responsibility to not have the frustrating feeling of hurry, while 'Elsi' promotes immediate responses. Thus, responsive care creates hurry. The interviewees, however, did not see this as a downside of 'Elsi', its tendency to create 'ghosts' that could undermine any effort to respond quickly, for example, but as their own fault. This raises the question of whether 'Elsi' creates additional work, rather than simply helping the nurses. When the work input becomes fast and responsive, the result is not more free time, longer breaks or the possibility of spending more time chatting with the residents, being present or playing a game. Instead, at the unit, time saved resulted in washing laundry, preparing meals, cleaning or doing the dishes. Some of the nurses criticised the constant increase in tasks that had little to do with nursing.

> We have to do so much non-nursing work – dishwashing, doing the laundry – which takes a lot of time. I would rather give this time to the residents and do something with them: go outside, play a game, or just sit with them. (Pirjo)

Added to the additional work related to 'Elsi', the amount of work seems to increase rather than decrease, when immediacy is valued. As discussed above, the workers had to consider whether 'Elsi''s alarms could be trusted and what the other workers thought about the alarms, especially the unusual ones. This demonstrates triangulation as an additional mode of work. Furthermore, doubling the surveillance is also a form of additional work. Although regular checking rounds were thought to be replaced by the all-seeing view that 'Elsi' enabled, the workers did not eliminate the 'just in case' patrolling. In fact, 'Elsi' could necessitate routine check rounds when it produced false alarms.

Conclusion

In this paper, I have applied the concept of uncertainty work to ethnographic data to understand how telecare technology is used in institutional care work as a form of risk management, and what the outcomes of this kind of technologically mediated care might be. I have shown how telecare technologies that ought to provide fast, targeted and pre-emptive care operate through different uncertainties. Uncertainty work in this context leads to outcomes, which I identified as epistemological, ontological and ethical uncertainties. First, the strategies of 'knowing everything' and 'knowing without knowing' were examples of epistemological uncertainty as they were both justifiable, albeit contradictory, ways of knowing. Second, the enactment of ad hoc and 'ghost' entities were examples of ontological uncertainty as they showed how risks are not only recognised and answered but also enacted on purpose or unexpectedly. Third, the possibility of valuing immediacy – that is, speed and responsiveness, at times leading to hurry and frustration – was an example of ethical uncertainty as it illustrated how values, such as immediacy and privacy, can produce ethically contradictory outcomes. Furthermore, different uncertainties are mutually constituted. For example, when the existence of risky entities is uncertain, 'knowing without knowing' becomes a legitimate epistemological strategy. Likewise ad hoc entities justify immediate reactions to risky entities that sometimes turn out to be non-existent.

As my analysis reveals, the nature of uncertainty as an often implicit and mundane resource and an outcome of telecare practices makes it clear that uncertainty is not an obstacle or something to be eliminated, but rather, something to embrace. While the analysis focuses on uncertainty, it is important to note that prediction is also focal for risk management – most of the alarms were, after all, 'correct', with 'Elsi'. However, caring with telecare requires collective and innovative strategies that differ from predicting the future. Keeping knowledge, entities and ethics unclear is itself a form of risk management. While prediction puts the focus on signals, coding, information as data flow and risks known in advance, uncertainty emphasises the worker's skills and the proliferation of new and often unknown risks.

The results are in line with earlier research that has shown how telecare is not a straightforward solution to existing problems but creates new problems (e.g., Mort et al., 2013b; Pols, 2010, 2012; Schillmeier and Domènech, 2010). However, instead of highlighting risk management leading to dehumanising effects, such as the erosion of dignity for care receivers (Pritchard and Brittain, 2015), insecurity and decentred care (Grosen and Hansen, 2021) or maintaining the sociotechnical system rather than caring for older people (Hillman et al., 2013), this paper highlights the aspiration to care for individual residents. However, due to uncertainties, it is not necessarily care needs that are tended to. Rather, false alarms place focus on the resident's size or 'ghosts', for example. Due to different uncertainties, the focus is not on maintaining the risk management system, such as answering alarms unconditionally, but on the care worker's senses, capabilities and responsibilities.

The different forms of uncertainty work have both productive and disruptive consequences. Due to epistemological uncertainty, alarms can be interpreted with different strategies, such as dismissing them. This enables care workers to be creative and innovative. However, it seems that 'Elsi' does not straightforwardly decrease the amount of work. Rather than saving resources through prediction, working with 'Elsi' creates additional work, such as triangulation and increased surveillance. The occurrence of different uncertainties does not induce a proliferation of insecurity (cf. Grosen and Hansen, 2021). This is due to the additional work undertaken by care workers. In this way, the responsibilities of care organisations and political institutions are potentially decreased when telecare technologies become mundane features of care work.

The politics that emphasise telecare as the solution to scarce care resources make it difficult to recognise the additional work that telecare technologies co-create. Emphasising austerity requires that risk management is based on saving resources while predicting the future. While resources might be saved budget-wise, this is not necessarily due to using telecare technology, but the outcome of dealing with the uncertainties that are co-created with telecare. Therefore, it is important to recognise the different uncertainties that come with risk management in telecare practices. Furthermore, more focus should be put on the additional work that the epistemological, ontological and ethical uncertainties create in future research on telecare practices.

Acknowledgements

I would like to thank the two anonymous reviewers for their helpful comments and suggestions. This research has been supported by grants from the Ella and Georg Ehrnrooth Foundation, the Finnish Cultural Foundation (grant number 85201646) and the Turku University Foundation (grant number 080812).

References

Brown SD and Capdevila R (1999) Perpetuum Mobile: Substance, Force and the Sociology of Translation. *The Sociological Review* 47(SI): 26–50.

Callén B, Domènech M, López D and Tirado F (2009) Telecare Research: (Cosmo)politicizing Methodology. *ALTER* 3(2): 110–22.

Cribb A (2020) Managing Ethical Uncertainty: Implicit Normativity and the Sociology of Ethics. *Sociology of Health & Illness* 42(SI): 21–34.

Deleuze G and Guattari F (1988) *A Thousand Plateaus*. London: The Athlone Press.

Doughty K, Cameron K and Garner P (1996) Three Generations of Telecare of the Elderly. *Journal of Telemedicine and Telecare* 2(2): 71–80.

Draper H and Sorell T (2013) Telecare, Remote Monitoring and Care. *Bioethics* 27(7): 365–372.

Foucault M (1977) *Discipline and Punish*. London: Allen Lane.

Fox RC (1980) The Evolution of Medical Uncertainty. *The Milbank Memorial Fund Quarterly* 58(1): 1–49.

Gabrys J (2019) Sensors and Sensing Practices: Reworking Experience across Entities, Environments, and Technologies. *Science, Technology, & Human Values* 44(5): 723–736.

Grosen SL and Hansen AM (2021) Sensor-floors: Changing Work and Values in Care for Frail Older Persons. *Science, Technology, & Human Values* 46(2): 254–274.

Hillman A, Tadd W, Calnan S, Calnan M, Bayer A and Read S (2013) Risk, Governance and the Experience of Care. *Sociology of Health & Illness* 35(6): 939–955.

Kamphof I (2017) A Modest Art: Securing Privacy in Technologically Mediated Homecare. *Foundations of Science* 22(2): 411–419.

Jaakola J (2020) Ethics by Other Means? Care Robot Trials as Ethics-in-Practice. *Tecnoscienza* 11(2): 53–72.

Kim K, Gollamudi S and Stenhubl S (2017) Digital Technology to Enable Aging in Place. *Experimental Gerontology* 88: 25–31.

López D (2010) The Securitization of Care Spaces: Lessons from Telecare. In: Schillmeier M and Domènech M (eds) *New Technologies and Emerging Spaces of Care*. Farnham: Ashgate, pp.39–55.

López D, Callén B, Tirado F and Domènech M (2010) How to Become a Guardian Angel: Providing Safety in a Home Telecare Service. In: Mol A, Moser I and Pols J (eds) *Care in Practice*. Bielefeld: transcript, pp.73–91.

López D and Domènech M (2008a) Embodying Autonomy in a Home Telecare Service. *The Sociological Review* 56(2): 181–195.

López D and Domènech M (2008b) On Inscriptions and Ex-Inscriptions: The Production of Immediacy in a Home Telecare Service. *Environment and Planning D: Society and Space* 26(4): 663–675.

López Gómez D (2015) Little Arrangements that Matter: Rethinking Autonomy-enabling Innovations for Later Life. *Technological Forecasting and Social Change* 93: 91–101.

Mackintosh N and Armstrong N (2020) Understanding and Managing Uncertainty in Health Care: Revisiting and Advancing Sociological Contributions. *Sociology of Health & Illness* 42(SI): 1–20.

MariCare (2020) Corporate Product Web Page. Available at: http://www.MariCare.com/en (accessed 30.11.2022).

Milligan C, Mort M and Roberts C (2010) Cracks in the Door? Technology and the Shifting Topology of Care. In: Schillmeier M and Domènech M (eds) *New Technologies and Emerging Spaces of Care*. Farnham: Ashgate, pp.19–37.

Milligan C, Roberts C and Mort M (2011) Telecare and Older People: Who Cares Where? *Social Science & Medicine* 72(3): 347–354.

Ministry of Economic Affairs and Employment (2015) *Hoito- ja hoivapalvelualan tila ja tulevaisuudennäkymät*. TEM raportteja 3/2015.

Moreira T, May C and Bond J (2009) Regulatory Objectivity in Action: Mild Cognitive Impairment and the Collective Production of Uncertainty. *Social Studies of Science* 39(5): 665–690.

Mortenson WB, Sixsmith A and Woolrych R (2015) The Power(s) of Observation: Theoretical Perspectives on Surveillance Technologies and Older People. *Ageing and Society* 35(3): 512–530.

Mort M, Finch T and May C (2009a) Making and Unmaking Telepatients: Identity and Governance in New Health Technologies. *Science, Technology, & Human Values* 34(1): 9–33.

Mort M, Roberts C and Milligan C (2009b) Ageing, Technology and the Home: A Critical Project. *ALTER* 3(2): 85–89.

Mort M, Roberts C and Callén B (2013a) Ageing with Telecare: Care or Coercion in Austerity? *Sociology of Health & Illness* 35(6): 799–812.

Mort M, Roberts C, Pols A, Domenèch M and Moser I (2013b) Ethical Implications of Home Telecare for Older People: A Framework Derived from a Multisited Participative Study. *Health Expectations* 18(3): 438–449.

