Bodies and Technoscience. Practices, Imaginaries and Materiality

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In our contemporary technology-driven societies, every aspect of life connected to our bodies — such as birth, reproduction, sexuality, gender, and aging — is profoundly influenced by technoscientific advances. The body is no longer a fixed entity but a dynamic battleground, constantly reshaped by technologies.

This compelling book delves into the evolving interface between human bodies and technoscience, exploring themes like technoscientific imaginaries, the cyborg concept, bodily transformations through technologies, datification, and biomedicalization. Approaching these topics from a Science and Technology Studies (STS) perspective, the book poses essential questions about the relationship between technology and the body: What are the consequences of our increasingly mutable physicality? What analytical frameworks can we use to study this ever-changing, hybrid body? How does STS help us understand the material and discursive construction of corporeality through technoscience? And how do our bodies, in turn, help shape the very nature of technoscience?

This book is of interest for scholars and students in Science and Technology Studies (STS), Sociology of the Body, and Social Theory, offering fresh insights into the crucial interplay between scientific knowledge, technology, and bodily experience. It invites readers to reconsider the essential questions regarding the interplay between technoscience and corporeality.

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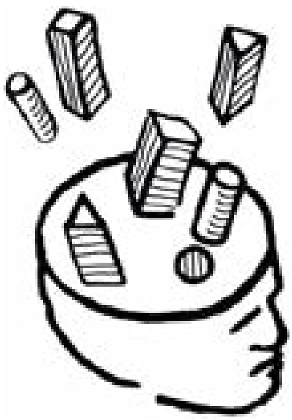

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Introduction

Exploring the Intersection of Bodies and Technologies in Social Theory and Science and Technology Studies: An Introduction

STEFANO CRABU, SIMONE ARNALDI, ASSUNTA VITERITTI

The examination of the interaction between bodies and technology is currently a pressing and relevant topic within academic circles, among policymakers and among practitioners. They are critically scrutinising the political, ethical and social challenges arising from the widespread incorporation of emerging scientific and technological advancements into human lives. These developments are altering identities, agency, behaviours and even augmenting human capacities to the extent that they are reshaping collective perceptions and blurring the boundaries between life and death.

In contemporary societies, no aspect of life related to the body and bodily experiences, such as birth, work, learning, reproduction, sexuality, gender and ageing, remains untouched by technological and scientific interventions. Examples of such interventions include deep brain stimulation, targeted drug delivery, augmented reality, sensory implants, brain-computer interfaces, DNA biosensors, prostheses, cosmetic surgery and diagnostic imaging. Research and innovation increasingly provide opportunities not only to explore the body but also to intervene and modify it at the very molecular level (Rose 2007). Consequently, the body is no longer a stable site of normalised biological functions but a mutable battleground open to diverse technologically mediated interventions.

When examining how the body has become a matter of concern in the field of social theory and how its relationship with technologies has been framed, it is valuable to commence by delving into the case of "healthy bodies". Generally, for healthy individuals, it is easy to overlook the body, much like a well-functioning metropolitan infrastructure that commuters take for granted as an embodied technology in the urban landscape. The body is similarly taken for granted as a part of the self, obviously for healthy people. Therefore, we agree with Turner (1996), who, in a foundational contribution to social studies of the body, argued:

> We have bodies, but we are also, in a specific sense, bodies; our embodiment is a necessary requirement of our social identification so that it would be ludicrous to say, "I have arrived and I have brought my body with me." (p. 42)

This tendency to "forget" the (healthy) body is undoubtedly part of the mundane routines embedded in everyday practices for managing ordinary life. However, it should be acknowledged that until recently, this forgetfulness also affected social scientists. Mainstream social sciences traditionally placed great importance on social structures and individual subjectivity, giving little attention to the social and material dimensions of physical bodies (see Lupton 2013 for a critical review of this issue). One reason for hesitancy in addressing the body in its social, cultural and material settings of interaction may be attributed to the need to avoid the risk of accusations of biological determinism, which social scientists traditionally directed at their colleagues working in the field of natural and life sciences. For instance, (post-)structuralist social scientists, particularly sociologists, dedicated extensive volumes and substantial discussions to the structural, political and economic dimensions of society/of social processes, as well as the institutions of social control. This resulted in the construction of a conceptual and theoretical framework in which the physical body was essentially marginalised and overlooked. Conversely, social scientists rooted in phenomenological epistemology and those adhering to symbolic interactionist approaches focused on theorising the social construction of society and individual behaviours. In doing so, they substantially neglected the exploration of the embodiment of everyday decision-making practices and routines.

The long neglect of the body and embodiment within the prevailing traditional approaches in the social sciences for many decades has resulted in a lack of theoretical attention in this area. However, it is worth noting that this lack of attention to the social meaning and relevance of the physical body in the accomplishment of social reproduction and social order has been partially mitigated by some significant contributions that laid the groundwork for what would become the field of body studies in the late 20th century.

Discussing the foundational framework of body studies is beyond the scope of this chapter. However, it is useful for social theorists to briefly review the key conceptual milestones that have enabled the study of the body as an object of attention. In this regard, Mauss's (1934) influential essay titled "Les techniques du corps" (Techniques of the body) pioneers in shedding light on how the physical body is not merely a biological entity but an emergent outcome of social and cultural dynamics. Mauss argues that the body is not a neutral or universal entity; instead, it is shaped by shared societal norms, beliefs, customs and rituals. He explores how different societies maintain distinct techniques for perceiving and mobilising the body, encompassing gestures, postures and bodily comportment. These techniques are learned through socialisation and play a crucial role in maintaining social order and identity. A central concept in Mauss's (1935) essay is "habitus", which refers to the ingrained, habitual bodily dispositions acquired through cultural practices. George Simmel, although not extensively focusing on the human body's relation to culture and society, provides a compelling account of how sensory perceptions mediated by the physical body – such as sight, hearing, touch and taste – influence human behaviour and social relationships. In his essay, aptly titled "The Sociology of the Senses", Simmel (1997 [1907]) argues that sensory experiences are not merely individual phenomena but are deeply intertwined with social and cultural contexts. For instance, he discusses how the visual aspect of clothing can serve as a form of social communication and how people use their senses to establish social boundaries and distinctions. In a similar vein, the phenomenologist philosopher Merleau-Ponty (1945) significantly contributes to the study of the body and perception. His work centres on the idea that our embodied experiences are fundamental to our perception of reality. By challenging the traditional dualistic view, which separates the mind and the body, he argues for an embodied perception and contends that our perception of the world is not solely the result of cognitive or mental processes or sensory input but is deeply intertwined with our bodily experiences. In other words, the body is not merely an instrument through which we perceive or interact with the world; it is an integral part of perception itself. He introduces the concept of the "lived body", which refers to our immediate, pre-reflective awareness of our own body. This lived body serves as the foundation for all our perceptual experiences. Merleau-Ponty emphasises that our body is not just an object in the world but the very means through which we engage with and understand the world. He also explores the idea of "motor intentionality", suggesting that our bodily movements and actions are not separate from our perceptions but are an integral part of the perceptual process. Our body's movements and gestures are meaningful expressions of our engagement with the world.

A dedicated reflection on the body in the context of power relations and knowledge emerged in the 1970s. In this regard, Foucault's (1975, 1976) work is paramount. He argues that throughout history, societies have exerted control and authority over individuals through dispositifs inscribed on and through the body. These dispositifs, which he refers to as "discourses" and "technologies of power", regulate and govern various aspects of the body, including health, sexuality and behaviour, effectively disciplining the body. One of Foucault's key insights is the concept of "biopower", which refers to how political and social institutions exercise control over populations by managing and regulating life itself. This includes controlling birth rates, managing disease and shaping societal norms related to the body. The French Author also emphasises the role of disciplinary institutions, such as prisons, hospitals and schools, in shaping the modern human body. These institutions use surveillance, normalisation and discipline to mould individuals into compliant, docile and productive members of society. However, Foucault also recognises that the body can be a site of resistance. Individuals can resist and subvert oppressive power mechanisms by reclaiming control over their bodies, often through practices of self-care and self-discipline.

The role of the body as a crucial element in mediating social interactions is central to Goffman's (1956) work. Goffman's perspective on the human body in social interaction is rooted in the concept of "the presentation of self". He argues that individuals engage in social interactions as if they were «theatrical actors on a stage», using their bodies as instruments to convey specific impressions to others. In his influential work "The Presentation of Self in Everyday Life", Goffman (1956) highlights that individuals strategically manage their bodily gestures, expressions and appearances to project a desired self-image or identity to others. He introduces the notion of "impression management" to describe this process, emphasising how people carefully craft their public personas. According to Goffman, the human body serves as a vital tool for conveying information and maintaining social order.

While these contributions have aided social theorists in understanding how the body serves as a "right tool" for everyday life, they have primarily overlooked the relationship between the body itself and the material dimension surrounding social practices. This aspect gained prominence in the early '90s with the emergence of cyber-feminism, which specifically focuses on the intersection of feminism, technology and the body in the digital age. Cyber-feminist thinkers, including Donna Haraway and Sadie Plant, delve into how digital technologies have transformed our understanding of gender and the body. A central concept in cyber-feminism is the idea of the "cyborg". Donna Haraway's "A Cyborg Manifesto" posits that in a technologically mediated world, humans and machines are increasingly entangled, challenging traditional binary distinctions between humans and non-humans. The cyborg, as a hybrid entity, represents the merging of the organic body with technology, questioning conventional gender norms and highlighting the potential for liberation from essentialist identities.

These recent contributions have been highly influential in prompting science and technology studies (STS) to explore the physical body as an emerging entity functioning within heterogeneous assemblages: networks of machines, animals, infrastructures, knowledge and more. STS is an interdisciplinary field that investigates how scientific knowledge and technologies, or technoscience, are co-produced within the intricate web of social and political structures, as originally discussed in Latour's (1987) seminal work. STS, in its effort to unravel this complex interweaving between technoscience and society, has moved beyond the concept of human corporeality as a "biographical body" (Corbin and Strauss 1987) to embrace the notion of the body as a "cyborg entity" (Haraway 1992). The concept of the "biographical body" focuses on life trajectory and physical dimensions, explaining how individuals manage their lives and shape their subjectivity to maintain a meaningful and consistent sense of self within a symbolic universe shaped by specific sociohistorical contingencies. In contrast, the idea of the "cyborg body", while still considering biographical and physical dimensions, emphasises the role of technologically mediated interventions in constructing the human body and redefining its capabilities and agency. This implies a body enacted through the biomechanical expansion of natural potential.

As Haraway (1990) states:

> We are all chimeras, theorised and fabricated hybrids of machines and organisms; in short, we are cyborgs. The cyborg is our ontology; it gives us our politics. The cyborg is a condensed image of both imagination and material reality, the two joined centres structuring any possibility of historical transformation. (p. 191)

Therefore, the human bodies and bodily experiences emerge as the result of complex assemblages of technologies, knowledge and power relations, as well as social and cultural elements. This prompts scholars to explore the intricate relationships between the body and (sometimes invisible) technological systems of innovation, experimentation, application, development, production, marketing, medical installation and monitoring. Technologies, due to their entanglement with physical bodies, can redirect or prescribe current bodily practices and behaviours and fuel future-oriented sociotechnical imaginaries (Crabu and Magaudda 2022). Moreover, technologies are often integrated into geographically dispersed and functionally differentiated sociomaterial networks of interdependence, which are essential for their functioning. Take, for example, digital health and postgenomic science. STS scholars who have explored these technoscientific domains have shown how digital infrastructures and platforms have transformed biomedicine from within (see Clarke et al. 2010). Patients can not only access increasing amounts of health-related information but also generate and share it (Oudshoorn and Somers 2006; Neresini et al. 2019; Tempini and Teira 2019). In this scenario, individuals are no longer passive consumers of medical knowledge and technologies; they are active and expert users who produce, distribute and consume biomedical data and knowledge. This makes the human body part of the broader biomedical sociomaterial landscape. For instance, precision medicine aims to develop therapeutic approaches based on genetic, environmental and lifestyle factors for individuals who are not necessarily sick and who can engage in intensive self-monitoring of their health status by collecting data on tablets and smartphones. This allows individuals to bridge the informational gap that can arise between one medical consultation and another. For example, individuals at risk of skin cancer can wear sensors (e.g., a patch) to detect thresholds of exposure to ultraviolet radiation, thus radically reshaping their everyday habits and identity as potential patients based on the feedback and predictive knowledge generated by this technology.

In general, from an STS perspective, several crucial research questions arise: what are the implications of such a mutable corporeality? What analytical approach can be adopted to investigate this changeable, hybrid body? How can STS explore the entanglements among bodies, scientific knowledge, and technologies? How can STS shed light on the way in which corporeality is materially and discursively constructed through technoscience? How do corporeality and the body contribute to defining technoscience itself?

This volume seeks to address these questions through its 13 chapters. These chapters explore various aspects, including technoscientific imaginaries, the impact of technologies on bodies, the concept of the cyborg, bodily transformation through technology, datification and the biomedicalisation of bodies, which can also lead to controversies regarding biomedical expertise. While the chapters unfold in a rhizomatic manner, they invite readers to reconsider key issues concerning the interplay of scientific knowledge, technologies and human bodies.

One central thematic issue addressed by the first three chapters revolves around how technologies contribute to the generation of expert knowledge and public sociotechnical imaginaries concerning life and the human body. Technologies can render visible what is essentially invisible to the human eye, such as molecules and atoms, shaping how we perceive the world. This theme is a central focus in the STS literature related to technoscientific imaging, as extensively examined, for instance, in Perrotta (2012). The exploration of this theme has been ongoing since the groundbreaking works of Lynch (1985a, 1985b, 1998), also in collaboration with Woolgar (1990). Therefore, the book chapters that delve into this theme contribute to addressing one of the pivotal questions in STS literature concerning how technologies play a role in co-producing expert knowledge and how this involvement is influenced by the embodied experiences and corporeality of research scientists.

Expanding on this inquiry, the first chapter by Federico Neresini puts forth a conceptual framework designed to investigate how scientists, through the utilisation of various technological tools, venture into the imperceptible realm of the material world. For instance, they employ a scanning tunnelling microscope to create images of the otherwise invisible "nanoworld". They create "literary inscriptions" (see Latour and Woolgar 1986), including numbers, tables, graphs, charts and images, which construct and naturalise scientific facts and theories that shape reality itself. In the second chapter, authored by Manuela Perrotta, the focus is on technoscientific imaginaries. This chapter delves into the incorporation of algorithmic technologies into the creation and utilisation of images of embryos in the context of fertility treatment. The case of embryo imaging serves as a notable example of how the progress in imaging technologies for in vitro fertilisation not only alters the way embryos are observed but also reshapes the overall processes of knowledge generation in the field of embryology. In this manner, the chapter. It sheds light on the factors that influence when and how images come to be regarded as "true" representations of the world, taking into account the specific contextual conditions in which this perception is shaped. Chapter Three by Barbara Pentimalli delves into the role of metaphors and aesthetic judgments used by scientific practitioners when visually exploring biological phenomena for diagnostic purposes. It highlights how metaphors, originating from anatomy books or daily work contexts, guide novices to observe relevant details and identify pathological signs.

The second thematic issue explored in Chapters Four, Five and Six concerns how the body in contemporary society is considered an object of technoscientific intervention. These interventions can reshape, discipline, exclude and standardise individuals and collectives through diverse technologies. Chapter Four, co-authored by Valeria Cappellato and Valentina Moiso, reflects on the biomedicalisation of bodies in breast cancer therapies and post-mastectomy breast reconstruction. The authors, by emphasising the significance of medical technologies in healthcare, both within hospital environments and in the daily lives of patients who use them, investigate how the concept of "good functioning" and the ideals surrounding a "healthy woman's body" materialise in the female body. The subsequent chapter by Mariia Kiseleva and Andrey Kuznetsov explores the bodily dimension of practitioners engaged in technological innovation, focusing on the Russian-based startup Trali, which developed self-driving trucks and advanced driver-assistance systems software. It argues that the body plays a fundamental role in constituting technoscience, a process labelled the "bodilisation of technoscience". Chris Hesselbein and Paolo Volonté's chapter investigates how technology and mass production normalise the female body within the fashion system and exclude bodies or body parts that do not conform due to seemingly "objective constraints". Through two case studies related to clothing production that result in the normalisation of "other" categories of bodies, the authors demonstrate how technologies can standardise the female body, restrict its diversity and consequently categorise many women as "others" based on "technical constraints". Additionally, they explore how women seek to navigate or overcome these constraints and exclusions.

The third thematic issue addressed in Chapters Seven, Eight and Nine explores the concept of the cyborg and its potential for critically examining mainstream notions of the "natural" body as a sociotechnical and cultural construct. Bianca Rumore's chapter, informed by STS and post-humanist literature, examines the material dimension of the processes that lead to becoming cyborgs. It analyses recent technologies for visual disabilities and introduces the concept of "cyborg communities" to understand the characteristics of the current cyborg scenario. In so doing, she examines how users and designers are engaging with ethical concerns and advocating for "cyborg rights", specifically focusing on issues of accessibility and inclusiveness. The chapter prompts scholars to address ethical dilemmas that may arise when technologies (permanently) modify the human body. In Chapter Eight, Casartelli explores the dilemma of plastic surgery, which encompasses the choice between eliminating or embracing physical imperfections, as this choice serves as an illustration of the Science versus Nature divide. The concept of "uncanny technoaesthetics" is introduced to explore the technological, aesthetic and political implications of plastic surgery. This concept is influenced by Masahiro Mori's well-known "uncanny valley" hypothesis and Simondon's examination of "technics". By integrating these ideas with feminist science studies, the chapter engages in theoretical discussions about the distinctions between the "natural" and the "artificial", promoting the idea that the uncanny can serve as a productive space for disruption. Therefore, the author argues that the uncanny valley emerges from the disconnect between our expectations and our actual experiences, providing a lens through which to investigate the construction of a "natural" appearance, ultimately challenging the fixed notion of humanity. Thus, the chapter by Stefan Nicolae draws on Gunther von Hagens's "Body Worlds Exhibition", which displays technically prepared organs, body parts and entire human bodies (commonly referred to as "plastinates") to the wider public. It identifies and analyses different "normative repertoires" in which science, art and morals are addressed and reshaped in assessments of plastinates. This chapter underscores how these repertoires render intense processes of boundary drawing undertaken by social actors, fine-tuning the normative demands of these realms of social life.

The fourth thematic issue revolves around the concept of datification in everyday life. As is well known, datification involves the translation of various aspects of individuals' daily experiences, behaviours and interactions into (digital) data. These datasets can then be collected, analysed and processed using digital technologies and media platforms. Elise Li Zheng's chapter specifically focuses on the practice of self-tracking within the context of China's tech sector, where an overworking culture prevails. This chapter explores the diverse practices and technological assemblages that help individuals articulate their health data within this social setting. Through interviews with users and their reflections on personal data, this chapter asserts that self-tracking practices are influenced by neoliberal languages, productivity culture and the intersection of workplace and personal life. Additionally, ideal user representations from the health tech market rise to a variety of self-tracking practices that often clash with one another. These practices aim to transform the body into a project for productivity while also perceiving it as a worked object, rendering it fragile and under stress in the process. The chapter establishes theoretical connections between health data and the broader social context, paving the way for further inquiries into how design features can address users' varying agential capacities, empowering individuals under different modes of surveillance, stress and control. The subsequent chapter, authored by Jessica Pidoux and Pascale Kuntz, delves into the definition of variables used as input for algorithms operating in digital landscapes. They identify two types of variables: declarative and non-declarative. Declarative variables, such as weight, are filled in by users through specific interfaces when creating their profiles and are accessible to users to describe their bodies for profile formation. Non-declarative variables, on the other hand, include data such as the number of times an app has been opened and are derived from usage traces collected during users' online activities on the platform or from external sources, such as social networks. The chapter particularly focuses on identifying declarative variables used in dating apps to describe "female" body morphology, drawing from fieldwork observations.

The fifth thematic issue primarily focuses on the formation and contestation of expert knowledge. Stefano Crabu and Barbara Morsello's chapter initially centres on how communities sceptical of institutional science attempt to challenge commonly used military metaphors in public and professional biomedicine discourse. These metaphors describe the human body and immune system as battlefields where health practitioners use therapeutic tools to combat diseases. The chapter highlights how these communities, in addressing prevailing biomedical discourses and related military metaphors, construct alternative interpretations of the human immune system and redefine the living body as a subject of self-management practices situated outside the boundaries of biomedicine. In doing so, the chapter illustrates that the critical examination of biomedical metaphors goes beyond a discursive critique and serves as a foundation for developing specific knowledge claims aimed at shaping a health and well-being model that diverges from biomedical interventions. The last chapter of this section, authored by Assunta Viteritti and Letizia Zampino, investigates processes related to knowledge design in the field of stem cell research. Stem cells are portrayed as a potent resource, akin to intelligent life, possessing the ability to take action, move, reproduce and replicate autonomously. The chapter views stem cells as adaptable entities that assume various forms depending on the environments they traverse, with ongoing inquiries about their interpretation and application consistently in focus. Throughout this transformation, the central inquiry revolves around how stem cells are interpreted and utilised, which is a constant consideration in their study. Drawing on the concept of interpretative flexibility (Pinch and Bijker 1984), the authors seek to examine some of the processes contributing to the increased stabilisation of stem cells as research objects.

The book is brought to a close with an afterword that includes a contribution by Guido Nicolosi, honouring the personal and intellectual heritage of Marina Maestrutti, whose work serves as the inspiration for this book. Indeed, after the sudden and unexpected passing of Marina on January 22, 2021, the initial motivation to publish this volume stemmed from the desire of the Italian Society for Science and Technology Studies (STS Italia) to honour her life and work by creating a book dedicated to her core research interests, which involved exploring how technologically advanced societies reshape and enact the human body, along with notions and practices of care, through a wide array of technologies. Just as Marina Maestrutti's work did, this edited collection illustrates how scholars in STS and, more broadly, social scientists can investigate the co-construction of the body as a result of interactions between human and non-human elements, materiality, knowledge and institutions.

A cherished and respected colleague, Marina served as vice president of STS Italia from 2016 to 2018. With a background in philosophy and anthropology of technology, she was affiliated with the University of Paris 1 Panthéon, where she conducted extensive research across various scientific and technological fields, including nanotechnology, robotics, biotechnological innovations, artificial intelligence and new medical devices and techniques. The central theme of her work resonates with the enduring tradition in social theory and STS, that underpins the chapters in this book, as they delve into the evolving boundaries and characteristics of the human body. This exploration acknowledges that the body has progressively grown more reliant on advanced technologies emerging from various technoscientific domains.

In essence, much like Maestrutti's work, this edited compilation showcases how scholars can explore the co-creation of the body through interactions involving human and non-human elements, materiality, knowledge and institutional factors. Such a perspective challenges the essentialist view of the human body, which presumes fixed and "normal" physical and mental attributes. This viewpoint advocates for a more process-oriented understanding of living bodies, acknowledging that they manifest as relational phenomena emerging from complex sociomaterial configurations across time and space.

Clarke, A. E., Shim, J. K., Mamo, L., Fosket, J. R., Fishman, J. R. (eds.)
2010 *Biomedicalization: A Theoretical and Substantive Introduction*, in A. E. Clarke, J. K. Shim, L. Mamo, J. R. Fosket, J. R. Fishman (eds.), *Biomedicalization: Technoscience, Health, and Illness in the U.S.* (pp. 1-44), Durham (NC), Duke University Press.

Corbin, J., Strauss, A. L.
1987 'Accompaniments of chronic illness: Changes in body, self, biography, and biographical time', *Research in the Sociology of Health Care*, *6*, 249-281.

Crabu, S., Magaudda, P.
2022 'Disentangling futures from a science and technology studies perspective', *TECNOSCIENZA: Italian Journal of Science & Technology Studies*, *13*(2), 5-12.

Foucault, M.
1975 *Discipline and Punish: The Birth of the Prison,* New York, Vintage Books.

Foucault, M.
1976 *The History of Sexuality, Volume 1: An Introduction*, New York, Vintage Books.

Goffman, E.
1956 'The Presentation of Self in Everyday Life', *American Sociological Review*, *21*(5), 631-632.

Haraway, D.
1990 *A Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s*, in L. J. Nicholson (ed.), *Feminism/Postmodernism* (pp. 190-223), New York and London, Routledge.

Haraway, D.
1992 *The Promises of Monsters: A Regenerative Politics for Inappropriate(d) Others*, in L. Grossberg, C. Nelson, P. A. Treichler (eds.), *Cultural Studies* (pp. 295-337), New York and London, Routledge.

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

Latour, B.
1987 *Science in Action: How to Follow Scientists and Engineers through Society,* Cambridge (MA), Harvard University Press.

Lynch, M.
1985a *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk in a Research Laboratory,* London and New York, Routledge and Kegan Paul.

Lynch, M.
1985b 'Discipline and the Material Form of Images: An Analysis of Scientific Visibility', *Social Studies of Science*, *15*(1), 37-66.

Lynch, M.
1998 'The production of scientific images: Vision and re-vision in the history, philosophy, and sociology of science', *Communication & Cognition*, *31*, 213-228.

Lynch, M., Woolgar, S. (eds.)
1990 *Representation in Scientific Practice,* Cambridge (MA), The MIT Press.

Lupton, D.
2013 *Medicine As Culture: Illness, Disease and the Body,* London, Sage.

Mauss, M.
1934 'Les techniques du corps', *Journal de Psychologie Normale et Pathologique*, *XXXII*, 271-293.

Merleau-Ponty, M.
1945 *Phénoménologie de la Perception,* Paris, Gallimard.

Neresini, F., Crabu, S., Di Buccio, E.
2019 'Tracking biomedicalization in the media: Public discourses on health and medicine in the UK and Italy, 1984-2017', *Social Science and Medicine*, *243*, 112621.

Oudshoorn, N., Somers, A.
2006 'Constructing the digital patient: Patient organizations and the development of health websites'. *Information, Communication & Society*, *9*(5), 657-675.

Perrotta, M.
2012 'The Study of Technoscientific Imaging in STS', *TECNOSCIENZA: Italian Journal of Science & Technology Studies*, *3*(2), 163-176.

Pinch, T. J., Bijker, W. E.
1984 'The Social Construction of Facts and Artifacts: Or How the Sociology of Science

and the Sociology of Technology Might Benefit Each Other', *Social Studies of Science*, *14*(3), 399-441.

Rose, N.

2007 *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century,* Princeton (NJ), Princeton University Press.

Simmel, G.

1997 [1907] *Sociology of the Senses*, in D. Frisby, M. Featherstone (eds.), *Simmel on Culture* (pp. 109-119), London, Sage.

Tempini, N., Teira, D.

2019 'Is the genie out of the bottle? Digital platforms and the future of clinical trials', *Economy and Society*, *48*(1), 77-106.

Turner, B.

1996 *The Body and Society: Explorations in Social Theory,* London, Sage.

Part I.
The Body Visible

1. Technologies in "making the invisible visible"*

FEDERICO NERESINI

"What do you do Dad?" My son Jacopo was still little and, like all children, he was curious about his parents' jobs, if for no other reason, to be able to tell his teachers and schoolmates.
"I work at the university."
"Yes, but what do you do at the university?"
… ??? Well, now, err… What do I say now?
"I fix the boilers."
Certainly I could have told him the truth, "I'm a sociologist," but how would I have explained what a sociologist is?

In actual fact, what is a sociologist?
It isn't easy to answer this question. But one part of the answer might be that sociologists make the invisible visible. Obviously, this doesn't solve the problem because we still need to clarify what this answer actually means.

A non-exclusive activity

If we carefully consider this concept, it becomes apparent that *making the invisible visible* is not exclusive to sociologists. On the contrary, other academics, often more highly regarded, may describe their work in the same manner. Take scientists, for instance.

* "Making the invisible visible" is the translation of the title of the article published by Marina originally in Italian "Rendere visibile l'invisibile. Il ruolo della visione e dell'immagine nella costruzione di una storia delle nanotechnologie" (Maestrutti 2008).

Whether engaged in laboratory research, like molecular biologists or chemists, or exploring the Earth and space to observe their characteristics, scientists have developed various procedures with the specific purpose of illuminating the order underlying the disorder, a characteristic aspect of our experience of the world. Scientific research can be seen as a process of extracting *order from disorder*, as observed by Latour and Woolgar in their study of the laboratory (Latour and Woolgar 1979), enabling us to discern what the vague noise of our perceptions might otherwise overlook.

Some of these processes of *order-from-disorder* extraction reach such a high level of stabilisation that they are reified in artifacts, commonly known as *scientific instruments*. Their role is so crucial that science would not exist without them. One might say, "If you're looking for scientific knowledge, follow the instruments."

From the most rudimentary to the most sophisticated versions used in laboratories worldwide, microscopes enable us to analise the structure and physiology of cells, various types of molecules, and even individual atoms, as seen in the nanotechnology sector with the atomic microscope, which utilises the so-called "tunnel effect" (Maestrutti 2011a; Neresini 2011). Telescopes and satellites have extended astronomers' vision into the hidden depths of space, while advanced instruments like interferometers can detect imperceptible phenomena such as electromagnetic waves (Collins 2017). Particle accelerators, such as those used by CERN, make sub-atomic particles visible.

Actually, scientists are not making things visible in the way we typically understand this expression. Instead, they are transforming the signals they collect into what Latour and Woolgar (1979) refer to as "literary inscriptions"— that is, numbers, tables, graphs, plots, and even images. These representations digitally render the inputs visible according to theoretical assumptions and visual conventions (Latour 1987; Mody 2006; Maestrutti 2011a). For example, physicists don't directly observe sub-atomic particles; rather, they observe the traces of their decay after a collision, during which the atomic structure within which they were organised is destroyed.

Thus scientific instruments can be seen as «reified theories» (Bachelard 1953; Latour and Woolgar 1979), contributing to building the world they allow us to observe. They cannot be considered neutral channels through which data representing reality flows to create an intermediary-free image. They are not "objective" in the sense of being "distortion-free"; if anything, the opposite is true. By providing access to a more in-depth vision, they embed and enable ways of building reality that we call "theories." They make the invisible visible by making it perceptible through the simultaneous process of its construction. It's not just a matter of recognising that "phenomena depend on certain material instrumentation; rather, the phenomena are thoroughly constituted by the material setting of the laboratory" (Latour and Woolgar 1979: 64).

As part of a socio-technical network, they enable scientists to both see and construct the world (Goodman 1978). Experimental apparatuses precisely create the phenomena that scientists study, as a lengthy transformation and purification process is needed for a *natural phenomenon* to become an *experimental entity* (Hacking 1983) — an object whose characteristics enable it to be used in the *trial of strength* (Latour 1987) that takes place in laboratories (Neresini 2019).

The field of nanotechnology provides an illustrative example. Marina Maestrutti's exploration of the history of the scanning tunneling microscope, a tool with "ambiguous" characteristics, demonstrates that its crucial role in the founding myth of nanotechnology depended not only on its ability to make atoms visible but also on its capacity to manipulate them, though under highly specific and uncommon conditions (Maestrutti 2008).

Scientific instruments, such as those in nanotechnology, can be seen as specific instances of *objects* that populate our world and with which we continually interact. Objects, including scientific instruments, are essentially "congealed social agreements, or rather, congealed moments in the history of people acting together" (Becker 1998: 69).

Our interpersonal relations not only result in objects but also contribute to shaping our identities as participants in interaction networks, where objects play a role. Our interaction with these objects is so vital that they are constructed by us while simultaneously constructing us. Scientific instruments are thus part of the vast array of «non-human actors» (Latour 1992) with which we interact daily, and our existence, as well as theirs, is intertwined with this interaction. This profound dependency is better described as "intra-action," than "inter-action"; the former refers to the "mutual constitution of entangled agencies" (Barad 2007). Unlike the conventional "inter-action," which assumes separate individual agencies preceding interaction, the concept of intra-action recognises that distinct agencies do not precede but rather emerge through their relationships: "agencies are only distinct in relation to their mutual entanglement; they don't exist as individual elements" (Barad 2007: 33).

Scientists are, therefore, shaped by the instruments they use, and vice versa.

Yet, scientists do more than make aspects and dimensions of reality visible. Their work in "heterogeneous engineering" (Law 1987, 1991) reveals a world in the making. The construction of socio-technical futures and scenarios accompanies and, simultaneously, nurtures their research and innovation processes, becoming an integral part of them (Borup et al. 2006; Selin 2007, 2008; Jasanoff and Kim 2015; Konrad et al. 2016). Also in this sense, research materialises the invisible, projecting it into a future which can only be imagined.

Just as Diesel described in his book – *Solidarismus: Natürliche wirtschaftliche Erlösung des Menschen* (1903)[1] – the advent of the new world his engine would usher in while he was obtaining the patent for it (Latour 1987), Nicolas Negroponte's *Digital Being* (1995) foresaw what a society completely revolutionised by computers would look like. In the same way, what Erik Drexler imagined in his *Engines of Creation* (1986) contributed to founding nanotechnology research by prefiguring "the coming era of nanotechnology," namely a socio-technical imaginary in which nano-machines would have not only over-

[1] That is *Solidarity: Natural Economic Redemption of Man*.

come all the obstacles currently stopping them from coming to fruition but would also be the main players in a society revolutionised by their advent.

Niels Bohr argued that it is «difficult to make forecasts, especially on the future»: how can we contradict him[2]? It is precisely this which all scientists do, however, though at differing levels of intensity. Their reasons for doing so are clearly not bound up with the survival of an unresolved conflict between science and astrology, but rather on a perhaps unconscious need to safeguard the fragile knowledge they generate by giving it a time frame long enough to allow it to consolidate. When the facts are first "uncovered," in fact, they are tentative because they still need to find a place for themselves within a context which did not previously contemplate them, being anyway ordered and stable. Also the world without the microbes before Pasteur was functioning and meaningful, and it is exactly for this reason that the microbes at *statu nascenti* were extremely weak and asking protection. The need to recruit actors to shore up the embryonic scientific facts derives from this, as does the importance of sounding convincing, even to the extent of prefiguring scenarios to make them credible and attractive. This is what the sociology of socio-technical promises and expectations teaches us (van Lente 1993; Konrad et al. 2016), and it is a lesson which Marina learnt and used very well. A considerable part of her work, in fact, focuses on the techno-scientific imagination creation process and its role in scientific research and technological innovation (Maestrutti 2007, 2011b, 2011c, 2016).

Making the "Taken for Granted" visible

Making the invisible visible, at least in the context explored thus far, doesn't appear to distinguish sociologists in an exclusive manner from other researchers. However, sociologists approach it uniquely, employing an original perspective that guides their knowledge-construction process and defines their epistemological stance. For example, the distinct nature of their «sociological eye» (Hughes 1984; Becker 1998) becomes evident when scientists' envisioned futures are not taken for granted but become subjects of analysis. This involves illustrating their role in the scientific fact-building process and examining how these futures gradually materialise and gain credibility.

The significance of socio-technical scenarios lies in their ability to shape attitudes and drive behaviors in the present, anticipating a future where new scientific knowledge and technological innovations will showcase their solidity and utility. Consequently, these scenarios not only forecast what might be evident in the future but also familiarise us with what is not yet seen as obvious, portraying it as an integral and natural part of our world. When science is still "in action," its facts remain uncertain, and their ac-

2 It is not clear whether it was actually Niels Bohr who first said this, although it has been attributed to him since A.K Ellis's 1970 book *Teaching and Learning Elementary Social Studies* and this Nobel prize winner may have been repeating an old Danish adage.

ceptance—what makes them "ready-to-use"—largely depends on how convincing they appear to potential supporters. This aligns with one of the translation strategies contributing to the enlistment process within the «fact-builders» network (Latour 1987: 104): demonstrating the usefulness of one's work to others, showcasing its ability to address urgent problems today.

In a similar vein, during their early stages, technological innovations desperately require an expansion of their network of supporters. However, even the most advanced prototypes, such as the initial engines crafted by Diesel with the collaboration of Krupp and MAN technicians (Latour 1987), find it challenging to achieve this goal. This is due to their often faltering performance, easily obstructed by even the simplest obstacles, and because their complete deployment hinges on certain conditions yet to be realised. Consequently, their only recourse is to project into a future where the innovation is fully consolidated and naturalised.

These are the mechanisms that the sociological eye highlights when scrutinising techno-scientific imaginaries and socio-technical scenarios.

Making the formation and functioning of the latter visible also enables sociology to demonstrate the existence of multiple and competing futures (Brown et al. 2000). Consequently, the future we typically envision is none other than the future that manages to emerge in a specific context and time. What sociology *makes visible* is thus a reflection of the precarious nature of what is considered solid, or at least credible. This is not for the purpose of sterile criticism but rather to pave the way for potential alternatives. The sociological eye implies distancing ourselves from the everyday taken-for-granted world, but it is precisely this distancing that renders it visible. The obscure material brought to light by the sociological eye is, in fact, concealed behind the *epoché* upon which our perception of reality rests.

Obviously, this problematisation of what is normally a-problematic does not apply only to socio-technical scenarios and future imaginaries. On the contrary, in the case of techno-science, this deconstruction has been applied by STS, above all, to scientific knowledge and "discoveries" as they emerge.

The endeavor of STS can be summed up precisely in this: making visible the multifaceted, time-consuming, unexpected, routine, messy, and fascinating construction work by which something initially weak and shaky is transformed into something as strong and commanding as a scientific fact. In other words, showing how a process whose outcomes are uncertain and dependent on specific circumstances can lead to knowledge capable of extending its existence and agency well beyond the limited confines within which it has begun to move. Quoting Latour once again, «facts and machines are like trains, electricity, packages of computer bytes, or frozen vegetables: they can go everywhere as long as the track along which they travel is not interrupted in the slightest.» For this reason, «every time a fact is verified and a machine runs, it means that the lab or shop conditions have been extended in some way» (Latour 1987: 249-250).

However, truly understanding the work of scientists, fully appreciating its trajectory, and raising awareness of its value and significance require sociologists to adopt a stance that is challenging to find and even more challenging to maintain. It involves carefully balancing the act of holding a sufficient distance to break up the suspension of doubt that characterises the everyday world of scientists, while simultaneously getting close enough to make this world understandable. Latour and Woolgar articulated this delicate balance well in their introduction to *Laboratory Life* (1979), where they reflected on the most suitable language for making the work of scientists visible. They proposed a "median" language that, on the one hand, avoids the technical jargon used by scientists in their articles and meetings and, on the other hand, retains the ability to take seriously what scientists say and do. This approach involves observing them closely—without obstructing their work—as they participate in assembling the heterogeneous networks upon which their existence, as well as that of the objects they construct (knowledge, tools, facts, and documents), depends.

Nevertheless, there are at least two additional realms where the fabric of everyday life unfolds, often staying beneath the threshold of visibility. These areas have garnered extensive attention from sociologists and scholars in science and technology studies (STS): one revolves around disability, while the other involves the heritage of material possessions and cultural resources subjected to exploitation and subordination through colonialism. What unites these spheres is their shared existence on the fringes of our perception, intentionally overlooked or deemed insignificant and undeserving of recognition.

Revealing the intricacies of scientists' everyday lives requires a specific perspective aligned with the sociological point of view. However, there's an inherent risk in this approach, which we might term the *temptation of deconstructing facts.* This risk involves deviating from the necessary detachment required to analise the construction process in which scientists are involved and assuming an ideal privileged vantage point from which to critically scrutinise it. In doing so, there's a danger of not only deconstructing scientific work but also eroding its value and credibility. The fact that scientists may take certain aspects for granted or overlook crucial elements for their work—such as the motives behind the funding of their research or the socio-political dynamics inherent in the scientific process—does not imply naivety, ignorance, or ill intent. It doesn't mean that the knowledge they generate lacks credibility or is misleading. Instead, it simply signifies that they must suspend judgment on certain prerequisites to carry out their work. This condition is inevitable for everyone, and sociologists are no exception. The sociological eye is not a special case; it's simply different from others.

STS has consistently paid due attention to and strived to take constructive account of this aspect in its research work. The commitment to integrate the co-production relationship between the observer and the observed into research practice was originally emphasised in the strong programme's principle of reflexivity— that the patterns of explanation proposed by the sociology of scientific knowledge «would have to be applicable to sociology itself [...] otherwise sociology would be a standing refutation of its own theories» (Bloor 1976: 7)— and is evident in the methodological proposals and ensuing debates it has inspired (Woolgar 1988; Collins and Yearly 1992; Callon and Latour 1992). Later, the imperative to not only make the observer-observed relationship explicit but also epistemologically productive was further emphasised by insights from feminist and post-colonial studies. Notable contributors to this dialogue include Haraway (1991, 1997), Barad (2007), Longino (1990), Harding (2008), and Verran (2002).

Resisting the *temptation to de-construct facts* is thus a fundamental aspect of STS and aligns with the median stance that sociologists strive to adopt for *making the invisible visible*. It involves a delicate balance not only between maintaining distance from and engaging with the social worlds under study but also between essentialism and relativism. This refers to the tension between those who deny the inherent relationship upon which both the observer and the observed depend and those who attribute it solely to the «factbuilders», excluding who studying their work. The sociological eye cannot rely on the «god trick of seeing everything from nowhere» (Haraway 1988: 583), placing itself outside time and space. Instead, it must embrace the awkwardness of its intermediary role, existing «somewhere in between» (Law 1999: 583) — an unstable and uncomfortable position that acknowledges the limitations of both realism and relativism. This represents the temptation to deconstruct facts, as it corresponds to «the perfect mirror twin of totalisation in the ideologies of objectivity; both deny the stakes in location, embodiment, and partial perspective; both make it impossible to see well» (Haraway 1988: 584).

The sociological eye's act of unveiling cannot merely result in deconstruction, as this would only leave heaps of rubble in the field of reality. Bringing to the surface what typically remains buried does not necessitate a disavowal of the robustness of the constructions under examination. This is because what is constructed is generally quite solid (Hacking 1999), and, as per Thomas's well-known theorem, what is defined as real has real consequences.

Demonstrating that scientific knowledge is constructed and context-dependent does not undermine its solidity. Quite the contrary.

From the Margins

The capacity of the sociological eye *to make the invisible visible* goes beyond the mere deconstruction of the taken-for-granted or the critical analysis of what is perceived as objective, self-evident, and independent of the constantly reconstructing processes. There is a deeper layer behind everyday life that often eludes our awareness. Consider, for example, the significant contribution of Science and Technology Studies (STS) to the analysis of infrastructures, those socio-technical assemblages underpinning much of our daily lives, such as transport networks, electricity grids, and the web. Among the various aspects explored by STS, at least two are particularly noteworthy: the processual or, more precisely, relational nature of infrastructures (Star and Ruhleder 1996), and their invisibility (Hughes 1987; Star and Ruhleder 1996).

Regarding the first aspect, STS suggests that the right question to pose about infrastructures is not so much "what" as "when." Like scientific instruments or any other artefacts, an infrastructure is not «just a thing with pre-given attributes frozen in time», as «a thing becomes a tool in practice, for someone, when connected to some particular activity» (Star and Ruhleder 1996: 112). Thus, infrastructures are essentially processes, and they do not become invisible because, once built, they sink into the background; rather, they remain invisible because they are an ongoing process.

This is why an infrastructure becomes visible "when it breaks: the server is down, the bridge washes out, there is a power blackout. Even when there are back-up mechanisms or procedures, their existence further highlights the now-visible infrastructure" (Star and Ruhleder 1996: 112). It also becomes visible when sociologists bring it out of the darkness of the taken-for-granted, giving it visibility as a study object. Similarly to scientists' relationships with their research objects, sociologists are also implicated in the construction of what they study. Social phenomena are products of the «trials of strength» (Latour 1987) through which sociologists challenge taken-for-granted routines, testing their resistance and making social phenomena visible as they determine them.

