

The background features large, stylized, semi-transparent letters 'S', 'T', and 'Q' in shades of blue and purple. The 'S' is on the left, the 'T' is in the center, and the 'Q' is on the right. A vertical blue bar runs down the right side of the page.

**Science
Technology
Studies**

2/2026

Science & Technology Studies

ISSN 2243-4690

Co-ordinating editor

Antti Silvast (LUT University, Finland)

Editors

Saheli Datta Burton (University College London, UK)
Ana Delgado (University of Oslo, Norway)
Kathrin Eitel (Zurich University, Switzerland)
Karen Kastenhofer (Austrian Academy of Sciences, Austria)
Ingmar Lippert (Goethe University Frankfurt, Germany)
Jörg Niewöhner (Humboldt-Universität zu Berlin, Germany)
Alexandra Supper (Maastricht University, Netherlands)
Olli Tiikkainen (University of Helsinki, Finland)
Mikko J. Virtanen (University of Helsinki, Finland)

Managing editor

Heta Tarkkala (University of Helsinki, Finland)

Editorial board

Nik Brown (University of York, UK)
Miquel Domenech (Universitat Autònoma de Barcelona, Spain)
Aant Elzinga (University of Gothenburg, Sweden)
Steve Fuller (University of Warwick, UK)
Marja Häyrynen-Alastalo (University of Helsinki, Finland)
Merle Jacob (Lund University, Sweden)
Jaime Jiménez (Universidad Nacional Autónoma de México)
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)
Salla Sariola (University of Helsinki, Finland)
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 39, Issue 2, 2026

Articles

Olga Kuchinskaya

Expert Patients and Networks of Expertise and Ignorance 2

Nathan Flore

“A Train We Can’t Miss” for Economic Recovery: The Sociotechnical Imaginary of Artificial Intelligence in the Walloon Region..... 19

Carsten Horn & Ulrike Felt

When Digital Health Encounters Regulation: The Approval Process for Prescription Apps in Germany 43

Bryony Parrish

Conceptualising Processes of User Learning in Domestication Theory: What, why, and how?..... 61

Book reviews

David Antolínez Uribe

Darin Weinberg (2024) *On Addiction: Insights from History, Ethnography, and Critical Theory* 82

Jongheon Kim

Antti Silvast and Chris Foulds (2022) *Sociology of Interdisciplinarity: The Dynamics of Energy Research*..... 85

Visit our web-site at

www.sciencetechnologystudies.org

Expert Patients and Networks of Expertise and Ignorance

Olga Kuchinskaya

University of Pittsburgh, USA/ okuchins@pitt.edu

Abstract

Patients with rare or understudied diseases often encounter a lack of medical answers about diagnosis or treatment and might seek new ways to obtain answers. The conceptual framework of “networks of expertise” helps analyze such encounters with a lack of medical answers as situations of medical ignorance, which are not necessarily accidental and have been shown to reflect the bias and organization of related networks of expertise. In this context, the paper analyzes and compares public narratives of patients’ experiences and suggests three possible patient strategies for responding to the lack of answers. These strategies include establishing external ties with experts and non-experts outside of one’s healthcare teams, engaging with patient organizations to affect medical research, and engaging with online communities as an alternative or supplementary network of expertise. In all three cases, patients’ efforts are both epistemic and organizational, seeking to (re)shape broader networks of expertise so that they are more likely to generate answers. These organizational dimensions of patients’ knowledge production work can be overlooked by the debates on “expert patients” and the relationship of patients’ expertise to that of credentialed experts.

Keywords: Patient Narratives, Expert Patients, Networks of Expertise, Ignorance, Rare Diseases, Understudied Diseases

Introduction

The lack of medical answers about diagnosis or treatment is a common problem for patients with rare and understudied diseases. It might take years before patients with, for example, rare genetic disorders receive their correct diagnosis (MacLeod et al., 2015). Many of these patients are children, and their condition is often serious or life-threatening; few of these conditions have curative (or any) pharmacological treatment (Cahan, 2018). Whether their condition is genetic or not, patients or parents of pediatric patients facing a dire health situation and no adequate answers might have to

become experts in their condition. In some cases, they might also have to educate doctors, as when a patient is admitted to an emergency room (E.R.) or meets new doctors who lack knowledge about their condition, medications, and side effects (MacLeod et al., 2015; Petersen, 2006). In the words of Mary Dunkle from the National Organization for Rare Disorders, these are “ordinary people who are doing remarkable things because they are suddenly faced with a life-or-death situation” (quoted in Goldberg, 2017).



This paper focuses on patients' responses to the lack of answers about diagnosis or treatment—medical ignorance—in the context where the stakes for getting adequate answers are exceptionally high. Ignorance and its production are important areas of research in science and technology studies (Mills, 2007; Proctor and Schiebinger, 2008; Sullivan, 2007; Sullivan and Tuana, 2007; Tuana, 2006). Much of this research, including my earlier work, points to broader, structural conditions for the production of ignorance (Kuchinskaya, 2014; Kuchinskaya and Parker, 2018). In other words, ignorance is not just a matter of the temporary lack of answers but, more importantly, a result of the broader conditions of knowledge production. Systematic production of areas of ignorance reflects general preferences and biases in how research is done and by whom, and what is funded and prioritized, and who is affected by under-researched conditions. If ignorance can result from systemic challenges of knowledge production, how might it be addressed by individual patients who encounter a lack of medical answers about their diagnosis or treatment?

To address this question, I outline and compare three possible patient strategies seeking to remedy such failure of knowledge production. I focus on exceptional cases of patients who actively engaged with their health care and developed high levels of expertise—often referred to as 'expert patients' (Anampa-Guzmán et al., 2022; Dumit, 2012; Fox and Ward, 2006; Fox et al., 2005; Shaw and Baker, 2004; Tyreman, 2005; Wilson, 2001). I analyze these patients' responses to situations of medical ignorance through the theoretical lens of 'networks of expertise' (Eyal, 2013: 2). Scholars in science and technology studies (STS) have long debated the nature of expertise, including scientific expertise and its relationship to lay knowledges (Collins and Evans, 2002; Kerr et al., 2007; Wynne, 2003). If we adopt the perspective of networks of expertise, expertise can be understood as not simply belonging to experts, medical or lay; rather, it is distributed in broader networks. Patients' encounters with areas of medical ignorance are consequently encounters with medical networks that fail to produce knowledge about diagnosis or treatment that

appears adequate and actionable from patients' embodied perspective. Furthermore, this paper suggests that expert patients' efforts to find answers are simultaneously organizational efforts reshaping relevant networks of expertise.

The paper compares three patient narratives (Segal, 2007) offered by expert patients with rare or understudied diseases. In all three cases, there is more to accounts of expert patients than patients seeking out doctors who can provide answers or increasing their own expertise, thereby becoming scientific experts. These accounts demonstrate organizational efforts affecting the composition of relevant networks of expertise. Comparing these cases reveals three different strategies adopted to affect networks of expertise and the different network configurations that result from these strategies.

Conceptual framework: from 'expert patients' to 'networks of expertise'

Expert patients

Experiencing a lack of medical answers can provide a strong impetus for patients and their families to get more actively involved in their health care. Whether they actually get involved, and what that involvement looks like, depends on many factors, such as resources, skills, competencies, and their health condition. Facing significant challenges, some patients do get involved and even develop a significant level of expertise in their condition. As mentioned above, studies have described them as expert patients but also 'informed patients' (Henwood et al., 2003; Kivits, 2006), 'active patients' (Heldal and Tjora, 2009; see also Gottlieb, 2021; Prainsack, 2017), or, as one clinical scientist writing for a popular audience puts it, 'smart patients' (Topol, 2015). These terms have been used in studies of people with chronic diseases, where patients have to do much of the work, and in studies of patients' use of information technologies.

Critics of the term 'expert patients' pointed to the difference between patients' experience based-understanding of their condition and doctors' education-based expertise (Badcott, 2005; Tyreman, 2005). They argued that the power

dynamic between patients and doctors leads patients to adopt medical terms and overlook broader societal conditions contributing to their health problems (Barker, 2008; Fox and Ward, 2006; Fox et al., 2005; see also Gottlieb, 2021). At the same time, sociologist of science Harry Collins, who sought to defend the special status of scientists compared to lay experts, made a special provision for “small numbers of initially ordinary people [who] can become scientific experts... through... experience of chronic disease” (Collins, 2014: 132). For Collins, these “experience-based experts” have “knowledge about the treatment of those diseases that compares or even exceeds that of their doctors” (Collins, 2014: 64).

Several STS scholars have specifically examined patients’ contributions to medical knowledge production, including in contexts where there are no readily available answers. This research offers multiple accounts of patients and patient groups integrating experiential and credentialed forms of knowledge and influencing research (Akrich et al., 2013; Callon and Rabeharisoa, 2008; Epstein, 1995; Kuchinskaya and Parker, 2018; Rabeharisoa et al., 2014; see also Caron-Flinterman et al., 2005; Serrano-Aguilar et al., 2009). As Jeannette Pols (2014: 77) observed for patients with lung emphysema, a chronic and severe disease, patients with such complex chronic diseases are “‘medically socialized,’ meaning that medical practices and knowledge form an integral part of their experience”. Taking patients’ contribution to knowledge production seriously, Annemarie Mol (2008: 54, 65) advocated the ideal of “shared doctoring”, a way for patients and doctors to “experiment, experience and tinker together.”

This paper contributes to the STS discussion of the knowledge production undertaken by patients, including those who experience a lack of medical answers (e.g., Dumit, 2006). Earlier STS research documented lay contributions to medical knowledge production and offered an interpretation of medical expertise as relational, negotiated, and contested. Particularly relevant are Steven Epstein’s (1995) classical research on ‘lay expertise’ and more recent studies on patients’ evidence-based activism and approaches to knowledge production (Akrich et al., 2013; Callon and Rabeharisoa, 2008; Jansky, 2023; Kuchinskaya and

Parker, 2018; Rabeharisoa et al., 2014). This paper contributes to this discussion by explicitly relating medical ignorance — a lack of adequate and actionable answers as experienced by patients — to the organization of networks of expertise. The paper demonstrates that the efforts of individual expert patients to generate knowledge about their disease involve organizational work that affects networks of expertise. The broader focus on networks of expertise rather than the individual expertise of specialists or expert patients allows us to compare and analyze patients’ approaches to reshaping these networks and to consider the composition of resultant networks.

Networks of expertise

My approach here builds on STS recognition of ‘social worlds’ that contribute to producing particular types of knowledge and typically include actors whose contributions are not credited. Social worlds depend on particular institutional and material arrangements, tools and devices, classifications, and conventions (Clarke and Star, 2008). Howard Becker provided an influential description of ‘art worlds,’ pointing out that the production of art depends not just on artists but also on the participation of much broader groups, such as viewers, critics, and various supporting occupations, as well as specific material arrangements (Becker, 2008). For Becker, social scientists’ narrow focus on professionals in the arts ignores vast areas of activity of the support personnel and audiences essential to the production of art yet deemed “unimportant or inconsequential” (Becker, 2002: 343; see also Gopnik, 2015). He emphasized the interdependence of the contributions of various actors, the material conditions of this collaborative work, and the role of conventions.

Gil Eyal (2013) offers a similar perspective in the context of the production of medical knowledge. Eyal focuses on expertise rather than experts, proposing a distinction between the two: “on the one hand, the *actors* who make claims to jurisdiction over a task by ‘professing’ their disinterest, skill, and credibility and, on the other hand, the sheer *capacity* to accomplish this task better and faster” (Eyal, 2013: 869, italics in the original). Medical expertise, then, is not something that is limited to doctors or researchers: it is distributed

in networks “linking together agents, devices, concepts, and institutional and spatial arrangements” (Eyal, 2013: 863). Experts and expertise are not reducible to each other. Indeed, in some contexts where patients might become significantly involved in the process of treatment and research, doctors “may lose jurisdiction, but the network of medical expertise is extended via generosity and dialogue” (Eyal 2013: 976).

Gil Eyal’s analysis thus frames the production of medical knowledge as essentially a question of *maximizing expertise*, which depends on the whole network of expertise. This comprises not just experts but patients and other non-experts, as well as “mechanisms by which their cooperation has been secured,” tools and devices used, and standards, conventions, and institutional arrangements enabling various contributions (Eyal, 2013: 871). From this perspective, the lack of medical answers faced by patients with rare and understudied diseases is a matter of the organization and functioning of broader networks of expertise.

This paper contributes to broadening conceptual interpretation of the work done by expert patients, demonstrating high levels of expertise and engagement in their health care. The three examples below illustrate that the efforts undertaken by these expert patients in response to the experience of medical ignorance are not exclusively epistemic but also organizational. This organizational dimension does not receive enough attention in the context of research on patients’ expertise; the term expert patients tends to emphasize individual levels of knowledge and engagement. As this paper demonstrates, focusing on these patients’ organizational efforts in the context of broader networks of expertise provides a way of analyzing and comparing their composition, affordances, and limitations.

Analyzing public narratives of expert patients and the question of medical ignorance

This research was prompted by my encounters with people who had understudied and rare diseases and described their experience of searching for a diagnosis and dealing with the lack of answers. Following my work with an undergradu-

ate student who analyzed her own “journey to diagnosis,” I began collecting publicly shared narratives describing patients’ experiences of dealing with the lack of answers. A number of them were shared by colleagues, acquaintances, and family members who dealt with undiagnosed, rare, or understudied health conditions and used these accounts to develop a perspective on the situation and their course of action. My particular interest was in stories where patients were willing and able to be actively involved in searching for answers (I include parents of pediatric patients under the term “patients”). In other words, these stories could be described as accounts of people who became expert patients since they developed an unusual degree of expertise and involvement in their health care. These accounts are unlikely to illustrate the typical responses from patients because they described people able to mobilize access to relatively high levels of resources to enable their efforts. They are more likely to be “extreme cases” of patient involvement (Flyvbjerg, 2001: 78).

When analyzing the collected accounts, including the three described in more detail here, I focused specifically on descriptions of networks of expertise and the work done to affect them. I used grounded theory to generate the main themes (Charmaz, 2006; Corbin and Strauss, 1990; Glaser and Strauss, 2017). The three accounts I describe below illustrate these themes, describing different ways of addressing medical ignorance (I return to other examples of patients’ search for answers in the discussion). Comparative analysis of these responses points to three different strategies and networks of expertise. These are not the only three ways possible.

The three cases are: (1) Jill Viles, who self-diagnosed her two rare genetic conditions; (2) Sharon Terry, who dealt with her children’s rare genetic disorder; and (3) Jennifer Brea, who suffered from an understudied yet relatively common autoimmune condition. Viles told her story in a TEDx talk “about the journey of searching for medical answers at the extremes of biology” (Viles, 2016b, see also 2016a), yet her story gathered much attention after David Epstein’s article in *ProPublica* and episode of *This American Life* (Epstein, 2016a, 2016b). Viles’s and Epstein’s versions are closely

aligned, though my analysis foregrounds Viles's first-person account. Terry's TED talk, "Science didn't understand my kids' rare disease until I decided to study it," has been viewed close to 1.5 million times (Terry, 2017, see also 2015). Jennifer Brea's TED talk, "What happens when you have a disease doctors can't diagnose," has been viewed more than 2.4 million times (Brea, 2016). Brea also described the same experience in the award-winning documentary *Unrest*, available on Netflix (Brea, 2017).

I approach these narratives as an example of patient narratives as public rhetoric (Segal, 2007). Just as medical knowledge is necessarily the production of networks of expertise rather than isolated individual experts, the narratives I analyze are likely to reflect the work not just of particular patients but other uncredited individuals, including, for example, various TED personnel. Indeed, patient narratives as media-circulating public rhetoric are likely to downplay the shared, networked effort on several levels: by making invisible the contributions of media support personnel along with their tools, conventions, and infrastructures; by emphasizing an individual "hero's journey" in the traditions of media storytelling; and overemphasizing the roles of human actors while barely commenting on media, sociotechnical, and infrastructural conditions. By reading the selected expert patient accounts through the lens of networks of expertise, this paper calls attention to what is generally downplayed by these representational strategies. Furthermore, comparing these accounts reveals different strategies for reshaping networks of expertise.

The value of these accounts is that, though highly produced, they are presented from a particular situated and embodied position, and, as such, they offer a kind of 'situated knowledge' (Haraway, 1988: 575; Halpern, 2019). Patients' struggles to find medical answers are at the core of these public narratives. These patients' perspectives are critical because a lack of medical answers is experienced most acutely by patients. In other words, it is a matter of positionality. As the examples below illustrate, while many rare diseases have a generally acknowledged lack of answers and treatments, other conditions—

such as chronic fatigue syndrome or ME—are described by a more complex state of knowledge/ignorance. CFS/ME is more prevalent in women, and commentators note the gendered nature of many understudied conditions, including autoimmune ones (e.g., Cleghorn, 2022; Tuana, 2006). Earlier STS writing described systematic issues with the production of knowledge and challenges experienced by individuals with CFS/ME (Dumit, 2006). Their suffering can be downplayed or explained away as psychological and irrational. What is adequate knowledge from some perspectives might appear as ignorance from the perspectives of people whose suffering is downplayed or systematically ignored in the context of institutional priorities or research agendas (Kuchinskaya and Parker, 2018; Mills, 2007; Sullivan, 2007; Sullivan and Tuana, 2007; Tuana, 2006). The situated, perspective-dependent assessment of areas of medical ignorance calls for the closer analysis of public narratives of patients who speak of their experience with the absence of medical answers and pathways to finding solutions.

The following section provides a summary and analysis of the narrative accounts from Jill Viles, Sharon Terry, and Jennifer Brea.

Findings

Stories of searching for diagnosis and treatment offered by Jill Viles, Sharon Terry, and Jennifer Brea can be read as describing their efforts to develop their own expertise and even conduct their own research. However, they also describe different aspects of seeking to affect networks of expertise.

These accounts represent different historical moments and different approaches to dealing with the absence of medical answers and attempting to affect networks of expertise around a particular disease. Viles's account describes her research in the 1990s, does not refer to the use of new media, and emphasizes Viles's personal search for answers, which still involved reconfiguring some networks of expertise. Terry faced her children's diagnosis in the mid-1990s, but her work is still ongoing. Here the focus is on traditional patient organizing and capacity-building, which I argue below, is also a way of rebuilding networks of expertise (indeed, Terry's TED talk appears to be an instrumental part of that work). Brea's account

documents a search for answers that began more recently. Her narrative refers to online communities, offering, I argue, yet another approach to (re) shaping networks of expertise (Brea's accounts are also part of her advocacy, as I discuss below). Despite their different historical moments and approaches, all three narratives point to some gendered dynamics, including less research about health conditions more prevalent among women and the caregiving roles performed by women (e.g., Cleghorn, 2021; Tuana, 2006).

The following sections summarize the accounts and then reflect on the networks of expertise in each case and efforts to affect these networks.

Jill Viles: One patient's search for answers as network-building

Jill Viles's account, offered in her TEDx talk and as presented by journalist David Epstein (2016a, 2016b; Viles, 2016b), emphasizes the lack of medical answers she faced about her condition and her search for a diagnosis. Her research and insights, the story goes, were at times forcefully dismissed but then repeatedly confirmed by experts. Viles and Epstein offer the following account. Her problems began when, as a young child, she started falling and having difficulty walking. Her father had similar experiences when he was a child, but it was thought to be a mild case of polio. At age 12, Viles lost the ability to ride her bike or skate. Around that time, Viles, her father, and her brother were each diagnosed with muscular dystrophy, but she was the only one constantly falling. She also had unusually little fat accumulation on her hands and legs. Doctors, including experts from the high-profile Mayo Clinic, could not explain any of it.

Frustrated with the lack of answers, Viles studied genetics in college. She also methodically combed through research on muscle dystrophy, eventually finding an article on a rare condition called Emery-Dreifuss. The photos in the article reminded Viles of her own and her father's physique. However, her self-diagnosis was dismissed by a neurologist she consulted. She eventually wrote to researchers in Italy who studied families with Emery-Dreifuss, searching for the underlying gene mutation. The Italian researchers had only found four families and asked for DNA from Viles and her family. Four

years later, in the mid-1990s, Viles received the confirmation of her self-diagnosis.

Viles's story doesn't stop there. While working as an intern in a lab, she found references to another rare condition, partial lipodystrophy, disrupted fat accumulation on parts of the body, especially limbs. She approached specialists at a medical conference at John Hopkins, but they insisted she did not have it. Discouraged, Viles stopped her research. She resumed it only 12 years later, after she got married, had a son, and lost her ability to walk when her son turned one.

The resumption of her research was prompted by Viles's sister, who showed her the pictures of the Canadian athlete, sprinter Priscilla Lopes-Schliep. Lopes-Schliep seemed to be missing fat, though her muscles, unlike Viles's, were incredibly pronounced. Viles suspected that Lopes-Schliep had a different manifestation of the same rare disease. Viles hoped that studying them together might explain why Lopes-Schliep had such developed muscles while Viles suffered from muscle dystrophy. Lacking a way to contact Lopes-Schliep, Viles wrote to the journalist David Epstein after hearing him talk about his book *The Sports Gene*. After Viles captured his attention and proved her expertise to him, Epstein contacted Lopes-Schliep through her agent. It took another year to find a doctor to test Lopes-Schliep; Viles eventually approached a leading specialist on lipodystrophy at a medical conference. The specialist performed genetic testing and confirmed Lopes-Schliep's lipodystrophy.

On the one hand, this is an account of nearly heroic efforts and Viles's personal abilities, determination, and tenacity. Viles could be described as a quintessential expert patient who develops extraordinary personal expertise and insight. However, it is also an account of network-building. Specifically, it illustrates Viles's efforts to establish connections with specialists outside her healthcare team and with non-experts whose contribution would be crucial. Viles contacted researchers in Italy who did genetic research on Emery-Dreifuss, interned at a lab, and approached lipodystrophy specialists at a conference at Johns Hopkins and then another specialist who agreed to test Lopes-Schliep. She also had somebody help her collect blood samples to send to the

Italian researchers (since blood samples were not ordered by a doctor and could not be collected in the Italian researchers' lab). She reached out to Lopes-Schliep, another patient with a different manifestation of the same rare condition, and also sought the help of a journalist (David Epstein) in securing this contact through Lopes-Schliep's agent.

Viles's engagement with the network of expertise around her case was limited to seeking and developing informal "external relations" with specialists outside of her immediate healthcare team (Heldal and Tjora, 2009) and with various non-experts who provided critical support. Nevertheless, Viles's efforts at conducting her own research and network-building—making connections with experts and non-experts—benefitted not only her but also others around her, including her father and Lopes-Schliep; it also changed at least one scholar's research agenda (Epstein, 2016b). According to Epstein's account, Viles's diagnosis of Emery-Dreifuss for herself and her father suggested cardiac problems, which her father was indeed experiencing, and Viles's insistence that a cardiologist see him likely extended her father's life (Epstein, 2016b). Lopes-Schliep received an important warning from the lipodystrophy specialist who did her genetic testing: he discovered that the athlete had dangerously high levels of fat in her blood, despite missing fat in her limbs.

One might observe that Viles's search for answers was both enabled and constrained by her position as a patient. On the one hand, her insights were repeatedly dismissed by experts. A neurologist Viles approached with an article about Emery-Dreifuss disease and later the experts at the Johns Hopkins conference found it hard to believe that Viles could diagnose herself with a rare disease or even two rare diseases. The readers' comments on Epstein's article indicate that this experience of one's insight being dismissed is not unusual for patients with rare diseases. On the other hand, as Epstein puts it: "A person with a rare disease in their family will often have seen more cases and different manifestations of the disease than any doctor has" (Epstein, 2016b). In cases like this, patients and their insights appear poorly incorporated into established networks of expertise

around these rare diseases. Indeed, Viles stopped her work for 12 years after being dismissed by the Johns Hopkins conference experts, spent a year looking for ways to contact Lopes-Schliep, and another year looking for a specialist who would test her. Viles's narrative thus gives a sense of the time lost due to working from the marginalized position of a patient as a knowledge contributor within these networks of expertise.

At the same time, while Viles's narrative points to these challenges or limitations of the underlying networks of expertise, her efforts did not seek to address the organization of these networks. Rather, Viles effectively expanded them by developing new, informal, personally based connections with outside experts and relevant non-experts who brought their knowledge, experience, institutional resources, and tools (such as taking blood samples or conducting genetic analysis). The two examples below illustrate other strategies based on joining forces with other patients.

Sharon Terry: Organizing to transform old systems

Sharon Terry's TED talk (2017, see also 2015) describes the search for answers that started for her and her husband, Patrick Terry, in 1994, after their children were diagnosed with pseudoxanthoma elasticum (PXE), a systemic, slowly progressing rare genetic disease that causes premature aging and ocular, cardiovascular and other complications. This section summarizes Terry's narrative account and then analyzes the knowledge production work it describes, including the work of developing their own expertise and research and reshaping broader networks of expertise around PXE.

Terry was concerned about the rash on her daughter's neck, which their doctor dismissed as nothing. Terry took her daughter to a dermatologist "without a referral and paying out-of-pocket." The dermatologist diagnosed her daughter and her son, who was with them, with PXE (Terry, 2015). However, doctors had few treatment answers for them as little was known about the disease. Later, the family was approached by researchers studying PXE, asking permission to sample of their children's blood. The Terrys noted

a lack of cooperation among the different teams of researchers: other groups also sought to draw their children's blood rather than sharing samples among themselves. The lack of collaboration did not stop there:

Pat and I went to the medical school library, and we copied every article we could find about PXE. We didn't understand a thing. We bought medical dictionaries and scientific textbooks and read everything we could get our hands on. And though we still didn't understand, we could see patterns. And it became quickly apparent within a month that there was no systematic effort to understand PXE. In addition, the lack of sharing that we experienced was pervasive (Terry, 2017).

In response, Terry and her husband sought to “collect blood and medical histories [of patients with PXE], and require that all scientists using these resources would share results with each other and with the people who donated” (Terry, 2017). They also established PXE International, a nonprofit dedicated to researching PXE and supporting individuals with the condition. PXE International obtained blood, tissue, and medical histories from more than 100 patients worldwide and eventually found more than 4,000 people with the disease.

Still, Terry and her husband also thought that “shared resources was not going to be enough” and decided to do “hardcore research” themselves, borrowing space from a lab at Harvard, where the postdocs tutored them on how to extract DNA and search for the gene. After a few years of work, they found the gene and “patented it so that it would be freely available” (Terry, 2017). They also created a diagnostic test, conducted clinical trials, and convened a research consortium and patient meetings.

Later, Terry and her husband sought to extend their work by joining Genetic Alliance, “a network of health advocacy, patient advocacy, research and health organizations” (Terry, 2017). In Terry's own words:

[A]s I learned about all those diseases and all those disease communities, I realized that there were two secrets in health care that were impacting me greatly. The first: *there are no ready answers for people like my kids or all the people I was working with, whether common or rare conditions.* And the

second secret: *the answers lie in all of us together, donating our data, our biological samples, and ultimately ourselves.* (Terry, 2017, italics added).

Terry became the president and CEO of Genetic Alliance, making her a leader in the patient advocacy community. Among other things, Genetic Alliance provided infrastructure—the Platform for Engaging Everyone Responsibly (PEER)—for connecting patients and researchers. Genetic Alliance explicitly worked to “transform” old systems where “entities won't share data—data that comes from people who gave their energy, their time, their blood and even their tears” (Terry, 2017). Terry also argued for including and valuing patients' contributions to and knowledge production: “We're part of this system, too. How do we make it so that people can share ideas freely?” (Terry, 2017).

Terry's account is a public testimonial that explicitly connects the lack of medical knowledge about PXE to problems with the organization of networks of expertise around it: the lack of cooperation among researchers and the insufficient inclusion of patients. It is an explicit reflection on how networks of expertise are organized and the role of patients in them, effectively presenting the problem of knowledge production as a problem of organizing.

Nevertheless, Terry and her husband could still be described as quintessential expert patients who achieved exceptional levels of personal expertise and even conducted their own “hardcore research.” Just as Viles's research effort required establishing new connections, Sharon and Patrick Terry's knowledge production work arguably required network building: people and institutions had to be approached to gain access to a lab at Harvard and obtain training in how to perform genetic analysis. However, learning to conduct “hardcore research” is more than establishing external connections. It is about becoming integrated into related networks of expertise, which comes with learning to use the equipment and understand the conventions of that practice (Becker, 2008: 57) and, as Terry did, successfully publishing the results of that research — that is, participating in the defining activities of the network of expertise.

However, Sharon and Patrick Terry's efforts to find adequate understanding and treatment of PXE consistently went beyond their own research. They explicitly sought to change the underlying competition-focused conditions of academic research around PXE and to create conditions that would promote more sharing and patient-centeredness. To that end, Sharon and Patrick Terry began by finding other patients with that rare disease, collecting their samples and data, and making their data collection both a benefit for researchers and a way to incentivize more collaboration and sharing. Terry also joined forces with other patients by establishing a patient organization and then joining a larger one, effectively changing their institutional position vis-à-vis researchers.

Through their collective effort, Sharon Terry and her collaborators at Genetic Alliance could then be said to affect networks of expertise around PXE and other rare diseases in at least two ways: by including more patients and remediating access to these patients' data. The latter included the design of the PEER platform and its later incarnations, which sought to increase researchers' access to patients with rare diseases, incentivize researchers' greater collaboration, and allow patients to "come together" to better advocate for their interests.

In sum, Terry's account is an example of reshaping the organization of networks of expertise around a rare condition by joining forces with other patients, changing their institutional position vis-à-vis researchers, and reshaping researchers' access to patient data by developing a new platform. Terry provides a quintessential example not only of an expert patient but also of a leader in patient organizing, with a career that spanned over 25 years (Frischen, 2020).

Jennifer Brea: "Online we came together"

While Viles's and Terry's children were diagnosed in the mid-1990s, Jennifer Brea describes a more recent struggle with obtaining a diagnosis and treatment. The first part of Brea's TED talk and her documentary *Unrest* tells a story of Brea's journey to diagnosis. It begins as a story of a 28-year-old Harvard Ph.D. student, about to get married, whose one infection was followed by extreme

fatigue, more infections, and then neurological, cardiac, and gastrointestinal symptoms. She became bedridden and went from one specialist to another, though they could not find anything wrong. A neurologist diagnosed Brea with "conversion disorder," which, as Brea points out, is a modern equivalent of hysteria (Brea, 2016). The diagnosis questioned the reality of Brea's illness, suggesting that all of Brea's symptoms, including infections, were caused by distant trauma or recent stress. The lack of answers made Brea think she "had a rare disease, something doctors had never seen." Then she "went online and found thousands of people all over the world living with the same symptoms, similarly isolated, similarly disbelieved" (Brea, 2016, 2017).

Brea found emotional, practical, and informational support in an online community of sufferers of myalgic encephalomyelitis, commonly known as chronic fatigue syndrome, ME/CFS. These interactions helped Brea understand her own condition better. With the help of her online community, she also found specialists who confirmed the diagnosis. After being prescribed antiviral drugs, she was able to walk again. Brea stresses the value of the online community as a place of knowledge production:

Online we came together, and we shared our stories. We devoured what research there was. We experimented on ourselves. We became our own scientists and our own doctors because we had to be. And slowly, I added 5% here, 5% there until eventually, on a good day, I was able to leave my house [...].

I don't know what would have happened had I not been one of the lucky ones, had I gotten sick before the Internet, had I not found my community. I probably would have already taken my own life, as so many others have done. (Brea, 2016)

Brea started filming her bad days to document her experience for her doctors and then also filmed others she met online, eventually directing her documentary *Unrest*. The documentary and Brea's TED talk explicitly aim to change the public conception of ME/CFS and emphasize the need for funding research. The problems, as Brea identifies them, include the public invisibility of the suffering caused by ME/CFS and the miscon-

ceptions held by many doctors, since “It is not in the textbooks of medicine,” and “When we crash, we disappear. So you don’t see us at our worst” (Brea, 2016).

Brea’s account is thus not about a rare but rather an understudied disease. Brea explicitly reflects on the reasons for systemic medical ignorance about the disease. The reasons, according to her, include the gendered history of ME/CFS, as most sufferers are women, and they frequently receive a psychosomatic diagnosis, which “can never be proven” yet precludes further search for answers. Both the documentary and the TED talk are thus public testimonials, describing a patient’s journey to diagnosis and calling for a change in the broader—cultural, institutional, and financial—conditions for research.

In the absence of certified experts who could provide answers, Brea describes relying on a network of other patients, reached through online platforms. Indeed, Brea’s narrative emphasizes not her own expertise but the importance of a collective effort (enabled by new media platforms) toward network-building and activism to raise awareness of this condition and demand sustained research: “I used to think that if I looked hard enough, I was going to find a cure... I am not going to find a cure on my own” (Brea, 2017). That network also facilitated Brea’s search for credentialed doctors and connected her with knowledgeable and sympathetic medical professionals.

Similar to Viles’s and Terry’s, Brea’s account portrays the experience of somebody who experienced a lack of answers and could be described as an expert patient actively involved in their health care and demonstrating outstanding medical expertise. Like Terry, Brea emphasizes the importance of patients “coming together.” However, she provides an example of a different composition of networks of expertise and strategies for (re) shaping them to achieve answers.

Specifically, to find answers, Brea had to find and engage with a different network of expertise — an online community rich with patient participation and patients’ experience but relatively poor in terms of its integration with the work and networks of credentialed specialists. The functioning of this network of expertise was made possible and mediated by online social media

platforms. These platforms thus acted as de facto “knowledge infrastructures” (Borgman et al., 2013), enabling communication among individuals and accumulation and collective interpretation of their experiences. YouTube and other social media platforms allowed the ME/CPS sufferers to come together—even as their physical state did not permit them to leave their houses. The design of these platforms then affects the knowledge production work of online patient communities. It enables and constrains knowledge production possible but, at the same time, is not under the control of its users and does not necessarily reflect their interests (Van Dijck et al., 2018).