Neven L (2015) By Any Means? Questioning the Link between Gerontechnological Innovation and Older People's Wish to Live at Home. *Technological Forecasting & Social Change* 93(SI): 32–43.

Oudshoorn N (2008) Diagnosis at a Distance: The Invisible Work of Patients and Healthcare Professionals in Cardiac Telemonitoring Technology. *Sociology of Health & Illness* 30(2): 272–288.

Oudshoorn N (2011) *Telecare Technologies and the Transformation of Healthcare*. London: Palgrave Macmillan.

Pickersgill M (2011) Ordering Disorder: Knowledge Production and Uncertainty in Neuroscience Research. *Science as Culture* 20(1): 71–87.

Pickersgill M (2020) Uncertainty Work as Ontological Negotiation: Adjudicating Access to Therapy in Clinical Psychology. *Sociology of Health & Illness* 42: 84–98.

Pols J (2010) Telecare: What Patients Care About. In: Mol A, Moser I and Pols J (eds) *Care in Practice*. Bielefeld: Transcript, pp.171–193.

Pols J (2012) *Care at a Distance*. Amsterdam: Amsterdam University Press.

Pritchard G and Brittain K (2015) Alarm Pendants and the Technological Shaping of Older People's Care. *Technological Forecasting and Social Change* 93: 124–32.

Roberts C, Mort M and Milligan C (2012) Calling for Care: 'Disembodied' work, Teleoperators and Older People Living at Home. *Sociology* 46(3): 490–506.

Sánchez-Criado T, López D, Roberts C and Domènech M (2014) Installing Telecare, Installing Users: Felicity Conditions for the Instauration of Usership. *Science, Technology, & Human Values* 39(5): 694–719.

Schillmeier M and Domènech M (2010) Introduction. In: Schillmeier M and Domènech M (eds) *New Technologies and Emerging Spaces of Care*. Farnham: Ashgate, pp.1–17.

Star SL (1985) Scientific Work and Uncertainty. *Social Studies of Science* 15(3): 391–427.

Star SL (1989) *Regions of the Mind*. Stanford: Stanford University Press.

Strauss A, Fagerhaugh S, Suczek B and Wiener C (1985) *Social Organization of Medical Work*. Chicago: University of Chicago Press.

Tirado F, Callén B and Cassián N (2009) The Question of Movement in Dwelling: Three Displacements in the Care of Dementia. *Space and Culture* 12(3): 371–382.

The Logics of Invited and Uninvited Material Participation: Bringing Blood Pressure Self-Monitoring Into the Clinic

Kate Weiner
Department of Sociological Studies, University of Sheffield, UK/k.weiner@sheffield.ac.uk

Flis Henwood
School of Applied Social Science, University of Brighton, UK

Jacob Andrews
Division of Psychology and Psychiatry, School of Medicine, University of Nottingham, UK

Catherine Will
Department of Sociology, University of Sussex, UK

Ros Williams
Department of Sociological Studies, University of Sheffield, UK

Abstract

This paper addresses debates concerning the 'participatory turn' in healthcare. It focuses on the case of blood pressure self-monitoring, understanding this as a form of patient participation at the level of individual care. Drawing and expanding on the work of Marres and Wynne and their notions of material participation and of uninvited engagement, we examine how patients' home blood pressure self-monitoring is incorporated into clinical care, how the materials of blood pressure self-monitoring mediate participation and how we might characterise the practices of participation found within everyday clinical care. Our analysis makes new conceptual links, suggesting that, in this context, invited participation appears to align with participation made easy, while uninvited participation involves more invested, more engaged participation. We offer two further developments of these concepts. First, we trouble characterisations of invited and uninvited participation as distinct and separate, observing movement between these. Second, through applying the logics of material participation in a new context, everyday clinical practice, we suggest that the logic of participation made easy might be extended beyond lay people, to apply to professionals as well. Our analysis illustrates how materials are mobilised to facilitate invited and uninvited participation within the context of the on-going asymmetries in doctor patient relationships.

Keywords: Material participation, Uninvited participation, Patient participation, Self-monitoring, Blood pressure, Primary care.

Introduction

Self-care, including self-monitoring, is seen as a key element of the so-called ‘participatory turn’ (Prainsack, 2017) in health care. This emphasises public and patient involvement in different arenas including policy, research, service review and individual health care (Sinding et al., 2012; Stewart, 2016; Prainsack, 2017; Nielsen and Langstrup, 2018). At the level of individual health care, patient participation is imagined to contribute not only to health service efficiencies in the face of growing demand, but also to empowering patients to contribute to, and thereby improve, their care experiences and outcomes (Sinding et al., 2012; Prainsack, 2017; Jones, 2018). While the active participation of patients continues to be “tirelessly promoted” in policy and commercial discourse (Nielsen and Langstrup, 2018: 260), social scientists have critiqued this in a number of ways. They have argued that ideas of patient involvement and self-care found in this discourse embed individualised notions of human action, have argued for a more relational understanding of autonomy and called for greater attention to the wider infrastructures of care (e.g., Mol, 2008; Danholt and Langstrup, 2012; Sinding et al., 2012). They have also drawn attention to structural and political influences on health, as well as the social function of medicine (e.g., Pilnick and Dingwall, 2011; Jones, 2018).

In policy discourse, the promotion of self-care and self-monitoring has been linked to the development of digital innovations. For example, the UK Topol Review (Topol, 2019) envisions that smartphone apps, sensors and wearables for diagnostics will help to track ‘vital signs’ such as heart rate, respiratory rate, oxygen and blood pressure, and that, within two years of launching, the new National Health Service (NHS) App will allow people to upload data from their ‘wearable and lifestyle apps’. The report rehearses the language of patient empowerment and participation, suggesting, for example, that making patient-generated data clinically useful will “empower patients to manage their own health or seek appropriate health support” (Topol, 2019: 10). These arguments represent a contemporary iteration of an established narrative about the empowering effects of new technologies in healthcare, long critiqued by social science and STS scholars (e.g., Oudshoorn, 2008). In this paper, we continue this critique by considering blood pressure self-monitoring as a form of patient participation and exploring how this is incorporated into clinical care.

In focusing on the processes of participation, we turn to insights from STS in particular. Reviewing this scholarship, Chilvers and Kearnes (2020: 253-254) observe a move from “a dominant imaginary of participation as confined to discrete, isolated, and ephemeral events and time-spaces” and concern with the development of “‘formalized mechanisms of voicing” (Michael, 2012: 530) to understandings that increasingly “encompass material, embodied, private, digital, uninvited, everyday, mundane forms of public engagement” (Chilvers and Kearnes, 2020: 355). In our analysis of the practices of participation associated with blood pressure self-monitoring we draw on two aspects of Chilvers and Kearnes’ characterisation of participation: uninvited and material participation

The notion of uninvited public engagement was a response to scholarship focussed on formal and discrete engagement events. Wynne (2007) proposes that uninvited public engagement arises in response to these expert-led interventions. Such interventions have an “implicit politics-as to what is salient and what is not salient” and “uninvited forms of public engagement are usually about challenging just these unacknowledged normativities” (Wynne, 2007: 107). Such uninvited participation tends to be imagined as coordinated and collective campaigns or actions (Wynne, 2007; Wehling, 2012). Stewart’s (2016) work on participation in health systems, however, identifies uninvited participation at both collective and individual levels. In applying the notion at the individual level, she details the way young people quietly subverted and resisted local health service processes. However, Stewart’s analysis suggests invited and uninvited participation are discrete practices, finding “a reasonably clear distinction between a space in which the ‘rules of the game’ are defined by organisational actors, and on in which they are improvised by citizens” (Stewart, 2016: 128). Our analysis suggests that this distinction may be less clear, and that there can be movement between these at the level of individual participation.

Marres' (2012) notion of material participation continues the concern with surfacing the underlying normativities of participation, but focusses on participation located in everyday material practice. In her study of environmental politics, she points to the way that material entities, such as everyday technologies of carbon accounting are "invested with capacities to mediate engagement, and […] raises analytical awareness of the situated, material, normative and performative aspects of participatory practices" (Nielsen and Langstrup, 2018: 261). Marres brings to light two distinct logics of material participation. On the one hand, she documents devices that are meant to mitigate the environmental costs of everyday life "without problematizing or altering the [everyday] activity itself" (Marres, 2012: 66). This form of participation is meant to require little effort, intended to make things easy for ordinary publics. Marres (2012: 67) argues: "the notion that participation in public affairs must somehow be made 'doable' for everyday people – who lack the time, space and shared knowledge that political engagement requires – has been an important trope of liberal theory". She notes, this has particular normative implications regarding the "bifurcation of two domains of engagement with public affairs – one for professionals and one for laypeople" (Marres, 2012: 68). Yet, she suggests, the trope of making things easy comes undone in evaluations of initiatives. These talk of the "hidden costs" of involvement, which require "more investments, labour and disruptions than promotional narratives…assume" (Marres, 2012: 77). While these evaluations bring into view the limits of the trope of minimization of effort, they do not necessarily problematize this logic, but might be used as a justification for abandoning the policy of participatory approaches to environmental change. Marres identifies an alternative, pragmatist logic of 'the more invested the more engaged' based on her analysis of individual and collective domestic environmental projects which documented the time, effort and disruption, that is, the costs of environmental change. These more experimental engagements with the valuations of environmental action have a performative effect, helping to raise questions about the broad social distribution of costs. The problem here is not with "people who aren't interested" or with "issues that are too complex" (Marres, 2012: 80), but with rethinking the issue of environmental participation.

In our analysis, we draw on Marres' concept of material participation and the different logics of participation this incorporates to consider the kinds of investments that are imagined, required or offered by self-monitoring and link this to notions of invited and uninvited participation. In the following paragraphs we discuss existing studies of self-monitoring, considering both health sciences and social sciences analyses and relate them to the concepts we have highlighted, whilst also drawing on insights from the sociology of health and illness. We observe that, just as environmental participation is normatively multivalent, scholarship on self-monitoring suggests that there are multiple registers of patient involvement/participation.