However, there are at least two additional spheres in which everyday life takes shape, remaining below the visibility threshold but extensively studied by sociologists and STS: disability and the patrimony of material goods and cultural resources exploited and subordinated by colonialism. What these share is precisely their survival at the margins of our vision, deliberately ignored or considered unimportant and unworthy of note.

A spotlight has been shone on disability by what is known as the British "social model," which hinges on the distinction between the condition of individuals lacking parts of the body or physiological functions (impairment) and the disadvantages, exclusions, and difficulties deriving from the incapacity of a given social model to take sufficient account of such conditions. As Marina noted (Maestrutti 2020), the shift in attention brought in by the social sciences from the impaired body to the social context has laid the groundwork for a critical analysis of the role of biomedical knowledge and techno-scientific research, both in overcoming impairment and in constantly reaffirming a normality centered on the individual rather than the network of relations on which even able-bodied individuals depend. It is a contradictory situation defined by the presence of two apparently irreconcilable forces: improving the condition of those with an impairment while weakening critiques toward a collective life organisation designed and acted on as an aggregate of individuals rather than an incessant process fed by the relationships between them.

Technology plays a central role in all this, but the sociological eye constantly calls on us not to underestimate the ambiguity of this stance. In some ways, it might be said that, in the bio-medical field, the technological fix approach leads not only to the repairing of defects caused by techno-science itself—such as the development of artificial limbs for injuries caused by car or workplace accidents, or adverse pharmaceutical effects or diseases due to unhealthy diets—but also covers up processes that the sociological eye seeks to uncover, such as the cult of the individual that characterises post- or late-modern societies (Lasch 1979; Giddens 1990, 1991; Beck, Giddens and Lash 1994; Bauman 1995).

This technological ambiguity has repeatedly played a relevant role in Marina's work on the subject of robotics (Faucounau et al. 2009; Wu et al. 2011), artificial limbs (Jarrassé et al. 2015), human enhancement (2011b) or cyborgs (2011c). In this and a great deal of her other works, Marina has also demonstrated how misleading it is to consider technology as a separate entity *applying* to bodies, everyday practices, and people's identities, highlighting its indissoluble bond with the construction of social relationships within which both the material nature of bodies as well as objects and imaginaries as well as symbolic worlds find space.

Marina also started employing this approach to align with the post-colonial vision. Through this, her analysis of the relationship between bodies, technologies, and imaginaries gained an enriched awareness of how inequality in resource distribution and social conditions influences the definition of this relationship.

The post-colonial perspective enhances the sociological commitment to *making the invisible visible* with new potential. This involves a dual shift—restoring visibility to the neglect of the global South and revealing the contradictions of the North that keep it subjugated. Furthermore, post-colonial epistemological displacement has heightened our ability to reflect on knowledge, its construction, and its use (see, for example, Harding 2008 and Santos 2018). In particular, the post-colonial perspective illuminates the observer-observed relationship in knowledge construction processes, reinforcing the awareness that the position of the former not only defines what is observable but also how to observe it. In fact, the very relationship between the knower and his/her object of study should not be conceived of as an individual relationship between a single observer and what he/she observes but rather as part of a network of relationships which are both an emerging effect and what make this effect possible. For instance, Verran's concept of «relational empiricism» suggests that researchers must not only demonstrate that their study is a product of a collective of relationships to which they actively contribute but also acknowledge that the «analyst [herself] is configured as an emergent part of the collective» (Verran 2013: 5). As we have seen, sociologists do not study things *per se*, because these things emerge from a network of relationships which they are not simply part of but which result from their involvement in such a network (Law 1999). The relational nature of knowledge and the pivotal role of a sociologist's position are therefore inherently connected. Simultaneously, this connection shapes and delineates their potential—and ability—to *make the invisible visible*.

A spark lit up Marina's eyes, an energy born from the friction between two poles—perhaps best interpreted as a fusion of disenchantment and irony. This intriguing spark, a sign of a sometimes uneasy but always attractive coexistence and a hallmark of those with a sociological eye, often played across her smile.

This occured because revealing the invisible necessitates a sense of disenchantment—a gradual detachment from the romantic notion that perceives ourselves and our culture as special, unique, self-sufficient, and therefore superior. On one hand, the sociological eye aligns with the progressive rationalisation of modern Western society, adopting, in Weberian terms, a worldview devoid of magic and emotional entanglements. We are now our own masters, yet the awareness gained, including on the potential of the social sciences, has stripped away the comfort of mystery in favor of a cold intellectualism.

On the other hand, as the dominance of techno-science aligns us more closely with other living beings sharing our evolutionary journey of matter and genetic predispositions, the social sciences chip away at the myth of individuality. They cast doubt on assumptions of superiority based on gender, race, and wealth, revealing our inherent dependence on the collective, on relationships, and thus on belonging to intricate networks.

So, it might seem that *unveiling* necessarily leads to *disenchantment*. However, this isn't the case, especially as long as the sociological eye retains its ability to be amazed by the world's variety. What, then, is needed to maintain this ability? Interestingly, it doesn't require sociologists to deny themselves but rather to take themselves even more seriously. For instance, disenchantment isn't an unavoidable fate for sociologists if we wholeheartedly embrace the call to "follow the actors" proposed by Actor-Network Theory, all the while maintaining the specificity of our point of view (Neresini 2022). The idea is that "unveiling" doesn't necessarily imply "removing." Latour (2005), in particular, urges us to "add in," appreciating the richness of the network of relationships we call "social phenomena."

This appreciation emerges when we recognise the heterogeneity of the networks we engage in, extending beyond interactions with other individuals to include objects, machines, and other living beings— *In short, what we may refer to as non-humans*. Furthermore, it occurs when we effectively resist the *temptation of deconstructing the facts*. As discussed earlier, this entails recognising the analytical and social importance of what we reveal as a product of a construction process, rather than diminishing its significance.

In doing so, sociologists position themselves as integral parts of the subjects they observe, laying the foundation for greater humility in our understanding of phenomena. This humility is a pivotal element in fostering a sense of wonder. In this context, sociological knowledge can be considered as a «matter of care» (Puig de la Bellacasa 2011), but in a reciprocal manner: the more sociologists care for their subjects, the more they, in turn, are cared for by the collectives whose lives they contribute to.

Humility, in this context, is synonymous with “irony,” or more precisely, “self-irony”: to experience amazement, we sociologists must not assert superiority. At the end of the day, we are, in a simple yet impactful way, just “telling stories” (Latour 1988).

Marina sometimes reminded us of this. Will we be able not to forget it?

Bachelard, G.
1953 *Le matérialisme rationnel,* Paris, PUF.

Barad, K.
2007 *Meeting the universe halfway: Quantum Physics and the Entanglement of Matter and Meaning*, Durnham & London, Duke University Press.

Bauman, Z.
1995 *Life in Fragments: Essays in Postmodern Morality*, Cambridge (MA), Basil Blackwell.

Beck, U., Giddens, A., Lash, S.
1994 *Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order*, Stanford, Stanford University Press.

Becker, H. S.
1998 *Tricks of the Trade: How to Think about Your Research While You're Doing It*, Chicago, University of Chicago Press.

Bloor, D.
1976 *Knowledge and Social Imagery*, Chicago, University of Chicago Press.

Borup, M., Brown, N., Konrad, K., Van Lente, H.
2006 'The sociology of expectations in science and technology', *Technology Analysis & Strategic Management*, *18*(3-4), 285-298.

Brown, N., Rappert, B., Webster, A.
2000 *Contested Futures: A Sociology of Prospective Techno-Science*, Aldershot, Ashgate.

Callon, M., Latour, B.
1992 *Don't Throw the Baby Out with the Bath School! A Reply to Collins and Yearley*, in A. Pickering (ed.), *Science as Practice and Culture* (pp. 343-368), Chicago (IL), University of Chicago Press.

Collins, H.
2017 *Gravity's Kiss: The Detection of Gravitational Waves*, Cambridge (MA), The MIT Press.

Collins, H., Yearley, S.
1992 *Epistemological Chicken*, in A. Pickering (ed.), *Science as Practice and Culture* (pp. 301-326), Chicago, University of Chicago Press.

Diesel, R.
1903 *Solidarismus: Natürliche Wirtschaftliche Erlösung des Menschen*, De Gruyter, Oldenbourg.

Drexler, E.
1986 *Engines of Creation: The Coming Era of Nanotechnology*, New York, Anchor Books.

Faucounau, V., Wu, Y. H., Boulay, M., Maestrutti, M., Rigaud, A. S.
2009 'Caregivers' requirements for in-home robotic agent for supporting community-living elderly subjects with cognitive impairment', *Technology and Health Care*, *17*(1), 33-40.

Giddens, A.
1990 *The Consequences of Modernity,* Cambridge (UK), Polity Press.

Giddens, A.
1991 *Modernity and Self-Identity: Self and Society in the Late Modern Age*, Oxford, Polity Press.

Goodman, N.
1978 *Ways of Worldmaking*, Indianapolis, Hackett Publishing Company.

Hacking, I.
1983 *Representing and Intervening*, Cambridge (UK), Cambridge University Press.

Hacking, I.
1999 *The Social Construction of What?*, Harvard, Harvard University Press.

Haraway, D. J.
1988 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective', *Feminist Studies*, *14*(3), 575-599.

Haraway, D. J.
1991 *Simians, Cyborgs and Women: The Reinvention of Nature*, New York & Abingdon, Routledge.

Haraway, D. J.
1997 *Modest_Witness@Second_Millennium. FemaleMan©_Meets_OncoMouse™: Feminism and Technoscience*, New York, Routledge.

Harding, S.
2008 *Sciences from Below: Feminisms, Postcolonialities, and Modernities*, Durham (NC), Duke University Press.

Hughes, E. C.
1984 *The Sociological Eye*, New Brunswick (NJ), Transaction Publishers.

Hughes, T. P.
1987 *The Evolution of Large Technological Systems*, in W. E. Bijker, T. P. Hughes, T. J. Pinch (eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (pp. 51-82), Cambridge (MA) & London, The MIT Press.

Jarrassé, N., Maestrutti, M., Morel, G., Roby-Brami, A.
2015 'Robotic Prosthetics: Moving Beyond Technical Performance. A Study of Socio-Anthropological and Cultural Phenomena Influencing the Appropriation of Technical Objects Interacting with the Body', *IEEE Technology and Society Magazine*, *34*(2), 71-79.

Jasanoff, S., Kim, S. H. (eds.).
2015 *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, Chicago, University of Chicago Press.

Konrad, K. E., Van Lente, H., Groves, C., Selin, C.
2016 *Performing and Governing the Future in Science and Technology*, in U. Felt, R. Fouche, C. A. Miller, L. Smith-Doerr (eds.), *The Handbook of Science and Technology Studies, fourth edition* (pp. 465-493), Cambridge (MA), The MIT Press.

Lasch, C.
1979 *The Culture of Narcissism: American Life in an Age of Diminishing Expectations*, New York & London, W. W. Norton & Company.

Latour, B.
1987 *Science in Action: How to Follow Scientists and Engineers Through Society*, Cambridge (MA), Harvard University Press.

Latour, B.
1988 *The Politics of Explanation: An Alternative*, in S. Woolgar (ed.), *Knowledge and Reflexivity: Frontiers in the Sociology of Knowledge* (pp. 155-176), London, Sage.

Latour, B.
1992 *Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts*, in W. E. Bijker & J. Law (eds.), *Shaping Technology/Building Society: Studies in Sociotechnical Change* (pp. 225-258), Cambridge (MA), The MIT Press.

Latour, B.
2005 *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford (UK), Oxford University Press.

Latour, B., Woolgar, S.
1979 *Laboratory Life: The Construction of Scientific Facts*, Princeton (NJ), Princeton University Press.

Law, J.
1987 *Technology and Heterogeneous Engineering: The Case of Portuguese Expansion*, in W. E. Bijker, T. P. Hughes, T. J. Pinch (eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (pp. 111-134), Cambridge (MA) & London, The MIT Press.

Law, J. (ed.).
1991 *A Sociology of Monsters: Essays on Power, Technology, and Domination*, London, Routledge.

Law, J.
1999 *After ANT: Complexity, naming and topology*, in J. Law & J. Hassard (eds.), *Actor Network Theory and After* (pp. 1-14), Oxford (UK) & Malden (MA), Wiley-Blackwell.

Longino, H. E.
1990 *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*, Princeton (NJ), Princeton University Press.

Maestrutti, M.
2007 *Imaginaires des nanotechnologies: Mythes et fictions de l'infiniment petit*, Paris, Sorbonne University.

Maestrutti, M.
2008 'Rendere visibile l'invisibile: Il ruolo della visione e dell'immagine nella costruzione di una storia delle nanotecnologie', *Rassegna Italiana di Sociologia*, *3*, 427-450.

Maestrutti, M.
2011a *Imaginaires des nanotechnologies: Mythes et fictions de l'infiniment petit*, Paris, Vuibert.

Maestrutti, M.
2011b 'Humain, transhumain, posthumain: Représentations du corps entre incomplétude et amélioration', *Journal International de Bioéthique*, *22*(3-4), 51-66.

Maestrutti, M.
2011c 'Cyborg identities and contemporary techno-utopias: Adaptations and transformations of the body in the age of nanotechnology', *International Journal of Bioethics*, *22*(1), 71-88.

Maestrutti, M.
2016 *Notre société sera-t-elle nano-technologique?*, Paris, Le Pommier.

Maestrutti, M.
2020 ‘Alle frontiere del corpo: Identità, corporeità e tecnologie nei Disability Studies’, *Rassegna Italiana Di Sociologia*, *1*, 151-175.

Mody, C. C. M.
2006 ‘Corporations, Universities, and Instrumental Communities: Commercializing Probe Microscopy, 1981-1996’, *Technology and Culture*, *47*(1), 56-80.

Mongili, A., Pellegrino, G. (eds.).
2014 *Information Infrastructure(s): Boundaries, Ecologies, Multiplicity*, Newcastle, Cambridge Scholars Publishing.

Negroponte, N.
1995 *Being Digital*, New York, Vintage Books.

Neresini, F.
2011 *Il nano-mondo che verrà: Verso la società nanotecnologica*, Bologna, Il Mulino.

Neresini, F.
2019 *Nouvelles technologies, nouveaux laboratoires? L’émergence des instruments à haut-débit dans les laboratoires de biologie moléculaire*, in E. Clarizio & X. Guchet (eds.), *Vie, anthropologie, politique: Perspectives italiennes contemporaines en philosophie des techniques* (pp. 117-144), Paris, Mimesis.

Neresini, F.
2022 *Technoscience*, in P. Rebughini & E. Colombo (eds.), *Framing Social Theory: Reassembling the Lexicon of Contemporary Social Sciences* (pp. 123-138), London, Routledge.

Puig de la Bellacasa, M.
2011 ‘Matters of care in technoscience: Assembling neglected things’ *Social Studies of Science*, *41*(1), 85-106.

Santos, B. D. S.
2018 *The End of the Cognitive Empire: The Coming of Age of Epistemologies of the South*, Durham, Duke University Press Books.

Selin, C.
2007 ‘Expectations and the Emergence of Nanotechnology’, *Science, Technology, & Human Values*, *32*(2), 196-220.

Selin, C.
2008 ‘The Sociology of the Future: Tracing Stories of Technology and Time’, *Sociology Compass*, *2*(6), 1878-1895.

Star, S. L., Ruhleder, K.
1996 ‘Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces’ *Information Systems Research*, *7*(1), 111-134.

Van Lente, H.
1993 *Promising Technology. The Dynamics of Expectations in Technological Developments, Enschede,* University of Twente.

Verran, H.
2002 'A Postcolonial Moment in Science Studies: Alternative Firing Regimes of Environmental Scientists and Aboriginal Landowners', *Social Studies of Science*, *32*(5-6), 729-762.

Verran, H.
2013 'Numbers Performing Nature in Quantitative Valuing', *Nature and Culture*, *2*, 23-37.

Woolgar, S. (ed.).
1988 *Knowledge and Reflexivity: New Frontiers in the Sociology of Knowledge*, London, Sage.

Wu, Y. H., Faucounau, V., Boulay, M., Maestrutti, M., Rigaud, A. S.
2011 'Robotic agents for supporting community-dwelling elderly people with memory complaints: Perceived needs and preferences', *Health Informatics Journal*, *17*(1), 33-40.

2. Seeing through Machines: Algorithms and the Pursuit of Mechanical Objectivity in Embryo Imaging

MANUELA PERROTTA

Introduction

Biomedical imaging has been extensively explored by science and technology studies (STS) scholars (Lynch and Woolgar 1990; Coopmans et al. 2014). A rich literature has shown the situated complexity of producing images in biomedical research laboratories (Prasad 2005, 2007; Joyce 2006; Alac 2008; Burri 2008), including the importance of local context of production in constituting their meanings. Among these studies, a growing body of work (for a review see Perrotta 2013) has focused on the invisible work done by researchers to produce authoritative images (Joyce 2005; de Rijcke and Beaulieu 2014) and how images become visual evidence (Beaulieu 2002; Roepstorff 2007; Beaulieu et al. 2012). How images become "true" representation of the world is not a new question in science and has been explored in different historical contexts (see Daston and Galison 2007). However, the development of digital imaging and image-processing algorithms has introduced new concerns regarding their use in various settings, including medical practices (Reich 2012; Torenholt and Langstrup 2021).

In this chapter, I contribute to the body of STS literature exploring technoscientific imageries, one of Marina Maestrutti's main research interests (see Maestrutti 2008, 2011), by analysing the introduction of algorithmic technologies in the production and use of embryo images in fertility treatment. The case of embryo imaging is a prime example of how the advancement of IVF imaging technologies is reconfiguring not only how embryos are visualised, but more generally the processes of knowledge production in embryology (Geampana and Perrotta 2021). In the last few years, conventional incubators have been replaced with time-lapse incubation and imaging systems (henceforth TLIISs). Time-lapse is an old imaging technique, where a camera is set to record a series of images at regular intervals. Before the introduction of TLIISs, an embryologist had to physically remove the developing embryos from the incubator for a brief period and check them each day under a microscope. The main advantage offered by TLIISs is that they allow embryologists to take thousands of images of the embryos (one every five to 20 minutes) without disturbing them, as they do not have to be removed from the incubator. In this way, TLIISs grant a continuous view of each embryo as it develops, rather than just viewing them once a day. In addition, TLIISs can be used together with embryo assessment and selection (EAS) algorithms with the aim of selecting or assisting embryologists in the selection of the embryos (I will discuss the difference between these approaches below) that most likely will develop into a baby. Due to the lack of evidence supporting their effectiveness in increasing the chances for couples of having a baby, TLIISs have been highly criticised both in the medical and in the social science literature (see Perrotta and Geampana 2020). However, little attention has been paid to how the use of algorithms reconfigures the production and use of embryo images.

The algorithms used to assess and select embryos accord with Gillespie's (2014: 167) definition of «encoded procedures for transforming input data into a desired output, based on specified calculations». As I explore in this chapter, EAS algorithms are computational and run automatically via proprietary software, although with different levels of opacity (Burrell 2016), playing an increasingly important role in defining what information is most relevant not only for embryo selection but for embryology knowledge more broadly. I explored elsewhere (Geampana and Perrotta 2021) the reconfiguration of knowledge production processes due to local algorithmic practices resulting from the increased use of TLIISs in fertility treatment. In this chapter, I focus on analysing the reconfiguration of professional expertise involved in «seeing through machines», by exploring how professional communities of embryologists have engaged with the ongoing pressure to overcome the subjectivity of visual judgment in embryo selection. In doing so, I aim to contribute both to the literature on technoscientific imaging and to the growing body of work exploring how algorithms are contributing to the transformations of expert fields in multiple ways (Pasquale 2015; Ananny 2016; Zarsky 2016).

Tensions between different forms of objectivity and expert judgment

As other scholars working on the reconfiguration of professional expertise emerging with the development of algorithms have pointed out (Christin 2016), the discussion on how machines are mobilised in expert fields to support the production of certain, true and objective knowledge is not new (see Ziewitz 2016).

Science historians Daston and Galison (2007) have showed how the meaning of the concept of objectivity has fluctuated significantly over the last three centuries. Their study of the production of scientific atlases since the eighteenth century illustrates how different forms of objectivity in the visualisation of natural phenomenon were introduced and institutionalised over the years. The authors define as "truth-to-nature" the form of objectivity connected to realism that dominated for most of the eighteenth and nineteenth centuries. At the time, scientists' attempt to capture "nature" was achieved through depictions that were deemed able to represent the ideal of a certain natural phenomenon (for instance an animal or a plant). In practical terms, this meant that several specimens were often mixed to capture this objective ideal. For instance, the ideal representation of a certain plant was obtained through a collage of several parts of the plants that were considered ideal, but actually belonged to different specimens. This practice, however, was questioned over the course of the nineteenth century due to the active human intervention required and thus the introduction of human subjectivity and individual idiosyncrasies. These doubts pushed toward the use of new technological developments deemed able to minimise human intervention and produce "unmediated" representations of the real world. Daston and Galison define this new paradigm as "mechanical objectivity" and link it the widespread belief in the superior objectivity of machines such as daguerreotypes, photographs, and X-rays. In their analysis, mechanical objectivity represents an epistemic virtue: the ability to produce certain, non-subjective truth. However, over the years scientists gradually realised that mechanical representation had limitations too, as machines only record some aspects of a certain phenomenon and include their own traces in these representations. In addition, the products of these machines, such as photographs and X-rays, included a high volume of information that required interpretation to be read and understood. To solve these problems a novel paradigm emerged, which Daston and Galison name "trained judgment". This form of objectivity acknowledges scientists' expertise and experience to interpret and supplement the data provided by machines. Although Daston and Galison underline that these forms of objectivity are not mutually exclusive and can co-exist, their approach to historically study scientific practices emphasises the processes underlying the historical and situated evolution of the concept of objectivity.

A different perspective on mechanical objectivity is offered by Porter (1995), another science historian who has a more sociological approach in exploring the practices that expert communities have adopted to produce objectivity. Rather than focusing on objectivity as the ability to produce certain, non-subjective truth, Porter's analysis focuses on the ways in which objectivity is constructed by reaching consensus inside scientific communities. When this "disciplinary objectivity" (Megill 1994) is difficult to reach, weaker communities often turn to mechanical objectivity to combat distrust and secure truth. For Porter, mechanical objectivity «can never be purely mechanical» (1995: 5) and involves instead the establishment of strict procedural rules to be followed to guarantee the objectivity of the outcomes. While most scientific communities agree that knowledge based completely on explicit rules is not fully attainable, the ideal of applying a unitary "scientific method" is often used to defend the community itself from external criticisms. For Porter, this has two main reasons: first, a decision based on quantification (or "made by the numbers") or strict protocols can remove the subjectivity of scientists, providing an appearance of impartiality and fairness; second, measurements are deemed able to help separate knowledge from its local context of production. Although Porter's work does not explore visual practices themselves, I argue that his analysis is useful to explore the shift to the quantification of visual judgment inscribed in image-processing algorithms.

In this chapter, I will not focus on the epistemic and political limitations of such a conception of scientific objectivity, which have been central to STS feminist debates (see Harding 2015). I am instead interested in exploring the work put in place by a community of experts to introduce measurable and quantifiable standards to reach objective visual assessment in a field that is perceived as highly subjective by its own members (see for instance, Fishel et al. 2020). Following Porter's conceptualisation of mechanical objectivity, in this chapter I use the case of TLIISs to explore the ongoing attempts to replace or enhance expert judgment in embryology by introducing EAS algorithms.

In popular accounts of healthcare, algorithms are often considered better than individuals at making decisions due to the amount of data they can access and reliably analyse (Watcher 2017). However, the purportedly objective nature of algorithmic judgement due to its being value-neutral has been sharply criticised by STS scholars (see Christin 2017), who have shown how the delegation of decision-making to algorithms is negotiated in practice and is often enacted as a continuation of existing practices and professionals' authority (Torenholt and Langstrup 2021). Drawing on these premises, my aim is to explore how the professional community of embryologists enacted different types of TLISs and EAS algorithms in their laboratory work, by focusing on the tensions emerging between expert and algorithmic judgment (Carlson 2018).

Some notes on methods

This chapter is based on wider research focusing on the introduction of TLIISs in IVF labs in England, which involved a variety of professional and lay stakeholders[1]. Although the perspectives of IVF patients on TLIISs have been explored in the wider project (see

[1] "Remaking the Human Body: Biomedical Imaging Technologies, Professional and Lay Visions" was a large qualitative research project (2016-2023), investigating the relationship between biomedical imaging technologies and professional and lay visions. Financial support for this research was provided by the Wellcome Trust [grant number 108577/Z/15/Z]. More information about the project can be found on the project blog available at <https://remakingthehumanbody.sbm.qmul.ac.uk/>; Last retrieved on 30/05/2022.

Hamper and Perrotta 2022) and have contributed to shape my understanding of this case, this chapter focuses on empirical materials collected to explore the perspectives of professional stakeholders only. These include over 80 hours of participant observations in two NHS fertility clinics, 43 individual interviews with a variety of IVF professionals (head of labs, embryologists, doctors, nurses, representatives of companies manufacturing TLIISs) and three focus groups with the staff of three NHS fertility clinics[2]. In addition, I have collected a large amount of documentary materials such as IVF clinic websites, promotional materials collected at fertility events such as The Fertility Show (a popular live event where perspective IVF patients can gain information about professionals and clinics) and The Fertility (the British national conference of professionals working on fertility).

As in the laboratory studies tradition (Latour and Woolgar 1979), I studied the use of TLIISs and image-processing algorithms as situated processes of knowledge production (Knorr-Cetina 1981) and as a set of epistemic practices that constitute how we know what we know (Knorr-Cetina 1999). In particular, I have studied EAS algorithms «in practice» (Christin 2017), by focusing on their use in IVF labs. To do so, I have adopted a research strategy named «algorithmic refraction» (Christin 2020) to emphasise that at the core of the analysis are the reconfigurations that occur when algorithms, people and institutions interact. In other words, my focus is not on the EAS algorithms themselves, neither in terms of their code nor the software they are embedded in, but in the way they are used in fertility labs.

Findings: automated judgment versus enhancing expert judgment

Despite the diffusion and normalisation of fertility treatment, success rates remain quite low (below 30% on average). To improve success rates, extensive research in reproductive medicine has focused on how to assess and select embryos to predict which embryos have greater pregnancy potential (see Perrotta and Giraud 2018). Conventional embryo assessment is based on morphological characteristics, that is, the appearance of the embryos and criteria such as the symmetry of cells and the presence of fragmentation[3].

[2] I am thankful to Dr Alina Geampana, one of the postdoctoral researchers working on the project, for her support in data collection with professional stakeholders, including observations and interviews. In this chapter, I am focusing only on the participant observations I have personally conducted, although similar data were collected from observations conducted by Dr Geampana in three additional sites.

[3] Fragmentation (the occurrence of small pieces of cytoplasm) is very common in human embryos, both those growing inside the body and in the IVF laboratory. In fertility treatment its assessment is crucial as higher degrees of fragmentation are associated with lower likelihood of pregnancy. The assessment of fragmentation is a typical example of potential professional disagreement, where professional judgment is required to distinguish between cells and fragments.

Due to the high level of uncertainty and the lack of certain knowledge in this field, since their introduction TLIISs have been represented as a revolutionary tool to increase the understanding of reproductive processes. Embryo videos resulting from TLIISs, in fact, do not only grant increased insight into the appearance of the embryos, but also allow the exploration of the temporal dimension of embryo development, which was previously impossible to visualise. TLIISs, in addition, provided for the first time the opportunity to generate a great amount of data without negatively affecting the embryos and their chances of success.

To analyse these data, several different EAS algorithms have been produced (see Kovacs 2014). In this chapter, I focus on the two most popular EAS algorithms and their associated TLIIS, representing two very different approaches in both their data production and their role in the embryo selection process: the «Early Embryo Viability Assessment» (henceforth Eeva) system and the «Known Implantation Data Score» (henceforth, KIDScore). Both are proprietary algorithms run through dedicated software, and their associated TLIISs generate images with very low levels of mediation[4]. However, they represent different models of accountability and judgment, which I discuss in the next two sections.

Automating judgment: The Eeva system and the pursuit of mechanical objectivity

The algorithm behind the Eeva system was originally designed and patented by a California start-up called Auxogyn (now Progyny) and then sold to the multinational pharmaceutical company Merck Serono. This algorithm was designed following the principle that there is a universal set of parameters that can predict embryo viability and, therefore, part of their marketing strategy was based on their identification of the correct set of variables which was at the base of their proprietary closed algorithm[5]. In addition, the algorithm was offered together with a TLIIS deemed able to generate data automatically (without the intervention of embryologists) and therefore usable in any lab despite different context, professional teams, and equipment. Due to these features, the Eeva algorithm was presented as able to select embryos without any human intervention based on the objective information collected. The opaque nature of Eeva and its lack of transparency were presented as a major strength of this tool, in comparison with all the other TLIIS available on the market requiring some form of human intervention to collect and analyse visual data. Eeva automated analysis generates a HIGH or LOW result per each

[4] Embryologists have to learn how to use TLIIS dishes and how to change the focus, before the system can start collecting pictures automatically. After dishes have been positioned, images are automatically collected and recorded by the software.

[5] Interestingly, before completing the divestiture of its Eeva business in January 2018 to Merck Serono, Auxogyn was at the centre of an international dispute for attempting to patent the timing of cellular development as «predictive parameters» in embryo selection (see van de Wiel 2019).

embryo (see Figure 2.1), indicating its potential without explaining how this automated judgment is produced.

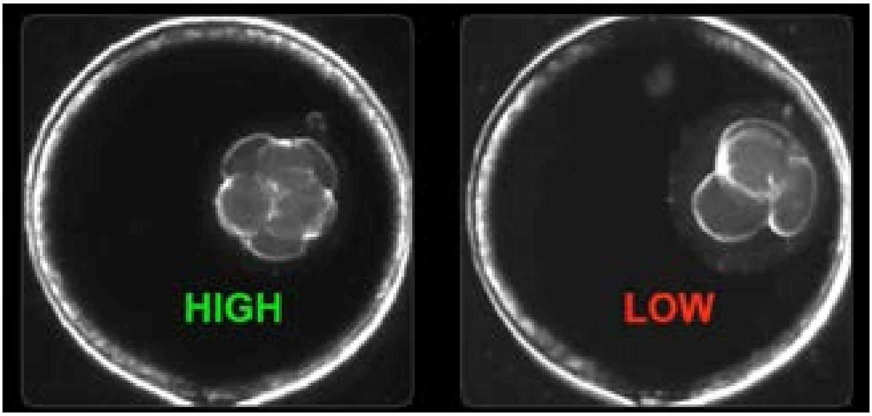

Figure 2.1 – Eeva's visual assessment[6]

Although the evidence supporting the effectiveness of the system have been contrasting (see van de Wiel 2016), the Eeva system became very popular in the UK immediately after its launch, attracting a lot of media attention when the first Eeva baby was born in Glasgow in June 2013 (see van de Wiel 2016). Just few years later, its diffusion was limited and none of the NHS clinics or the professionals interviewed were using it during the years of our fieldwork (2018-20). Several participants, however, had either used it previously or had had discussion about the system within their labs.

Interestingly, our findings show a significant resistance to the Eeva model. The selected parameters on which its automated analysis were based were part of the proprietary algorithm and therefore unknown by the professionals using it. Although in principle our participants were excited about the opportunity offered by TLIISs and algorithms (as I will discuss more in detail below), the completely opaque nature of Eeva's functioning generated significant distrust among the professional community. One of the embryologists reflected on the use of the Eeva's algorithm in their lab:

> I've never understood this system. And I feel that's why most of the people in the laboratory weren't very happy with Eeva because there is not really, or we couldn't understand the reason why the Eeva was selecting or grading the embryos in that order instead of any other orders. […] We don't trust the algorithm. The algorithm is only for like a second opinion. So if you have two embryos looking the same… But obviously if there is an embryo that is average but has got a good grade you're not going to transfer that, you're going to transfer the one that is top quality. (Embryologist)

[6] Source: "Eeva In Action (ASRM 2013)" video, available on the Eeva Test YouTube channel at <https://www.youtube.com/watch?v=hdL0kY5rPbM>; Last retrieved on 30/05/2022. The website screenshot is included in compliance with fair use guidelines, serving educational or informational purposes.

The excerpt shows how, in the lab of the interviewer, the automated judgment offered by the Eeva system ("a good grade") was rejected by the embryologists who continued making their decisions on embryo selection on the basis of their expert judgment (selecting the embryo they assessed as "top quality"). Eeva was instead used as a support, "a second opinion", when embryologists deemed that two or more embryos had the same morphological characteristics.

More broadly, critics focused on the way in which objectivity was pursued by the system. The automatic collection of data from the images removed the need to gather input by human embryologists – which is instead required by competitor systems. Eeva, instead, was able to generate outputs based on computer-based interpretations of the visual assessment of several unknown parameters. In this way, the Eeva system embedded (or aspired to embed) the type of mechanical objectivity described by Daston and Galison (2007) in their work. However, the fact that neither the parameters or the visual assessment methods were known or understood by embryologists made the system impossible to verify. In addition, the system did not just claim the ability to automatically select the relevant information to assess an embryo, but the ability to select embryos themselves. This attempt to automate judgement was sharply criticised by many of our participants. For instance, one of the senior embryologists specialised in TLIISs claimed:

> I think they are right in that… If you show the same embryo image to Eeva, it's going to give you the same parameters. Whereas if you showed it to two embryologists, they're going to have a discussion: that is definitely a fragment, no, no, I think that's a cell, etc. So the way that you bypass this subjectivity on the human side is with protocols, is with definitions and tightening them up. So they [Eeva's promoters] are correct, the machine is going to be consistent every time, the human is going to vary. But the issue is that it [Eeva] might be consistently saying something wrong. […] The consistency is there, it's the accuracy that I question. (Senior embryologist and head of embryology lab)

As the interviewee points out, the ability to guarantee consistency offered by the Eeva system was not paired with an ability to be correct, or at least to convince embryologists about its accuracy. It is important to underline that Eeva's promoters were trying to "blackbox" their criteria for predicting embryo development in a field characterised by a high level of uncertainty, where it is still widely unknown why certain embryos result in a pregnancy and others do not. As the same senior embryologist suggests, embryology is still characterised by a dominance of tacit knowledge that is embedded in the laboratory practices and reproduced inside the community, but not completely made explicit: «The embryologists do sometimes see things that a machine wouldn't know because you haven't been able to quite put it into words and if you can't define it you can't teach the machine». As I will show in the next section, being aware of what is unknown or not known yet, the community of embryologists has a variety of practices in place to limit subjectivity and reduce what they define as inter-subject variation (see Fishel et al. 2020). However, the Eeva model did not allow for these practices to be enacted.

This first closed model was rapidly dismissed when in 2018 Eeva was bought by Merck Serono, which changed the Eeva model to integrate it in their own incubator called GERI. Interestingly, the integration of Eeva into GERI was embedded in a wider transformation of the Eeva model, which opened its black box over the last few years:

> We saw the development of the way Merck presented EEVA: in the beginning they said it knows which one [embryo] to choose because they were convinced that it would choose the right ones. Then it was helping you [embryologist] to select the ones [embryos] to choose. And then in the end it was a guide. So they actually went from where they really believed that it was choosing the right things to something that would be helpful together with the normal assessment. That's why I think they were not more successful. They simply promised too much. (Company representative)

As the last excerpt shows, the wider embryology community – including both embryologists and other key actors working in the development of laboratory tools – agreed on the inability of the original closed model to make accurate automated judgement. Interestingly, even though interviewees showed a general optimism in the future improvement related to use of EAS algorithms, they also shared a wider distrust toward the idea of automated algorithmic judgement as an alternative to expert judgment made by embryologists. This distrust was summarised by the same interviewer, a representative of a competitor company: «As the technology develops, I'm pretty sure that in the future we will see even more automatisation but still we will need the final decision to be made by an embryologist».

Enhancing expert judgment: integrating the KIDScore in the co-production of objectivity

The other most popular EAS algorithm is the KIDScore, produced by Vitrolife (a company specialised in equipment and products for IVF labs) and marketed in conjunction with Embryoscope (currently the most popular TLIIS worldwide). Unlike Eeva, the KIDScore[7] required manual annotation (i.e., for an embryologist to manually register certain traits and biological events) of the most relevant characteristics of an embryo to calculate scores. These scores (from 1 to 9.9) reflect the statistical chance of implantation based on the Vitrolife database, correlating embryo development variables with implantation outcome after transfer (i.e., pregnancy or babies born) and are offered with additional information on each embryo (see Figure 2), which provide a context for their interpretation. Unlike Eeva, the KIDScore is advertised[8] as a «decision support tool»

[7] Here I am referring to the D3 or D5 versions of KIDScore, respectively for embryo selection at day 3 and day 5.

[8] Source: Evaluation tools, available on the Vitrolife website at <https://www.vitrolife.com/products/time-lapse-systems/evaluation-tools>; Last retrieved on 30/05/2022.

which is able to assign «an objective score to each embryo», but leaving professionals to decide the level of automatisation they prefer.

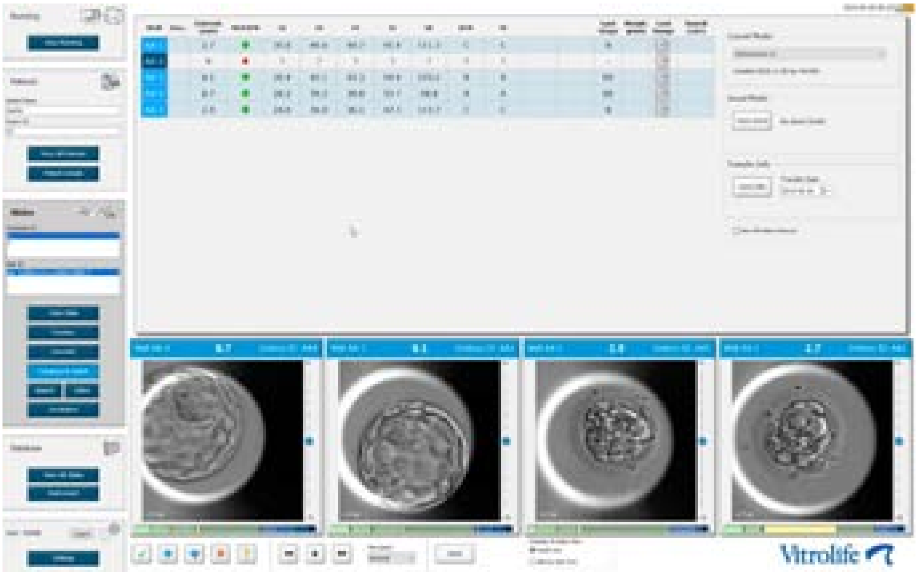

Figure 2.2 – KIDScore's visual assessment[9]

While the full automation promoted by the Eeva model encountered the resistance of large parts of the professional community, KIDScore's more open approach was welcome by many professionals. The flexibility of KIDscore consisted of allowing embryologists to select and collect data on some of the parameters suggested by the software, and even modify the algorithm by using in-house data to support the analysis instead of Vitrolife's centralised database. In this way, KIDscore allowed some space to adapt the algorithm to the needs of an individual clinic, while remaining a tool to move away from the perceived human subjectivity of the embryologists.

Subjectivity was perceived as a problem in the expert community well before the introduction of TLIISs and EAS algorithms. To generate objectivity in EAS several practices have been enacted in fertility labs to make sure that the best embryo is selected:

> I think that's [subjectivity] always going to be a problem because every embryologist is always going to be very subjective. […] We should all follow the same criteria so ideally, in an ideal world we should all be grading the same. It's never going to happen. […] Any case where we are unsure, we don't know how to grade it or it is borderline, we'll always ask a senior [embryolo-

[9] Source: "Compare and Select – optimising embryo evaluation" video, available on the Vitrolife website at <https://www.vitrolife.com/support/support-material/instruction-movies/>; Last retrieved on 30/05/2022. The website screenshot is included in compliance with fair use guidelines, serving educational or informational purposes.

gist] or a second person to come to a joint conclusion. I agree that is fair enough and objective. (Trainee embryologist)

To deal with the subjectivity of the morphological assessment, embryologists compare their judgment with others, ideally more expert, in their lab. This is a common strategy to reduce subjectivity and foster more objective outcomes and is arranged both in-house and through national quality assessment exercises (known as the UK NEQAS Reproductive Science Scheme). These exercises consist in having the same embryo assessed by some or all the members of a lab and then comparing the results to evaluate their consistency among the lab; and in the national community, activating additional training processes to guarantee uniformity if necessary.

The use of the KIDScore adds another layer of subjectivity to the process as embryologists have to record not only the morphological characteristics of the embryos but also the time of several biological events, such as the appearance of pronuclei or the cellular divisions. As mentioned earlier, this process is called "annotation" and involves an individual embryologist to manually assign a value and a time-stamp for each registered parameter in the database:

> We [embryologist] can be a little subjective based on the timings or what we put as a for example, a T2, T3 [time of cellular division in 2 or 3 cells], but I think if you have a good in-house system in place that encourages uniformity amongst practitioners it will help in eliminating that factor. (Senior embryologist)

To explain what a good in-house system to foster consistency and uniformity of judgment is, the same senior embryologist provided their personal experience in joining «a good lab»:

> I was shown what to do and asked to do something, i.e., annotate and grade an embryo. Once I've done that, another embryologist checks to make sure whether or not it tallies. Another embryologist will grade the same embryo in time intervals and then compare it to my result. So gradually, on a weekly basis, they see how you've progressed until there is less subjectivity between you and your trainer and then they would say "we're happy with the way you annotate, we're happy with the way you grade embryos". Then you get signed off in terms of grading on the Embryoscope. But in addition to that on a quarterly basis we will have an e-mail sent around for quality control. […] All the embryologists will write their answer on this [in-house designed] paper that has basically key information, key time intervals for T2, T4, T5, T6, T7, T8 [indicating further cell divisions] and a blastocyst [an embryo at 5]. You write next to it what time you thought these embryos have reached these stages. And then it's plotted on a spreadsheet to see the differences between us. So that gives us a control to make sure that we're all together, we're all uniform. (Senior embryologist)

This excerpt shows how the process of producing objectivity with the TLIIS follows a very similar process embryologists used in assessing morphological criteria, by putting in place lab practices that aim to limit their subjectivity and individual idiosyncrasies to produce uniformity of results. As in Porter's (1995) analysis, objectivity is constructed by reaching consensus inside their scientific community through the establishment of strict procedural rules[10]. Although, as in Porter's case, this is not a purely mechanical form of objectivity, due to the availability of images and videos that do not negatively impact embryo development, embryologists can dedicate time to discuss their assessment criteria and practices:

> It [TLIIS] is quite good for training purposes and also to compare our grading. She [the head of the lab] could grade ones [embryos] and then I could also grade them and it wouldn't affect the embryos because they wouldn't have to come in and out. (Embryologist)

Unlike Eeva, the use of KIDScore has been integrated in established professional practices to reduce subjectivity. Although the final output of the KIDScore is to produce a score that, like in the case of Eeva, represents the embryo assessment based on a proprietary opaque algorithm, its more open approach to data production allowed embryologists to integrate its use in their local practices to enact uniformity and limit the subjectivity human judgment, which is considered part and parcel of the embryology profession. In addition, the use of the KIDSCore and, more in general, TLIISs that allow embryologists to collect their own data are seen as an opportunity to gain further information and, in the long term, develop knowledge. As one of the interviewees, a medical director involved in innovation and research in this field, stated: «In time lapse what we see is literally visualised aspects of pre-implantation development that cannot be seen in any other way».