While Brea’s account emphasizes the epistemic value of that community, her public-facing TED talk and documentary are explicitly positioned as efforts to affect the organization of academic, publicly funded research. She does that by leveraging the new media tools (that allowed access to other patients with ME/CPS and their experience) to make the problem more publicly visible and attract more funding for research on ME/CPS.

In sum, Brea’s account is a more contemporary example of patients’ coming together online to perform knowledge production work facilitated and constrained by new media. It is also an example of networks of expertise involving very few credentialed specialists. Finally, Brea’s account itself explicitly seeks to affect the organization of networks of expertise around ME/CPS by raising the social profile and awareness of the condition. This account is not just a representation of how networks are formed but also part of the network formation

Discussion and conclusion

This paper analyzed popular, public-facing accounts of three patients—Jill Viles, Sharon Terry, and Jennifer Brea—who faced an absence of medical answers about their own or their children’s conditions. Facing dramatic health challenges, they did what “expert patients” might be expected to do. They surveyed extensive amounts of literature and sought to diagnose themselves (as described by Viles), conducted “hardcore research” (as described by Terry), or experimented

on themselves using knowledge and suggestions obtained online (as Brea describes).

Yet the narratives of Viles, Terry, and Brea demonstrate a more complex picture if we consider them through the prism of Gil Eyal's networks of expertise (2013). Medical networks of expertise these women encountered could not generate adequate answers about their or their children's diagnosis and treatment. These patients intervened in the organization of these networks, and they did it in three distinct ways: 1) by establishing external ties with specialists outside one's immediate healthcare team, as well as non-experts and other patients expected to offer critical support or insight (as Viles did); 2) through traditional forms of organizing with other patients to affect the institutional organization of knowledge production (as Terry did); or 3) by engaging with relevant online communities that can serve as an alternative network of expertise in the absence of adequate medical support from credentialed health care specialists (as Brea did). In Terry's case, the organizational efforts included (re)shaping the underlying research infrastructures. In Brea's case, alternative network-building relied on social media platforms. In all three cases, the organizational work of extending and reshaping networks of expertise appears not secondary but essential to dealing with medical ignorance. In sum, these public patient narratives describe not just hero-like efforts to develop personal expertise and conduct research to remedy situations of medical ignorance. They illustrate significant efforts at organizing networks of expertise that would be more adept at generating relevant knowledge.

The contribution of this analysis is two-fold. First, the paper contributes to the discussion of expert patients and lay expertise by pointing at the broader dimensions of expert patient work that transcends their own expertise and knowledge production. In the cases analyzed here, epistemic efforts of expert patients faced with a lack of adequate medical answers about their conditions are also organizational efforts affecting the organization of knowledge production in their case, including who is involved in generating answers and how.

Second, the paper contributes to the earlier STS scholarship on patients' activism (Akrich et al., 2013; Epstein, 1995; Geiger, 2021; Jansky, 2023; Rabeharisoa et al., 2014), which has already suggested an intertwining of knowledge production and activism and organizational efforts of patients. The paper contributes by bringing together the analysis of networks of expertise and STS analysis of the production of knowledge/ignorance -- and arguing that situations of medical ignorance experienced by patients could be interpreted as situations of inadequate organization of relevant networks of expertise. Patients' efforts to generate answers in such situations are both epistemic and organizational. The value of applying the lens of networks of expertise is that it allows for a more nuanced understanding of the composition of these networks and efforts at reshaping them. The paper offered three examples of reshaping relevant networks, drawn from different historical periods, where patients sought to generate answers in different ways: by establishing external ties with specialists and non-experts outside one's immediate healthcare team, through traditional forms of organizing and capacity-building, and through engaging with relevant online communities that can serve as an alternative network of expertise.

More broadly, the analysis suggests that networks of expertise can be described in terms of different aspects of their composition: whether and to what extent they allow contributions by patients, what types of professional experts are included, how these networks are institutionally supported and mediated, what are the affordances and limitations of these media, and what conventions and standards facilitate or limit the work of these networks. However, the through-line for all three cases analyzed in this paper is the question of the integration of patients into networks of expertise around their condition.

Viles, whose account most resembles a hero-like effort to generate her own answers and then affect medical research, still had to do significant network-building. Similar to the expert patient described by HENDAL and TJORA (2009), Viles sought to establish external relations with specialists outside her immediate healthcare team. She also made critical connections with

non-experts who helped her efforts and a patient outside her family presenting a different manifestation of the same disease. Her focus was not on broader institutional conditions of knowledge production, even when her position vis-à-vis those networks impeded her search for answers. She lost years after some experts dismissed her suggestions because she was “just a patient.” Yet, Viles’s and other patients’ integration into the relevant networks of expertise appears critical since research on some rare diseases is based on isolated cases. As Epstein points out, Viles then had uniquely extensive knowledge of her own and her family’s symptoms and history with the disease. Though that epistemic position enabled her insight, she had no simple way of contributing her insight to the broader networks of expertise around her condition -- and had to reshape her network by forming external relations with various experts and non-experts.

In contrast to Viles, Terry’s search for answers about the treatment for PXE was a matter of organizing and, specifically, establishing patient organizations. That traditional organizing and non-profit work made it possible for Terry and her fellow contributors to impact whether researchers collaborated among themselves and what resources were available to them. Perhaps most notably, with the PEER platform, Terry and her collaborators also could achieve these and other goals by organizing and remediating researchers’ access to patient data. They increased the data available to researchers of this and other rare diseases — and created the conditions for more patient-centric research and more answers for individual sufferers (as well as more patients’ control over their data).

Generally, patient organizing and capacity-building described by Terry might be similar to the work done by other foundations and charities organized and funded by patients. Other public accounts of expert patients describe similar efforts to affect the organization of professional networks around rare conditions by joining or forming such organizations (e.g., Goldberg, 2017). Indeed, patients might continue to engage in organizational work affecting the underlying networks of expertise, in potentially transformative ways, even in areas with relatively high levels

of medical knowledge. From the perspective of networks of expertise, it could be viewed as a question of maximizing expertise, assessed from patients’ perspective, and remedying inadequacies of health care and knowledge production.

The network of expertise in Brea’s narrative was dominated by the online community of ME/CFS sufferers, which Brea credited with helping her survive. This narrative also provides an example of patients’ platform-mediated organizing in search of answers. The result of this organizing—online communities of patients—can also be viewed as an important part of networks of expertise around some conditions (see also Griffiths et al., 2012). They are arguably most important when patients, like Brea, feel dismissed by their doctors (e.g., Carroll and Frakt, 2018; Earl, 2017; Kennedy, 2016; Warraich, 2019; see also Kuchinskaya and Parker, 2018).

These alternative, social media-based networks might provide informational support, including information on access to more sympathetic doctors who can provide some care. In these cases, as in Brea’s narrative, new media platforms used by various online patient communities—platforms such as Facebook and YouTube or dedicated platforms like PatientsLikeMe.org—might serve as de facto knowledge infrastructures for patients seeking answers. Indeed, how these platforms transform patients’ roles and involvement in health care is the subject of recent research (Erikainen et al., 2019; Geiger, 2021; Jansky, 2023). This paper suggests the importance of whether and how the patients and credentialed experts are integrated within the resultant networks. There are reasons to be cautious about the kinds of medical knowledge online communities generate; self-experimentation facilitated by online communities can be dangerous (e.g., Velasquez-Manoff, 2016). However, such collective risky patient self-experimentation might indicate that these patients lack access to adequate support through traditional medical channels. The problem, in other words, might be the isolation of these patients from networks of credentialed experts, their support and resources.

The analysis in this paper is limited by using public, media-circulating patient narratives as its data source. The value of the narratives was their

explicit positionality. However, the analysis is also limited by attempting to make visible what this kind of data generally obscures: the collective, tools- and infrastructure-dependent work. More ethnographic research involving interviews and observations would be needed to account more fully for the complexity of roles that patients might play within networks of expertise and the role and the (re)shaping of the tools that mediate the epistemic work within these networks.

Finally, it is important to recognize that the work done by Viles, Terry, and Brea required

skills, access to adequate health care, as well as substantial financial, physical, family, education, and other resources. For many patients and their families, these resources are already depleted by the disease, the work of managing it (Corbin and Strauss, 1988) and of navigating health care. Patients cannot be expected to do more work. Arrangements that require more work, including attempts to integrate patients and specialists around particular conditions, should also consider resources that would be necessary to support patients.

References

- Akrich M, O'Donovan O and Rabeharisoa V (2013) The entanglement of scientific and political claims: Towards a new form of patients' activism. *Centre de Sociologie de l'Innovation: CSI Working Papers*.
- Anampa-Guzmán A, Freeman-Daily J, Fisch M et al. (2022) The rise of the expert patient in cancer: From backseat passenger to co-navigator. *JCO Oncology Practice* 18: 578–583.
- Badcott D (2005) The expert patient: Valid recognition or false hope? *Medicine, Health Care and Philosophy* 8: 173–178.
- Barker KK (2008) Electronic support groups, patient-consumers, and medicalization: The case of contested illness. *Journal of Health and Social Behavior* 49: 20–36.
- Becker HS (2008) *Art Worlds: Updated and Expanded, 25th anniversary edition*. Berkeley: University of California Press.
- Becker HS (2002) Studying the new media. *Qualitative Sociology* 25: 337–343.
- Borgman CL, Edwards PN, Jackson SJ, Chalmers MK, Bowker GC, Ribes D, Burton M, Calvert S (2013) Knowledge infrastructures: Intellectual frameworks and research challenges. Available at: <https://escholarship.org/uc/item/2mt6j2mh> (accessed 24.10.2024).
- Brea J (2016) What happens when you have a disease doctors can't diagnose. Available at: https://www.ted.com/talks/jennifer_brea_what_happens_when_you_have_a_disease_doctors_can_t_diagnose (accessed 24.10.2023).
- Brea J (Dir) (2017) *Unrest*. Netflix.
- Cahan E (2018) Darwin's orphan: A childhood with epidermolysis bullosa. *The Mighty*. Available at: <https://themighty.com/2018/10/epidermolysis-bullosa-butterfly-boys-what-its-like/> (accessed 24.10.2023).
- Callon M and Rabeharisoa V (2008) The growing engagement of emergent concerned groups in political and economic life: Lessons from the French association of neuromuscular disease patients. *Science, Technology, & Human Values* 33: 230–261.
- Caron-Flinterman JF, Broerse JE and Bunders JF (2005) The experiential knowledge of patients: A new resource for biomedical research? *Social Science & Medicine* 60: 2575–2584.
- Carroll AE and Frakt A (2018) Sometimes patients simply need other patients. *The New York Times*, 9 July. Available at: <https://www.nytimes.com/2018/07/09/upshot/sometimes-patients-simply-need-other-patients.html> (accessed 24.10.2023).
- Charmaz K (2006) *Constructing grounded theory: A practical guide through qualitative analysis*. London: Sage.
- Clarke AE and Star SL (2008) The social worlds framework: A theory/methods package. In: Hackett EJ, Amserdamska O, Lynch M and Wajcman J (eds) *The Handbook of Science and Technology Studies*. Cambridge: MIT Press, pp. 113–138.
- Cleghorn E (2022) *Unwell women: Misdiagnosis and myth in a man-made world*. New York: Dutton, Penguin Random House.
- Collins H (2014) *Are we all scientific experts now?* Cambridge: Polity Press.
- Collins HM and Evans R (2002) The third wave of science studies: Studies of expertise and experience. *Social Studies of Science* 32: 235–296.
- Corbin JM and Strauss A (1988) *Unending work and care: Managing chronic illness at home*. San Francisco: Jossey-Bass.
- Corbin JM and Strauss A (1990) Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology* 13: 3–21.

- Dumit J (2006) Illnesses you have to fight to get: Facts as forces in uncertain, emergent illnesses. *Social Science & Medicine* 62: 577–590.
- Dumit J (2012) *Drugs for life: How pharmaceutical companies define our health*. Durham: Duke University Press.
- Earl J (2017) Mom shares pregnancy warning sign that could mean danger for baby. *CBSNews*, 4 April. Available at: <https://www.cbsnews.com/news/mom-shares-pregnancy-warning-sign-that-could-mean-danger-for-baby/> (accessed 24.10.2023).
- Epstein D (2016a) Something only I can see, *This American Life Podcast*, ep. 577. Available at: <https://www.thisamericanlife.org/577/something-only-i-can-see> (accessed 24.10.2023).
- Epstein D (2016b) The DIY scientist, the Olympian, and the mutated gene. *ProPublica*, 15 January. Available at: <https://www.propublica.org/article/muscular-dystrophy-patient-olympic-medalist-same-genetic-mutation?token=d0bN47zStvHcmbER7GvkvKAYTIy9JN7t> (accessed 24.10.2023).
- Epstein S (1995) The construction of lay expertise: AIDS activism and the forging of credibility in the reform of clinical trials. *Science, Technology, & Human Values* 20: 408–437.
- Erikainen S, Pickersgill M, Cunningham-Burley S and Chan S (2019) Patienthood and participation in the digital era. *Digital Health* 5: 1–10.
- Eyal G (2013) For a sociology of expertise: The social origins of the autism epidemic. *American Journal of Sociology* 118: 863–907.
- Flyvbjerg B (2001) *Making social science matter: Why social inquiry fails and how it can succeed again*. Oxford: Cambridge University Press.
- Fox N and Ward K (2006) Health identities: From expert patient to resisting consumer. *Health* 10: 461–479.
- Fox NJ, Ward KJ and O'Rourke AJ (2005) The 'expert patient': Empowerment or medical dominance? The case of weight loss, pharmaceutical drugs and the Internet. *Social Science & Medicine* 60: 1299–1309.
- Frischen K (2020) From competition to sharing: How her children's rare disease led Sharon Terry to revolutionize medical research. *Forbes*, 8 May. Available at: <https://www.forbes.com/sites/ashoka/2020/05/08/from-competition-to-sharing-how-her-childrens-rare-disease-led-sharon-terry-to-revolutionize-medical-research/> (accessed 24.10.2023).
- Geiger S (ed) (2021) *Healthcare activism: Markets, morals, and the collective good*. Oxford: Oxford University Press.
- Glaser BG and Strauss AL (2017) *Discovery of grounded theory: Strategies for qualitative research*. London: Routledge.
- Goldberg E (2017) Young doctor diagnosed with a death sentence hopes to cure himself -- before it's too late. *HuffPost*, 4 April. Available at: https://www.huffpost.com/entry/david-fajgenbaum-castleman-disease_n_58a21b86e4b0ab2d2b17fa0c?guccounter=1 (accessed 24.10.2023).
- Gopnik A (2015) The outside game. *The New Yorker*, 14 May. Available at: <https://www.newyorker.com/magazine/2015/01/12/outside-game> (accessed 24.10.2023).
- Gottlieb S (2021) The fantastical empowered patient. In: Geiger S (ed) *Healthcare activism: Markets, morals, and the collective good*. Oxford: Oxford University Press, pp. 198–223.
- Griffiths F, Cave J, Boardman F, et al. (2012) Social networks—The future for health care delivery. *Social Science & Medicine* 75: 2233–2241.
- Halpern M (2019) Feminist standpoint theory and science communication. *Journal of Science Communication* 18: C02.

- Haraway D (1988) Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies* 14: 575–599.
- Heldal F and Tjora A (2009) Making sense of patient expertise. *Social Theory & Health* 7: 1–19.
- Henwood F, Wyatt S, Hart A and Smith J (2003) 'Ignorance is bliss sometimes': Constraints on the emergence of the 'informed patient' in the changing landscapes of health information. *Sociology of Health & Illness* 25: 589–607.
- Jansky B (2023) Digitized patients: Elaborative tinkering and knowledge practices in the open-source type 1 diabetes "Looper community." *Science, Technology, & Human Values* 01622439231170443.
- Kennedy P (2016) Opinion: The insomnia machine. *The New York Times*, 17 September. Available at: <https://www.nytimes.com/2016/09/18/opinion/sunday/the-insomnia-machine.html> (accessed 24.10.2023).
- Kerr A, Cunningham-Burley S and Tutton R (2007) Shifting subject positions: Experts and lay people in public dialogue. *Social Studies of Science* 37: 385–411.
- Kivits J (2006) Informed patients and the internet: A mediated context for consultations with health professionals. *Journal of Health Psychology* 11: 269–282.
- Kuchinskaya O (2014) *The politics of invisibility: Public knowledge about radiation health effects after Chernobyl*. Cambridge: MIT Press.
- Kuchinskaya O and Parker LS (2018) 'Recurrent losers unite': Online forums, evidence-based activism, and pregnancy loss. *Social Science & Medicine* 216: 74–80.
- MacLeod H, Oakes K, Geisler D, Connelly K and Siek K (2015) Rare world: Towards technology for rare diseases. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*: 1145–1154.
- Mills C (2007) White ignorance. In: Sullivan S, Tuana N (eds) *Race and epistemologies of ignorance*. Albany: SUNY Press, pp. 13–38.
- Mol A (2008) *The logic of care: Health and the problem of patient choice*. London: Routledge.
- Petersen A (2006) The best experts: The narratives of those who have a genetic condition. *Social Science & Medicine* 63: 32–42.
- Pols J (2014) Knowing patients: Turning patient knowledge into science. *Science, Technology, & Human Values* 39: 73–97.
- Prainsack B (2017) *Personalized medicine: Empowered patients in the 21st century?* New York: NYU Press.
- Proctor R and Schiebinger L (eds) (2008) *Agnology: The making and unmaking of ignorance*. Stanford: Stanford University Press.
- Rabeharisoa V, Moreira T and Akrich M (2014) Evidence-based activism: Patients', users' and activists' groups in knowledge society. *BioSocieties* 9: 111–128.
- Segal JZ (2007) Breast cancer narratives as public rhetoric: Genre itself and the maintenance of ignorance. *Linguistics and the Human Sciences* 3: 3–24.
- Serrano-Aguilar P, Trujillo-Martín MM, Ramos-Goñi JM, Mahtani-Chugani V, Perestelo-Pérez L and Posada-de la Paz M (2009) Patient involvement in health research: A contribution to a systematic review on the effectiveness of treatments for degenerative ataxias. *Social Science & Medicine* 69: 920–925.
- Shaw J and Baker M (2004) "Expert patient"—Dream or nightmare? *BMJ* 328: 723–724.
- Sullivan S (2007) White ignorance and colonial oppression. In: Sullivan S and Tuana N (eds) *Race and epistemologies of ignorance*. Albany: SUNY, pp. 153–172.
- Sullivan S and Tuana N (2007) *Race and epistemologies of ignorance*. Albany: SUNY.

- Terry S (2015) Presentation at Stanford Big Data in Biomedicine Conference. Available at: <https://www.youtube.com/watch?v=hGuC0-On7hQ> (accessed 24.10.2023).
- Terry S (2017) Science didn't understand my kids' rare disease until I decided to study it. TEDMED talk. Available at: <https://www.tedmed.com/talks/show?id=619693> (accessed 24.10.2023).
- Topol EJ (2015) *The patient will see you now: The future of medicine is in your hands*. New York: Basic Books.
- Tuana N (2006) The speculum of ignorance: The women's health movement and epistemologies of ignorance. *Hypatia* 21: 1–19.
- Tyreman S (2005) An expert in what?: The need to clarify meaning and expectations in "The Expert Patient." *Medicine, Health Care and Philosophy* 8: 153–157.
- Van Dijck J, Poell T and De Waal M (2018) *The platform society: Public values in a connective world*. Oxford: Oxford University Press.
- Velasquez-Manoff M (2016) The parasite underground. *The New York Times*, 16 June. Available at: <https://www.nytimes.com/2016/06/19/magazine/the-parasite-underground.html> (accessed 24.10.2023).
- Viles J (2016a) Jill Viles speaks at the 2B Empowered Conference. Available at: https://www.youtube.com/watch?v=HDTZEmMKNMU_ (accessed 24.10.2023).
- Viles J (2016b) Searching for medical answers at the extremes of biology. Published online as 'Rethinking Genetic Dichotomy'. TEDxDrakeU talk. Available at: <https://www.youtube.com/watch?v=28u3icqEZeM> (accessed 24.10.2023).
- Warraich H (2019) How one woman changed what doctors know about heart attacks. *The New York Times*, 1 February. Available at: <https://www.nytimes.com/2019/02/01/well/live/doctors-women-heart-attacks-scad.html> (accessed 24.10.2023).
- Wilson PM (2001) A policy analysis of the expert patient in the United Kingdom: Self-care as an expression of pastoral power? *Health & Social Care in the Community* 9(3): 134–142.
- Wynne B (2003) Seasick on the third wave? Subverting the hegemony of propositionalism: Response to Collins & Evans (2002). *Social Studies of Science* 33(3): 401–417.
- .

“A Train We Can’t Miss” for Economic Recovery: The Sociotechnical Imaginary of Artificial Intelligence in the Walloon Region

Nathan Flore

Aspirant FNRS, SPIRAL research center and Public Decision Institute, University of Liège (Belgium)/
nathan.flore@uliege.be

Abstract

The Walloon Region adopted its own AI strategy in 2019, called DigitalWallonia.4ai. This paper analyses it and explores the coproduction (Jasanoff, 2004) of AI adoption and of Wallonia’s future by means of Jasanoff and Kim’s (2009) concept of sociotechnical imaginary. Given its industrial history, the Walloon Region is an interesting case to analyse the interplay of cultural traits, artefacts, and imaginaries, which has been scarcely explored in the interpretive literature on AI. Studying this Region also contributes to the broadening of the scope of research on sociotechnical imaginaries. A document analysis was conducted, along with interviews of prominent AI promoters. The data were interpreted through discourse analysis, and tropes were used as heuristics to reconstruct the desirable future at the heart of the imaginary. The results show that the latter is entrepreneurial and deeply embedded (Jasanoff, 2015b) with the Region’s economic history and connected with transnational, continental, and national imaginaries.

Keywords: Sociotechnical Imaginary, Coproduction, Identity, Trope, Wallonia

Introduction

In 2019, the Walloon Region released its artificial intelligence (AI) strategy, called *DigitalWallonia.4ai*. Even though the government allocated initially €875,000 to the programme, nearly €2,000,000 was invested in total during the 2019-2021 period (Digital Wallonia, 2019a). In 2021, Willy Borsus, Wallonia’s Minister in charge of the digital economy, announced that *DigitalWallonia.4ai* would receive €20,000,000 for the next three years (de Bergeyck, 2021; Digital Wallonia, 2019a). This sharp increase in budget allocation reflects the importance AI promotion has gained in the Region. Wallonia

faced a brutal economic recession from World War II until the 1980s when its mines and metalworking industries were shut down or offshored. Rebuilding an active industrial base has thus been a major challenge for decades. The Region intends to take advantage of what it frames as the emergence of “Industry 4.0”, that is, the Fourth Industrial Revolution (Digital Wallonia, 2020; Service public de Wallonie, nd). The promotion of AI – in Wallonia as well as in other regions and countries – takes place in this perceived context of a fourth revolution (Bod-



This work is licensed under
a Creative Commons Attribution 4.0
International License

dington, 2023). This paper studies the imaginary underlying AI promotion in Wallonia.

Jasanoff and Kim (2009) launched a broad-based research programme centred on the analysis of sociotechnical imaginaries through cross-national comparison. Following this seminal publication, much research has been conducted at the national level, at the expense of research on sociotechnical imaginaries in fragmented and subnational contexts (Rudek, 2022: 231). This article intends to shed light on a regional imaginary, contributing to efforts to broaden the scope of research on sociotechnical imaginaries beyond the initial focus on nation states (Jasanoff, 2015a). It aims specifically at examining the embedding (Jasanoff, 2015b) of the Walloon AI imaginary in Walloon culture and artefacts. The embedding of such imaginaries in regional cultures, rather than nation-state cultures, has been scarcely explored in the interpretive literature (Cath et al., 2018; Kim, 2023; Köstler and Ossewaarde, 2022). This contribution unravels the imaginary's discursive entanglements with perceptions of Wallonia's past, and its material embedding within a sociotechnical network. Wallonia was an industrial powerhouse during the nineteenth and the early twentieth century. It built its economic prosperity on coal mines, textile manufacturing and metalworking industries. The region's economy collapsed after the Second World War and stagnated until the 1980s, as a result of the closure of mines, the ageing industrial infrastructure, the lack of investment in industrial processes, and the fierce international competition (Leboutte et al., 1998). As Wallonia's economy was on the decline, Belgium evolved into a federal state following the 1970 and particularly the 1980 state reforms that established the Regions. Nowadays, Wallonia is a post-industrial region with great control over territorial and economic matters, thus making it an interesting case when it comes to studying the imaginary of technologies such as AI.

This paper analyses AI adoption from a constructivist perspective, viewing it as an intrinsic and transformative aspect of Walloon identity. In other words, it attempts to find out the extent to which the promotion of AI coproduces (Jasanoff, 2004) the identity of the Walloon Region. This

question is of special interest given the performative effect that the imaginaries underlying AI promotion have on public expenses and on the empowerment of specific stakeholders. The promotion of AI in Wallonia and the ways in which this technology is envisioned as a key to a brighter future for the Region are discussed by means of document analysis and interviews, and through the lens of 'sociotechnical imaginaries' (Jasanoff and Kim, 2009). As part of this endeavour, great emphasis is put on the analysis of tropes related to the reconstruction of the desirable futures, an idea at the heart of this Walloon imaginary.

The next section provides an overview of seminal publications on imaginaries and collective identities, and a review of existing research on AI sociotechnical imaginaries. It is followed by a description of the methodology used in this study and an introduction to Wallonia's AI policy, *DigitalWallonia.4ai*. The main part of the paper then describes the nature and evolution of the Walloon AI imaginary, from its origin to its embedding (Jasanoff, 2015b), with an emphasis on the latter.

Literature review

Imaginaries and identity in STS

This section reviews the applications of the concept of 'sociotechnical imaginary' (Jasanoff and Kim, 2009) in publications dealing with the coproduction of technoscientific developments and identitiesⁱ in AI imaginaries.

Jasanoff and Kim's foundational work on Korean and American nuclear power provided the first definition of sociotechnical imaginaries, i.e., "collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects" (Jasanoff and Kim, 2009: 120). While Jasanoff and Kim's initial definition revolved around national policies, several scholars have argued that sociotechnical imaginaries should encompass other types of collectives such as international organisations, multinational companies, or public protests (Sadowski and Bendor, 2018; Smith, 2009, among others). Therefore, Jasanoff (2015a: 4) redefined sociotechnical imaginaries as "collectively held, institutionally stabilised, and

publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology". This second definition is used here to account for the role of heterogeneous organisations involved in the construction of Wallonia's sociotechnical imaginary of AI. By coining the concept of sociotechnical imaginaries, Jasanoff and Kim (2009) initiated a research programme (Lakatos, 1976) led by STS scholars. Amid many contributions, Hilgartner's (2015) concept of 'sociotechnical vanguards' aimed at describing more accurately the origin of sociotechnical imaginaries. These vanguards are defined as "relatively small collectives that formulate and act intentionally to realise particular sociotechnical visions of the future that have yet to be accepted by wider collectives, such as the nation" (Hilgartner, 2015: 3). In this case, the concept of 'vanguard vision' is combined with Jasanoff and Kim's (2009) definition to describe the nature and the evolution of the AI imaginary.

AI imaginaries

Although the existing research on AI imaginaries does not predominantly apply Jasanoff and Kim's (2009) concept of sociotechnical imaginaries, some scholars have studied AI policies from an interpretive perspective. This literature includes two strands, namely publications that analyse the way artistic productions envision AI and the ones that employ document analysis to explore the imaginaries associated with national AI strategies. The former are overlooked in this paper since they do not deal with the link between AI and community building, but rather tend to focus on ethical issues (e.g., Hermann, 2021).

Cath et al. (2018) compared three parliamentary reports on AI to unravel ways in which "good AI societies" are envisioned. The American report emphasises the need to ensure AI remains safe and fair while working for the "public good". The report issued by the European Union asserts that AI should preserve "intrinsically European and humanistic values" (European Parliament Committee on Legal Affairs cited by Cath. et al., 2018: 524). The British report urges AI developers to take ethical and legal stakes into account in the

future and calls for "socially beneficial" AI (House of Commons Science and Technology Committee cited by Cath et al: 524). Cath. et al. showed that even though the three reports suggest guidelines to deal with social and ethical issues in AI strategies, they do not propose any idea of what a "good AI society" could look like (Cath et al., 2018). They suggest filling this knowledge gap by using multi-stakeholder consultations and urge governments to address this question given the private sector's inability to do it.

Köstler and Ossewaarde (2022) reviewed policy and media documents in order to analyse the framings of AI in Germany. Their study revealed that the German government envisions AI as a competitiveness-enhancing technology necessary to protect the country's leading economic position in Europe and in the world. They observed the German government's tendency to emphasise the progress made by the USA and China in order to challenge all German AI stakeholders. Furthermore, Köstler and Ossewaarde (2022) indicated that AI promoters often display a specific vision of the country's past, which is based on its strong industries. Moreover, they stressed that the way Germany's past is envisioned prevents potential AI futures from being materialised since the capitalist history of the country is transposed to AI imaginaries.

Similarly, Ciuriak et al. (2020: 13) analysed the Chinese, European and American AI policies and highlighted the existence of an "adversarial" narrative that leads to contentious political and commercial relations at the global level. AI is indeed seen by each country as a powerful tool to increase economic competitiveness. Although China, the EU and the United States (US) have all embraced this "adversarial" narrative based on competitiveness, they have adopted different positions on the type of AI that should be favoured and the way it should be promoted. China views AI as an opportunity to become a global economic powerhouse by "build[ing] up an 'AI first mover advantage'" (Ciuriak et al., 2020: 8). The EU regrets its marginal position in the global AI landscape and seeks to achieve strategic autonomy in AI while stressing its ambition to develop a human-centric use of this technology. The US wants to protect private initiatives in AI development and

commercialisation against national regulations (Ciuriak et al., 2020).

Bareis and Katzenbach (2021) conducted a discourse analysis of national AI strategies in China, the US, France, and Germany. These strategies were conceptualised as sociotechnical imaginaries in order to shed light on the wider implications of the former on resource allocation and public policy. Their results overlap with some of Ciuriak et al.'s (2020) and Köstler and Ossewaarde's (2022) findings in so far as they indicate that the 'inevitability' narrative, which is pervasive in AI policies, comes from this emphasis on competitiveness, along with standard technological determinism. Interestingly, Bareis and Katzenbach's contribution conceptualises the interplay of global and national imaginaries. They state that the perceived inevitability of AI adoption leads to the belief that AI adoption is necessary to preserve national competitiveness. This belief engenders policy initiatives, which are always underpinned by national cultures and aspirations (Bareis and Katzenbach, 2021: 11). This perception of inevitability is created by the discursive inclusion of AI in the "historical legacy of technological progress" (Bareis and Katzenbach, 2021: 11) and by the framing of AI as a 'technological fix' for social problems (Katzenbach, 2021). Kim (2023) analysed the Korean and French national AI strategies using the sociotechnical imaginary framework as well. Like Bareis and Katzenbach (2021), he emphasised that there are substantial differences in the way AI is promoted in different countries. However, he also noted that Korea and France share a sense of urgency regarding AI adoption. According to Kim, both national AI strategies indeed incorporated an "AI essentialism" stemming from the digital industry. Nevertheless, the two IT imaginaries diverge as each state has its own history of successful and failed projects.

Paltieli (2021) studied the national AI strategies of eleven countries and two international organisations using discourse analysis. He argued that the imaginaries underlying these documents rely on national myths and reproduce the existing national narratives. Furthermore, he argued that such imaginaries are valuable since they show how citizens and states could profit from better data control.

All the publications reviewed in this paper used document analysis techniques to examine *the framing, narratives or imaginaries* of national AI strategies. Interestingly, they stress the existence of common emphases on technological determinism, competitiveness and "adversarial" discourse (Ciuriak et al., 2020: 13). However, they fall short in studying the material and cultural embedding (Jasanoff, 2015b) of those discourses, except for Köstler and Ossewaarde's paper, which stressed the salience of Germany's past in discourses promoting AI. Moreover, they are either publications that provide extensive accounts of single actors' discourse or contributions that focus on very few policymakers. This paper aims at going one step further by adopting a coproductionist perspective (Jasanoff, 2004) on AI promotion and regional identities. Therefore, it provides an original contribution to the field by presenting in-depth empirical research on the coproduction of an AI sociotechnical imaginary and Wallonia's identity through an analysis of multiple stakeholders' discourses, at the level of the region. It also includes an innovative analysis of tropes with a view to rebuilding a sociotechnical imaginary.

Methodology: Reconstructing a sociotechnical imaginary

Data collection

Policy documents are often the primary sources for researchers working on sociotechnical imaginaries because they present the goals of public and private policies. Sadowski and Bendor (2019), for instance, analysed "as many documents as possible" from IBM and Cisco to study the concept of smart city as a sociotechnical imaginary (Sadowski and Bendor, 2019: 8). In a similar vein, this paper is based on the collection and analysis of all the public data sources that were likely to offer valuable insights into the sociotechnical imaginary of AI in Wallonia, including official documents and the website of Digital Wallonia, websites of the Walloon organisations that promote AI, and press articles. Appendix 1 specifically presents the websites that were analysed. The documents and press articles are listed in the bibliography.