Schüll's (2016) analysis of the marketing of tracking technologies resonates with the liberal trope of participation made easy through its focus on 'micronudges' and the move to presenting 'actionable data'. These are pitched "as a way to embrace the project of self-enterprise without undertaking the tedious, nebulous, and anxiety-provoking work of lifestyle management" (Schüll, 2016: 329). In other settings, patient investment in participation is valorised. Danesi et al. (2020) for example illustrate how clinicians hope their patients will invest effort in learning how to use and interpret flash glucose monitoring, seeing it both as a pedagogic tool and an opportunity to start a conversation about insulin. (On this latter point, see also Fiore Gartland and Neff, 2015). Health sciences scholarship also hints at the valorisation of investment in blood pressure self-monitoring, which might facilitate lifestyle change or better 'medication adherence' (Fletcher et al., 2016). Other scholarship (e.g., West et al., 2018), focussed on the utility of patient-generated data, presents a rather ambivalent picture of the investments expected of patients and clinicians. This highlights clinicians' concerns about accuracy and the workload implications of managing this data (RCGP, 2010, 2013; Morgan, 2016; Zhu et al., 2017, Morrissey et al., 2018; Fisker et al., 2021). It has been suggested that patients receive little feedback or interpretation on the data they generate and that these data are used as a check on patients rather than to facilitate dialogue (Morgan, 2016). This scholarship is suggestive of attenuated patient investments which might approach 'participation made easy': Patients are providers of data with no need to engage with or interpret these data, reinforcing a continued division between professional and lay worlds, in other words a thoroughly liberal form of engagement in Marres' terms.

The foregoing scholarship suggest that patients' self-monitoring is not unequivocally welcomed by clinicians, who express concerns about accuracy, workload, and also about patient anxiety, which forms a recurrent trope in clinical discussions (e.g., British Hearth Foundation, 2015; Morrissey et al., 2018; Fiske et al., 2021). These concerns imply that clinicians have doubts about patients' capacities to engage with self-monitoring in the right ways and amounts. We suggest these concerns might be understood as issues of professional authority, which, as medical sociologists have discussed, are inextricably linked with patient participation (e.g., Pilnick and Dingwall, 2011). As this scholarship shows, patients are well aware of the tensions associated with participation; they may be reluctant to discuss their own self-care practices (Stevenson et al., 2003) and tread carefully when trying to insert their own ideas or concerns into medical consultations to avoid usurping the epistemic authority of their clinicians (Bergen and Stivers, 2013; Stevenson et al., 2021). While not explicitly referenced, there are hints of this in scholarship relating to how clinical trials of self-tracking technologies work out in practice. These have shown how patients may curate (Weiner et al., 2020) their records in preparation for sharing them with their health care professionals, leaving out or including particular data, (Nielsen, 2015; Piras and Miele, 2017; Danesi et al., 2018) as a way to keep the clinic at a distance or make their own concerns visible or legible (Street, 2012) to their clinicians. Given the 'interactional delicacy' (Stevenson et al., 2019) of participation at the clinic, these practices of curation may help patients avoid or raise particular issues. They also illustrate the perhaps unexpected investments patients make when they are invited to self-monitor. To sum up, the scholarship on self-monitoring initiatives suggests expectations of both quite circumscribed and highly invested patient participation that align with Marres' notions of 'participation made easy' and 'the more invested, the more engaged'. It also suggests that patients may make unexpected investments in self-monitoring and we have linked this to the tensions of patient participation. Considering self-monitoring through the lens of **material** participation helps to centre how materials (such as self-monitoring records) might be enrolled in maintaining clinical authority or in negotiating tensions of patient participation, and thus reinforcing or mitigating divisions between professional and lay domains.

The scholarship we have discussed above focuses on how patients respond to invitations to engage in self-tracking initiatives, such as clinical trials or demonstration projects. We aim to build on this scholarship by considering how patients participate and how clinicians respond in practice when participation may or may not be expected. In contrast to the scholarship discussed above, our own study was not part of a specific clinical initiative or trial. We focus on the case of blood pressure self-monitoring undertaken with devices acquired independently of the clinic, and how this self-monitoring is managed in everyday clinical practice. While our participants had all acquired their own devices, we do not think their participation in the clinic should be seen, a priori, as uninvited. In the UK, a range of blood pressure monitoring devices are available to buy in supermarkets, pharmacies and online retailers (see Williams et al., 2020 for more detail) and self-monitoring is supported in clinical guidance as one response to white coat hypertension (NICE, 2019), that is, raised blood pressure induced by visiting the clinic. Furthermore, while our participants had bought (or had been gifted) their own monitors, their accounts suggest that their home monitoring was sometimes enrolled into the clinic, through being commissioned by their doctor or nurse to measure in advance of review appointments. This 'invited participation' is one way that clinics respond to the problem of white coat hypertension. All of this helps to expand ideas around invitations to participate, illustrating that these may be extended in different places and ways. Commercial offers and clinical guidelines both, arguably, constitute invitations to participate in self-monitoring. Clinicians may extend specific invitations to participate in everyday clinical practice through inviting patients to use their own monitoring devices. Yet, patients may also initiate their own monitoring, uninvited in this context, which, as we will demonstrate, they may hope to discuss with their clinicians.

In this paper we expand on the literature on patient participation in self-monitoring, focussing not on innovations, initiatives or trials, but on everyday practice. We consider the case of blood pressure monitoring as a well-established exemplar of a device that has escaped the clinic and is now widely available as a consumer technology, yet remains of central clinical interest (See Williams et al., 2020). We explore how home blood pressure monitoring re-enters the clinic to consider how patients' self-monitoring is incorporated into clinical care, how self-monitoring materials mediate participation and how we might characterise the participation that is evident within the everyday practices of the clinic. Our analysis draws on and links Marres' (2012) ideas concerning the different participatory logics underpinning material participation and Wynne's (2007) notion of invited and uninvited participation. In doing so, we apply and extend these concepts in a new context.

Methods

This paper draws on data collected as part of a 3-year study of self-monitoring, focussing on the cases of blood pressure (BP) and weight/BMI, with this paper focusing solely on BP monitoring. Ethical approval was given by the lead author's institutional Ethics Review Committee and full details of the overall study design and methods can be found in Weiner et al. (2020), Will et al. (2020) and Andrews et al. (2020). Two distinct data sets are drawn on in this paper. The first data set was collected via interviews with people who self-monitor their blood pressure and the second from focus groups with primary care professionals who talk about their management of patient self-monitoring.

For the interviews, we recruited participants through advertising on email lists at three UK universities and noticeboards across campuses, at older people's groups and at community centres in less-advantaged areas. Participants varied in terms of age, sexuality, ethnicity, socio-economic background and health. We undertook 47 semi-structured interviews involving 55 people, including 8 interviews with couples. Interviews were designed to explore the broad practices of self-monitoring, including the potential wider infrastructure of care involved. Crucial to our study was its focus on people who had acquired or purchased their BP monitors independently of the clinic. Interviews explored how people came to acquire their BP monitors, what they do or do not do with these devices, what records they keep (if any), who else, if anyone, is involved with the practice and with whom data are shared. People came to monitor their blood pressure for many reasons. As might be expected, some of our participants had been diagnosed with hypertension, and had been prescribed medication. Others had experienced a high reading in the clinic or elsewhere. A few related their self-monitoring practice to general fitness and health narratives, family history or saw blood pressure monitoring as a form of stress monitoring (See Weiner et al., 2020). While our inclusion criteria meant that all participants had acquired their devices independently of the clinic, we found that health care professionals often featured in their interviews. Clinicians were in evidence, for example, in narratives about how people started monitoring their BP or how they came to acquire devices, how they keep and with whom they share records, and their understandings of blood pressure.

In the second stage of the research, we undertook focus groups with primary care practitioners, to explore their views and experiences of managing self-monitoring in the clinic. We employed a set of vignettes to structure these focus groups and prompt discussion. We developed these vignettes drawing on our interviews with people who self-monitor, selecting excerpts from these interviews to provide good illustrations of interviewees' talk relating to the clinic (See Andrews et al., 2020, for further discussion of vignette methodology and detail of procedure). We recruited general practitioners (GPs) and practice nurses (PNs), through two NIHR Clinical Research Network (CRN) clusters[1], aiming for diversity in the participating practices. In total, we conducted five focus groups, with a total of 21 health care professionals. Three of these focus groups involved health care professionals based in lower socio-economic areas, and two involved health care professionals based in higher socio-economic areas.

Interviews and focus groups were audio recorded, transcribed in full and analysed thematically (Hammersley and Atkinson, 1995). We collaboratively developed a coding frame for the interviews, which was broadly informed by our theoretical interest in everyday practices and care infrastructures, whilst also allowing space for emergent themes. For the focus groups, we devised a set of codes where some themes aligned with the topics of the vignettes, which were themselves informed by the themes from the interviews, and others were more emergent.

In the analysis below, we consider how the clinic and clinicians feature in interviewees' talk about their self-monitoring, and how clinicians propose they respond to their patients' self-monitoring practices. We focus, for example, on reports of self-monitoring being discussed in clinical consultations or of people submitting their own records to the practice (e.g., "drop them off at reception"). We pay attention to moments when participation appears to be invited or uninvited and movements between these, to the underlying logics of participation that emerge, and to the ways in which materials appear to mediate these different enactments of participation. The analysis is divided into four sections. The first two draw on both interview and focus group data to consider the different ways these suggest patient participation in self-monitoring is enacted in the clinic. The first section illustrates the way patients might be invited to self-monitor in relatively circumscribed ways which we suggest equates with participation made easy. We then consider occasions where participation appears at first sight to be uninvited, and the more involved and invested participation that appears to be associated with this. Then, drawing solely on the focus group data, we detail clinicians' concerns about investments in self-monitoring, both the investments they need to make to manage this in the clinic, and the potentially burdensome (over)investments of their patients. The final section suggests that clinicians sometimes manage or respond to this by retreating to 'participation made easy'.

Analysis

Invited participation as participation made easy

Interviewees were recruited into our study on the basis that they had bought their own monitors. Just three explicitly told us that their doctor had suggested that they buy a monitor, a clear clinical invitation to participate in blood pressure monitoring. Yet the clinic loomed large in many other interviewees' accounts of their monitoring practice and clinicians sometimes appeared to extend invitations to self-monitor blood pressure and support this. In this section we will suggest that such invitations involved an expectation of relatively limited and circumscribed patient investments that conform to the logic of 'participation made easy'.

Interviewees told us that they drop off (i.e. deliver) their own records, or bring them to clinic appointments, sometimes in response to a request or invitation from their clinicians. Geraldine, a woman in her late 70s, tells us she has white coat hypertension and was asked to take her blood pressure for one week in the run up to her appointments. She tells us her readings are used as the basis for treatment decisions "whether I get tablets for six months or he says I'd like to see you again in three". Interviewees' accounts of these appointments indicated something of the investments in formal care required or expected of patients. For example, they expressed a great deal of uncertainty about what happens to the self-generated data that they give to their clinicians.Interviewees often suggested that their self-generated records were "scanned-in'" or "put on my notes". However, the degree to which this data became part of their formal electronic record was not clear.