Discussion and conclusion

Exploring the case of the introduction of TLIISs and EAS algorithms, in this chapter I analysed their use "in practice" (Christin 2017) in IVF labs, by focusing on the emerging changes in visualisation practices and different ways to use algorithms to select or support the selection of embryos.

The findings show how different relationships between image production and image processing and interpretation are enacted using different visualisation tools. As mentioned above, Eeva and KIDScore interact differently with their associated TLIIS. In both cases, the level of mediation to produce the images is minimal while the possibilities to intervene in data processing are substantially different. As I showed above, the auto-

[10] STS scholars (Cambrosio et al. 2006) define forms of objectivity based on protocols and procedures as «regulatory objectivity», to underline the endogenous nature of this form of regulation of medical communities. Although the case of the use of TLIISs represents a prime example to explore how a community tries to reach consensus, clinical practices in fertility care are significantly less standardised than in other medical fields (see Perrotta and Geampana 2021), making the case of TLIISs not representative of a wider development of regulatory objectivity in fertility care.

mated production of images themselves was not challenged. The production of objective results was shifted from image production to the processing and interpretation of images and how these were negotiated between embryologists and TLIISs. Interestingly, research participants, and particularly embryologists, seemed more interested in the potential that the TLIISs offered to visualise the early development of embryos in lab and the related knowledge production potential, rather than in the changes that occurred in visualising practices themselves. The changes required in seeing embryos through a computer monitor rather than a microscope were downplayed, while the dominant narrative focused on the possibility offered by the technology to see the embryos without disturbing them. Similarly, the transition from the assessment of still images to the assessment of videos was framed as a matter of fact without further consideration. Although a change of focus from morphology to morphokinetic in the assessment and selection of embryos is emphasised in the community and in the medical discourse (see Fishel et al. 2020), this shift is not equally discussed by professionals in terms of the changes in their visual practices. The focus is again on the possibility offered by TLIISs to observe embryos continuously and, as an obvious consequence, the need to train embryologists regarding "what" to observe, by focusing on the timing of biological events in addition to conventional appearance of the embryo. The main concerns of embryologists regarding the change of visualisation practices were related to the possibility to separate the visual embryo judgment from its context, by translating the visual elements into decontextualised data. These concerns were framed as part of more general considerations on the use of algorithms in IVF.

Furthermore, the findings show how, even when algorithms are similar – in this case, both aimed at producing (semi)automated assessment of embryo potential based on closed, unknown, proprietary algorithms – they differ significantly in the way in which are enacted in IVF practices. Despite the marketing strategies of Eeva's promoters, both algorithms were used by embryologists to support expert judgment (or provide a second algorithmic opinions) rather than as an automated alternative to it. Interestingly, several interviewees claimed that the inability of algorithms to replace expert judgment was probably due to the fact that most of the current limited knowledge in embryology is still tacit and not yet made explicit. In addition, there was a consensus on the fact that the expert judgment of a human embryologist will be needed also in the foreseeable future. The main reason for this lack of trust toward algorithms seems to lie in what Ziewitz (2016) calls their "inscrutability". Current EAS algorithms, with their closed, unknown, proprietary structure, show the same lack of transparency and the limited accountability of algorithms discussed in the literature (Pasquale 2015). These characteristics, though, do not allow embryologists to integrate them in their lab practices and require a leap of faith in the automated judgement that professionals are not willing to take. However, the new possibilities of visualisation offered by the use of TLIISs allow embryologists to improve their «disciplinary objectivity» (Megill 1994) by integrating them in their practices to limit subjectivity. Similarly to what is already suggested in the literature (Torenholt and Langstrup 2021), the use of EAS algorithms in practice does not reflect the expected disruption proposed by Eeva's promoters but rather a continuation of existing practices aimed at co-producing objectivity through the interactions of embryologists and more sophisticated machines. For these reasons, the more flexible structure of the KIDScore makes this algorithm more appealing to the expert community – although further attempts to automate judgment are made by TLIISs' manufacturers[11].

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[11] Vitrolife has recently introduced a new tool called IDAScore (an AI-based algorithm with fully automated scoring of embryos) which follows Eeva's principle. However, as this tool did not exist at the time of empirical work and it is not very diffused yet, I have not discussed this in this chapter.

References

Alac, M.
2008 'Working with Brain Scans: Digital Images and Gestural Interaction in fMRI Laboratory', *Social Studies of Science*, *38*(4), 483-508.

Ananny, M.
2016 'Toward an Ethics of Algorithms: Convening, Observation, Probability, and Timeliness', *Science, Technology, & Human Values*, *41*(1), 93-117.

Beaulieu, A.
2002 'Images Are Not the (Only) Truth: Brain Mapping, Visual Knowledge, and Iconoclasm', *Science, Technology, & Human Values*, *27*(1), 53-86.

Beaulieu, A., De Rijcke, S., Van Heur, B.
2012 *Authority and Expertise in New Sites of Knowledge Production*, in P. Wouters, A. Beaulieu, A. Scharnhorst, S. Wyatt (eds.), *Virtual Knowledge: Experimenting in the Humanities and the Social Sciences* (pp. 25-56), Cambridge (MA), The MIT Press.

Burrell, J.
2016 'How the machine "thinks": Understanding opacity in machine learning algorithms', *Big Data & Society*, *3*(1), 1-12.

Burri, R. V.
2008 'Doing Distinctions Boundary Work and Symbolic Capital in Radiology', *Social Studies of Science*, *38*(1), 35-62.

Cambrosio, A., Keating, P., Schlich, T., Weisz, G.
2006 'Regulatory objectivity and the generation and management of evidence in medicine', *Social Science & Medicine*, *63*(1), 189-199.

Carlson, M.
2018 'Automating judgment? Algorithmic judgment, news knowledge, and journalistic professionalism', *New Media & Society*, *20*(5), 1755-1772.

Christin, A.
2016 'From daguerreotypes to algorithms: Machines, expertise, and three forms of objectivity', *ACM Sigcas Computers and Society*, *46*(1), 27-32.

Christin, A.
2017 'Algorithms in practice: Comparing web journalism and criminal justice', *Big Data & Society*, *4*(2), 2053951717718855.

Christin, A.
2020 'The ethnographer and the algorithm: Beyond the black box', *Theory and Society*, *49*(5), 897-918.

Coopmans, C., Vertesi, J., Lynch, M. E., Woolgar, S. (eds.)
2014 *Representation in scientific practice revisited,* Cambridge (MA), The MIT Press.

Daston, L., Galison, P.
2007 *Objectivity,* Princeton (NJ), Princeton University Press.

De Rijcke, S., Beaulieu, A.
2014 *Networked Neuroscience: Brain Scans and Visual Knowing at the Intersection of Atlases and Databases*, in C. Coopmans, J. Vertesi, M. E. Lynch, S. Woolgar (eds.), *Representation in Scientific Practice Revisited* (pp. 131-152), Cambridge (MA), The MIT Press.

Fishel, S., Campbell, A., Foad, F., Davies, L., Best, L., Davis, N., Smith, R., Duffy, S., Wheat, S., Montgomery, S., Wachter, A.
2020 'Evolution of embryo selection for IVF from subjective morphology assessment to objective time-lapse algorithms improves chance of live birth', *Reproductive Biomedicine Online*, *40*(1), 61-70.

Geampana, A., Perrotta, M.
2021 'Predicting Success in the Embryology Lab: The Use of Algorithmic Technologies in Knowledge Production', *Science, Technology, & Human Values*, *48*(1), 212-233.

Gillespie, T.
2014 *The Relevance of Algorithms*, in T. Gillespie, P. J. Boczkowski, K. A. Foot (eds.), *Media Technologies: Essays on Communication, Materiality, and Society* (pp. 167-194), Cambridge (MA), The MIT Press.

Hamper, J., Perrotta, M.
2022 Watching embryos: Exploring the geographies of assisted reproduction through encounters with embryo imaging technologies, *Social & Cultural Geography*, *24*(9), 1557-1575.

Harding, S.
2015 *Objectivity and Diversity,* Chicago (IL), University of Chicago Press.

Joyce, K.
2005 ‘Appealing Images: Magnetic Resonance Imaging and the Production of Authoritative Knowledge’, *Social Studies of Science*, *35*(3), 437-462.

Joyce, K. A.
2006 ‘From Numbers to Pictures: The Development of Magnetic Resonance Imaging and the Visual Turn in Medicine’, *Science as Culture*, *15*(1), 1-22.

Knorr-Cetina, K.
1981 *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*, Oxford, Pergamon Press.

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

Kovacs, P.
2014 ‘Embryo selection: The role of time-lapse monitoring’, *Reproductive Biology and Endocrinology*, *12*:124.

Latour, B., Woolgar, S.
1979 *Laboratory Life: The Construction of Scientific Facts*, Princeton (NJ), Princeton University Press.

Lynch, M., Woolgar, S. (eds.)
1990 *Representation in Scientific Practice*, Cambridge (MA), The MIT Press.

Maestrutti, M.
2008 ‘Rendere visibile l’invisibile: Il ruolo della visione e dell’immagine nella costruzione di una storia delle nanotecnologie’, *Rassegna Italiana di Sociologia*, *49*(3), 427-450.

Maestrutti, M.
2011 *Imaginaires des nanotechnologies: Mythes et fictions de l’infiniment petit*, Paris, Vuibert.

Megill, A. (ed.)
1994 *Rethinking objectivity*, Durnham, Duke University Press.

Pasquale, F. A.
2015 *The Black Box Society: The Secret Algorithms That Control Money and Information,* Cambridge (MA), Harvard University Press.

Perrotta, M.
2013 ‘The Study of Technoscientific Imaging in STS’, *TECNOSCIENZA: Italian Journal of Science & Technology Studies*, *3*(2), 163-176.

Perrotta, M., Geampana, A.

2020 ‘The trouble with IVF and randomized control trials: Professional legitimation narratives on time-lapse imaging and evidence-informed care’, *Social Science & Medicine*, *258*, 113115.

Perrotta, M., Geampana, A.

2021 ‘Enacting evidence-based medicine in fertility care: Tensions between commercialization and knowledge standardization’, *Sociology of Health & Illness*, *43*(9), 2015-2030.

Perrotta, M., Giraud A. S.

2018 ‘Enacting standards in imperfect worlds: Exploring flexibility in practicing standards’, Paper presented at *SCOS/ACSCOS Conference – Imperfection, incompleteness and impermanence in organizational life*, 17-20th August, Tokyo, Japan.

Porter, T. M.

1995 *Trust in numbers: The pursuit of objectivity in science and public life*, Princeton (NJ), Princeton University Press.

Prasad, A.

2005 ‘Making images/making bodies: Visibility and disciplining through magnetic resonance imaging (MRI)’, *Science, Technology & Human Values*, *30*(2), 291-316.

Prasad, A.

2007 ‘The (Amorphous) Anatomy of an Invention: The Case of Magnetic Resonance Imaging (MRI)’, *Social Studies of Science*, *37*(4), 533-560.

Reich, A.

2012 ‘Disciplined doctors: The electronic medical record and physicians’ changing relationship to medical knowledge’, *Social Science & Medicine*, *74*(7), 1021-1028.

Roepstorff, A.

2007 *Navigating the Brainscape: When Knowing Becomes Seeing*, in C. Grasseni (ed.), *Skilled Visions: Between Apprenticeship and Standards* (pp. 191-206), New York & Oxford, Berghahn Books.

Torenholt, R., Langstrup, H.

2021 ‘Between a logic of disruption and a logic of continuation: Negotiating the legitimacy of algorithms used in automated clinical decision-making’, *Health*, *27*(1), 41-59.

Van de Wiel, L.

2016 *Cellular Origins: A Visual Analysis of Time-Lapse Embryo Imaging*, in M. Lie & N. Lykke (eds.), *Assisted Reproduction Across Borders* (pp. 306-319), New York, Routledge.

Van de Wiel, L.

2019 'The datafication of reproduction: Time-lapse embryo imaging and the commercialisation of IVF', *Sociology of Health and Illness*, *41*(S1), 193-209.

Wachter, R.

2017 *The Digital Doctor: Hope, Hype, and Harm at the Dawn of Medicine's Computer Age*, New York, McGraw-Hill Education.

Zarsky, T.

2016 'The Trouble with Algorithmic Decisions: An Analytic Roadmap to Examine Efficiency and Fairness in Automated and Opaque Decision Making', *Science, Technology, & Human Values*, *41*(1), 118-132.

Ziewitz, M.

2016 'Governing Algorithms: Myth, Mess, and Methods', *Science, Technology, & Human Values*, *41*(1), 3-16.

3. «How ugly is this coronary!» Technoscientific Imaginaries and Body Metaphors in the Biomedical Field

BARBARA PENTIMALLI

Introduction

In the last three decades, we have witnessed the increase in the use of imaging technologies in the biomedical field (Cartwright 1995; van Dijck 2001, 2005; Burri 2012; Burri et al. 2014; Pentimalli 2016; Maestrutti 2018). Making visible what was previously invisible to the naked eye (Maestrutti 2008) and providing practitioners with an *externalised retina* (Lynch 1988), medical imaging technologies have fueled the promise to access the "truth" within the human body (Beaulieu 2002; Joyce 2005). A body rendered seemingly *transparent* (van Dijck 2005) and visually explorable as an *anatomical landscape* (Maestrutti 2018) without having to cut it open. This gave the illusion that visualising technologies provide a photography of the interior human body. The same physicians tend to consider these images as a faithful reproduction of body organs. They give them a «scientific objectivity» (Daston and Galison 1992) and forget or do not problematise the sociotechnical adjustments that have contributed to their fabrication (Burri 2012).

These medical visual practices, mediated by imaging technologies, created new *technoscientific imaginaries* and *metaphors* of the human body[1] as made apparent through

[1] My interest in the study of *technoscientific imaginaries* and *body metaphors* in the biomedical field has been fuelled by the fruitful exchange of publications and reflections that I have had over the years

the ethnographic study I conducted in a hemodynamic laboratory practicing coronary angiographies and angioplasties[2]. By adopting the approaches of *Social Studies of Scientific Imaging and Visualization* (Burri and Dumit 2007) and *Workplace Studies* (Luff et al. 2000), my paper shows that medical images are not only produced by imaging technologies but also by the entanglements between bodies, knowledge, senses, practices and other heterogeneous artifacts. Moreover, these images are not transparent and require an *interpretative work* (Burri 2012) that mobilises a *professional vision* (Goodwin 1994) and a *diagnostic eye* (Pentimalli 2020) for being able to see, notice and make sense of pertinent cues signalling a coronary pathology. The medical team interprets «what is going on» within the perceptual space of the screen as well as in interactional space shared with colleagues (Alač 2008; Alač and Hutchins 2004). They exploit pointing gestures, gazes, handling of artifacts, verbal instructions and comments – using metaphors and aesthetic judgments – to highlight and make visible and intelligible to one another the relevant details of the coronaries appearing on the screen.

This paper analyses *metaphors* and *aesthetic judgments* used by practitioners when they are visually exploring coronaries for diagnostic work. Some metaphors come from the pictures within anatomy books while others are created in the daily work context. By highlighting the *epistemic role* of metaphors (Lakoff and Johnson 1980; Kompa 2021; Vet and Ney 2021; Cameron 2002) which are central to diagnostic work (Bleakley 2017), I also show how they act as *instructions* (Boyd 1993; Brown 2003) to guide novices to see pertinent details and shapes signaling a coronary pathology.

After briefly reviewing the literature of *Social Studies of Scientific Imaging and Visualization*, I describe the research context of the hemodynamic laboratory by stressing the active role of medical images. Then, relevant empirical findings are illustrated to highlight the epistemic and instructional role of metaphors to make diagnosis and instruct novices.

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[2] I conducted my ethnographic field research in the hemodynamic laboratory two or three times a week over a period of five months. In addition to observing the daily activities in the laboratory and writing field notes, I took pictures of the images of heart chambers and blood vessels appearing on the screen, replicating the way young physicians collect images of (un)healthy coronaries to improve their ability to do diagnostic work. Throughout my observation, I paid close attention to the multimodal resources (pointing gestures, gaze orientation, handling of artifacts, verbal instructions, comments…) used by practitioners as they look at and interpret medical images during coronary angiographies and angioplasties.

Laboratory studies (Latour and Woolgar 1979; Knorr-Cetina 1981; Lynch 1985a, 1985b, 1988; Lynch and Woolgar 1990) already highlighted that scientific images (drawings, photos, graphics, charts, diagrams) allowed scientists to transform the phenomena under study into *docile objects* (measurable, manipulable, visible, describable) and then present these same images, at conferences or in publications, as illustrative evidence of scientific phenomena (Lynch 1985a). With the advent of new imaging technology, mainly in the biomedical field, *Social Studies of Scientific Imaging and Visualisation* (Burri and Dumit 2007; Perrotta 2012) developed research interested in the production and interpretation of scientific (medical) images. The visualisation of the interior human body was a major challenge from the first anatomical illustrations to advanced endoscopic, RMI and X-rays techniques. Before the rise of these new medical imaging technologies, the clinical gaze had to deduce the symptoms and causes of pathology by decrypting the truth hidden in the invisible depths of the body's organs and tissues (Foucault 1963). Physicians «depended primarily on their senses (sight, touch, hearing) in order to imagine the interior body» (van Dijck 2005: 5) and relied on the patients' profane and subjective narrations of their symptoms, surrounded by mistrust, inaccuracy and suspicion. As stressed by Joyce (2005), three rhetorical narratives characterised the advent of new imaging technologies[3]: they provide «access to a previously unknowable interiority of the body» (p. 457); medical images are more objective than «clinical examinations and other "low-tech" tools such as stethoscopes, touch, and patient histories» being «subjective and inaccurate sources of knowledge» (p. 441); the images talk, know, reveal the truth about human body and create authoritative knowledge.

Following the story of visualising technologies, traced by José van Dijck (2005), in her book *The Transparent Body. A Cultural Analysis of Medical Imaging*, we notice that any imaging technology «has promised to further disclose the body's inside» (p. 4) and has fuelled the myth of *body transparency*. Endoscopies not only amplify the physician's visual abilities «but also aimed at extending a surgeon's manual skills under the skin, so that examination and operation could take place during one and the same surgical expedition» (van Dijk 2005: 65). Today, physicians are «able to visualise, diagnose, and remove unwanted growths inside the body, leaving only a small scar on the patient's skin» (*ibid.*). Even if endoscopies are mini-invasive, they are still surgical interventions penetrating the body's interior. Another important visual technology is the X-ray machine which enables physicians «to look through the skin and detect diseases» (van Dijck 2005: 84). Like endoscopy, X-ray technology seemed to make the interior body transparent and created «an illusion of unmediated, objective reality» (van Dijck 2005: 98). The pictures produced by X-rays were considered more objective and reliable than the subjective sen-

[3] She analyses the narratives around Magnetic Resonance Imaging.

sorial impression of physicians, previously based on listening and palpating the patient's body (van Dijck 2005). Even ultrasound created the illusion that it was disclosing the body's interior. This technology certainly increased the physician's «ability to detect foetal abnormalities at an earlier stage, but the expectation that ultrasound will at once visually reveal each and every defective condition are the earliest prenatal stage is illusory» (van Dijck 2005: 104). As with all visualising technologies, the interpretation of medical images requires knowledge of anatomy and experience in reading them to notice significant cues for diagnostic purpose. These images «did not mirror reality in themselves» but implied new forms of skills, knowledge and practices «to interpret the meaning of streaks and shadows that to the untrained eye are meaningless» (Pasveer 1989: 363).

The story of medical imaging technologies shows how the human body seems to become even more accessible and penetrable with physicians peering inside the patient's body without having to open it (van Dijck 2005). As stressed by Maestrutti (2018: 277), «the visualisation of body seen from inside often refers to the experience of exploration and travel in order to produce the cartography of unknown territory»[4] (*my translation*), a kind of *bioturism* (Sawchuk 2000) in a body traversed by miniaturised technologies. Lévy (1998) suggested that medical imaging devices certainly erase the human skin and enable physicians «to see inside the body without breaking its sensitive surface, sectioning vessels, or cutting tissues», but these visualising technologies also create «new layers» and reveal «other skins, buried epidermises, unsuspected surfaces» (p. 40). Therefore, any new visualising technology makes other types of skin, surface, space and body visible that have to be interpreted. There is no doubt that these imaging technologies, providing physicians with an *externalised retina* (Lynch 1988) and an *equipped gaze* (Sicard 1998), help to see (Grosjean 2014) and make visible what was previously invisible to the naked eye (Maestrutti 2018). But, as advanced as they are, these technologies never produce images that are «a perfectly mechanical reproduction of our bodily interior» and every new one «raises new problems of perspicuity and interpretation» (van Dijck 2005: 80).

According to Burri et al. (2014), imaging technologies, which have apparently made the human body transparent, have become themselves transparent. Medical images do not reveal the complexity of the technology used to produce them. Therefore, technology is blackboxed and made invisible, and each medical image seems to be a photorealistic depiction of nature (Daston and Gallison 1992) because of its *visual evidence* and *persuasiveness* (Burri 2012). This «technology paradox […] implies that the better developed and more complex an imaging technology is, the more likely people are to forget about it once they look at the image» (Burri et al. 2014: 166). Medical images acquire the status of scientific evidence legitimising the rationality of diagnosis while they are instead epistemic objects whose fabrication is then neglected and forgotten (Burri 2012). Furthermore, any image does not speak for itself but by comparison with other images, and each image

[4] Casini (2020) also talks about *corporeal cartographies*.

is constructed and interpreted along sociotechnical alignments with heterogeneous elements such as other technologies, medical records, laboratory tests, practical knowledge and professional gestures of the clinical team.

Moreover, scientific visualisation activities are embodied in social and cultural practices (Lynch and Woolgar 1990) and take place within professional and epistemic communities having developed particular *ways of seeing* (Goodwin 2000) that novices should learn to become able to notice the relevant scientific phenomena[5]. Research on scientific vision (Goodwin 1994; Alač 2005, 2008; Styhre 2010; Vertesi 2012; Grosjean 2014) highlighted that visual ability is learned by working side by side with experienced practitioners to observe their gesture, gaze orientation and hear their comments while they are indicating and noticing the pertinent cues that stand out in the images. Novices also have to learn how to use technologies increasing the visibility of the phenomena under scrutiny. Therefore, sociological researchers interested in scientific visualisation should resituate the (medical) images in their own context of production, use and interpretation (Burri and Dumit 2007), and focus on practitioners' abilities to see and read them. The *education of clinical gaze* is an important issue for the scientific legitimacy and credibility of medicine. The participation of medical students in autopsy and surgery – implying close inspection and exploration of the human body to make interior anatomy visible (Pizza 2005) and completing their study of images in anatomy books – as well as their participation in the interpretation of inner body images produced by imaging technologies, shape their medical gaze. The human body is thus transformed into an observable and describable epistemic object.

Learning to see and interpret medical images is also facilitated by the use of metaphors whose *epistemic and instructional role* in the scientific domain has been highlighted (Boyd 1993; Cameron 2002; Kompa 2021). Each metaphor «brings together two domains that are distinct and somehow incongruous, but whose juxtaposition can be made sense of» (Cameron 2002: 674). Each metaphor has *heuristic, exploratory and explanatory value* (Kompa 2021: 23). Metaphors guide scientific research and theory building (Ortony 1993), help the teaching of scientific concepts and theories (Boyd 1993) and are central to medical diagnostic work (Bleakley 2017). Therefore, they may act as instructional means guiding novices to see the relevant details of scientific phenomena (for medical images: pertinent shapes and cues signaling a pathology) by making certain aspects visible and noticeable while downplaying others (Kompa 2021: 40).

5 For a detailed analysis of learning *Professional Vision* see Pentimalli (2016, 2020), Pentimalli and Réméry (2020).

The hemodynamic laboratory – where I conducted my ethnographic research – is situated in the cardiac unit of an Italian public hospital. The hemodynamic provides an alternative to open-heart surgery through the use of medical imaging technologies enabling the performance of coronary angiography and angioplasty for diagnostic and therapeutic purposes. Coronary angiography consists in inserting a catheter in the patient's artery and gently pushing it until it reaches the heart. A radio opaque contrast (dye) is then injected into the catheter allowing the visualisation of the heart's chambers and blood vessels, through rapid X-ray screening from a variety of angles. The X-ray images are projected onto monitors and interpreted by clinicians in conjunction with other information resources (ECG, blood tests, patient's clinical history and symptoms…) to assemble a diagnosis and decide future treatment (Byrne and Stengel 2010). If the test locates a stenosis (occlusion and narrowing in the blood vessels), the angioplasty treatment will reopen it through a balloon inflated in the coronary.

The hemodynamic laboratory comprises two contiguous areas separated by a glass wall: the "procedural room" where coronary angiography and angioplasty are undertaken, and the "polygraph room" where the team looks at the medical images to make a diagnosis. The glass wall allows mutual visibility but co-team members can also hear each other, since the door between the two rooms is always open[6].

Fig. 3.1 – The "polygraph room" and the "procedural room" beyond the glass wall

[6] For security reasons (to prevent the risk of X-rays exposure), the team should communicate through a microphone and the door between the two rooms should be closed. But practitioners leave the door open to better coordinate with each other and to easily pass from one room to another (to get material, to look at the screen in the "polygraph room" with experienced physicians not engaged in the procedure but commenting the images with those involved).

The "polygraph room" is equipped with a long desk where several screens are disposed:

Fig. 3.2 – The different monitors/screens of the polygraph room
From left to right: 1) the polygraph to visualise and monitor the patient's Electrocardiogram (ECG), measure the pressure curves and make hemodynamic calculations (cardiac range, valve area); 2) the PC recording the hemodynamic tracings and measures; 3) the PC to describe the procedure and write the diagnosis report; 4) the screen where the images of coronaries are projected; 5) the machine recording image sequences; 6) the machine calculating scoping and X-ray dose.

In this room, a radiology technician and a nurse work side by side. The first one inserts a patient's personal data into PC (3) to activate the screen (4) where the images of coronaries are projected, and records images chosen by physicians (5). The second one describes the material (stent, catheter, balloon, etc.) and glances at the ECG (1) to check the patient's vital signs and verbally warn physicians in case of critic tracings.

The work in the hemodynamic laboratory is carried out with and through images displayed on the screens/monitors. The ECG allows to check the patient's heartbeat. The dynamic images (sequences of a few seconds) render the heart pumping and the fluids flowing into the coronaries visible while the static images (screenshots) are produced and chosen by physicians before and after the procedure. During the coronary angiography, the physician frames what he wants to see in the foreground, by filming vessels from different perspectives, thanks to the dye making the blood flow through the arteries visible. If this diagnostic procedure localises a narrowing, a catheter with a little balloon is inserted to dilate it[7]. At the end of the procedure, the physician asks the technician to put back on the screen the image of stenosis, previously recorded, by saying: «to see!». The physician looks at and compares the video-sequence, in which the coronary and blood flow are visible, after his corrective intervention, with the image made before, to visually check if the problem is solved.

[7] «The physician chooses the angle and makes different projections, otherwise a vessel could look healthy. When he makes the diagnostic image, if he sees a lesion, he asks you [to put again] the previous image to visualise the point in which to place the little balloon with the stent» (Radiology technician). As written by Byrne and Stengel (2010), «blood vessels are three dimensional and require pictures to be taken from a variety of angles to ensure that overlaps are exposed and any ambiguities in vessels are uncovered» (p. 140).

The monitors where the images of coronaries are displayed play different roles. They allow the physician to make a diagnosis by noticing the narrowing which impedes the flow of dye but also enable him to see the "journey" of mini-invasive technologies through the patient's arteries. By comparing the images taken at the end of the procedure with the previous images which allowed the diagnosis, the physician sees if the narrowing has disappeared and blood flows better. Just after the intervention, he chooses which images and sequences must be archived by the technician, selecting those that highlight arteries, stenosis and blood flow before and after the procedure. These sequences of images are then recorded on a CD and introduced in the patient's medical record with the procedure report adopting narrative expedients to attest the rationality of medical decisions (Berg 1996). The selected images play the role of visual evidence certifying the scientificity of medical intervention, even if they correspond to a sociomaterial construction of epistemic objects (Burri 2012). In fact, this production of images lies on the alignment among different technologies and artefacts: the catheter in the patient's arteries, the dye colouring and making the blood flow visible, the X-rays… The patient's collaboration is also essential: he must be awake, hold his breath then release it, feel the pinching pain caused by the warm of the dye which is pertinent information for the physician making the intervention. Moreover, if the role of sight/visual seems essential, the body knowledge/expertise of practitioners should not be underestimated. The observation of physicians inserting and gently pushing the catheter through the patient's arteries, reveals a *gestural dexterity* in handling microscopic instruments as an extension of their own hands (Maestrutti 2018). They are in fact able to synchronise their hand and finger gestures with their glances at images projected on the screens. As stressed by a head doctor during a vocational learning session for technicians:

> The physician is busy with his eyes and you [technicians] are the addition of our eyes. We must enter and gently move through the arteries, we don't get into the coronary to do the "autostrada del sole"[8], the manual ability is important.

Technicians, keeping their eyes on the polygraph room's screens, may suggest to physicians which direction to take in order to frame some details ("higher", "lower"). Since the physician is the one who keeps control of the procedure, he may reaffirm it through ironic comments addressed to technicians[9]. One day, an experienced technician – in the presence of a physician standing behind her – makes a comment to a nurse about the condition of the coronaries: «Here, there is a strange pirouette, a stenosis and another». Then the nurse says ironically to the physician: «Doctor, she's talking to you!». The latter

[8] The spatial metaphor of the "sun highway" – the main and longest (759,4 Km) Italian highway connecting Milan with Naples via Bologna, Florence and Rome – means that we should not "travel" through the coronaries at full speed without any delicacy or precautionary gesture.

[9] A physician mockingly says to a radiology technician: «are you conducting the procedure?». The technician sardonically answers: «well… the radiological eye».

starts laughing. The nurse's joke humorously denounces the invasion of the physician's legitimate territory of knowledge and action. Technicians, having followed pathological anatomy courses, say that their «eye is trained». The more experienced have really developed a *diagnostic eye* not formally recognised, since the diagnostic work is a matter for physicians (Larkin 1978).

Finally, the interpretative work is not performed on a single and isolated image but needs a *convergent objectivity* (Allamel-Raffin 2010) resulting from the comparison among several images made from various angles. These images also acquire meaning in the conjunction with other medical information and body measures (ECG, blood tests, clinical history in the medical record…), while physicians talk to each other to negotiate and reach a shared diagnosis. The visibility and meaning of medical images is also produced through pointing gestures, gaze orientations, metaphors and aesthetic judgments.

The Epistemic and Instructional Role of Metaphors and Aesthetic Judgments

During the interpretation of medical images, the team frequently relies on metaphors and aesthetic judgments. In this way, they not only produce useful knowledge for medical diagnosis (Bleakley 2017) but they also facilitate the novices' learning of *professional vision* (Goodwin 1994). Metaphors describe the "representations" of the anatomical body (Joyce 2006) produced by visualising technologies. The local context and the epistemic culture support the choice of particular rhetorical practices over others (Beaulieu 2002)

Besides the *spatial metaphors* illustrating the inside of the human body as *anatomical landscape* and *territory* to navigate and explore along its *roads*[10] (Maestrutti 2018) – in this case the coronaries also named *branches* by anatomy books – practitioners use metaphors to create a correspondence with some shapes and entities belonging to the animal, religious, food or fishing world. Bringing together «two domains that are distinct and somehow incongruous» (Cameron 2002: 674), metaphors highlight and make noticeable salient features which are relevant for the diagnostic work, while downplaying others that are considered less pertinent (Lakoff and Johnson 1980; Kompa 2021). These metaphors play an *instructional role* and have an *explanatory value* in designating particular shades and shapes that young physicians should learn to recognise and see.

In order to indicate, highlight and describe the pertinent elements appearing on the screen, nurses and technicians use metaphors connecting with the lexical field of fishing. In this way, they make novices – and also the ethnographer in the field – perceive the relevant difference between pathological shapes/signs and miniaturised artefacts.

10 Physicians, using MRI technologies, also talk about «marching through the body» (Joyce 2005: 444).

The metaphor of "fishing net"
A nurse, sitting next to me and in front of the screens, asks me: «Now, can you see better?». I answer: «A little better». Then, he says: «I've been here for several years, and I don't always understand everything, you must have a *trained eye*, this one is, do you see the little net? It's a stent. It's like a little net. Sometimes you can confuse it with calcifications».

Fig. 3.3 – Picture of the stent looking like a little net

Practitioners also evoke animals – such as *the spider* – to name and illustrate the ramification structure of coronary appearing on the screen in a shape similar to that of a spider.

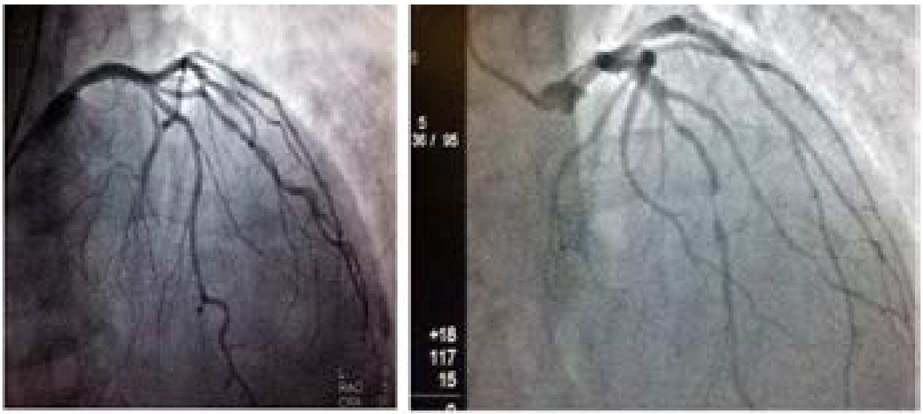

Fig. 3.4 – *The spider*

Metaphors are also exploited to make visible particular shapes which signal a coronary disease. It is the case of the coronary in a "crown rosary" shape whose successive stenosis look like grains threaded in the rosary.

The metaphor of "crown rosary"

During the diagnostic procedure, a technician describes to me what happens on the screen: «He did the spider, they are all sick these arteries, they are all a bit in crown rosary shape, how ugly are they! The circumflex is totally sick and here (by pointing the index finger) there is a narrowing».

Fig. 3.5 – Arteries in a "crown rosary" shape

The shape signalling unhealthy coronary may also be compared with a set of "little sausages" as noted, one day, by a physician.

The metaphor of "little sausages"

An experienced physician comments the image on the screen: «He has the diagonal totally closed, all in little sausage shapes, it's a strange disease, is he diabetic?». A second physician answers: «No, tobacco and obesity». The physician decides to consult the head physician who exclaims: «He has a contradiction of calibre, oh my god! Something really» and says how to proceed: «The stent, we can put it, if you put a little stent here and a little stent there (by finger pointing on the screen), or otherwise an initial balloon and a medical balloon». The first physician says, sounding worried: «Let's see if it passes» and the technician comments: «So sinuous this coronary!».

Thanks to the comments on the particular shapes of arteries, young physicians and registrars may better understand where to focalise their gaze, what to consider in the foreground or leave in the background, to only see and notice the specific shapes indicating unhealthy arteries.

Nurses also may use metaphors while interacting with patients to explain – through a connection with the familiar plumbing world – what is going to happen and calm them down just before starting the procedure.

The metaphor of the plumber

The team is ready to start the procedure and the patient is lying on the bed. A nurse says to him: «We are going to study blood circulation, using a coronary angiography. If a blood vessel is clogged, the plumber will intervene and insert the stent, a simple operation even if it is within your heart».

While practitioners are looking at the medical images, they also comment on the beauty or the ugliness of lesions or coronary shapes. These *aesthetic evaluations* are useful to notice and recognise the shapes signalling unhealthy coronaries as well as to develop the *vis-ability* (Schindler 2009) of young physicians and registrars. When they talk about a «beautiful lesion» it means that it corresponds to a typical case described in the images of anatomy books: an easily recognizable «narrowing in the little branch». Often, they also notice the ugliness of coronaries.

«How ugly is this coronary!»

A technician is talking with a nurse sitting at her side in the polygraph room: «Do you see it? You see, how ugly is this coronary!» The nurse adds: «It's bumpy».

«This one is really ugly!»

A nurse wonders: «The right is good?». The technician answers: «Well… not really». The nurse adds: «The circumflex looks good, here it is!». Then appears the image of the descending artery and the technician exclaims: «This one is really ugly! What are they going to do? It's a railroad he has to do if he puts the stents on!».

Along with *aesthetic evaluations*, the words "bumpy" (leaving implicit the route) and "railroad" both seem refer once again to *metaphors of space and journey* (Maestrutti 2018) through the coronaries. The question «Do you see?» and the verbal invitation «You see» – frequently accompanied by pointing gesture highlighting salient elements appearing on the screen (Goodwin 2003b, 2000) – show how much the action of seeing is not immediate (Alač and Hutchins 2004) if you are not a competent member of the team. The question and the invitation exhort colleagues to orient their attention and gaze towards the pertinent cues and shapes signalling a pathology by contributing to their visibility (Alač 2008).

Sometimes, senior physicians perform mimic gesture making the coronary shape visible to registrars. The participants use their body, hands and eyes to see and reason together (Latour 1986).

The gesture mimicking the coronary curve

A highly skilled physician and a young one are watching the images taken during the procedure to write the diagnosis. While talking to each other, they point towards some particular elements of heart ramifications. The expert moves his fingers along the circumflex artery then mime a curve with the palm of the hand facing up. In the meantime, a third physician arrives. The first one asks him: «Give you a voice to this image?». He answers without hesitation: «Not critical» while the physician, who posed the question, declares: «The boy says that it's critical, it's most likely borderline». The third physician adds: «But it's not a damaged plate, I would describe it like an irregularly contoured plaque».

Gaze orientation, mimicking and pointing gestures act as dynamic multimodal resources organising the perception (Alač 2005) and making the pertinent coronary shapes visible. Here, the young physician ("the boy") makes an over-interpretation (Joyce 2005) by labelling the coronary shape as "critical" (i.e., abnormal) while the experienced physicians think that, even if it is "borderline" because of the irregularly contours, it does not correspond to a coronary disease.

Understanding what is beautiful or ugly within a particular epistemic community makes young physicians learn the categories of the profession (Goodwin 1994) and to see relevant elements for diagnostic work. By observing the coronary shapes and hearing their aesthetical evaluation, they develop a *diagnostic eye* (Pentimalli 2020). At the end of the procedure, they frequently take pictures of the medical images to collect a "photo album" and construct an *atlas of images* as a useful benchmark for the diagnostic work and the writing of medical reports.

Despite the ability of physicians to recognise at a glance the pertinent shapes signalling a pathology, their diagnostic work is full of uncertainties and requires the advice of senior colleagues. Moreover, this diagnostic work does not only rely on the reading of medical images, even if they are inserted in medical records and acquire scientific objectivity, thanks to their visual evidence and persuasiveness (Amman and Knorr-Cetina 1988; Burri 2012). Before taking medical decisions, physicians assemble various information and visual resources about the patient's body (medical records, blood analysis, ECG, risk factors [obesity, age, former smoker]). Writing the diagnostic report is also a training moment for young physicians. Guided by experts, they learn how to translate the visual relevant details indicating a pathology into clinical written texts (Joyce 2005).

Conclusions

The increasing use of imaging technologies in the biomedical field creates *technoscientific imaginaries* and *metaphors* of the inner human body, as also happens in the hemodynamic laboratory doing coronary angiography and angioplasty whose activities I observed during my field research. In this context, the visualising devices provide images of heart ramifications by making them perceptible and explorable (Maestrutti 2018), by rendering visible and spatial what would be otherwise invisible and elusive (Alač 2005). But any medical image is not the faithful photography of the coronary and imaging technologies do not disclose the "transparent truth" of the inner body (Byrne and Stengel 2010; Joyce 2005).

On the one hand, these medical images have been manufactured through the use and alignment of different artefacts and technologies (dye, X-rays, monitor, stent, etc.) by involving the gestural dexterity of physicians in inserting microscopic instruments into the patient's body. Moreover, their interpretation relies on other visual information to establish the patient's clinical frame and requires the anatomical knowledge of practitioners. Physicians tend to forget all these sociomaterial alignments. They consider these images as scientific evidence (Burri 2012) legitimising the rationality of their diagnosis, whereas these images correspond to constructed epistemic objects.

On the other hand, «being able to see relevant events on the screen is not a transparent, "natural" ability (Lynch 1988; Pasveer 1989), but a socially organised element of culture that is instantiated within, and sustained by, a community of practice (Lave and Wenger 1991)» (Byrne and Stengel 2010: 141). The ability to notice at a glance pertinent cues and particular shapes signalling unhealthy coronaries requires both a *diagnostic eye* (Pentimalli 2020) and the ability to interpret the embodied semiotic performances (Goodwin 2003a, 2003b) accomplished by co-team members in the interactional space in front of the screen (Alač 2005). The interpretation of "what is going on" in the perceptual space of the screen goes along with the use and interpretation of multimodal semiotic resources (Mondada 2016) making the significant details of heart ramifications appearing on the screen visible and intelligible to each other.

The visibility of pertinent elements involves pointing fingers and mimicking gestures to attract attention, encourage joint participation and orient the gaze towards suspicious cues. Practitioners also exchange comments and doubts by mobilising metaphors and aesthetic judgments that are essential to the diagnostic work (Bleakley 2017). These metaphors/aesthetic judgments really play an epistemic and instructional role (Boyd 1993; Cameron 2002): they guide young physicians to see the pertinent shapes and cues signaling a coronary pathology, by making certain aspects visible and noticeable while downplaying others (Kompa 2021: 40).

Finally, the diagnostic eye does not only involve visual ability but also the knowledge of professional jargon and gestures, the meaning of metaphors and aesthetic comments about the coronary shapes. In this way, the less experienced practitioners learn the categories and the ways of seeing of their professional/epistemic community and become able to see and notice the signs of heart pathology since they participate in the socially and situated interpretation of images.

Alač, M.

2005 'From Trash to Treasure: Learning About the Brain Images Through Multimodality', *Semiotica*, *156*(1/4), 177-202.

Alač, M.

2008 'Working with Brain Scans. Digital Images and Gestural Interaction in fMRI Laboratory', *Social Studies of Science*, *38*(4), 483-508.

Alač, M., Hutchins, E.

2004 'I See What You Are Saying: Action as Cognition in fMRI Brain Mapping Practice', *Journal of Cognition and Culture*, *4*(3), 629-661.

Allamel-Ruffin, C.

2010 'Objectivité et images scientifiques: Une perspective sémiotique', *Visible – Images et dispositifs de visualization scientifique*, *6*, 9-40.

Amman, K., Knorr-Cetina, K.

1988 *The Fixation of (Visual) Evidence*, in M. Lynch & S. Woolgar (eds.), *Representations in Scientific Practice* (pp. 85-122), Cambridge (MA), The MIT Press.

Beaulieu, A.

2002 'Images Are Not the (Only) Truth: Brain Mapping, Visual Knowledge, and Iconoclasm', *Sciences, Technology, & Human Values*, *27*(1), 53-86.

Berg, M.

1996 'Practices of Reading and Writing: The Constitutive Role of the Patient Record in Medical Work', *Sociology of Health & Illness*, *18*(4), 499-524.

Bleakley, A.

2017 *Thinking with Metaphors in Medicine: The State of the Art*, London, Routledge.