In addition to document analysis, semi-structured interviews were conducted with representatives of organisations that promote AI in the Walloon Region between March and May 2022. Face-to-face interviews were preferred, but the covid-19 policy of the interviewees' organisations forbade it most of the time. The analysis of these interviews confirmed the hypotheses formulated after examining written sources, and guaranteed the triangulation of the results. In fact, the use of interviews in the context of sociotechnical imaginary research is well established. Rudek (2022: 230) showed for instance in his meta-analysis that interviews were used in forty-one percent of the forty-three papers dealing with sociotechnical imaginary in energy studies that he analysed. Fourteen semi-structured interviews were conducted. In addition to this selection, the snowball method was applied to ensure that no major player in AI promotion within Wallonia was forgotten. Fourteen interviews were sufficient to reach data saturation. Five interviewees were officials from the institutions steering DigitalWallonia.4ai (Agence du numérique, Agoria, Infopôle Cluster TIC and Réseau IA), and three others were managers of AI companies based in Wallonia. The remaining interviewees came from public institutions – including the Research Department of the Service public de Wallonie (Walloon Public Service), a public funding agency, and a "Pôle de compétitivité" (Competitiveness cluster), – as well as representatives of Walloon companies, of the research consortium Trusted AI Labs (TRAIL) and the Walloon Digital Affairs minister. Appendix 2 lists the interviewees' profiles.

Data analysis

The essential features of the Walloon sociotechnical imaginary of AI were unraveled using discourse analysis. Tropes were analysed to identify the essential facets of the imaginary's desirable future. In this case, the tropes used to reconstruct the Walloon AI imaginary were identified inductively and manually in the research material, as they are pervasive in the stakeholders' AI adoption discourse. They serve as a powerful tool to grasp the essence of discursive productions (Angelo and Vormann, 2018; Jasanoff, 2015a: 27; Haraway, 1989;

Hermann, 2021) as they are travelling pieces of an imaginary, revealing the imaginary's desirable futures. Tropes are thus useful for understanding the future that AI actors envision for Wallonia when they promote this technology. First, they are helpful in identifying intertextual coherence (Kövecses, 2023) in discourses building the sociotechnical imaginary. Second, they enable the researcher to account for the historical context of salient discourse traits that may create and transform collective identities. They also transform the framing of public and private technological policies, as they are performative. Therefore, examining their form and circulation is highly relevant to the study of sociotechnical imaginaries.

Results

The sociotechnical imaginary of AI in Wallonia

Even though sociotechnical imaginaries can arise from individual visions, they are only labelled as such when these visions are disseminated within a collective, thus becoming "communally accepted" (Jasanoff, 2015a: 4). In the case of AI in the Walloon Region, the imaginary originates from a combination of several factors, including a vanguard vision, multilevel pressure and Wallonia's master narrative of economic "recovery". It is a key aspect of the Region's digital policy and is unsurprisingly enshrined in the DigitalWallonia.4ai programme, which is dedicated for the support of AI adoption. The following sections present the origin of Wallonia's AI imaginary, the institutional architecture of AI promotion in Wallonia and the Region's AI strategy.

The origin: When a technological vanguard meets multilevel agenda settings

The adoption of an official regional AI policy and the emergence of a sociotechnical imaginary of AI in Wallonia stems from the creation of the Réseau IA (AI Network) in 2019 by Frédéric Peters and Christophe Montois. At the time both of them worked for Thelis, a Walloon company specialised in IT management. They felt that many companies were willing to include AI models in their processes or products but were unsure how to proceed in practice. This was confirmed by the survey they conducted on small and medium-sized companies

(Digital Wallonia, 2020b). Furthermore, some companies wanted to find information on possible AI software solutions (Lovens, 2021a). Besides, Frédéric Peters was struck by the ubiquity of Asians and Americans in AI keynotes during the Barcelona Mobile World Congress and wanted to “put Wallonia in the race” (Lovens, 2021b). Frédéric Peters and Christophe Montois’s core aim was thus to gather companies and other organisations active in the field of AI in Wallonia through the Réseau IA:

(...) Is it worth doing it alone, knowing that Wallonia is lagging far behind Asia and the United States which are leading the sector? And one must bear in mind that even if a 20-person design office put in 100% of its resources, it would never be more than a drop in the artificial intelligence ocean. So, based on this observation, we thought ‘well, rather than adding a drop to the ocean, let’s try to gather a few drops of water that we have around us and do something bigger’ (...) (interview 14) (All verbatim records and quotations were translated into English by the author).

This idea that “little drops of water make the mighty ocean” is strongly related to the trope of the “critical mass” which is widespread in Walloon AI promotion discourse. Building on the global ‘adversarial’ (Ciuriak et al., 2020: 13) sociotechnical imaginary of AI, the network was built on a vanguard vision in which Wallonia’s AI companies would join forces and ideas to “catch up”, and “jump onto the bandwagon” (Kiwix, 2018). By establishing the Réseau IA, Frédéric Peters and Christophe Montois constituted a sociotechnical vanguard (Hilgartner, 2015). Their initiative was indeed intended to trigger a larger sociotechnical revolution (Hilgartner, 2015: 3) involving a wide adoption of AI in Wallonia. Nonetheless, this vanguard vision was competing with another vanguard, led by IBM and Google. The latter were at the time discussing the possibility of collaborating with Digital Affairs Minister Willy Borsus and his staff to promote AI adoption in the Region (interview 14). Eventually, the discussions between Wallonia’s Digital Affairs Minister, on the one hand, and IBM and Google, on the other hand to form a partnership stalled. Among other things, Willy Borsus was not eager to spend public money on a project involving those multinational companies

(interview 14). Consequently, the Walloon Digital minister endorsed Montois and Peters’ vision of a networked, and competitive ‘AI-adopting’ Wallonia.

Wallonia’s Agence du Numérique (Digital Agency) planned to put in place a new branch of Digital Wallonia fully dedicated to AI. Its managing team wanted to fill the gap it perceived in the Walloon digital strategy but feared it would not gain political support without the backing of influential partners (interview 2). To strengthen their initiative, they joined forces with Réseau IA, Infopôle Cluster TIC and Agoria before submitting the project to Wallonia’s Digital Affairs Minister (interview 2). Simultaneously, the European Union adopted a “Coordinated Plan on Artificial Intelligence” (European Commission, 2018) and put pressure on each member state to adopt their own AI plan. The adoption of Wallonia’s AI strategy was also influenced by an ongoing initiative launched in 2018 by the federal minister in charge of the Digital Agenda, Alexander De Croo. The Federal Minister had gathered forty experts from companies, public institutions, universities, and other organisations to discuss a Belgian AI plan, which led to a series of 48 recommendations to federal policymakers supported by AI4Belgium. This multilevel political pressure strengthened Agence du numérique/ AdN (Digital Agency) and its partners’ resolve to formulate an AI policy, as well as the momentum built by the Réseau IA (AI Network).

In 2019, these converging processes led to the start of the Walloon DigitalWallonia.4ai partnership and strategy. In short, the creation of the Réseau IA, combined with multilevel political pressure and with the Walloon Digital Agency’s projects, resulted in the formulation of the regional AI policy, DigitalWallonia.4ai. Progressively, the enshrinement of their *vanguard vision* in public policy led to the emergence of an AI socio-technical imaginary.

DigitalWallonia.4ai: A partnership and a strategy

The Réseau IA, the first initiative entirely dedicated to AI adoption in Wallonia, received support from the Digital Affairs Minister. At the time, the Digital Agency did not have any programme focusing exclusively on AI, and the Réseau IA brought

together companies that developed or utilised AI software in order to spark discussions on their shared concerns. In 2019, DigitalWallonia.4ai was created on the basis of a partnership between the AI Network, the Walloon Digital Agency, the business federation Agoria, which represents Belgian technological companies, and the Infopôle cluster TIC, a network that unites stakeholders in Wallonia's digital sector. It is also supported by the Service public de Wallonie (Walloon public service, department of research) and AI4Belgium.

DigitalWallonia.4ai is both a strategy and a partnership. Its strategic layer, unveiled in 2019, is predominantly intended to foster company development through three programmes, namely Start IA, Tremplin IA and Cap IA. It is based on four pillars: "Society and AI", "Companies and AI", "Education and AI", and "Partnerships and AI" (Digital Wallonia, 2021a). The first pillar aims at raising public and professional awareness of AI and its potential opportunities. It primarily involves organising events and seems less significant than the second pillar for DigitalWallonia.4ai stakeholders.

The second pillar, which focuses on companies, is the core of DigitalWallonia.4ai. It is dedicated to the promotion of AI adoption by Walloon companies with a view to offering "augmented products and services" (Digital Wallonia, 2021a). To this end, DigitalWallonia.4ai offers three funding schemes: Start IA and Tremplin IA, which were launched along with the strategy in 2019, and Cap IA that started in February 2021. They represent a crucial facet of the AI sociotechnical imaginary in Wallonia, namely AI as a competitiveness enhancer. Start IA funds three days of coaching with AI experts, who assess a company's activities, identify opportunities for AI implementation in its processes or products, and prioritise the company's investments. Tremplin IA was designed to encourage the production of proofs of concept with the help of an AI specialised company. It aims at helping companies implement any ideas they developed independently or as a result of Start IA coaching. Cap IA differs significantly from Start and Tremplin IA. While Start and Tremplin IA are generic programmes targeting any company interested in improving its production or commercialisation processes, Cap IA is aimed at companies

specializing in AI development. Its objective is to support the growth of startups and their potential development into scaleups and medium-sized businesses (Digital Wallonia, 2021a).

DigitalWallonia.4ai's third pillar focuses on training and education in the field of AI. In practice, businesses and the general public are provided with a series of AI training courses in which Agoria emphasises the need for companies to adopt AI processes to keep up with their competitors. This is also a key feature of the Walloon AI sociotechnical imaginary. Companies therefore seem to be the main targets of DigitalWallonia.4ai even in the context of the third pillar.

The fourth pillar of the strategy is entitled "partnerships, innovation, research and AI". Its goal is to spur collaborations between the four institutions that founded DigitalWallonia.4ai and thirty official partners (Digital Wallonia, 2021a). For instance, DigitalWallonia.4ai supported the creation of the research consortium "Trusted AI Labs" (TRAIL) and contributed to the development of the project "Applications and Research for a Trustworthy Artificial Intelligence" (ARIAC), which aims at making AI tools available to improve the Region's competitiveness in four sectors: medicine, media, mobility and manufacturing (Digital Wallonia, 2021a).

The performance of the Walloon AI imaginary

This section examines how the sociotechnical imaginary is made visible to the public and to the main targets of DigitalWallonia.4ai, i.e., Walloon-based companies. The imaginary is displayed publicly through the brand DigitalWallonia.4ai whose main goal is the promotion of AI in Wallonia. The branding is managed by the Walloon Digital Agency, as part of its communication mission (Agence du Numérique, 2022). Moreover, the Agency has established a network of "Digital champions" whose mission is to promote Wallonia's digital strategy, to bolster digital transformation and to push forward innovative ideas (Digital Wallonia, 2019b).

Wallonia's AI promotion landscape is complex. Public agencies collaborate with limited companies under public and private law, non-profit organisations, research centres and universities, funding agencies, educational institutions, companies and business federations, Pôles de

compétitivité and Clusters. These diverse actors cooperate to promote AI adoption in the Region. DigitalWallonia.4ai is thus used to increase the visibility of AI support programmes for companies.

The website of Digital Wallonia outlines the goal of its branding as follows:

The Digital Wallonia brand aims to embody the digital character of Wallonia. It aims to unite public and private players and initiatives involved in the implementation of the Digital Wallonia strategy and, more generally, in the digital transformation of Wallonia. (Digital Wallonia, 2018).

The branding of DigitalWallonia.4ai serves as a means for institutions in charge of AI promotion to facilitate partnerships (Digital Wallonia, 2018) and create an impression of unity (interview 5). Such unified branding is also necessary because companies may struggle to find their bearings in the complex network of organisations they could collaborate with (interviews 3, 4, 14). By associating a brand with the main public initiative dedicated to AI adoption in the Region, the Digital Agency seeks to increase its visibility for Walloon entrepreneurs and thus foster the use of its AI adoption programmes in companies that do not operate in the digital sector but wish to enhance their productivity and competitiveness through AI processes:

(...) When you take a look at Wallonia’s business landscape, there are so many players and so many support schemes that everything turns into a confusing mess. There are too many things to see clearly. On the other hand, if you come up with a brand which everyone can latch onto, well, everyone will only remember one thing, they’ll only remember DigitalWallonia.4ai, Start IA, Tremplin IA and so on, and everyone can grab hold of it. And the advantage is that you don’t muddy the waters,



Figure 1. Digital Wallonia’s logo

you make them crystal clear in this case. (interview 14).

In practice, this branding translates into public communication campaigns that use a specific style guide and a specific logo (Figures 1 and 2).

The DigitalWallonia.4ai brand is also intended to enhance the international visibility of the Region’s digital programme. The brand is used by the Agence wallonne à l’Exportation et aux Investissements étrangers (Walloon agency for exportation and investments - AWEX) during its trade missions, and within the context of the so-called Digital Wallonia Hubs, which support the international expansion of Walloon-based companies active in the digital sector.

In addition to the brands promoting AI initiatives, a group of “Digital Wallonia Champions” was established by the Agence du Numérique (Digital Agency). The mission of these champions is to advocate for AI adoption in Walloon-based companies. The digital champions are a network of 150 individuals who have been contributing to the Digital Wallonia strategy and have been involved in at least one partnership in their area of digital expertise (IA, cybersecurity, etc.) with another specialised organisation (Digital Wallonia, 2019c). They have three missions. The first and most important one is to promote the use of digital technology. It involves highlighting the opportunities digital technology offers and acting as “ambassadors of digital excellence in Wallonia” (Digital Wallonia, 2019b: 33). The second mission of the “champions” is to promote the Digital Wallonia strategy and showcase projects successfully completed within this strategy. Finally, they are supposed to serve as “bridges” between the



Figure 2. Digitalwallonia.4ai’s logo

needs of their sector and the Walloon government (Digital Wallonia, 2019b: 33).

Therefore, the promotion of AI in Wallonia is based on what could be described as “evangelisation” efforts conducted by individuals recognised by the Agence du numérique as leaders in promising digital technology projects. Successful AI companies are encouraged to produce a virtuous cycle in which the Walloon AI “ecosystem” grows, enhances its overall competitiveness and reaches “critical mass”, which is of paramount importance at the international level. The adoption of AI in Wallonia’s companies is further evidenced and encouraged through the “champions” network and widely disseminated use cases. The imaginary is embedded (Jasanoff, 2015a) in the Region through these use cases disseminated by DigitalWallonia.4ai. There is therefore a direct link between the way the socio-technical imaginary is performed (Jasanoff, 2015a) and the desirable futures (Jasanoff, 2015a: 4) it includes.

Desirable futures ‘requiring’ technological advances

This section examines the core of Wallonia’s AI sociotechnical imaginary, specifically how the Region’s future and identity are coproduced (Jasanoff, 2004) with the promotion of AI adoption, i.e., how Wallonia’s desirable futures (Jasanoff, 2015a: 4) are envisioned to depend on AI adoption and how this adoption reshapes the Region’s identity. This review of the features of this imaginary is based on the identification of recurrent tropes in the documents and interviews of AI promoters.

“A train we can’t miss”

This trope is unequivocal evidence of technological determinism in AI promotion. AI adoption is said to have its own development pattern which is independent of local stakeholders’ action. Walloon entrepreneurs, policymakers and civil servants that are in favor of wide-scale AI adoption argue that the latter is bound to happen given the existence of other countries’ AI strategies, the global commercial competition, and the marketing needs of Walloon companies.

Walloon AI promoters refer specifically to the Region’s position in the world when they discuss the need to adopt this technology. They present Wallonia as being caught between the two main actors in the field of AI research and adoption, namely the United States and China (interviews 7, 10). Then, they affirm that there is no real choice to be made if Walloon companies want to remain competitive (interview 8). The goal is not to be overwhelmed by foreign companies in the context of a global and highly competitive market (Connect, 2021). This part of Wallonia’s AI socio-technical imaginary corresponds to a broader European narrative based on the idea that the Union should make its way between two giants (the United States and China) to become more autonomous and to spread its own vision of AI (Ciuriak et al., 2022). While the EU seemingly used to be primarily concerned with mitigating the risks associated with AI and other digital technologies, it now appears to be focused on increasing investments in AI research and commercialisation in Europe. The EU Commission and member states adopted the Coordinated Plan on Artificial Intelligence in 2018, and revised it in 2021. Although both versions emphasise the EU’s ambition to promote a “human-centric” AI, the second one goes one step further, aiming at “creating EU global leadership in human-centric AI with member states” (European Commission, 2021: 1). The coordinated plan advances another objective: fostering Europe’s competitiveness by optimising industrial processes through AI adoption (European Commission, 2018). The Walloon Region has partly endorsed the EU’s imaginary. In 2020, the TRusted AI Labs (TRAIL) were created to gather researchers around the development of AI processes that do not jeopardise citizens’ fundamental rights. The EU and the Walloon Region have also promoted AI adoption to enhance their competitiveness. Therefore, the Walloon AI socio-technical imaginary partly overlaps the EU’s. It is “adversarial” (Ciuriak et al., 2022: 13), and centred on the global sale of a “human-centric” AI that enhances competitiveness.

There are also marketing and commercial stakes that reinforce the need for AI adoption. As this technology has drawn so much attention, some companies fear that they will lose consumers

if they do not propose services or products that include AI:“(…) as of 2022 there has been so much hype around AI that many businesses, especially medium-sized and larger companies, are thinking ‘if I don’t do it I’m a has-been and therefore I’m screwed’” (interview 11). The “hype”, as the interviewee frames it, is not to be overlooked. Such a trend is influenced by- and impacts long-term and wide-scale dynamics such as globalisation, public investment in technology or national innovation policies. This phenomenon should thus be investigated rather than left behind under the pretext that it is nothing more than marketing discourse (Hockenhull and Cohn, 2021; Rieder, 2018). In the present case, Walloon companies feel compelled to adopt AI in their processes or to provide services and products based on this technology. This sense of obligation and even urgency to adopt AI among entrepreneurs is increased and consolidated in discourses spread by trade associations. For instance, in 2022, the federation of Belgian technological companies, Agoria, published on its website an article that highlighted the importance of raising awareness of AI adoption:

(…) Because even though more and more companies in our country are already using artificial intelligence, many are still lagging behind. It is very important that these companies also realise as soon as possible that AI can help them given its wide range of applications (Agoria, 2022).

The train trope exemplifies the way AI promoters frame this technology. From their point of view, it appears there is no credible alternative to AI use as for smart city development (Sadowski and Bendor, 2019) and digital data conservation (Markham, 2021). Its wide adoption seems unavoidable and Walloon stakeholders feel powerless regarding the choice to adopt it or not, a situation that Deetz’s concept of ‘discursive closure’ (Markham, 2021) describes perfectly. This concept describes “how certain patterns of thought, talk, actions, or interactions tend to function like negative feedback loops in social ecologies, discouraging evolution and change” (Markham, 2021: 393). The sociotechnical imaginary of AI in Wallonia is strongly linked to a type of ‘discursive closure’ regarding general AI adoption.

Reindustrialising Wallonia

In Wallonia, AI is also framed primarily as a means to restore the Region’s leading economic position. During the first ‘Industrial Revolution’ massive earnings were yielded by coal, followed by metallurgy, but by 1960s and the following decades these sources of profit began to decline. Digital technology and AI in particular are nowadays seen as a new potential for economic development. This subsection shows how AI promoters envision Wallonia’s future through the lens of its industrial history.

The promotion of AI in Wallonia is based on- and builds the Region’s history. Wallonia’s misfortune is said to come from its inability to transition from the first industrial revolution to subsequent ones, resulting in an economic downturn in the 1960s and 1970s (interview 10; Agoria, 2020). Therefore, AI advocates believe that it is vital for the Region to take advantage of what they perceive as a new industrial revolution that includes the rise of AI:

Wallonia owes all its wealth to its success during the Industrial Revolution in the last century. In the era of the digital revolution, we must take the lead, dare, be enterprising and capture the full potential of this new digital society (Digital Wallonia, 2019e).

This discourse suggesting that Wallonia should make the most of global AI development to increase its economic performances is underpinned by two key rationales. The first one posits that Wallonia can take on a prominent role in the international development of AI, which would boost the region’s economy (Digital Wallonia, 2019d). The second one, which is more salient, views AI primarily as a tool to foster the growth of Walloon-based companies.

Driven by their resolve to deindustrialise the Region, former and current Walloon ministers tend to embrace the second rationale, pleading for the reshoring of industries to create more jobs and stimulate economic development (Borsus, 2022; Gouvernement wallon, 2014, 2021). Rather than abandoning its industrial legacy, Walloon policymakers plan on using AI to transform the Region into a strong industrial hub. In that vein, Walloon Digital Affairs Minister Willy Borsus asserted that “For our region, AI may be one of the levers that contribute to our tools for redeployment, reconver-

sion, and renewed growth for our region, and one of the tools, also paradoxically, for the reindustrialisation of our region” (Borsus, 2022). The importance of AI for reindustrialisation is also visible in the implementation of a public programme called “Industry of the future” aimed at fostering the adoption of digital technology in the Region’s factories (Agence du numérique, 2021).

The consortium approach used in the “industry of the future” programme highlights another feature of Wallonia’s AI sociotechnical imaginary, namely the importance of cross-sector partnerships symbolised by the use of the concept of ‘ecosystem’. Reindustrialisation through AI adoption is thus also strongly linked to competitiveness concerns, as the following subsection will demonstrate.

Competitiveness

Competitiveness is one of the most pervasive themes across AI-related policy documents in Wallonia, but also in the discourse of private stakeholders. It seems there is a general tendency to justify public support for AI adoption by referring to competitiveness matters, as illustrated by the Walloon Digital Affairs ministerⁱⁱ and key stakeholders’ discourse (interviews 1, 5, 7, 12; Union Wallonne des Entreprises, 2021). This subsection shows that the two-sided perception residents of Wallonia have of their Region leads them to frame AI as a major opportunity to build a future in which Wallonia rebuilds its wealth.

It was confirmed through document analysis that policymakers in Wallonia, such as the government and members of parliament, acknowledge the effects of globalisation and share concerns about its impact on the Region’s future economic opportunities. Walloon digital affairs minister Willy Borsus, declared for instance that “The global competition is underway, at any moment, at any time, it is not even a question of choice anymore” (Borsus, 2022). In fact, the concerns seem less about globalisation itself than the risk of facing more economically competitive companies (interview 8).

The adoption of technology is therefore envisioned as a Hobson’s choice if Wallonia wants to remain attractive and competitive on global markets in the long termⁱⁱⁱ. This concern is

enshrined in the 2019 policy statement (Parlement wallon, 2019: 43), which targets digital technology in its broadest sense and links it to companies’ productivity and competitiveness. Likewise, the regional digital strategy, Digital Wallonia 2019-2024, underlines that the Region’s international competitiveness should be improved by means of digital technology (Parlement wallon, 2019: 10). Interviewees also assert that the high level of wages in Belgium compels companies to make productivity gains to remain competitive. In this context, they frame AI as an essential technology that has to be adopted in Walloon companies (interviews 1, 5, 11, 14).

AI promotion is strongly associated with competitiveness gains, as illustrated by the content of parliamentary questions^{iv}. Other types of discourses on AI adoption and competitiveness can be broken down into two main ideas: AI as a competitiveness-increasing technology for Wallonia’s overall industrial competitiveness and AI as a competitiveness enhancer in strategic sectors. First, AI is considered to suit most sectors’ needs in terms of process optimisation, product personalisation and market openings (interviews 5, 7, 10, 13, 14; Digital Wallonia, 2019a; Digital Wallonia, 2020a; Regional IT, 2021). It seems effective in process industrialisation (interviews 2, 5, 13) because it allows companies to automate repetitive, costly, and sensitive industrial operations. Walloon AI actors tend to go further, asserting that manufacturing industries will not survive without the adoption of digital technology, in the context of the so-called “industry 4.0” (interview 10). It seems that this question is of special importance for the Walloon government as it implemented an *ad hoc* programme called “Industry of the future” as part of the 2021 intelligent specialisation strategy. This programme intends to enhance the competitiveness of manufacturing and even bring back to Wallonia industries that were relocated during the past decades. It further crystallises the competitiveness goal inscribed in the 2019 policy statement (Parlement wallon, 2019), as well as in the “Stratégie de spécialisation intelligente” (intelligent specialisation initiative), the Digital Wallonia strategy and in previous policy documents.

AI is also promoted as part of a different vision of Wallonia’s future economic development, which

focuses on the strength of specific sectors that have been bolstered by the so-called clustering policy. This policy was inspired by the French Pôles de compétitivité (Competitiveness clusters) programme and initiated in the beginning of the century with the creation of Wallonia's own Pôles de compétitivité. Walloon industries created the Grappes technologiques' (Technological clusters), which are groups of companies dedicated to the acceleration of industrial innovation, and the so-called Clusters, that is, networks of companies, which could also involve educational institutions and sector-specific research centres, aimed at supporting the development of small and medium companies (Infopôle Cluster TIC, 2022). The Grappes were abandoned in 2004, whereas the "cluster" approach was enshrined in the Region's legislation in 2007^{vi} (Dujardin et al., 2017: 14-15). This specialisation strategy was further implemented by creating Wallonia's own Pôles de compétitivité (Competitiveness clusters) in the 2006 "plan Marshall" ("Marshall plan"^{vii}). This first "Marshall plan" succeeded the "Contrat d'avenir pour la Wallonie" (Deal for the Future of Wallonia) which aimed at reaching the European average employment rate. Nowadays six Pôles exist, each responsible for the development of their specific sector: Biowin, GreenWin, Wagrallim, Logistics in Wallonia, Mecatech, and Skywin. The strategy "Digital Wallonia 2019-2024" plans to make the Pôles de compétitivité "digital by design" (Parlement wallon, 2019: 10), since the Pôles need to ensure there is a strong digital component in their projects in order to "guarantee the international competitiveness" (Parlement wallon, 2019: 10) of companies that are supported and to match with advances in applied research.

The Region's industrial strategy, centred around the Pôles de compétitivité, was thus amended to include the adoption of digital technology. The creation of the project "Applications et Recherche pour une Intelligence Artificielle de Confiance" (ARIAC, Applications and research for a trustworthy artificial intelligence) in the context of TRAIL further solidified the link between competitiveness goals and AI adoption. ARIAC is indeed an applied research programme meant to supply Walloon-based companies with AI tools in order to grant them a competitive advantage^{viii} (Service

public de Wallonie, 2021). Competitiveness clearly constitutes a crucial facet of the sociotechnical imaginary of AI in Wallonia.

A few other tropes structure discourses on AI promotion in Wallonia. The 'ecosystem' trope is also linked to another trope that helps to rebuild the sociotechnical imaginaries of AI in the Walloon Region, the "critical mass". As many Walloon AI stakeholders consider that they are too small to compete in the global market, they call for the emergence of Walloon 'big players' that would strive to first position themselves at the European level and then reach international markets. Building a "critical mass" is seen as the key to generating Walloon champions that are able to compete at the European level (interview 13), that is, companies that grow drastically while continuing to create value in Wallonia. The "critical mass" is also considered an obligatory stage in establishing a virtuous cycle of business initiatives. Finally, the combination of a thriving "ecosystem" and of a "critical mass" of entrepreneurial AI users is seen as a necessity to "put Wallonia on the map", which constitutes a widely shared trope as well. These tropes also convey the general idea that AI adoption is a crucial competitiveness tool for Wallonia's "recovery".

The evolution of the Walloon AI sociotechnical imaginary

To become a sociotechnical imaginary, the desirable futures must spread outside of their 'native' collective, outside the technological vanguard they arose from. Then, the imaginary needs to be entrenched in the socioeconomic and material infrastructure of a community to conquer the imagination of its inhabitants (Jasanoff, 2015b: 326). This embedding (Jasanoff, 2015b) is often achieved through the building of artefacts such as genetically modified crops, a rocket, or a power plant, but can also rest on legal instruments or on the "relative hardness of long-entrenched cultural expectations and interpersonal relations" (Jasanoff, 2015b: 326). The next sections examine the threefold embedding of the Walloon AI sociotechnical imaginary in the Region's post-industrial culture, AI software and widely promoted use cases.

Interconnectedness with the Walloon master narrative

The sociotechnical imaginary of AI in Wallonia is embedded in the socioeconomic identity of the Region: AI promoters connect their discourse on the necessity to adopt AI in Walloon companies to the possibility of reindustrialisation after decades of company offshoring. This subsection shows how the AI sociotechnical imaginary is being embedded in the Region's culture, especially through its connection to the Walloon master narrative of "recovery". Van Oudheusden et al. (2017) brought attention to the "catching-up" narrative that goes along with the promotion of a knowledge-based economy for Wallonia. They underlined that Walloon stakeholders use a discursive repertoire that revolves around the idea of economic recovery when pleading for the advent of a Walloon knowledge-based economy, as illustrated by the name of the "Marshall Plans" themselves (Van Oudheusden et al., 2017: 186). This prominent repertoire is based on the belief that the Walloon Region could recover from the economic hardship it has been facing since its massive deindustrialisation in the 1960s, and even "catch up" with Flanders. Macq (2021) showed that this "recovery" narrative, which he considers to be the Region's sociotechnical imaginary, is reflected in its collaborative innovation oriented towards specific economic sectors considered to be strategic for Wallonia's development. The goal of the participatory events he analysed with Delvenne is indeed to spur the introduction of new products to the market and to stimulate entrepreneurial projects (Delvenne and Macq, 2020).

This "recovery" narrative, which draws on Wallonia's industrial past and is central to AI promotion, is framed here using the concept of 'master narrative'. Originating from Lyotard's (1979) work on what he called metanarratives, the concept of 'master narrative' refers to the collective cultural framework that provides guidance for individuals' daily lives based on the group's perception of itself. A master narrative provides answers to the questions, "Of what story or stories do I find myself a part?" (sic) and "What am I to do?" (MacIntyre, 2007: 231 cited by Halverson et al., 2011). The Walloon Region rests on its socioeconomic history. Wallonia was one of the world's

most prosperous Regions in the nineteenth and early twentieth centuries. At the end of the Second World War, its coal and metal industries collapsed, and it experienced an economic downturn. A "recovery" narrative emerged, transforming the reconstruction of the Region's economy into a political priority. This master narrative has been pushed since the 1960s in the context of the Walloon Movement (Mouvement Wallon), a political movement that had arisen decades earlier in reaction to the Flemish claims for more political autonomy based on their cultural difference. Nevertheless, Wallonia's economic decline redirected the Walloon movement to socioeconomic matters. The Fédération Générale du Travail de Belgique (General Federation of Labour in Belgium), a leftist labour union, played a key role in the rise of the movement, and particularly its iconic leader, André Renard. The latter demanded increased political decentralisation to enhance Wallonia's ability to deal with its economic difficulties and to adopt its own social policies. From this point, the original ambition of the movement to promote the Walloon culture had been sidelined for the benefit of socioeconomic demands (Joris, 1999). The first reform of the state (1970) created the Regions and their economic framework. The following reforms broadened and deepened the regions' jurisdiction over economic and territorial matters. To deal with the economic bleeding, the Walloon government announced a "Contrat d'avenir pour la Wallonie" (Deal for the Future of Wallonia) in 2000, followed in 2006 by the first of the four versions of the "pla, Marshall plan"^{ix} (Marshall plan), whose denomination marks the continuous attention that has been given to the Region's "economic recovery". The first "Marshall plan" created the Pôles de compétitivité (Competitiveness clusters) and paved the way to a long-term strategy of economic specialisation aimed at increasing Wallonia's competitiveness and ultimately its industrial performance.

While Wallonia's master narrative of "recovery" played a crucial role in the regionalisation of Belgium, the situation has since evolved. Although the 2014 Walloon policy statement asserts that "[with the sixth reform of the state] Wallonia finally has the full range of levers required for its full economic, social and human develop-

ment" (Parlement wallon, 2014: 6), Wallonia's economic performance does not look to be in line with its ambitions. Walloon leaders, as far as they are concerned, have stopped pursuing more autonomy for their region. In his 2022 speech on the state of Wallonia (Parlement wallon, 2022), Minister-President Elio Di Rupo encouraged members of parliament "(...) to intensify the current momentum and to become more ambitious for Wallonia", claiming that "this is how [they] will restore hope to the women and men of Wallonia". He concluded his speech asserting that "Wallonia will make it" (Parlement wallon, 2022). It seems that the political elite no longer respond to the frustrating feeling of a declining Wallonia with regionalist demands. Instead, they focus on promoting of technology adoption as a way rebuild a strong economy in the Region. The recovery narrative remains prominent in discourses on the Region's economy, and perceptible in the Government's communication (Parlement wallon 2014; Parlement wallon, 2016; Parlement wallon, 2019; Parlement wallon, 2022 among others), but it takes flesh in the promotion of a 'knowledge-based economy' (Van Oudheusden et al., 2017) and of a 'creative economy' (Macq, 2018: 10) which are supposed to restore the Region's prosperity. This transition is still underway, but can clearly be seen in the words of former Walloon MP and current federal Deputy Prime Minister Pierre-Yves Dermagne:

Our regionalism is not romantic, we do not wake up humming Li Bia Bouquet [Namur's official song] or the Song of the Walloons. Our regionalism is realistic and pragmatic: Wallonia has run out of black gold or coal, so it must rely on grey matter (Radio télévision belge francophone, 2015).

No later than 18 June 2022, socialist party leader Paul Magnette asserted for his part that "(...) for us [socialists], things are clear: a seventh state reform in 2024 is neither necessary nor desirable. Because Wallonia has the necessary powers to work on its recovery, unlike in the past" (Coppi, 2022).