Henry (aged 65) provides home monitoring readings as part of the process of requesting a repeat prescription. He compiles his own hand-written readings, completing one sheet per day and taking readings over several days. He says he has dropped these sheets off with the receptionist in the past, although the last time he scanned in the sheets and emailed them to the practice. We asked if his doctor saw these sheets, and he responded:

> Well, I don't know if he sees the detail. He sees the average. Whether his receptionist calculates an average and just puts that on my record or whether he sees all the details, I don't know. I don't know if you've seen a GP lately but when you see a GP he's just looking at a computer screen and you don't really know what he's got on it.

Henry's account neatly illustrates the way, from the patients' perspective, the process of capturing and processing home monitoring data in the clinic may be completely black-boxed. What happens to the data and the sense in which it is useful for the clinic, and ultimately, potentially, also for the patient, remains opaque. In these circumstances, however, interviewees did sometimes formulate hunches about the utility of their data. Nora (aged 33), for example, recounts that she hands in her readings to the reception, and although she had not heard anything directly, her repeat prescription was approved. She surmised that "somebody somewhere looked at it, decided not to increase my medication and approved my next one [prescription]".

Other interviewees conveyed more ambivalence about how and whether their own readings were useful to the clinic. Emily, a woman in her 30s, has hypertension and takes medication. She tells us that her doctor recommended she bought a blood pressure monitor and that she had used it particularly around the times of settling into her medication and medication changes. While her doctor had apparently asked her to monitor during these times, she is uncertain what use he makes of her readings, which she collates in a diary to take to appointments. We asked if her doctor looked at the readings and she responded:

> Emily: Yes, he would have looked at them. [...] He'd never note them down anywhere though.
> Interviewer: Yes. Do you remember him saying anything about them?
> Emily: He probably would have gone, umm, and made a very concerned face, because he seems to be that type of person [...] He just looked at them to see if they were kind of where he wanted them to be or not.

In the focus groups with clinicians, we drew on the excerpt above from our interview with Emily and asked clinicians about how they might work with their patients' self-generated data. They suggested they would, and do, use patient-generated data as the basis for prescribing decisions and do record self-generated data in patients' electronic records, both in a designated numeric field and in narrative fields. They suggested a variety of ways they might manage their patients' data including writing two or three of the home readings into their notes, selecting the "best looking reading", calculating an average, writing down a range, or getting a feel for the data, as one GP explained "I look and think that looks about right. You can get a ballpark average in your head".However, the use the clinicians make of patient-generated data may not be visible to patients as it may take place outside of the consultation, as suggested by one of the GPs:

> GP1(2): [I'm] pretty confident the doctor is, kind of, looking at them [Emily's records] and she says he's not writing them down, but I wouldn't usually write anything down during a consultation. I would write it down afterwards and obviously you're looking for thresholds and so if the blood pressure was obviously well controlled […] if every reading is below 140 over 90, then I think the exact number is maybe not directly relevant […] So I'm, sort of, reading between the lines, but thinking the doctor has looked, he's probably happy with what he's seen. She's obviously ambivalent, she's not sure whether or not the doctor is taking it seriously or really cares. I hope my patients don't think that.
> I think I tell them the conclusion I've drawn from what they've brought.

The doctor's equivocation at the end of this excerpt seems a quite potent indication of the investments expected of patients, where clinicians' investments in their patients' self-generated data may remain unknown and clinicians may, at most, communicate an outcome. Clinicians' support of self-monitoring figured around the time-limited and structured practices of producing the right amounts and right kinds of readings to support scheduled review meetings and clinic routines e.g., an average of three consecutive readings taken morning and afternoon over a period of one or two weeks. This was seen as an efficient way for clinicians to identify issues and make medication decisions. A clear sense of this was presented by one of the clinicians (GP1(4)) who explained they often asked people to drop results at reception, and only invited these patients for an appointment if the doctor identifies an issue. He explained:

> In general, we're trying to get away from checking blood pressures ourselves and just really dealing with the data and seeing a person if they've seen a healthcare assistant and their blood pressure has been up or their home blood pressure has been up, bringing them in to talk about what we do about that [...] I think we're trying to get away from GPs doing that [checking blood pressure] and so the GPs have got the time to see the people that need changes and discussion.

In the data we have discussed so far, patient participation emerges as an expectation that patients drop off their readings and wait for either a repeat prescription or to be called into the clinic. These accounts of preferred clinic practices and what happens to patient-generated data may be thought of as enactments of 'invited participation' that depend on very clear divisions of labour. Patients are expected to produce and provide readings but are not expected to invest in understanding or interpreting these readings or their implications for treatment decisions, which appear to remain largely the clinicians' responsibilities. This seems to enact the liberal logic of 'participation made easy'. Our argument builds on Marres (2012: 68) idea that within this logic, participation is made doable for ordinary people whilst retaining a separation between professional and lay "domains of engagement with public affairs". In this case, we suggest, participation is made doable for **both clinicians and patients** whilst maintaining a division between patient and professional domains of engagement with health care.

Uninvited participation as more invested and more engaged

Patients may be glad if their home monitoring reduces the number of appointments they have to attend, or it provides a smooth process of requesting a repeat prescription. Yet the clinic routines are premised on clinicians' understanding of the purpose of self-monitoring, as broadly a way to identify patients whose blood pressure is poorly managed ("up") in order to discuss medication strategies. This does not recognise that patients may have their own reasons for wanting to talk with their clinicians. Our interviews suggest that people may sometimes take matters into their own hands in unexpected or (at least initially) uninvited ways, using monitoring to prompt a discussion in the clinic to raise their own concerns. These include, for example, that they do not want, or think they do not need, to take medication, that they have white coat hypertension and would like to avoid further (in their view) unnecessary trips to the clinic, that they are worried about their blood pressure, or they would like a change of medication. In this section we will suggest that accounts that appear to involve uninvited participation entailed enactments of an alternative logic of participation which is more invested and more engaged than 'participation made easy'.

A number of our interviewees talked of their wish to come off or reduce their medications, in keeping with broader lay 'resistance' to pharmaceuticals (Pound et al., 2005; Weiner and Will, 2016). Bob and Alice are an older couple who both have hypertension and other chronic conditions. Their daughter originally gave them a blood pressure monitor, and during the interview a clear story emerged of them both using their own self-monitoring records to negotiate reductions in medication. Bob's story shows his deliberations about wanting to reduce his medication and the way this was entwined with his desire to be a good citizen, not waste state resources, be a good patient and maintain his relationship with his doctor. The chronology of events is not clear in Bob's narrative. We could not untangle when he started taking his records to the clinic or whether this was in response to an invitation from the clinic to do so. It is nevertheless clear that, at some point, the clinic has advised him how to self-monitor ("the nurse told me to do it three times") and requested that he bring in his device for calibration, in Alice's words, "to make sure it was working right". The boundary between invited and uninvited participation in BP monitoring is unclear here with the clinic clearly supporting, and thereby, arguably, 'inviting' a practice that it had not necessarily initiated. However, Bob's account of how he used the data from his BP monitoring to justify a reduction in his medication offers insights into a trickier set of negotiations about the boundaries of invited and uninvited participation. Bob described how he had slowly and incrementally reduced his medication, whilst keeping a check on his blood pressure, and how he eventually came to "confess" this to his doctor:

> Bob: The reason why I went is because I were being prescribed these tablets, so I were basically throwing the tablets away [...]
> Alice: They were on repeat prescription, you see. I said, 'why don't you just stop accepting them'? He says, 'but then they'll know I'm not taking them'.
> Bob: So initially, I were a bit frightened to tell him, because I were accepting tablets and not taking them, and I thought, God, I shouldn't be doing that. And then, I thought I've got to go and tell him. So I made my mind up to confess, so to speak. It's like Crimewatch[2], isn't it? So I went and I says, listen […] I've reduced it and reduced it, and I'm now taking ten milligrams, I've been taking them for a year or so, whatever, and these are my readings [...] So they agreed that, they said, yeah, well, stop taking them. But if I hadn't have done my own experiment, I'd have still been taking 30 milligrams.

According to Bob's account, his doctor had explicitly told him not to reduce his medication. Bob then took matters into his own hands, through his "own experiment", but the account conveys the delicacy of raising these kinds of issues in the clinic. His account can be recognised as a classic example of a patient disclosure of a medical misdeed (Bergen and Stivers, 2013), that is, Bob's admission of his failure to follow his doctor's recommendations. Such disclosures have to be managed carefully as they challenge doctors' authority and risk exposing patients as having acted improperly. We hear this in Bob's use of the phrase *confess* and in his account of using his blood pressure readings (*and here are my readings)* to demonstrate that his action was medically warranted. In the end, Bob's initially uninvited participation in his own medication management appears to have been accepted and to have brought about a satisfactory outcome, that is, a reduction in pills with his doctor's knowledge and sanction. The account illustrates clearly how the materials of participation act as a highly significant part of such enactments, with the blood pressure records being mobilised explicitly to facilitate this more engaged form of participation.

In other instances of what appeared to be uninvited participation, people wished to intervene in the diagnostic process rather than medication management. Interviewees were concerned to substantiate they have white coat hypertension, that is, high blood pressure induced by having readings taken in the clinic, which meant that they might not require (further) clinical intervention. Some interviewees reported taking their own readings to the clinic as a foil for the readings that were taken by clinicians in the clinic. Here, interviewees might want to fend off further appointment invitations. Brenda, a retired nurse in her early 80s does not expect her readings to replace the clinic taking her blood pressure or for her own readings to be entered into her record. She takes them as a way to bargain against repeat visits:

> Interviewer: did you take the readings with you to the surgery[3]?
> Brenda: I have done but they always take their own, they have to. And I think, possibly, when I started showing them this, they didn't ask me to keep coming back...I used to take a whole page of data at a time.
> Interviewer: Right but did you think they wrote it down or do you think they just recognised
> Brenda: No they just
> Interviewer: They acknowledged it?
> Brenda: Yes
> Interviewer: Oh okay that's interesting, so it's a kind of bargaining chip in some ways?
> Brenda: Yes and we said why do I have to come, look, you know?