Boyd, R.
1993 [1979] *Metaphor and Theory Change: What is "Metaphor" a Metaphor for?*, in A. Ortony (ed.), *Metaphor and Thought* (pp. 481-532), Cambridge (MA), Cambridge University Press.

Brown, T. L.
2003 *Making Truth: Metaphor in Science*, Champaign, University of Illinois Press.

Burri, V. R.
2012 'Visual Rationalities: Towards a Sociology of Images', *Current Sociology*, *60*(1), 45-60.

Burri, V. R., Dumit, J.
2007 *Social Studies of Scientific Imaging and Visualization*, in E. J. Hackett, O. Amsterdamska, M. Lynch, J. Wajcman (eds.), *The Handbook of Science and Technology Studies* (pp. 297-317), Cambridge (MA), The MIT Press.

Burri, V. R., Carusi, A., Aspradaki, A. A.
2014 'Visualising Bodies Within and Beyond Laboratories and Clinics', *TECNOSCIENZA: Italian Journal of Science & Technology*, *5*(1), 165-189.

Byrne, P., Stengel, K.
2010 *Heartfelt and Heartseen: Making a Diagnosis through Coronary Angiogram*, in M. Bücher, D. Goodwin, J. Mesman (eds.), *Ethnographies of Diagnostic Work: Dimensions of Transformative Practice* (pp. 133-148), London, Palgrave Macmillan.

Cameron, L.
2002 'Metaphors in the Learning of Science: A Discourse Focus', *British Educational Research Journal*, *28*(5), 673-688.

Cartwright, L.
1995 *Screening the Body: Tracing Medicine's Visual Culture,* Minneapolis and London, University of Minnesota Press.

Casini, S.
2020 *Nuove cartografie corporee: Dal molare al molecolare, dal corpo trasparente a quello potenziale*, in S. Casini, F. Di Blasio, G. Perletti (eds.), *Trasparenze*, Bergamo: Elephant & Castle – Laboratorio dell'immaginario.

Daston, L., Galison, P.
1992 'The Image of Objectivity', *Representations*, *40*, 81-128.

Foucault, M.
1963 *Naissance de la Clinique*, Paris, Presses Universitaires de France.

Goodwin, C.
1994 'Professional Vision', *American Anthropologist*, *96*(3), 606-633.

Goodwin, C.

2000 *Practices of Seeing. Visual Analysis: An Ethnomethodological Approach*, in T. Van Leeuwen, C. Jewitt (eds.), *Handbook of Visual Analysis* (pp. 157-182), London, Thousand Oaks.

Goodwin, C.

2003a *The Semiotic Body in Its Environment*, in J. Coupland, R. Gwyn (eds.), *Discourses of the Body* (pp. 19-42), New York, Palgrave Macmillan.

Goodwin, C.

2003b *Pointing as Situated Practice*, in S. Kita (ed.), *Pointing: Where Language, Culture and Cognition Meet* (pp. 217-241), Mahwah (NJ), Lawrence Erlbaum.

Grosjean, S.

2014 'Existe-t-il une *manière de voir* organisationnelle? De l'intérêt de suivre les «*practices of seeing*» en organisation', *Revue d'Anthropologie des Connaissances*, *8*(1), 143-177.

Joyce, K. A.

2005 'Appealing Images: Magnetic Resonance Imaging and the Production of Authoritative Knowledge', *Social Studies of Science*, *35*(3), 437-462.

Joyce, K. A.

2006 'From Numbers to Pictures: The Development of Magnetic Resonance Imaging and the Visual Turn in Medicine', *Science as Culture*, *15*(1), 1-22.

Knorr-Cetina, K.

1981 *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science,* Oxford & New York, Pergamon Press.

Kompa, N.

2021 *Insight by Metaphor – The Epistemic Role of Metaphor in Science*, in A. Heidenreich, K. Mecke (eds.), *Physics & Literature: Theory, Popularization, Aestheticization* (pp. 23-47), Berlin & New York, De Gruyter.

Lakoff, G., Johnson, M.

1980 *Metaphors We Live By*, Chicago (IL), The University of Chicago Press.

Larkin, G. V.

1978 'Medical Dominance and Control: Radiographers in the Division of Labour', *Sociological Review*, *26*(4), 843-858.

Latour, B.

1986 'Visualization and Cognition: Thinking with Eyes and Hands', *Knowledge and Society*, *6*, 1-40.

Latour, B., Woolgar, S.

1979 *Laboratory Life: The Construction of Scientific Facts*, Princeton (NJ), Princeton University Press.

Lave, J., Wenger, E.

1991 *Situated Learning: Legitimate Peripheral Participation*, Cambridge (MA), Cambridge University Press.

Lévy, P.

1998 *The Virtualization of the Body*, in Lévy, P. (ed.), *Becoming Virtual, Reality in the Digital Age* (pp. 35-44), New York & London, Plenum

Luff, P., Hindmarsh, J., Heath, C.

2000 *Workplace Studies: Recovering Work Practice and Informing System Design*, Cambridge (MA), Cambridge University Press.

Lynch, M.

1985a 'Discipline and the Material Form of Images: An Analysis of Scientific Visibility', *Social Studies of Science*, *15*(1), 37-66.

Lynch, M.

1985b *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk in a Research Laboratory,* London and New York, Routledge and Kegan Paul.

Lynch, M.

1988 'The Externalized Retina: Selection and Mathematization in the Visual Documentation of Objects in the Life Sciences', *Human Studies*, *11*, 201-234.

Lynch, M., Woolgar, S. (eds.)

1990 *Representation in Scientific Practice,* Cambridge (MA), The MIT Press.

Maestrutti, M.

2008 'Rendere visibile l'invisibile: Il ruolo della visione e dell'immagine nella costruzione di una storia delle nanotecnologie', *Rassegna Italiana di Sociologia*, *3*, 427-450.

Maestrutti, M.

2018 *Imaginaires, images, vision: Les nouvelles représentations du corps de l'imagerie médicale*, in F. Kroger, M. Maestrutti (eds.), *Les imaginaires et les techniques* (pp. 275-289), Paris, Presse des Mînes.

Mondada, L.

2016 *Multimodal Resources and the Organization of Social Interaction*, in A. Rocci, L. de Saussure (eds.), *Verbal Communication* (pp. 329-350), Berlin & Boston, De Gruyter Mouton.

Ortony, A.
1993 *Metaphor and Thought*, Cambridge, Cambridge University Press.

Pasveer, B.
1989 'Knowledge of Shadows: The Introduction of X-ray Images in Medicine', *Sociology of Health & Illness*, *11*(4), 360-381.

Pentimalli, B.
2016 'Imparare a rendere visibile l'invisibile in un laboratorio di emodinamica', *SocietàMutamentoPolitica*, *7*(14), 121-150.

Pentimalli, B.
2020 'L'œil diagnostique: Voir et apprendre à voir dans un laboratoire d'hémodynamique', *Revue d'Anthropologie des Connaissances*, *14*(3), https://journals.openedition.org/rac/10241.

Pentimalli, B., Rémery, V.
2020 'The Factory of Gaze: Learning and Training Within Communities of Practice', *Revue d'Anthropologie des Connaissances*, *14*(3), https://journals.openedition.org/rac/11181.

Perrotta, M.
2012 'The Study of Technoscientific Imaging in STS', *TECNOSCIENZA: Italian Journal of Science & Technology Studies*, *3*(2), 163-176.

Pizza, G.
2005 *Antropologia medica: Saperi, pratiche e politiche del corpo*, Roma, Carocci Editore.

Sawchuk, S.
2000 *Bioturism, Fantastic Voyage and Sublime Inner Space*, in J. Marchessault, K. Sawchuk (eds.), *Wild Science: Feminist Images of Medicine and Body* (pp. 9-23), New York, Routledge.

Schindler, L.
2009 *The Production of "Vis-ability": An Ethnographic Video Analysis of a Martial Arts Class*, in U. T. Kissmann (ed.), *Video Interaction Analysis: Methods and Methodology* (pp. 135-154), Frankfurt am Main, Peter Lang.

Sicard, M.
1998 *La fabrique du regard: Images de science et appareils de vision (XV-XX siècle)*, Paris, Odile Jacob.

Styhre, A.
2010 'Knowledge Work and Practices of Seeing: Epistemologies of the Eye, Gaze, and Professional Vision', *Culture and Organization*, *16*(4), 361-376.

van Djick, J.
2001 'Bodies Without Borders: The Endoscopic Gaze', *International Journal of Cultural Studies*, *4*, 219-237.

van Dijck, J.
2005 *The Transparent Body: A Cultural Analysis of Medical Imaging*, Seattle & London, University of Washington Press.

Veit, W., Ney, M.
2021 'Metaphors in Art and Science', *European Journal for Philosophy of Science*, *11*(2).

Vertesi, J.
2012 'Seeing like a Rover: Visualization, Embodiment, and Interaction on the Mars Exploration Rover Mission', *Social Studies of Science*, *42*(3), 393-414.

Part II.
The Body
Proper

4. A "Restored" Female Body: Practices and Imaginaries in Breast Cancer Treatments

VALERIA CAPPELLATO, VALENTINA MOISO

Introduction

The chapter contributes to study of the biomedicalisation of bodies in the path from health to illness and back again by focusing on therapies and treatments for breast cancer, including surgery and post-mastectomy breast reconstruction. In order to reflect on the biomedicalisation of these trajectories, we have reconstructed *ex post* an original autoethnographic shadowing of our bodies during the treatment process that both of us have undergone, doing so in a continuous dialogue with the literature and empirical analyses carried out on this subject. The female body is conceived as a site where the representations of "good functioning" and the imaginaries of the "healthy woman's body" acquire material form. Throughout the illness trajectory, the female body is altered according to implicit norms and rules that can produce a misalignment between the physician and the patient. During breast cancer treatment, the body is manipulated and transformed (even transfigured) by the care practices to which it is subjected: it is poisoned by substances infused in chemotherapy and by radiation in radiotherapy; it bears the signs of treatments, such as tattoos to line up the radiotherapy machine for each session; it wears "artifacts", such as the infusion port; it is mutilated by cancer removal surgery. In the course of breast cancer treatment, the female body is manipulated and modified in order to "restore" and repair its shape and functions: firstly, when prostheses are implanted; secondly, when people who are experiencing temporary or permanent hair loss during chemotherapy enhance their look with wigs, nail reconstruction or permanent make-up. Assembled during the various phases of the treatment process is a variety of types of knowledge, techniques and tools which diverge according to both the specific goals of the therapies and their impact on the female body and, therefore, according to the implementation of "restorative" actions.

Based on the analytical framework set out in the next section, our exploratory analysis was guided by a number of broad questions that focused specifically on the issue of the different configurations of breast cancer. In particular, we sought to determine how artifacts mediate not only experience and perception, but also actions and practices and how breast cancers were configured in the discursive practices of various constituents (doctors and the authors of clinical guidelines) embedded in specific diagnostic and therapeutic procedures and in different measures associated with them. In order to explore these topics, we based our analysis on the autoethnography described in Section 4.3. We produced autoethnographic material during our treatments for breast cancer and the post-treatment phase, which lasted about three years. On subsequently reading it, each of us "followed" her body through all phases, observing the transformations that occurred, and the technoscientific configurations that constituted or accompanied them. Analysis of the two partially different illness trajectories enabled us to draw some conclusions about the factors that contribute to re-signifying the materiality of bodies. Do therapeutic and reconstructive options take account of implicit normative models concerning the female body? What kind of imaginaries about the female body recall certain "recovery" actions performed during the various stages of illness and treatment?

Theoretical background

Breast cancer is the most frequently diagnosed cancer among women, but there is uncertainty about etiology, diagnosis, therapy, and aftercare. There is no single, unambiguous cause of it, even though, in the medical context, diseases are defined and treated within a framework that assumes distinctive causality, recognizable symptoms, and scientifically determined treatment. Notwithstanding attention to genetic causes, only five to ten per cent of diagnosed women have inherited a mutation in the breast cancer genes, BRCA1 or BRCA2. Furthermore, the literature evidences the local and socio-historical situatedness of experiences of cancer (see Pérez et al. 2022).

The development of knowledge and technologies has contributed to change the care system. However, many conditions do not fit well within this framework, creating ambiguity about how to treat them. Sulik (2009) underlines that, also in Parsons' view, the advancement of science and medicine will increase biomedical uncertainty. For physicians and clinical specialists, a strategy to curb it could consist of both (i) establishing and referring to rigorous diagnostic and therapeutic protocols, and (ii) making use of advanced technology and biomedical surveillance. The role of technology has been central in the development of various clinical and medical specialties, contributing to their differentiation. Those processes could produce new kinds of inquiry at the intersection among technology, patienthood and a variety of healthcare specialisms or practices, and even some tensions among specialists. The therapeutic value of treatment approaches has been agreed upon, and cost-effectiveness analyses have given rise to treatment algorithms and clinical protocols. However, those therapeutic values – as «criteria to act and discern action» (Lambek 2015: 7) – are fluid and mobilised in decision-making situations where different treatment modalities are discussed in the clinic and there is little certainty about their potential outcomes (Pérez et al. 2022). The dependence on biomedical technoscience in medicine could extend medicalising processes by reconfiguring the logic of medical knowledge and practice (Clarke et al. 2003). From this perspective, advanced technology produces a shift from disease and cure (medicalisation) to choice, enhancement, and risk (biomedicalisation). Furthermore, the process of *datafication* – understood as the reduction of social items such as relations, behaviours, emotions in data managed through digital devices (van Dijck 2014) – has not led to a personalisation of care but instead to a greater individualisation of the risk and disease pathways (Neresini 2020). The everyday self-monitoring of treatment effects has even changed the relationship between the patient and his/her own health management (Lupton 2016; Moretti and Morsello 2017). Patients carry out a number of established actions in their daily routines that are related to individual risk control, especially when uncertainty about treatment is fuelled by a mismatch between the doctor's and the patient's expert-by-experience knowledge – an issue that has long been present in the literature (Glaser and Strauss 1965). In breast cancer, the issue of risk control is studied in relation to the risk of becoming ill primarily with regard to genetic tests; but from the point of view of patients it is important to consider also the risk of an additional disease caused by treatments with alleged toxic effects on many vital organs. In the absence of a clear discourse on the actions to be taken to preserve the body, women face uncertainty about the "right" strategy to be adopted; and the issue of the individualisation of risk in the decision-making process arises (Charles et al. 1998). Moreover, little is known about the daily life strategies of women diagnosed with breast cancer at a younger age, even if research findings indicate that they experience increasing morbidity rates and more social problems than older patients do (Bloom et al. 2001; Connell et al. 2006), also because they are more likely to be mothers of dependent children (Fisher and O'Connor 2012).

Illness, disease, and health care are therefore more than phenomena bringing together humans and nonhuman actors and objects in mismatches which are constantly changing (Lupton 2021). As well as techno-scientific transformations, it is extremely important to recognise the importance of another fundamental component of the therapeutic *assemblage* (Deleuze and Guattari 1988): the body. Numerous scholars have urged us to consider the heterogeneity of the different contexts in which the body – alongside the care pathways – takes shape (Le Breton 2000; Borgna 2005). They maintain that the practices of body discipline are the result of changed customs in society (Elias 1978), and that the body is a social (and class, we would say) constructed place of practical sense, a manifestation of habitus and an investment of power and domination (Bourdieu 1984). The body can be interpreted as the locus where processes of identity building take place, also according to how institutions – such as medicine – impose and reinforce group identification. Binary oppositions grounded on cultural norms and assumptions are frequently adopted in discourses on embodiment in an attempt to draw distinctions between, for instance, the female and the male body, normal (or ableist) and deviant, health and illness or disease, sanity and psychosis, to name but a few (Lupton 2016). Those distinctions recall the natural body (Haraway 1991) as the archetype for objectified scientific discourses. In this case, the body afflicted by cancer also belongs to the female-gendered body group and, indeed, as we will show, in some way also to that of deviant or un-*docile bodies* (Foucault 1975). The governmentality of bodies can thus be seen as the power exercised through medical discourses and practices to define which behaviour during cancer treatment is considered "normal", which devices and effects are to be passively accepted, and which are to be denied and camouflaged, regardless of individual well-being, which depends on personal experiences, needs and identities. Politics of the body produce and normalise bodies, making them functional to a power reproduction which is not at all gender-neutral (Ghigi and Sassatelli 2018).

In this framework, discourses are especially significant as arrangements of conceptual and material relations and practices (Dahl 2017): narratives, imageries and metaphors, far from being neutral, are devices of signification which, when employed in medical and lay discourses, construct specific realities, highlighting some therapeutic alternatives and obscuring others. As Susan Sontag importantly pointed out in "Illness as Metaphor" (1978), looking at the signs of illness on other people's bodies is still taboo in contemporary Western societies, even more so when the illness is connected to motherhood. Breast reconstruction is considered to be part of the expected course of treatment by medical professionals (Gershfeld and Jacoby 2020; La et al. 2019). In the clinical setting, a patient's choice is interpreted as the way in which s/he can exert power and control on what in fact cannot be controlled but only managed: the disease. Breast reconstruction is normalised, although neither the choice nor the ensuing results can be taken for granted (La et al. 2019). Crompvoets (2012) for example, notes that women are not necessarily happy with the shape, appearance or performance of their breasts after reconstruction; but they know that they conform with cultural norms. Thus, conformity with the ideal female body is closely linked to the individual's responsibility to control his/her body, which should be adapted to the culturally shared aesthetic standards in a given time and space. This is also because, as Mol (2008) states, by definition, a citizen is someone who controls his own body, but diseases interfere with this.

Cobb and Starr (2012) in their research study on breast cancer patients described a disconnection between women's experiences of reconstructive surgery and the commodification of breast cancer in the "make-over" metaphor. The "make-over" metaphor is defined by the authors as a cultural discourse whereby elective cosmetic surgery apparently makes the neoliberal subject able to choose and take sole responsibility for the body remodeling process, despite the need to submit to technological competence. The metaphor constructs surgical reconstruction as a positive personal transformation in which body reshaping is necessary and clearly represents survival. As such, the metaphor:

> «obscures the pain and complications of the disease and its treatments in an attempt to deny the body's limits, and it frames the corporeal as endlessly malleable in the search for "normality", insisting that it can be moulded and shaped as if it was something separate from ourselves» (Cobb and Starr 2012: 98).

Finally, the issue of the embodied character of everyday life during illness and care calls the patient's perspective into question. Sociologists maintain that patients possess «lay knowledge and expertise» (Blume 2017) and consider them not as passive subjects, but as «experts by experience» with knowledge about their own bodies, symptoms, and life situations (Castro et al. 2019). Experiential expertise can contribute to improving ways to cope with problems resulting from medical protocols, taking their consequences for daily life into account. But its legitimation by, and its interconnection with, medical knowledge is not taken for granted.

Autoethnographic trajectories

This chapter is based on a collaborative autoethnography approach used as a method to collect useful information in order to reconstruct a shadowing of our bodies. Autoethnography is one of the qualitative research methods which use autobiographical experiences as primary data to be interpreted and analised in order to connect the personal to the social. In the medical field it has demonstrated its capacity to give access to experiences that would otherwise be difficult to intercept (Neresini 2020). Breast cancer autoethnography gives the opportunity to combat dominant narratives that do not take into account the voice of women who have experienced it (Greenhalgh 2017). Its lack of distinction between the subject and the object of the research is the main criticism of this method. In the recent literature, it is seen as a problem that can be solved by argumentations (Cardano 2020) that are more careful, critical and transparent in reporting the methodological choices and interpreting the results than are those of previous analyses (Gariglio and Ellis 2018).

Autoethnographic notes were written during the treatment paths: in analysing the notes, we shadowed our bodies following the trajectory framework stated by Corbin and

Strauss (1991). The trajectory framework is a conceptual model built on the idea that chronic conditions have a course that varies and changes over time. The term *trajectory* is used to signify the pathway of an illness or disease and the interaction of several factors (medical, psychosocial, cultural) in shaping outcomes. The trajectory framework gives structure to the lived experience of illness through the conceptualisation of specific phases along a continuum. Corbin and Strauss describe these phases as pretrajectory, trajectory onset, stable, unstable, acute, crisis, comeback, downward, and dying, even if the pathway is not linear and remains a dynamic and unpredictable process. Significantly, in redefining the trajectory framework, Corbin (1998) emphasised that all the actors involved (individuals, families, health care providers, resource agencies, communities, organisations, institutions) give shape to the course of an illness.

Referring to Corbin and Strauss's model (1991), we have redefined both of the authors' disease trajectories by identifying diagnosis, intervention, treatment, reconstruction and rehabilitation as their main phases.

The two illness and care paths are now briefly described.

First authoress's diagnosis and treatment path

In 2016 I underwent a bilateral mastectomy performed at a cancer research and care center in the province of Turin (Piedmont); a treatment chosen not because of the still unknown genetic data but because of my family's significant history of breast cancer. Subsequently to the histology and cancer diagnosis I began the genetic diagnostic procedure. I then underwent surgery for breast cancer in 2016, given that the CHEK2 genetic mutation had been detected both in my case and in that of my sister, who died in 2007 from breast cancer at the age of 41. In the absence of a clear specific protocol for the CHEK2 mutation, screening examinations should therefore be prescribed by the gynecologist in consideration of the medical history of the family. The field notes were written during the period from the examination that showed a suspicious lesion until the genetic testing of my granddaughters. They are predominantly accounts of the visits to different specialists written in the first instance to keep track of the conversations that took place and my observations regarding some inconsistencies, which are accompanied by notes on the dialogues that took place with the family network concerning the treatment choices and the interruptions in the flow of communication among the actors in the field.

Second authoress's diagnosis and treatment path

Immediately after diagnosis, at the start of chemotherapy, a genetic counseling was requested also in order to drive the course of treatment in case I had aggressive triple-negative cancer at my rather young age (38). I tested negative, so the treatment path proceeded as the protocols prescribe: infusion chemotherapy, operation with conservative surgery (quadrantectomy), radiotherapy, further chemotherapy, from March 2018 to July 2019. The treatment was carried out in Turin, with a consultation at a specialised institution in Milan, where I also had the surgery. I had two additional consultations with recognised specialists in this field, and I was then included in an immunotherapy trial, but in the control sample. These consultations were due to the uncertainty of my case: being negative by family history and genetic testing, while the tumor was non-receptive to some treatments (e.g., hormonal), made the search for causes and consequently the search for care more difficult. Autoethnographic notes were written throughout this period in a daily diary which collected data in different categories from food to emotional condition.

Starting from our individual experiences, we have deeply talked about the meaning of our respective trajectories paying attention to similarities and differences in medical advice and in the choice of treatments. We collaboratively discussed emerging themes and conducted analyses throughout the activity (see Geist-Martin et al. 2010). Our trajectories partially differed according to the specificity of our cancers: in this chapter we focus on treatment and reconstruction, which are respectively the central phase for Author 2 and Author 1.

A good external shape*: the camouflage during the treatment*

In facing a year of neoadjuvant and adjuvant chemotherapy, my major concern was about the impact of treatment on the well-being of my body. The doctors' instructions were only focused on maintaining a "healthy exterior": i.e., getting my eyebrows tattooed and/or using a wig (I did not). In my opinion, care of my "internal health" was even more important. The body changes and suffers during chemotherapy. The effects vary across individuals, but they are intense and remind the patient that the treatment is acting on every single one of his/her cells. Some common effects are expected by doctors, who suggest how to treat them: in my case, anti-nausea medication, skin creams to counteract small wounds on my fingers, cortisone as an anti-inflammatory solution. The injections to support my immune system, in turn, created annoying osteoarticular pains: I avoided them by moving to the mountains, where "magically" my white blood cells started to increase on their own. "Mountain air", it seems, has a real effect and not just a psychosomatic one; but nobody had told me this in advance. Being hungry for information on other substances or practices that could have helped, I put the same question to the doctors on shift (often different ones and often residents) at each check-up before the infusion session: «How can I help my body to react to the toxicity of the treatments? I don't mean the way it looks but the way it works». Given the doctors' lack of guidance in this regard, I purchased two herbal preparations and aloe juice from my trusted herbalist, who had experienced cancer.

> Blood tests not perfect. Liver is suffering. At the check-up there were not only residents but also a doctor I had never met before [and would never meet again, *ed.*] who paid particular attention to me. He forbade me to take integrators of any kind, except one for intestinal spasms. Aloe is probably contributing to the liver distress: it is a natural chemotherapy drug, he told me. This is why the liver gets stressed. (Author 2, April 2018)

But the main revelation was another.

> While explaining to me why I shouldn't purify anymore, his face broke into a smile and he said: "We have to poison you, otherwise you won't get well. Whatever purifies you kills the benefits of the chemotherapy drugs. You will be able to get your body into good shape later".
> […]
> Suddenly, getting my body into good *external* shape seemed grotesque to me.
> I had never thought of a cure as a poison. Oncology treads a fine line between poisoning a body just enough to recover it and killing it. Behind the wigs and make-up, I have begun to notice the signs that women undergoing chemotherapy bear: the hollowed-out eyes, the weight loss combined with the swelling caused by cortisone. I keep on getting massages from a therapist to help my body, and I wonder if a practice like this one shouldn't be included in the information package provided by doctors. (Author 2, April 2018)

This example evidences a misalignment between clinical management and individual self-tracking of treatment effects in daily life. The only clear advice on how to preserve the body focused on how to preserve the physical appearance in order to maintain a good *external* shape with camouflage during the poisoning due to chemo. In the specialist's worlds, this was not only a matter of beauty; it was also a matter of duty. The justificatory rhetoric surrounding advice often centered on my role as a mother.

> Last night we went out for dinner. There was a bald woman, and my children kept on looking at her. They were upset. My little daughter clung to me all the evening. I wouldn't do this to your children. (Ex-post reconstruction of what one of my oncologist doctors said, March 2018)

I was implanted with an internal device, "the port". This is a pad under the skin, from which a 15 cm canula runs to a large central vein, and into which the needles are inserted to infuse the chemotherapy. Only later did I discover that I could have opted for an external device on my arm, which would have avoided a horrible, everlasting scar between my neck and breast: but because I was the mother of a one-year-old girl, it had been autonomously judged an uncomfortable solution by the doctors. In many Western societies, mothers usually do not wear necklaces and earrings for the first years of their children's lives because their babies will try to pull them.

In the absence of a protocol, priorities on what is a good shape to be preserved are established in a somewhat arbitrary manner. This uncertainty is particularly evident in the case of radiotherapy treatment. This involves bombarding the cancer site with a beam of rays on a daily basis after the tumor's surgical removal. In order to direct the rays correctly, three blue-green tattoos are engraved on the body in the form of three small dots slightly larger than a nevus. I found out that the patient could negotiate with the doctor the exact point to receive the tattoo, but this was not possible in my reference hospital.

> The doctor explained to me that the tattoo is done discreetly, because many women complain that it is visible when they wear a bikini and people can guess they have had breast cancer. I am really amazed. In the *debacle* of the body, these women look at a dot on the neckline. (Author 2, November 2018).

This returned to my memory during the removal of my port. It was a rushed operation, in which I had a vagal crisis because the doctors didn't give me any sedatives. This left me with a 5 cm long scar above my breast. It is very visible on my neckline and would need another operation to be eliminated.

Those differences in considering marks on the body can be understood as referring to divergent cultural organisations which orient doctors in their practices and hence cure trajectories.

Breast reconstruction and body restoration?

Implants and surgical reconstruction technologies may be part of one of the stages in the trajectory of breast cancer. Women diagnosed with early-stage breast cancer must decide – before undergoing the surgery – whether to undergo breast conservation or mastectomy as part of their treatment.

I've had my first session with the oncologist. There was a long discussion. The oncologist favored quadrantectomy but I still opted for mastectomy. Then he spoke to me about reconstruction, but my attention was focused on the surgical option. Today, the theme of reconstruction has become secondary. (Author 1)

Considering my age, my family history, the mutation status, and the higher risk of developing a contralateral breast cancer, I underwent a bilateral mastectomy – persuaded by the normalisation of breast reconstruction in medical narratives and practices, where it is often posited as beneficial to the quality of life and psychological adjustment – followed by an immediate breast reconstruction using prosthetic breast implants in multiple stages. The first stage of the procedure is placement of a tissue expander; following placement of the expander in the submuscular pocket, expansion is carried out at intervals of one week on an outpatient basis. The completion of expansion takes several weeks until the desired size is achieved. The temporary expander is then removed (several months later, but in my case three years later) and replaced with a permanent implant. The expansion phase of the implant can last a varying amount of time, also in relation to the goal that the plastic surgeon wants to achieve. Breast surgeons seem to be conditioned by implicit cultural norms and ideal models of the female body.

> I've been to the hospital today, and I saw the same male breast surgeon that operated on me. I thought we were going to talk about the replacement of the expander. I thought he wouldn't add any more saline. Instead, he took the syringe and proceeded. I told him that his female doctor colleague, during the previous examination, had told me that it was not necessary to fill the expander any further. According to the female doctor, I had completed the expansion. He

> disagreed. He looked at my body and said I had not yet reached the proportionate measures. "What proportionate measures does he have in mind?", I wondered. His colleague had also spoken of proportionate measures achieved, but evidently they did not agree with each other on what they were and did not even ask me what my expectations were. (Author 2)

After (or before) a mastectomy due to breast cancer, a woman must decide whether to undergo reconstruction of her breast(s). By choosing reconstruction, women restore not only their body but also their socially acceptable selves. Who can define to whom, why, and under what conditions a reconstruction is desirable?

Doctors promote the prosthesis as a device that aligns the post-surgical body with well-being and normality. Therefore, prosthetics are a point of convergence where the self and the body appear to be in harmony (Crompvoets 2012). The Italian guidelines state: «After mastectomy surgery, immediate breast reconstruction is desirable because it improves the quality of life of women» (Aiom 2019).

Whilst during the diagnosis phase image-related issues may be less important than survival, sometime after surgical treatment the suffering due to a loss of control over one's bodily appearance and self-presentation is a significant experience (Ucok 2005). Furthermore, a breast prosthesis is not necessarily integrated into the body because it does not have a real purpose of restoring functions other than those that refer to the appearance and image of integrity. Women often perceive breast restoration as a matter couched mainly in visual terms (Gershfeld and Jacoby 2020) as a multidimensional performance of recovery, of normality and of gender (Crompvoets 2012). However, my experience shows that the model to which the two breast surgeons referred – the universalised natural female body (Haraway 1991) – is not uniform and remains implicit.

Conclusion: re-politicising care and cure

The breast cancer trajectory can be interpreted as an «assemblage of health» (Andrews 2019) in order to reveal how the spatial and temporal dimensions interact in producing and reproducing discourses, practices, and experiences of health, illness, and medical care and, thus, female body representations and meanings. The care trajectories briefly described in this chapter show how medical representation of breast cancer has been outlined in terms of disease (organic injury): the effects of treatments are relevant if they have had an impact on the ensuing cure pathway. On a broader view, medical discourses are often monopolised by the two main groups of social expectations and related normative pressures on women's bodies that can be traced back to patriarchy: on the one hand, the sexualised body; on the other, the maternal body, an aspect less explored in the literature.

Practices intended to camouflage the signs of cure on the body are rhetorically presented as "keeping up the mood" by making people feel colorful and beautiful. We can identify at least two latent functions. The first is purely clinical. It has been proven that mood has an effect on the body's resistance to treatment: so that anything that helps to preserve the continuity of infusions, and thereby their effectiveness, is welcomed and supported by the medical profession. The second function is social: in a society where bearing the signs of cancer on the body (which are the signs of treatment in the case of breast cancer) is still considered a stigma, giving women advice on how to camouflage them means helping them to maintain the mundane relationship as "normal" as possible. Advice that insists on frivolous aspects such as make-up contributes to the definition of pink activism (the activism carried out by women who experienced cancer) well known in the literature (Ehrenreich 2001; Sulik 2010). On the other hand, pink activism has been crucial in helping women not to hide themselves during treatment, even if this behavior is still sadly widespread among patients (Morsello 2021; Herzlich and Pierret 1987). This is when a major contradiction emerges: restoring the affected body means reinforcing the normative ideal of the ableist (a "normal" body of a non-disabled person) and handsome female body.

Parenthood is not gender neutral (Naldini 2015). Normative pressures are stronger and become even more coercive when a society is gender inequal, as in the Italian case. Such norms are embedded and traceable also in the practices of managing women's bodies during cancer treatment, where they act in defining how it is licit and desirable to imagine these bodies and their functions. Motherhood could even have a positive influence on illness by providing psychological and material resources to cope with it. This is not just a matter of intersubjective relations between mother and child (Morsello 2021), or of re-evaluation of the work-family balance (Mackenzie 2014; Shannon and Shaw 2005) and of the caregiving status (Sulik 2009); it also concerns how imaginaries of mothers' bodies – and their functions – affect the trajectories of treatments.

Reconstruction is entangled, on the one hand, with hegemonic body norms, plastic surgeons' discourses (Coll-Planas et al. 2017) and individual choices concerning one's body (Crompvoets 2012), and on the other, with potential divergent ideal types of "proportionate bodies" that orientate breast surgeons. Thus, many elements contribute to shaping uncertain treatment trajectories (and bodies). Therefore, patients have to deal with the uncertainty of the restoration process, with a body that changes several times with the mastectomy and the insertion of the temporary implant during the various sessions of filling the expander, and finally with the replacement of the expander with the definitive prosthesis. The familiar body becomes an unfamiliar body for a long period even though women's breast cancer narratives recount reconstruction as a way to recuperate a woman's feminine identity, restoring "wholeness" and wellness to her body (Crompvoets 2003, 2012). Technologies mediate actions by attempting to implement adequate, acceptable, or desirable practices and experiences (Verbeek 2006). This ability to mediate (moral) practices and experiences, however, is not a compulsory or static property of the artifacts themselves; rather, it emerges from the context in which these artifacts are used and within complex networks of interaction among the different actors involved, both professionals and lay people.

In the context of pressures to normalise post-mastectomy breast reconstruction to restore "lost" femininity, it is also necessary to remember the increasing number of women who decide against breast restoration and negotiate their non-normative "flat" bodies (La et al. 2019). In the breast cancer literature, breast loss means femininity loss (Crompvoets 2012; La et al. 2019). Crompvoets talks about a process of "risk switching" from being at risk of disease (spreading, returning) to being at risk of compromising bodily and gender integrity, in other words "fantasy wholeness" (Crompvoets 2012). Plastic surgeons who perform reconstructive breast surgery draw on healthy bodies which clearly align with normative ideas of femininity and they label non-reconstructed post-mastectomy bodies as incomplete and physically deformed (Coll-Planas et al. 2017). The normalisation of breast restoration is linked to norms of femininity. Indeed, "femininity" can be understood as a way of "doing" gender as a woman (Paechter 2006).

It has been shown that oncology is a field – like many others in medicine – in which care differentiation is needed (Crabu 2017) also in relation to the individual body's reactions to cure. This concerns thematising and objectifying the following: priorities, the factors deemed worthy of consideration when counselling oncology patients about treatments, the devices to be incorporated (Maestrutti 2011), and the marks that these will leave on bodies. The issues that should be taken into account during the cure decision-making process are numerous and complex. In order to reduce complexity, doctors often simplify. However, not providing patients with all the necessary information may generate asymmetrical and power-imbalanced relationships between practitioners and patients. Thus, doctors can exercise greater discretionality and patients – especially those with fewer cultural resources – end up with less power to negotiate their needs and preferences. Our reflections in this chapter question the several treatment effects on the body and the different strategies with which to limit negative side-effects. Massages, acupuncture, sexual counselling, sport assistance, are paid-for services provided by private centres and not available at public hospitals. Female bodies bear different signs of breast cancer treatment. They depend on many factors, and the perception of them is highly subjective, even though it is influenced by "pink activism", which is becoming commercial.

Neoliberal health discourses focus on choice, positioning the subject as both a patient and a consumer who actively and responsibly seeks out health information and produces health by making his/her choices accordingly (Briggs and Hallin 2007), and in line with the information provided by health professionals. Within this neoliberal rhetoric, a breast cancer patient has the responsibility to make the "right" and "best" decision (Gibson et al. 2015), which hopefully conforms with the dominant clinical discourses.

Furthermore, following Sontag's injunction to resist a metaphorical interpretation of illness (Sontag 1978), we also suggest extending and differentiating – in both open and inclusive cure contexts – "possible" discourses and meanings of female bodies in order to overcome their patriarchal normative representation as well as the consumerist logic that surrounds them.

AIOM

2019 Linee guida per la neoplasia della mammella. *Associazione Italiana di Oncologia Medica*.

Andrews, G. J.

2019 'Health geographies II: The posthuman turn, *Progress in Human Geography*, *43*(6), 1109-1119.

Bloom, J. R., Stewart, S. L., Johnston, M., Banks, P., Fobair, P.

2001 'Sources of support and the physical and mental well-being of young women with breast cancer', *Social Science & Medicine*, *53*(11), 1513-1524.

Blume, S.

2017 'In search of experiential knowledge', *Innovation: The European Journal of Social Science Research*, *30*(1), 91-103.

Borgna, P.

2005 *Sociologia del corpo*, Roma e Bari, Laterza.

Bourdieu, P.

1984 *Distinction: A Social Critique of the Judgment of Taste*, Cambridge (MA), Harvard University Press.

Briggs, C. L., Hallin, D. C.

2007 'Biocommunicability: The neoliberal subject and its contradictions in news coverage of health issues', *Social Text 93*, *25*(4), 43-66.

Cardano, M.

2020 *Defending Qualitative Research: Design, Analysis, and Textualization*, London, Routledge.

Castro, E. M., Van Regenmortel, T., Sermeus, W., Vanhaecht, K.
2019 ‘Patients’ experiential knowledge and expertise in health care: A hybrid concept analysis’, *Social Theory and Health*, *17*(3), 307-330.

Charles, C., Whelan, T., Gafni, A., Reyno, L., Redko, C.
1998 ‘Doing nothing is no choice: Lay constructions of treatment decision-making among women with early-stage breast cancer’, *Sociology of Health & Illness*, *20*(1), 71-95.

Clarke, A. E., Shim, J. K., Mamo, L., Fosket, J. R.
2003 ‘Biomedicalization: Technoscientific transformations of health, illness, and US biomedicine’, *American Sociological Review*, *68*(2), 161-94.

Cobb, S., Starr, S.
2012 ‘Breast cancer, breast surgery, and the makeover metaphor’, *Social Semiotics*, *22*(1), 83-101.

Coll-Planas, G., Cruells, M., Alfama, E.
2017 ‘Breast surgery as a gender technology: Analyzing plastic surgeons’ discourses’, *Studies in Gender and Sexuality*, *18*(3), 178-189.

Connell, S. E., Patterson, C. M., Newman, B. M.
2006 ‘A Qualitative Analysis of Reproductive Issues Raised by Young Australian Women with Breast Cancer’, *Health Care for Women International*, *27*(1), 94-110.

Corbin, J. M.
1998 ‘The Corbin and Strauss Chronic Illness Trajectory Model: An Update’, *Scholarly Inquiry for Nursing Practice*, *12*(1), 33-41.

Corbin, J. M., Strauss, A.
1991 ‘A nursing model for chronic illness management based upon the Trajectory Framework’, *Scholarly Inquiry for Nursing Practice*, *5*(3), 155-174.

Crabu, S.
2017 ‘Lavoro di cura e innovazione tecnoscientifica: Il caso della medicina personalizzata’, *Salute e Società*, *16*(3), 197-213.

Crompvoets, S.
2003 ‘Reconstructing the self: Breast cancer and the post-surgical body’, *Health Sociology Review*, *12*(2), 137-145.

Crompvoets, S.
2012 ‘Prosthetic fantasies: Loss, recovery, and the marketing of wholeness after breast cancer’, *Social Semiotics*, *22*(1), 107-120.

Dahl, H. M.
2017 *Struggles in (Elderly) Care: A Feminist View*, London, Palgrave Macmillan.

Deleuze, G., Guattari, F.
1988 *A Thousand Plateaus: Capitalism and Schizophrenia*, London, The Athlone Press.

Ehrenreich, B.
2001 'Welcome to Cancerland: A mammogram leads to a cult of pink kitsch', *Harper's Magazine*, Report.

Elias, N.
1978 *The Civilizing Process*, New York, Urizen.

Fisher, C., O'Connor, M.
2012 '"Motherhood" in the Context of Living With Breast Cancer', *Cancer Nursing*, *35*(2), 157-163.

Foucault, M.
1975 *Discipline & Punish: The Birth of the Prison*, New York (NY), Vintage Books.

Gariglio, L., Ellis, C.
2018 '«Good Ethnography is Autoethnographic and Good Autoethnography is Ethnographic»: A Dialogue between an Ethnographer and an Autoethnographer', *Rassegna Italiana di Sociologia*, *59*(3), 555-579.

Geist-Martin, P., Gates, L., Wiering, L., Kirby, E., Houston, R., Lilly, A., Moreno, J.
2010 'Exemplifying Collaborative Autoethnographic Practice via Shared Stories of Mothering', *Journal of Research Practice*, *6*(1).

Gershfeld, L. A., Jacoby, R.
2020 'Immediate Breast Reconstruction: Does It Restore What Was Lost? A Qualitative Study', *Illness, Crisis & Loss*, *28*(2), 141-157.

Ghigi, R., Sassatelli, S.
2018 *Corpo, genere e società,* Bologna, Il Mulino.

Gibson, A. F., Lee, C., Crabb, S.
2015 '"Take ownership of your condition": Australian women's health and risk talk in relation to their experiences of breast cancer', *Health Risk & Society*, *17*(2), 132-148.

Glaser, B. G., Strauss, A. L.
1965 *Awareness of Dying*, Chicago (IL), Aldine Publishing Company.

Greenhalgh, T.
2017 'Adjuvant chemotherapy: An autoethnography', *Subjectivity*, 10, 340-357.

Haraway, D.
1991 *Simians, Cyborgs, and Women: The Reinvention of Nature*, London, Free Association Books.

Herzlich, C., Pierret, J.
1987 *Illness and Self in Society*, Baltimore, Johns Hopkins University Press.

La, J., Jackson, S., Shaw, R.
2019 '"Flat and fabulous": Women's breast reconstruction refusals post-mastectomy and the negotiation of normative femininity', *Journal of Gender Studies*, *28*(5), 603-616.

Lambek, M.
2015 *Living as if it mattered*, in M. Lambek, V. Das, D. Fassin, W. Keane (eds.), *Four Lectures on Ethics: Anthropological Perspectives* (pp. 5-51), Chicago, Hau Books.

Le Breton, D.
2000 *Anthropologie du corps et modernité*, Paris, Presses Universitaires de France.

Lupton, D.
2016 *The Quantified-Self: A Sociology of Self-Tracking*, Cambridge, Polity Press.

Lupton, D.
2021 *The Sociomaterial Nature of the Body and Medicine*, in S. C. Scrimshaw, J. Fisher, R. A. Rubinstein, S. D. Lane (eds.), *The SAGE Handbook of Social Studies in Health and Medicine* (pp. 103-121), Thousand Oaks, Sage.

Mackenzie, C. R.
2014 '"It is hard for mums to put themselves first": How mothers diagnosed with breast cancer manage the sociological boundaries between paid work, family, and caring for the self', *Social Science & Medicine*, 117, 96-106.

Maestrutti, M.
2011 'Cyborg identities and contemporary techno-utopias: Adaptations and transformations of the body in the age of nanotechnology', *Journal International de Bioéthique*, *22*(1), 71-88.

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

Moretti, V., Morsello, B.
2017 'Self-management and Type 1 Diabetes: How Technology Redefines Illness', *TECNOSCIENZA*: *Italian Journal of Science and Technology Studies*, *8*(1), 51-71.