It appears that the sociotechnical imaginary of AI has been incorporated into the technological facet of the Walloon master narrative. The tropes of reindustrialisation and competitiveness are

omnipresent in AI promotion, which shows that technology is framed as an opportunity to restore the Region's economic position and prosperity. AI is part of this potential 'technological turn' in the discursive construction of the Region's identity. Moreover, the embedding of the AI sociotechnical imaginary into Wallonia's culture reinforces, and is reinforced by, AI adoption in Walloon industries, research centres and public service. Nevertheless, the AI sociotechnical imaginary does not rest only on deep historical and cultural foundations. It is also embedded more tangibly in software and AI use cases.

Digital Wallonia 4.ai's "artefacts": Start, Tremplin, Cap IA and TRAIL's "software bricks"

The main outputs of DigitalWallonia.4ai include proposals stemming from Start IA projects, the Tremplin IA proofs of concept and AI products commercialised thanks to Cap IA (DigitalWallonia.4ai, 2022). These programmes are indeed the core of DigitalWallonia.4ai (interviews 2, 3). The Start IA and Tremplin IA programmes are available to all Walloon-based companies regardless of their size, digital maturity, and sector (Digital Wallonia, 2021b). What is more, they have now been made available to associations and public institutions. As soon as those organisations benefit from one of these programmes, the AI imaginary they convey will become embedded in their organisation and processes. The vision of the Walloon Region promoted by the Digital Agency, its partners and Digital Champions is realized through the software produced. Likewise, the AI products that are generated by Cap IA programmes materialise the imaginary. These products travel on the Belgian, European, and global markets thus symbolising the Region's ambition to "put [itself] on the [AI] map". This ambition is in fact shown to field actors and commodified.

TRAIL also contributes to the materialisation of the AI imaginary, steering it towards a more research-oriented focus. TRAIL produces, through its "Factory", a set of "software bricks" intended to be directly exploited by Walloon companies and to trigger an increase in industrial competitiveness. These bricks, meant to be used all around the Region, may be similar to the artefacts in which other sociotechnical imaginaries are embedded,

yet they travel more easily, thereby reinforcing the AI imaginary.

Interestingly, the software produced by Walloon AI public programmes is used as a banner that the Digital Agency, its partners and TRAIL fly to promote their programmes and perspective on AI development. The next subsection focuses on this trend by using the case of a specific company, Fernand Georges.

AI use cases as translators

The Digital Agency and its partners never fail to mention the Start IA, Tremplin IA and Cap IA programmes when promoting the Walloon AI strategy (Borsus, 2022; interview 5). In addition to the promotion of the programmes themselves, use cases are proudly brought up during public events, in the media and in workshops aimed at professionals. Agoria presents “inspiring” and “spectacular” use cases during events such as the “AI Inspiration Sessions” (Agoria, 2022) and “Carrefours de l’IA” (AI Crossroads), organised under DigitalWallonia.4ai. These monthly webinars include the presentation of AI use cases in the Walloon Region, as well as research results (Digital Wallonia, 2022). When it comes to the companies that have already benefited from Start IA, Tremplin IA and Cap IA, Julie de Bergeyck and Antoine Hublet asserted in an interview that “[they] are grateful to these pioneers who will hopefully inspire many other stakeholders to participate. Today, the ambition is to continue and accelerate together the process of digital transformation of Walloon-based companies through the integration of AI technologies” (De Bergeyck, 2021). Lisa Lombardi, digital expert for the Union Wallonne des Entreprises (Walloon Business Union - UWE), affirmed similarly that “We need ambassadors, digital success stories” (Connect, 2021). This focus on the exhibition of cases in which companies are considered to have used AI in an innovative and successful way led to the creation of Digital Wallonia Champions, whose first mission is to “promote digital technology and its uses” (Digital Wallonia, 2019b: 33). Those “Champions”, selected for their experience in AI projects, are in a sense living embodiments of the Walloon AI imaginary.

Fernand Georges, a Walloon-based hardware store, is a striking example of the role of use

cases in the Walloon sociotechnical imaginary of AI. The company developed an AI model with B12 Consulting in the context of a Tremplin IA project called “UnlockAI”. A picture is all the AI model needs in order to automatically design a lock that fits with the one to be replaced (Agoria, 2021). When discussing the Region’s AI strategy, a surprisingly high number of AI promoters mention this company to support their claims (interviews 2, 5, 6, 8). Those AI promoters insist on how novel this AI application is, as evidenced by the title of a press article on Walloon AI startups: “AI at the service of a hardware store!” (Lovens, 2021a). Their emphasis on surprise could be meant to encourage other small and medium-size companies to adopt AI, and more importantly to stress that Walloon-based companies can enhance their processes regardless of their economic sector, as the following extracts show:

Or almost everywhere, it’s... so just in all these societal challenges, it already brings a lot. And then, at the level of companies too, whatever the sector, I suppose you’ve seen the often-mentioned use case of this Walloon SME, hardware, right? It can really be found at all levels of the company (...)
(interview 5).

Some AI promoters also underline the age of Fernand Georges, titling “Fernand Georges, a *century-old* hardware store, embraces AI with B12 Consulting” (our emphasis) (Agoria, 2021) or asserting that “[AI is adopted] in a field like hardware, which means that it can be used in any field, since ironmongery is a very old trade” (interview 6). They mention competitiveness as well, stating that Fernand Georges would not be able to survive without digital transformation given the harshness of the market (interview 2).

The example of Fernand Georges symbolises the way the Walloon AI sociotechnical imaginary is embedded in use cases and their dissemination. Fernand Georges and the ones mentioned on DigitalWallonia.4ai and its partners’ websites, in the media, and during webinars translate (Callon, 1984) the ambitions of the Region’s AI policy into an entrepreneurial discourse that is spread easily across the world of small- and medium-size Walloon companies. Novel AI use cases are then reported straightforwardly in the media.

Conclusion

This paper examined the components of the Walloon AI sociotechnical imaginary, along with its evolutions, in a bid to answer the main research question: how does the promotion of AI adoption coproduce (Jasanoff, 2004) the identity of the Walloon Region?. It established that this imaginary stems from the combination of an entrepreneurial vanguard vision, the Walloon Digital Agency's ambition to fill a gap in its missions, and multilevel political pressure exerted by the EU and the Federal State. The AI Network played a decisive role in the implementation of Wallonia's AI strategy. It gathered small and medium-size companies willing to contribute to the promotion of AI in the Region and convinced the Digital Minister to adopt a Walloon AI policy. In parallel, the digital agency's managers struggled to start an AI programme, as its inexistence was considered a weak spot in their institutional projects. Moreover, having adopted the "Coordinated Plan on Artificial Intelligence" (European Commission, 2018), the EU required member states to adopt their own AI policies. The entrepreneurial origin of the AI Network was reflected in the composition of DigitalWallonia.4ai's steering committee. DigitalWallonia.4ai is structured around four axes, among which the second one, which focuses on support for businesses, clearly stands out. This support consists of three programmes: Start IA, Tremplin IA and Cap IA. The Walloon AI imaginary is publicly performed through the brand DigitalWallonia4.ai, which corresponds to the name of the programme. The brand gives visibility to the strategy and aims at enrolling new companies in its three programmes and drawing international visibility to the Walloon strategy. Besides, the network of Digital Champions sustains the branding effort through an 'evangelising' effort and the promotion of use cases.

The identification of several tropes during the analysis of interviews and document data enabled the reconstruction of the desirable futures at the heart of the sociotechnical imaginary. In this envisioned future, Walloon-based companies massively adopt AI and trigger a virtuous economic circle that may foster the Region's "recovery". These results corroborate Bareis and Katzenbach's (2021), Kim (2023) and

Köstler and Ossewaarde's (2020) findings in so far as the desirable future sustained by the Walloon AI sociotechnical imaginary combines ubiquitous characteristics of AI imaginaries and idiosyncratic features, i.e. features dependent on the Region's history and culture. The tropes of AI as a "train we can't miss" and of competitiveness align with the usual framing of AI narratives in national strategies (Bareis and Katzenbach, 2021; Ciuriak et al., 2022; Köstler and Ossewaarde, 2020). In Wallonia, AI adoption is seen by the political and economic elite as an inevitable technological development which needs to be harnessed in an effective way for the Region's development. The competitiveness trope, associated with the perceived necessity of AI adoption, stems from the supposedly inescapable development of AI. However, the competitiveness trope is also inseparably connected to Wallonia's history and the idiosyncratic reindustrialisation trope. AI is seen as an asset to rebuild the Region's prosperity through an increase in productivity which will be beneficial to its industries, particularly in strategic economic sectors Wallonia has been invested in since the beginning of the twenty-first century. AI is envisioned as a powerful tool to deepen this specialisation in strategic sectors, as the trope of the 'critical mass' proves as well. This trope embodies the imagined position that Wallonia could take in global markets by using cutting-edge technology such as AI. The 'critical mass' is associated with the last two tropes of the AI imaginary. The 'ecosystem' is framed as a prerequisite to the emergence of actors able to reach a 'critical mass'. It involves the gathering of heterogeneous actors from both the private and public actors. Finally, AI should "put Wallonia on the map" by taking advantage of the Region's strong research base and the emergence "big players" in AI, supported by proactive public funding.

The interpretive character of this study permitted to highlight the embedding of the AI imaginary in the Region's master narrative of economic "recovery", that has been pushed by the rise of the Walloon Movement since the 1960s. AI is deemed necessary to straighten out the economy and seems to embody the technological turn of the Walloon master narrative, with a political elite now more enthusiastic to promote cutting-edge

technology adoption than further regionalisation. These results reinforce Van Oudheusden et al's (2017) and Macq's (2018) findings on the discursive salience of technology in the Region's "recovery" narrative. Further research should explore how this "turn" is manifested through the promotion of other technologies in the Region. It should also pay close attention to the way citizens contribute to building sociotechnical imaginaries in relation to this narrative or not. However, research on regional identity always bears the risk of essentialising it (Paasi, 2011: 14) due to its performativity. It is important, therefore, to stress that the Walloon identity, which is coproduced with the promotion of technology, is neither disembodied nor stable. On the contrary it is constructed on a daily basis, and even the Walloon "recovery" master narrative may fade eventually if Walloons were to change the perception of their history and culture. In addition to this cultural embedding, use cases, as well as software developed within DigitalWallonia.4ai's programmes, proved to be crucial in this process. They are embodiments of the imaginary and disseminate it in the Region through business events and the programme's marketing campaigns. The case of Fernand Georges illustrated this process and the ability of use cases to gather a wide range of stakeholders by translating the imaginary into examples that travel straightforwardly. These uses cases reinforce the strength of the Walloon network of AI promoters and the imaginary it sustains.

As concerns methodology, using semi-structured interviews alongside the traditional analysis of policy documents proved valuable. It was especially relevant to rebuild the imaginary's desirable futures through the identification of tropes used by the interviewees and by stakeholders of the Walloon AI sector. This approach also enhanced the accuracy of the analysis since the interviews provided additional information from stakeholders themselves. Moreover, the wide range of data sources and types permitted a strong triangulation of the results. Nonetheless, this paper focused on Walloon AI 'big players' during the data collection period and did not explore the way 'average' Walloon citizens envision AI. Further research addressing the coproduction of regional identities and AI imaginaries from citizen perspectives would be complementary to the approach adopted here.

Acknowledgements

This contribution has been awarded the David-Constant Medalist Prize 2022. This prize is granted to a scientific contribution written within the year following its proclamation by the recipient of the David-Constant Medal. This medal recognizes the best student in law, political science, or criminology for their overall academic performance throughout their studies at the Faculty of Law, Political Science, and Criminology of the University of Liège.

References

- Angelo H and Vormann B (2018) Long waves of urban reform: Putting the smart city in its place. *City* 22(5-6): 782-800.
- Bareis J and Katzenbach C (2021) Talking AI into being: The narratives and imaginaries of national AI strategies and their performative politics. *Science, Technology, & Human Values* 47(5): 855-881.
- Boddington P (2023) *AI ethics: a textbook*. Singapur: Springer Nature.
- Borsus W (2022) Presentation of Willy Borsus [conference session]. L'IA et le monde d'aujourd'hui. N-HiTec, Liège, 28 March.
- Callon M (1984) Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. *The sociological review* 32(1): 196-233.
- Ciuriak D, Ptashkina M and Rodionova V (2022) The technology nexus of AI. In: Osler Hampson F and Narlikar M (eds) *International Negotiation and Political Narratives: A Comparative Study*. London: Routledge, pp. 119-136.
- Cath C, Wachter S, Mittelstadt B, Taddeo M and Floridi L (2018) Artificial intelligence and the 'good society': the US, EU, and UK approach. *Science and engineering ethics* 24(2): 505- 528.
- Coppi P (2022) Paul Magnette: "Une septième réforme de l'Etat n'est ni nécessaire ni souhaitable". *Le Soir*, 18 June. Available at: <https://www.lesoir.be/449146/article/2022-06-18/paul-magnette-une-septieme-reforme-de-letat-est-ni-necessaire-ni-souhaitable> (accessed 25.6.2022).
- Delvenne P and Macq H (2020) Breaking bad with the participatory turn? Accelerating time and intensifying value in participatory experiments. *Science as Culture* 29(2): 245-268
- Dujardin C, Lefebvre P, Lefèvre, M, Louis V and Vanderkelen F (2017) L'évaluation des pôles de compétitivité wallons: méthodes, résultats et mise en perspective européenne. *Courrier hebdomadaire du CRISP*, 2339-2340: 5-78.
- European Commission (2018) Coordinated Plan on Artificial Intelligence, *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions*, COM(2018) 795. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018DC0795> (accessed 23 April 2022).
- European Commission (2021) Fostering a European approach to Artificial Intelligence, *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions*, COM(2021): 205. Available at: https://eur-lex.europa.eu/legal-content/FI/ALL/?uri=CONSIL:ST_12778_2021_REV_1 (accessed 12 February 2025).
- Gouvernement wallon (2014) Déclaration de Politique Régionale, Oser, Innover, Rassembler. 20 (SE 2014) - N° 1. Available at: http://nautilus.parlementwallon.be/Archives/202124_2014/DPR/20_1.pdf (accessed 25 March 2022).
- Gouvernement wallon (2021) Stratégie de Spécialisation Intelligente de la Wallonie (S3) : Une Wallonie innovante, compétitive, collaborative, au service d'ambitions économiques et sociétales affirmées. Available at: https://economie.wallonie.be/sites/default/files/Strategie%20de%20spécialisation%20intelligente%20de%20la%20Wallonie%202021-2027%20%28S3%29%20-%20Mars%202021_.pdf (accessed 29 April 2022).
- Halverson J, Corman S and Goodall HL (2011) *Master narratives of Islamist extremism*. New York: Palgrave Macmillan.
- Haraway D (1989) *Primate visions: gender, race, and nature in the world of modern science*. New-York: Routledge.
- Hermann I (2021) Artificial intelligence in fiction: between narratives and metaphors. *AI & Society* 38(1): 1-11.

- Hilgartner S (2015) Capturing the imaginary. In: Hilgartner S, Miller C and Hagendijk R (eds) *Science and democracy: making knowledge and making power in the biosciences and beyond*. London: Routledge, pp. 33-55.
- Hockenull, M and Cohn ML (2021) Hot air and corporate sociotechnical imaginaries: Performing and translating digital futures in the Danish tech scene. *New Media & Society* 23(2): 302-321.
- Jasanoff S (2004) The idiom of co-production. In: Jasanoff J (ed) *States of Knowledge: The co-production of science and social order*. London: Routledge, pp. 24-56.
- Jasanoff S (2015a) Future Imperfect: Science, Technology, and the Imaginations of Modernity. In: Jasanoff J and Kim SH (eds) *Dreamscapes of modernity*. Chicago: University of Chicago Press, pp.1-33.
- Jasanoff S (2015b) Imagined and Invented Worlds. In: Jasanoff J and Kim SH (eds) *Dreamscapes of modernity*. Chicago: University of Chicago Press, pp. 321- 342.
- Jasanoff S and Kim SH (2009) Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea. *Minerva* 47(2): 119-146.
- Joris P (1999) Les projets fédéralistes wallons. In: Busquin P, Collignon R and Destatte P (eds) *L'idée fédéraliste dans les États-nations : regards croisés entre la Wallonie et le monde*. London: Presses interuniversitaires européennes, pp. 253-259.
- Katzenbach C (2021) "AI will fix this" –The Technical, Discursive, and Political Turn to AI in Governing Communication. *Big Data & Society* 8(2): 1-8.
- Kim J (2023) Traveling AI-essentialism and national AI strategies: A comparison between South Korea and France. *The Review of Policy Research*, 40(5): 705–728.
- Köstler L and Ossewaarde R (2022) The making of AI society: AI futures frames in German political and media discourses. *AI & society* 37(1): 249-263.
- Kövecses Z (2023) Metaphor and Discourse. In: Gee JP and Handford M (eds) *The Routledge Handbook of Discourse Analysis*, London: Routledge, pp.170-183.
- Lakatos I (1976) Falsification and the methodology of scientific research programmes. In: Harding SG (ed) *Can theories be refuted? Essays on the Duhem-Quine Thesis*. Dordrecht: D. Reidel Publishing Company, pp. 205-259.
- Leboutte R, Puissant J and Scuto D (1998) Du "miracle belge" au "déclin wallon". In: Leboutte R, Puissant J and Scuto D (eds.) *Un siècle d'histoire industrielle (1873-1973): Belgique, Luxembourg, Pays-Bas, industrialisation et sociétés*. Paris: Sedes, pp.195-241.
- Lovens PF (2021a) Intelligence artificielle: la Wallonie est-elle en retard? Les start-up montrent la voie à suivre. *La Libre*, 15 October. Available at: <https://www.lalibre.be/economie/entreprises-startup/2021/10/15/intelligence-artificielle-la-wallonie-est-elle-en-retard-les-start-up-montrent-la-voie-a-suivre-OO5FZE7D4ZCP-DA224XSYRPJTAI/> (accessed 20 April 2022).
- Lovens PF (2021b) Le moment est venu d'amplifier les actions en faveur de l'IA. *La Libre*, 17 October. Available at: <https://www.lalibre.be/economie/entreprises-startup/2021/10/17/le-moment-est-venu-damplifier-les-actions-en-faveur-de-lia-ZRQZCCP6E5DKZH7CIEDDO2P3V4/> (accessed 21 April 2022).
- Liotard JF (1979) *La condition postmoderne : rapport sur le savoir*. Paris : Éditions de Minuit.
- Macq H (2018) *Co-crée, pour quoi? Justifications et imaginaires sociotechniques sous-tendant une nouvelle vague de participation publique en sciences et technologies* [communication]. Journées Doctorales sur la Participation du Public et la Démocratie Participative Tours.
- Markham A (2021) The limits of the imaginary: Challenges to intervening in future speculations of memory, data, and algorithms. *New media & society* 23(2): 382-405.
- Paasi A (2011) The region, identity, and power. *Procedia-Social and Behavioral Sciences* 14: 9-16.

- Paltiel G (2021) The political imaginary of National AI Strategies. *AI & society* 37(4): 1613- 1624.
- Parlement wallon (2014) Déclaration de politique Régionale, “oser, innover, rassembler”. 20 (SE 2014) — N° 1. Available at: http://nautilus.parlement-wallon.be/Archives/2014_2014/DPR/20_1.pdf (accessed 4 April 2022).
- Parlement wallon (2016) Déclaration de Politique Régionale, “La Wallonie plus forte”. 880 (2016-2017) - N° 1. Available at: http://nautilus.parlementwallon.be/Archives/2016_2017/DPR/880_1.pdf (accessed 3 April 2022).
- Parlement wallon (2019) Déclaration de Politique Régionale 2019-2024. 34 (2019-2020) - N°1. Available at: http://nautilus.parlement-wallon.be/Archives/2019_2020/DPR/34_1.pdf (accessed 2 April 2022).
- Parlement wallon (2022) Discours de M. le Ministre-Président Di Rupo sur l'état de la Wallonie. Available at: http://nautilus.parlement-wallon.be/Archives/2021_2022/CRI/cri22.pdf (accessed 5 April 2022).
- Rieder G (2018) Tracing big data imaginaries through public policy: the case of the European Commission. In: Saetnan AR, Schneider I and Green N (eds) *The Politics of Big Data*. London: Routledge: pp. 89-109.
- Radio télévision belge francophone (2015) Poussée régionaliste au PS: tout le monde n'est pas du même avis. Radio télévision belge francophone, 21 October. Available at: <https://www.rtbef.be/article/poussee-regionaliste-au-ps-tout-le-monde-n-est-pas-du-meme-avis-9113695> (accessed 21.4.2022).
- Rudek TJ (2022) Capturing the invisible. Sociotechnical imaginaries of energy. The critical overview. *Science and Public Policy* 49(2): 219-245.
- Sadowski J and Bendor R (2019) Selling smartness: Corporate narratives and the smart city as a sociotechnical imaginary. *Science, Technology, & Human Values* 44(3): 540-563.
- Smith E (2009) Imaginaries of development: The Rockefeller Foundation and rice research. *Science as Culture* 18(4): 461-482.
- Van Oudheusden M, Charlier N and Delvenne P (2017) Flanders Ahead, Wallonia Behind (But Catching Up): Reconstructing Communities Through Science, Technology, and Innovation Policy Making. *Bulletin of Science, Technology & Society* 37(4): 185-198.

Notes

- ii Identities are one of the “four main sites of coproduction” investigated by the contributors of the “States of Knowledge” (Jasanoff, 2004: 6).
- iii Question of M-M. Schyns of 5 November 2021, C.R.I.C., Walloon Parliament, 2021-2022, n°116.
- iii Question of M-M. Schyns of 5 November 2021, C.R.I.C., Walloon Parliament, 2021-2022, n°116.
- iv See also Question of E. Lomba of 5 November 2021, C.R.I.C., Walloon Parliament, 2021-2022, n°117; Question of M. Hardy of 12 March 2021, C.R.I.C., Walloon Parliament, 2021-2022, n°310; Question of M-M. Schyns of 17 November 2021, C.R.I.C., Walloon Parliament, 2021-2022, n°64; Question of J. Kampopole, C.R.I.C., Walloon Parliament, 2019-2020, 11 October 2020, n°17, p. 20; Question of E. Fontaine, C.R.I.C., Walloon Parliament, 2016-2017, 2 May 2017, n°163, p. 41.
- v The Grappes technologies were set up after the release of the Prométhée project (1998-2000), which consisted in an assessment of innovation fields in Wallonia, supported by the European fund of regional development.
- vi Décret wallon du 18 janvier 2007 relatif au soutien et au développement des réseaux d’entreprises ou clusters, *Moniteur belge*, 9 février 2007 ; Arrêté d’application du gouvernement wallon du 16 mai 2007, *Moniteur belge*, 13 juin 2007.
- vii Décret-programme du 23 février 2006 relatif aux actions prioritaires pour l’avenir wallon, *Moniteur Belge*, 7 mars 2006.
- viii ARIAC is also part of Wallonia’s economic specialisation strategy as it is aimed at strengthening the position of Walloon companies in specific sectors.
- ix Décret-programme du 23 février 2006 relatif aux actions prioritaires pour l’avenir wallon, *Moniteur Belge*, 7 mars 2006.

Appendix 1. Websites part of the corpus

Institution	year	Page title	url	Accessed
Agence du numérique	2021	Industrie du Futur : bilan et actions	https://www.digitalwallonia.be/fr/publications/industrie-du-futur-home/	10 April 2022
Agence du numérique	2022	Missions	https://www.adn.be/fr/missions	2 May 2022
Agoria	2020	La Wallonie retrouvera son ADN historique en mariant numérique et industrie	https://www.mynewsdesk.com/fr_be/agoria/pressreleases/la-wallonie-retrouvera-son-adn-historique-en-mariant-numerique-et-industrie-3099754	28 April 2022
Agoria	2021	Fernand Georges, quincaillerie centenaire, se lance dans l'IA grâce à B12 Consulting	https://www.agoria.be/fr/digitalisation/intelligence-artificielle/fernand-georges-quincaillerie-centenaire-se-lance-dans-lia-grace-a-b12-consulting	24 April 2022
Agoria	2021	DigitalWallonia4.AI fête ses 2 ans : toute entreprise doit se poser la question d'intégrer l'IA dans son business	https://www.agoria.be/fr/digitalisation/intelligence-artificielle/digitalwallonia4ai-fete-ses-2-ans-toute-entreprise-doit-se-poser-la-question-dintegrer-lia-dans-son-business	5 April 2022
Agoria	2022	L'intelligence artificielle? Une évidence!	https://www.agoria.be/fr/services/expertise/digitisation/intelligence-artificielle/lintelligence-artificielle-une-evidence	14 May 2022
Connect	2021	Compte-rendu de l'intervention, " Il nous faut des ambassadeurs, des success stories du numérique"	https://ready-to-connect.be/lisa-lombardi/	12 May 2022
Digital Wallonia	2018	Digital Wallonia. Marque de la Wallonie Numérique	https://www.digitalwallonia.be/fr/publications/marque-digital-wallonia/	15 April 2022
Digital Wallonia	2019	DigitalWallonia4.ai : l'intelligence artificielle au service des citoyens et des entreprises en Wallonie	https://www.digitalwallonia.be/fr/publications/digitalwallonia4ai-service-citoyens-entreprises/	17 April 2022
Digital Wallonia	2019	Digital Wallonia bilan 2015-2018, vision et actions 2019-2024	https://content.digitalwallonia.be/post/20190626100319/Bilan-strategique.pdf	4 April 2022
Digital Wallonia	2019	Devenir Digital Wallonia Champion	https://www.digitalwallonia.be/fr/publications/devenir-digital-wallonia-champion/	17 April 2022
Digital Wallonia	2019	Thibaut Claes	https://www.digitalwallonia.be/fr/personnes/thibaut-claes/	18 April 2022
Digital Wallonia	2019	Thierry Geerts	https://www.digitalwallonia.be/fr/personnes/thierry-geerts/	5 April 2022
Digital Wallonia	2020	Découverte des lauréats de la seconde édition Tremplin IA POC's individuels	https://www.digitalwallonia.be/fr/publications/dw4ai-tremplin-ia-2/	5 April 2022

Institution	year	Page title	url	Accessed
Digital Wallonia	2020	10 projets d'intelligence artificielle retenus pour le premier appel Tremplin IA	https://www.digitalwallonia.be/fr/publications/10-projets-tremplin-ia/	23 April 2022
Digital Wallonia	2021	DigitalWallonia4.ai : bilan et actions	https://www.digitalwallonia.be/fr/publications/digitalwallonia4-ai-home	26 April 2022
Digital Wallonia	2021	DigitalWallonia4.ai : le 3ème appel à candidatures Tremplin IA	https://www.digitalwallonia.be/fr/publications/dw4ai-tremplin-ia-3/	19 April 2022
Digital Wallonia	2021	Intelligence artificielle et industrie 4.0 , un écosystème riche en Wallonie,	https://www.digitalwallonia.be/fr/publications/intelligence-artificielle-industrie-40/	6 March 2024
Digital Wallonia	2022	Les Carrefours de l'IA - l'IA, l'économie circulaire et durable	https://www.digitalwallonia.be/fr/agenda/carrefours-ia-economie-circulaire/	18 March 2022
digitalwallonia4.ai	2022	Indicateurs	https://digitalwallonia4.ai/#entreprises-resultats	22 June 2022
Infopôle Cluster TIC	2022	Infopôle	https://clusters.wallonie.be/infopole/fr	18 April 2022
Kiwix	2018	Thelis SA Et Plusieurs Entreprises Wallonnes Lancent Le "Réseau IA", Collectif Entrepreneurial Wallon Consacré À L'intelligence Artificielle	https://www.kiwix.be/news/23/55/Thelis-SA-et-plusieurs-entreprises-wallonnes-lancent-le-reseau-ia-collectif-entrepreneurial-wallon-consacré-à-l-intelligence-artificielle	19 March 2022
Regional IT	2021	Jean-Philippe Parmentier prend les commandes de l'Infopole Cluster TIC	https://www.regional-it.be/2021/03/11/jean-philippe-parmentier-prend-les-commandes-de-infopole-cluster-tic/	21 March 2022
Service public de Wallonie	2021	Le gouvernement valide le projet ARIAC pour une intelligence artificielle de confiance	https://economie.wallonie.be/content/le-gouvernement-de-wallonie-valide-le-projet-«-ariac-digitalwallonia4ai-»-pour-une	29 March 2022
Service public de Wallonie	No date	Favoriser le déploiement des technologies de l'industrie 4.0	https://www.wallonie.be/fr/plans-wallons/plan-de-relande-de-la-wallonie/projets/favoriser-le-dploiement-des-technologies-de-lindustrie-40	6 March 2024
Union Wallonne des entreprises	2021	Coup d'accélérateur pour l'IA en Wallonie	https://www.uwe.be/wp-content/uploads/2019/11/Article-IA.pdf	16 April 2022

Appendix 2. List of interviews

Interviewee #	Professional profile
1	Walloon Digital Affairs Minister
2	AI expert, DigitalWallonia.4ai
3	AI expert, DigitalWallonia.4ai
4	Infopôle Cluster TIC
5	Representative in the steer committee of DigitalWallonia.4ai; Digital Wallonia champion
6	Agoria Wallonia
7	Walloon public service (SPW), department of research; Digital Wallonia champion
8	Digital Expert, Walloon Business Union
9	TRAIL; Digital Wallonia champion
10	Director of the Belgian branch of an AI multinational company (GAFAM); Digital Wallonia champion
11	Manager of an AI consulting company
12	Manager of an AI consulting company
13	Digital expert, W.I.N.G. fund - SRIW
14	Pôle Mecatech; AI Network; Digital Wallonia champion

When Digital Health Encounters Regulation: The Approval Process for Prescription Apps in Germany

Carsten Horn

Department of Science and Technology Studies, University of Vienna, Austria/ carsten.horn@univie.ac.at

Ulrike Felt

Department of Science and Technology Studies, University of Vienna, Austria

Abstract

In late 2019, Germany took significant steps towards becoming a forerunner in digital health. A new legislation stipulated that medical apps for different indications could now be prescribed to patients by their healthcare providers – the so-called Digital Health Applications (DiGAs). Patients' public health insurance then covers the costs of these apps. The precondition for apps to be eligible for prescription and remuneration is that they undergo a prior approval process with the German Federal Institute for Drugs and Medical Devices. We take this transformation of an ordinary health app into a medico-legal product, a DiGA, as the point of departure for a detailed examination of the regulation of digital health in practice. Analysing the approval process for DiGAs allows us to generate insights into what qualities of apps are assessed and how it addresses the fluid ontology of digital apps. Based on regulatory documents and interviews with developers of Digital Health Technologies, we approach the approval as a multi-faceted process and provide two accounts that unpack the complexities digital health poses for regulation: (1) the re-negotiation of the boundary between health-related lifestyle and medical apps and (2) the tension between the dynamic developments of apps and the static nature of regulation. Drawing on Latour's legal sociology and the notion of reality tests developed by Boltanski and Thévenot, we argue that the approval process performs a two-fold ontological politics that transforms the ontology of both apps and regulation itself.

Keywords: Digital Health, Ontological Politics, Medical Apps, Regulation, Healthcare, DiGA

Introduction: The regulation of health-related digital apps

Similar to other healthcare systems, the German healthcare system faces significant challenges: high expenditures, an aging population with growing numbers of chronic diseases, fragmentation and shortages of healthcare provision, especially in rural areas and for mental health.

Responses to these challenges often focus on digital technologies (Blümel et al., 2020). Thus, Germany is not much different from other countries and regions, especially the European Union (EU) which promotes digital health – envisioned in the so-called European Health Data Space, for



*This work is licensed under
a Creative Commons Attribution 4.0
International License*

instance – as a panacea for healthcare (Felt, 2025; Lievevrouw et al., 2024). While situating itself in the context of such developments, Germany takes a somewhat independent approach, seeking to position itself as a forerunner rather than a follower. A novel legislation passed in late 2019 is particularly striking. It stipulates the introduction of digital apps into healthcare provision as part of the larger imaginary of a digitalised German healthcare system in which digital data collected by wearables and other sensors, telemedicine and electronic health records enable enhanced (cost-) efficiency, greater equity and an overall improved quality of more personalised healthcare. The Digital Health Applications (*Digitale Gesundheitsanwendungen, DiGAs*) are an important “building block” (Lauer et al., 2021) in this vision as these apps collect data and introduce digital(ised) therapies.

The new regulatory framework is envisioned to create “transparency, safety and reliability” (Lauer et al., 2021: 1195). It provides that Digital Health Applications can either be prescribed by healthcare providers (including psychological psychotherapists) – which has earned these apps the moniker ‘prescription apps’ (*Apps auf Rezept*) – or requested by insured persons directly from their insurance provider. This provision constitutes a partial departure from the traditional system where medical doctors were gatekeepers for prescription drugs. Similar to other prescriptions, however, the costs for DiGAs are then covered by statutory health insurance. In a healthcare system where insurance is mandatory for permanent residents and provided by public sickness funds, this means around 87% of the population (Blümel et al., 2020) are entitled to DiGAs¹.

To become eligible for remuneration by public sickness funds, apps need to undergo an approval procedure at the German Federal Institute for Drugs and Medical Devices (*Bundesinstitut für Arzneimittel und Medizinprodukte, BfArM*). They then become listed as DiGAs in the Digital Health Applications Directory (*DiGA-Verzeichnis*). At the time of writing in March of 2024, 62 apps are available for diverse conditions. These are sorted into twelve categories that range from mental health over metabolic diseases to physical injuries. Besides providing education, apps incorporate

therapy and treatment plans that often combine the tracking of habits or moods and exercises.