In this account, Brenda offers her own readings as a way to evidence or corroborate that she has white coat hypertension, to support her request to not have to keep returning to the clinic. As in Bob's account, Brenda also suggests a need to tread carefully when negotiating an apparently uninvited aspect of BP self-monitoring. As a retired nurse, it is possible that the clinic might see Brenda's own readings as credible, but she is modest in her expectations. She evokes her understanding of clinic workings (*they always take their own, they have to)*, providing a tacit acknowledgement of the boundaries of clinical responsibilities. As in Bob's account, the mobilisation of the materials of participation (here, *a whole page of data*) appears central to warranting Brenda's uninvited participation in her blood pressure management.

Bob and Brenda's accounts demonstrate different investments in participation than those scripted by clinicians' versions of invited participation (*drop off your data and wait for a response from the practice*). These might be seen as attempts to change the frame of participation, reimagining what are salient (Wynne, 2007) issues for clinical consultations, to make space for patients' concerns that do not necessarily align with those of clinicians. These investments are not meant to replace or necessarily challenge clinical care, but to bring patients' concerns into the clinic in such a way that they are made legible (Street, 2012) to clinicians. Yet, the delicacy with which such investments are approached indicates that interviewees are aware of the potential threats these pose to clinical authority and the asymmetry of clinical relationships (Pilnick and Dingwall, 2011). Through observing this delicacy, the investments become recognisable as enactments of uninvited participation, at least initially. We have noted the way interviewees drew on materials in these enactments to help warrant their actions. In the following section, we focus on clinicians' accounts of their response to high levels of patient investments in self-monitoring. We will suggest that this is largely interpreted as problematic and appears to elicit invitations to engage in ways that transform investments to conform to 'participation made easy'. We continue to pay attention to the role of materials in these moves.

Troublesome/troubling investments.

Patient participation, whether invited or uninvited, was often viewed as troublesome for clinicians who expressed concern about the levels of investments or effort required of both themselves and their patients. Dealing with patients' own data was experienced as time consuming, especially when people provided large numbers of readings, or when records were not structured in the preferred way. A discussion between two GPs [GP1(4) and GP2(4)] provided a particularly rich illustration of the difficulties clinicians face and the pragmatic ways they manage patients' data within the time constraints of primary care practice. One suggested "Some people just bring, like, it'll be a storm of numbers that they throw at you and expect you to [manage them]". He explained that this was one reason they have a proforma to give to people to structure the data returned to them and that there was "a big box at the bottom that says average". In this way, the practice encourages people to calculate the average themselves, because for clinicians "it's time consuming" and "if you've only got ten minutes, you can't spend five minutes putting numbers into a calculator to work out an average". His colleague described "when people bring in a big sheet that's not on the proforma, that is a real heart sink moment". They went on to explain how they work with the data, suggesting they will record an average in their notes, and have the raw data scanned into the record. When there is "a massive pile of data" which are "safe" [ie within target range] then they might record a range or "take a guestimate average" rather than calculate an average.

As mentioned above, some practices provided a structured proforma as one way of investing in helping their patients to produce useful or credible data. Clinicians appeared to have ways of assessing the credibility of the patient generated records they receive as the following comment suggests:

> I get a lot of hand-written things dropped in, whether I was expecting it or not and I think […] if the data looks useful and credible, you know, so there's a column that says morning and a column that says afternoon and they've carefully written it down for a week and that was on the advice of a clinician, then I think that will certainly be good enough for me (GP1(2)).

Here, credibility is judged through the correct structuring and completeness of the data. It is also judged, in part, on the basis that self-monitoring had been licensed by a clinical colleague. The distinction between invited and uninvited participation is explicit in this quote (*whether I was expecting it or not*) and invited participation is privileged (*on the advice of a clinician*) in as much as this is likely to be seen as more credible. We also see that participation may be invited in specific ways involving engagements with clinic-sanctioned materials (here, a structured proforma) that mediates participation.

Clinicians framed self-monitoring as potentially burdensome for their patients in a number of ways and expressed a wish to protect them from the responsibility and potential time, cost or anxiety associated with this. One clinician (GP1(3)) commented on the time "burden" of self-monitoring: "People have got better things to do with their lives, than checking their blood pressure all the time", suggesting that the more anxious people were about their readings the more time-consuming monitoring becomes. Another GP (GP2(4)) commented "if their blood pressure is okay, I tell them to put your machine away". Clinicians were also sanguine about the utility and significance of blood pressure monitoring, recognising the rough accuracy of both home and clinic readings and expressing a toleration of variations. They viewed high blood pressure as something that does not require an urgent response, but as something to be sorted out "over months and years". Educating patients on these matters was seen as a further way to allay anxiety and protect them from the burdens of monitoring. As one clinician commented (GP1(2)): "Our aim is that they understand that blood pressure is important, and this healthy balance with it, that it's really just not a massive deal, especially when we know it's well controlled and we just need to check it once a year and everything will be fine and let's just all chill out".

During the focus groups there was just one comment that stood out as counter to this narrative of troublesome or over-investments. In this instance a nurse recognised the demands on patients of self-monitoring but did not frame this as inappropriate. Responding to our vignette that showed Emily's ambivalence about the value of her self-monitoring data (discussed in the first section of the analysis), this nurse responded by suggesting that patients needed encouragement. It is very notable however, that she draws on the case of diabetes rather than blood pressure monitoring in her own example:

> PN2(1): sometimes if people come and bring their glucometers and show their readings. I've got an HB1 [reading[4]] and I think that's more interesting to me than some of these readings and I don't value the work and the time they have put into producing this information and bringing it to me, and then I feel bad. But, you know, it's usually to do with time and things. But I think it's incredibly important that we do value, you know, we're asking them to do quite time-consuming stuff. And then if we don't show that we're actually valuing what they're bringing us, that's really not very good, and it's not going to encourage them to carry on doing it, I guess.

In this case, rather than minimising investments (*put your machine away, chill out*), the *time-consuming work* of patients' ongoing investments in self-monitoring is to be supported and encouraged. It is possible that the nurse is referring to the pedagogic value of self-monitoring as, in clinical terms, she does not value patients' glucose measurements as highly as her own HB1 measures. It was notable that a pedagogic narrative about blood pressure self-monitoring did not feature in our focus groups, although we discerned this as a possibility within the clinical literature (e.g., Fletcher et al., 2016).

With the exception of the last quote, clinicians' comments suggest they are concerned about the potential over-investment of their patients in self-monitoring and clinical care. These are potentially seen as calling for too much effort from both patients and clinicians. As embedded in calls to *put your machine away*, *check it once a year* and *just chill out*, clinicians' comments again seem to imply a logic of 'participation made easy'. The discussion also illustrates how clinics may draw on materials (such as the proforma) to try to contain patient investments to make them manageable for both patient and clinician. In the final section we will address instances where clinicians discussed responding to what they saw as inappropriate patient investments that are troublesome for both patients and themselves. The accounts suggest that they may respond with an invitation to participate in ways that clearly reinstitutes the logic of 'participation made easy'.

The retreat to 'participation made easy'

As we have discussed in the previous section, dealing with large volumes of patient-provided data was difficult for clinicians to manage. The following excerpt suggests it was also seen as possibly indicative of inappropriate investments by patients, associated with anxiety:

> So I got one today which was probably put in the eight page letter, 50 blood pressure readings, unspecified time […] Timewise it's impossible to take an average of that many blood pressure readings. […] there's the thing you're interested, yes, done properly, yes. Done improperly, i.e. infrequently, at the wrong time, associated with lots of anxiety. It's not that you're not interested, but it's not helpful […] So I sent a message to reception saying, thanks for your blood pressure readings, I can see you're worried about them, what I would suggest you do is do them twice a day for a week and book an appointment with me […] and we'd use the average of those recordings to make our treatment decisions. (GP1(2))

We do not know the patient's rationale for dropping off these data, whether the clinician was familiar with the patient or was inferring that the volume of data relates to patient anxiety. It is possible that the patient was worried, but we can suggest potential alternative rationales such as trying to look credible (more data shows commitment) or trying to have concerns recognised. The clinician's response, requesting that the patient repeats the measures and book an appointment, shows how the doctor tried to contain the patient's investment to focus on the "the thing you're interested in" which is narrowed to the doctor making "treatment decisions". The patient is therefore offered an attenuated role limiting their potential to bring their own concerns to the consultation. This example suggests how ostensibly uninvited participation may be transformed into an invitation to participate in ways that facilitate clinical practice which, at the same time, reinstitute a logic of 'participation made easy'. We suggest this retreat to 'participation made easy' make participation easy or doable not just for patients but also for clinicians. From the clinicians' perspective, particular forms of participation facilitate clear treatment decision-making within the time constraints of primary care consultations.

In another example, it was interesting that a practice nurse (PN1(2)), responding to a vignette which she interpreted as representing an anxious patient, suggested that offering 24-hour ambulatory monitoring "takes the pressure off" people having to do it themselves:

> It's on for 24 hours and then you can forget about it, he's not got the added anxiety of, oh, I've got to take my blood pressure and, oh, what's it going to be and am I doing it right? And all that, am I writing it down properly? And what does it actually mean? He can wear it, forget about it for 24 hours and then it comes back to us and then we can look at it and reassure him that, actually, those 24 hours' worth of readings were fine.

Twenty-four hour ambulatory monitoring involves clinical staff emplacing a wearable monitor on patients. The automated device takes and records readings at regular intervals without the intervention of the patient, whose involvement is limited to returning the device to the practice. Thus, the nurse is suggesting a minimisation of patient investments, mediated through a material intervention (the use of a 24-hour ambulatory device). Resonating with Marres (2012), clinicians may recognise the hidden costs of patient involvement, that is, the investments and disruptions involved. Yet, as Marres (2012) suggests, in this instance, rather than troubling the logic, this nurse suggests a stauncher retreat to 'participation made easy'.

Here and in the previous section we have shown how clinicians may view participation as both burdensome for themselves and their patients. Our analysis has also suggested that clinicians may privilege invited participation and find ways to transform uninvited into invited participation in a way to make it less burdensome for both patient and clinician, and in doing so effect a retreat to the logic of participation made easy. Through their discussions, clinicians displayed concern for their patients' wellbeing, and a desire to protect them from unnecessary burdens and from anxiety. On the one hand, this can be read as an expression of their care for their patients. Yet, in their desire to protect patients from the burdens of monitoring beyond that sanctioned clinically, or even in suggesting to take home monitoring out of their patients' control through offering 24-hour ambulatory monitoring, these discussions fail to recognise the rationales or projects of some patients' own monitoring regimes. Through their investments in self-monitoring, patients may want to communicate one of a number of different concerns (such as a wish to reduce medication or avoid further clinic appointments), implicitly opening up the saliency of different issues within clinical consultations. However, in framing these concerns as patient anxiety or unnecessary burden for patients, clinicians risk closing down the alternative rationales embedded in their patients' investments.