Morsello, B.
2021 *IBRIDE. L'esperienza del cancro al seno tra mutazione genetica e identitaria un'analisi sociologica,* Roma, Roma TrE-Press.

Naldini, M.
2015 *La transizione alla genitorialità: Da coppie moderne a famiglie tradizionali*, Bologna, Il Mulino.

Neresini, F.
2020 *Io e il mio DNA: Abbiamo davvero un destino genetico?*, Bologna, Il Mulino.

Paechter, C. F.
2006 'Masculine femininities/feminine masculinities: Power, identities, and gender', *Gender and Education*, *18*(3), 253-263.

Pérez, I. A., Gibbon, S., Lanceley, A.
2022 'Therapeutic Values in Cancer Care', *Medical Anthropology*, *41*(2), 121-128.

Shannon, C. S., Shaw, S. M.
2005 '"If the Dishes Don't Get Done Today, They'll Get Done Tomorrow": A Breast Cancer Experience as a Catalyst for Changes to Women's Leisure', *Journal of Leisure Research*, *37*(2), 195-215.

Sontag, S.
1978 *'Illness as Metaphor'*, *The New York Review of Books*, XXIV(21 & 22).

Sulik, G. A.
2009 'Managing biomedical uncertainty: The techno scientific illness identity', *Sociology of Health & Illness*, *30*(7), 1059-1076.

Sulik, G. A.
2010 *Pink Ribbon Blues: How Breast Cancer Culture Undermines Women's Health*, Oxford, Oxford University Press.

Ucok, O.
2005 'The Meaning of Appearance in Surviving Breast Cancer', *Human Studies*, *28*(3), 291-316.

van Dijck, J.
2014 'Datafication, dataism and dataveillance: Big Data between scientific paradigm and ideology', *Surveillance & Society*, *12*(2), 197-208.

Verbeek, P. P.
2006 'Materializing Morality: Design Ethics and Technological Mediation', *Science, Technology, & Human Values*, *31*(3), 361-380.

5. The body professional. How do AV developers acquire their bodies?

MARIIA KISELEVA, ANDREI KUZNETSOV

In this paper, we explore the bodily dimension of the professional within the process of development of technological innovation. We have finished ethnographic research on the Russian-based startup called Trali which developed a self-driving truck and ADAS (Advanced driver-assistance systems) software. The technological startup came out as a place where «fluid ontology» was revealed, and the processes of acquiring the body could be observed. This is relevant for both humans who became professionals and gained a qualification during their working process and technologies (self-driving cars and software), which, starting from scratch, gradually acquired their bodies. We want to use gathered data to analyse how the body of an autonomous vehicle (AV) developer could be acquired. We want to elaborate on the notion of the body and talk about why did we chose this particular concept in the rich field of innovation studies and how this concept could contribute to our research. We will give an overview of our fieldwork in Trali and present cases from our study that will help us understand how AV developers acquire their bodies.

Towards the bodilisation of technoscience. What does it mean – to acquire an AV body?

Recent innovation studies have come to the understanding of innovation as an «interactive learning process» (Lundvall 2016; Edwards-Schachter 2018; Moulaert et al. 2013; Johnson and Andersen 2012). Based on this understanding researchers suggest social learning as a new framework of innovation politics that is an alternative to the regulation approach (De Vries and Horstman 2007). The social learning approach to innovation politics is particularly relevant in the case of AV technologies (Stilgoe 2017; Stilgoe and Cohen 2021) to which our research is related. In this paper, we want to add a bodily dimension to this common understanding of innovations and their politics as a multi-level learning process. Drawing on the ethnography of the AV startup we will take a close look at how developers acquire their professional bodies through their innovation activities understood as a learning process. To do this we turn to Bruno Latour's conception of the body as a «process of learning to be affected» (Latour 2004).

Before we turn to the theoretical discussion below it is instructive to ask why do we put the body at the centre of our study of AV technologies? Our research intentions to make this move are the following. First, we want to highlight that the technosciences and particularly sociotechnical innovations always imply embodied subjectivities (Mol 2008). It's not merely that the body serves as a constantly transforming battleground influenced by technoscience, as the editors of this volume accurately point out; rather, these bodily dynamics are integral to technoscience itself. Hence, we advocate for the *bodilisation of technoscience*.

Second, the focus on the body allows us to go beyond dualistic reflections on human nature, and to work directly with different non-material and material bodily impediments. Traditional definitions tend to separate the body from the material equipment that makes it sensitive to the world. Instead, drawing on the ethnography of an AV startup we will look closely at how the bodies are affected and what kind of humans and non-humans accompany employees' learning practices, what makes them change and how they change.

Third, we look for links between the sociology of the body and Science & Technology Studies (STS), between research on embodied subjectivities (Gomart and Hennion 1999; Mol 2003, 2008) and the studies of sociotechnical innovations (Laurent and Tironi 2015; Marres 2020; Stilgoe 2017; Stilgoe and Cohen 2021). To be compatible these approaches should take into account dynamic, shifting and fluid natures of both bodies and innovation projects. In this chapter, we focus on the approaches that understand these transformations of bodies and innovations through the concept of learning.

Finally, we opt for the focus on the learning trajectories of bodies and innovations not least because the idea of learning is at the centre of the field of AV technologies. Neural networks, the software responsible for the solution of the problem of so-called autonomous driving, are developed through machine learning. So AVs are machines that are supposed to learn from their environment and from one another. Passions and efforts of AV developers are focused on the process of training their vehicles to take into account more and more differences in the mobile world around them. But in the meantime developers themselves acquire some professional bodies that make them sensitive to more and more of these differences. It is this process we are going to study. Now let's turn to the concept of innovation as learning.

What does it mean to think of innovation as a learning process? This shift in understanding implies at least two crucial consequences. First, it puts an end to a firm-centric approach to innovations. Crucial actors and resources necessary for successful innovation are located outside the firms. To innovate firms had to learn to recognise these crucial agents and resources in their environment and to interact with them. It is not an isolated firm that innovates but a firm plus its environment that it is capable of taking into account and learning from. Hence the research focus shifts from a firm to an innovation system. Second, this new focus on the interactive learning process between innovating organisations and their environments highlights the shifting character of their boundaries. The distinction between "the inside" and "the outside" is less relevant than the connections between heterogeneous actors, capacities and resources whatever their location.

To closer examine a firm-centric approach, we decided to refer to the field that we found relevant: the studies conducted in the domain of organisational research where ethnography was used as the main method. The authors we studied concentrated mainly on the activities of certain firms. Although the main subject was not innovation itself, they provided us with some insights into the functioning of technological companies. Early researchers of the incipient IT industry indicated the new type of working culture that one can discover inside high-tech companies (Kunda 1995). In this emerging culture, employees were no longer attached to the strict dress code and schedule. On the contrary, workers' decision to work extra hours was perceived as the new routine, the generally accepted norm. Although this description appeared in the mid-nineties, it still corresponds with the modern everyday life of the tech industry, be it a corporation or a startup. Interestingly, the author pointed to the blurred boundaries between self and company among the traces of this new culture. Here the questions arise: do these boundaries actually have to be established or reestablished? Can we make do with the shifting self a worker obtains in the emerging tech industry?

These questions will be answered by describing the bodies workers obtain in our cases. Further, the research where ethnography was used as the main method of studying tech collectives highlight the key role of communication and distribution of knowledge among the workers (Grimm 2012; Obstfeld 2017; Whitson 2018; Rahman 2016). The dissemination of knowledge and search for solutions happen during joint work. Faced with a certain complex task, developers tend to work in groups and solve problems together. Despite its importance, this topic is considered to be an under-investigated one:

«social work, negotiation and collaboration play a fundamental but too little discussed role in game development literatures» (Whitson 2018). Although attributed to game development, we argue that this case can be extrapolated to other domains in the IT industry. In addition, researchers have discovered that innovative and creative work in the tech industry has a «collaborative and distributed nature of development work» (Whitson 2018) and have also found the «unexpected social character of programming» (Grimm 2012). Hence, the link between soft and hard skills lies in the basis of workflow in tech companies. Also, during our ethnographic study, we faced developers working together, sitting close to each other and literally taking the keyboard from one another. Examining real working conditions, the importance of hard skills turns out to be overrated (Darrah 1996). The importance of communication results in the prevalence of soft skills over hard skills: hard skills are developed while sharing knowledge and learning together.

Thus, the ideas we found relevant for us in the organisational literature are the importance of communication and the distribution of knowledge within the collectives that have become an integral part of the high-tech innovation industry. However, here we are missing the employees' identities that they obtain while working in tech companies. Using an ANT and especially Latour's concept of the body, we offer language that describes the acquisition of a body.

Importantly, instead of emphasising connections or dialectics between technological content and social context, or simply between technology and society (Jasanoff 2004), researchers in the Science and Technology Studies (STS), Actor-Network Theory (ANT) and particularly Bruno Latour (Latour 1990, 1996) came to similar insights on innovations though from another more radical perspective. Latour reconceptualises "the inside" and "the outside" of the innovation project as a script or program of action and its anti-program. In between these two adversarial programs of action is the frontline of controversy that accompanies the development of an innovation. One key theoretical consequence here is that on both sides of the frontline we can find elements generally considered technical, social, scientific, legal, semiotic, material, economic, political, etc. Another one is that the frontline between a program and an anti-program of action is shifting. Yesterday's enemy of an innovation project might be its today's ally and vice versa. So Latourian theory of sociotechnical innovations focuses on following or tracing the dynamic shape of the frontline of the controversy around innovation. It is the interaction between programs and anti-programs and not between technology and society that helps us to understand the dynamics of innovations. And only once the frontline is stabilised and the innovation project is black-boxed it makes sense to talk of the late outcomes of this stabilisation, i.e., of society and technology. ANT is interested not in the success or failure of innovation projects but in their description and understanding of their dynamics. However, it helps to switch between different standpoints within this process. For our purposes, it is important to note that from the standpoint of the innovator success depends on the capacity of proponents of the innovation to learn positively from the environment, which also includes the actors who are hostile or indifferent to the project.

Contrary to what has usually been assumed, ANT is not content with a description of innovations. In the late 1990s, a large EU-funded PROTEE project guided by Latour provided policy suggestions for evaluations of radical innovations drawing on the results obtained previously in ANT and STS (Latour 2000). One of the main conclusions of the report is that «innovations fail to explore their environment, and thus gain a positive learning curve for four basic reasons» (*Ivi*: 12). Two of them are particularly relevant to our discussion. First, «the project has been conceived in "ballistic" terms, that is as something that goes from an original idea to reality without learning in the process what should be done» (*ibid.*). And second, «the project has been unable to generate a coherent picture of its opposition and has considered opponents as obstacles instead of taking them strategically as occasions to entirely renegotiate what the project is about» (*ibid.*). To remedy these pathologies of radical innovations PROTEE report suggested a set of procedures and indicators to organise interactions between innovators and decision-makers or evaluators so as to diagnose the quality of the learning curve in the project.

Interestingly, nowadays some innovators proceed as if they have drawn a lesson from the PROTEE report. AV projects tend to break up with the "ballistic" understanding of the project and explore their environment. These changes in innovation practices are called a new «experimental mode of industrial innovation» (Laurent and Tironi 2015; Marres 2020). Innovators «use sociotechnical instruments in order to explore social and technical uncertainties and produce public demonstrations» and do not «pretend that they could craft a workable technical solution within the boundaries of the company» (Laurent and Tironi 2015: 209).

The point of this discussion is to show the connection between Latour's theory of sociotechnical innovations and his conception of the body. The latter is an extension of the former and not just an isolated foray into the field of study where he is not an expert. The keywords describing this connection are «shifting frontlines or boundaries» and «learning process».

Talking about the body Latour starts from the discourse on cyborgs (Haraway 1991, 1997; Gray 1995; Pickering 1995) and sorts it out. He discerns two meanings of the word "cyborg". The first one is «technophiliac, science fiction, masculinist cyborg» defining the «prosthetic character of our post-human, post-modern... existence» (Latour 2002: 127-128). The second one is a «feminist, polemical, political meaning» that points to «uncertainty about body limits, body fates, body components» and defines the «front line, or, more exactly, highly contrasted pattern of many front lines» (*Ivi*: 128). It is upon this second feminist meaning suggested particularly by Donna Haraway that Latour builds his discussion of the politics of the body and incarnation. Just as Latour dispenses with the dichotomy society / technology in his theory of innovation, he disincarcerates (Latour 2012) the talk about the body from a series of deadlock oppositions, i.e., Mind/

Body, Culture/Nature, subjective phenomenological body/objective physiological body. To regain this freedom of speech Latour puts the body into new opposition. The antonym of the word "body" is not "mind" or "soul", but "death". This semiotic translation highlights a stark difference between the two aforementioned meanings of cyborg. While technophiliac cyborgs feed the dreams of a life freed from the imperfect cage of the body (e.g., Hans Moravec), feminist cyborgs point to the situatedness and embodied character of technosciences. «If the opposite of being a body is dead, there is no life to expect apart from the body, especially not an after-life, nor a life of a mind: either you have, you are a body, or you are dead...» (Latour 2004: 205). From this "patho-logical" definition Latour comes to a more positive one based on Vinciane Despret's study of William James' theory of emotions (Despret 2004). «[T]o have a body *is to learn to be affected*, meaning "effectuated", moved, put into motion by other entities, humans or non-humans. If you are not engaged in this learning you become insensitive, dumb, you drop dead» (Latour 2004: 205, *emphasis in the original*).

What are the implications of this understanding of the body for the studies of technologies, particularly AV technologies? For sure, the implications are numerous. Below we discuss the ones we consider the most interesting for our study.

To be or to have: towards a variable ontology of the body

Latour is talking about having and not being a body. What difference does this make? Ontology based on the verb "to be" provides a poor vocabulary for talking about the body, particularly the bodies articulated and configured by technosciences. A body either exists or does not. In this ontology entities alternate between total and unquestionable existence and no less total nothingness. On the contrary, ontology based on the verb "to have" allows the description of qualitatively and quantitatively variable existences (Latour 1996a: 173-175). It allows accounting for partial and unstable existences. Within this ontology, it is possible to have more or less body or to have multiple qualitatively different versions of a body coexisting together (Mol 2002). The variable ontology of the body is constituted by the learning process: transformations of its boundaries, components and competencies through engagement with a multiplicity of heterogeneous entities. Hence it makes sense to speak of the gradual acquiring or loss of a body. That is why the ontology based on the verb "to have" is more adapted to the description of «entanglements among bodies, scientific knowledge and technologies» that the editors of this volume invited us to explore.

But variable ontology of the body also makes our method of approaching technologies vary. Does some sociotechnical entity, for instance, AV, posited by an innovation project have a body? Is this body alive and real? Given what we already said about Latour's theory of innovations, we will not be able to answer these questions if we do not trace how this AV project learns to be affected by its environment and look only at one snapshot of its trajectory. «The body is… what leaves a dynamic trajectory by which we learn to register and become sensitive to what the world is made of» (Latour 2004: 206). In fact, the question we just posed is at the heart of every AV project. All of them are struggling to train their vehicles to acquire bodies suitable for the so-called "autonomous driving" (Stayton and Stilgoe 2020; Stayton et al. 2017). Developers teach their vehicles to be affected by the complex environments in which they drive and not to be just immutable objects transversing uniform and abstracted space. To do this innovators should become more sensitive and take into account more and more differences in the world. That is how they acquire their own professional bodies within the same learning process in which their vehicles get their ones. Below we will focus on this particular aspect.

Alternation of activity and passivity

It is crucial to note that Latour's definition of the body combines verbs both in the active (*to learn*) and passive (*to be affected*) voices. The body's perception of the environment and sensitivity to it might be deemed as the passive states are its active achievements. Having a body is not just undergoing causal effects that come from the external world but learning to be affected by these effects, that is, learning to take into account new entities and differences. It makes sense to link this aspect of Latour's conception of the body with his theory of action. «To do is to make happen. When one acts, others proceed to action. […] One can only share in the action, distribute it with other actants» (Latour 1996: 237). When can we say that an AV developer acts? It is when a vehicle she or he trains to be affected by, for instance, certain terrains (e.g., Hind 2019), proceeds to act without her or his immediate presence or intervention (see also Latour 1992: 248-249). The action of an AV developer is shared with its vehicles and thus is distributed between various places and times. This link between two usually unrelated parts of Latour's work, on the one hand, helps to bring back bodily dimension into the general theory of action. On the other hand, it highlights that active bodies are shared between entities, including human actors, dislocated and distributed across various times and places. That is why the body is «*an interface that becomes more and more describable as it learns to be affected by more and more elements*» (Latour 2004: 206, *emphasis in the original*).

Body and its material setups

The definition of the body as an interface and a dynamic learning trajectory makes it possible «to give back to the body all the material impedimenta that make it sensitive to differences» (*ibid.*). Traditional approaches tend to demarcate body and material set-ups that make it sensitive to the differences in the world. Latour's approach to the body makes these set-ups coextensive with the body itself (*Ivi*: 207). Talking about the body as a trajectory of learning to be affected we necessarily come to the description of the heterogeneous and distributed equipment and apparatuses folded into the practices of technosciences, disciplines and industries. Thus, purely organic or biological skin-bound bodies of flesh and bone give way to the assemblages that cut across the boundaries between the organic, technological, semiotic, and social. Just as the dichotomy society /

technology hinders an understanding of the learning trajectory of innovation projects, so the oppositions between nature and culture, the organic and technological, the physiological and phenomenological are useless for the description of these changeable and hybrid bodies. So, on the one hand, we come to the understanding that the interface of learning to be affected is always imbued with practices and devices of technosciences and not only in the case of intervention (e.g., prosthesis, surgery, or therapy). And, on the other hand, we become sensitive to the multiplicity of partially connected bodies (Mol 2002) that are coextensive with the material set-ups and that might be attached to one and the same person.

Symmetrical description of affects and effects

The last crucial aspect of Latour's approach to the body we would like to discuss is that affects and effects align in one definition. Let's look at it again: «[T]o have a body is to learn to be *affected*, meaning *"effectuated"*, moved, put into motion by other entities» (reference?, *emphasis is ours* – MK, AK). It helps us to describe symmetrically, that is, with one analytical repertoire, the instances of learning to be sensitive to both emotional and physical influences. We acquire bodies when we learn the differences in the world that make us do, speak, feel, or experience something. Affects and effects not only can be described symmetrically, but they are also a part of the same process of having a body. As Latour clarifies «effect and affect come from *facere* and are cases of what I have called factishes, that is something that includes an active act of construction in "facts" as well as in "fetishes"» (Latour 2004: 207, emphasis in the original). Latour's conception of factishes (Latour 1999) revolves around the concept of attachment that is also applicable to emotional, social and physical ties. All this helps to bring emotional and bodily dimensions to the analysis of learning processes of socitechnical innovations.

We hope that by now it is clear that Latour's approach to the body opens up many interesting lines of research on the dynamic interfaces between body, action, knowledge and technologies. For instance, we might bring the implications of this approach back to the theory of sociotechnical innovation. Here we could talk about technological projects and their entities, particularly AVs, as living bodies and modes of life in a manner that is less metaphorical and more meaningful than before. Or we might delve into the complexities of general sociological theory and explore what implications Latour's politics of body and incarnation have for the relations between physical movement, moral action and social interactions. Another opportunity is to learn from critical supplements that were made to Latour's theory by studies of the «politics of being unaffected» (Bissell 2022) and to explore (in)securities of embodied action of people working in the digital environments, particularly those outsource workers who markup huge datasets so crucial for the development of AV technologies. But below, we will take another path. We will look at the learning processes that took place in the company that specialised in autonomous driving. We will see how the mentioned aspects of a variable ontology of the body could be traced in the everyday life of the startup. We will try to trace the shifting trajectory of the workers' transformation from yesterday's university graduates to AV specialists by following the learning trajectories of developers and will answer the question of how employees acquire their (professional) bodies.

Trali: a startup for AV technologies

From December 2020 to April 2021 one of us was doing an ethnography of AV technologies in a company called Trali[1]. It was a Russian-based startup which developed a self-driving truck and ADAS (advanced driving-assistance system) software. The history of Trali began in the summer of 2018 and ended in the spring of 2021. Partly due to the turmoil of the COVID-19 pandemic, the startup team did not manage to find an investment to continue their work. However, Trali was able to present several projects and products and became quite famous within the Russian AV community during almost three years of its existence.

Team description

At the time of our research, the company consisted of ten people: six of them were IT developers (in a wide sense), one was a hardware engineer and three of them were managers (CEO included). Our main focus was directed at the developers of the AV and their experience in the startup.

The company's staff who was in charge of technology can be divided into categories: two neural network engineers (Timofey, Pavel), three software developers (Evgeni, Maksim, Ivan), one simulation engineer (Lev), and one hardware engineer (Kirill). However, the differentiation was not strict. According to Timofey, a neural network engineer, duties were actually flexible: «We were divided into two teams – those who deal with algorithms and those who deal with neural networks. But our paths were still crossing each other» (an interview with Timofey). Evgeni, a software developer in Trali, described his job interview in the following way: «No one had any experience, no one knew what they wanted. We were just chatting to show the CEO that I'm a smart dude and that's it» (an interview with Evgeni). When we tried to ask him how his duties were changing, he answered: «I did everything. I did a lot of things really» (*ibid.*). Here we should note that most of the interviewees described their working experience in the same way: «In a startup everyone does everything» (an interview with Timofey). We can assume that this is the specifics of working in a startup.

We will go a bit deeper into this topic, but now we want to present some facts about the company's employees, which allow them to switch roles easily. All of them came from

[1] To do our study we had to sign an NDA, so the company name and the names of the employees are fictitious.

similar backgrounds. They received bachelor's degrees in Natural Sciences and Applied Sciences (degrees vary from Astrophysics to Applied Mathematics). They mostly studied in Russia (except for one who did his studies in Western Europe). The average age of the Trali employees (except the CEO and other managers) was 24. For most of them, it was their first job. For all team members, it was their longest work experience by the time we conducted this study: everyone had their positions for more than a year.

Startup projects

We will also note that the end product that the company was going to produce had changed several times during the lifetime of the company. Along with the transformation of the product, the staff duties were changing too. Besides the two main projects mentioned above (a self-driving track and ADAS software) Trali also participated in many other collaborations.

Constantly changing end-products and tasks resulted in different kinds of expertise employees have to acquire quickly. The challenges they faced varied from "ordinary" coding-related tasks to preparations for meetings and presentations with partners and potential investors. Once two of the company's software developers even had to travel overseas to the Caribbean region to sign a contract with an investor. Maksim, one of the participants of this journey, explains: «Some rich dude found us and invited us. CEO was too lazy to go and he sent us. I still don't understand why. That's the story. We just talked with him and then left» (an interview with Maksim, a software developer). Limited by the time of research, we did not manage to observe all the twists and turns within the three years of the company's story. However, with the help of our interviews, we tried to reconstruct how the company changed its products and how the duties were changed.

Methods and materials

Now, having the startup described, we can address the questions we will focus on in this chapter. Concentrating on the definitions of learning and obtaining the body, we will have a closer look at employees' personal stories in order to find out how the startup members became developers, especially emphasising the role of their working processes. To do so we have to ask the following questions. What were their duties? What was their working routine? How did they solve problems? What kind of tools did they use? How did they collaborate with each other?

To answer these questions, we choose ethnography and interviews as the primary methods to rely on in our research. Ethnography started in December 2020 and finished in April 2021. During our stay in the company, we kept a diary that included photo, video and audio fixation. Also, we conducted in-depth semi-structured interviews with seven startup participants excluding managers. This selection is explained by the fact that we concentrated on IT engineers (in the widest sense) and their work. The length of the interviews varied from 30 to 90 minutes. The interviews were guided by questions about their educational and professional trajectories. The main focus was their experience in Trali, e.g., history of getting into a startup, what they did at the beginning of their employment and how their responsibilities had changed. We let participants talk freely about important events and relationships within the company. Through their interviews, we also restored the chronology of the startup and found out what engineers did in each project they were engaged in.

The diary and interviews were encoded. In both sources, we indicated three categories: first was dedicated to the general information about startup lifetime, number of staff, projects and partners. Some of the employees shared their reflections upon the startup closure. In this category, we also put sketches from meetings and teamwork (mainly found in the diary). The second was about self-driving: what it consists of and how it works; special attention was paid to neural networks. The third category received the name "personal". It contained the background of employees, their responsibilities and duties, and the resources they used while working. The transcribed video, audio and photo data was also divided into these categories. To fit a huge number of situations, practices, stories and surprises that we came across during our research of the team of developers, we work with excerpts related to the "personal" category, with an additional focus on collective work from the first category. From an analysis, we decided to choose 3 cases illustrating different sides of the process of specialisation. It was hard to make a clear distinction and assign specific traits to each situation, so sometimes traits will be repeated. Thus, it will demonstrate the circulating nature of these traits.

In the first case, we will trace an individual trajectory of specialisation. We will try to follow the personal history of becoming a developer. In the second case, we will analyse one scene that we observed where the task was solved together. In the third case, we will see the steering column manufacturing process. Sometimes we will go beyond the cases under consideration, involving different statements of others and other situations that we have observed in Trali in order to confirm our assumptions and findings.

The role of articles

In Trali Evgeni was in charge of path planning[2]. Namely, he was developing a planner. The purpose of the motion planner is «to analyse everything that is around it [the vehicle] and draw a line along which the vehicle will drive and determine its speed» (field diary, 08.12.2020).

The first day we observed Evgeni working he explained to us how the planner should work and what he had already done. During an interview, Evgeni said that throughout the entire working period the planner was his main project.

Here (see Figure 5.1) are the curves which stand for different trajectories of the car. Ideally, the car should reach each point. Both in simulation and in real life, cars should

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2 Path planning, alongside with car localisation and object detection and recognition, represent the main tasks developers are called to solve in order to create an AV.

drive along different trajectories. AVs have to know not only how to drive in a straight direction or turn at an intersection but also to avoid obstacles, which can suddenly occur everywhere on the road. The planner is a crucial and integral part of the whole AV enterprise.

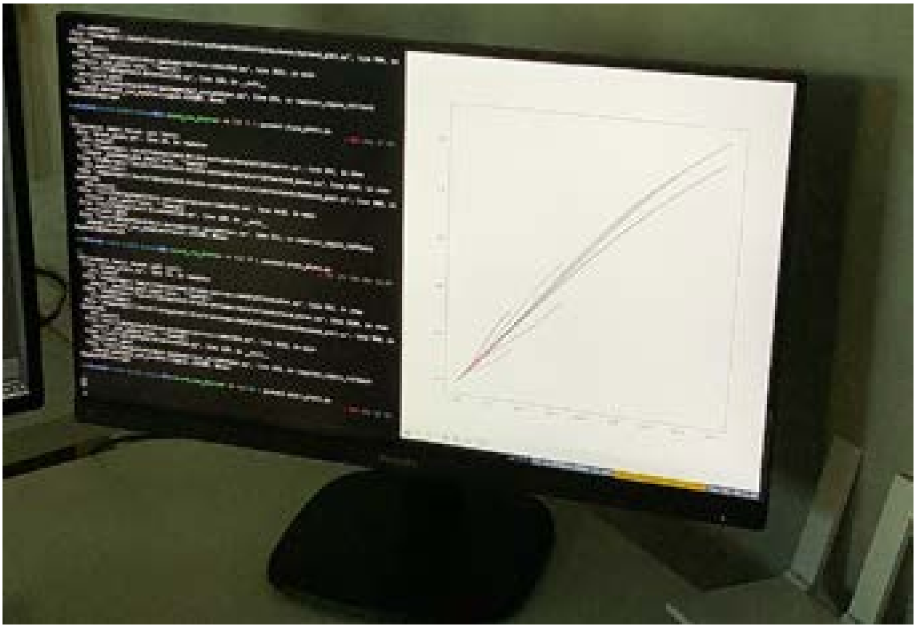

Fig. 5.1 – An Evgeni's planner. The curves stand for different trajectories of the car (Field diary, 08.12.2020).

First time we met Evgeni he sat in front of three monitors. One screen had a Wikipedia page open, which stated Newton's method (minimisation and maximisation problem). The second had a code. On the third monitor, an article about planning methods for autonomous on-road driving[3] was opened. Evgeni himself was writing on a sheet of paper and counting formulas that had no numerical values, only letters. He explained:

> There's a lot of math involved here. I read articles and look at methods that can be used to solve my problem. I steal different formulas from them, but I still have to count almost everything myself. I mostly read article reviews and then go deeper for some more specific materials. (Field diary, 08.12.2020)

In addition to technical and material mediators we could distinguish an emphasis Evgeni placed on scientific articles. Articles could be named as a vital part of obtaining a profes-

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3 Katrakazas, C., Quddus, M., Chen, W.-H., Deka, L. (2015). Real-time motion planning methods for autonomous on-road driving: State-of-the-art and future research directions. *Transportation Research Part C: Emerging Technologies*, *60*, 416-442.

sionalised body. We would also note additionally that "to steal" was a significant recurrent verb in developers' narratives. Later, we will come back to this word.

However, Evgeni was not the only person who worked with scientific articles. All the team members worked with such literature, most commonly taken from archive.org. Other digital tools were also involved (except Wikipedia mentioned above): YouTube educational videos[4] as a source of information (Timofey, Pavel, Ivan, Kirill) and even Telegram channels about Machine Learning (Timofey).

Evgeni mostly worked with algorithms, so for him the connection with mathematics was extremely important. In the interview he described his previous experience which in his opinion led him to IT development: «I studied programming from a very young age, starting when I was 8. Then I studied at the math school, then at Mathematics and Mechanics study program at the university». Speaking about learning, he also made a distinction between learning and task-solving. He attributed learning to self-learning processes and named all working relation processes "task-solving". The obtaining of the body, following Evgeni's logic, occurs as a gradual task-solving. It has a cumulative nature. However, Evgeni said:

> You look at how these tasks were solved before you, and the only source of solving such problems is some university work done by different people. You look at what approaches they used, their pros and cons, try to combine them, try to see what ideas they implement, and then you just do something. (An interview with Evgeni)

Although Evgeni insisted on the differentiation between *learning* and *task solving* it brings us back to the role of the articles which were mentioned earlier. For him, articles were the main tool in task-solving.

For Evgeni Trali was his first workplace, where he spent 2 years. Evgeni left Trali several months before the company was closed. Now he is working in a big electric vehicle manufacturing company. He says: «I was just snapped up. I passed all the interviews here in a week. This is nonsense. Usually, it takes a month. I was pushed at the speed of light. They really didn't want me to run away somewhere else. It all happened thanks to hanging out at Trali». Here the dichotomy of having/being come to the scene. The process of getting into programming was gradual. He did not say that he was already born with outstanding planner-developing skills. On the contrary, he came a long way, which started in childhood. Together all steps (programming courses, university, Trali) made him sensitive to the planner he worked on. Only after, when this sensitivity was obtained, it led him to new career opportunities. Also, in Evgeni's specialisation process articles took a significant part as well as the mobilisation of different tools. He also defines his duties as task-solving, which is a cumulative process.

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[4] For example, Timofey and Pavel watched a math YouTube channel 3Blue1Brown.

Elaboration on Evgeni's planner: learning and stealing

Many of the company's members worked together in teams. However, it was related not only to the division of responsibilities and the integration of different parts of their work into one system. Collaborative work and the process when everyone learnt to be affected and affect one another accompanied their duties and were also recurrent practices within the company.

This hypothesis was proved again during an interview series. For example, Maksim, a software developer, explained why and how they worked together:

> Everyone knew what other's work tasks were and how they were coping with them. Everyone spoke the same language. At this point, there were no disagreements. Someone could have read something somewhere and shared it with the others. Someone could have said the opposite, like, «what an ******* you are and what are you doing». [...] Although the tasks vary everywhere, math is always the same. So when there were discussions, anyone could be a part of it and everyone knew who was speaking and what. (An interview with Maksim, a software developer)

According to Maksim's words, the tasks could differ, but math, as their fundamental basis, helped them to manage tasks and cope with difficulties. It was also crucial that everyone worked with additional sources (for example, with the articles mentioned above) and was aware of everyone's duties. To share the same language means to share the same background and work closely.

Now we dive deeper into their actual work to understand what collaborative learning means and also to share other findings. When Evgeni left Trali the team faced certain difficulties. Ivan became responsible for the planner Evgeni previously was in charge of. Ivan was the youngest person in the team. He was in the last year of his bachelor's. He joined the team one year ago (in the spring of 2020). Previously he had no working experience, and actually made his first steps in coding while working in Trali. Meanwhile, the company was invited to participate in an AVs racing competition. To make this happen, the team should have improved their planner.

For Ivan alone it was hard to figure out how Evgeni's planner was working, so Lev, a simulation engineer, and Timofey, a neural network engineer, also joined the work on the planner. They made this decision at the team meeting on March 19th, 2021. However, understanding what was happening in the Evgeni planner and making it work well was also a comprehensive task for them. Lev told me on the same day:

> Evgeni's planner is a good one, but I don't understand what's going on in it. Just to keep you informed, this is the best planner that we had so far. (Field diary, 19.03.2021)

Moreover, they had to solve the task of an integration of planner and MPC. MPC, which stands for model predictive control, is responsible for turning the steering wheel and wheels both in an online simulator and on real roads. Further, we will present excerpts from the field diary dedicated to collaborative work on this planner that took place on the following days.

> Kirill [an engineer] is sitting with Timofey (for the first time I see this). They read articles, and there are papers with equations on the tables. Timofey says: "I don't understand the scientific idea of the article". Timofey says that he reads an article for the needs of the competition. (Field diary, 23.03.2021)

Now let's move on to the working session which was described in the diary on April 1st. Timofey, Ivan and Lev started to work approximately at 16:00, when Timofey and Ivan came to the office.

> Lev sat down next to Timofey, they were discussing MPC. Lev says: "If it's all got to be written from scratch, we won't write it. It will take longer than stealing it".
> Lev codes, Timofey observes. Ivan came to them, and asked several times what they were doing, but did not receive an answer.
> Lev continues to write a code, and Timofey carefully looks at his screen.
> Ivan asks again what they are doing. Lev says: "Increase the delay".
> Ivan says that there are very complex formulas, but MPC does not want to do so. Timofey said he wants to do MPC on torch [PyTorch] and rewrite it for C++.
> Timofey: "For MPC, you need to count the derivative".
> Now Timofey is writing code, Lev says: "Nothing will work here".
> Lev takes the keyboard from him and says: "Oh, that's how it will work". He says: "Wow, I'm shocked, everything works. You [Timofey] are just a God of C++".
> Lev says: "Look at how it compiles, and if it goes, then it's okay".
> Ivan looks at the computer and asks clarifying questions all the time: "What does it mean? What does it stand for?" They look on GitHub at what each new variable means.
> Lev and Timofey continue to code, and they say to me: "We have a very sweaty coding session here". They show each other something all the time, Timofey writes on a piece of paper, Ivan keeps asking questions, and usually, Lev answers his questions. 17:38 Timofey says: "I'm going to bed". Lev says: "I won't write without you".
> Ivan: "I will write, where is this article [the article they examine and exploit]?"
> I leave at 18:40, Ivan, Timofey and Lev are still sitting in front of the screens». (Field diary, 01.04.2021).

What can we learn from these examples? Countless times we observed them working in groups of two and three people. They were writing code together, using the keyboard one after another, or just looking at the co-worker's screen and making comments on one's work (sometimes jokingly or even sarcastically). However, the presented task could not be solved solely in a short time. Watching them working, we noted that collaborative working and learning could be necessary to solve tasks. It also enables learning (in its most ordinary sense) processes, as in the presented scene Ivan was trying to understand what was going on and make a contribution. Here we can observe him learning through watching others coding and asking questions. What does it mean for this team – to work collaboratively? From the materials presented above we can identify several practices, setups or commonplaces for all participants involved: to share materials, to share the same background, to share one space physically (and sometimes to use one shared material setup – a keyboard), to alternate passivity and activity (to observe someone working and to ask questions) and to find joint decisions. Everyone and everything benefits from this process. Developers try to find solutions, and the software undergoes changes.

There are also other examples of alternation of passivity and activity. For instance, Timofey described his routine tasks in the interview in the following way: «You sit, do research, read articles, stare at the wall» (an interview with Timofey, a neural network engineer). Even in his facetious narration, he describes the alternation of passivity and activity, which allows him to solve tasks and elaborate on new ideas.

However, this example covers not only collaborative learning in the company. They were constantly using the verb "to steal". However, it is unlikely to have a connection with the theft. Actually, it was a work with different resources. «It will take longer than stealing it» says Lev in the field diary excerpt above. It obviously does not mean that he is going to thieve the technologies somewhere, but to use the schema of MPC and planner integration which was already used in the article. They just used all available resources (and setups): articles, forums, YouTube videos, open-source materials and other different sources.

Solving engineering tasks

Yet another case describes how the body develops alongside the materiality of a technical setup. The case is based on a completely different story which was outside the timeframe of our study. This situation took place in the autumn of 2019 and we learned about this story through one of our interviews.

Now we will look at the work of the only hardware engineer in the team. Kirill, an engineer, is in charge of the task proposed by the investor. His responsibility is high: if he pulls the task off, he will start attracting financing for the project. His task was to make a steering column that would be able to connect to a computer for a well-known Russian van manufacturer. He was given a month to do it, then two additional months were supposed to be given to create software for the van, but it was not his responsibility.

However, Kirill immediately encountered difficulties arising from the side of the investor and the van manufacturer. The investor promised to provide the scheme of the steering column, but the manufacturer refused. Kirill was outraged: «And what should I do? They [investors] told me: "You're an engineer here, so you must know how to do it!"» (interview with Kirill, a hardware engineer). As was mentioned above, the given time was strictly limited and the engineer decided to mobilise the available resources and his competencies: «I decided to take the steering column from the existing van. I did reverse engineering of the steering column, redesigned it and added elements of the servo system» (*ibid.*). He removed the steering column from a van in a city in the northwest of Russia (hundreds of kilometres from the startup headquarters!), where the production factory was located and transferred it to the Trali office. He did all measurements independently and digitised them at home. He sent the documentation, a 3D model of the steering columns and all details to the factory that produces the column. Then he sent the original column back to the manufacturer.

When faced with such a task for the first time, Kirill had no idea how much time it could take: «I was so afraid of not being on time that I did the main part of digitising and initial estimation over the weekend» (*ibid.*).

The previous time he had already made schemas for the shuttle, so he already had some expertise. The material setups that he worked with and was learning from to become sensitive mobilised all his resources to complete the task.

In addition, he had a specialised engineering education:

> I wanted to be an engineer of all and everything. My speciality is electrical power engineering and electrical engineering, but my specialisation is the technique of high voltage electrical insulating cable capacitor technology. (*ibid.*)

Now his expertise was challenged again. However, several sources helped him to handle it. Below we provide an excerpt from an interview in which Kirill describes how he acquired the skills to cope with various engineering tasks.

> - I have read a lot of articles about electric vehicles and propulsion systems.
> - Scientific articles?
> - Sure. Textbooks on automotive engineering, on the calculation of suspensions of kinematic circuits, on which centers of mass are, calculations, all of this. I found a lot of articles on propulsion systems and batteries. I had a lot of materials. And there were also my own assumptions and hypotheses, but they were all supported by calculations and theory. When I look at some technical cases, I immediately imagine what's happening here and why. And the logical chain, and spatial thinking. It's the same for everyone else [at the startup], but with the code. Code is a path from an idea to implementation. In my case, this [an implementation] is cutting systems. I came up with an idea, and my hands went to design it in 3D programs.
> - And where did you learn how to use these programs?
> - I studied and got into it all by myself. (*ibid.*)

Although the area of Kirill's work differs from others, we can find commonplaces here – articles and different external sources. Here he also made an emphasis on his personal interests (to become an engineer) as well as described his way of thinking and building logical chains, enabling sort of technical/engineering imaginaries. He also was in charge of the contacts with the 3rd parties: he found manufacturers who produced all the details (and also the self-driving truck earlier).

Fig. 5.2 – The steering column that was made according to Kirill's schemas. this photo was provided by Kirill

Through this task, his engineering competence was challenged: «It was a great moment when I put this steering column in, and it stood up perfectly, like a factory one. And they started the car, and everything worked» (*ibid.*). Despite the initial fear, Kirill managed to do the steering column. Further, with the help of software, the steering column was able to turn the van in the right direction and avoid obstacles, in other words, it made the van sensitive to the environment. The story of working with the steering column and learning from it is the story of making Kirill sensitive to it, accumulating all his previous knowledge and trying to make something he was not sure he would manage. Alongside the acquisition of new competencies, such as the selection of details (servomotors, and power supplies) and making calculations in a short time, he proved that he could solve complex engineering tasks.

Conclusions

The definition of the body as an interface and a dynamic learning trajectory was applied within the framework of studying the innovation. With the help of ANT and organisational studies, we explored the startup Trali's workflow. Thus, the concept of learning lies at the core of innovational activity, and the bodily dimension adds different implications to the innovational studies. Here we explored the changing boundaries of the body and the transformation that engineers have undergone: from university graduates with no work experience to AV engineers.

However, can we say that professionalisation happens even though the startup is not successful in the end? Yes. Despite the fact that Trali could not maintain its existence, for all participants of the startup, it became a springboard into a future career. All ex-Trali participants continue to work in IT in different prominent companies. Some of them continue their path in the field of autonomous mobility.

Four aspects in the Latourian concept of the body we found relevant for studying technologies, particularly AV technologies. When these aspects were taken into account, they revealed practices and setups that came to the scene during the process of professionalisation. First, the body can be obtained. It is not predestined and not given from birth, so professionalisation can be viewed as a process of obtaining a body, that is a body of AVs specialist. All Trali employees started with almost zero working experience and surely did not know how to develop a self-driving truck or ADAS software that will potentially allow each car to be transformed into an autonomous one. Second, alternation of passivity and activity is crucial in this process of obtaining the body. This alternation was shared with others. For all of them, collaborative working and learning and exchanging different things were also crucial in their ways to acquire professional bodies. Third, this approach takes into account the body and its material setup. So what we can say for sure is that cyborgs (actors that acquired yet another body) are born *in relation to*, in this case *in relation to* autonomous vehicles' software and hardware. Here professionalisation is possible only when we look at it in its connection with autonomous vehicles. Through all cases we have learned that the role of literature and other sources was extremely important. Numerous times all employees used scientific articles, some of them used YouTube videos, Telegram channels, forums, etc. For them, it was a source of inspiration as well as a help to cope with challenges. We also observed that they highlighted math as their common background that allowed them to «speak the same language» and work with each other. They combined both material and digital sources. They wrote code, read literature, solved equations on paper and took away each other's keyboards. Thus, different material and non-material setups accompanied employees' specialisation. Fourth, a symmetrical description of affects and effects makes us turn to emotional reactions (e.g., in the last case of Kirill, a hardware engineer). We acquire bodies only when we learn the differences in the world. They make us act, feel and experience.

This approach allows us to trace dynamics, which is necessary to take place in all innovation enterprises. Thus, this notion of the body and a dynamic learning trajectory allows us to study not only human actors, but also non-humans, such as emerging innovations and how their bodies can be acquired from an idea to its incarnation, including all kinds of changes and difficulties.

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Materials

The field diary was compiled by Mariia Kiseleva and Andrei Kuznetsov. It contains materials from the observation and interviews with Trali's employers. All materials were anonymised. This text contains anonymised fragments of interviews with Timofey, Pavel, Evgeni, Maksim, Ivan, Lev, and Kirill. December 2020 – April 2021.

Bissell, D.

2022 'The Anaesthetic Politics of Being Unaffected: Embodying Insecure Digital Platform Labour', *Antipode, 54*(1), 86-105.

Darrah, C. H.

1996 *Learning and Work: Exploration in Industrial Ethnography*, London, Routledge.