From a Science and Technology Studies (STS) perspective, health apps are noteworthy because they challenge established regulatory categories and procedures. On the one hand, they straddle the boundary between lifestyle technologies and medical devices (Lucivero and Prainsack, 2015). Regulating such apps then requires re-negotiating this distinction. On the other hand, their fluidity – the possibility of frequently and rapidly updating them – clashes with the relatively static nature of regulation, especially as “[c]urrent regulatory pathways were developed for traditional (hardware) medical devices” (Torou et al., 2022: 1; Bierbaum and Bierbaum, 2017; Diedericks, 2019). Therefore, as one of the first efforts to integrate digital apps into standard healthcare provision, the case of DiGAs can illuminate some of the challenges that digital (health) technologies pose to regulation. It harbors significant contributions to debates on digital health in STS and beyond. Thus far, critical scholars have concentrated on imaginaries or promises of digital health. Only more recently, practices of designing (e.g. Felt et al., 2023) and using (e.g. Jansky, 2023) digital health technologies have come into view. With few notable exceptions (e.g., Lievevrouw et al., 2022a; Marelli et al., 2020), the regulation of digital health has not been investigated in detail, however. This is surprising: Regulation is crucial in and for the development of digital health technologies. It mediates between imaginaries, design and use in ways that reshape our understanding of both digital health and regulation.

In this article, we set out to investigate this transformative encounter of digital health and regulation in the case of the regulation of DiGAs. The research question we pursue is *how specific ordinary health apps can become prescriptible and reimbursable Digital Health Applications*. Answering this question requires identifying (1) what qualities an app needs to possess to become a legal object in the sense of this regulation and teasing out (2) how the approval process addresses the fluidity of digital apps. We approach these questions through a conceptual lens that links Bruno Latour’s (2010) legal sociology with Luc Boltanski and Laurent Thévenot’s (1999)

notion of “reality tests.” While the former draws our attention to the ontological transition at stake in the regulation, the latter illuminates the organisation of the approval procedure and its underlying politics. We consequently argue that this procedure is a multi-faced reality test in which the BfArM assesses whether an app can become a legal object in the German healthcare system. To account for the rapid evolution of digital apps, the BfArM deploys four strategies. It (1) extends the requirements for approval to test the developer company; (2) intervenes in the development of the app from its earliest stages; (3) subsumes DiGAs under the established regulatory practices for pharmaceuticals; (4) and emulates the flexibility of apps in the regulatory framework.

We unfold our argument as follows. We begin by situating our research within the only just emerging scholarship on the regulation of digital health. In particular, we show that the rapid advancement of digital health has created challenges for regulation and scholarship at the same time. Previous STS research into regulation in the biomedical domain provides resources to consider these challenges. We then develop our conceptual framework and show how it helps to frame our case. After briefly presenting our methodology, we present the empirical findings of our research in two steps. We describe the qualities of DiGAs assessed in the approval process and then outline the four strategies sketched above. In conclusion, we discuss how our findings illustrate the co-emergence of digital health and regulation and reflect on the affordances of our conceptual framework.

Digital health, regulation and STS

Critical scholars of digital health have often approached their object of research as “first and foremost, a vision” (Wieser, 2019: 428; Petersen, 2019). More recently, scholarship has begun implementing Deborah Lupton’s (2014) call to move “beyond techno-utopia” and to interrogate lived, socio-material realities of digital health. Attending to regulation intersects both of these approaches. On the one hand, promissory discourses and their politics serve as the background of state-led initiatives to implement digital health technologies into healthcare systems (Geiger and Gross, 2017).

They go hand in hand with new understandings of health (Sharon, 2018), citizenship, and patienthood (Felt, 2025). On the other hand, regulatory requirements shape design practices that have to negotiate the different “layers” of regulation (Williams et al., 2018). For the situated realities of consumers of digital health, it also makes a difference if health apps are labeled as “medical,” a sort of “quality brand” (Lievevrouw et al., 2022a: 562; see also Geiger and Kjellberg, 2021), prescribed by healthcare providers, and remunerated by public health insurance.

Yet, the regulation of digital health has rarely been an object of detailed exploration. We can arguably attribute this gap to the slow emergence of regulation due to what we could call the dialectics of regulation and digital health. As Elisa Lievevrouw and colleagues (2022a) have shown, regulation in different sectors has created the conditions for the growth of digital health in the USA. It aims to settle the intricate ontology of digital health apps otherwise straddling the boundaries of consumption and medicine through its categories and institutional purviews (Geiger and Kjellberg, 2021; Lievevrouw et al., 2022b; Lucivero and Prainsack, 2015). In turn, however, digital technologies tend to quickly outgrow regulatory frameworks, leading to a situation where we could describe regulation as “lag[ging] behind a rapidly evolving digital health sector” and requiring adjustments both of regulation and of the identities of regulatory institutions (Diedericks, 2019: 66; Lievevrouw et al., 2022b; Marelli et al., 2020). The approval process for DiGAs allows us to explore this co-emergence of regulation and its object, as well as the provisions it makes to keep up with the development of digital technologies.

To investigate the regulation of digital health, we can draw inspiration from earlier STS scholarship on regulation in the biomedical domain. For instance, studies of the regulation of pharmaceuticals have debated the question of who shapes changes in regulatory frameworks: patient activism or the pharmaceutical industry (Davis and Abraham, 2011). The introduction of DiGAs is mainly embedded in a broader top-down strategy of the German Minister of Health at the time (Bandelow et al., 2020), as patients tradition-

ally had little clout in drug regulation in Germany (Daemmrich and Krücken, 2000). The other perspective – highlighting that the pharmaceutical industry uses different mechanisms to skew regulation in the direction of its (profit-)interests (Abraham and Davis, 2009; Davis and Abraham, 2011) – seems to have a better fit, given that the German regulatory model is based on a close collaboration between regulators, the medical profession and industry (Daemmrich and Krücken, 2000). However, if we explain regulation solely through its political economy, this may obscure regulators' potential influence on the companies. Understanding the politics of regulatory processes may thus require a different conceptual framework.

Studies on regulating medical devices direct our attention to the performativity of regulatory frameworks and their ontological import (Faulkner, 2009, 2012a, 2012b). Hybrid technologies such as tissue engineering that straddle the boundaries of pharmaceuticals and medical devices are particularly instructive examples. Here, policymakers and regulators have to decide whether to “break” or “stretch” existing frameworks that then reshape the ontologies of novel technologies (Faulkner and Poort, 2017). In this case, tissue engineering has been subsumed under categories and institutions of the regulations of pharmaceuticals in the EU (Faulkner, 2012b).

Conceptual framework

From the preceding literature review, we can draw two conclusions. First, attending to the ontological dimension of regulation is particularly important for technologies such as digital health that blur established boundaries. Regulation resolves this uncertainty in one way or another by establishing a clear distinction. Second, a more fine-grained perspective is necessary to understand how the approval procedure addresses the fluidity of DiGAs. Our conceptual framework incorporates these sensitivities by combining Latour's legal sociology and Boltanski and Thévenot's notion of reality tests.

Latour's legal sociology is suitable for addressing the ontology of regulation because it conceives the law as a practice that enables a particular way of being, a “mode of existence”

(Latour, 2013) that shapes how an entity relates to other entities. In his ethnography of the Conseil d'État, Latour (2010) describes, for instance, how a meteorological map produced by scientists becomes a piece of evidence in legal proceedings. In this view, at the center of the law is the work of “grounding” (van Dijk, 2015: 178), bringing an entity – in our case, a DiGA – into a stable legal position. Legal practitioners who engage in grounding seek to create durable relations between an extra-legal entity and legal texts through which this entity obtains legal relevance. This does not mean they simply subsume the entity under the legal provisions (Latour, 2010; Lezaun, 2012). Instead, a resonance has to be created between them. This is important because it means that we cannot simply identify the regulatory requirements for DiGAs but have to investigate what enables the resonance between an ordinary health-and-wellness app and these requirements.

“Value objects” (Latour 2010: 127f.) mediate between the statements of the law and the entities involved in a legal case. The notion of ‘value objects’ is borrowed from semiotics, where this concept refers to what animates the relations among actors of a plot by transporting values between them. In a similar way, value objects animate, shape, and mediate the communication between an entity and legal texts. Legal practitioners seek to extract and align value objects from the encounter between the entities in question in a legal process and the relevant legal text. They propose a (fragile) sequence of value objects that can underpin a legal claim and ground an entity in the legal text. This entity then re-emerges as a “jurimorph” (McGee, 2015: 64), which is an “attention-orienting device[.]” (Latour, 2015: 335): It reminds us that this entity may not itself be legal (like the meteorological map in the example above) but has now become a legal object through its successful grounding in the law.

Accordingly, Latour provides a vocabulary to unpack the ontological dimension of the approval procedure for DiGAs. To identify what qualities an app needs to possess to potentially become a DiGA, we need to identify the value objects that mediate between the materiality of the app under consideration and the requirements laid down

in the regulatory framework. Thus, value objects cannot be reduced to these requirements as if DiGAs are only subsumed under these. Instead, they point us to the deeper-seated layer of negotiations and exchanges between developer companies and the BfArM about what a DiGA should be and deliver. This will allow us a glimpse at the broader values underpinning the digitalised German healthcare system. The value objects we extract point us to the different visions of the healthcare system, the role of the BfArM, the developer companies and the users of DiGAs.

However, Latour's framework does not help us specify how the transition to a stable legal object has to be organised to account for the fluidity of digital technologies. Addressing this shortcoming requires that we elaborate on the implicit role that *tests* play in his sociology of the law as a mode of existence. Considered through this lens, this approach describes a process of testing wherein the ontology of an entity is at stake – whether or not it can exist as a legal entity. Boltanski and Thévenot (1999: 359) describe similar situations as “critical moments”. These are moments where divergent definitions of a situation collide and suspend its self-evidence. In such circumstances, actors stage ‘reality tests’ that assess the ontological status of actors, human and non-human, in order to ‘repair’ the situation. Reality tests are socio-material practices organised in particular ways that can become contested themselves (Boltanski and Thévenot, 1999). Actors may question whether the assumptions of the test and the way it is carried out are appropriate for the situation at hand. This draws our attention to the “infrapolitics” (Potthast, 2012: 562) of reality tests: the way tests posit the actors who test, the actors who are tested, the relation between them, and the test's temporal and spatial arrangement. This framework now enables us to specify the implicit test carried out in the approval process to assess whether an app can become a DiGA. It also makes visible the (infrapolitical) strategies this test deploys to address the fluidity of digital apps.

Methodology

Our research targets a particular point in the trajectory of DiGAs: their approval. It marks the

moment when a DiGA becomes a legal object in the German healthcare system. This moment precedes negotiations about pricing (with insurance companies) or the actual prescription of the app (by healthcare providers). Hence, we zoom in on the perspectives of the two key actors of this part of the process, the BfArM, and developers of potential DiGAs.

We approached the viewpoint of the BfArM through publicly available documents pertinent to the regulatory procedure. Regulatory documents are crucial actors in the regulation process. They are often not only the first point of contact with regulation, but they also co-construct the objects and domains to be regulated (Asdal, 2015). Therefore, “legislative texts and documents could be accorded a more prominent place in theorising the emergence of new biomedical and other sociotechnological fields” (Faulkner, 2012a: 772). This is especially crucial for fields currently reshaped by regulation, such as digital health. The documents we collected encompass Germany's 2019 Digital Healthcare Act and the 2020 Digital Health Application Ordinance as the documents in which the legislation for Digital Health Applications is outlined; the so-called DiGA Guide (Federal Institute for Drugs and Medical Devices, 2020) meant to assist developers (and other interested parties) regarding the approval process; another set of documents authored by officials at the BfArM and developers published in a special issue of the German Federal Health Bulletin dedicated to Digital Health Applications (Broich et al., 2021; Brönneke et al., 2021; Lauer et al., 2021; Löbker et al., 2021; Ludewig et al., 2021); and two blogposts published by officials at the BfArM (Grünewald, 2022; Löbker, 2021). Recruiting interlocutors at the BfArM proved difficult with contact persons citing the general workload they face. We interpret this as a sign of ongoing reorganisations to accommodate the regulation of DiGAs at the BfArM. This hypothesis was corroborated by some of the developers we spoke to.

Our analysis of the perspective of DiGA developers is based on interviews and an article co-authored by developers for the German Federal Health Bulletin (Laumann et al., 2021). Interviews allow to explore views of “those who have knowledge of or experience with the

problem of interest" (Rubin and Rubin, 2012: 3) – in our case, the developers whose DiGA has passed the approval process and the representative of a digital health lobbying organisation. The interviews were semi-structured to cover the topics our research sought to explore but also to give respondents the space needed to set their own priorities. This enabled us to exploit the full benefits of interviews as an interactive practice (Silverman, 2006). Developers were recruited using the contact data provided in the article authored by DiGA developers (Heimann et al., 2021) and by contacting other companies listed in the DiGA registry. The digital health lobbyist was recruited through personal networks. Of the 25 companies contacted, only three agreed to an interview. We view this low response rate as a significant result in itself. In their rejections, developers mentioned that they had few additional capacities for interviews because they were currently finishing their clinical research as a requirement to have their DiGA permanently listed. Moreover, some interlocutors intimated that they feared repercussions for critical remarks on the approval process, which could also explain why others were reluctant. Hence, we decided to anonymise the interview excerpts we draw on in this article. All information that could identify or trace statements back to respondents has been erased. We introduce quotes from interviews by linking them to the respective group (developers, digital health lobbyist). Our sample is limited to developers who have passed the approval process. This gives it a 'success bias' and excludes those developers whose applications have been rejected or retracted. These constituted the largest group at the time of research (Lauer et al., 2021). Their views would have allowed for an even more nuanced perspective, but information on ongoing assessments or negative outcomes of the approval processes is not in the public domain. For obvious reasons, companies do not publish this information, either. This made it impossible for us to follow this option further.

The research was carried out in the spring/summer of 2022 –which situates our findings as a snapshot of a process that is developing fast. Due to the restrictions of COVID-19 at the time, all interviews were conducted online (Lobe et al.,

2020) using a videoconferencing tool provided by the University of Vienna. Informed consent was obtained (in written form) during the first contact with developers and (orally) before the start of the interview. Interviews lasted between 30 and 90 minutes. They were transcribed verbatim. We analysed interview transcripts and documents drawing on the thematic coding approach (Rivas, 2018). Through iterative coding and constant comparison across data sources, this approach seeks to identify underlying themes and concepts in the material. For presenting our findings, quotations were translated from German after the analysis.

The ontological transition of digital health applications

We begin by tracing what qualities an app has to have to become a prescriptible and remunerable DiGA following the novel German regulatory framework. We first extract the value objects that mediate between the apps and the regulation and then identify the emerging jurimorphs.

Value-objects of the approval process

To be eligible for the approval process, digital apps must first obtain the CE mark. According to the EU's Medical Device Regulation (MDR), it certifies them as medical devices.² From the perspective of the BfArM, this requirement distributes the regulation of the risks of DiGAs. As certified medical devices, a Notified Body has already tested them and subsumed them under a risk class. "[T]he CE conformity marking of the medical device is considered to be proof of safety and functional capability" (Digitale Gesundheitsanwendungen-Verordnung - DiGAV, 2020, §3(1)). For the developers, the requirement introduces a temporal order to the application process. The certification is "a step that precedes, a very important step" (developer) wherein "no exceptions are possible" (Federal Institute for Drugs and Medical Devices, 2020: 37). Accordingly, the two value objects we can identify are (1) *the distributed process of risk regulation across several regulatory bodies* and (2) *the temporal sequence of the application process*.

The following three requirements concern the technical features of the app: interoperability,

privacy and information security, and usability. In the early stage of the regulation all three were assessed through checklists (with 'yes', 'no', and a justification if 'no' was selected as the only potential responses) that developers needed to fill in themselves. This was changed with a recent reiteration of the regulation, stipulating that developers must provide certificates issued by the German Federal Office for Information Security.

Since interoperability is considered an "essential success factor for the entire digitalisation strategy" (Broich et al., 2021: 1295), DiGAs need to comply with this expectation.³ For example, in the broader vision of a digital healthcare system, data produced by DiGAs will eventually become shareable with care providers. Consequently, the value object is that (3) *the submitted DiGA-to-be supports the vision of the German digitalised healthcare system imagined by policymakers and the BfArM as the responsible regulatory agency.*

The requirements for data protection and information security build on existing regulatory frameworks. This further underscores the distributedness of regulation. In many cases, the DiGA regulatory framework draws on legal frameworks, such as the General Data Protection Regulation (GDPR) or standards established by other national and international regulatory agencies with which the BfArM collaborates. Similar to the case of medical apps in the US (Lievevrouw et al., 2022a), the regulation of DiGA then also co-produces the organisational identity of the BfArM which presents itself as well-networked with other regulatory bodies and authorities. But the regulation also makes provisions beyond established legal frameworks. "Data processing is geographically restricted, there may be no advertising, and only certain purposes of data processing relevant to the provision of care are permitted" (Ludewig et al., 2021: 1199). These stipulations mark a crucial difference between DiGAs and ordinary health-and-wellness apps. The latter can, and frequently do, include advertisements, and data is processed for commercial purposes.

Existing frameworks also inform the requirements for information security. These consider security not as a "conglomerate of technical measures, but rather as a process to be anchored in the company" (Federal Institute for Drugs and

Medical Devices, 2020: 45). This broad understanding of security speaks to the presumed characteristics of digital technologies, particularly to the speed of their developments. A "secure DiGA is always only a snapshot: The DiGA evolves in short release cycles, and new threats and risks affect it from outside. Security measures that are state-of-the-art today can therefore be ineffective in just a few months" (Federal Institute for Drugs and Medical Devices, 2020). Having analysed these requirements, we can identify two further value objects: (4) *the difference from commercial health apps based on enhanced user privacy and (5) an organisational structure conducive to information security against the backdrop of rapid developments.*

The requirements for usability provide a glimpse of how the future user of DiGAs is imagined within the regulatory framework. Generally, usability is informed by an idea of fairness that imagines the potential DiGA user's state of mind. "[U]sers of DiGA find themselves in a special life and/or illness situation simply because of their motivation to use a particular DiGA, which must not be exploited by the manufacturer to take advantage of the users or lead them to make irrational decisions" (Federal Institute for Drugs and Medical Devices, 2020: 66). Beyond this, there is a tension in the digital literacy assumed of future users. On the one hand, users are considered to have a basic understanding of digital technologies. Consequently, DiGAs should align with the "usual look & feel of digital applications for persons used to dealing with applications" (Federal Institute for Drugs and Medical Devices, 2020: 71). On the other hand, users are envisioned as fallible and not overly tech-savvy so that DiGAs need to be robust against 'false' uses. Therefore, these regulations point to the value objects of (6) *a particular attention to the vulnerability of the envisioned user and (7) an appreciation of the heterogeneity and diversity of users with diverging levels of digital literacy.*

Finally, developers need to provide evidence of the clinical efficacy of their app. The regulatory framework introduces a conceptual novelty for this. The notion of the "positive healthcare effect" (Ludewig et al., 2021) encompasses improvements in the user's *health* (similar to pharma-

ceuticals) but also improvements in *healthcare provision*, including the ability to better navigate the healthcare system. Moreover, the way in which this requirement can be proven introduces a temporal distinction between DiGAs listed in the registry. While developers must provide clinical evidence to have their DiGA listed permanently from the outset, DiGAs can also be listed provisionally for one year. In this case, although developers need to respond to the other requirements and provide a scientific evaluation concept, submission of their clinical evidence is postponed until the end of the provisional listing period. During this listing period, the DiGA can already be prescribed (and remunerated) and data from its use can serve to produce the evidence. In principle, the requirements allow for several ways and methodologies to prove the positive healthcare effect. However, in practice, this range was reduced to randomised clinical trials (Lauer et al., 2021). Proving the positive effect on health marks a further distinction from other health apps. As one developer summarised, the effect “can’t just be sold somehow on the marketing side, but [...] actually has to be demonstrated.” The value object here is, thus, (8) *the scientifically proven positive impact on health and healthcare provision*.

Emerging jurimorphs

If the existence of these eight value objects can be argued to be present in the encounter of an app and the regulatory framework, this app can become a DiGA. At this point, we may say the app is legally grounded and has become a ‘jurimorph’: It is a legal object primarily defined through its relation to the regulation. It is important to note that this is a purely legal qualification. There is not necessarily a real *technical* difference between a DiGA and other health-related lifestyle apps, e.g., in terms of capabilities or features. The digital health lobbyist put it bluntly: “Any fitness tracker can do more” than a DiGA on a technical level. The legal status acquired in the approval process appears to make all the (ontological) difference as it integrates the app into the healthcare system and makes it eligible for prescription and remuneration. In other words, the regulation establishes the otherwise slippery boundary between health-related lifestyle apps and medical apps

through a legal specification through which apps come to exist as DiGAs in a legal mode. The same app, existing outside the German healthcare system, would be just another health-related lifestyle app.

But it is not only the app that is jurimorphed. Previously, the medical profession was dominant in the German healthcare system (Daemmrich and Krücken, 2000) and only medically-trained healthcare providers could prescribe treatments. With the introduction of the new legislation, the right (and obligation) to prescribe DiGAs extends to psychological psychotherapists who were previously excluded. This signifies a shift in the power relations within the German healthcare system. Even more far-reaching is the shift introduced by the stipulation that an insured person may request a DiGA for their condition directly from their health insurance. It allows them to almost completely sidestep the previous gatekeeping role of healthcare providers and their expertise on suitable therapies. While this novel mode of obtaining treatment in the German healthcare system comes close to the consumerist logic of health-related lifestyle apps, it does not render medical knowledge entirely inconsequential. Even if they request a DiGA from their insurance directly, insured persons need a diagnosis from their healthcare provider to justify their request.

Finally, the developers obtain new rights and obligations once their app has become a DiGA. They now have the *right* for their app to be prescribed. One developer reported they frequently received feedback from potential users that physicians refused to prescribe their app. Its new socio-legal status, following its approval, now gives them a lever to demand its prescription. “I think this year I’m going to sue a doctor”, the interviewee said. With the approval of their app as a DiGA, in their view, “this has become malpractice” from a medico-legal perspective. Furthermore, developers are obliged to report any ‘significant changes’ to their DiGA to the BfArM which will assess whether it still meets the regulatory requirements. Such changes encompass both technical and textual changes. For instance, if a developer conducts further clinical trials to add clinical indications for which their app may be prescribed, this would constitute a significant

textual change to the description of their app in the official registry and would consequently entail an assessment of the trial data.

The approval process as a reality test: Responding to the complexities of digital health

The obligation to report ‘significant changes’ of the DiGA indicates the previously mentioned tension between the dynamic development of digital technologies and regulation. Digital media are “constantly asking/needing to be refreshed” (Chun, 2017: 2) and there is a cultural expectation of frequent updates (Simon, 2018). Apps, in particular, are fluid and open-ended objects where more or less stable versions only exist until the next update. This fluidity has the potential to undermine regulation designed as a one-off assessment. In this section, we explore how the approval process for DiGAs responds to this fluidity and what kinds of politics we can observe.

Testing the developer company

The first strategy the BfArM deploys is to extend the test to the developer company. In other words, the approval procedure does not only assess the qualities of the potential DiGA. Through the way it is organised, it *also* tests the qualities of the developer company. First and foremost, the financial resources of the applicants are put to the test. Some costs directly arise from the approval process (the DiGA Guide estimates costs of at least 3,000€) and the clinical trial to prove the positive health/healthcare effect. Indirect costs stem from possible waiting times. For one developer, the approval process took longer than initially calculated, posing a potentially existential threat: “You have to be able to do it, I mean, it didn’t get us into trouble, but...”. Given that according to privacy and information security requirements, the company cannot earn money through in-app advertisement, the process favors particular business models: start-up companies with sufficient venture capital or corporations. As one interviewee observed, somewhat frustratedly, “it’s actually almost only spin-offs of corporations that ultimately bring new DiGAs to the market” (developer).

The work ethics of employees of the developer companies are also implicitly put to the test. The approval process consists of a back-and-forth between the BfArM and the developers, as the former follows up with additional queries throughout the three-month process. The deadlines for these additional queries are “very, very tight and very, very strict” (developer). We learned of cases where the query would arrive on Friday, and responses would be expected by Monday, requiring the developers to be flexible and work over the weekend. Furthermore, developing a DiGA “hasn’t paid off yet” (digital health lobbyist). Once an app has been listed permanently, prices are negotiated between developers and the umbrella organisation of German health insurance firms (during the preliminary listing, developers can set a price). Because DiGAs are pitted against (cheaper) pharmaceuticals for the same condition in these negotiations, the calculated sum likely remains below developers’ expectations. One developer reflected on another developer company, presuming that for them, the price negotiations would be “considerably difficult [...] because the drugs that are called there [for the same condition], they cost somewhere around [low two-digit price].” This makes it close to impossible to bargain for a medium three-digit price for the app. More than financial considerations, developers need to be motivated by a sense of idealism. “There is a lot of enthusiasm to actually improve the world a little bit and to improve treatment” on the part of the developers “who [often] are more or less directly or indirectly affected” (digital health lobbyist) by the condition their app responds to.

Finally, the approval process implicitly tests how well developers can bridge the cultural gaps between regulation and the digital industries. As the digital health lobbyist concisely put it: “When I’m in administration, I talk in an administration language. A start-up talks in a start-up language. And then there are always problems with understanding”. This language barrier is a hurdle that the developer companies must overcome mostly by themselves because the one-off encounters offered by the consulting services at the BfArM do not suffice. Overall, we can conclude that the dimensions thus tested point to an interest in the *longevity* of the DiGA within the digitalised

German healthcare system. Through the organisation of the approval procedure, developer companies must prove that they are financially viable, interested in more than short-term profits and able to maintain good relations with the BfArM.

Reverse regulatory capture: The BfArM as an obligatory passage point

The BfArM figures as an ambivalent actor in the empirical material we collected. On the one hand, manufacturers describe it as “friendly, competent, professional and solution-oriented” (Heimann et al., 2021: 1249). The BfArM itself states that it “want[s] manufacturers to go through the process successfully” (Löbker, 2021). The range of consultation offers exemplifies this attitude. The so-called kick-off meeting, for example, is one way “to give [manufacturers] orientation in early development phases on the way to market access for their (digital) innovative approaches” (Broich et al., 2021: 1296). One document describes the BfArM’s overall approach as “consulting and accompanying” (Löbker et al., 2021: 1247) developers throughout the development of their app and their application.

On the other hand, the interviews with developers offer a different perception of the relational dynamics. One developer confessed that they “never had the feeling that they were trying together to bring a DiGA to the market, but it was always, we try to bring the DiGA to the market and they try to prevent it.” Regarding the consultations offered by the BfArM, some developers felt pressured into purchasing this service to have a chance at being successful. The BfArM also ascribes responsibility for failed applications to the developers. Failed applications “had not been the subject of consultations before the application [...] or the recommendations of the BfArM had not been followed” (Löbker et al., 2021: 1246). While the consultation results are not legally binding for the BfArM and its decision-making, developers must justify their approach if they deviate from them.

The regulatory framework posits the BfArM as an “obligatory passage point” (OPP) (Callon, 1984) that developers must pass through if they want their app to become a DiGA. Developers then need to find out “to what the BfArM attaches a

great deal of importance” (developer) and adjust their app accordingly, even if they disagree with its priorities. Because their ultimate goal is to get their app approved as a DiGA, “then you just do it at that moment” (developer) and acquiesce to the BfArM’s demands. Through simultaneously “consulting and accompanying” and gatekeeping access to the German healthcare market as an OPP, the BfArM can steer the development of apps through their lifecycle and along the imaginations that underpin the German approach to digital health. This guidance possibly contains the fluidity of the app within the boundaries defined by the BfArM. We can refer to this second strategy as a ‘reverse regulatory capture’ as opposed to the regulatory capture hypothesis in research on the regulation of pharmaceuticals (Davis and Abraham, 2011). Unlike the pattern of companies influencing the regulation of pharmaceuticals in their favor that other scholars have identified, the regulatory agency captures the developers and can shape the development of DiGAs from the beginning. This indicates different power relations in regulatory processes between ‘classical’ pharmaceuticals and digital health.

The (incomplete) pharmaceuticalisation of digital health

The third strategy is what we propose to call the – however incomplete – ‘pharmaceuticalisation of digital health’. The explicit requirements reflected in the value objects identified above do not carry equal weight in the approval procedure. In our interviews, for instance, the developers confessed that they were not even aware of all the requirements. “Uhhhhm. User Friendliness? [...] So my guess is that we first designed it the way we think it’s good and then saw what the BfArM had to say about it” (developer). Moreover, the BfArM does not assess all requirements symmetrically. Technical features – usability, information security and privacy, interoperability – were mostly assessed through checklists in the early phase of the regulation (now replaced by certificates). This means that the BfArM examines “manufacturer’s statements about the product qualities” (Federal Institute for Drugs and Medical Devices, 2020: 7), not the technology itself. One developer explained: “The BfArM does not want to check [the require-

ments for data protection and data security] because it can't check them" (developer) due to a lack of expertise in these technical features. By contrast, it scrutinises clinical evidence meticulously. One developer "felt that the big issue at the end, of course, is always the proof of medical benefit." Interviewees suggested that this "extreme focus on the medical stuff" (digital health lobbyist) is due to the institutional history of the BfArM which has historically been the German authority of pharmaceuticals (Daemrlich and Krücken, 2000). As a result, pharmaceuticals and clinical tests are the agency's main areas of expertise. "The BfArM is a medical authority," one developer said, instead of an authority on the digital. The digital health lobbyist concurred: "That is simply their home".

In effect, this strategy bypasses the complexities of digital technologies by treating DiGAs *as if* they were pharmaceuticals. "People are trying hard to force digital health applications into the mold of pharmaceuticals" (digital health lobbyist). This regulatory pharmaceuticalisation manifests in the institutional responsibility of the BfArM and the focus on clinical evidence.⁴ The approval process stretches existing categories, procedures, and institutions to accommodate DiGAs (Faulkner, 2012b; Faulkner and Poort, 2017). However, regulatory pharmaceuticalisation remains incomplete. The characteristics specific to digital complexities resist being subsumed entirely. The BfArM has begun cooperating more closely with other German regulatory bodies to establish criteria and procedures for assessing DiGAs (akin to what Faulkner (2012b: 404) calls "proliferation of organisation structures"). For instance, for the certificates to prove data and information security, the BfArM has collaborated with the German Federal Office for Information Security. Additionally, several interlocutors reported that the BfArM has recently expanded its expertise on digital technologies, illustrating that novel regulations for digital health also transform the institutional identities of regulatory institutions (Lievevrouw et al., 2022a). Finally, the new regulatory category of the 'positive healthcare effect,' encompassing impacts on both health and healthcare, similarly tries to incorporate the affordances of digital tech-

nologies for facilitating orientation in the German healthcare system.

Continuity and agility: Emulating the fluidity of digital apps

Developers are required to report 'significant changes' even after the approval of their app as a DiGA. A "continued close supervision by the BfArM [...] ensures that the interaction between DiGA manufacturers and the BfArM continues even after the listing" (Heimann et al., 2021: 1253). This only seemingly resembles practices of post-marketing pharmaceutical surveillance (Langlitz, 2009) and medical device surveillance (Zippel and Bohnet-Joschko, 2017). The crucial difference is that this continuous monitoring does not concern adverse effects but changes to the app itself. For developers, this constitutes a severe constraint to what digital technologies afford: "In such a super agile environment like software development, where I have the possibility to iteratively adapt things within weeks, to make things better, to react to feedback, we end up again in such a one-way street or in such a dead-end, where we are somehow presented with product cycles from the old economy again" (developer). Supported only by a checklist, developers must decide by themselves what exactly constitutes a significant change. This leads to considerable uncertainty which has particularly high stakes due to the penalty a failure to report a significant change could entail. One developer reported that, in light of this uncertainty, "we have tried to avoid it [changing the app] as far as possible" (developer).

Still, the regulatory framework acknowledges the potential for digital technologies to develop continuously. Policymakers have conceptualised "law-making as an agile process" (Ludewig et al., 2021: 1205). The regulatory framework is, like the apps it targets, itself continuously and self-reflexively evolving. Importantly, regulatory changes apply retroactively. Developers have to prove the compliance of their DiGA with the changing requirements even if their app has already been approved. Otherwise, they risk that it is stripped of its status. For example, following a novel iteration of the regulation, developers had to submit data and information certificates by April 2023.

The intentional incompleteness of the agile regulatory framework adopted to emulate the fluidity of digital technologies has implications for the status of the regulatory framework and, subsequently, for the work of grounding aiming to turn apps into a stable legal object. To keep up with the developments of digital technologies, the agile regulation only stands still temporarily – until new provisions are introduced. This vitality of the regulatory framework evidently collides with the work of ‘grounding,’ if this means forging relations between the app and the legal text and constituting the app as a stable legal object. This becomes clear when we take the topological implications of grounding seriously: “[A]cts of grounding are [...] closely related to a judgment in which the ground will bring something (the matter of judgment) to a stand (zum-stehen bringen [sic!]) as an object (Gegenstand) when it will have provided a sufficient (vollständig [sic!]) account of it” (van Dijk, 2015: 179). Grounding, i.e. bringing something to a stand on the ground, requires that this ground be solid and able to carry the weight of what is to stand on it. It presupposes that the law is stable. Because the agile regulatory framework for Digital Health Applications is itself fluid, it only provides a slippery ground. Hence, the ontological transition of a health app into a DiGA, which requires a grounding in the regulatory framework, remains forever incomplete. In other words, the strategy of emulating the fluidity of digital apps makes the regulation itself fluid which illustrates the co-emergence of digital health and regulation in their encounter.