Discussion

In setting out their agenda for remaking participation in science and democracy, Chilvers and Kearnes (2020: 358) note the recent turn from studies of discrete participatory events to scholarship that attends to the diversity of participation, addressing "the increasing multiplicity and multivalence of public engagement with(in) contemporary technoscience and democracy". The current study contributes to this agenda, employing, linking and building on the ideas of invited and uninvited participation (Wynne, 2007), and material participation (Marres, 2012) in health care.

We contend that the existence of a consumer market for self-monitoring devices and an increasing call for self-monitoring within health policy both offer more or less explicit invitations for people to participate in their own health care. In our analysis we have considered what this participation looks like when it enters the clinic, treating participation as a dynamic sociomaterial practice which may emerge in different ways. Our analysis has explored the relationship between invited and uninvited participation and their links with the underlying logics of material participation in various aspects of BP self-monitoring. We have argued that when clinicians imagine or invite participation, this aligns with a logic of 'participation made easy', whereas the uninvited participation our interviewees discussed aligned with a logic of 'the more invested, the more engaged' in participation. We make two further moves in our analysis. First, by applying Marres' (2012) ideas in a new context, everyday clinical practice, we extend the logic of 'participation made easy', suggesting this might apply to professionals, here clinicians, as well as lay people. Second, while we identified invited and uninvited participation in BP self-monitoring, we do not see these as distinct and immutable, but observed movement between these. In the following paragraphs we will outline these arguments in more detail.

Clinicians may invite patients to self-monitor their blood pressure to service review appointments, for the smooth running of clinical interactions and the clinic. Clinicians' accounts suggested that they might invite their patients to self-monitor and make records in circumscribed ways over particular time-frames (e.g., record twice a day for a week) and that these data will be used to make prescribing decisions. We have proposed that this enacts an implicit logic of 'participation made easy' (Marres, 2012) which involves a division of labour encoding a traditional division of expertise. It is the patients' job to produce (sometimes prespecified kinds of) data, and the clinicians' job to interpret this and infer treatment plans. While this might be interpreted as paternalistic, we suggest that from the clinicians' perspective, participation made easy is understood as participation made useful or useable in the context of the clinic. From this perspective, treatment decisions can be made within the time constraints of primary care work, without causing undue stress, worry or work for patients. We note that through these enactments, patient participation is made easy for both patients **and** clinicians, containing the investments required of both. Yet, we have suggested, through these enactments, some patient concerns get lost.

We have also demonstrated occasions when patients' participation is uninvited in the context of the clinic, when people use their self-monitoring as a way to raise their own concerns here. In the examples we discuss, we saw unsolicited participation in self-monitoring linked with a wish to reduce medication (and in that case also unsolicited participation in medication management) and with a wish to substantiate white coat hypertension and therefore reduce the requirement for further clinic appointments. This enacts a different, more invested and more involved form of participation centred on the life world experiences and concerns of patients. The analysis illustrated the sensitivities of inserting or making these concerns legible (Street, 2012) to clinicians, as these are implicitly understood by patients as a potential threat to clinical authority. We can interpret this through the language of Wynne (2007) and Marres (2012) to suggest that the delicacy with which this is approached helps to make visible the normativities of different enactments of participation.

We have demonstrated that clinicians expressed a great deal of concern about the investments or efforts required of both themselves and their patients when patients participate. These were expressed as judgements about the credibility of patient-generated data, doubts about the proportionality of patients' investments relative to the issue at hand, and the time investments required of both clinicians and patients. We have shown how instances of uninvited participation might be subverted when clinicians respond by inviting their patients to participate in circumscribed ways, and thus revert back to a logic of 'participation made easy'.

We know of only one other study (Stewart, 2016) that draws on the idea of uninvited participation in everyday individual clinical interaction. Our findings resonate with Stewart's (2016) in the sense that her data also highlights the sensitivity of uninvited participation – her young participants quietly subverted service use while avoiding direct challenge of clinicians. Yet, Stewart (2016: 128) implies a clear division between invited and uninvited participation, suggesting a clear distinction between the spaces in which these take place. By contrast, in our research we find both invited and uninvited participation in a single interactional space – the clinic - and movements between these. To account for these differences, we might draw on the context of the studies. Stewart's research focussed on uninvited participation where young people engaged in occasional, transactional service use. In our study, participants had more durable relationships with the clinic and participation emerges as invited or uninvited through specific, but ongoing interactions and negotiations between clinicians and patients.

Our analysis also illustrates the way materials are mobilised to facilitate different modes of participation. As we have discussed, participants' accounts suggest they approach uninvited participation with some trepidation as to the sensitivities of raising one's own concerns in the clinic. Participants described bringing their own records of self-monitoring to clinical consultations which were used to warrant their actions or claims. We have also noted how clinicians might offer structured proformas, provide instructions as to how to self-monitor and record, or offer a device for 24-hour ambulatory monitoring as an alternative to self-monitoring. All of these might work to circumscribe their patients' participation and are offered as part of an invitation to 'participation made easy'.

What broader points might be taken from this analysis? The 'participatory turn' (Prainsack, 2017) in health care is promoted across multiple domains - health care policy, research, practice and industry (Nielsen and Langstrup, 2018). Yet, drilling down with our specific case study, we find not all participation is straightforward or welcome. A broader question emerges, then, about the circumstances and ways in which participation is valorised. Studies by Zhu et al. (2017) and Fiske et al. (2020) suggest that participation through 'digital self-care' (Fiske et al., 2020) is valorised by clinicians only when invited by themselves and/or undertaken with their guidance. Working with the concepts of invited and uninvited participation, we have shown that, in the case of blood pressure monitoring, clinicians tended only to support participation when undertaken at the invitation of, and in collaboration with, themselves, sometimes re-framing what started as uninvited participation in ways that transform it into a clinical invitation.

A second distinction in our analysis relates to the underlying logic of participation. In the case of blood pressure monitoring, we have suggested that instances of uninvited participation sometimes enacted a strongly invested and involved form of participation whereas the primary care clinicians in our study tended to invoke and revert to the logic of participation made easy. While it is possible there may be circumstances under which greater patient investments in blood pressure monitoring are valorised, this did not emerge in our study. However, the work of Danesi et al. (2020) suggests that in the case of diabetes, more invested and engaged forms of material participation are encouraged, an observation also hinted at in the current study. This is likely to relate to the treatment regimens for these differing conditions since diabetes patients are encouraged to make continuous adjustments to their insulin doses, whereas clinicians tend to adjust regimens for blood pressure medication infrequently (although, as we have seen, patients may take matters into their own hands). It would be interesting to work through what kinds of participation are valorised for other conditions and in other clinical settings.

Finally, we have shown how what we might think of as 'materials of participation' are mobilised in clinical interactions. We have seen how our participants brought materials into the clinic in the hope of making their concerns legible (Street, 2012), but also the delicacy with which this is approached because of the risks of being seen as challenging clinical authority. Other scholars have also attended to the materiality of participation, showing how people may curate the self-monitoring records they share with their clinicians (Nielsen, 2015; Piras and Miele, 2017; Danesi et al., 2018; Weiner et al., 2020) to either facilitate or avoid particular conversations. This curatorial work is often invisible to clinicians and provides another avenue for patients to pursue their own concerns without directly challenging the authority of their clinicians.

Conclusion

We have provided a detailed analysis of participation in blood pressure self-monitoring, expanding on different types of participation in the clinic, and showing how this is shaped by the relational and material aspects of clinical care. We have raised some questions about how this might apply beyond the specific case of blood pressure monitoring. Despite policy and industry enthusiasm, we wonder what scope there is for different logics of material participation to be enacted in the clinic, given the unrelenting pressure on primary care, and the intransigent asymmetry of clinical interactions.

Acknowledgments

This work was supported by the Leverhulme Trust under Grant RPG-2015-348. We would like to thank all the people who participated in the research for their time and interest. We are grateful to Dr Lauren White for her assistance in compiling relevant literature, and the two anonymous reviewers for their insightful and helpful comments.

References

Andrews JA, Weiner K, Will CM, Henwood F and Dickson JM (2020) Healthcare practitioner views and experiences of patients self-monitoring blood pressure: a vignette study. *BJGP Open* 4(5): bjgpopen20X101101.

Bergen C and Stivers T (2013) Patient Disclosure of Medical Misdeeds. *Journal of Health and Social Behavior* 54(2): 221-240.

British Heart Foundation (2015) *I've got my Blood pressure under control.* London: British Heart Foundation.

Chilvers J and Kearnes M (2020) Remaking Participation in Science and Democracy. *Science, Technology, & Human Values* 45(3): 347-380.

Danesi G, Pralong M, Panese F, Bernand B and Grossen M (2020) Techno-social reconfigurations in diabetes (self-) care. *Social Studies of Science* 50(2): 198-220.

Danesi G, Pralong M and Pidoux V (2018) Embodiment and Agency through Self-tracking Practices of People Living with Diabetes. In: Ajana B (ed) *Metric Culture*. Bingley: Emerald Publishing Limited, pp.117-135.

Danholt P and Langstrup H (2012) Medication as Infrastructure: Decentring Self-care. *Culture Unbound* 4(3): 513-532.

Fiore-Gartland B and Neff G (2015) Communication, Mediation, and the Expectations of Data: Data Valences Across Health and Wellness Communities. *International Journal of Communication* 9: 1466–1484.

Fiske A, Buyx A and Prainsack B (2020) The double-edged sword of digital self-care: Physician perspectives from Northern Germany. *Social Science & Medicine* 260: 113174.

Fletcher BR, Hinton L, Hartmann-Boyce J, Roberts NW, Bobrovitz N, McManus RJ (2016) Self-monitoring blood pressure in hypertension, patient and provider perspectives: A systematic review and thematic synthesis. *Patient Education and Counseling* 99(2): 210-219.

Hammersley M and Atkinson P (1995) *Ethnography: Principles in Practice,* London: Routledge.

Jones L (2018) Pastoral power and the promotion of self-care. *Sociology of Health & Illness* 40(6): 988-1004.