De Vries, G., Horstman, K.

2007 *Genetics from Laboratory to Society: Societal Learning as an Alternative to Regulation*, London, Palgrave Macmillan.

Despret, V.

2004 'The Body We Care For: Figures of Anthropo-zoo-genesis', *Body & Society, 10*(2-3), 111-134.

Edwards-Schachter, M.

2018 'The Nature and Variety of Innovation', *International Journal of Innovation Studies, 2*(2), 65-79.

Gomart, E., Hennion, A.

1999 'Sociology of Attachment: Music Amateurs, Drug Users', *The Sociological Review, 47*(1), 220-247.

Grimm, C.

2012 *Inside a Secret Software Laboratory: An Ethnographic Study of a Global Software Package Producer,* Wiesbaden, Springer Gaber.

Gray, C.

1995 *The Cyborg Handbook*., London, Routledge.

Haraway, D.

1991 *Simians, Cyborgs, and Women: The Reinvention of Nature*, London, Free Association Books.

Haraway, D. J.

1997 *Modest_Witness@Second_Millennium. FemaleMan©_Meets_OncoMouse™: Feminism and Technoscience*, New York, Routledge.

Jasanoff, S. (ed.)

2004 *States of Knowledge: The Co-Production of Science and the Social Order*, London, Routledge.

Johnson, B., Andersen, A.

2012 *Learning, Innovation and Inclusive Development: New Perspectives on Economic Development Strategy and Development Aid*, Aalborg, Aalborg University Press.

Latour, B.

1996a *Aramis, or, The Love of Technology*, Cambridge (MA), Harvard University Press.

Latour, B.

1996b 'On Interobjectivity', *Mind, Culture, and Activity, 3*(4), 228-245.

Latour, B.

2002a *Body, Cyborgs, and the Politics of Incarnation*, in S. T. Sweeney & I. Hodder (eds.), *The Body* (pp. 127-141), Cambridge (MA), Cambridge University Press.

Latour, B.

2002b *Gabriel Tarde and the End of the Social*, in P. Joyce (ed.), *The Social in Question* (pp. 117-132), London, Routledge.

Latour, B.

2012 'Désincarcérer les corps?', *Psychiatrie Française, XXXXIII*, 23-37.

Latour, B.

1999 'Factures/fractures: From the concept of network to the concept of attachment', *RES: Anthropology and Aesthetics, 36*, 20-31.

Latour, B.

2004 'How to Talk About the Body? The Normative Dimension of Science Studies', *Body & Society, 10*(2-3), 205-229.

Latour, B.

2000 *PROTEE: PROcédures dans les Transports d'Evaluation et de suivi des innovations considérées comme des Expérimentations collectives*. Report.

Latour, B.

1990 'Technology is Society Made Durable', *The Sociological Review, 38*(1_suppl.), 103-131.

Latour, B.

1992 *Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts*, in W.

E. Bijker, J. Law (eds.), *Shaping Technology/Building Society: Studies in Sociotechnical Change* (pp. 225-258), Cambridge (MA), The MIT Press.

Laurent, B. & Tironi, M.
2015 'A Field Test and Its Displacements: Accounting for an Experimental Mode of Industrial Innovation', *CoDesign, 11*(3-4), 208-221.

Lundvall, B. Å.
2016 *The Learning Economy and the Economics of Hope*, Anthem Press.

Marres, N.
2020 'Co-existence or Displacement: Do Street Trials of Intelligent Vehicles Test Society?', *The British Journal of Sociology, 71*(3), 537-555.

Mol, A.
2002 *The Body Multiple: Ontology in Medical Practice*, Durham, Duke University Press.

Mol, A.
2008 'I Eat an Apple: On Theorizing Subjectivities', *Subjectivity, 4*(1), 12-32.

Moulaert, F., MacCallum, D., Mehmood, A., Hamdouch, A.
2013 *The International Handbook on Social Innovation: Collective Action, Social Learning, and Transdisciplinary Research*, Cheltenham, Edward Elgar Publishing.

Obstfeld, D.
2017 *Getting New Things Done: Networks, Brokerage, and the Assembly of Innovative Action*, Redwood City, Stanford Business Books.

Pickering, A.
1995 'Cyborg History and the World War II Regime', *Perspectives on Science, 3*(1), 1-48.

Rahman, H. A., Barley, S.
2017 'Situated Redesign in Creative Occupations: An Ethnography of Architects', *Academy of Management Discoveries, 3*(4), 404-424.

Stayton, E., Stilgoe, J.
2020 'It's Time to Rethink Levels of Automation for Self-Driving Vehicles [Opinion]'. *IEEE Technology and Society Magazine, 39*(3), 13-19.

Stayton, E., Cefkin, M., Zhang, J.
2017 'Autonomous Individuals in Autonomous Vehicles: The Multiple Autonomies of Self-Driving Cars', *Ethnographic Praxis in Industry Conference Proceedings*, *1*, 92-110.

Stilgoe, J. & Cohen, T.
2021 'Rejecting Acceptance: Learning from Public Dialogue on Self-Driving Vehicles', *Science and Public Policy, 48*(6), 849-859.

Stilgoe, J.
2017 'Machine Learning, Social Learning and the Governance of Self-Driving Cars', *Social Studies of Science, 48*(1), 25-56.

Whitson, J.
2018 'What Can We Learn From Studio Studies Ethnographies? A "Messy" Account of Game Development Materiality, Learning, and Expertise', *Games and Culture, 15*(3), 266-288.

6. Sizing Bodies and Making "Others": Standardising and Appropriating Apparel

CHRIS HESSELBEIN, PAOLO VOLONTÉ

Introduction

Technoscientific studies of the body often focus on emerging technologies and how these reconfigure social roles as well as our bodies in terms of their perceptions, abilities, and experiences. Prosthetic and medical devices as well as reproductive, computational, and biotechnologies as much problematise the boundary between the natural and the hybrid body as they reinscribe existing social structures (Haraway 1991; Martin 1987; Treichler et al. 1998). Studies of technology from the perspective of gender and race, in particular, have noted how gendered and racial divisions of labour and social inequality play out on the level of everyday life through domestic objects, urban infrastructures, and computational technologies (Benjamin 2019; Cowan 1983; Wajcman 1991, 2004). One category of technology that has not yet received much attention in technoscientific studies of the body, however, is that of clothing, which is surprising considering the inseparability of body and clothes in the clothes-body complex (Klepp 2011) as well as the crucial role clothes play in naturalising the body and social identity.

In contemporary societies, the relationship between clothing and the body as well as the experience of wearing clothing are strongly informed by standardised manufacturing processes and the categories of inclusion and exclusion that underpin these processes of production. Anyone who has ever gone in search of a pair of jeans, for example, knows that finding one's "size" does not necessarily result in finding one's "fit". In mass manufacture, clothes are prototyped by the pattern maker on an "abstract" body (Corrigan 1997: 64) – that is, on a fit model's body and a mannequin – which is theoretically representative of all possible customer bodies. As might be expected, the use of this impersonal body has led to a gradual splitting of clothes from actual bodies because now clothes "encounter" the body only after they have been manufactured. The results of these standardised manufacturing processes, namely the clothes that are eventually presented to and bought by consumers, embody or "materialise" the sociotechnical decisions and considerations that underpin such production processes. However, these are not necessarily the same considerations that consumers might have, and particularly for those who have "non-standard" bodies. In other words, the problem of finding apparel that fits is considerably more difficult for those whose bodies are more divergent than standardised production processes have taken into account.

In this chapter we will focus on the role of technology and mass production in the normalisation of the female body within the fashion system and in the resulting exclusion of bodies or body parts that do not fit on the basis of seemingly "objective" reasons. By means of two case studies of apparel production that lead to the naturalisation of "other" categories of bodies, we show not only how technologies standardise the female body, delimit its variability, and therefore "other" a significant number of women on the basis of "technical constraints", but also how women attempt to negotiate or work around such constraints and exclusions.

Our first case study focuses on the exclusion of fat bodies[1] in the mass production and standardisation of clothes in the fashion industry. The sizing system employed in the production of clothing strives to find a balance between two challenges, namely the variability of consumers' bodies as well as the complexity and costs of producing and distributing clothing for all possible body sizes. However, the abstractions and generalisations that manufacturers rely on are inherently imprecise and ill-suited to many bodies, particularly when attempting to move beyond a certain size threshold. We will show that the development of the sizing technique incorporates the normalisation of thinness as an essential characteristic of female beauty and fashionable bodies, and the resulting exclusion of fat bodies from the domain of fashion.

Our second case study focuses on the standardised sizing and manufacturing systems used in women's footwear production. Similar to the previous case study, footwear producers face a dual challenge in finding an economically optimal solution to a wide variety of bodies and feet. In contrast to the previous case, standardised and mass-manufactured

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1 In many languages, "fat" has a negative connotation, which means that people often resort to a wide range of euphemisms when referring to fat bodies. However, using such euphemisms only confirms and reinforces the fat stigma. Therefore, we will here use "fat" and "fatness" in their neutral, merely descriptive, and stigma-free meaning.

women's footwear results not in the exclusion of entire bodies but instead of body parts, namely small and irregular or otherwise non-standard feet belonging to adults. Finding appropriate women's shoes is therefore an everyday challenge for those women who wish to wear fashionable, professional or "feminine" footwear[2]. We will show that these challenges are negotiated and circumvented through a variety of appropriation techniques and tinkering practices that consumers use to adapt and make their shoes "work" for the idiosyncrasies of their particular feet and bodies. The composition of the two case studies illustrates in a complementary way how standardised forms of production result in a situation in which apparel is rarely, or only poorly, suited to most bodies, and that women are often required either to modify their apparel or their bodies.

The two case studies were conducted separately by the two authors at different times and places. The study of the exclusion of fat bodies in the mass production of fashionable clothes is mainly based on secondary data and analysis of media content (texts and images). The study of the standardised sizing and manufacturing systems used in women's footwear was carried out through in-depth interviews and ethnographic observations in New York City during 2016-2019.

Bodies, clothes, and sociotechnical standards

According to Cavallaro and Warwick, «it is dress that has time and again been assigned the responsibility of transforming the incomplete body into a complete cultural package» (Cavallaro and Warwick 1998: 3). Although we are used to talking about dress and the body as two different and separate entities, the body in social life is a dressed body (Entwistle, [2000]2015: 6), and only exceptionally appears "undressed" or "naked". Dressing is therefore one of the primary ways of making bodies appropriate and acceptable to social situations in such a way that they can "fit in" according to their assigned roles and expectations. Consequently, bodies that are not dressed according to perceived role or identity are seen as transgressive, inappropriate, and out of place. Jennifer Craik observed that clothes «are activated by the wearing of them just as bodies are actualised by the clothes they wear» (Craik 1993: 16). The human body, therefore, and particularly the body as a social entity, is always an assemblage of flesh and matter, nature and technology, human and non-human elements (Haraway 1991). Fashion scholars have highlighted this relationship as a clothes-body complex, fashion-body-hybrid, body-clothes assemblage, or as dressed embodiment (see Klepp 2011; Haller 2015; Ruggerone 2017; Hesselbein 2021a).

One of the primary cultural functions of the clothes-body complex is to structure, differentiate, and maintain forms of social identity, such as gender, class, ethnicity, and sexuality. For example, as Elizabeth Wilson notes, «fashion is obsessed with gender, [it]

2 The inverse is the case for, among others, drag queens and trans* women, who often struggle to find women's shoes that fit their larger-than-standardised-for feet.

defines and redefines the gender boundary» (Wilson, [1985]2003: 117). Clothing is often used both to highlight and to obscure bodily differences between men and women as well as other groups. In doing so, it not only draws attention to such bodily differences, but it also imbues these differences with social meaning. Clothes separate individuals in terms of their appearance but at the same time draw them together into common categories. Even though clothing is often viewed as an individual and voluntary choice or expression of identity, especially in a Euro-American context, it can also be considered a tool of de-differentiation, homogenisation, and disciplining in which there is relatively little room for choice. Michel Foucault made it clear that fashion, as a practice of disciplining bodies, is a fundamental tool of power in today's societies, where power produces its effects not only through censorship and repression, but also through the stimulation of desire. By imposing an ideal of beauty that is far from real bodies and substantially unattainable, fashion subjects especially women to constraints based on self-monitoring and adaptation to a construct of "normality". This is a new mode to cope with power, he writes, «which presents itself no longer in the form of control by repression but that of control by stimulation. "Get undressed – but be slim, good-looking, tanned!"» (Foucault, [1975]1980: 57).

The fraught character of "choice" is all the more apparent when certain groups and bodies are excluded from being granted the ability to choose. This is the case for bodies for which no, or very little, apparel is being produced, as they are too distant from the standards established by the industrial production system and therefore cannot be accommodated by the main tool of such standardisation, that is, the sizing system: fat, tall, short, curved, pregnant bodies, etc.

Clothes are therefore one of the most effective means of drawing and redrawing, and naturalising, the boundaries between biological and social categories of differences, and for example, making bodies appear as "masculine" or "feminine". The important role of clothing in structuring and naturalising gender roles, often to the detriment of women, has caused early feminist analyses to be relatively hostile towards fashion. That is to say, fashion and femininity were considered as instruments of oppression through which women were turned into passive and sexualised objects of the male gaze (Brownmiller 1984). More recent feminist appraisals of fashion have signalled a change in that they have more positively re-evaluated fashion as providing avenues for self-expression, creativity, and pleasure (Evans and Thornton 1989; Wilson, [1985]2003). Indeed, from this perspective, the process of continuously changing one's appearance through clothing can be seen as liberatory insofar as it "denaturalises" the body and highlights its malleability. The high heel – often seen as the epitome of femininity – nicely captures this ambiguity. On the one hand, high heels are derided for being frivolous, impeding, and harmful, on the other, they are praised as a potent symbol of sexual independence, female empowerment, and professional success. The transformational quality of high heels for enacting and subverting "natural" gender roles is further underscored by their popular use among drag queens and trans* women.

Fashion is, of course, not only a highly effective means of gender differentiation, but also a powerful technique for assigning various social roles as well as defining certain categories of "others". An important aspect to the normalisation and naturalisation of certain bodies is the exclusion of "other" body categories, which by nature of their exclusion highlight the normality of those categories and bodies that are "naturally" included. Every naturalisation involves the creation of classes of unnatural occurrences, that is, exemplars of diversity with respect to the standard. And very often this construction of diversity brings with it the exclusion of what is non-conform in the spectrum of opportunities reserved for what is conform. The exclusion of certain categories of "others" has been most notable in fashion runway shows where, now still, people of colour, people with disabilities, and fat people are only occasionally allowed to participate as exceptions that confirm the rule. However, this is just the tip of the iceberg. The exclusion takes also place at a much earlier stage, namely during design and manufacture as well as through processes of technical standardisation and mass production. In the next section we will demonstrate how this is the case for fat bodies.

Sociotechnical standards are a crucial yet relatively invisible and taken-for-granted means of streamlining procedures, regulating behaviours, and coordinating complex infrastructures, people, and things (Lampland and Star 2009). As such, standards are often nested inside one another, interlocked with other standards that are found across organisations, countries, or technical systems, relative to certain communities of practice, and therefore «distributed unevenly across the sociotechnical landscape» (*Ivi*: 5). Classification systems, moreover, always have "residual" or "other" categories assigned to those things, objects, or people that do not fit (Bowker and Star 1999). A classification cannot comprise of everything; one size never fits all. In other words, standards always codify, embody, prescribe certain values and ethics, often with great consequences for those whose identity, body, or practice does not "fit" well with such standards. Those that remain outside of such systems help us see the boundaries of classifications and standards as well as the ethics and values that these embody or ignore. The exclusion of these residual categories is frequently presented as justified because their inclusion would decrease the efficiency of the sociotechnical system for those already included. Unlimited diversity and inclusion, in short, is never seen as a practical or economical option. Such exclusions eventually become normalised, particularly when they are embedded in bodies, practices, or technologies, and thus reproduced on the level of production and consumption as well as broader cultural discourse (see Bordo 1993; Volonté 2019; Hamraie 2016; Roulstone et al. 2017). In other words, examining standards of apparel production and the clothes they produce, which fit some bodies but certainly not other bodies, highlights whose bodies and identities are presented as natural or normal and whose are not.

Classification system and standards are not, however, simply passively accepted and incorporated by all. Perhaps the most notable examples of this are the success of the women's rights movement against the standard "male" body in medical research, and the relative success of the disability rights movement in changing the standards used in design and construction by architects and urban planners so that people with mobility impairments are no longer (or at least less often) excluded (see Epstein 2009; Hamraie 2016). Similarly, in fashion, runways have become significantly more diverse in terms of the variety of bodies that are allowed to model clothes, and high heels are no longer an official part of women's professional dress codes in many countries.

In the following sections we will discuss the consequences that standardised production processes have within the fashion system, with its fundamental need for classification, and what this involves for those with non-standard bodies and body parts, that is in particular, for those with fat bodies and small feet. How does manufacturing technology give rise to the exclusion of certain consumers such as fat women from the range of clothing opportunities offered by the fashion system? How might consumers interact with the classifications and standards that are built into production techniques as well as embedded in items of apparel such as women's footwear, and how do they adapt shoes that do not fit well so that they work better for their particular feet?

Standardising women's clothing

Historical research has shown that there is a link between the rise of the thin ideal in fashion and the industrialisation of clothing production (Wissinger 2015: 108-140). The transition from custom-made to ready-made clothing necessitated the standardisation of sizes, and this has resulted in a reversal of the relationship between dress and the body. Clothes are no longer adapted to the bodies that wear them, instead bodies are required to adapt to the standardised dimensions of clothes manufactured and retailed by the fashion industry. The technique of standardisation has made it possible to consider clothing as a self-sufficient artifact that is separated from the concreteness of the personal body, an independent object that is available for mass consumption by a number of body types (Bertola 2014: 117-121).

A sizing system is designed with the intention of offering the best fit for purchasers of ready-made clothes, thus «providing enough variation to accommodate all customers but limiting the number of sizes for efficiency of production and distribution» (Ashdown 2014: 17). The smaller the number of sizes, the lower the accommodation rate of customers. The larger the number of sizes, the higher the manufacture and retail costs and the complexity of the purchasing process. The goal of a sizing system is to identify the best balance between these two opposing needs. The efficiency of the sizing system originates from a specific technique called size grading (Moore et al. 2001). Size grading reduces the need to repeat body measurements for each size because measurements for larger-size garments are obtained through incremental changes to the base size. The processes that inform the size grading algorithm generally have a proportional characteristic, that is, they reproduce the shape of the base pattern by proportionally enlarging all of its parts.

However, the enormous reduction in costs made possible by this technique results in a concomitant reduction in the variability of garment sizes and shapes. The range of available sizes will only fit customers whose bodies might be different from the fit model in overall body dimensions but that are identical in body proportion. Ashdown describes the system as follows, «Different companies have fit models of different proportions; therefore each company provides [a] good fit for those customers whose body shape most resembles their fit model» (Ashdown 2014: 27).

This makes clear how the sizing system reconstructs the unity of the clothes-body complex by adapting the body to clothes, and not vice versa. In principle, sizing should be a tool for making garments fit bodies. In practice, it ends up "manufacturing" bodies that adapt to clothes. Inadvertently, it is not the consumer who chooses the brand, but the brand that chooses the consumer. Each brand constructs its own audience by deselecting ("othering") certain bodies.

The general outcome of the standardisation and marginalisation processes employed by the sizing system is even more powerful if we consider those who are regularly unable to find the right fit while purchasing clothes, such as fat women and women of ethnic groups with non-Caucasian body morphologies (Bougourd 2007: 108). In fact, the size grading technique produces not just standardisation, but a standardisation that favors slim as opposed to average body sizes. The technology that lies at the basis of the mass production of apparel results in a constraint that excludes fat bodies from fashion. Size grading can only be extended to larger bodies up to a certain size, as shape and size differences between bodies belonging to a range of slim sizes are more likely to conform to similar proportions than bodies that are above a certain weight. Let us quote a pattern maker:

> We know pretty well what a [US] size 6 woman will look like if she edges up to a 10; her bust line might increase an inch. But if a woman goes from a size 16 to a 20, you just can't say with any certainty how her dimensions will change. [...] You'll have some people who gain weight entirely in their trunk, some people who will gain it in their hips. [...] There are so many variables; you never win. (Kathleen Fasanella, quoted in Bellafante 2010)

For the apparel industry this means that, up to (US) size twelve, proportional size grading enables a large proportion of the population to be accommodated. However, the accommodation rate falls steeply beyond size twelve because then most of the variation is typically found outside the proportions of the original model: more on the hips, bottom, bust or belly (Boorady 2014). Size grading below the size-twelve threshold, especially when it has been automated and digitised, is quick, profitable and effective. Larger sizes require the creation of a dedicated pattern for each specific size and body shape, which makes it much more complicated and harder to standardise the mass production of clothing for these groups.

As a result, a significant proportion of apparel created by the fashion industry is never manufactured for average and overweight bodies. Very few items offered by brands participating in, for instance, Paris Fashion Week are retailed in sizes larger than twelve (Volonté 2021: 148). The fashion industry restricted itself during the process of industrialisation to a limited range of body sizes through its own technological development. The culture of slenderness is difficult to fathom if we disregard its hybrid character as a combination of symbolic values and material constraints. The thin ideal did not appear out of nowhere and induce the fashion industry to limit itself to slim sizes. Rather, the thin ideal evolved alongside a system of industrial production that was technologically discouraged from producing large sizes, and therefore developed practices that were technically within its possibilities.

However, technology is not independent of social processes but embedded in and informed by such processes, as technological innovations and cultural values are mutually co-produced (Jasanoff 2004). Like all technologies, size grading incorporates the needs, expectations, beliefs, habits, and idiosyncrasies of various relevant social groups (Bijker 1995). The fact that there is an upper threshold for the applicability of this technique – above which it becomes inefficient – is not an incidental consequence of how it was developed, but an inherent condition of the fact that it was developed in the first place. The threshold is a central aspect of the technique because it is a major part of its development; it is both one of the reasons the technique was adopted and one of the reasons for its success. The crucial point is that the size grading technique was able to establish itself only because it adequately responded as a whole, including the intrinsic technical "limits", to the needs of various relevant social groups. The exclusion of large sizes did not occur after an "objective" design and implementation process but was a condition for this technology to develop.

The technique of size grading informed – through its material process of clothing manufacture (e.g., the physical machinery and its performance, forms of master patterns, size of dummies and models, algorithm-based rules, etc.) – the standardisation of garment shapes and sizes, the consequent standardisation of clothes-body complexes, and, accordingly, the decision to sacrifice the capacity to accommodate fat bodies to the efficiency of the production process. Sizing is a powerful instrument for the normalisation of bodies as it places bodies within a hierarchical system of classification that actually excludes individuals on one end of the continuum, ipso facto stigmatising their bodies as substandard.

Negotiating women's footwear

Fat women frequently indicate having great difficulty in finding clothes that meet their needs. They feel excluded from the fashion system, as they are often forced to resort to unfashionable multi-brand stores and clothes that cover rather than enhance the body. Yet, protest and complaint, or the creation of so-called fat fashion brands, are not the only ways that "othered" people can negotiate the standardisation of bodies in fashion. We now turn to the case of high-heeled shoes to discuss how consumers experience and negotiate the relationship between non-standard feet and standardised footwear.

Similar to apparel production, the transition from custom-made or self-made footwear to mass-produced shoes necessitated the standardisation of sizing and manufacturing techniques. Earlier, relatively loose definitions and measurements of length[3] eventually became codified into more accurate and specified systems of sizes for feet and footwear that were determined with standardised measurement devices, such as the Ritz Stick and the Brannock Device (Morgan 2016). However, there remains today a high degree of variability in shoe sizes – as well as in clothes sizes – across and within countries and between (and even within) brands. There are several major shoe sizing systems that differ in what they measure (i.e., the foot, the shoe, or the "last"), what unit of measurement they use (i.e., sizes correspond to different intervals of measurement, which results in different increments between "half" and "full" sizes), and where they start measuring from (different systems "place" or "start" with measuring 0 or 1 in different locations, which means size can be proportional either to the foot or the shoe). This complexity is further exacerbated by differences between conversion tables, which create overlaps and gaps between sizing systems, and by the fact that only few systems take the width or girth of feet into account even though these are just as crucial determinants for insuring fit and comfort as length.

Footwear's range of sizes is based on the most common sizes and shapes of feet in a consumer population as well as the differences between regions and genders (Jurca et al. 2019). An essential part in the manufacture of shoes is the last, which is a human-foot shaped form on which shoes are constructed and that therefore is the primary determinant of the size and inner shape of a shoe. Shoes and lasts are initially developed in one size and width, namely the "sample size". Similar to clothing manufacture, a complete size range of shoes is developed by means of grading, that is, by scaling up (or down) from the sample size to develop other sizes and widths (Luximon 2013). Scaling factors are defined by means of grading tables that are well defined for each sizing system by the International Organisation for Standardisation, but it is unclear on what data these grading tables are based on, and furthermore, they have not been updated in decades. What is more, grading tables only provide scaling factors for width and girth, which means that these scaling factors are kept constant across entire size ranges even though there are several other significant variances in feet, such as instep height as well as forefoot and heel width, that would ideally be considered (Jurca et al. 2019). The failure to accommodate

[3] Interestingly, many common measurements that are still in use today are based on the lengths of body parts or bodily actions, and particularly on the parts and actions of the lower body. For example, both the "foot" and the "step" or "stride" have been used across multiple eras, cultures, and countries to standardise units for measuring length.

for such variances is particularly pernicious in the case of high heels, which are comparatively complex not only in their construction, but also their wearing because they angle one's foot and often have smaller toe boxes[4].

The diversity and complexity of sizing systems and the implications these have for manufacturing processes, which are generally more determined by economic costs and benefits than the actual needs of customers, result, once again, in a situation in which bodies are either forced to conform to apparel that poorly approximates their size and shape or are otherwise excluded. Because currently almost all commercially available high heels are mass-produced, most shoes do not fit perfectly even if they are one's "normal" shoe size. The potential consequences of ill-fitting footwear, particularly high heels, are not only discomfort and social embarrassment, but also long-term foot deformity and acute trauma (Branthwaite and Chockalingam 2019). In other words, feet that fall outside of the standards used in footwear manufacture are forced to bear the consequences imposed by industrial mass-production.

Consumers who cannot afford the considerable cost of a bespoke high heel must therefore make do with off-the-rack shoes and adapt them to the singularities of their own feet or vice versa. The abundance of brands to choose from, combined with uncertainty about what is suitable for one's feet (given the ever-changing nature of the interactions between foot and shoe) often leads consumers to believe that their feet are unusual, different, or abnormal in some way (Curwen and Park 2014). Because of such bodily differences and the variance in shoe sizes and designs, each pair of shoes run the risk of rubbing one's foot the wrong way. The results of such friction can be painful, so it is hardly surprising that high-heel consumers go to great lengths to avoid such pain. The problem of fit and the risk of painful friction lead many people to modify their shoes and feet to keep adverse effects to a minimum. In short, standardised and mass-produced high heels do not simply work, that is to say, they are negotiated and made to work by consumers, and often with tenacious creativity and resourcefulness.

The remainder of this section provides two examples of how high-heel wearing women experience the encounter between standardised footwear and non-conforming feet, and what techniques women might resort to in order to improve the encounter between body and shoe[5].

In order to minimise the risk of buying uncomfortable and painful high heels, women often resort to a variety of testing and "breaking in" mechanisms either during the moment of buying high heels or right after. Such strategies go some way in allowing consumers to

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4 The high heel is relational: its definition not only varies according to context and wearer, but also depends on the wearer's intention and physical ability. One person might find a pair of high heels immobilising, while another wearer might find them laughably easy to walk in.

5 The interview accounts introduced in this section are based on research conducted by one of the authors during their dissertation fieldwork in New York City during 2016-2019. For more on the strategies and techniques that are employed in high-heel wearing, see Hesselbein 2021b.

ascertain, and to some extent ameliorate, the relationship between mass-produced shoes and the particularities of their feet. More importantly, to correct the perceived mismatch between the particularities of their feet and standardised shoes, wearers frequently resort to a variety of "fixes" or "hacks" to address the idiosyncrasies of their feet and to improve wearing comfort. Many women who wear high heels anticipate some degree of discomfort and take precautions, such as applying bandages to their feet before going out. But some shoes – and some feet – are more complicated. One interviewee, a dance instructor with particularly high foot arches, likes to wear open-toed shoes. The commonly available gel inserts are not high enough to support her arches; insoles, which are larger and more supportive, are unwieldy and too large for the shoes that she likes to wear. To provide her arches with more support, she places a folded sanitary pad on the arches of shoes in which she needs more support, and tapes it down to ensure that it stays in place.

Minor adaptations to shoes and feet are a common way for high-heel wearers to negotiate and "correct" the gap that exists between their shoes and their feet. Most adaptations to high heels focus either on increasing the padding or cushioning below the foot or on decreasing the pressure and friction caused by shoes that are too slippery or snug. High-heel wearers frequently alleviate or even prevent painful friction by using baby or talcum powder, anti-blister sticks, candle wax, and even roll-on deodorant.

Although most footwear adaptations are designed to remedy problems caused by shoes that are too tight, sometimes the opposite is true, and wearers must modify shoes that are too loose. Women with relatively small feet, for example, are often forced to buy shoes that are too large, because only children's shoes are available in their size. Similarly, feet that are unequal in size or an in-between size or wider than average will need to be accommodated in some way (people with these issues often opt for shoes that are a size larger than called for by the length of their feet).

Another interviewee – a senior operations manager with a short stature and a particularly youthful demeanour – often wears shoes that are too big. Most of the shoes in her size are children's shoes, which, needless to say, she refuses to wear. She goes to great lengths to assert her maturity and authority in the workplace, and she considers high heels an essential part of her fashion arsenal. As a result, she must often wear shoes that are too large. This complicates walking, because high heels already require a degree of skill, even without a heightened chance of their falling off. She wears large, full-sized insoles in most of her shoes, and when possible, socks too, but even this is sometimes not enough to fill the additional space. Certain makes of shoes, such as D'Orsay or slingback heels and sandals, make it hard to use insoles, or to hide them from view. This problem calls for other solutions. On the day of our interview, she showed me how she had stuffed a sock into the toe box of her shoe: «I've tried using cotton balls and newspapers before, but they squish and become flat very quickly. I usually stuff two sockettes into the front of my shoe, which works perfectly». For her, socks are not only an item of clothing; they are also a means of adapting adult-sized shoes to her diminutive feet.

Standardised sizing and manufacturing techniques in footwear production, and the classificatory systems and grading scales that inform these techniques, can be a problem for anybody with feet that do not conform or "fit" into these systems. However, the problem is exacerbated for women with smaller than average feet who wish, or who might even be required, to wear feminine footwear, such as high heels. This issue is particularly difficulty for them because high heels are often thought to be the most appropriate footwear for a range of social events as well as for the performance of professionalism and authority in workplaces. However, although standardised sizing and classification systems can be exclusionary to those who have non-standard feet, consumers can, and frequently do, rely on a range of creative adaptations and hacks that allow them to adapt and appropriate such mass-produced items to their own specific needs.

Conclusions

This chapter has discussed the role of fashion in the normalisation of female body shapes and sizes by leveraging three of the key interventions that Science and Technology Studies has to offer to the study of technoscience: first, to make visible the co-construction of sociality and materiality, second, to denaturalise the implicit political and ethical aspects of this process, and third, to show how things might therefore be constructed otherwise either by manufacturers or users/wearers. By applying this approach to the study of two mundane technologies – clothing and footwear – we sought to highlight how methodological tools and concepts that are usually applied to complex sociotechnical systems and computational technologies can fruitfully be expanded to include objects that are not usually thought of as technology but that nonetheless play a similar role in naturalising certain bodies and social norms.

The size grading technique is an indispensable tool for the mass production and manufacture of both clothing and footwear. But this technique has two important implications for the social perception of the human body: its shape and size are standardised in line with the goods sold by apparel companies; the standardised shape and size of the body are further normalised through a production system that favours manufacturing needs rather than consumer needs. As a consequence, the fashion system employs a classification of human bodies that involves the categorisation of "normal" and "abnormal" bodies, and that posits "abnormal" bodies as being in need of correction, adjustment, and realignment with supposed normality.

We have discussed the marginalisation of fat bodies in the fashion system to show that the current normalisation of the female body – as young and slender – is mediated by the incorporation of the thin ideal in the size grading technique. That is to say, the materiality, obduracy and efficiency of manufacturing technologies contribute to the creation and maintenance of categories of "other" bodies that are not deemed to be beautiful, desirable, or cool. Further, we have highlighted how people with relatively "normal" as well as "abnormal" feet can be hindered, and to some extent even excluded, from wearing a type of shoe that many deem essential to the performance of feminine desirability, professionalism, and authority. Having a body that falls outside of standardised modes of production does not, however, need to prevent one from wearing high heels necessarily. High-heel wearers can successfully negotiate their "otherness" and avoid being marginalised by standards of mass production by employing a range of mundane techniques and "hacks". Both cases, in other words, highlight how the co-construction of body and technology can result in the creation and naturalisation of the human "natural" body, and exclusion of certain "other" bodies. The case of footwear adaptations shows, however, the extent in which the power and obduracy of standardised mass-production techniques can be subverted and appropriated, and therefore that sociotechnical "things" can be otherwise.

Ashdown, S.
2014 *Creation of ready-made clothing: The development and future of sizing systems*, in M.-E. Faust, S. Carrier (eds.), *Designing Apparel for Consumers: The Impact of Body Shape and Size* (pp. 17-34), Cambridge (UK), Woodhead Publishing.

Bellafante, G.
2010, July 28 'Plus-Size Wars', *The New York Times Magazine*. Available at: <https://nyti.ms/2ZrfN1B>; Last retrieved on 25/08/2019.

Benjamin, R.
2019 *Race after Technology: Abolitionist tools for the new Jim code*, Medford, Polity Press.

Bijker, W. E.
1995 *Of Bicycles, Bakelites, and Bulbs*, Cambridge (MA), The MIT Press.

Boorady, L. M.
2014 *Overweight and obese consumers: Shape and sizing to design apparel that fits this specific market*, in M. E. Faust, S. Carrier (eds.), *Designing Apparel for Consumers: The Impact of Body Shape and Size* (pp. 153-168), Cambridge (UK), Woodhead Publishing.

Bordo, S.
1993 *Unbearable Weight: Feminism, Western Culture, and the Body*, Berkeley, University of California Press.

Bougourd, J.
2007 *Sizing systems, fit models and target markets*, in S. P. Ashdown (ed.), *Sizing in Clothing: Developing Effective Sizing Systems for Ready-to-Wear Clothing* (pp. 108-151), Cambridge (UK), Woodhead Publishing.

Bowker, G. C., Star, S. L.
1999 *Sorting Things Out: Classification and its Consequences*, Cambridge (MA), The MIT Press.

Branthwaite, H., Chockalingam, N.
2019 'Everyday footwear: An overview of what we know and what we should know on ill-fitting footwear and associated pain and pathology', *The Foot*, *39*, 11-14.

Brownmiller, S.
1984 *Femininity*, New York, Simon & Schuster.

Cavallaro, D., Warwick, A.
1998 *Fashioning the Frame: Boundaries, Dress and the Body*, Oxford and New York, Berg Publishers.

Corrigan, P.
1997 *The Sociology of Consumption: An Introduction*, London, Sage.

Cowan, R. S.
1983 *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave*, New York, Basic Books.

Craik, J.
1993 *The Face of Fashion: Cultural Studies in Fashion*, London, Routledge.

Curwen, L. G., Park, J.
2014 'When the shoe doesn't fit: Female consumers' negative emotions', *Journal of Fashion Marketing and Management, 18*(3), 338-356.

Entwistle, J.
2015 [2000] *The Fashioned Body: Fashion, Dress and Modern Social Theory* (2nd ed.), Cambridge (UK), Polity Press.

Epstein, S.
2009 *Beyond the Standard Human?*, in M. Lampland, S. L. Star (eds.), *Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life* (pp. 35-53), Ithaca (NY), Cornell University Press.

Evans, C., Thornton, M.
1989 *Women and Fashion: A New Look*, London, Quartet Press.

Foucault, M.
1980 [1975] *Body/Power*, in C. Gordon (ed.), *Power/Knowledge: Selected Interviews and Other Writings 1972-1977* (pp. 55-62), New York, Pantheon Books.

Haller, M.
2015 'Mode Macht Körper: Wie sich Mode-Körper-Hybride materialisieren', *Body Politics, 3*(6), 187-211.

Hamraie, A.
2016 'Universal design and the problem of "post-disability" ideology', *Design and Culture, 8*(3), 285-309.

Haraway, D.
1991 *Simians, Cyborgs and Women: The Reinvention of Nature*, London, Free Association Books.

Hesselbein, C.
2021a 'Walking the catwalk: From dressed body to dressed embodiment', *Fashion Theory, 25*(3), 367-393.

Hesselbein, C.
2021 *Wearing High Heels: Femininity, Embodiment, and Sociomateriality* [PhD dissertation number 28861850]. Cornell University.

Jasanoff, S.
2004 *Ordering knowledge, ordering society*, in S. Jasanoff (ed.), *States of Knowledge: The Co-production of Science and Social Order* (pp. 13-45), London, Routledge.

Jurca, A., Žabkar, J., Džeroski, S.
2019 'Analysis of 1.2 million foot scans from North America, Europe and Asia', *Nature: Scientific Reports*, *9*, 19155.

Klepp, I. G.
2011 'Slimming lines', *Fashion Theory*, *15*(4), 451-480.

Martin, E.
1987 *The Woman in the Body*, Milton Keynes, Open University Press.

Lampland, M., Star, S. L. (eds.)
2009 *Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life*, Ithaca (NY), Cornell University Press.

Luximon, A.
2013 *Handbook of Footwear Design and Manufacture*, Cambridge (UK), Woodhead Publishing.

Morgan, S.
2016, June 'The development of footwear sizing systems', *SATRA Bulletin*, 34-43.

Moore, C. L., Mullet, K. K., Young, M. P.
2001 *Concepts of Pattern Grading: Techniques for Manual and Computer Grading*, New York, Fairchild.

Roulstone, A., Sheldon, A., Harris, J.
2017 *Disability and Technology*, Oxford (UK), Routledge.

Ruggerone, L.
2017 'The feeling of being dressed: Affect studies and the clothed body', *Fashion Theory*, *21*(5), 573-593.

Treichler, P. A., Cartwright, L., Penley, C.
1998 *The Visible Woman: Imaging Technologies, Gender, and Science*, New York, New York University Press.

Volonté, P.
2019 'The thin ideal and the practice of fashion', *Journal of Consumer Culture*, *19*(2), 252-270.

Volonté, P.
2021 *Fat Fashion: The Thin Ideal and the Segregation of Plus-Size Bodies*, London, Bloomsbury Publishing.

Wajcman, J.
1991 *Feminism Confronts Technology*, University Park, Pennsylvania State University Press.

Wajcman, J.
2004 *TechnoFeminism*, Cambridge (UK), Polity Press.

Wilson, E.
2003 [1985] *Adorned in Dreams: Fashion and Modernity*, London and New York, I.B. Tauris.

Wissinger, E.
2015 *This Year's Model: Fashion, Media, and the Making of Glamour*, New York, New York University Press.

Part III.
The Cyborg Body

7. Theorising Cyborg Communities and Visual disabilities: Case Study of V(irtual)Eyes

BIANCA RUMORE

Introduction

Since the 1990s, the affirmation and the increase of informatics, nanotechnology, cosmetic surgery and genetic engineering products have resulted in a reconstitution of social life and a redefinition of the human body, health, and diseases (Featherstone and Burrows 1996). The fusion of the technological and the biological has become a familiar idea thanks to the exorbitant technological magma of those years. This implies the development of certain «socio-technical frames» (Flichy 2007: 145), emerging as the combination of «the frame of functioning and the frame of use» (*ibid.*) of different technologies. Patrice Flichy has indeed defined the frame of functioning, mainly elaborated within the scientific community and in research laboratories, as the «body of knowledge and know how mobilised or mobilizable in a technological activity» (Ivi: 82), involving designers, producers, repairers, stakeholders and also users of technologies. Nineties' socio-technological changes have been accomplices of the post-human cultural *humus*, placing the human being in front of challenges and opportunities that exceeded often the imagination. The above frames of functioning, created by technologists and scientists, have inspired the aesthetics of human-machine hybridisation. Such technological frame has fuelled the work of avant-garde artists (e.g., Sterlac[1] and Orlan[2]), cyberpunk storytellers like William Gibson[3], and philosophers such as Donna J. Haraway. This is how the cyborg has penetrated the grammars of the postmodern subject, taking shape in the fruit of a posthuman vision (Marchesini 2002; Maestrutti 2011). Although the term "cyborg" first appeared in 1960 in the article *Cyborgs and Space* by the scientists Manfred E. Clynes and Nathan S. Kline, the concept is commonly derived from Norbert Wiener's "cybernetics" of the 1940s. It will, however, gain notoriety mainly in the 1990s, constituting together with "cyberspace" and "cyberpunk" a single set of keywords. Not to mention the science fiction scenarios, where films like *Terminator* (1984, 1991) or *Robocop* (1987), for example, have begun to draw cyborgs such powerful, often male and militarised hybrid, unable of feeling emotions. Donna Haraway with *A Cyborg Manifesto* (1985) will bring the cyborg in the academic sphere, proposing it as a philosophic counter-paradigm. On one hand, all the aforementioned concepts, symbols and images, produced within the artistic, literary, academic and cinema worlds, contribute to the elaboration of a social imaginary of cyborg technologies, which is one of the very important components of the

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1 Sterlac, born in 1946 in Limassol (Cyprus), began his artistic career in the 1970s. Together with Orlan, he is an exponent of the neo-futurist stream of Technological Art, based on the human-machine hybridisation. Since the 1980s, he has begun to develop the idea of the amplification of the body. In each of his performances – e.g., *Amplified Body, Laser Eyes*, *Third Hand* (1981-1994) – body systems such as brain waves, muscle movements, pulsations, heartbeat and blood circulation are expanded and enhanced by means of transducers and sensors such as the plethysmograph for pulsations. For Sterlac, hybridisation is a technique for overcoming a body that he considers to be defenceless, "obsolescent", condemned to a condition of biological precariousness because it is no longer able to keep up with technological innovations and accelerations, genetically inadequate for the scenarios opened up by the new discoveries of the universe, unable of coping with the mass of information which overwhelms it (Macrì 1998).

2 Born in 1947, Orlan is a radical performer and contemporary mutant of the neo-futurist stream of Technological Art. In the 1990s, Orlan's global project tended to express the alarming consequences of aesthetic surgery and technological development. The artist created on the computer a model of past female icons' combination. Then, she attempted to apply the digital model to her own face, through repeated face plastic surgery operations from 1990 to 1995, documented as real performances, e.g., *Opération Réussie* (1991). Through her performances, she explores the relationship between identity, body and technology, questioning women's stereotypes, gender and limits of the "Progress" in Western culture (*ibid.*).