Conclusion: Digital health otherwise

Early commentators on the DiGA regulation described it as a “first-of-its-kind opportunity” (Gerke et al., 2020: 5) and a likely blueprint for other countries. Indeed, Belgium and France have introduced regulations to integrate medical health apps into their healthcare systems. Emerging evidence suggests that there are slight differences in the otherwise overall similar architecture of these regulations and their outcomes (Schudt et al., 2022). While it is beyond the scope of this article to go into further detail, we encourage

future research to take a comparative perspective and to tease out these similarities and differences – and their ontological and infrapolitical implications. In this article, we have attempted to lay the groundwork for such explorations by zooming in on the regulation for DiGAs in Germany.

Our study offers so far rare detailed insights into the approval process for health apps as these become integrated into healthcare systems. While scholars of digital health have largely investigated imaginaries or use and design practices of digital health, this focus on regulation has allowed us to pinpoint the challenges that emerge when fluid digital health apps encounter structured regulatory frameworks. Attending to such frictions will become increasingly important as digital health becomes more widely adopted and regulation is applied to other, similarly fluid digital technologies, such as Artificial Intelligence (AI).

We have shown that both digital health and regulation transform when they encounter each other – which we conceptualise as a two-fold “ontological politics” (Mol, 1999). The *being of both* is (re-)negotiated in their encounter. On the one hand, the approval process re-traces the blurry boundary between lifestyle and medical apps by staging what we have termed a ‘reality test’ to assess whether a specific app can exist as a legal object. Regulators must be able to identify and align eight value objects that mediate between the app and the regulatory provisions. Consequently, the power dynamics within the German healthcare system shift as the DiGA, insured persons, healthcare providers, and developers re-emerge as ‘jurimorphs’ with new rights and obligations. For instance, the possibility for insured persons to bypass healthcare providers may signal an increased consumer orientation in the German healthcare system, even though healthcare providers remain responsible for diagnosing the condition a DiGA may address.

On the other hand, we have shown that the approval process incorporates four infrapolitical strategies to get a grip on the ontological fluidity of the – at least potentially – rapidly evolving digital apps. Each strategy comes with new risks and complexities when trying to contain this evolution. (1) We have seen that the extension of the test to the developer company serves to

ensure the company's viability. Conversely, this can limit the pool of developers who can get their app approved. (2) The 'reverse regulatory capture' we have described is a way for the BfArM to intervene at an early stage in developing possible DiGAs. Steering them towards its vision of a digitalised German healthcare system, however, might not entirely meet the needs of patients. (3) What we have called a 'regulatory pharmaceuticalisation' of digital health, the stretching of existing categories, procedures, and institutional responsibilities for pharmaceuticals to digital health remains incomplete. The technical characteristics of DiGAs overflow the focus on their medical contribution. This is illustrated by reports on security flaws (Heidrich and Endres, 2021) or our interlocutors' doubts about whether the procedure in its current form gives due diligence to the characteristics of their digital products and whether a *break* with previous frameworks might not be better. (4) Finally, emulating the fluidity of digital technologies in the regulation renders *both* unstable. One consequence is that DiGAs can only be temporarily stabilised legal objects, undermining their ability to fully exist in a legal mode.

Overall, it therefore remains uncertain whether the regulation is "fit for purpose" (Marelli et al., 2020) and whether the strategies – as is the stated goal – indeed foster "transparency, safety and reliability." For instance, regulatory pharmaceuticalisation may initially create trust because it resembles the tried and tested ways of approving pharmaceuticals. Yet, it may neglect the specific risks of digital technologies. Extending the question of the 'fitness' of regulation, our case raises the broader question of what strategies regulations of other, equally rapidly evolving digital technologies (e.g., AI and machine learning) take and what their (ontological) consequences and implicit politics are.

Finally, this article offers a conceptual contribution. It illustrates the fruitfulness of bringing Latour's legal sociology, or his "Inquiry into Modes of Existence" more generally, into conversation with Boltanski and Thévenot's orders of worth approach. While these research programs undoubtedly diverge in what they consider to be the basic units of reality (networks vs. orders of worth) and where to study them, they speak to

each other in multiple ways and have a history of conceptual exchanges – Boltanski, for instance, adopts and adapts the very concept of reality tests from early Actor-Network Theory (Guggenheim and Potthast, 2012). We have expanded on such exchanges by bringing the notion of reality tests back to speak to Latour's legal sociology and to address what we perceive to be one of its gaps when studying regulation, such as the introduction of DiGAs. While Latour's approach has been fruitful in describing the ontological transition that occurs in the approval process, it has been less so in illuminating the infrapolitics of this procedure. At the same time, the meaning of 'reality tests' changes when it encounters Latour's legal sociology. What is at stake in the reality tests of regulatory processes is whether and how an entity can transition to a legal mode of existence.

Focusing on the regulation of digital health, as we have done here, foregoes some of the crucial questions that critical digital health studies have addressed and that we must also ask about DiGAs, e.g. their desirability or socio-material consequences. Certainly, DiGAs embody a form of 'technological solutionism' (Morozov, 2013), the idea that (digital) technologies can solve the problems healthcare systems are currently facing – even though these may require more structural transformations. Solutions, which always bear the traces of the problems to which they respond, point us to how we frame the problems DiGAs (purportedly) address and who has the power to participate in this framing. Nuanced understandings of different ways of regulating digital health help to open up a space for intervention into how problems are constructed and guide digital health in directions we may find more desirable.

Acknowledgments

The authors would like to thank Jörg Potthast for his comments on an early version of this paper. Moreover, they are grateful for the instructive and generous comments by the anonymous reviewers which have helped to sharpen the arguments.

References

- Abraham J and Davis C (2009) Drug Evaluation and the Permissive Principle: Continuities and Contradictions between Standards and Practices in Antidepressant Regulation. *Social Studies of Science* 39(4): 569–598. DOI: 10.1177/0306312709103480.
- Asdal K (2015) What is the issue? The transformative capacity of documents. *Distinktion: Journal of Social Theory* 16(1): 74–90. DOI: 10.1080/1600910X.2015.1022194.
- Bandelow NC, Eckert F, Hornung J et al. (2020) Der Politikstil von Jens Spahn – Von Konsensorientierung zu Konfliktbereitschaft. *Gesundheits- und Sozialpolitik (G&S)* 74(1): 6–11. DOI: 10.5771/1611-5821-2020-1-6.
- Bierbaum M and Bierbaum ME (2017) Medical Apps im Kontext von Zulassung und Erstattung. In: Pfannstiel MA, Da-Cruz P and Mehlich H (eds) *Digitale Transformation von Dienstleistungen im Gesundheitswesen I*. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 249–263. DOI: 10.1007/978-3-658-12258-4_16.
- Blümel M, Spranger A, Achstetter K et al. (2020) Germany. Health System Review 2020. Health Systems in Transition. Copenhagen: World Health Organization.
- Boltanski L and Thévenot L (1999) The Sociology of Critical Capacity. *European Journal of Social Theory* 2(3): 359–377. DOI: 10.1177/136843199002003010.
- Broich K, Löbker W and Lauer W (2021) Beitrag des BfArM zur Potenzialentfaltung der Digitalisierung im Gesundheitswesen – digital readiness@BfArM. *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 64(10): 1292–1297. DOI: 10.1007/s00103-021-03417-7.
- Brönneke JB, Hagen J, Kircher P et al. (2021) Digitalisierte Gesundheitsversorgung im Jahr 2030 – ein mögliches Szenario. *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 64(10): 1285–1291. DOI: 10.1007/s00103-021-03416-8.
- Bundesamt für Arzneimittel und Medizinprodukte (2023) DiGA. Digital Health Applications. Available at: https://www.bfarm.de/EN/Medical-devices/Tasks/DiGA-and-DiPA/Digital-Health-Applications/_node.html (accessed 29 July 2023).
- Bundesministerium für Gesundheit (2020) Digitale Gesundheitsanwendungen-Verordnung - DiGAV. Available at: <https://www.gesetze-im-internet.de/digav/BJNR076800020.html> (accessed 30 July 2023).
- Callon M (1984) Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay. *The Sociological Review* 32(1): 196–233. DOI: 10.1111/j.1467-954X.1984.tb00113.x.
- Chun WHK (2017) *Updating to Remain the Same. Habitual New Media*. new media. Cambridge, Massachusetts: The MIT Press.
- Daemmrich AA and Krücken G (2000) Risk versus Risk: Decision-making Dilemmas of Drug Regulation in the United States and Germany. *Science as Culture* 9(4): 505–534. DOI: 10.1080/713695270.
- Davis C and Abraham J (2011) Rethinking Innovation Accounting in Pharmaceutical Regulation: A Case Study in the Deconstruction of Therapeutic Advance and Therapeutic Breakthrough. *Science, Technology, & Human Values* 36(6): 791–815. DOI: 10.1177/0162243910374809.
- Diedericks H (2019) Digital Pills and Promises: Ethical Regulation of Digital Medication. In: *Proceedings of the 9th International Conference on Digital Public Health*, New York, NY, USA, 20 November 2019, pp. 63–67. DPH2019. Association for Computing Machinery. DOI: 10.1145/3357729.3357746.
- Faulkner A (2009) *Medical Technology into Healthcare and Society*. London: Palgrave Macmillan UK. DOI: 10.1057/9780230228368.
- Faulkner A (2012a) Law's performativities: Shaping the emergence of regenerative medicine through European Union legislation. *Social Studies of Science* 42(5): 753–774.

- Faulkner A (2012b) Tissue engineered technologies: regulatory pharmaceuticalization in the European Union. *Innovation: The European Journal of Social Science Research* 25(4): 389–408. DOI: 10.1080/13511610.2012.723333.
- Faulkner A and Poort L (2017) Stretching and Challenging the Boundaries of Law: Varieties of Knowledge in Biotechnologies Regulation. *Minerva* 55(2): 209–228. DOI: 10.1007/s11024-017-9326-0.
- Federal Institute for Drugs and Medical Devices (2020) *The Fast-Track Process for Digital Health Applications (DiGA) according to Section 139e SGB V. A Guide for Manufacturers, Service Providers and Users*. Bonn: Bundesamt für Arzneimittel und Medizinprodukte.
- Felt U (2025) Policy Imaginaries of European Citizen-Patients: European Integration and the Digital Infrastructuring of Health Care. In: Marelli L (ed) *Project Europe. Remaking European Futures Through Digital Innovation Politics*. Cheltenham: Edward Elgar.
- Felt U, Öchsner S, Rae R et al. (2023) Doing co-creation: power and critique in the development of a European health data infrastructure. *Journal of Responsible Innovation* 10(1): 2235931. DOI: 10.1080/23299460.2023.2235931.
- Geiger S and Gross N (2017) Does hype create irreversibilities? Affective circulation and market investments in digital health. *Marketing Theory* 17(4): 435–454. DOI: 10.1177/1470593117692024.
- Geiger S and Kjellberg H (2021) Market mash ups: The process of combinatorial market innovation. *Journal of Business Research* 124: 445–457. DOI: 10.1016/j.jbusres.2020.11.010.
- Gerke S, Stern AD and Minssen T (2020) Germany's digital health reforms in the COVID-19 era: lessons and opportunities for other countries. *npj Digital Medicine* 3(1): 1–6. DOI: 10.1038/s41746-020-0306-7.
- Grünewald A (2022) BfArM - Blog - DiGA & Datenschutz: die 5 häufigsten Mängel im Antrag... In: *BfArM-Blog*. Available at: https://www.bfarm.de/DE/Aktuelles/Blog/_docs/2022-03-11-diga-datenschutz.html (accessed 25 June 2023).
- Guggenheim M and Potthast J (2012) Symmetrical twins: On the relationship between Actor-Network theory and the sociology of critical capacities. *European Journal of Social Theory* 15(2): 157–178. DOI: 10.1177/1368431011423601.
- Heidrich J and Endres J (2021) Ungeprüft auf Rezept: Bundesinstitut genehmigt Medizin-Apps trotz Datenschutz-mängel. c't, 7 May. Heise.
- Heimann P, Lorenz N, Blum N et al. (2021) Erfahrungen von Herstellern digitaler Gesundheitsanwendungen (DiGA) mit dem Fast-Track-Verfahren des BfArM. *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 64(10): 1249–1253. DOI: 10.1007/s00103-021-03422-w.
- Hoeyer K (2023) *Data Paradoxes. The Politics of Intensified Data Sourcing in Contemporary Healthcare*. Infrastructures series. Cambridge, Massachusetts: The MIT Press.
- Jansky B (2023) Digitized Patients: Elaborative Tinkering and Knowledge Practices in the Open-source Type 1 Diabetes "Looper Community". *Science, Technology, & Human Values*: 01622439231170443. DOI: 10.1177/01622439231170443.
- Langlitz N (2009) Pharmacovigilance and Post-Black Market Surveillance. *Social Studies of Science* 39(3): 395–420. DOI: 10.1177/0306312708101977.
- Latour B (2010) *The Making of Law. An Ethnography of the Conseil d'Etat*. Cambridge & Malden, MA.: Polity.
- Latour B (2013) *An Inquiry into Modes of Existence. An Anthropology of the Moderns*. Cambridge, MA: Harvard University Press.
- Latour B (2015) The Strange Entanglement of Jurimorphs. In: McGee K (ed) *Latour and the Passage of Law*. Edinburgh University Press, pp. 331–353.

- Lauer W, Löbker W, Sudhop T et al. (2021) Digitale Gesundheitsanwendungen (DiGA) als innovativer Baustein in der digitalen Gesundheitsversorgung in Deutschland – Informationen, Erfahrungen und Perspektiven. *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 64(10): 1195–1197. DOI: 10.1007/s00103-021-03420-y.
- Lauer W, Löbker W and Höfgen B (2021) Digitale Gesundheitsanwendungen (DiGA): Bewertung der Erstattungsfähigkeit mittels DiGA-Fast-Track-Verfahrens im Bundesinstitut für Arzneimittel und Medizinprodukte (BfArM). *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 64(10): 1232–1240. DOI: 10.1007/s00103-021-03409-7.
- Lezaun J (2012) The Pragmatic Sanction of Materials: Notes for an Ethnography of Legal Substances. *Journal of Law and Society* 39(1): 20–38.
- Lieievrouw E, Marelli L and Van Hoyweghen I (2024) Weaving EU digital health policy into national health-care practices. The making of a reimbursement standard for digital health technologies in Belgium. *Social Science & Medicine* 346: 116620. <https://doi.org/10.1016/j.socscimed.2024.116620>
- Lieievrouw E, Marelli L and Van Hoyweghen I (2022a) The FDA's standard-making process for medical digital health technologies: co-producing technological and organizational innovation. *BioSocieties* 17: 549–576. DOI: 10.1057/s41292-021-00232-w.
- Lieievrouw E, Marelli L and Van Hoyweghen I (2022b) The Role of US Policymaking in the Emergence of a Digital Health Assemblage. *Science as Culture* 31(1): 72–91. DOI: 10.1080/09505431.2021.2025214.
- Lobe B, Morgan D and Hoffman KA (2020) Qualitative Data Collection in an Era of Social Distancing. *International Journal of Qualitative Methods* 19: 160940692093787. DOI: 10.1177/1609406920937875.
- Löbker W (2021) #5 Tipps für DiGA-Antragsteller. In: *BfArM-Blog*. Available at: https://www.bfarm.de/DE/Aktuelles/Blog/_docs/2021-10-06-tipps-diga-antragsteller.html;jsessionid=25BE03F3A688593BE0566610A5F359F9.internet271?nn=1017174 (accessed 25 June 2023).
- Löbker W, Böhmer AC and Höfgen B (2021) Innovationsunterstützung im BfArM – Erfahrungen aus den Beratungen zu digitalen Gesundheitsanwendungen (DiGA). *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 64(10): 1241–1248. DOI: 10.1007/s00103-021-03410-0.
- Lucivero F and Prainsack B (2015) The lifestylisation of healthcare? 'Consumer genomics' and mobile health as technologies for healthy lifestyle. *Applied & Translational Genomics* 4: 44–49. DOI: 10.1016/j.atg.2015.02.001.
- Ludewig G, Klose C, Hunze L et al. (2021) Digitale Gesundheitsanwendungen: gesetzliche Einführung patientenzentrierter digitaler Innovationen in die Gesundheitsversorgung. *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 64(10): 1198–1206. DOI: 10.1007/s00103-021-03407-9.
- Lupton D (2014) Beyond Techno-Utopia: Critical Approaches to Digital Health Technologies. *Societies* 4(4). 4. Multidisciplinary Digital Publishing Institute: 706–711. DOI: 10.3390/soc4040706.
- Marelli L, Lieievrouw E and Van Hoyweghen I (2020) Fit for purpose? The GDPR and the governance of European digital health. *Policy Studies* 41(5): 447–467. DOI: 10.1080/01442872.2020.1724929.
- Marent B and Henwood F (2022) Digital Health. In: Chamberlain K and Lyons AC (eds) *Routledge International Handbook of Critical Issues in Health and Illness*. Routledge International handbooks. London and New York: Routledge, pp. 261–275.
- McGee K (2015) On Devices and Logics of Legal Sense: Toward Socio-technical Legal Analysis. In: McGee K (ed) *Latour and the Passage of Law*. Edinburgh: Edinburgh University Press, pp. 61–92.
- Mol A (1999) Ontological Politics. A Word and Some Questions. *The Sociological Review* 47(1_suppl): 74–89. <https://doi.org/10.1111/j.1467-954X.1999.tb03483.x>

- Morozov E (2013) *To Save Everything, Click Here. The Folly of Technological Solutionism*. First edition. New York: PublicAffairs.
- Petersen A (2019) *Digital Health and Technological Promise. A Sociological Inquiry*. London: Routledge. DOI: 10.4324/9781315200880.
- Potthast J (2012) Politische Soziologie technischer Prüfungen. *Leviathan* 40(4) 536–562. DOI: 10.5771/0340-0425-2012-4-536.
- Potthast J (2017) The Sociology of Conventions and Testing. In: Benzecry CE, Krause M, and Reed IA (eds) *Social Theory Now*. Chicago: University of Chicago Press, pp. 337–360.
- Rivas C (2018) Finding themes in qualitative data. In: Seale C (ed) *Researching Society and Culture*. London: Sage, pp. 431–453.
- Rubin HJ and Rubin IS (2012) *Qualitative Interviewing. The Art of Hearing Data*. 3rd ed. Los Angeles London New Delhi Singapore Washington DC: SAGE.
- Schudt F, Rohloff-Meinke C, Koehler N, Sohrabi K, Gross V and Scholtes M (2022) A Comparative Overview of Digital Health Applications between Belgium and Germany. *Current Directions in Biomedical Engineering* 8(2): 509–511. <https://doi.org/10.1515/cdbme-2022-1130>
- Sharon T (2018) When digital health meets digital capitalism, how many common goods are at stake? *Big Data & Society* 5(2): 2053951718819032. DOI: 10.1177/2053951718819032.
- Silverman D (2006) *Interpreting Qualitative Data. Methods for Analysing, Talk, Text and Interaction*. London: Sage.
- Simon V (2018) iMaschine2. Music-Making Apps and Interface Aesthetics. In: Morris JW and Murray S (eds) *Appified. Culture in the Age of Apps*. ADD LOCATION: University of Michigan Press, pp. 266–275.
- Techniker Krankenkasse (2022) *DiGA-Report 2022*. Hamburg.
- Torous J, Stern AD and Bourgeois FT (2022) Regulatory considerations to keep pace with innovation in digital health products. *npj Digital Medicine* 5(1): 121. DOI: 10.1038/s41746-022-00668-9.
- van Dijk N (2015) The Life and Deaths of a Dispute: An Inquiry into Matters of Law. In: McGee K (ed) *Latour and the Passage of Law*. Edinburgh: Edinburgh University Press, pp. 160–196.
- Wieser B (2019) Digitale Gesundheit: Was ändert sich für den Gesundheitsbegriff? *Österreichische Zeitschrift für Soziologie* 44(4): 427–449. DOI: 10.1007/s11614-019-00389-6.
- Williams R, Will C, Weiner K et al. (2020) Navigating standards, encouraging interconnections: infra-structuring digital health platforms. *Information, Communication & Society* 23(8): 1170–1186. DOI: 10.1080/1369118X.2019.1702709.
- Wolfangel E (2023) Wenn Hacker mit Gesundheits-Apps besonders leichtes Spiel haben. *Die Zeit*, 9 May. Available at: <https://www.zeit.de/digital/datenschutz/2023-05/gesundheitsapp-datenschutz-depression-edupression-sicherheitsluecke> (accessed 30 July 2023).
- Zippel C and Bohnet-Joschko S (2017) Post market surveillance in the German medical device sector – current state and future perspectives. *Health Policy* 121(8): 880–886. DOI: 10.1016/j.healthpol.2017.06.005.

Notes

- 1 A “unique feature” (Blümel et al., 2020: xxii) of the German healthcare system is the co-existence of statutory and private health insurance. Specific professions (especially public servants) and residents with a salary above a certain threshold can opt out of the mandatory statutory insurance and choose private insurance. As of 2020, this was the case for around 11% of the German population (Blümel et al., 2020). Privately insured residents do not have a legal entitlement to the remuneration of the DiGA and private insurance may cover the prescription of apps not approved by the BfArM.
- 2 This means that the boundary between consumer technology and medical device that digital apps blur has, to a certain extent, already been settled: The app must already be a legal object although it has not become a DiGA.
- 3 Even if this vision of interoperability is not extended beyond the German context, it cannot be disentangled from broader debates. On the one hand, the BfArM presents itself as closely networked with other authorities in Europe, being in “close cooperation at national and European level” (Broich et al., 2021: 1293). On the other hand, the vision dovetails with debates and imaginaries of digital health on the level of the European Union (Felt, 2025).
- 4 This also differs from the way that medical devices are treated according to the EU’s MDR. The MDR calls for clinical trials only for high-risk medical devices. However, DiGAs can only belong to risk classes I or IIa defined by the MDR. Still, for their approval as DiGAs clinical efficacy needs to be proven.

Conceptualising Processes of User Learning in Domestication Theory: What, why, and how?

Bryony Parrish

Environmental Change Institute, School of Geography and the Environment
University of Oxford, UK/ bryony.parrish@ouce.ox.ac.uk

Abstract

The idea that users learn about new technologies in order to make them work within their daily lives is an important concept in domestication theory. It offers a way to conceptualise technology-user co-construction across household- and societal-level trajectories, and can be applied to identify policy relevant insights. However, while cognitive, symbolic and practical dimensions of learning in domestication are well established, processes of *how* users learn remain under-conceptualised. To address this gap, this paper employs process analysis to examine how users learned about a novel lower-carbon home heating technology (smart hybrid heat pumps). Starting from the principle that learning emerges from interactions between elements of technologies and of users' daily lives, it abductively develops a framework of four learning processes: *receiving*, *experiencing*, *interpreting* and *responding*. It illustrates how these four interlinked processes give rise to cognitive, symbolic and practical learning, then discusses their role in domestication trajectories and implications for policy.

Keywords: Domestication Theory, Users, Learning, Process Analysis, Smart Hybrid Heat Pumps

Introduction

Domestication theory offers important insights into possible outcomes when users encounter new technologies. It highlights that users do not passively consume technologies, but actively construct their meaning and use. This challenges technological determinism: the assumption that technology impact is inherent within technological artefacts. Users' routines and identities may also change through domesticating technologies. Conceptualising domestication as processes of *learning* about technologies illuminates how this co-construction of technologies and users develops over time and across multiple scales, includ-

ing households and wider society (Sørensen, 1996, 2006).

Nonetheless, certain aspects of learning within domestication remain under-conceptualised. Emphasis has been placed on *why* learning happens: because users seek to make new technologies 'work', practically and symbolically, within their daily lives; and *what* types of learning occur. *Cognitive* learning involves users constructing understandings about what new technologies are for and how they work; *symbolic* learning involves the construction of meanings associated with technologies; and *practical* learning involves



This work is licensed under
a Creative Commons Attribution 4.0
International License

constructing routines of use in daily life (Sørensen et al., 2000; Sørensen, 2006). However, a general conceptualisation of *how* learning emerges has not been developed.

This paper responds to calls to further develop conceptualisations of learning processes in domestication theory (Juntunen, 2014) by addressing the question: taking domestication theory as a starting point, how can processes of user learning about a new end-use energy technology be conceptualised? The question is addressed through analysing user learning about an innovative energy efficient and smart automated home heating technology called smart hybrid heat pumps (SHHP) in the context of a technology trial. This paper presents findings of a process analysis (Pettigrew, 1997; Langley, 1999) based on repeat semi-structured interviews and observations with members of ten participating households. The analysis elaborates on the concept that cognitive, symbolic and practical learning emerge from interactions between technologies and users by identifying four interlinked learning processes, each of which emerges from interactions between elements of new technologies and users' daily lives:

- *Receiving* emerges from interactions between information that is available to users, and information that is important to users.
- *Experiencing* emerges from interactions between technology characteristics and users' routines and material arrangements.
- *Interpreting* emerges from interactions between information received and experiences, and meanings and understandings users hold.
- *Responding* emerges from interactions between meanings and understandings users hold, and strategies, actions and resources available to them.

The paper then discusses how this framework could inform actions aiming to influence learning processes in support of policy objectives, such as reducing greenhouse gas emissions from homes through the deployment of new end-use technologies (see also Sørensen, 2013).

The paper proceeds by outlining existing conceptualisations of learning in domestication theory, before detailing the methodological approach employed to develop these. It then presents empirical evidence to illustrate the four learning processes and their relationship to cognitive, symbolic and practical learning. The paper concludes by discussing contributions to conceptualisations of users' learning within domestication theory; policy implications; and opportunities for further work.

Conceptualisations of learning in domestication theory

Conceptualising domestication as learning

Domestication describes processes that occur as users seek to make technologies 'work' within their daily lives, expressing the idea that users must "tame" "wild" technologies so that they become meaningful, useful and familiar (Sørensen, 1996: 10, 2006: 45). Domestication theory originated in media and cultural studies, which highlighted that 'working' implies the creation of both routines of use and meanings, and defined four phases through which this occurs (Silverstone et al., 1992):

- Appropriation: acquiring technology
- Objectification: physically placing and displaying a technological artefact
- Incorporation: using technologies as part of the routines of daily life
- Conversion: using technologies in symbolic communication outside of the household

Domestication theory was developed within science and technology studies (STS) to bridge between two contrasting understandings of technology-user interaction. On the one hand, work on the social construction of technology (SCOT) highlighted technologies' *interpretive flexibility*, or the potential for technological artefacts to develop diverse meanings when appropriated by different user groups (Oudshoorn and Pinch, 2003). On the other hand, the concept of *technology script* highlighted how designers' ideas about expected or correct use are embodied within material features of technological artefacts, and enable or constrain use (Akrich, 1992). Influences

such as social norms, advertising and authoritative voices may also act to script the “proper” use of technology (Bakardjieva, 2006:74).

Sørensen (1996) suggested that conceptualising domestication as a form of *social learning* – which emerges through interactions between groups, such as designers and users of artefacts – can bridge this apparent disconnect. The concept of user learning simultaneously illuminates how technologies contribute to the development of users’ routines and identities, and how users contribute to create technologies’ meanings and uses. Active learning, rather than passive reception of new technologies, occurs because users read and translate scripts to make technologies designed for ideal users ‘work’ in their own particular contexts (Akrich, 1992; Sørensen, 1996).

Building on the conceptualisation of domestication as learning and the four domestication phases, Sørensen, Aune and Hatling (2000) identified three more generic ‘dimensions’ of domestication processes. The *practical* dimension involves users’ construction of patterns of use; the *symbolic* dimension involves the construction of meanings associated with technology, potentially including users’ own identities; and the *cognitive* dimension involves learning about artefacts and appropriating knowledge. Each dimension involves cognitive processes (Sørensen, 2006), though it is important to remember that users learn as part of efforts to make new technologies “function and make sense” rather than to develop technically correct understandings (Sørensen et al., 2000, 240). The three dimensions can be understood as categories of learning occurring in domestication (Hargreaves et al., 2017; Parrish et al., 2021).

Current conceptualisations of learning within domestication theory and opportunities for conceptual development

There is longstanding interest in analysing processes of user learning during domestication. As Sørensen (1996: 3) explains,

“What we want to achieve by studying social learning is to be able to highlight the temporal dimension of sociotechnical change, and thus to clarify the processes that may explain the particular

features of a given trajectory of technological impacts.”

Understanding the emergence of these impacts – including “the construction of new practices, of new needs, and new demands” Sørensen (1996: 4) – is highly relevant for policy. For example, the adoption and use of new technologies in the home has been associated with trajectories of increasing expectations of comfort, cleanliness and convenience, and associated environmental impacts via increased use of energy and other resources (Shove, 2003). Studying domestication as social learning holds the potential to examine the “microhistory” (Sørensen, 1996: 3) of the relationship between technology and culture through which such trajectories emerge. However, the processes through which users learn have remained conceptually underdeveloped.

The previous section indicates that current conceptualisations of learning in domestication theory identify why users learn about new technologies – to read and translate scripts and make new technologies ‘work’ as part of their daily lives – and what types of learning are involved – cognitive, symbolic and practical learning, at the level of households and wider society. A wide range of influences on processes of domestication have also been identified. As well as being influenced by technology and other forms of script, domestication involves users responding to the interests and needs of themselves and others, for example members of their household or wider social network (Sørensen, 1994, 2006; Bakardjieva, 2006). This can involve negotiation between household members with different interests and needs (Nyborg, 2015), which may also change throughout users’ lives, for example with retirement or the arrival of children (Bakardjieva, 2006; Haddon, 2006; Juntunen, 2014).

Further influences are the range of *resources* users are able to draw upon. These include individuals’ competences or skills (Sørensen, 1996), households’ access to economic resources, which can influence technology acquisition and use (Bakardjieva, 2006), and existing material arrangements in the home that can impact on the incorporation of new technologies (Juntunen, 2014). Domestication can also be influenced by resources

available at a societal level, such as infrastructures, technological alternatives, and socially circulating meanings (Sørensen, 1994, 2006). For example, the domestication of private cars is influenced by road and other infrastructures, the availability of alternatives such as public transport, and the range of socially circulating meanings associated with driving or not driving a car, such as ideas of individual freedom or environmental harm and protection (Sørensen, 2006). While diverse meanings may support diverse patterns of use or non-use, domestication may also be disciplined by social norms and expectations so that non-use requires considerable effort: for example, it may be difficult to resist conforming with socially dominant meanings that 'good' parenting requires driving a car to transport children (Sørensen, 2006).

Such resources may change over time. Users' past experiences and prior domestications can suggest strategies and actions for practical learning (Sørensen, 1994) and influence technology uptake and symbolic learning (Haddon, 2006), for example by increasing users' trust in a technology type (Juntunen, 2014). Prior domestication processes can also alter material arrangements in the home with implications for new technologies' adoption (Juntunen, 2014). Societal-level resources also change over time, including via collective household-level domestication processes, which can change social norms and influence marketing and design via market research and designers' ideas about users (Silverstone, 2006; Sørensen, 2006). The observation that outcomes of household-level domestication processes, and their emergent societal-level outcomes each influence "possibilities of learning new ways of doing and thinking" about technology (Sørensen, 2006: 56) have been conceptualised as domestication pathways (Juntunen, 2014) or trajectories (Sørensen, 2006).

Notwithstanding these contributions, *processes* illuminating how learning emerges during domestication remain under-conceptualised. Previously identified processes, such as learning-by-doing (Ryggaug and Toftaker, 2014; Hargreaves et al., 2017), learning-by-using (Juntunen, 2014) or learning by trial-and-error (Sørensen, 1996; Sørensen et al., 2000), do capture essential characteristics of users' learning about new technologies, namely, that learning occurs during use and is of a

practical nature: seeking to make the technology 'work', rather than (necessarily) developing a technically correct understanding such as might be sought by consulting a users' manual or a qualified expert. The concept of trial-and-error also expresses the potential for users to learn about technologies creatively, developing approaches to learning that work within their daily lives. Nevertheless, these concepts remain rather abstract and do not support a detailed analysis of how and why learning about technology unfolds, including how this varies between different households. In a recently published handbook on domestication theory (Hartmann, 2023) this gap remains unaddressed.

The conceptual framework developed in this paper contributes to articulate how users' learning emerges through the interplay of different influences. Conceptualising of learning processes could help to inform policy by more closely relating influences on users' learning (such as peers, installers, or technology design) to outcomes of cognitive, symbolic or practical learning, in turn suggesting specific ways in which these outcomes might be influenced in support of policy objectives. In a previous study, I was able to show how policy-relevant outcomes emerged from users' learning about smart hybrid heat pumps and identified ways in which actors such as installers might influence these outcomes (Parrish et al., 2021). This paper builds on Parrish et al. (2021) by developing a generic framework of learning processes to support the application of a similar approach to other contexts and technology types.

Methodology

Overall approach: data collection and process analysis

Process analysis involves looking for patterns within temporally ordered data to answer questions about how and why change or stability may occur (Langley et al., 2013). In contrast with so-called variance approaches (such as regression analysis) which render time as simply a 'medium' in which pre-defined variables act on one another (Van De Ven and Poole, 2005), examining temporal progression enables interactions between

elements to be studied, and emergent outcomes identified (Abbott, 1988, 2007). This makes process analysis well suited to analysing user learning within domestication theory.