Marres N (2012) *Material Participation: Technology, the Environment and Everyday Publics*. Basingstoke: Palgrave MacMillan.

Michael M (2012) "What Are We Busy Doing?": Engaging the Idiot. *Science, Technology, & Human Values* 37(5): 528-554.

Mol A (2008) *The Logic of Care: Health and the Problem of Patient Choice.* Abingdon, Oxon: Routledge.

Morgan H (2016) 'Pushed' self-tracking using digital technologies for chronic health condition management: a critical interpretive synthesis. *DIGITAL HEALTH* 2: 2055207616678498.

Morrissey EC, Glynn LG, Casey M, Walsh JC and Molloy GJ (2017) New self-management technologies for the treatment of hypertension: general practitioners' perspectives. *Family Practice* 35(3): 318-322.

National Institute of Health and Care Excellence (NICE) (2019) *Hypertension in adults: diagnosis and management* [NICE guideline 136]. London: National Institute of Health and Care Excellence (NICE)

Nielsen KD (2015) Involving Patients with E-health – The Dialogic Dynamics of Information Filtration Work. *Science & Technology Studies* 28(2): 29-52.

Nielsen KD and Langstrup H (2018) Tactics of material participation: How patients shape their engagement through e-health. *Social Studies of Science* 48(2): 259-282.

Oudshoorn N (2008) Diagnosis at a distance: the invisible work of patients and healthcare professionals in cardiac telemonitoring technology. *Sociology of Health & Illness* 30(2): 272-288.

Pilnick A and Dingwall R (2011) On the remarkable persistence of asymmetry in doctor/patient interaction: A critical review. *Social Science & Medicine* 72(8): 1374-1382.

Piras EM and Miele F (2017) Clinical self-tracking and monitoring technologies: negotiations in the ICT-mediated patient–provider relationship. *Health Sociology Review* 26(1): 38-53.

Pound P, Britten N, Morgan M et al. (2005) Resisting medicines: a synthesis of qualitative studies of medicine taking. *Social Science & Medicine* 61: 133-155.

Prainsack B (2017) *Personalized Medicine Empowered Patients in the 21st Century?* New York: NYU Press.

Royal College of General Practitioners (2010) *Enabling Patients to Access Electronic Health Records. Guidance for health professionals*. London: Royal College of General Practitioners.

Royal College of General Practitioners (2013) *Patient online: the road map.* London: Royal College of General Practitioners.

Schüll ND (2016) Data for life: Wearable technology and the design of self-care. *BioSocieties* 11(3): 317-333.

Sinding C, Miller P, Hudak P, Keller-Olaman S, Sussman J (2012) Of time and troubles: Patient involvement and the production of health care disparities. *Health* 16(4): 400-417.

Stevenson FA, Britten N, Barry CA, Bradley CP and Barber N (2003) Self-treatment and its discussion in medical consultations: how is medical pluralism managed in practice? *Social Science & Medicine* 57(3): 513-527.

Stevenson F, Hall L, Seguin M, et al. (2019) General Practitioner's use of online resources during medical visits: managing the boundary between inside and outside the clinic. *Sociology of Health & Illness* 41(S1): 65-81.

Stevenson FA, Seguin M, Leydon-Hudson G, et al. (2021) Combining patient talk about internet use during primary care consultations with retrospective accounts. A qualitative analysis of interactional and interview data. *Social Science & Medicine* 272: 113703.

Stewart E (2016) *Publics and Their Health Systems: Rethinking Participation.* London: Palgrave Macmillan.

Street A (2012) Seen by the state: Bureaucracy, visibility and governmentality in a Papua New Guinean hospital. *The Australian Journal of Anthropology* 23(1): 1-21.

Topol E (2019) *The Topol Review. Preparing the Healthcare Workforce to Deliver the Digital Future.* Leeds: Health Education England

Wehling P (2012) From invited to uninvited participation (and back?): rethinking civil society engagement in technology assessment and development. *Poiesis & Praxis* 9(1): 43-60.

Weiner K and Will C (2016) Use, non-use and resistance to pharmaceuticals, in Hyysalo, S., Jensen T. and Oudshoorn, N, (eds) The New Production of Users: Changing innovation collectives and involvement strategies. Routledge, Abingdon, Oxon. pp. 273-296.

Weiner K, Will C, Henwood F and Williams R (2020) Everyday curation? Attending to data, records and record keeping in the practices of self-monitoring. *Big Data & Society* 7(1): 2053951720918275.

West P, Kleek MV, Giordano R, Weal M and Shadbolt N (2018) Common Barriers to the Use of Patient-Generated Data Across Clinical Settings. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, Paper 484.

Will CM, Henwood F, Weiner K and Williams R (2020) Negotiating the practical ethics of 'self-tracking' in intimate relationships: Looking for care in healthy living. *Social Science & Medicine* 266: 113301

Williams R, Weiner K, Henwood F and Will C (2020) Constituting practices, shaping markets: remaking healthy living through commercial promotion of blood pressure monitors and scales. *Critical Public Health* 30(1): 28-40.

Wynne B (2007) Public Participation in Science and Technology: Performing and Obscuring a Political–conceptual Category Mistake. *East Asian Science, Technology and Society: An International Journal* 1(1): 99-110.

Zhu H, Colgan J, Reddy M and Choe EK (2017) Sharing Patient-Generated Data in Clinical Practices: An Interview Study. *AMIA ... Annual Symposium proceedings. AMIA Symposium* 2016: 1303-1312.

Notes

1 National Institute for Health Research (NIHR) Clinical Research Network (CRN) clusters are local groups of research-active GP practices.

2 Crimewatch is a British television programme that reconstructs unsolved crimes to seek information from the public.

3 In Britain, people refer to the doctor's office as the 'GP surgery' or 'surgery'

4 HbA1c is a measure of blood glucose.

Paterson Mark (2021) *How we Became Sensorimotor. Movement, Measurement, Sensation.* University of Minnesota Press: Minneapolis, MN. 320 pages.ISBN 978-1-5179-1000-6

Nona Schulte-Römer
nona.schulte-roemer@hu-berlin.de

"From my doctoral thesis onwards, I have been interested in historicizing the senses," writes Mark Paterson author of *How we became Sensorimotor. Movement, Measurement, Sensation* (2021) on his website. The sociologist and associate professor at University of Pittsburgh is currently working on human-robot interaction design as part of a fellowship in Edinburgh, where he explores "past efforts and future directions for more inclusive tactile and gesture-based interactions between diverse human users and physical robots". He has published numerous articles in humanities and social science journals and several monographs including *The Senses of Touch* (2007) and *Seeing with the Hands* (2016). In his most recent book, he now addresses the question of how scientists came to better understand and conceptualise the inner senses and mobility of the human body. Unfortunately, he loses himself in historic detail rather than outlining the topicality of his research in relation to 21st century robotics and neuro science.

So, what makes a body move and how were its miraculous inner movement brought to light? To explore this question, Paterson offers an impressively broad overview of historic scientific discourses in the fields of medicine, physiology and psychophysics. Each of his six chapters "focuses upon a particular thematic related to bodily sensation, including the 'muscle sense', pain, fatigue, balance, proprioception, and the philosophical uptake of the physiological concept of 'motricity'" (p. 2). As outlined in the introduction (p. 15), the historical focus is on the "generative" period 1833 to 1945, when new scientific concepts and approaches emerged in parallel with new experimental approaches and innovative techniques. With the aim to understand and map hidden somatic sensations and reflexes inside the body, new methods and instruments were primarily applied in lab studies—on the legs of frogs and dogs, decerebrated cats and other vertebrates and even on the brains of conscious epilepsy patients. However, there was more to this neuro experimentalism. As Paterson outlines, scientific curiosity also raised interest outside the laboratories and beyond science. Around 1900, sensorimotor inquiries involved transdisciplinary exchange between scientists and artists that resulted in "strange drawings of distorted human anatomy" known as homunculi (p. 63, quoting Griggs, 1988: 105) and cutting-edge chronophotography of running horses (Chapter 4, p. 159) proving that in full gallop all four hooves are, for a moment, simultaneously in the air. Around the same time, art historians and architects discussed the nature of 'haptic' and 'optic' perception in light of new insights into the oculomotor interplay of eyes and ears, today known as the vestibular-ocular reflex (VOR, Chapter 3). Basic research on the sensorimotor human body also found new application fields – contemporaneously, in factories where graphical methods were used to record the workers' movements and optimize tiresome workflows (Chapter 5 on fatigue), and today in the form of neuroprosthetic systems. These allow people with amputations to not only use their artificial limbs, but also regain a sensation of touch through their protheses. Yet, these exciting developments are only mentioned as a teaser in the introduction of the book and only superficially interlinked with the historical analysis of the book.

Paterson further highlights "the numerous transverse movements and points of connection between academic fields and the artistic world during this period… to focus on a unique sensory modality in formation, tracking scientific pieces of the bigger epistemic picture." (p. 17). He is thus not just telling a story of scientific discoveries and transdisciplinary uptakes. Instead, his archival work and references to historians of science tackle underlying conceptual work of identifying, categorizing, distinguishing and naming sensations and their motoric implications. Inspired by "a Foucauldian archaeology of physiological perception", Paterson's aim is to reveal "a form of medico-scientific discourse and praxis that identifies, measures, and tracks hitherto underexamined sensations within the body by means of increasingly sophisticated equipment, at first in the laboratory and then in the field." (p. 16) From the perspective of science and technology studies (STS), this project of revealing the sociotechnical construction of the sensorimotor body has a great appeal.

Unfortunately, Paterson's account of the emerging epistemic picture is often buried under too much, too sparsely contextualised information. Arguments and analyses too often recede behind mere descriptions of historical publications and the naming of key figures – without offering deeper insights into their experimental practice. What blurs the picture even more is the curious dramaturgy of the text. Rather than telling his histories of concepts in a chronological order, the author likes to jump back and forth between the centuries, historical and contemporary scientific contributions. He also tends to announce and hint at key arguments several times before actually elaborating them. Such foreshadowing can be a stylistic device to create suspense in readers. For me, it evoked a strenuous sense of repetition to a point where I experienced some of the sensations discussed in the text – primarily fatigue – albeit not in a somatic, but rather cognitive way. My feeling is that a more diligent editing could have remedied these shortcomings.