3 William Gibson, especially with *Neuromancer* (1984), and other writers, like Bruce Sterling (1980), have been described as cyberpunk storytellers. The term "cyberpunk", introduced by Bruce Bethke (1983), refers to the fictional body present in Gibsonian and other literature's future worlds of cyberspaces, characterised by technological developments, post-human forms and power struggles (Featherstone and Burrows 1996: 7). For Stone, the publication of *Neuromancer*:

crystallised a new community. [It] reached the hackers and the technologically literate and socially disaffected who were searching for social forms that could transform the fragmented anomie that characterised life in […] electronic industrial ghettos. Gibson's powerful vision provided for them the imaginal public sphere and refigured discursive community that established the grounding for the possibility of a new kind of social interaction. [It] is a massive textual presence not only in other literary productions […] but in technical publications, conference topics, hardware design, and scientific and technological discourses in the large. (Stone 1991: 95) more general «frame of use» (Flichy 2007: 149) of technologies. The frame of use refers in fact to social meanings and symbolic dimensions of technical artifacts. It has shaped over time by different actors (e.g., journalists, advertisers, writers, artists), users' and social activities related to each technology (e.g., routines of daily life, social practices, types of people, places and situations connected to a technology). On the other hand, the cyborg literature – space discourses, science fiction, literary and cultural studies – mostly keep on using cyborgs as a myth and metaphor of reconceptualisation of human body, based on the union of the organic/natural system and the technological/cultural system. In these perspectives the cyborg often refers only to a fictional connotation, omitting real stories of people living everyday with wearable or integrated technology (Haddow et al. 2015; Oudshoorn 2020). In order to avoid the mistake of identifying the cyborg with the prodigious imagery of cyberpunk literature, science fiction and the technological art, it should be pointed out that the concept of cyborg extends beyond narrative barriers. Nowadays, people with different medical devices, such as pacemakers, bionic eyes (i.e., retinal and cortical prostheses), limb prostheses, cochlear implants can be analytically labelled in terms of cyborgs (Maestrutti 2020; Oudshoorn 2020). They often share similar personal lives and bio-medical diagnoses (e.g., same disabilities, diseases or sensitive and physical malfunctions), and also social problems and ethics issues for which they are struggling and fighting. Drawing on both post-humanist literature and Science and Technology Studies (STS), this chapter aims to rematerialise the cyborg, analysing the recent technologies for visual disabilities and introducing the concept of cyborg communities. Based on the case study of V(irtual)Eyes[4], it will develop theoretical tools for a better understanding of the mission and the characteristics of the current cyborg communities. In conclusion, vEyes allows us to consider how users and designers are interfacing with ethical issues and fighting for "cyborg rights", i.e., accessibility and inclusiveness.

Rematerialising the Cyborg

According to Haraway, the cyborg is «a creature of social reality as well as a creature of fiction» (Haraway 1991: 149). Contemporary examples and histories of people living

[4] This case study is based on a biographic approach (Bertaux 1980) and derived from a variety of sources. The paragraph titled *Cyborg communities: the role of users between accessibility and inclusivity in the case study of V(irtual) Eyes* is grounded on: i) the analysis of Massimiliano Salfi's Facebook account (<https://www.facebook.com/massimiliano.salfi>; Accessed between September 2021 and March 31, 2022) and vEyes' account (<https://www.facebook.com/progettoveyes>; Accessed on April 3, 2022) on Facebook; ii) the analysis of Second Sight (2022), Pixium Vision (2022) and vEyes Magazine (2022) websites. The Concluding section is based on the observations of *vEyes land*, Milo (Catania, Italy) in July 2022, the conduct of life history about Massimiliano Salfi, the founder of vEyes, between 3 December 2021 and July 14, 2022, the analysis of vEyes website (2022; Accessed between February 2022 and April 31, 2022) and vEyes Magazine (2022; Accessed between February 2022 and April 31, 2022).

with cyborg technologies are changing and re-shaping the fictional idea of cyborg as militarised hybrid, mostly male, of Nineties' imaginaries. For this reason, Gill Haddow and her colleagues introduced the concept of «everyday cyborgs» (Haddow et al. 2015), distinguishing current people who have in reality technological interventions from the above-mentioned cyborg figures. The notion of "everyday cyborgs" in fact allow scholars to overcome the metaphoric use of the cyborg and to consider the material part of hybrid bodies, analysing the different cyborg technologies, their characteristics and social consequences in lived experiences (Sobchack 2006; Oudshoorn 2020).

Although there are recent science-fiction series like *Westworld* (2016 – *in progress*) and *Inhumans* (2017), which still represented bionic transformations as utopias or dystopias, more and more movies and documentaries are inspired by "everyday cyborg", like *Cyborgs Among Us* (2017), *Skyscraper* (2018), *Toy Story 4* (2019), *50000 Passi* (2020). Compared to Nineties, the contemporary social imaginaries give space and voice to real bodies technologically transformed. Under the label of "inclusive marketing"[5], next to LGBT+ and body positivity campaigns, people with embedded technologies became the main characters of advertising, being on the most famous magazine covers and on social media. It is the case of Neil Harbisson, a cyborg artist with the so-called "eyeborg", an antenna implanted in the head, who featured on *Absolut vodka* campaign in the 2019. "Absolut" as brand has been supporting the battles for the rights of LGBT+ communities for many years; in July 2019 they launched the hashtag "we are a new world", showing people with embedded technologies in the advertising signs, next to the different sexual orientations. These concerned groups of people, on par with LGBT+ and disability communities, would like to have the same rights as the rest of society. With the hashtag "we are a new world", "Absolut" supported their requests, underlying the urge to renovate the same concept of human being (Rumore 2020). In this framework, it seems also necessary to mention the Paralympic gymnast Bebe Vio, having two prostheses of the legs and two prostheses of arms. She is a famous voice of disabilities in Italy and could be defined as a «resilient cyborg», according to Oudshoorn's classification (Oudshoorn 2020). The company "Barbie" has reproduced and launch in the market a Barbie in her image and likeness, as a symbol of inclusion for who have lost a body part which is now artificial (Regina 2019). The above public personalities living with their devices, alongside people with peacemakers and other hybrids, testify the relevance of the bodily cyborg and the analytical relevance of referring to the notion of everyday cyborgs.

In addition, the recent social practices and techno-artistic performances, despite the original definition of "cyborg", emphasise also its flexibility. In fact, it is currently difficult to give a definitive definition of the cyborg, because this concept is changeable, dynamic,

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[5] *«Inclusive marketing means creating content that truly reflects the diverse communities that your company serves. […] marketers' […] responsibility is to relay […] brands' messaging in a way that resonates with people from all backgrounds, regardless of race, ethnicity, gender identity, age, religion, ability, sexual orientation, or otherwise» (*Marketing-Interactive 2019).

susceptible to constant modification. Linda F. Hogle (Hogle 2005) and Chris Hables Gray (Gray 2010) make the same classification, differentiating cyborgs according to their purpose and the type of technology they use; there are "restorative" technologies and "enhanced" technologies. "Restorative technologies" aim to restore lost biological functions, organs and limbs; "enhanced technologies", on the other hand, are designed to increase and strengthen abilities in order to overcome the boundaries of human body. In the *Cyborg Handbook* (1995) Gray still associated "enhanced cyborgs" with the protagonists of science fiction. Shortly afterwards, the first enhanced cyborgs, like Steve Mann and Neil Harbisson, made their appearance, considering the technology essential to augment the perception of the world (Case 2014; Rumore 2020). In this regard, the question of technologies as a source of body augmentation thus has begun to fuel more and more socio-ethical debates. In this framework, Roger Clarke underlines the difference in biomedical field among "prosthesis", "orthosis" and "exoskeleton" (Clarke 2010). The "prosthesis" replaces a previous ability or serves to restore a deficient one; instead, the "orthosis" extends human abilities. The term "prosthesis" indeed derived from the Greek *prostithenai* ("to add to") and its first use referred to 1550s linguistics, understanding prosthesis like an addition of a letter or syllable to words. In 1706 medicine introduced the first artificial limbs; only around 1900, the word prosthesis will refer officially to an «artificial part of the body» (Palmerini et al. 2014). A prosthesis can be defined as a «device that physically replaces a missing body part, which may be lost due to physical injury, disease or congenital condition» (*ibid.*). In this sense, prosthesis could be implanted internally, as bionic eyes, as well as prostheses of the upper and lower limbs of the body for biomechanics and kinesthetics issues (Palmerini et al. 2014). On the other hand, since the 1950s in orthopaedics, an orthosis, from the Greek *orthoun* ("to straighten"), has referred to «a brace, splint or other artificial external device which serves to support the limbs or spine or to prevent or aid relative movement» (OED 2014). Finally, there is also the "exoskeleton", from the Greek *exo* "external" and "skeleton", which in zoology refers to «a rigid outer covering for the body in some invertebrate animals, particularly arthropods» (*ibid.*). Only in the recent medical field, the exoskeleton has become a type of "active" orthosis, providing a structural part to support and help people with motor disabilities. Furthermore, although Clynes and Kline illustrated a cyborg with "exogenous" or external components (Clynes and Kline 1960), Clarke notes how today the improvement and repair of the body include numerous methods of application of technologies (Clarke 2010). In this sense, everyday cyborg technology can be *incorporated* (i.e., under the skin or on the surface of the skin) and/or *wearable*. For this reason, in disability studies, cyborg anthropology and philosophy, an early prosthetic literature (Jain 1999; Sobchack 2004; Sobchack 2006; Dalibert 2014; Dalibert 2016) has been growing with the aim of going beyond the biomedical definition, which reduces the prosthesis to a material and physical condition, forgetting psychological and social implications. Like cyborg literature, these disciplines identify the term prosthetic as the overcoming of occidental dichotomies, especially body/technology, male/

female, and normal/disabled. Opposed to cyborg studies, prosthetic ones have started to address issues such as «prosthetic consciousness» (Wilson 1995; Sobchack 2006: 19) and «prosthetic aesthetics» (Smith and Morra 2002; Sobchack 2006: 19). With the concept of prosthetic consciousness, Robert Rawdon Wilson meant «a reflexive awareness of supplementation» (Wilson 1995: 242). On one hand, he has taken into account psychological dimensions of fear related to prostheses' potential failure when they do not work or do not work adequately and the situations in which they might turn against their users. On the other hand, Wilson has explored the process of identity building when an alien mechanical part is joined to someone's body, discovering the shifting of identity boundaries and the emergence of doubleness and multiplicity in the conception of one self. Instead, Marquard Smith and Joanne Morra (2002) have explored the prosthetic aesthetics, focusing on the multiple ways in which the modern visual culture – photography, ornamentation, drawing, performance, theatre, body art, sculpture, installation art, television, video – has represented and dealt with prosthesis issues of deficiency, autobiography, desire and phenomena such as that of the "phantom limb".

Jain (1999) and Oudshoorn (2020) have criticised the prosthetic perspective because, despite the different attempts, many authors investigate the devices without considering the distinction among all kinds of technologies. It should be pointed out that whether the technology is embodied and implanted or if it is a wearable device, this will imply different medical and social and ethical issues for cyborgs (Gray 2010). It is against this background that Gray pointed out: «basically an infinite number of possible cyborgs exist, life multiplied by human invention and intervention» (Gray 2011: 88). For this reason, in *Cyborg Database* (2010) Gray collects all the incorporations and bionic modifications under the general umbrella of «cyborgisation»; Cyborgisation is the social phenomenon of development of various cyborgs living with different technologies and thus it refers to the increase of all kind of human-technology relations. On the basis of the analytical framework described above, the following illustration of technologies for visual impairment and blindness and the concept of the "cyborg community", which will be introduced and argued in the paragraphs 3 and 4, will allow us to investigate and deepen the global trend towards cyborgisation in relation to visual disabilities, taking into account the ethical issues of accessibility and inclusion.

Technologies for Visual Impairment and Blindness

Since the Nineties, the cyborg imaginaries have fuelled and stimulated the design of assistive technologies (Maestrutti 2020). The continuous proliferation of wearable and incorporated technology in the domain of visual disabilities is related to the dominant role of organ of vision in the Western culture, starting from Humanistic/Renaissance perspective (de Kerckhove 1994). In contemporary society, the eyes still represent the primary source of human life. In 2019 World Health Organization published the *World report on vision*, showing how «Globally, at least 2.2 billion people have a vision impairment or blindness, of whom at least 1 billion have a vision impairment that could have been prevented or has yet to be addressed» (WHO 2019: 13). For these reasons, the sight and eye conditions care develop and invent wearable devices and imbedded solutions. Just to mention bionic eyes, augmented reality (AR) glasses and 3D printed digital contact lenses. In this regard, the most brilliant ophthalmologists during the last years introduced incorporated technologies in order to treat certain eye conditions, like age-related macular degeneration (AMD) or retinitis pigmentosa (RP). Both involve gradual degeneration of retinal photoreceptors, causing blindness. In cases of blindness, the visual prostheses (e.g., retinal prosthesis, cortical visual implant) mostly known as "bionic eyes", could restore certain level of perception of images to people (Salfi 2017). There have been three leader companies which have designed visual prosthetics implant. The first is a Californian company, the *Second Sight*; the second is the French *Pixium Vision* and the third is the German *Retina Implant AG*. In 2021, *Pixium Vision* and *Second Sight* announced their partnership, becoming an international leader in the field of vision restoration. In contrast with these two, *Retina Implant AG* discontinued business activities in March 2019[6]. The most famous retinal prosthesis is Argus II implant by Second Sight, created in 2007. It has designed for blind people suffering from retinitis pigmentosa (RP). In 2011 CE Mark approved the device in Europe. Since 2013 it has been the world's first U.S. Food and Drug Administration (FDA) approved technology for supplying artificial vision in people with late-stage RP. As the company states on its website: «Our Argus® II Retinal Prosthesis System is intended to provide useful vision to blind individuals severely impacted by RP. It combines a miniature eye implant with a patient-worn camera and processor to transform how you experience the world» (Second Sight 2022). The patient, living with this implanted prosthesis in the eyes, has to wear also sunglasses with a micro-camera, cable-connected to a comfortably pocketed micro-computer. Firstly, the camera of the sunglasses captures outside images, extracting essential information and transforming it in 60-pixel image; then, the camera, through an antenna, will transfer the information via Wi-Fi to prothesis implanted touching the retina. The information is about which electrodes need to be active for the stimulation. Actually, Argus II allows blinds to perceive light sources and patterns, recognise shapes and line of other people in black and white contrast environment, and read big characters of almost 2 cm (Second Sight 2002; Salfi 2017). In general, Second Sight has recorded a general improvement sense of orientation and navigation in the world, providing gradually independence to the patients. As the computer scientist Massimiliano Salfi pointed out: «It is not known whether the overheating that is usually present in a WiFi signal transmission system, of the electrical parts in contact with the inner eye area, leads to any consequences over time

[6] Retina Implant AG has introduced its retinal prosthesis, called Alpha AMS, approved by CE Mark in 2013 and fully refundable by the National Health System.

(at least, no such cases are reported)» (Salfi 2017). Argus II costs about $150.000 and restores only a minimal portion of vision. It is necessary to explain how this law level of perceptions, even just the sight of the light, give to blind people higher mental wellness. Because of the price, today there are only 350 Argus II's users in the world. In addition, Pixium develops bionic vision systems, by starting a 10-patient study in 2016 with the first retinal implant, called IRIS II, occurring in France in January. Pixium Vision is currently testing the new sub-retinal implant *Prima*, conducting clinical trials with 10 patients in France and in the United States (Pixium 2022). On the other hand, in the frame of the evolution of visual prostheses, since 2018 Second Sight has been developing an alternative to retinal prosthesis: Orion, conducting experiments under authorisation by FDA. This is a cortical prosthesis which stimulates electrically, instead of the eye, the visual cortex, the part of the occipital region of human brain which processes visual information. Human visual perception of eye system, indeed, depends on the transformation of light signal into electrical stimulus; the latter need to be transferred through optical nerve to visual cortex. In the visual cortex the electrical signal is processed by the brain, generating human vision. The cortical prothesis like Orion could provide electrical stimulus to the cortex and the brain could react, identifying light patterns (Salfi 2017). Cortical prosthesis, in this sense, could restore a partial sight to blind people suffering from glaucoma, trauma, cancer and diabetic retinopathy. Apart from bionic eyes, the Italian Institute of Technology has created and is testing the first artificial liquid retina, a prothesis which could literally replace the previous and damaged retina, being implanted in the eyes (Benfenati and Lanzani 2022). Concerning wearable technologies for visual impairment and blindness, numerous start up and companies invent more and more innovative devices and digital apps, collecting useful data in order to trace and improve the health condition of patients. *OrCam MyEye 2*, *dbGLOVE* and *Horus* are only three examples of the number of devices launched on the assistive technology market. In comparison with incorporated tech, the wearable solutions are simpler to design and create, having a price relatively lower and apparently less ethical implications. These characteristics generate a market full of commercial products for visual disabilities and eye conditions, in which to distinguish real assistive tech from marketing strategy begins to be difficult. OrCam MyEye 2 is defined by its own company, OrCam technologies, as the most advanced assistive wearable device for blind and visual impaired people. This camera is designed for all range of age. It is capable of identifying faces and products and reading texts thanks to Artificial Intelligence (AI), optical characters recogniser (OCR) and machine learning. Moreover, dbGlove is an Italian product which allows the users to write messages on the glove with the other hand and to transfer these to an external screen, through Internet or a pc or a smartphone. In this way, dbGlove digitalises different alphabets based on the sense of touch, like the Braille, and makes possible the communication between the user and the others. In addition, the smart device Horus has created by Eyra LTD, an Italian start-up; it scans the images and the text nearly the users, converting them into verbal messages. Since 2017, the version with English audio has launched on the market at a price of $2,000.

Cyborg communities: the role of users between accessibility and inclusivity in the case study of V(irtual) Eyes

The aforementioned academic nomenclatures (restorative and enhanced technologies, prosthetic consciousness, prosthetic aesthetics)[7] seem to want to harness the cyborg within the limits of totalising categories, mirroring that «classificatory mania» (Maffesoli, [1996]2000: 43), typical of cognitive strategy of Western culture. According to Geoffrey C. Bowker and Susan Leigh Star (2000), each category is indeed capable of revealing and valorising some perspective and silencing another, as result of certain political and information's environment decision processes. The same cyborg classification confirms, once again, that «morbid rationalism» which Michel Maffesoli ([1996]2000: 44) recognises as pathological because of its obsessive-compulsive attempt to explain reality by reducing it within rigid taxonomies. Beyond the categories and theories developed by the Academy (STS scholars, disability studies, cyborg anthropology and posthuman philosophy)[8] cyborg communities have declared their own conceptions of cyborgs, renegotiating constantly their identities. *Biohack.me*, an online platform for "self-biohackers", describes its community in the following words:

> Grinders are passionate individuals who believe the tools and knowledge of science belong to everyone. Grinders practice functional (sometimes extreme) body modification in an effort to improve the human condition. We hack ourselves with electronic hardware to extend and improve human capacities. (Biohack.me 2022)

Biohackers call themselves "grinders", doing "temporary" or "permanent" body modification through electronic devices. One example is the *Science for the Masses*, a group of biohackers from California, who self-induced the temporary sense of night vision. Neil Harbisson and his collaborators, in the circuit of the Cyborg Foundation[9], proclaim their "cyborgism" which would explain the various types of relationships which can be established between technology and organisms:

> Cyborgism is an artistic and social movement that aims to create artwork through new senses or the extension, reduction or modification of an existing sense as a result of the union of cybernetics and the body. (Cyborg Foundation 2022)

7 See paragraph *Rematerialising the cyborg*.

8 *Ibid.*

9 The Cyborg Foundation is an online platform that researches, develops and promotes all projects related to the creation of new senses and perceptions by applying technology to Humans; in addition, the Cyborg Foundation fights for the recognition of cyborg rights (Cyborg Foundation 2022; Rumore 2020).

The cyborg itself seems to escape any tendency towards categorisation; being originally a hybrid between the artificial and the natural, the machine and the human, it disrupts Western boundaries (D'Andrea 2005). The cyborg indeed creates a regime of confusion and indistinction, which Gilbert Durand ([1960]1991) calls nocturnal. As Perniola pointed out: «The hard core with which we are forced to deal is the cyborg, the technological guinea pig, the living currency, the human capital» (2000: 5). The cyborg subjectivity is not determined, it is not reducible either to flesh or to mind; it cannot be purged from the Human or the machine because it is both, simultaneously, and it finds its personal character through the creative process and exchange with otherness. The subjectivity of the cyborg begins to take shape on an «ontological promiscuity» (Marchesini 2002: 70), where the contamination with the alterity of the human being and the machine is not a matter of choice. The contamination with non-human otherness no longer constitutes a threat to the definition of identity, but rather a starting point. It is against this background that cyborg community can be defined as a community where the members of the group are actors of the socio-technological innovation at different levels (designers, users, and supporters). They implicitly or explicitly support the transition to the "cyborg" and fight for everyday cyborg rights, designing reparative or enhanced technologies in the name of accessibility and inclusiveness. Based on the analysis of V(irtual)eyes, cyborg communities' characteristics, dynamics and mission can be explored. VEyes is a Sicilian non-profit organisation, founded in 2012 by the computer scientist Massimiliano Salfi, after his daughter's diagnosis of retinitis pigmentosa (RP)[10]. For this reason, vEyes team – engineers, psychologists, ophthalmologists – focuses on the study of visual disabilities, designing wearable and incorporated technologies, such as vEyes Wear and visual BCI (Salfi 2018). VEyes technologies are more and more innovative, having Wi-Fi connection and running software. They also have the capabilities of collecting and transferring data. Moreover, vEyes creators think these devices as open-source (OS) technologies, releasing them for free, or at low cost, to meet social needs (Sgroi 2019). VEyes designs *ad hoc* devices, such as *Tourist Eyes*, *vEyes RRE*, *vEyes Wear*, *visual BCI*, *Poseidon 2.0, Leonard.* In the domain of assistive technologies for visual disabilities, it can be seen how vEyes has been conceived as a collective project; it was born in 2012 after a medical diagnosis of Massimiliano Salfi's daughter. In this sense, the initiative of vEyes is, first of all, based on a family and personal story. Salfi as father of a child suffering from RP was and still is aware of social problems and challenges of this genetic vision disorder. He is also conscious of the material needs of the RP, as well as bioethics implications and level of accessibility of assistive devices (incorporated and wearable), created and launched in the market by Second Sight, Pixium Vision and other companies[11]. The Salfi family is the social portrait of about 1.5 million people in the world struggling with progressive

[10] See paragraph *Technologies for visual impairment and blindness.*

[11] *Ibid.*

vision loss, culminating in blindness. In total, 2 million people worldwide suffer from hereditary retinal degeneration; currently a real and approved cure does not exist for these eye conditions (IAPB 2022). Retinitis pigmentosa can appear between adolescence and adulthood; Salfi's daughter represents less frequent cases of children affected by RP in early childhood (*ibid.*). In this framework, technology remains an alternative solution to reduction of sight and blindness. On the same wave, Neil Harbisson see Paragraph *Rematerialising the cyborg* who as a child was diagnosed with achromatopsia, a rare visual condition causing a total inability to see and perceive colours. For this reason, in 2003 he created its own device, the so-called "eyeborg", equipped with a colour sensor, capable of converting colours into 360 sound waves. In 2010, also Harbisson, after medical and personal problems, created Cyborg Foundation in order to develop cyborg technologies. Inspired by the concept of «plural artist» by Balzola and Rosa ([2011]2019: 50), we define the characteristics of each cyborg community as the following:

1. *processuality*, i.e., the conception of cyborg technology as always in progress. The cyborg tech is never a final product because is subject to modification and recombination;
2. configuration as a *collective author*, i.e., a research project, a non-profit association, a non-profit organisation, a foundation, etc., made up of designers, users and supporters who propose themselves as a collective process;
3. *the purpose of techno-social innovation*. The collective author studies, creates and implements cyborg technologies in order to improve or extend sensory or mental abilities;
4. *the interactivity*, i.e., the level of engagement and participation that the collective author establishes with the inside, the members of the community, and with the outside, the public and future users of the "cyborg" technology;
5. *the fight for cyborg rights* in order to protect and defend a sphere of norms and values, fight social and bioethical problems, such as accessibility and usability.

The cyborg communities are indeed social groups which represent meeting points between tech companies and users, thinking and creating incorporated and wearable technologies through a collective process and bottom-up approach. Today the design of assistive technologies is growing faster and faster and is raising ever-increasing expectations for the disabled people; on a theoretical level, the industrial companies know very well the value of users and patients for the development of innovative devices for disabilities (Maestrutti 2020). Especially in the field of visual disabilities, the role of users is not marginal. In this sense, for the industrial and bio-medical engineering patients' experiences about how they feel and perceive the world is a sine qua non of each experimental procedure and deployment of devices. The same Second Sight underlines the importance of users, dedicating a section of its website to patients' histories with their interviews and clips. Second sight declares openly its support to the users with the following slogan:

«Second Sight's mission is to develop neurostimulation technologies to enhance the lives of blind individuals, while supporting our current users» (Second Sight 2022). Despite all the statements, most of these types of companies continue to have a top-down approach, still considering the users as only consumers (Maestrutti 2020); the leader companies of visual disabilities' technologies offer products at unaffordable prices, forgetting individual needs. In this framework, cyborg communities constitute collective authors, positioning themselves between standardisation and individuality of disables' tech. In cyborg communities, users and supporters are active part of innovative process. They participate to the elaboration of technologies alongside the research group, composed of designers, engineers, computer scientists and doctors. In the circle of cyborg communities, the technologies are the results of a dynamic and holistic perspective, focusing on real voices and needs of users and activities of the supporters. In this sense, the power of digital activism is not to be underestimated. Users are not simply «wearers», like Dutch Stichting ICD dragers Nederland describe them (STIN 2022); moreover, they are not only «recipients», term very frequent in the medical literature. The role of users is indeed strongly related to the action and mission of socio-technical innovation. According to Patrice Flichy (2007), the socio-technical action includes different actors particularly designers and users; the design of technologies has relevant as their social use in the process of technical innovation. On the same wave, von Hippel has introduced the concept of «innovation community» (von Hippel 1976; Lüthje et al. 2005), starting to analyse in depth the various role of users, such as «lead-users» (*ibid.*). As van Oost et al. pointed out:

> «The work of von Hippel and his colleagues is primarily business oriented and aims to enhance the quality of a company's innovation processes by making companies aware of users as a potential rich source of innovative ideas for product development». (van Oost et al. 2009)

On the contrary, cyborg communities' focus on users is linked to socio-ethical and normative agenda; cyborg communities need to involve more social groups in technological development and communicate to them. For this reason, vEyes' team is plural and interdisciplinary and shares a common research location, the so-called *vEyes land*, in Milo, near Catania, in Italy (vEyes 2022). In vEyes the level of communication and interaction with the members of the community is stimulated by real and online events, parties and psychological meetings. These, held by the psychologist and psychotherapist Serena Sciuto, offer the possibility to patients, especially children, and their families to talk about processes of visual diseases' coming and acceptance, including the role of technologies. In this regard, the birth of vEyes Orchestra in 2016 represents the first example of orchestra accessible to blinds and visual impaired people. It consists of 54 musicians who use vEyes devices during the artistic performances. The project vEyes Orchestra also includes a music school in Milo. Moreover, the news published on vEyes Magazine and Salfi's Facebook account allow the members of the community and the public in general to follow vEyes' activities and to know technological development in the field of assistive technologies. In the end, the choice of fighting for cyborg rights seems implied from the very beginning of communities; also, they could present them-selves explicitly as a rebellion to standard tech systems and to lucrative market of assistive devices. In the case of vEyes, the creation of open source technologies is an implicit declaration of the battle for democratising cyborg devices for blindness and visual impairment. VEyes defines its-self as «the open alternative at the service of the social» (*ibid.*); it also supports the prevention of eye conditions, developing free apps and medical services especially for children, i.e., *RedEyes*, «the app that saves the sight to children» (*ibid.*).

Conclusions

The cyborg communities and the case of vEyes are mirroring both the trend toward cyborgisation of humans and the trend toward «democratising innovation». The growth of vEyes, next to other communities, underlines the fact that bionic modifications and prosthetic changes seem to be more and more common. It also shows the need of overcoming the sphere of science-fiction related to cyborgs, who are current social actors, forming social groups. They are requiring for recognition of rights of access of all kinds of devices and socio-political representations, defending certain normative values. Inspired by Haraway, the cyborg artist Neil Harbisson argues: «we are all consciously or unconsciously in transition of becoming biological cyborgs, you can notice it in language» (Harbisson 2017: 6-7). The cyborg artist compares the demands of recognition and accessibility of cyborg identities to the same social needs of gender transitions and LGBT+ communities. Gradually, more and more people will come face to face with the issue of «becoming technology» (Cyborg Foundation 2022). In this regard, according to the *Insight Summary Report 10 Hot consumer trends* by Ericsson ConsumerLab (2016), more than half of European citizens in 2016 would have extended their senses. Exactly, the trend eight, called «Internables», showed the trend in consumers aiming to improve their physical wellbeing by constantly monitoring and quantifying their progress through the use of wearable technological devices. Ericsson report stated that the next generation of «body-monitoring technology» could coincide with an "internable", i.e., being inside the human body (*ibid.*). In this regard, next to human enhancement, Ana Sofia Elias and Rosalind Gill have also considered how the proliferation of self-tracking and self-monitoring apps self-moni-toring, like "beauty apps", generate self-optimisation's processes when the acts of self-tracking create performative and entrepreneurial actors (Elias and Gill 2018). These processes consolidate the links between neoliberalism and «quantified self» (QS) (Lupton 2014), conceptualised by Deborah Lupton as «a "self-tracking" or "reflexive monitoring" self who uses the affordances of digital technology to collect, monitor, record and share a range of – quantified and non-quantifiable – information about herself or himself while engaging in “the process of making sense of this information as part of the ethical project of selfhood”» (Elias and Gill 2018: 60). The 2016 trend (Ericsson 2016) was reconfirmed by the annual trend report *The Wired World* (Wired 2019), which ranked «Technology that will give us new senses» as one of the top eight trends for 2019. The most recent Ericsson report, *10 Hot Consumer Trends 2030*, includes the AR glasses and the Internet of senses among the highest consumer expectations (Ericsson 2022). The cyborg communities are already working towards this direction, re-considering and changing the human perceptions through wearable and imbedded technologies. Unlike the absolutely positive and idealised images of human augmentation, the increasing numbers of these technologies and their integration with persons generate also a new class of ethical, practical and legal issues, which international and national law have to deal with. Within the interdisciplinary project *Everyday 2.0: Law's boundary work and alternative legal futures* of the University of Birmingham, Muireann Quigley and her colleagues are analysing legal *vacuum* in British and European laws, still having a limited approach, based on the rigid separation between people and objects. Quigley and Ayihongbe identified five main areas of bioethical cyborgs' issues: «i) medical device regulation, safety, and product liability; ii) damage to devices and liability; iii) data and privacy; iv) security and biohacking; and v) intellectual property rights» (Quigley and Ayihongbe 2018). Conducting qualitative interviews, these researchers aim to answer several questions related to cyborg technologies, e.g., who amongst patients, doctors and companies should control or own the software in implanted medical devices; or also how law can face risks around unauthorised third-party device access and hacking. Moreover, Harbisson and cyborg artists believe that Artificial Senses allow them to extend and get deeper their experience of reality (Cyborg Foundation 2022). Despite these positions, Balzola and Rosa wonders whether the sensory extension, produced by technology, separates the body from a direct relationship with the world. They actually saw in prostheses an enormous contradiction:

> On the one hand it makes accessible to the senses what nature has not foreseen, on the other hand it places the senses within a technological apparatus that separates them from reality, mediating their information through artificial instruments. (Balzola and Rosa, [2011]2019: 64-65)

In their opinion, artificial extension would constitute a surrogate for the subject's feeling: sensibility, delegated to technology, would be incapable of evolving. For them, the use of the technological would induce the senses to be activated only under the stimulus and stimulation of the technology itself, leaving the body desensitised, amputated, immobilised (*ibid.*). On the other hand, the evolution of these communities is evidence of the global trend of democratising innovation. According to von Hippel (2005), the rising demand of technology accessible for everybody in the world is increased by the extensive use of information and communication technology, especially with social media and digital activism.

In the end, future STS perspectives could deepen the role of cyborgisation of Humans' visions, expectations and promises in the constitution of emerging technologies, as well as detect differences and similarities of languages and semantics between bottom-up and top-down approaches, investigating their relevance in making technoscientific futures and imaginaries.

Balzola, A., Rosa, P.
2019 [2011] *L'arte fuori di sé: Un manifesto per l'età post-tecnologica*, Milano, Feltrinelli Editore.

Benfenati, F., Lanzani, G.
2022, February 23 'La retina artificiale: Come le nanotecnologie possono ridarci la vista', *Agenda Digitale*. Available at: <https://www.agendadigitale.eu/sanita/la-retina-artificiale-come-le-nanotecnologie-possono-ridarci-la-vista/>; Last retrieved on 30/09/2022.

Bertaux, D.
1980 'L'approche biographique: Sa validité méthodologique, ses potentialités', *Cahiers Internationaux de Sociologies LXIX*, July-December, 197-225.

Bethke, B.
1983 'Cyberpunk', *Amazing Science Fiction Stories, 57*(4), 94.

Biohack.me
2022 'Who We Are'. *biohack.me*. Available at: <https://wiki.biohack.me/Who_We_Are>; Last retrieved on 30/09/2022.

Bowker, G. C., Star, S. L.
2000 *Sorting Things Out: Classification and Its Consequences*, Cambridge (MA), The MIT Press.

Case, A.
2014 *An Illustrated Dictionary of Cyborg Anthropology*, Scotts Valley, CreateSpace Independent Publishing Platform.

Clarke, R.
2010 'Cyborg Rights'. *International Symposium on Technology and Society (ISTAS) – Institute of Electrical and Electronics Engineers (IEEE)*, New York, 9-22.

Clynes, M. E. & Kline, N. S.
(1960). Cyborgs and Space. *Astronautics*, *9*, 26-27; 74-76.

Cyborg Foundation
2022 *Cyborg Foundation. Available at*: <https://www.cyborgfoundation.com/>; Last retrieved on 30/09/2022.

D'Andrea, F.
2005 *Immaginare la macchina: La realtà simbolica del cyborg*, in F. D'Andrea (ed.) *Il corpo a più dimensioni: Identità, consumo, comunicazione* (pp. 21-53), Milano, FrancoAngeli.

Dalibert, L.
2014 *Posthumanism and somatechnologies: Exploring the intimate relations between humans and technologies* [PhD dissertation], Enschede, University of Twente.

Dalibert, L.
2016 'Living with spinal cord stimulation: Doing embodiment and incorporation', *Science, Technology, & Human Values*, *41*(4), 635-660.

de Kerckhove, D.
1994 *Remapping sensoriale nella realtà virtuale e nelle altre tecnologie ciberattive*, in P. L. Capucci (ed.), *Il corpo tecnologico*, Bologna, Baskerville.

Durand, G.
1991 [1960] *Le strutture antropologiche dell'immaginario: Introduzione all'archetipologia generale*, Bari, Dedalo.

Elias, A. S., Gill, R.
2018 'Beauty surveillance: The digital self-monitoring cultures of neoliberalism', *European Journal of Cultural Studies*, *21*(1), 59-77.

Ericsson ConsumerLab
2016 '10 Hot Consumer Trends 2016', *ericsson.com. Available at*: <https://www.ericsson.com/en/reports-and-papers/consumerlab/reports/10-hot-consumer-trends-for-2016>; Last retrieved on 30/09/2022.

Ericsson ConsumerLab
2022 '10 Hot Consumer Trends 2030', *ericsson.com. Available at*: <https://www.ericsson.com/en/reports-and-papers/consumerlab/reports/10-hot-consumer-trends-2030-connected-intelligent-machines>; Last retrieved on 30/09/2022.

Featherstone, M., Burrows, R. (eds.)
1996 *Cyberspace/cyberbodies/cyberpunk: Cultures of technological embodiment*, London, Sage.

Flichy, P.
2007 *Understanding technological innovation: A socio-technical approach*, Cheltenham, Edward Elgar Publishing.

Gibson, W.
1984 *Neuromancer*, New York, Ace.

Gray, C. H.
1995 *The Cyborg Handbook*, New York, Routledge.

Gray, C. H.
2010 *The cyborg database*. Available at: <http://cyborgdatabase.org>; Last retrieved on 30/09/2022.

Gray, C. H.
2011 'Homo cyborg: Fifty years old', *Revista Teknokultura*, *8*(2), 83-104.

Haddow, G., King, E., Kunkler, I., McLaren, D.
2015 'Cyborgs in the everyday: Masculinity and biosensing prostate cancer', *Science as Culture*, *24*(4), 484-506.

Haraway, D.
1985 'Manifesto for cyborgs: Science, technology and socialist feminism in the 1980s', *Socialist Review*, *80*, 65-108.

Haraway, D.
1991 *Simians, cyborgs and women: The reinvention of nature*, New York, Routledge.

Harbisson, N.
2017 'Cosmic Senses: How the use of the internet as a sense, instead of the use of the internet as a tool, can allow us to extend our perception of nature and extend our senses to outer space', in *Neil Harbisson: A collection of essays* (pp. 6-7), London, Cyborg Arts Limited.

Hogle, L. F.
2005 'Enhancement technologies and the body', *Annual Review of Anthropology*, *34*(1), 695-716.

IAPB
2022 *IAPB Italia Onlus: L'agenzia Internazionale Per La Prevenzione Della Cecità*. Available at: <https://iapb.it/i-tuoi-occhi/>; Last retrieved on 30/09/2022.

Jain, S. S.
1999 'The prosthetic imagination: Enabling and disabling the prosthetic trope', *Science, Technology, & Human Values*, *24*(1), 32-46.

Lupton, D.
2014, July 28 'Beyond the quantified self: The reflexive monitoring self', *This Sociological Life*. Available at: <https://simplysociology.wordpress.com/2014/07/28/beyond-the-quantified-self-the-reflexive-monitoring-self/>; Last retrieved on 30/09/2022.

Lüthje, C., Herstatt, C., von Hippel, E.
2005 ‘User-innovators and “local” information: The case of mountain biking’, *Research Policy*, *34*(6), 951-965.

Macrì, T.
1998 *Il corpo postorganico: Sconfinamenti della performance*, Genova e Milano, Costa & Nolan.

Maestrutti, M.
2011 ‘Cyborg identities and contemporary techno-utopias: Adaptations and transformations of the body in the age of nanotechnology’, *International Journal of Bioethics*, *22*(1), 71-88.

Maestrutti, M.
2020 ‘Alle frontiere del corpo: Identità, corporeità e tecnologie nei Disability Studies’, *Rassegna Italiana Di Sociologia*, *1*, 151-175.

Maffesoli, M.
2000 [1996] *Elogio della ragione sensibile* (M. L. Cascone Trombà, Trad.), Roma, Seam Edizioni.

Marchesini, R.
2002 *Post-human: Verso nuovi modelli di esistenza,* Torino, Bollati Boringhieri.

Marketing-Interactive
2019, February 21 ‘6 principles of inclusive marketing’, *Marketing-Interactive*. Available at: <https://www.marketing-interactive.com/6-principles-of-inclusive-marketing>; Last retrieved on 30/09/2022.

Oxford English Dictionary (OED)
2014 *Oxford University Press Available Online*. Available at: <http://www.oxforddictionaries.com/>; Last retrieved on 30/09/2022.

Oudshoorn, N.
2020 *Resilient Cyborgs: Living and Dying with Pacemakers and Defibrillators*, London, Palgrave Macmillan.

Palmerini, E., Azzarri, F., Battaglia, F., Bertolini, A., Carnevale, A., Carpaneto, J., Cavallo, F., Di Carlo, A., Cempini, M., Controzzi, M., Koops, B.-J., Lucivero, F., Mukerji, N., Nocco, L., Pirni, A., Shah, H., Salvini, P., Schellekens, M., Warwick, K.
2014 *RoboLaw Guidelines. Regulating Emerging Robotic Technologies in Europe: Robotics facing Law and Ethics* (No. 289092). RoboLaw. Available at: <http://www.robolaw.eu/index.htm>; Last retrieved on 30/09/2022.

Perniola, M.
2000 *L’arte e la sua ombra*, Treviso, Biblioteca Einaudi.

Pixium

2022 *Pixium Vision – Bionic Vision for those who have lost their sight*. Available at: <https://www.pixium-vision.com/>; Last retrieved on 30/09/2022.

Quigley, M., Ayihongbe, S.

2018 'Everyday Cyborgs: On Integrated Persons and Integrated Goods', *Medical Law Review*, *26*(2), 276-308.

Regina, S.

2019, November 28 'Bebe Vio, una Barbie celebra la campionessa paralimpica: «Modello per le bambine»', *Corriere Della Sera*. Available at: <https://milano.corriere.it/notizie/cronaca/19_novembre_28/bebe-vio-barbie-bambola-celebra-campionessa-paralimpica-modello-bambine-dream-gap-mattel-0462a2f4-11c8-11ea-934f-a2282c2d0229.shtml>; Last retrieved on 30/09/2022.

Rumore, B.

2020 'Cyberbodies e Artificial Senses (AS): Il caso Neil Harbisson', *FUTURI – Rivista Italiana di Future Studies*, *14*(7), 131-140.

Salfi, M.

2017 'Gli occhi bionici: Protesi retiniche e protesi corticali sono solo luci ed ombre? (1ª puntata)', *vEyes Magazine*. Available at: <https://magazine.veyes.it/2017/10/16/gli-occhi-bionici/>; Last retrieved on 30/09/2022.

Salfi, M.

2018, April 'L'innovazione tecnologica Open al servizio del sociale', *TEDxSSC*. Available at: <https://www.ted.com/talks/massimiliano_salfi_l_innovazione_tecnologica_open_al_servizio_del_sociale>; Last retrieved on 30/09/2022.

Second Sight

2022 'About us', *Second Sight*. Available at: <https://vivani.com/vivani/>; Last retrieved on 29/11/2023.

Sgroi, O.

2019, April 10 'Massimiliano Salfi, l'informatico che salva la vi(s)ta ai bambini', *Corriere Della Sera*. Available at: <https://www.corriere.it/buone-notizie/19_aprile_10/massimiliano-salfi-l-informatico-che-salva-vista-bambini-b40bcb7a-5bae-11e9-ba57-a3df5eacbd16.shtml>; Last retrieved on 30/09/2022.

Smith, M., Morra, J.

2002 *The Prosthetic Aesthetic,* London, Lawrence & Wishart.

Sobchack, V.

2004 'Is Any Body Home? Embodied Imagination and Visible Evictions', in *Carnal Thoughts: Embodiment and Moving Image Culture* (pp. 179-204), Berkeley, Los Angeles & London, University of California Press.

Sobchack, V.

2006 ‘A Leg to Stand On: Prosthetics, Metaphor, and Materiality’, in *The Prosthetic Impulse: From a Posthuman Present to a Biocultural Future* (pp. 17-41), Cambridge (MA):, The MIT Press.

Sterling, B.

1980 *The Artificial Kid*, New York, Harper & Row.

Stichting ICD dragers Nederland (STIN)

2022 *Homepage*. Available at: <https://www.stin.nl/>; Last retrieved on 30/09/2022.

Stone, A. R.

1991 *Will the Real Body Please Stand Up?: Boundary Stories about Virtual Cultures*, in M. Benedikt (ed.), *Cyberspace: First Steps* (pp. 81-118), London & Cambridge (MA), The MIT Press.

van Oost, E., Verhaegh, S., Oudshoorn, N.

2009 ‘From Innovation Community to Community Innovation: User-initiated Innovation in Wireless Leiden’, *Science, Technology, & Human Values*, *34*(2), 182-205.

vEyes (Virtual Eyes) ONLUS

2022 *vEyes*. Available at: <https://www.veyes.it/>; Last retrieved on 30/09/2022.

vEyes (Virtual Eyes) ONLUS

2022 *vEyes Magazine*. Available at: <http://magazine.veyes.it/>; Last retrieved on 30/09/2022.

von Hippel, E.