Process analysis was applied to analyse semi-structured interviews and observations with ten households and two installers involved in the FREEDOM Project trial (Turvey et al., 2018) of smart hybrid heat pumps (SHHP). This UK government funded and industry led trial was conducted over the heating season of 2017-2018 with 75 households in Bridgend, South Wales. SHHP comprised electrically-driven air source heat pumps in combination with natural gas (fossil methane) fuelled boilers. This configuration was designed to enable the majority of space heating to be provided by the heat pump, while switching to the boiler during peak heat demand. Natural gas currently fuels most home heating in the UK, and it has been suggested that SHHP could help to avoid or defer the electricity network expansion required to support heat pump deployment (CCC, 2018, 2019).

Smart controls automated operation of SHHP, including switching between electricity and gas. App-based controls allowed users to input their desired temperature settings and timings for each day of the week, and remotely check and adjust heating using mobile devices. Wall-mounted thermostats also allowed temperatures to be checked and adjusted, though without changing the programmed schedule.

All interviewed households had 'wet' heating systems, where heated water is circulated through pipes to wall mounted radiators. The majority were connected to natural gas distribution networks, or 'mains gas', but two had boilers fuelled by relatively expensive liquid petroleum gas (LPG), delivered by road and stored in outdoor tanks. Most households in the UK have wet heating systems fuelled by mains gas, and often heat their homes solely in the morning and evening (Hanmer et al., 2019). However, unlike gas boilers, heat pumps operate more efficiently if they are run more constantly; in line with this, average heat pump peak electricity demand during the trial was measured at 04:00am and 14:30pm (Turvey et al., 2018). Domestic hot water was provided exclusively by the boiler element of SHHP and was available on demand,

with app-based controls relating to space heating only. The analysis in this paper focusses on users' learning related to SHHP providing space heating, including use of controls, as these were more novel aspects of the technology.

To investigate users' learning about SHHP over time, semi-structured interviews were conducted with household users at two time points: initial interviews during or soon after technology installation, and follow-up interviews towards the end of the trial. Parrish et al. (2021) includes details of topic guides' content and their development. All user interviews took place in users' homes and included any adult household members who wished to take part. Following the trial, semi-structured interviews were conducted with the two installers responsible for setting up trial controls with the users; in six cases it was also possible to observe the final stage of installation, where installers explained trial equipment and set up controls with users. Processes of learning were identified primarily through analysis of user interviews, with analysis of installer interviews and observations employed to gain further insights into how these emerged.

14 households were interviewed in total. Of these, one declined a follow-up interview, while SHHP controls did not function as intended for another three. This paper analyses learning in the 10 remaining households. Table 1 summarises their composition, and indicates that many interviewees had occupations relating in some way to energy or technology, which may have influenced learning about SHHP. An overview of household composition is also presented as this may influence routines of using. As each household represents a case for the purposes of process analysis, this sample aligns with the recommendation to focus process analysis around careful comparison of a relatively small (6-10) number of cases (Pettigrew, 1997).

Steps in applying process analysis

Data analysis to conceptualise processes of user learning involved four main steps:

Table 1. Description of interviewed households

Interviewee(s) (all pseudonyms)	Household circumstances
Richard and Sophie	Working couple with a child at university. Richard teaches engineering at college while Sophie works for the local council.
Alan and Carol	Retired couple with adult children. Alan worked as a carpenter.
Anne and Cai	Retired couple with adult children. Cai worked as an electricity system engineer.
Jim and Rachel	Couple with adult children, one living at home. Jim works in the electricity sector while Rachel is often at home.
Ruth and Harry	Working couple. Ruth works for the local council while Harry is a toolmaker.
Clive	Couple with adult children, two living at home.
Hayley	Couple with three children. Hayley is a homemaker, her husband works as a carpenter.
Nick	Single man who works in a factory producing petrol engines.
Laura	Working couple with two children. Laura is a primary school teacher.
Paul	Working couple with children. Paul works in the electricity sector.

1. Themes of receiving, experiencing, interpreting and responding emerged though inductively coding user interviews, and process analysis was selected as an approach to abductively develop their conceptualisation.

Coding structures for initial and follow up user interviews were developed separately, and higher-level themes of receiving, experiencing, interpreting and responding emerged when these separate coding structures were merged (see Data Analysis A).

Rather than drawing on existing conceptualisations of learning in socio-technical systems (see, for example, van Mierlo and Beers, 2020), an abductive approach was chosen to remain firmly grounded in existing conceptualisations of learning in domestication theory, including giving equal weight to practical and symbolic as well as cognitive dimensions of learning. Drawing on existing notions of interactions between technologies and users, and households and wider society in domestication theory (Silverstone, 2006; Sørensen, 2006), the analysis sought to conceptualise users’ learning as *emerging from interactions between elements associated with the new technology and with users’ daily lives*. Process analysis supported this as it enables identification of processes through analysis of complex empirical data (Langley, 1999), and is well suited to study interactions (Abbott, 2007).

Analytical chronologies – temporally sequenced written data, “reaching towards theory presentation” by testing analytical vocabulary and identifying preliminary patterns and sequences (Pettigrew, 1997: 346) – were prepared to confirm the usefulness of the four themes before proceeding (see example in Data Analysis B).

2. To structure process analysis, concepts of cognitive, symbolic and practical learning were used to identify outcomes of user learning.

Process analysis is facilitated by identifying defined “outcomes” in the data, then seeking explanations about how these arose (Pettigrew, 1997: 342-344). To do this, the established concepts of cognitive, symbolic and practical learning in domestication were operationalised as follows:

- Cognitive: understandings related to what SHHP does and how it works.
- Symbolic: meanings related to feelings that users communicated about SHHP or symbolic understandings. Symbolic understandings were differentiated from cognitive understandings based on a judgement of whether the user could explain why they held the idea (irrespective of whether the explanation was technically correct).
- Practical: routines of interacting with SHHP controls and of using heat (such as using

heating to dry laundry or care for children, or using different approaches to create thermal comfort).

These outcomes do not denote any final result of domestication, but understandings, meanings and uses observed at particular moments in time.

3. Three temporal periods were defined to further structure process analysis.

Defining temporal periods is a common way to structure process analysis. It enables conceptual ideas to be replicated in successive time periods and helps to analyse how processes progress and interact over time (Pettigrew, 1997; Langley, 1999; Langley et al., 2013). The domestication phases discussed above cannot fulfil this function as they do not follow a temporal progression. Instead, three temporal periods were identified based on “discontinuities” observed in the empirical data (Langley et al., 2013: 7):

1. *Uptake/installation*: the time period over which interviewees decided to become involved in the trial and had the SHHP installed in their homes; relates primarily to technology adoption rather than use.
2. *Early use*: characterised by an initial period of adjusting control settings (often referred to by interviewees as “tweaking” or “playing” with settings) and forming initial routines of using SHHP.
3. *Later use*: this temporal period simply follows early use and extends until the end of the period of analysis. It had different characteristics in different households: for example, in some households, routines created in early use remained largely undisturbed throughout later use, while in others these changed following a period of cold weather.

4. Using these two structuring devices, influences on learning outcomes were identified for separate households, then categorised into generic elements interacting in learning processes.

Influences on cognitive, symbolic and practical learning about SHHP across the three temporal periods were identified for each household separately (see example in Data Analysis C).

The synthesis of these influences into generic elements was supported by creating visualisations: an approach used in process analysis to move towards greater generalisation and abstraction (Langley, 1999). Visualisations were sketched by hand and developed iteratively, responding to questions and insights arising with each iteration (see examples in Data Analysis D). Constructing visualisations forced synthesis into generic elements able to capture a range of specific influences on learning. As visualisations were structured across the three temporal periods, their construction also supported longitudinal replication and testing (Langley et al., 2013) of learning process’ conceptualisation.

Conceptualising users’ learning about smart hybrid heat pumps in the FREEDOM Project trial

This section identifies four interlinked processes through which users learn about new technologies during domestication: *receiving*, *experiencing*, *interpreting* and *responding*. Each process emerges from interactions between two elements, which relate to different aspects of the technology and of users’ daily lives. The section is structured around the temporal periods of uptake and installation, early use, and later use to illustrate how analysis across these three temporal periods enabled conceptualisations of the learning processes to be developed, tested and refined. Finally, the conceptualisation of learning processes based on this analysis are summarised: Table 2 summarises the interacting elements involved in each learning process, while Figure 1 summarises interlinkages between the four learning processes, and their relationship to outcomes of cognitive, symbolic and practical learning.

Uptake and installation: conceptualising processes of receiving and interpreting

Across all interviewed households, users’ learning during the period of uptake and installation mainly involved constructing understandings and meanings about SHHP (cognitive and symbolic learning). This involved the processes of users *receiving* information, and *interpreting* this information by drawing on meanings and understandings they already held.

Receiving

The process of receiving information varied between users according to their needs and interests. For example, some interviewees explained that they focussed on receiving practical information about the controls, and paid less attention to more technical details:

A new sort of system on the market, that - with a heat pump. I didn't understand any of that.

Everything he [installer] said to me really was just more - I was in a rush as it is, right, app is on here, OK. (Nick, initial interview)

Other users actively sought information to learn about elements of the technology that are important to them. This could involve questioning installers, online research or consulting social networks. For example, Jim (initial interview) explained that "That's why I went on the internet, to look at it... I like electronics." Hayley (initial interview) explained that "My husband's in the trade, he was asking different people [...] to see if they thought it was suitable", and Laura used online research to gain reassurance about the legitimacy of the trial itself:

So often you get people trying to push solar panels, and this and that, and you think what is your motive? Because there are a lot of schemes, aren't there, that seem too good to be true, and I did wonder. But yeah, I read up and realised that it's actually a bona fide trial! (Laura, initial interview)

These quotes illustrate how users' needs and interests influence their attention to information that is presented to them, for example by installers, as well as decisions to seek additional information about new technologies. Thus, the process of *receiving* information can be conceptualised as emerging from the interaction between the *information available to users* and *information important to users* as they seek to make new technologies 'work'.

It is important to note that this way of thinking about users receiving information does not imply falling back on ideas about passive users and 'information deficit' models (e.g. Simis et al., 2016). Users are active when they direct their attention to different parts of the information provided to

them, for example by technology installers and written materials provided about the technology. Empirical data presented across the empirical analysis in this paper illustrates how users also actively sought additional information: from installers, members of their social networks, the internet, and in one case a fellow triallist who made contact after seeing the heat pump unit installed on the outside of a house. In either case, users decide what information is important to them, guided by their needs and interests.

Interpreting

To construct understandings and meanings about SHHP, users drew on existing understandings and meanings that they associated with information received about the new technology. For example, a previous analysis of this data identified that many interviewees constructed the cognitive misconception that heat pumps cannot provide space heating at lower outdoor temperatures. This may have resulted from users interpreting the information that heat pumps are less *efficient* at lower outdoor temperatures, provided by installers, to construct the understanding that they are not *effective* at these temperatures (Parrish et al. 2021). This illustrates how the construction of understandings (cognitive learning) may be influenced by users' existing understandings of technical language.

When constructing meanings (symbolic learning), interviewees often associated SHHP with experiences of or ideas about "smart" technology and app-based controls more generally. For example, Harry (follow-up interview) related the SHHP controls to technologies he already used, including online banking and his car notifying him of low tyre pressure, and concluded "everything's smart now, so why wouldn't your heating be?". Meanwhile, Hayley (initial interview) made sense of new smart heating controls that she found "a bit scary" with the reflection that "that's the way technology is going, though, isn't it? With everything."

These quotes illustrate how processes of *interpreting* emerge from interactions between *information received* and *meanings and understandings* users already hold: including cognitive understandings of technical language, meanings

derived from users' prior experiences of technologies they associate with the new technology, or ideas about technological progress more generally. They indicate how cognitive and symbolic learning emerge through inter-linked processes of receiving and interpreting. The following sub-section further develops the conceptualisation of interpreting by illustrating how users may interpret their *experiences* of technology, as well as information received.

Early use: conceptualising processes of experiencing, interpreting and responding

This temporal phase involved users developing routines of using the new technology (practical learning). This sub-section illustrates how this practical learning emerged from processes of users *experiencing* the SHHP system, *interpreting*, and *responding* to their experiences.

Experiencing

Users' experiences of SHHP formed an important part of developing routines of use. These varied between households due to interactions between *characteristics of the technology* and users' existing *routines and material arrangements*.

For example, night-time heating was characteristic of SHHP because heat pump efficiency generally increases with more constant operation. This differed from interviewees' previous routines of using heat. However, although many interviewees described experiencing warmer temperatures during the night-time, this was not the case for Richard and Sophie: they "always have the [bedroom] window open, because fresh air's good for you" (Richard and Sophie, initial interview). Clive similarly did not experience night-time heating. He explained that "we just like a cold bedroom. Window is never closed" and that he does not have a radiator installed in his master bedroom:

When I was young we used to go down to my Auntie's farm.... I always remember going in the bedroom one evening, and the snow was coming in the windows, and she had about that much, the old-fashioned blankets, sheets and quilts, and eiderdowns as they called them, that thick, and I know where she's coming from now... So we don't have a radiator in there. (Clive, initial interview)

These quotes illustrate how processes of experiencing heating varied due to users' existing routines of opening windows, and material arrangements of radiator installation. Similarly, more constant day-time heating provided by SHHP was only experienced by interviewees whose existing routines meant they were sometimes at home during the day.

Experiences of SHHP controls also varied due to users' prior routines of using apps and mobile devices. For example, Alan (follow-up interview) explained that "I've only got a clockwork phone, anyway. The others do my head in". Consequently, he experienced the wall-mounted thermostat as easier to use than the app-based controls:

If you're just walking by [the thermostat], saves getting the iPad out or whatever you call it. Saves getting that out and switching it on. (Alan, follow-up interview)

Conversely, users with existing routines of using smartphones and apps experienced the app-based controls as easier to use, and even "addictive":

Before if it got a little bit too hot, and I was lazy just laying on the settee thinking I can't be arsed to get up and touch the thermostat, I'd leave it. At least with my phone it's just right next to me. I'll check the app, what it is, and just turn it down a little touch. So I manage it a lot more now, on the app, than I would before. (Nick, initial interview)

You do find it addictive! I do, I get into work sometimes in the morning, and I check my Facebook, and I check [...] WhatsApp, and then I usually see what the heating's doing. (Harry, initial interview)

These quotes illustrate how processes of *experiencing* emerge from *interactions between technology characteristics* (such as more constant heating and designed features of controls) and *users' routines and material arrangements* (including the location of radiators, and routines of time spent in the home, opening windows, and using apps and mobile devices). The following sub-section illustrates how differing patterns of practical learning suggest processes of experiencing may be followed by processes of *interpreting* and *respond-*

ing as users endeavour to make new technologies ‘work’.

Interpreting

Building on the previous section, this sub-section further conceptualises the process of *interpreting* by illustrating how users interpret their *experiences*, as well as information they receive. While users sometimes acted to change their experiences of heating from SHHP to fit their existing routines, they also changed some routines to fit novel experiences; these contrasting patterns of practical learning can be understood to follow users *interpreting* which of their experiences represent SHHP ‘working’.

During early use, most interviewees adjusted SHHP control settings to make experiences of heating by SHHP better fit their existing routines. For example, Hayley adjusted the heating schedule to better fit her routines of caring for her family:

We were putting it to come on a little bit earlier, so it was warm for when the children come home from school. (Hayley, follow-up interview)

Other households changed control settings with the aim of avoiding or reducing night-time heating which they experienced as uncomfortably warm. For example, Anne (initial interview) commented that “I nearly melted away last night... so I’ve turned the radiator in the bedroom just about off today”. Similarly, Alan (follow-up interview) explained that “We don’t like it too warm in the nights”, and interpreted the experience of night-time heating as surprising and unwelcome:

In the beginning, you wake up in the night and think good God, it’s warm here! You’re throwing your duvet off. (Alan, follow-up interview)

By contrast, households who experienced more constant day-time heating all changed their routines to fit this novel experience. For example, Alan (initial interview) explained that with their former heating system “Because we’re busy people we don’t tend to have it on a lot in the day”. However, he explained that with the new SHHP:

I think the system is great, because the house is never cold. You know, sometimes you’re out, and you come in and think, Oh, God! So you turn the heating up, and then you’ve got to sit there for half an hour with your coat on, you know what I mean? So I think the system is great in that respect, ‘cause you come in, you can take your coat off straight away because it’s not uncomfortable. (Alan, follow-up interview)

Interpreting experiences can thus result in constructing specific meanings of SHHP technology (symbolic learning), such as that “the system is great”, alongside influencing practical learning.

Responding

The process of *responding* helps to understand the actions users take after interpreting their experiences. This sub-section illustrates how the process of responding emerges from interactions between *meanings and understandings* users construct about technology and *actions and resources* they can access and use.

After his living room temperatures rose following installation of the SHHP thermostat, Clive adjusted his thermostat settings based on the new SHHP thermostat being located in his hallway, rather than living room. He explained how understanding thermostat operation informed this response:

A thermostat in a hallway is not the ideal place to put it. Usually it should go in your living area. And from my point of view, my hallway is always colder than everywhere else. So I brought it down here into the lounge, but found that it lost signal [...] So I had to put it back into the hallway [...] what I’ve had to do is reduce the temperature on that thermostat to compensate for it being colder out there, and giving me the ideal temperature in here. (Clive, follow-up interview)

Similarly, Alan explained how an understanding he constructed during the trial, that more constant heating is more efficient, meant he responded to experiences of night-time heating by turning down thermostatic valves (TRVs) on his bedroom radiators rather than reducing the night-time temperature setting in the app:

I think you're defeating what you're trying to do then, aren't you? You're warming up from nearly zero, then, up to where you want it. So it's back to the old system, then, before they put this in. (Alan, follow-up interview)

These quotes illustrate that processes of responding can involve pre-existing or newly constructed *understandings* related to new technologies, together with access to *resources* such as TRVs, and repertoires of appropriate *actions*, such as adjusting thermostat control settings.

Meanings can also form part of processes of responding. The previous sub-section introduced the idea that processes of responding arise from users interpreting their experiences as SHHP 'working' or not working. Meanings constructed through interpreting information received about SHHP can also inform responding. For example, Paul explained that constructing meanings of SHHP as a more "efficient" and "economic" system (Paul, initial interview) contributed to his household increasing their use of heat compared to their former LPG-fuelled boiler. These meanings enabled Paul to respond in line with socially circulating meanings that 'proper' modern heating involves heating multiple rooms in the house: he described the SHHP as a "truly usable system" (Paul, follow-up interview) because it allowed them to depart from their previous "olden days" routines:

We'd all have huddled around here [in the living room] as a family, which is a nice thing, don't get me wrong, it's back to the olden days I suppose, everyone had an open fireplace, but now that we've got rooms that are more comfortable to be in, the kids tend to go up to their own rooms now, my wife will spend more time out in the kitchen. (Paul, follow-up interview)

This illustrates how processes of responding give rise to practical learning. The following sub-section further develops the conceptualisation of responding, by illustrating how different *strategies* adopted by users form part of the interacting elements involved in this process.

Later use: further conceptualising processes of experiencing and responding

This temporal period extends from the time after households created initial routines of using SHHP (early use) to the end of the period of analysis. In later use, different households exhibited sometimes markedly different patterns of learning. Analysing learning in later use enabled processes of *experiencing* and *responding* to be further conceptualised, through applying concepts developed when analysing early use, and elaborating on these as necessary to explain new empirical observations.

Experiencing

Interviewees' accounts in later use suggest that experiences of technology can change over time. For example, with accumulated experience many interviewees stopped frequently checking or adjusting control settings in the SHHP app. Sophie initially remarked "I don't know how many times I've looked at it today - I've been showing people!" (Sophie, initial interview), but later described how:

I don't look at the app any more...three or four weeks?... That was probably about it, and then I lost interest in it. (Sophie, follow-up interview)

Sophie explained this change occurred because the information available in the app is "the same thing every day" (Sophie, follow-up interview). This suggests that her experiences of the app changed due to her initial routine of regular checking, together with the technology's characteristics. Consequently, she re-interpreted the app as uninteresting and responded by changing her routines. This replicates analysis in the temporal phase of early use by illustrating how inter-linked processes of experiencing, interpreting and responding give rise to practical learning. It also highlights that processes of experiencing involve routines constructed in the course of domesticating a new technology, as well as users' prior routines.

Responding

The role users' *strategies* can play in processes of responding was demonstrated by two households experiencing similar issues with their heating and

drawing on contrasting strategies to respond, with marked differences in learning as a result.

Both Hayley and Harry began to experience low room temperatures during a period of particularly cold weather. Their accounts, and observations of their installer working in other households, suggest this was because the flow temperature of the gas boiler component of the SHHP was initially set to 50°C (a relatively low setting) to increase efficiency. Hayley responded through the strategy of immediately asking for expert help:

We were turning it up... when we had the cold spell, but the room temperature was going up to 18[°C], it wouldn't go any higher. So [husband] spoke to [installer], and he explained we had to go upstairs and do something on the boiler, which [husband] done, so the room temperature could come up. So that's all done now. (Hayley, follow-up interview)

This enabled the household to change their experiences of SHHP relatively quickly, and they did not interpret their experiences, or information they received, to construct new understandings, meanings, or routines of use:

We don't know why, but for some reason the room temperature wasn't going up over 18. (Hayley, follow-up interview)

Hayley's account also illustrates how processes of *responding* and *receiving* can be linked if users seek additional information (for example, checking room temperatures or asking installers) as part of the process of responding. Applying the concepts of interpreting and responding to Laura's quote presented in the temporal phase uptake and installation reveals that similar processes occurred during uptake: after Laura drew on existing meanings about "people trying to push solar panels" to construct the meaning that the trial may be "too good to be true", she responded by seeking additional information in order to conclude that "it's actually a bona fide trial!". Like other forms of responding, processes of receiving are influenced by the resources available to users as well as the strategies and actions they draw upon. For example, Laura was able to seek information online because she had internet access

and could conduct this kind of research, while in the temporal phase uptake and installation Hayley describes how her husband was able to seek informal advice from tradespeople who were members of his social network.

Like Hayley, Ruth and Harry experienced a period of uncomfortably low evening temperatures, and found that changing control settings did not have the expected effect:

Ruth would say to me, it's a bit cold, turn the heating up... So I said right, I'll turn it up, to 25[°C]. And I'd sit there, and I'd think, nothing's happening. It doesn't seem to be getting any warmer. Whereas before, when we had just the gas, you'd turn it up, and the boiler would kick in, and whoomph, it would ramp up. (Harry, follow-up interview)

Unlike Hayley, Harry adopted a strategy of trial-and-error to respond to this experience, experimenting with a range of adjustments to control settings over a couple of weeks. This included *actions* drawn from previous learning about technologies Harry associated with SHHP; for example, he described how:

I went and turned it off and turned it back on again. Because to me, that's always the issue, isn't it, with electronics? (Harry, follow-up interview)

Harry also began interpreting his experiences of SHHP in ways that influenced the actions he took when responding. This was initiated by an interaction with another triallist who knocked on his door:

He said, I've noticed you've got the heat exchanger outside... and he said, I've had it installed in my house.... and he was convinced [laughing]... he said, I'm sure they're turning it down. (Harry, follow-up interview)

While Harry was initially dismissive, over time he found that "it made me think, then, because we were having these little issues" (Harry, follow-up interview). He began to re-interpret the SHHP smart controls, including through comparison with familiar technologies, and wondered whether they involved remote control in pursuit of certain objectives:

There's not a laptop downstairs running my heating system, is there? There's just a box, and I'm thinking, really? Can't be that clever. Unless it's being done remotely.

I don't know if it wasn't explained really well, but because we've got this heat exchanger, so I assume that because that uses less energy it [SHHP system] decides, I'll use that more than the gas. (Harry, follow-up interview)

This new understanding of the SHHP controls led Harry to increase temperature settings and extend the timing of the main heating periods programmed via the app, to try to counteract the controls "trying to do it so efficiently" (Harry, follow-up interview). This included raising the boiler flow temperature. However, following a strategy of trial-and-error initiated a series of learning processes that led to practical, and potentially cognitive and symbolic learning. Harry ultimately responded to his experiences by changing his routines of heating in long-lasting ways (at follow-up interview, a warm spring day, his room temperature setting remained at 23°C, compared to 19°C at initial interview). He also began to re-interpret how the SHHP operated and under whose control.

Summary of learning processes

The preceding analysis illustrated how users learn about new technologies via processes of receiving, experiencing, interpreting and responding, which emerge from interactions between elements of new technologies and elements of users' daily lives. These interacting elements are summarised in Table 2. The analysis also illustrates how the four learning processes may be interlinked, with sequences of learning processes resulting in cognitive, symbolic and practical learning. Figure 1 provides an overview of these links. Cognitive

and symbolic learning emerge from interlinked processes of users *receiving* information or *experiencing* different aspects of new technologies, then *interpreting* information and experiences to construct new understandings and meanings. Practical learning emerges from interlinked processes of *interpreting* whether experiences represent technology 'working' and *responding* accordingly. Processes of responding link back to processes of *receiving* when they involve users seeking additional information, and to processes of *experiencing* when users' actions (such as changing control settings) change their experiences of technology.

It is important to note that Figure 1 provides only an abstract summary of the relationship between the four learning processes and the three types of learning outcomes. In practice, the links between learning processes and outcomes may vary in different households and at different times. For example, returning to the empirical analysis in the temporal period later use illustrates that experiencing may not be followed by cognitive, symbolic, or practical learning if, as in Hayley's case, this is not necessary for users to make the technology work; responding may not result in practical learning if it involves one-off actions as part of a strategy of trial-and-error; and, as in Harry's case, users may pass through multiple rounds of learning processes (from responding back through receiving/experiencing) as part of a single endeavour to make technology 'work'. This reiterates that users learn pragmatically as part of seeking to make new technologies 'work', practically and symbolically, rather than to develop 'correct' knowledge or understanding, and that the outcomes of any particular domestication process remains an empirical question. The following section discusses the conceptual contribution represented by this novel framework and its wider implications.

Table 2. Four processes of user learning, emerging from interactions between elements of the technology and of users' daily lives.

PROCESS	INTERACTING ELEMENTS	
RECEIVING	Information available to users	Information important to users
EXPERIENCING	Technology characteristics	Routines & material arrangements
INTERPRETING	Information received & experiences	Meanings & understandings
RESPONDING	Meanings & understandings	Strategies, actions & resources

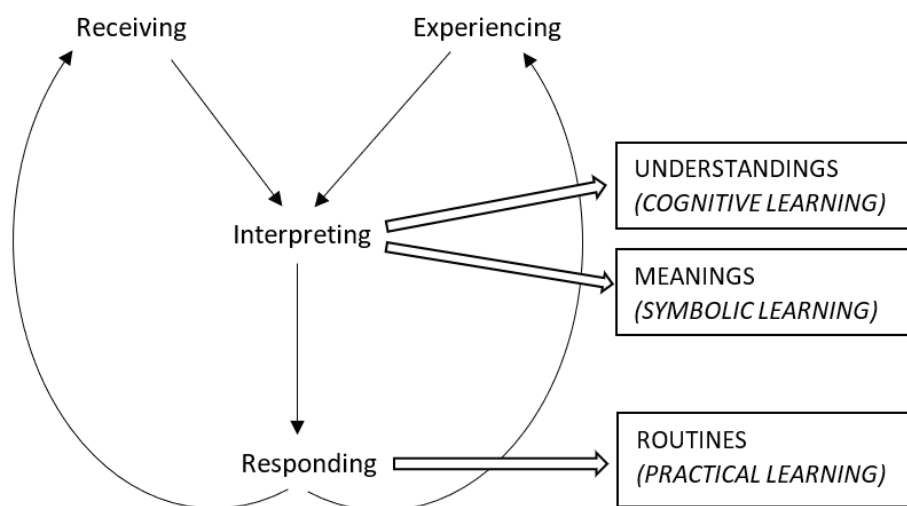


Figure 1. Links between the four learning processes and their relationship to cognitive, symbolic and practical learning. The figure illustrates overall relationships, which may unfold differently in different households and different moments in time.

Discussion and conclusions

Through a process analysis of users’ learning about smart hybrid heat pumps (SHHP), this paper develops a novel framework of four interlinked learning processes that articulates how users’ learning emerges during technology domestication. This section positions this contribution in relation to existing conceptualisations of users’ learning in domestication theory, showing how it builds upon and develops them. It then discusses how the novel framework could advance the potential for domestication theory to inform policy making, and identifies opportunities for further work.

Conceptual development

The framework developed in this paper offers an approach to understand how cognitive, symbolic, and practical learning about new technologies emerge from interactions between elements of the technology and of users’ daily lives. This conceptual approach is grounded in existing conceptualisations of interactions in domestication processes, including users’ negotiations with technology script, and societal-level elements such as social norms (see, for example, Silverstone, 2006; Sørensen, 2006). However, it goes beyond these by defining *how* cognitive, symbolic and practi-

cal learning emerge though specific interactions between defined elements. This addresses calls to further conceptualise learning processes within domestication theory (Juntunen, 2014).

The framework of learning processes builds on previous work on learning in domestication theory. By identifying that much learning takes place during technology use, it re-emphasises the importance of learning-by-doing in domestication (Ryghaug and Toftaker, 2014; Hargreaves et al., 2017), but develops conceptualisations of concrete learning processes happening within this. It also encompasses the potential for trial-and-error (Sørensen, 1996; Sørensen et al., 2000) to form an important part of users’ learning. However, it identifies this as one of a range of possible ‘strategies’ that users might adopt, and highlights that different strategies can have important implications for learning outcomes. Similarly, the framework’s definition of interacting elements builds on and supports previous work identifying various influences on users’ learning: for example, the element ‘information important to users’ can be considered as one aspect of users’ needs and interests, which are conceptualised as a central influence on domestication (see, for example, Sørensen, 1996, 2006); ‘information available to users’ may include information from

advertising and authoritative voices, previously identified in analyses such as Bakardjieva (2006) as influences on user learning; while the potential for 'existing material arrangements' and 'existing routines' to influence the domestication of new technologies has been demonstrated by analyses such as Juntunen (2014) and Judson et al. (2015). However, because the framework defines generic elements, it should be applicable to analyse users' learning about other technologies in other contexts. Defining interacting elements also offers a systematic approach to more comprehensively analyse users' learning, which can draw attention to important but less striking aspects of this. For example, while changes in routines can stand out as examples of practical learning, stability in routines is another form of practical learning, which involves continuing to interpret certain experiences as technology 'working', and responding by maintaining those routines. This invites us to consider how and why domestication processes result in change in some routines alongside stability in others, and what informs users' ideas about which experiences constitute technology 'working'.

Temporality is a key dimension of social learning, including learning during domestication (Sørensen, 1996). While the framework of four learning processes does not include an explicit time dimension, the temporal dimension of social learning is captured when outcome(s) of one process become element(s) interacting in subsequent processes. Figure 2 visualises how the framework can help to illuminate the emergence of such domestication pathways (Juntunen, 2014) at the household level. Users' accounts presented in this article illustrate, for example, how processes of interpreting SHHP involved meanings developed through prior domestications of related technologies, such as technologies users identify as 'smart'; that experiencing SHHP was strongly influenced by routines of use constructed through prior domestications of gas boilers and mobile devices; and that processes of responding can be informed by understandings of controls, such as thermostats and thermostatic radiator valves, also constructed during the domestication of gas boilers. This builds on previous work identifying how prior domesti-

cations may influence technology uptake and symbolic learning (Haddon, 2006); that the domestication of new technologies is influenced by previously constructed routines of use (see, for example, Sørensen, 1994; Judson et al., 2015; Nyborg, 2015); and that prior domestications can suggest strategies and actions for practical learning (Sørensen, 1994).

The framework can also help to illuminate societal domestication trajectories, which emerge through reciprocal relationships between household-level domestication processes and societal-level influences on these, such as social norms or large-scale material infrastructures (Sørensen, 2006). Figure 3 illustrates how the framework can illuminate reciprocal relationships between household domestication processes and socially circulating meanings. It visualises how socially circulating meanings – such as Paul's account of meanings relating to 'proper', modern heating – can influence the construction of routines via processes of interpreting which experiences represent technology 'working', and responding accordingly. This could result in the construction of new routines, such as Paul's account of his family spending more time in newly-heated rooms. It could also reinforce existing routines. This practical learning is accompanied by symbolic learning, such as Alan's description of more constant daytime heating as 'great', and collective symbolic learning can influence socially circulating meanings and subsequent household-level domestications.

Previous work on domestication has shown that initially novel or luxurious experiences can come to be normalised and taken for granted over time (Pantzar, 2023), and the adoption and use of new technologies has been associated with trajectories of increasing expectations of comfort, cleanliness and convenience (Shove, 2003). By supporting investigation of relationships between household domestication processes and societal-level elements such as social norms, processes of experiencing, interpreting and responding may help to illuminate one aspect of the "ratchet-like" (Shove, 2003: 399) mechanism underlying this. Given the environmental impacts of associated resource use, this also has implications for policy.

Policy implications

Identifying actions that could influence users' learning in support of policy objectives is an important implication of conceptualising processes of user learning. In a previous study (Parrish et al. 2021), I identified that users constructed the technical misconception that heat pumps are ineffective at lower outdoor temperatures (cognitive learning), which counters policy expectations that learning about heat pumps through using a hybrid system will support future acceptance of stand-alone heat pumps (CCC, 2018, 2019, 2023). Finding that this misconception likely arose through the ways users interpreted information provided to them by installers enabled me to suggest it could be avoided by using non-technical language. Similarly, in this previous study I suggested that ensuring SHHP users have access to thermostatic radiator valves on bedroom radiators, and know how to use them, could help to avoid experiencing uncomfortably warm nighttime temperatures, and unintended uses of SHHP (practical learning) that may emerge as a result.