Nevertheless, I think that the book offers readers with an interest in STS informative starting points for multi-disciplinary explorations into body-environment interactions, technoscientific conceptualisations, generalisations and (graphic) inscription as well as a deeper understanding of historical representations of our complex affects and motility. In particular, Paterson's rich account of scientific insights into complex reflexes and "proprioception" (Chapter 1) and "abstract" and "concrete" movements (Chapter 6) offers food for thought and may even nudge practice theorists to conceptualise sociomaterial interactions and habituated practices in more-than-social-scientific ways. Moreover, the fascinating account of early 20th century homunculi drawings raises fascinating questions regarding the performative power of pictorial, even imaginative scientific representations and translations (cf. Coopmans et al., 2014). As Paterson outlines, homunculi map sensorimotor neural relations by projecting limbs, facial organs and genitals onto illustrations of brain hemispheres. Situated at the boundaries between science and imagination, they constitute strangely semi-artistic, scientifically contested inscriptions that nevertheless gained popularity and scientific relevance to the present day, as Paterson suggests. One might wonder whether homunculi were so appealing not despite, but because of their grotesque, maybe speculative style.

Finally, several chapters allude to scientific controversies that seem worthy subjects for more in-depth explorations into the social construction of the sensorimotor human body. To give only two examples, chapter 2 outlines the scientific debate over the nature of pain in relation to touch. Paterson problematises the measurement of these subjectively experienced neural processes through the still relevant construct of the 'just noticeable difference' (JND) and its potential to "tip the whole organism from perception to action" (p. 110). In chapter 4, he then raises the more art-related question of whether perception should be conceptualised as haptic and kinaesthetic, rather than static retinal and just aesthetic, as suggested by the modernist architect Le Corbusier.

To conclude, *How we Became Sensorimotor* is not an easy read and from my STS-inspired perspective, it did not fully answer its question in the title. Nevertheless, the book offers numerous and inspiring insights for STS inquiries into the sensorimotor conditions of body-environment relationships, sociomaterial interactions and embodied affects. The book also provides several thought provoking clues for further explorations into how physiological, medial and psychophysical insights affected architectural and art historical discourses (Chapter 3) and how sensorimotor evidence influenced research in the humanities and social sciences in the 19th and early 20th century beyond phenomenological research (Chapter 6). Last but not least, Paterson seems intrigued by innovative experimental settings and sociomaterial technoscientific inscription devices. There lies a great potential for exploring some of his rich archival material through the lens of STS.

References

Coopmans C, Vertesi J, Lynch M E and Woolgar S (eds) *Representation in scientific practice revisited.* Cambridge, MA: MIT Press.

Griggs R A (1988) Who is Mrs. Cantlie and why are they doing those terrible things to her homunculi? *Teaching of Psychology* 15(2): 105-106.

Paterson M (2021) Sensation. Available at: http://www.sensory-motor.com/ (accessed 27.4.2023).

Hidalgo César A, Orghian Diana, Albo-Canals Jordi, De Almeida Filipa & Martin Natalia (2021) How Humans Judge Machines. Cambridge, MA: MIT Press. 256 pages. ISBN: 9780262045520

Manh-Tung Ho

tung.homanh@phenikaa-uni.edu.vn

How humans judge machines by Hildago et al. (2021) is a very readable and informative book on the topic of human-machine relations. Central to the book's contribution is the study of more than 5,900 subjects, who were asked to judge the morality of scenarios where humans and artificial intelligence (AI) make consequential decisions. These scenarios are not far-fetched; for example, the respondents were asked to review how morally wrong and how much intention was involved when AI or humans made decisions about security checking in an airport or screening a job applicant. The book provides a systematic comparison of the differences between people judging humans versus judging machines, with the results presented in a series of pleasing and intuitive visualizations, bringing to light the complexity of our judgment towards AI, which depends not only on moral dimensions but also on contexts. For example, Hildago et al. show people judge machines the harshest when it comes to situations involving physical harm such as failure of diagnosis or a car crash. Meanwhile, people judge humans more harshly when the situations are perceived as not fair.

Here, the moral dimensions are derived from the theory of moral foundations by Jonathan Haidt (2007), which proposes there are five dimensions of morality: Harm, Fairness, Loyalty, Authority, and Purity. Hildago et al. argue that this method could "quantitatively unpack" the ethics of how humans relate to AI in the same way it has allowed psychologists to unpack variations in moral preferences. For more than 80 scenarios, the authors asked each respondent to pick four words that best describe each from a list of carefully selected twenty words. To illustrate, if the respondents picked indecent and harmful, then the scenario involves the purity and harm dimensions. The authors also introduce us to the moral space, a mathematical construct that quantifies the perceived morality of a situation as a function of a person's perception of how an agent (a human or a machine) involved in the situation has performed in each of the dimensions above. The data show most of the demographic variations in the data can be accounted for, implying the high applicability of Haidt's theory of the five moral foundations.

Going on this journey from one experiment to another, Hildago et al. show us many deep-seated intuitions we harbor about AI. The most crucial difference between our judgments towards AI versus towards humans is that we tend to not ascribe intention to AI, thus we judge them more by the outcomes, while the morality of a situation involving a human decision-maker is judged more by the intention. A poignant example is that in the event of a natural disaster, machines will be judged harshly if they try to save humans and fail, while people in the same scenario will still be judged positively. Such observation is greatly relevant since we are increasingly in the presence of AI systems whose performance is not of 100% success or accuracy rate but is nonetheless better than their human counterparts. For example, data from the 65,000 miles of self-driving cars by Waymo demonstrated how the current generation of autonomous vehicles can entirely avoid collision modes that are often caused by human drivers such as road departure or fixed objects collision (Schwall et al., 2020). Such technologies can save many more lives and prevent many more deaths, and yet given human psychology, they would still be perceived as not trustworthy as humans.

The authors caution us that the book is strictly positive, meaning it merely describes how humans judge machines, not how we should judge machines. Yet, the aforementioned observations clearly imply that, for humans to create an AI-powered world that maximizes the benefits for people, we should relax our very human tendency to use intention as a heuristic to judge the morality of a situation. Toward the end of the book, the authors explore such a dilemma via the concept of machine responsibility, where legal concepts of liability, negligence, and recklessness are useful. In sum, the authors surmise that all liability must fall on humans. Thus, as a society, we need to think deeply about how to allocate responsibility to different humans: the engineers, the users, the sellers, etc., so as mitigate the unintended consequences that will occur upon the creation of new laws and regulations on AI use.

One of the issues that could be expanded on is the problem of cross-cultural differences in building and judging AI systems. The authors conclude that different AI systems trained with datasets from different societies will be encoded with different biases and preferences. For example, since the data of the book come from people living in the United States, a more individualistic and libertarian society, it is expected that in the scenarios where the government deploys the AI will be viewed with more distrust. However, in a country where communitarian ethics are more dominant such as East Asian nations, we can expect different results (Vuong, 2022; Roberts et al., 2021; Mantello et al., 2021).

Nevertheless, the beauty of the moral space construct and the experimental design in How humans judge machines is that future studies can build upon such methods and further explore how different moral values interact with each other and determine the perceived morality of a situation that involved machines. In this sense, the book offers a novel, interdisciplinary set of methods and tools for quantitatively probing how our moral intuitions are shifting with each encounter with ever more impressive and prevalent AI systems. Critically, it supplements the lack of emphasis on moral dimensions in technological adoption among previous empirical studies dominated by the Technological Acceptance Model (Taderhoost, 2018). The Technological Acceptance Model and its variations postulate that acceptance of new technology is primarily a function of perceived utilities and ease of use. This intuition might not hold anymore since AI systems interact with us in more sophisticated, yet subtle ways and often produce surprising results. For example, an AI system that analyzes the emotions of workers in an Amazon factory might not be visible to the workers, yet the knowledge of its existence can have outsized effects on workers' well-being and productivity (Du, 2022). More importantly, these effects can have very different cultural underpinnings depending on the native understanding of values such as individual liberty, privacy, autonomy, security, or fairness (Ishibushi, 2021; Degli Esposti et al., 2017; Miyashita, 2021).

As shown in How humans judge machines, perceptions of how machines change and interact with our behaviors and psychology can be a great source of unease in society. Thus, by placing human values and moral psychology at the heart of studying human-AI interaction, Hidalgo et al. (2021) remind us of our coevolving and increasingly interdependent relationship with technologies.

References

Degli Esposti S, Pavone V and Santiago-Gómez E (2017) Aligning security and privacy: The case of Deep Packet Inspection. In: Friedewald MJ, Burgess P, Čas J, Bellanova R, and Peissl W (eds) S*urveillance, Privacy and Security*. London: Routledge, pp. 71-90.

Du L (2022) Amazon grapples with more labor strife, this time in Japan. *Bloomberg,* September 6. Available at: https://www.bloomberg.com/news/articles/2022-09-06/amazon-grapples-with-more-labor-strife-this-time-in-japan?leadSource=uverify%20wall (accessed 14.2.2023).

Haidt J (2007) The new synthesis in moral psychology. Science 316(5827): 998-1002.

Hidalgo CA, Orghian D, Canals JA, De Almeida F and Martin N (2021) *How humans judge machines*. Cambridge, MA: MIT Press.

Ishibushi K and Matsakis L (2021) Masafumi Ito, leader of the Amazon Japan Union, sues for wrongful termination. Available at: https://restofworld.org/2021/lawsuit-amazon-japan-union/ (accessed 3.10.2023).

Mantello P, Ho MT, Nguyen MH and Quan-Hoang V (2021) Bosses without a heart: socio-demographic and cross-cultural determinants of attitude toward Emotional AI in the workplace. *AI & Society 3*8: 97–119. https://doi.org/10.1007/s00146-021-01290-1

Miyashita H (2021) Human-centric data protection laws and policies: A lesson from Japan. *Computer Law & Security Review* 40: 105487. https://doi.org/https://doi.org/10.1016/j.clsr.2020.105487

Roberts H, Cowls J, Morley J, Taddeo M, Wang V and Floridi L (2021) The Chinese approach to artificial intelligence: an analysis of policy, ethics, and regulation. *AI & Society*:36(1): 59-77.

Schwall M, Daniel T, Victor T, Favaro F and Hohnhold H (2020) Waymo public road safety performance data. *arXiv preprint* arXiv:2011.00038.

Taherdoost H (2018) A review of technology acceptance and adoption models and theories. *Procedia Manufacturing* 22: 960-967. https://doi.org/https://doi.org/10.1016/j.promfg.2018.03.137

Vuong QH (2022) *Mindsponge theory*. Warsaw: De Gruyter.

Science & Technology Studies

Volume 36, Issue 2, 2023

Editorial

Articles

Book reviews