The generic framework of learning processes developed in this paper should support similar analyses of user learning and identification of policy implications related to other technologies and contexts. If observed understandings, meanings, or uses of a new technology are identified as relevant for policy, the framework can help to trace back through the processes and interacting element through which they emerged, and identify specific ways in which these could be changed. As an example, cognitive learning could be influenced by paying attention to processes of *receiving* and *interpreting* information, and the interacting elements through which they emerge: *information available to users, information important to users, and understandings and meanings users already hold*. As well as avoiding technical language, general policy implications include seeking to provide information that is relevant and accessible to users, for example by relating it to users' needs and interests, providing it verbally as well as in writing, and providing a channel to seek expert advice over a period of time, as changing experiences mean new forms of information may become relevant (see also Parrish et al., 2021). It could also be helpful to

support other means for users to access information, including peer-to-peer learning (Judson et al., 2015). For some users, online forums can be well suited to support peer-to-peer learning: reducing uncertainty, helping users to adapt new technologies to local contexts, and increasing their social legitimacy. As they are not limited to particular spatial scales, they can include large numbers of users and accommodate sub-groups that support diverse user needs (Hyysalo, 2021). They can help users to form relationships with 'warm experts' (Bakardjieva, 2005), which could be important if their immediate social networks do not have knowledge of particular new technologies (c.f. Hargreaves et al., 2017). Empirical data presented in this paper also highlights the potential for peer-to-peer learning to disseminate misconceptions. The potential for moderation could be another benefit of online forums if it helps to avoid this. However, excessive moderation of forums may reduce the potential for user learning (Hyysalo, 2021), so care should be taken to balance these concerns. As a second example, practical learning could be influenced by paying attention to processes of *experiencing, interpreting and responding*, and the interacting elements through which they emerge: *technology characteristics, routines and material arrangements, understandings and meanings users already hold, and strategies, actions and resources* available to respond. By helping to identify specific policy actions, this work builds on previous studies suggesting influences on users' learning, including technology design, installers, or users' peers could be policy targets, without identifying how these might be changed (see, for example, Hargreaves et al., 2017; Judson et al., 2015). Of course, this is not intended to suggest that it is possible to influence users' learning in a deterministic way: as the outcome of domestication processes is always an empirical question (Sørensen, 2006), making policy informed by domestication theory would also imply adopting more reflexive policy practices. This is discussed further by Sørensen (2013) and Jensen et al. (2019).

Illuminating processes involved in societal domestication trajectories also has relevance for decarbonisation policy. Trajectories of increasing service demand accompanying the adoption of new technologies (Shove, 2003) may jeop-

ardise efforts to address climate change, even alongside increases in technical efficiency (Darby and Fawcett, 2018; Labanca and Bertoldi, 2018; Shove, 2018). The analysis presented in this paper shows how socially circulating meanings about the normal or desirable performance of technologies, or expectations about technological development, can influence users' learning. It also suggests how the emergence or reproduction of social norms through collective household domestication processes could contribute to societal domestication trajectories. The potential to illuminate processes by which social norms emerge is an important feature of domestication theory, particularly as such processes are not typically considered in policy making (Shove, 2010).

Opportunities for further work

Further work could apply the framework to further investigate the interrelationship between users' learning about new technologies and societal trajectories of escalating demand for energy services, with the aim of identifying how these might be disrupted.

It would also be helpful to test the framework of learning processes by applying it to analyse learning about other technologies in other contexts. Expanding the empirical sample to include non-users could test the processes of receiving and interpreting information, while involving a higher number of household members in data collection could illuminate how learning processes interact with the negotiation of needs and interests within households. The framework of learning processes should also be tested through application to other technology types: as an example of a more efficient and automated

technology, SHHP were designed to substitute for a technology (gas boilers) which users had previously domesticated, and to perform emissions reductions without requiring active input from users (Stumpf et al., 2018). Furthermore, users' learning is likely to differ in contexts other than technology trials, for example in peer-to-peer learning, so the applicability of the framework in diverse contexts should be assessed.

As it stands, the framework of learning processes developed in this paper advances conceptualisations of users' learning in domestication theory by illuminating *how* users learn about new technologies, and relating this to existing conceptualisations of what users learn and why. This also contributes to efforts to apply domestication theory to derive policy recommendations, by helping to identify how specific actions could influence learning outcomes.

Acknowledgements

This paper is based on doctoral research funded by the UK ESRC (Economic and Social Research Council) (grant number ES/J500173/1). Preparation of the paper was supported by the ESRC's Post-doctoral Fellowship (grant number ES/Y010094/1).

I would like to thank all interview and observation participants for their time and willingness to contribute to this research, as well as the FREEDOM Project partners who enabled it. Particular thanks are due to Dr Edwin Carter for his support throughout the whole process. I would also like to thank my PhD supervisors Dr Sabine Hielscher and Prof. Timothy J. Foxon for their invaluable support and guidance as I conducted this research, and Dr Jake Barnes, Dr Emily Vrain, and two anonymous reviewers for their helpful feedback on paper drafts.

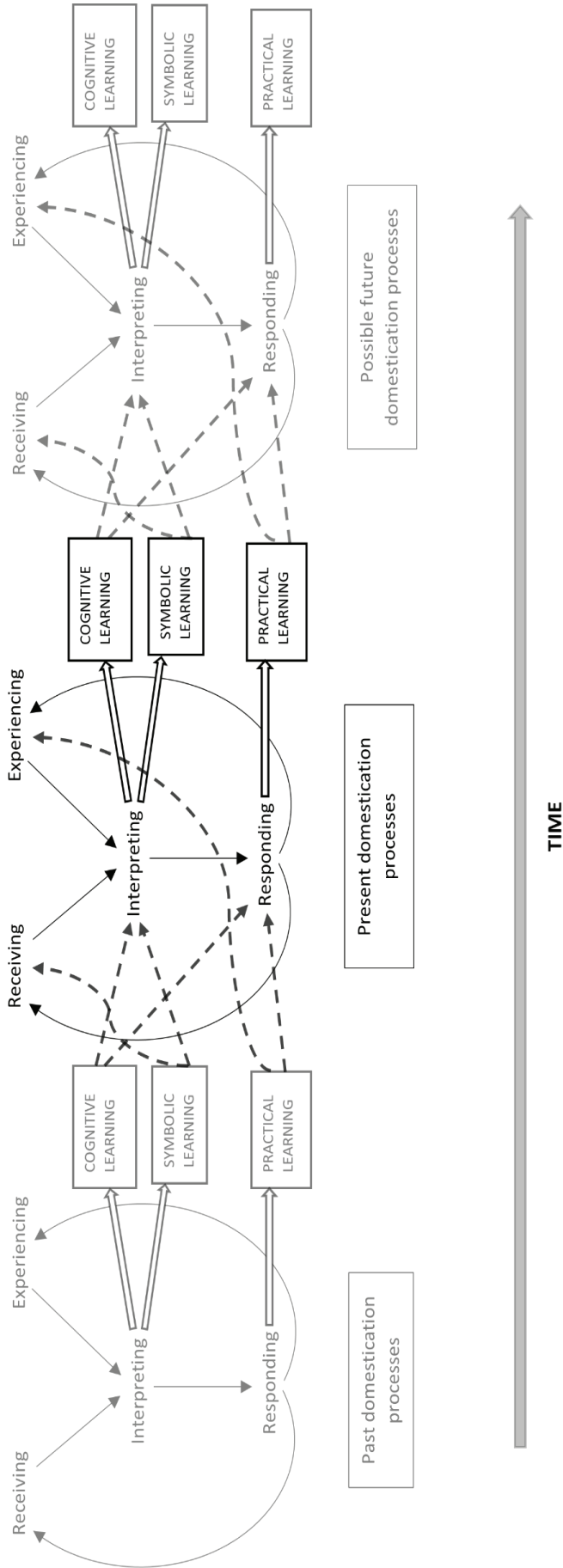


Figure 2. Visualising interactions between learning processes and household domestication trajectories. Dashed arrows indicate how cognitive, symbolic and practical learning give rise to elements interacting in learning processes during later domestications. For example, understandings and meanings constructed through cognitive and symbolic learning influence processes of interpreting if they interact with information received and experiences of new technologies. Meanings constructed through symbolic learning may influence processes of receiving if they influence what information is important to users, and routines constructed through practical learning influence experiencing if they interact with the characteristics of new technologies. Strategies and actions of responding may be influenced by previous cognitive learning, for example understandings of how to use controls, and practical learning in the form of practical know-how or routines of responding to common experiences.

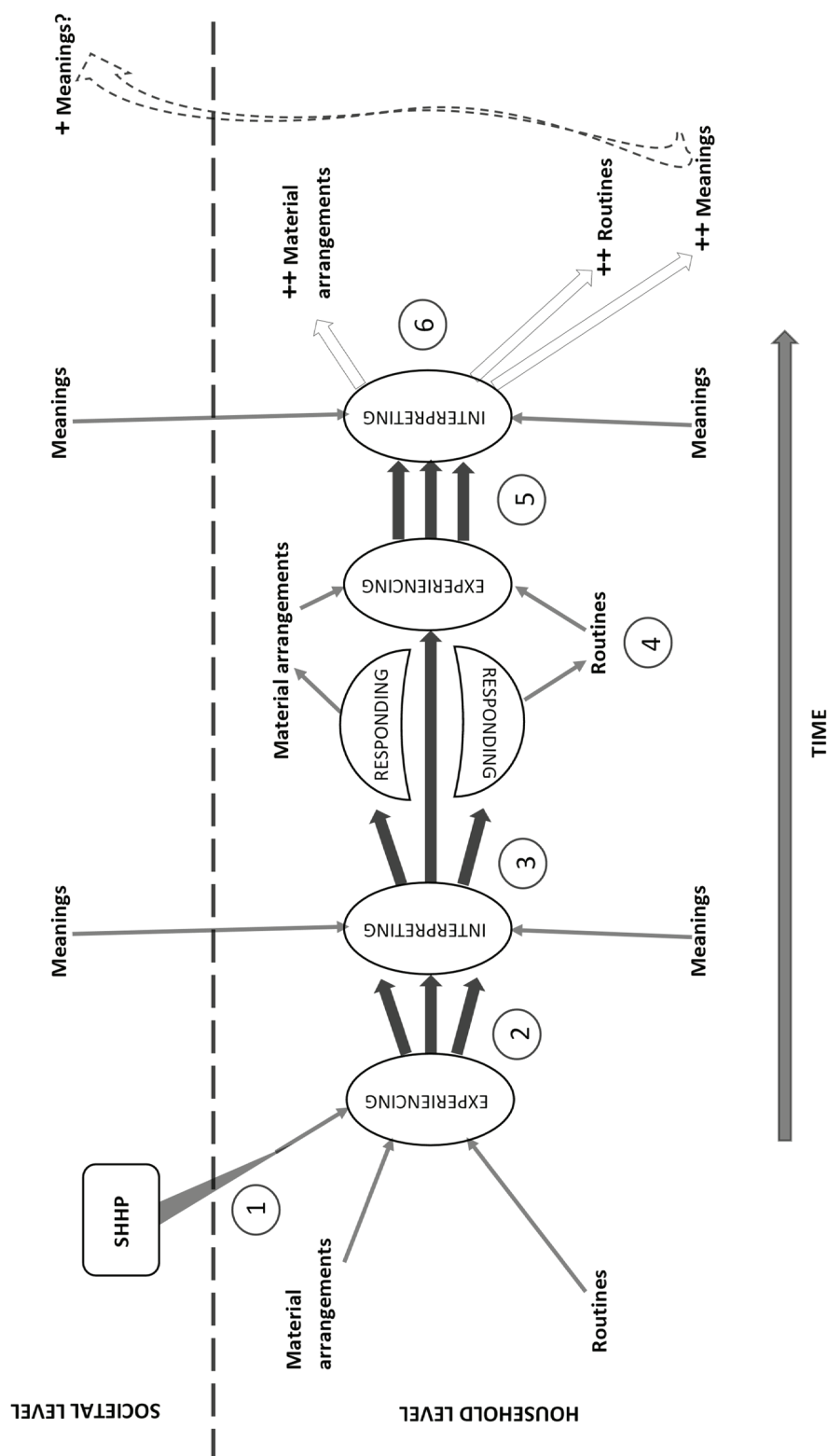


Figure 3. Visualising relationships between learning processes at the household level, and socially circulating meanings of what constitutes ‘working’

1) SHHP becomes part of household material arrangements through uptake and installation. 2) Processes of experiencing different SHHP characteristics emerge from their interaction with pre-existing household routines and material arrangements. 3) Processes of interpreting whether or not different experiences constitute ‘working’ emerge from their interaction with meanings of ‘working’ constructed through previous household-level domestications, and/or those circulating at the societal level. 4) Processes of responding may change routines and/or material arrangements as users seek to make SHHP ‘work’. 5) Processes of experiencing change as a result of changes in material arrangements and routines. 6) If experiences are interpreted as ‘working’, this may reinforce current material arrangements, routines, and meanings of ‘working’. Collectively, this may also contribute to meanings of ‘working’ circulating at the societal level.

References

- Abbott A (1988) Transcending General Linear Reality. *Sociological Theory* 6(2): 169–186.
- Abbott A (2007) Mechanisms and Relations. *Sociologica* 2: 1–22.
- Akrich M (1992) The de-scription of technical objects. In: Bijker WE and Law J (eds) *Shaping Technology/ Building Society*. Cambridge, MA: MIT Press, pp. 205–224.
- Bakardjieva M (2005) *Internet Society: The Internet in Everyday Life*. London: SAGE.
- Bakardjieva M (2006) Domestication running wild. From the moral economy of the household to the mores of a culture. In: Berker T, Haartman M and Punie Y, et al. (eds) *The Domestication of Media and Technology*. Maidenhead: Open University Press, pp. 62–79.
- CCC (2018) *Hydrogen in a low-carbon economy*. London: Climate Change Committee.
- CCC (2019) *UK housing: Fit for the future?* London: Climate Change Committee.
- CCC (2023) *Progress in reducing emissions 2023 Report to Parliament*. London: Climate Change Committee.
- Darby S and Fawcett T (2018) Energy sufficiency: An introduction. Concept paper. European Council for an Energy Efficient Economy (ECEEE). Available at: <https://www.energysufficiency.org/libraryresources/library/items/energy-sufficiency-an-introduction/> (accessed 3 August 2021).
- Haddon L (2006) Empirical studies using the domestication framework. In: Berker T, Haartman M, Punie Y, et al. (eds) *The Domestication of Media and Technology*. Maidenhead: Open University Press, pp. 103–122.
- Hanmer C, Shipworth D, Shipworth M et al. (2019) Load shifting with smart home heating controls: satisfying thermal comfort preferences. *ECEEE Summer Study Proceedings* Presqu'île de Giens, France, 3-8 June 2019, pp. 1377–1386. European Council for an Energy Efficient Economy (ECEEE)
- Hargreaves T, Wilson C and Hauxwell-Baldwin R (2017) Learning to live in a smart home. *Building Research and Information* 46(1): 127–139.
- Hartmann M (ed) (2023) *Routledge Handbook of Media and Technology Domestication*. Abingdon: Routledge.
- Hyysalo S (2021) *Citizen Activities in Energy Transition - User Innovation, New Communities, and the Shaping of a Sustainable Future*. Abingdon: Routledge.
- Jensen CL, Goggins G, Røpke I et al. (2019) Achieving sustainability transitions in residential energy use across Europe: The importance of problem framings. *Energy Policy* 133: 110927.
- Judson EP, Bell S, Bulkeley H et al. (2015) The Co-Construction of Energy Provision and Everyday Practice: Integrating Heat Pumps in Social Housing in England. *Science & Technology Studies* 28(3): 26–53.
- Juntunen JK (2014) Domestication pathways of small-scale renewable energy technologies. *Sustainability: Science, Practice & Policy* 10(2): 28–42.
- Labanca N and Bertoldi P (2018) Beyond energy efficiency and individual behaviours: policy insights from social practice theories. *Energy Policy* 115: 494–502.
- Langley A (1999) Strategies for theorizing from process data. *Academy of Management Review* 24(4): 691–710.
- Langley A, Tsoukas H, Smallman C et al. (2013) Process studies of change in organization and management: Unveiling temporality, activity and flow. *Academy of Management* 56(1): 1–13.
- Nyborg S (2015) Pilot Users and Their Families: Inventing Flexible Practices in the Smart Grid. *Science & Technology Studies* 28(3): 54–80.
- Oudshoorn N and Pinch T (eds) (2003) *How Users Matter: The Co-Construction of Users and Technology*. Cambridge, Massachusetts: The MIT Press.
- Pantzar M (2023) A journey from domestication approaches to practice-based approaches. In: Hartmann M (ed) *Routledge Handbook of Media and Technology Domestication*. Abingdon: Routledge, pp. 219–234.

- Pettigrew AM (1997) What is a processual analysis? *Scandinavian Journal of Management* 13(4): 337–348.
- Ryghaug M and Toftaker M (2014) A Transformative Practice? Meaning, Competence, and Material Aspects of Driving Electric Cars in Norway. *Nature and Culture* 9(2): 146–163.
- Shove E (2003) Converging Conventions of Comfort, Cleanliness and Convenience. *Journal of Consumer Policy* 26(4): 395–418.
- Shove E (2010) Beyond the ABC: Climate Change Policy and Theories of Social Change. *Environment and Planning A* 42: 1273–1285.
- Shove E (2018) What is wrong with energy efficiency? *Building Research & Information* 46(7): 779–789.
- Silverstone R (2006) Domesticating domestication. Reflections on the life of a concept. In: Berker T, Haartman M, Punie Y et al. (eds) *The Domestication of Media and Technology*. Maidenhead: Open University Press, pp. 229–248.
- Silverstone R, Hirsch E and Morley D (1992) Information and communication technologies and the moral economy of the household. In: Hirsch E and Silverstone R (eds) *Consuming Technologies: Media and Information in Domestic Spaces*. London: Routledge, pp. 208–226.
- Simis MJ, Madden H, Cacciatore MA et al. (2016) The lure of rationality: Why does the deficit model persist in science communication? *Public Understanding of Science* 25(4): 400–414.
- Sørensen KH (1994) *Technology in use. Two essays on the domestication of artefacts*. Centre for Technology and Society Working Paper 2/94. Trondheim: Norwegian University of Science and Technology.
- Sørensen KH (1996) *LEARNING TECHNOLOGY, CONSTRUCTING CULTURE. Socio-technical change as social learning*. STS Working Paper 18/96, Trondheim: Norwegian University of Science and Technology.
- Sørensen KH (2006) Domestication: the enactment of technology. In: Berker T, Hartmann M, Yves P, et al. (eds) *Domestication of Media and Technology*. Maidenhead: Open University Press, pp. 40–61.
- Sørensen KH (2013) BEYOND INNOVATION Towards an extended framework for analysing technology policy. *Nordic Journal of Science and Technology Studies* 1(1): 12–23.
- Sørensen KH, Aune M and Hatling M (2000) Against linearity: on the cultural appropriation of science and technology. In: Dierkes M and Groete C V (eds) *Between Understanding and Trust. The Public, Science and Technology*. Amsterdam: Harwood, pp. 237–257.
- Stumpf S, Skrebe S, Aymer G et al. (2018) Explaining smart heating systems to discourage fiddling with optimized behavior. *CEUR Workshop Proceedings* 2068. ExSS '18, Tokyo, Japan, 11 March.
- Turvey N, Clarke C and Calder C (2018) *FREEDOM Project Final Report*. Newport: Wales and West Utilities.
- Van De Ven AH and Poole MS (2005) Alternative approaches for studying organizational change. *Organization Studies* 26(9): 1377–1404.
- van Mierlo B and Beers PJ (2020) Understanding and governing learning in sustainability transitions: A review. *Environmental Innovation and Societal Transitions* 34: 255–269.

Darin Weinberg (2024) *On Addiction: Insights from History, Ethnography, and Critical Theory*. Durham and London: Duke University Press. 188 pages. ISBN: 9781478030829

David Antolínez Uribe

Independent researcher/d.antolinez.uribe@gmail.com

“On Addiction” approaches its title topic from several angles. In an earlier work, anchored in ethnography, Darin Weinberg (2005) explored the inclusion/exclusion of insane, homeless and addict people in two Alcoholic Anonymous groups. In the present book, the author narrows down his focus to addiction yet expands his intellectual resources beyond fieldwork. As the subtitle indicates, there are plenty passages dealing with the history of addiction and of sociology itself. In a sense, this book aligns itself with a tradition within ethnomethodology interested in mental health – Garfinkel’s studies on intersexuality, Pollner’s explorations of mundane reasoning and Sack’s conversational analysis of a suicide hotline, to name a few. One can also find a collage of Foucauldian subjectivity studies, Bourdieu’s habitus, embodied cognition *à la* Merleau-Ponty, analytic philosophy of mind (Davidson, Frankfurt and Rorty) as well as STS. Chiefly, Weinberg claims that existing theories of addiction leave unaccounted the alternating gain and loss of self-control. And as a consequence of this, the status of addiction as a disease is still contested, thus debilitating possible alliances between scientific inquiry and policy-making on the matter. The book’s ultimate goal is to provide a more nuanced comprehension of addiction, hoping to close this gap.

Right from the introduction one sees the ambitious scope of the project. In a tone reminiscent of Actor-Network Theory (ANT), Weinberg argues that both natural and social explanations

are insufficient to comprehend the entanglements between suffering, willpower, self-exploration, performance enhancement and other key features of addiction. Medical research fails to reconcile neurological, epidemiological and clinical data, all of them pointing out to different contributing mechanisms of addiction. For their part, social theories have a historical ambivalence between subscribing to health discourses that conceptualize addiction as a disease on the one hand, and adopting a morally agnostic stance stressing the subcultures around drugs and the rational choice of users on the other. According to Weinberg, both approaches fall short in providing a convincing justification for therapeutic assistance – rather than indifference or legal persecution – for addicts. The two perspectives are plagued with several antinomies – free will/determinism, mind/body, science/ethics, rationality/emotion, nature/culture, universal/particular, theory/practice, objectivism/subjectivism, macro/micro, presentism/historicism – leading to reductionism in theory as well as inefficiency in practice. The alternative, Weinberg suggests, is to craft an interdisciplinary view capable to overcome these dichotomies and explain the labile gain and loss of self-control in the diverse situations people inhabit. Not an easy task, to say the least.

The first half of the book is primarily a historical review of how addiction came to be of interest for health sciences, the different (dis)encounters between medical and social research, and



the underlying philosophical compromises of attempts to theorize addiction. One of the main concerns for Weinberg is that despite the wide range of hypothesis of addiction – focused on withdraw symptoms, deficits in impulse regulation, functionality deterioration, attributed meanings, cultural (dis)approval of drugs or cost-benefit calculations – scientists have not established a sharp boundary between normal and pathological drug intake. Besides contemporary scientific debates, Weinberg also alludes to controversies between Puritan and Civic republican discourses in the early modern era to remind us that the notion of ‘disease’ is not immune to historical mutations. Although terms such as ‘sin’, ‘slavery’, ‘redemption’ and ‘virtue’ may strike as odd to our current secular sensitivity, they address the issue of addiction as a chronic condition embedded in certain lifestyles. There is also a detailed reconstruction of Alfred Lindesmith’s seminal work on the sociology of addiction. As I read these pages, I learned a great deal about the fierce struggles among different theories within the sociology departments in America at the dawn of the 20th century and the uneasy relationship with the rising paradigm of behaviorism.

The second half advances what Weinberg calls ‘an ecological understanding of addiction’. Even if defined as a disease, clinicians have been suspicious about the prognosis of addiction. Therapeutic communities, first inspired by indoors hospitals and later recast as outpatient programs, are said to be the better treatment – and thus, for Weinberg, the best places to do fieldwork. Most notably, these communities are artifacts capable of establishing a division between ecologies of addiction and recovery. Patients and counselors must adopt two non-negotiable prepositions to be admitted in these groups: 1) addiction is a genuine disease; and 2) it can solely be cured through the ongoing participation in the program. To support the former tenet addicts ought to be conceptualized as victims of pathological mechanisms, while to substantiate the later patients must be portrayed as choosing agents. These shifting discourses are not intended as factual descriptions, but rather as a peculiar choreography of various incoherent elements of the patient’s self, niches inhabited and available theories about

addiction. Then, passing to a more abstract tone, the book discusses this issue of discontinuity alongside the akrasia (deficit of willpower) thesis proposed by psychologist Nick Heather. Weinberg insists that volition and emotional restraint do not always go hand in hand, and that self-control should be understood as inserted in practical situations with singular cues, group dynamics and learned patterns of behavior. Unfortunately, these arguments are embedded in abstract discussions of critical sociology and philosophy of mind, rather than illustrated with the gathered ethnographic material. Even though Weinberg advocates for casuistry over theoretical generalizations, he seems to prefer erudite philosophy over thick descriptions.

The book closes with an explicit engagement with ANT and post-humanism. This is a feast for readers familiarized with the writings of Haraway, Hayes, Pickering, Latour, Gomart and Mol. At last, Weinberg seems to have found a new, non-dichotomic vocabulary. Here we find statements such as: “addictions take form as learned embodied sensibilities and felicities that tend to bind us to the worlds within which they are acquired and can be availed” (p. 144); “[w]e also differ with respect to our relative freedom to leave or transform the environments within which particular bodily articulations have developed (p.145)”; and “the status of addiction as a form of disease need not be decided with rigid reference to whether suffering can be decisively linked to dysfunctional biological mechanisms but with reference to patterns of seemingly harmful and intransigent bodily articulation with which we cannot, or do not want to, identify ourselves (p. 146)”. Indeed, it is promising to re-conceptualize addiction outside the traditional frameworks of medical and social research. Yet the reader might feel that this new perspective is somewhat underdeveloped in the book. A more sustained dialogue with STS would enrich the discussion on some themes like the heated controversies around drug policies (Stengers and Ralet, 1991), the labile boundaries between normal and pathological (Gieryn, 1983), the uneasy relationship between sociologists of science and policy-makers (Collins and Evans, 2002) and the actual harm of dichotomies in the patients’ bodies (Whynacht, 2018). Weinberg set his own expect-

tations high and frames his project echoing the ANT-style critique of naturalism and sociologism, so one might wonder why not pursue this line of

though further. Having said that, "On Addiction" is a highly recommendable book that hopefully will influence future studies on the matter.

References

- Collins H and Evans R (2002) The Third Wave of Science Studies: Studies of Expertise and Experience. *Social Studies of Science* 32(2): 235-296.
- Gieryn T (1983) Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists. *American Sociological Review* 48(6): 781-795.
- Stengers I and Ralet O (1991) *Drogues, le défi hollandais*. Paris: Laboratoires Delagrangue.
- Weinberg D (2005) *Of Others Inside: Insanity, Addiction, and Belonging in America*. Philadelphia: Temple University Press.
- Whynacht A (2018) 'Marks on bodies': agential cuts as felt experience. *Catalyst: Feminism, Theory, Technoscience* 4(1): 1-30.

Antti Silvast and Chris Foulds (2022) *Sociology of Interdisciplinarity: The Dynamics of Energy Research*. Palgrave Macmillan, Cham, Switzerland. 125 pages. ISBN: 978-3-030-88454-3

Jongheon Kim

INRAE, France/ Jongheon.kim@inrae.fr

In “Sociology of Interdisciplinarity: The Dynamics of Energy Research”, Antti Silvast and Chris Foulds offer a timely and critical intervention into discussions surrounding interdisciplinary research. While interdisciplinarity is widely advocated as essential for tackling complex challenges like the energy transition, the authors argue that its practical execution, lived experiences, and sociological underpinnings are often insufficiently examined. This concise book makes a compelling case for the crucial, yet frequently underutilised, role of STS in providing the conceptual tools necessary to unpack the intricate dynamics of interdisciplinary collaborations, particularly within the energy field. As they state, STS has numerous conceptual tools available “to explain how and why different research and innovation actors do (not) collaborate ‘successfully’, and with what effects” (p. vii).

The book’s core contribution is the development of “A Sociology of Interdisciplinarity”, a framework explicitly detailed in the concluding chapter. The framework moves beyond descriptive accounts of barriers and challenges by employing an STS lens to analyse interdisciplinary research as a social activity. It comprises six key dimensions: (1) the impacts of funding structures on research practices and outcomes; (2) the role of distinct ‘epistemic cultures’ that shape knowledge production across and even within disciplines; (3) the function of ‘boundary objects’ (like models or concepts) in mediating between different social

and epistemic worlds; (4) the dynamics of disciplinary ‘appropriation’, where one field may adopt or misunderstand the tools and concepts of another; (5) the ‘interpretative flexibility’ inherent in key concepts and technologies within interdisciplinary settings; and (6) the persistent ‘importance of disciplines’ as organising principles and sources of identity. Silvast and Foulds utilise this framework to scrutinise the mundane practices, institutional contexts, and power relations that shape how interdisciplinary energy research unfolds on the ground.

The above framework is not presented in isolation but is grounded in three detailed empirical case studies. Chapter 2 examines the UK’s pursuit of “whole systems thinking” in energy research, focusing on the National Centre for Energy Systems Integration (CESI). It reveals the diverse expectations surrounding the role of Social Sciences and Humanities (SSH) within modelling-heavy projects, the heterogeneity of modelling approaches themselves (e.g., regarding energy demand), and the difficulties in translating research for policy contexts. Chapter 3 explores Norway’s Centres for Environment-Friendly Energy Research (FMEs), illustrating how national funding schemes and institutional setups influence the configuration of interdisciplinarity, the roles assigned to SSH, and the framing of goals like “environmental innovation”. Chapter 4 provides a valuable counterpoint by analysing a



*This work is licensed under
a Creative Commons Attribution 4.0
International License*

largely monodisciplinary Finnish project focused on assigning a monetary price to electricity reliability. This case effectively underscores how the framework's dimensions - epistemic differences within engineering, the performative role of cost calculations as boundary objects, the translation between research and regulation, and the implicit marginalisation of non-economic social factors— are relevant even outside explicitly interdisciplinary mandates.

A key argument advanced by Silvast and Foulds is that much scholarship on interdisciplinarity often remains descriptive, cataloguing barriers without sufficiently theorising the underlying social processes. The book's primary strength lies in offering a necessary corrective through its novel and rigorous application of established STS concepts to the *practice* of interdisciplinarity itself. This STS-informed approach moves the discussion beyond generic challenges towards a more nuanced, sociologically informed critique by emphasising the *sociotechnical* construction of interdisciplinary knowledge. The authors convincingly demonstrate how research dynamics are shaped by factors such as funding scripts, distinct knowledge-making cultures, mediating boundary objects, disciplinary misunderstandings, and contested interpretations, even as disciplinary identities persist. This multi-scalar perspective, effectively linking micro-level interactions to macro-level institutional contexts, showcases the analytical purchase of these STS tools. Furthermore, the rich empirical chapters make these concepts tangible, powerfully illustrating the framework's utility in understanding the complexities of contemporary research collaborations.

While impactful, the book consciously presents its framework as *a* sociology, deliberately inviting further refinement and application rather than offering a definitive statement. This reflexive stance acknowledges certain inherent limitations that also point towards avenues for future inquiry. The empirical grounding in European energy research, while providing depth and

coherence, naturally raises questions about the framework's transferability. Applying it to different geographical contexts or research domains (such as biomedical science or the digital humanities) would necessitate careful adaptation and sensitivity to varying institutional and epistemic landscapes. Furthermore, the book excels in its critical analysis of current interdisciplinary dynamics, particularly the challenges encountered by SSH scholars within techno-centric projects. However, it offers fewer concrete prescriptions or detailed models for alternative, potentially more equitable or effective, modes of collaboration, focusing instead on enhancing sociological understanding and reflexivity. Building on this work, future research could fruitfully explore cases where SSH perspectives have successfully shaped interdisciplinary agendas from the outset, test the framework's robustness across diverse fields, and investigate how these sociological insights might be translated into more actionable strategies for designing and managing interdisciplinary research programs.

Nonetheless, "Sociology of Interdisciplinarity" represents a valuable and necessary contribution to STS, energy studies, and the broader study of research policy and practice. It is essential reading for STS scholars examining the social dimensions of knowledge production in contemporary, mission-oriented science. Researchers across all disciplines engaged in energy-related interdisciplinary projects will gain significant insights into the often-implicit dynamics shaping their collaborations. Furthermore, research managers, funders, evaluators, and policymakers seeking to foster more effective and equitable interdisciplinary research would do well to consider the sociological factors Silvast and Foulds bring to the fore. By demonstrating *how* interdisciplinary research is constructed, the book provides a crucial foundation for thinking more critically and reflexively about how to better realise its purported benefits for addressing grand societal challenges.

Science & Technology Studies

Volume 39, Issue 2, 2026

Articles

Expert Patients and Networks of Expertise and Ignorance **2**
Olga Kuchinskaya

“A Train We Can’t Miss” for Economic Recovery: The Sociotechnical
Imaginary of Artificial Intelligence in the Walloon Region **19**
Nathan Flore

When Digital Health Encounters Regulation: The Approval Process for
Prescription Apps in Germany **43**
Carsten Horn & Ulrike Felt

Conceptualising Processes of User Learning in Domestication Theory:
What, why, and how? **61**
Bryony Parrish

Book reviews

Darin Weinberg (2024) *On Addiction: Insights from History,
Ethnography, and Critical Theory* **82**
David Antolínez Uribe

Antti Silvast and Chris Foulds (2022) *Sociology of Interdisciplinarity:
The Dynamics of Energy Research* **85**
Jongheon Kim