1976 ‘The dominant role of users in the scientific instrument innovation process’, *Research Policy*, *5*(3), 212-239.

von Hippel, E.

2005 *Democratizing Innovation*, Cambridge & London, The MIT Press.

Wilson, R. R.

1995 ‘Cyber(Body)Parts: Prosthetic Consciousness’, *Body & Society*, *1*(3-4), 239-259.

WIRED Business

2018, November 20 ‘These are the eight trends that will shape the world in 2019’, *WIRED*. Available at: <https://www.wired.co.uk/article/the-wired-world-in-2019>; Last retrieved on 30/09/2022.

World Health Organization (WHO)

2019 *World report on vision*, Geneva, World Health Organization. Available at: <https://www.who.int/publications/i/item/9789241516570>; Last retrieved on 30/09/2022.

8. Science vs. «Nature»: Uncanny technological, aesthetic, and political implications of plastic surgery practices

SARA CASARTELLI

This is a waltz thinking about our bodies
What they mean for our salvation
Thom Yorke, *Suspirium* (2018).

Fig. 8.1 – "Before" and "After" an abdominal high definition liposculpture (Tambasco 2022).

Three are the operations involving the little girl:
- A partial glossectomy: her tongue being shortened to stop it protruding.
- An asian blepharoplasty: folds of skin being removed from her eyelids to reduce the «mongoloid» appearance
- An otoplasty: pinning her ears back to prevent them from sticking out. The patient is Georgia Bussey, a five-year-old British girl with Down syndrome. «Society is not going to change overnight so Georgia has to fit into society rather than society fitting into the way she is» says her mother (BBC 1998).

Introduction

This chapter uses two very different examples to describe disparate instances of body modification performed through plastic surgery procedures. The first example is provided using two pictures displaying the oblique left angle of a man's body, respectively before and after an abdominal liposculpture performed in Rome. Liposculpture is a quite aggressive approach to body contouring that enables the surgeon to perform body sculpting of the superficial tissues to define the 3-dimensional surface musculature (Hoyos and Millard 2007). The second fragment describes a media sensation in the early 2000s where Georgia Bussey, a five-year-old British girl with Down Syndrome, undergoes plastic surgery three times. Georgia's parents justified such a radical choice as a defense to society's discriminatory attitude towards the disabled body. Their call was not spared a harsh judgement by the very society they wanted to protect their daughter from. Outrage was also expressed by the parents of other Down syndrome children, who compared these operations to «child abuse» (Dobbin 2008). Although this case goes back to the early 2000s, a second occurrence of aesthetic plastic surgery performed on a child to erase the traits associated with Down syndrome reignited the same debate ten years later. Triggering both the public and the scientific community, Georgia Bussey's quandary undoubtedly remains an issue of contemporary relevance.

The subject of contention is the criteria for inclusion of diversity within the social fabric. In other words, the ethical, moral, and political appropriateness of adapting one's own body or that of others to standards, including physical standards, of social integration (Ghigi 2008). This dilemma, dramatically exposed in the example of the surgical removal of physical features typical of Down syndrome, is rooted in the history of cosmetic surgery itself. From the erasure of the outward signs of syphilis, to the elimination of the most obvious features of «racial» features, the ethical conundrum at the heart of the elective scalpel (Ghigi 2008) has always played out in a sort of antagonism with the plastic surgeon on one side and the body on the other: Science vs. «Nature». This article explores this antagonism and its ambiguity by problematizing the very categories that sustain it: such as the «natural» and the «artificial». These are certainly complicated categories to deal with, but it is possible to study them empirically. Through the two empirical cases described above, I will introduce the concept of *uncanny technoaesthetics*. My hope is that these unfamiliar practices may teach us something about how we deal with our bodies, ultimately challenging our idea of the mundane, the natural, and the fixity of the human body.

My muses, in a nutshell. This work inherits from discussions in feminist theories and science and technology studies, that problematize epistemological distances between objects and subjects, science and politics, nature and culture. Framed at the intersection of feminist scholarship and STS, this chapter draws from work done under a range of disciplinary and methodological affiliations, including anthropology of science, contemporary feminist theory, and material semiotics. Although not exclusive to feminist STS, certain problematics act as guiding questions for feminist scholars engaging with technoscience. Primary among these is the ongoing project of unsettling foundational dichotomies, including the division of subject and object, human and nonhuman, and nature and culture (Suchman 2008). Donna Haraway suggested in the early eighties the idea of the Cyborg, a hybrid of machine and organism, to indicate the blurring and confused boundaries between science and politics. Whereas this boundary is just an optical illusion (Haraway 1991), the Cyborg suggests a way out of it. Pointing at the inextricable relation between nature and culture, Haraway invited her feminist colleagues to find ways out of the «maze of dualisms in which we have explained our bodies and our tools» (Ivi: 180). Since Donna Haraway's intervention, feminist STS scholars have increasingly embraced the epistemological inseparability of subjects and objects as well and the entanglement between «natural» bodies and «artificial» augmentations. In fact, «human» bodies are always already intimately engaged with a range of augmenting artifacts (Ivi: 195, as cited in Suchman 2008).

The everyday ubiquity of technologies that remake the human renders them commonplace and normalized (Haraway 1991). If we think of aesthetic surgery in this sense, there are many examples. We are all accustomed to a nose job performed on an outstanding nose. Very few would complain on a surgical otoplasty performed on prominent ears of a healthy child, or a breast augmentation when «appropriate» (whatever this may mean). Cosmetic surgery is for the most part normalized in our culture. For the most part. The examples provided at the beginning of this paper, for instance, are not so easy to digest. On the contrary, they make us queasy, uneasy, uncomfortable. And they get us there in two very different ways! The photographs shows a body shaped and contoured using body fat. The second fragment depicts an instance of aesthetic surgery performed on a girl to hide as much as possible her genetic chromosomal abnormality. These are two extreme examples I chose to help us denaturalize the impulse to ameliorate and «normalize» bodies. They do so, as they render uncanny the process by which we modify them. Let's start unpacking this term, the *uncanny*.

Uncanny draws from Masahiro Mori's famous hypothesis: the «uncanny valley». As we will see later, this theory calls attention to the feeling of unease caused by robots or digital creations that resemble humans too closely. According to Masahiro Mori's hypothesis, when robots look too human, they are experienced as eerie and uncanny. In her analysis of «plastic surgery monsters» in South Korea, Leem (2021) shows us this discomfort can also occur the other way around. That is, when humans resemble robots too much, when they become too artificial. Too *plastic*. Joining Mori's theory with contributions from feminist science studies, I follow Leem (2021) and Rhee (2013) to develop Mori's concept and call for an alternative reading of the uncanny valley. Like Haraway's Cyborg, the uncanny valley points at the entanglement between machine and organism and brings to the fore the inextricability of human and humanoid. The uncanny valley, however, has a different take. It points at the horror, the fall, that place and moment where the foundations on which all contemporary science is based no longer hold up. It thus can be viewed as a site that renders visible our limits and normative conceptions so that we might expand our vision of the human beyond them (Rhee 2013).

Uncanny technoaesthetics also takes from another perspective based on philosopher Gilbert Simondon. According to Simondon (2012: 3), what matters in aesthetics is not only the sensation of the consumer of the artwork but what is more original is the sensation of the artist who engages with matter that is being transformed through work. In this sense technoaesthetics cannot be separated from their usage of, and actions on, their own body. Applying this idea to plastic surgery I explore technoaesthetics of the body and argue that it is concerned with the one who practices it, as well the one who contemplates it.

The paper is organized as follows. In the first part I use Bussey's story to present my theoretical landmarks. Engaging with the classic sociological theme of stigma, I adopt a radically different stance. Enriching the trope of the cyborg, I invite the reader to take a walk into the uncanney valley. The second part introduces empirical material from my fieldwork to articulate the concept of uncanny technoaesthetics. The paper makes two claims. First, the uncanny valley echoes in the dissonance between expectation and experience. Second, technoaesthetics of the body are concerned with the one who practices it, as well as the one who contemplates it.

The empirical material was collected as part of a wider research on plastic surgery practices, started in October 2021. The data comprises of archival research, 15 semi-structured interviews with cosmetic surgery providers in Italy, ethnographic observations of doctor-patient interactions and when possible, ethnographic observations inside the operating theatre. I interviewed plastic surgeons to explore how they characterized plastic surgery looks and results. Interviews provided insight into surgeons' explanations of looks (Menon 2019). I initially recruited my informants through the online list of ordinary members of the SICPRE (Italian Society of Plastic, Reconstructive and Aesthetic Surgery) and conducted almost all interviews in person in plastic surgeons' offices and in hospitals, allowing me to observe the settings, interactions between professionals, plastic surgeons' advertising materials and before-and-after photographs of patients. Findings suggest that there is productive power arising from getting out of our comfort zone, in an uncanny place where the body becomes both a battleground and a technoaestethic playground.

I came across Georgia Bussey's case while studying the history of contemporary plastic surgery and body modification. Body modification is the praxis of permanently altering one's appearance. The term «body modification» refers to various and diverse practices which include piercing, tattooing, branding, cutting, binding, and inserting implants to alter the appearance and form of the body. The list of practices can be extended to include forms in which the body surface is not directly inscribed and transformed using instruments to cut, pierce and bind, such as gymnastics, bodybuilding, anorexia and fasting, which are generally much slower processes (Featherstone 1999: 1). Further on, the body can also be altered using prosthesis and technological systems. These range from simple prosthetic devices to enhance body motor and sensory functions to the building of technological environment around the human being. Alternatively, the technology may be built into the human being to replace or augment the functioning of inner organs, body surfaces, senses and limbs, as cyborg imagery modifies the horizons of what a body can be (*ibid.*). Among these latter practices, we find plastic surgery procedures. People are increasingly tasked with both the aesthetic and scientific management and optimization of their bodies. Every society has had its own dictates about which bodies are «most beautiful» or «most adequate» and invented practices to conform bodies to these standards (Ghigi 2008). The history of medicine is also part of this process (Ivi: 212). Medicine has created a legible and objectifiable body and has extended beyond the dimension of illness and cure to the management of normality and perfection. Processes of medicalization and biomedicalization have in fact established increasingly extreme frontiers of disability, giving scientific and technological research a leading role in proposing solutions that often border on the mere promise of "healing", i.e., of restoring a state of «normality» (Maestrutti 2020, *my translation*). Amidst this process, the body became a privileged political arena where to fight identity battles (Ghigi 2008). The body of course is not just a passive object of medical practices, but also site of experience and vehicle of its own aesthetic transformation (Edmonds 2008). For these reasons, the body is a particularly porous zone of reflection which is «good to think with» (Scheper Hughes and Lock 1987). In this contribution I develop a cross-disciplinary, i.e., social and medical, approach to the body. Far from relegating the biological to the medical sphere, I'm instead interested in the inextricable entanglement between the social and the biological, where the latter is not a given of nature, but an entity that never ceases to build and rebuild itself through social interactions (Vidal-Naquet 2011). The case of Georgia Bussey, in this sense, is salient as it points us to the bio-social plasticity of the human body.

Let's take a closer look. Down syndrome is a chromosomal condition that is associated with intellectual disability, a characteristic facial appearance, and weak muscle tone (hypotonia). People with Down syndrome often have a characteristic facial appearance that includes a flattened appearance to the face, outside corners of the eyes that point upward (upslanting palpebral fissures), small ears, a short neck, and a tongue that tends to stick out of the mouth. The general impression, which is also shared by people affected by the syndrome, is that children diagnosed with Down's syndrome look more like each other than like their parents (Abbate 2010). It is also based on these considerations that in the 1970s some authors began to propose the application of aesthetic plastic surgery to modify the facial features of the patients (Ivi: 586, *my translation*). The surgical techniques proposed to erase the physical features of Down's syndrome, as far as the face is concerned, have been categorized in two distinct groups: functional and aesthetic plastic techniques. The first group considers macroglossia and is generally aimed at reducing the size of the tongue by means of glossectomy, to facilitate the act of speaking. For this paper, focus is on the second group, that of aesthetic plastic procedures aimed solely at improving face *appearance*. These practices can be summarized as the lifting of the nasal bridge by means of additive rhinoplasty, the correction of cheekbones by implanting prosthesis, the (partial) correction of the auricle implant, by means of otoplasty, and the eyelid correction through blepharoplasty. In addition to a glossectomy, Georgia Bussey was also subjected to these two last procedures.

The case of Georgia Bussey sparked a fierce debate. On the media, the issue was primarily framed as ethical. On one hand, there were those who argued that if the erasure of the physical stigma can mitigate the perception of its discrimination, there is no reason why such operations should not be carried out. In fact, the bearer of Down syndrome is destined to be socially penalized, not least because they are immediately recognizable as such. On the other hand, it was argued the erasure of the stigma contributed to the stigmatization at a collective level and hindered the actual perception of it (Ghigi 2008). The scientific community was also divided on the issue. Some experts argued the surgery had positive outcomes as it facilitated smoother social integration for the children, other studies affirmed there was no evident and measurable change in the acceptability and social integration of children with Down's syndrome (Abbate 2010: 586, *my translation*).

The issue that is violently exposed in Georgia Bussey's example is innate in the heritage of plastic surgery itself: the surgical elimination of physical stigma. From the cancellation of the most obvious features of one's «race», to the erasure of the consequences of syphilis, where the bridge of the nose collapses, to the need of both men and women to fight wrinkles, cellulite, time. The dilemma inherent in cosmetic surgery can be summarized as the erasure or acceptance of the physical stigma. To let «nature» be or artificially intervene on our body. Rather than taking a normative stance on this ethical quandary, that can solely be declined as right or wrong, the work I do here is quite different. Developing the trope of the Cyborg I take the reader into the uncanny valley, giving a new interpretation to Georgia Bussey's case, where wrong or right is not interesting anymore. Science and technology scholars have sought to go beyond a simple acknowledgement of natural/artificial embodiment to articulate the specific and multiple configurations of bodily prosthesis and their consequences (Suchman 2008: 148) and construct revolutionary approaches that engage science and technology not just as a matrix of dominations, but as the core of the social, the core of who we are: cyborgs. As Jarrin and Pussetti remind us, it is important to resist the impulse to romanticize unaltered bodies, as if we could return to a time when our biology was not irrevocably intertwined with technology (2021: 13). But if we accept cyborgization as a process already underway for a long time, then what makes this case so special? When answering this question, we must keep in mind that aesthetic plastic surgery modifies only the external aspects of Trisomy 21, which has chromosomal origins, merely correcting those traits that make it immediately recognizable. Its effects can be substantial in terms of the first impression the subject makes on a stranger's gaze (Goffman 1990). The problem is that undergoing surgery does not reduce the effects of Down syndrome, it just changes the appearance. In this dissonance between one's expectation and the actual experience, I contend, lies the uncanny valley.

Masahiro Mori is a roboticist professor at the Tokyo Institute of Technology who, in 1970, published an essay entitled "Bukimi No Tani" in a Japanese journal called *Energy* in which he envisioned people's reactions to robots that looked and acted almost like a human. In particular, he hypothesized that a person's response to a humanlike robot would abruptly shift from empathy to revulsion as it approached, but failed to attain, a lifelike appearance. Since 2005, Mori's uncanny valley theory has had significant influence in U.S. humanoid robotics; and recently, the theory has also gained traction in discussions of human "realism" in computer graphics and video game animation (Rhee 2013: 302). Using Rhee's contemporary reading of the uncanny valley as a site of entanglement[1] (Ivi: 302), this chapter does a similar operation as that of Leem (2021) in her anthropological study of «plastic surgery monsters» in South Korea. Thus, I translate the notion of uncanny from robotics to plastic surgery procedures.

Mori's theory holds that humans are attracted to robots that bear some resemblance to humans and are repelled by robots that resemble humans too much, experiencing these all-too-human robots as eerie and uncanny. Following Leem, I argue it can also work the other way around: humans look uncanny at some point when they look too artificial, too "fake". For example, when we are confronted with facial surgery for children with Down syndrome. Namely, the uncanny valley is within the «unsettling confusion about the boundary between human and nonhuman» (Rhee, 2013: 313). It's there, where we stumble upon the doubt we went "too far". The uncanny valley points at the horror, the

[1] It is worth noticing the origin of the concept of «uncanny» in Western culture. The first speculations are to be attributed to psychiatric studies, in particular, I here refer to a paper published in 1919 entitled *The Uncanny* by Sigmund Freud (translated in English and available online). As Freud acknowledges, the term was first used by the German psychiatrist Ernst Jentsch in his essay *On the Psychology of the Uncanny* (1906). In this paper Freud develops the concept with reference to humans, non-humans, and the imaginary related to it. We can appreciate the polysemy of the concept that refers to «subjects», «feelings», and «atmospheres». The feature that emerges is that, as Freud writes: "It [the uncanny] undoubtedly belongs to all that is terrible – to all that arouses dread and creeping horror; it is equally certain, too, that the word is not always used in a clearly definable sense, so that it tends to coincide with whatever excites dread" (1919: 1).

fear of that place and moment where the foundations on which all contemporary science is based no longer hold up and take on a life of their own. It's in that place, where even the most modern (Latour 2009) amongst us has a glimpse of nostalgia to our old, safer world where natural and artificial were neatly separated.

The uncanny valley is here to disturb. We – all of us on Terra – that live in disturbing, mixed-up times, troubling and turbid times (Haraway 2016). And this is why I *love it*[2]. Its uncanny, troubling, active, productive. There is in fact a generating unease that emerges by the uncanny feeling one gets when strange practices become familiar and beckon to us, or when a familiar practice is rendered strange. This feeling is crucial, even more when the question is how the human is being remade (Jarrin and Pussetti 2021: 14). The example of Georgia Bussey brings the inextricability of nature and artifice to the fore in a troubling way and urges us to critically engage the boundaries around the category of «natural», so that we might expand our visions of the human beyond them (Rhee 2013). Indeed, how the human is defined has very real effects, particularly for those who are excluded from the community of humans and the rights, protections, and privileges accorded therein (Ivi: 310). Challenging the fixity of the natural and borders protecting abiding definitions of the human, the uncanny valley ultimately makes us question what was human is in the first place, before asking how the human is being remade.

Technoaesthetics: shaping the human body

In the following section I endeavor to analyze empirically the crafting of the natural look, articulating the concept of uncanny technoaesthetics through the example of liposculpture. I'll start from mere materiality:

> This is how we extract fat through liposculpture, we centrifuge this fat in a special centrifuge [...] at 3000 rpm for 3 minutes. Then we separate this fat from the oil or triglycerides to the aqueous solutions, [so] we are left with only pure fat which can be re-injected, and [this] is called lipofilling. This principle of lipofilling has been applied since 1990 by me and many plastic surgeons in body remodeling, because body remodeling does not only mean removing, but also putting back where it is necessary, recreating harmonies and profiles. I'll repeat myself, so very often we remove adipose tissue from a trochanter, centrifuge the fat and use that fat to increase the volume and the projection of a buttock, for example, or to restore and give a little more tone to the breasts[3]

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2 By using the term *love* in this context, I situate myself in a specific tradition of feminist scholarship that mobilizes terms coined in the private sphere to put them to use in relation to public issues (de Laet and Mol 2000; de La Bellacasa 2011). Referring to the heuristic value of destabilizing our naturalized understanding of the body I try to contribute to shaping novel ways of «doing» normativity. To love is to be moved. And movement is change (Casartelli 2021).

3 Interview conducted in March 2022. Translation is mine from Italian: *Cosi è come estraiamo il grasso attraverso la liposcultura, lo centrifughiamo in una centrifuga speciale [...] a 3000 giri al minuto*

In this excerpt a plastic surgeon I interview is explaining how liposculpture (interchangeably referred to also as "lipofilling") works. The fat located in one spot is sucked with a thin cannula. After centrifugation and preparation it is injected – always through special devices – in the predetermined areas. Nowadays this tumescent technique is considered the technique par excellence for liposculpture. This technique consists in the injection of a fluid (Klein's solution) into the interested areas. This fluid causes the fat to swell and become "tumescent" which facilitates its removal. Klein's solution is a liquid consisting of saline solution (water + salt), adrenaline (which constricts the blood vessels decreasing blood loss during the procedure), lidocaine (local anesthetic), and bicarbonate (which decreases the burning that would be felt during the lidocaine injection). This technique, which has become popular since the 1980s, is still considered to be the safest method, particularly because it limits blood loss and thus allows the removal of a greater amount of fat while minimizing complications. If we go back to the picture presented in the introduction (8.1), we see a very sophisticated example of liposculpture. In addition to fat removal muscles have been "drawn" through a body contouring technique. We see muscles made of fat. If we were to touch this surface, we would experience something very different to what expected. Once again, the dissonance between expectation and experience takes us into the realm of the uncanny valley. But what about technoaesthetics? The concept of technoaesthetics draws from the philosopher Gilbert Simondon. In a letter he wrote but never sent to Jacques Derrida in 1982 he asks a question: «why not think about founding and perhaps even provisionally axiomatising a aesthetico-technics or techno-aesthetics?» (Simondon 2012: 1). His argument develops describing a «continuous spectrum that connects aesthetics to technics». For too long the realm of aesthetics has remained domain of subjective contemplation, which erases any substantive understanding of technology's effects upon the larger cultural sphere. We got it wrong, contemplation is not techno-aesthetics' primary category. Art is not only about the result, the object of contemplation. For those who practice, it's very much a form of action. Technoaesthetics acts on and is acted on by the world. In the words of my informant:

> He must be an artist. If he is not, he cannot be a plastic surgeon. When we talk about liposculpture […] Liposculpture is remodeling… the contours and harmonies of a body, using a small cannula and aspirating fat. Imagine Michelangelo sculpting the "Pietà". What does he do? He takes a block of marble and sculpts it, removing parts and fragments of the marble until he gets the wonderful jewel that is the "Pietà". A plastic surgeon does the same thing. With a cannula

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per 3 minuti. separiamo questo grasso dall'olio o dai trigliceridi alle soluzioni acquose, [così] ci rimane solo grasso puro che può essere reiniettato e [questo] si chiama lipofilling. Il principio del lipofilling è stato applicato dal 1990 da me e da molti chirurghi plastici nel rimodellamento corporeo, perché il rimodellamento corporeo non significa solo togliere, ma anche rimettere dove è necessario, ricreando armonie e profili. Mi ripeto, molto spesso asportiamo tessuto adiposo da un trocantere, centrifughiamo il grasso e lo utilizziamo per aumentare il volume e la proiezione di un gluteo, ad esempio, o per ridare un po' di tono al seno…

that is not a chisel, he finely reshapes a body, removing fatty tissue where necessary, restoring shape and harmony to the profile of a body…[4]

Fig. 8.2 – Sculpture *La Pietà* by Italian Renaissance painter and sculptor Michelangelo Buonarroti.

Triggered by my questions aimed at clarifying the role of the surgeon's taste, in this fragment the doctor makes a metaphor between the craft of the plastic surgeon and the craft of an artist. Interestingly enough, etymologically the word "artificial" means art, profession, craft. Only later does it acquire the mannerist meanings of artefact as opposed to natural. The etymon as well transcends the limitations of both technics and aesthetics to take full account of the character and experience of the material conditions of existence, all of which are inescapably both aesthetic and technical. Without going into the legitimacy of the comparison, what emerges from my informant's words is how aesthetics is not only the sensation of the "consumer" of the work of art. Rather, it is a set of sensations of the artists themselves: it's about a certain *contact with matter that is being transformed through work* (Simondon 2012: 3, emphasis is mine).

As the body of the operator gives and receives, art liberates technics and techniques from their technological and cultural contexts to surpass their initial function. Simondon's intercategorical fusion gives us one more insight into human cyborgization, explaining

[4] Interview conducted in March 2022. Translation is mine from Italian: *Deve essere un artista. Se non lo è, non può essere un chirurgo plastico. Quando parliamo di liposcultura […] la liposcultura è rimodellare… i contorni e le armonie di un corpo, usando una piccola cannula e aspirando il grasso. Immaginate Michelangelo che scolpisce la "Pietà". Cosa fa? Prende un blocco di marmo e lo scolpisce, rimuovendo parti e frammenti del marmo fino a ottenere il meraviglioso gioiello che è la "Pietà". Un chirurgo plastico fa la stessa cosa. Con una cannula che non è uno scalpello, rimodella finemente un corpo, rimuovendo il tessuto adiposo dove necessario, restituendo forma e armonia al profilo di un corpo…*

how the technoaesthetic body is not solely there to be looked at. It's usage, in action, it «becomes something orgasmic, a tactile means and motor of stimulation» (Simondon 2012: 3). There we have it, the uncanny playground. A space of relational human-technology ontology, where people and things are inseparably intertwined and co-constituted, and the body is shaped in a processual relation, a process of continuous becoming in which humanity is incessantly remade. Maybe the question was wrong from the beginning. We should no longer ask how we shape the body, but how does the body shape us?

Conclusions

In this paper I mobilized uncanny technoaesthetics to explore the technological, aesthetic, and political implications of plastic surgery practices. The empirical examples used in the article were specifically chosen to take us out of our comfort zone. I asked what was salient about these cases, and what they could teach us about how we deal with our bodies. I'm in debt with Rhee's contemporary reading of the uncanny valley, that goes beyond the uncanny valley as intended by roboticist Masahiro Mori. Through Rhee's interpretation the Uncanney Valley becomes a place of destabilization that challenges the fixity of the human rather than reifying it and opens up boundary-constructions for critical engagement (Rhee 2013). I then went further to say that there can be a *productive unease produced by the uncanny valley.* As it destroys unhelpful barriers, it also critically engages the boundaries and normative conceptions around the category of «natural» so that we might learn to expand our visions of the human beyond them (Rhee 2013).

Drawing from Leem, I applied the concept of uncanny technoaesthetics to bodies which underwent extreme plastic surgery procedures, testing this notion on two different empirical cases. The first example helped to clarify the blurred lines between categories foundational to science and technology. Rather than engaging with the ethical quandary inherent in the history of plastic surgery, that is, whether it is right or wrong to adapt one's own body or that of others to standards, including physical standards, of social integration, I instead drew from feminist STS scholarship to interrogate the empirical boundaries of "natural" and "artificial". As such, the article explored nature and culture, human and non-human, and developed in new areas the epistemological inseparability of subjects and objects as well and the entanglement between «natural» bodies and «artificial» augmentations. The second part focused on technoaesthetics. Technoaesthetics of the body is concerned with the one who contemplates it as well as the one who practices it (Leem 2021). Technoaesthetics crucially redefines the natural, including not only the human body, but any non-human body as well – animal, technological, immaterial – formed by the speed or slowness of matter-taking-form matter taking form. «Such bodies embody life through technics and technicities that do not dissociate the natural and the artificial, the analog and the digital, matter and form» (Oliveira et al. 2017: 2). In conclusion, uncanny technoaesthetics can show how through entangled agencies and practices of matter and meaning, techno-scientific worlds «come to matter» (Puig de la Bellacasa 2009; Barad 2007).

References

Abbate, B.

2010 'La chirurgia plastica estetica nei bambini con sindrome di Down: Aspetti tecnici ed etici', *Minerva Pediatrica*, *62*(6), 585-590.

Barad, K. M.

2007 *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*, Durham (NC), Duke University Press.

BBC

1998, November 18 '*Down's syndrome mother denies vanity', BBC News Health*. Available at: <http://news.bbc.co.uk/2/hi/health/216479.stm>; Last retrieved 27/04/2022.

Casartelli, S.

2021 'Moving Bodies: Creative Infrastructures of Identification', *TECNOSCIENZA: Italian Journal of Science & Technology Studies*, *12*(1), 37-62.

De Laet, M., Mol, A.

2000 'The Zimbabwe bush pump: Mechanics of a fluid technology', *Social Studies of Science*, *30*(2), 225-263.

Dobbin, M.

2008, March 11 'Down Syndrome plastic surgery "child abuse"', *The Age*. Available at: <https://www.theage.com.au/world/down-syndrome-plastic-surgery-child-abuse-20080311-ge6tx1.html>; Last retrieved 27/04/2022.

Edmonds, A.

2008 'Beauty and health: Anthropological perspectives', *Medische Antropologie*, *20*(1), 151-162.

Featherstone, M.

1999 'Body modification: An introduction', *Body & Society*, *5*(2-3), 1-13.

Freud, S.
1919 'The "Uncanny"', *Imago*.

Goffman, E.
1999 *Stigma: Notes on the Management of Spoiled Identity*, London, Penguin Books.

Haraway, D. J.
1991 'A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century', in *Simians, Cyborgs, and Women* (pp. 149-181). New York: Routledge.

Haraway, D. J.
2016 *Staying with the Trouble,* Durham, Duke University Press.

Hoyos, A. E., Millard, J. A.
2007 'VASER-assisted high-definition liposculpture', *Aesthetic Surgery Journal*, *27*(6), 594-604.

Jarrín, A., Pussetti, C. (eds.)
2021 *Remaking the Human: Cosmetic Technologies of Body Repair, Reshaping, and Replacement* (Vol. 2), New York and Oxford, Berghahn Books.

Latour, B., Giorello, G.
2009 *Non siamo mai stati moderni*, Milano, Elèuthera.

Leem, S. Y.
2021 *Uncanny Techno-Aesthetics: "Plastic Surgery Monsters" or Gangnam Beauty in the 21st century's Korea* [Conference presentation]. 4S2021. Toronto, Canada.

Maestrutti, M.
2020 'Alle frontiere del corpo: Identità, corporeità e tecnologie nei Disability Studies', *Rassegna Italiana di Sociologia*, *61*(1), 151-175.

Menon, A.
2019 'Cultural gatekeeping in cosmetic surgery: Transnational beauty ideals in multicultural Malaysia', *Poetics*, *75*, 101354.

Oliveira, A. M., Palazuelos, F. R., Fonseca, T. M. G.
2017 'Interactivity between bodies and milieus within techno-aesthetic art objects', *Psicologia & Sociedade*, *29*: e148036.

Puig de La Bellacasa, M.
2009 'Touching technologies, touching visions: The reclaiming of sensorial experience and the politics of speculative thinking', *Subjectivity*, *28*(1), 297-315.

Puig de La Bellacasa, M.
2011 'Matters of care in technoscience: Assembling neglected things', *Social Studies of Science*, *41*(1), 85-106.

Rhee, J.
2013 'Beyond the Uncanny Valley: Masahiro Mori and Philip K. Dick's Do Androids Dream of Electric Sheep?', *Configurations*, *21*(3), 301-329.

Scheper-Hughes, N., Lock, M.
1987 'The mindful body: A prolegomenon to future work in medical anthropology', *Medical Anthropology Quarterly*, *1*(1), 6-41.

Simondon, G.
2012 'On techno-aesthetics', *Parrhesia*, *14*(1), 1-8.

Suchman, L.
2008 *Feminist STS and the Sciences of the Artificial*, in E. J. Hackett, O. Amsterdamska, M. E. Lynch, J. Wajcman (eds.), *The Handbook of Science and Technology Studies* (Vol. 3, pp. 139-164), Cambridge (MA), The MIT Press.

Tambasco, D. [@damianotambasco]
2021, November 22 '*LIPOSCULTURA4D® addome, fianchi e torace. Pre e immediato post-op', Instagram.* Available at: <https://www.instagram.com/p/ClO7FZEMWGF/?igshid=NzJjY2FjNWJiZg>; Last retrieved 21/06/2023.

Vidal-Naquet, P. A.
2011 'Book review, Special issue: "The body in disability studies"', *Medische Antropologie*, *161*, 1-4.

9. Dead Bodies – Living Boundaries: Towards Socio-Technical Imaginaries of Plastination

STEFAN NICOLAE

Introduction

Technoscientific (re)configurations address bodies at different levels of their appearance and in variable modes ranging from technological interventions as prostethics or cosmetic surgery up to body monitoring technics as, for instance, technically enhanced prenatal diagnosis or health apps. Such “hybrid bodies” became the foreground for salient ways of conceiving the interwoven references of (scientific) knowledge and technologies. While the *living* body dominates the scene of technoscientific practices and therefore plays a central part in posthumanist and biomedical discourses, less attention is paid to entanglements between technology and the *dead* body. I will place this topic at the core of my inquiry.

The following chapter draws on Gunther von Hagens’ *Body Worlds*-Exhibition, in which technically prepared organs, body parts as well as entire human bodies (the so called “plastinates”) are displayed in different artistic postures for a broad public. Since the first European exhibition in 1997 in Mannheim (Germany), *Body Worlds* and the conservation technique of “plastination” are a matter of constant – public and academic – concern regarding how these overtly defy established practices of handling and exposing human (dead) bodies or biological material. Sociological discussions drawing on these questions have highlighted different ontological regimes (Hirschauer 2002) and time structures brought up by the technically modified corpses (Nicolae 2013) or the visitors’ experience of them during the exhibition (vom Lehn 2008; see also Walter 2004), while discourse (see Hermes da Fonseca 2006), cultural (Troyer 2020), or historical (see Lantos 2011) analyses have extensively addressed the broad public impact of the *Body Worlds*.

In contrast to these approaches, I will, firstly, show how plastination produces a "boundary object" (Star and Griesemer 1989; see also Star 2010) while rendering thereby its ambivalent stance of bridging as well as challenging the limits of technological achievements, artistic craftsmanship, and moral expectations. As hybrids produced at the meeting point between technology and human bodies, I argue that the exhibits of the *Body Worlds* are at the same time hybrids brought up at the crossroads of technological, aesthetic, and moral *knowledge*: technoscientific (re)configurations of dead bodies and their products, the plastinates, co-construct themselves. Bearing this in mind, I will "follow the actors" (von Hagens, anatomists, pathologists, art critics) not so much in their concrete practices of embalming, positioning, and exhibiting the plastinates, but rather in their practices of discursively producing and legitimising these hybrids.

Yet this is just one part of the story. Equally important is, secondly, to look at how socio-technical imaginaries raise along the *Body Worlds*-Exhibition and forge normative visions about society (see Jasanoff 2015). However, this would require less a discussion on the (ontological) status of plastinates, but rather a focus on the practices of production, negotiating, and stabilising the meaning of these exhibits. An analysis of exchanges on the exhibition (in the form of online-threads in internet forums dedicated to the *Body Worlds*), the empirical material on which my analysis builds upon, is able to identify three "normative repertoires" in which science, art, and morals are constantly addressed and complementary reshaped in the assessments of plastinates. Against the background of appraising the exhibition, these repertoires analytically render intensive processes of boundary-drawing undertaken by social actors while fine-tuning the normative exigencies, or the "goods" of these three realms of social life. Thus the analysis takes up the valuable intuitions of Marina Maestrutti on the interconnection between art and technoscience (Maestrutti 2011b; see also Maestrutti 2011a), tries to capture the dynamics of the multiple shifts which directly irritates the tacit profile of the technoscientific and social world, enriches the perspectives on socio-technical imaginaries of the body, and engages with methodological options in the sociology of (e)valuation (Lamont 2012; see also Nicolae et al. 2019).

Methodological considerations

Online threads in which the plastinates and the *Body Worlds*-Exhibition are assessed are a privilege research site for understanding how their meaning is discursively produced, negotiated, and stabilised. In general, the analysis of online materials has several important advantages. It is, first, a less reactive method as an interview situation and, second, it very rare offers insights into the social structure of the participants in such exchanges, as the identities of the users remain at least uncertain. Such an online exploration enables, third, to focus exclusively on the argumentative structures that can be reconstructed analytically and, finally, fourth, it prevents the researcher from fancying about social-economical characteristics of the users (e.g., income, gender, race, or sexual orientation) or a class-specific way of assessing phenomena.

The analysed threads are mostly informative. Many users ask, for instance, whether the *Body Worlds*-Exhibition is suitable for children, some of them recommend coming exhibitions in their own town, while others just copy-paste large fragments from the exhibition's catalogues. Nevertheless, there is a lot more in the discussions as a simply "visitor's digest". Indeed, a closer look reveals an intriguing complex fabric of "pros" and "cons", of different ways of legitimating and criticising the plastinates and their presentation while drawing on plural criteria which, are themselves divergently understood and applied. This complexity is well exemplified in Hannah's[1] post:

> Well. I find this corpse robbing not only disgusting and perverse, but, besides all these, also obscene. It is fully emptied from any kind of science, not to mention art. Just disgraceful and without any respect towards life and death. (T4: 270-273)

As this quote puts it in a nutshell, exhibiting plastinated human corpses not only arouses a moral unease among the users, but at the same time the discussions touch upon another two important aspects. The users are provoked to articulate and sustain their understanding of *morals* – and, in addition, of *art* and *science*. These three topics calibrate the discussion through something I would like to call "repertoires" in which actors' representations of "do's" and "don'ts", of the allowed and not allowed, of adequate and inadequate interpretations become subject of dynamic transformations. I chose the name "repertoires" in order to differentiate these broad ways of talking about *Body Worlds* and plastination from others, more established concepts of "discourse" or "narrative", as I was not able to identify, on the one hand, the empirical systematics required by these tools, as well as, on the other hand, the objectified or institutionalised profile of the generated descriptions. In comparison, repertoires live from elective affinities between different formulations, trigger both negative and positive utterances, and encompass both actors' preferences and dislikes. In other words, these "repertoires" render the evaluative grammars, which the forum users employ.

Drawing on the works of Charles Tilly (1984, 2006) and Anne Swidler (1986), Lamont (1992) and Lamont and Thévenot (2000) coined the term of "evaluation repertoires" as «schemas of evaluation mobilised at the discursive or interactional level» (ibid. 8). Albeit the repertoires are not confined to "predefined logics", but emerge empirically

[1] For the present paper I replaced all users' nicknames used in the threads with fictive names. The posts were translated into English and quoted using the thread's number and lines.

(Lamont 2009), they are still indebted to «a central expectation or […] principle from which the repertoire draws its consistency» (Barbot and Dodier 2015). Therefore, Barbot and Dodier would propose the term "normative repertoire" whose analysis «involves reconstructing the network of expectations to which the actors refer in their evaluation, and the pattern that they mobilise to this effect» (ibid. 83). Thus, the methodological clue consists in emphasising «a set of evaluations» produced by actors instead of several «foundational criteria» of judgments (Dodier and Barbot 2016: 305) – or to put it differently: the analytical *raison d'être* of normative repertoires relies precisely on the plurality of actors' fine-tuned normative exigencies they encompass.

The present research engages with ten threads from German internet forums dealing with diverse topics and cumulating 1,963 posts (see Table 9.1)[2]. The timeframe for the analysed threads was set between 2006 and 2015, in order to cover both the original *Body Worlds*-Exhibition (dedicated solely to human plastinates) as well as the exhibition on animal bodies, *Body Worlds: Animal Inside Out*-Exhibition (started in 2010). Additionally, only inactive (closed) threads with more than 15 posts were considered.

Tab. 9.1 – Overview of the empirical material

Thread	Thread Theme	Forum Topic	Postings	Users	Duration (in months)
T1	*Body Worlds*, plastinated corpses, art from corpses	General	1480	254	84
T2	Organ-Plastinates as lifestyle objects	Wellness	37	12	< 1
T3	Corpses plastination	Popular science	15	9	1
T4	*Body Worlds*	General	57	22	2
T5	*Body Worlds*	Medicine	36	15	< 1
T6	*Body Worlds* / Is this art, information, or just a horror-show?	Culture	25	9	1
T7	*Body Worlds*	Hobby	19	12	1
T8	Fascination plastination	Transgender	18	15	9
T9	*Body Worlds* in Germany - Fascinating or repulsive?	Travel	76	42	22
T10	*Body Worlds*	General	200	47	< 1

The threads were downloaded, formatted, anonymised, and archived. For pragmatic reasons, the threads were thematically structured and posts were sequentially[3] analysed.

2 For a more detailed presentation of the material, see Nicolae (forthcoming).

3 For a detailed presentation of the method and methodology of the Objective Hermeneutics adapted for this material see Oevermann et al. (1987).

How does a corpse become a "plastinate" – and not just as an ordinary "anatomical specimen"? In the following, I discuss the stages of this technical process and the several intermingled demands implied therein and stress the tension between the techniques of producing the plastinates and their presentation drawing on plastinators' discursive frame present in several *Catalogues on the Exhibition* and literature dealing with the history of plastination and the exhibition. Chronologically, the different developments of the *Body Worlds*-Exhibition and the plastination technique are well marked, especially when these are analysed within medical or artistic contexts. However, this difference is less sharp when plastination is conceived as *both* a technique of preserving human biological material *and* a mode of visualisation of the human body (see Brock 2009). Designating plastination as «anatomical art», as an «aesthetic and instructive presentation of the body's interior» (von Hagens 2019: 37) supports this symbiosis. In the words of Gunther von Hagens, the developer of plastination: «"Presentation" in this case can be understood both in the sense of an artistic rendering and in the sense of the work performed by a skilled labourer in the field of art» (*ibid.*).

> The term "plastination" is a word of my own invention. In my initial patents of 1977/78, I referred to the procedure as "Polymer Impregnation of Perishable, Biological Specimens", but I did not think that it was very catchy; it was also completely inappropriate for popularising the technology, particularly abroad. (ibid. 32)

The first results of the «surface preserving impregnation of biological objects with plastics» were first presented to the German Society for Anatomy, in Aachen (Germany), in April 1977 (Koser 2014: 83). Although the later focus on human dead bodies was at that point still in the background, the differences to the classical anatomical conservation of biological material were already evident: the natural decaying process is successfully stopped by pouring formalin directly on organic material in glasses, as typically anatomical specimens show, yet this technique fails to preserve the form and appearance of the specimens. Plastination surmounts exactly this burden as it renders invisible the very medium of conservation. As «genuine anatomical specimens», the plastinates are «transparent» and «true to details down to the microscopic level» (von Hagens 2001: 41f; see also von Hagens et al. 1987). The bodies become «comprehensible» and «instructive» for the «medical training» *and* can be «shown to a large public» (Kriz 2001: 33) – even if at first the technical performance was moderate and «the first round of plastinates looked anything but promising» (von Hagens 2019: 32). Rather, flows, defects, bubbles, and a persistent smell dominated the first exhibitions[4].

[4] Regarding the first exhibition in Mannheim (1997) Liselotte Hermes da Fonseca notes:
"As scientific studying objects, the first 'whole-body plastinates' hung slackly on big hooks planted in their heads. Their color was that of pickled, pale chicken-meat and in addition they smelled intense – an

The limits of visibility are pushed back to the cellular level of each specimen. In technical terms, two processes enhance this translation: "dewatering and degreasing" and "forced impregnation" (von Hagens 2019: 25f). While body liquids and fats are firstly slowly dissolved in an acetone bath, in a second step the acetone is replaced «up to the last cell» (ibid. 22) by a reactive polymer. Plastinators see this procedure as a nature's patent: «just as the babies use a partial vacuum to suck the milk out of their mothers' breast, acetone is sucked from the specimen in the vacuum» (ibid. 24). Carefully replacing water through silicon rubber, epoxy, or polyester resin helps «the body cells and the natural surface» to preserve their «condition before conservation» (ibid. 22). Hence, due to "forced impregnation", the preparation resumes the pre-mortal condition of the human body – an exigence that traditional anatomical specimens never met.

Technically «deconstructing the mortality» (Höhn 2001: 215f) accompanies the individuality of each specimen as every plastinate remains «an individual up to its genetics» and displays an «individual life» (von Hagens 2001: 44). Contrary to an anatomical model, which is «always an interpretation» (Institute for Plastination 2011, 16'25''), and always «the same as the next other» (von Hagens 2019: 22), i.e., sacrificing the "anatomical specificity" (Ziegler 1998) for the typology of what the specimens stand for, the plastinates recapture the uniqueness of every single human individual.

This claim also guides the next step: the *positioning* of the plastinate. As the body receives its final form through gas or heat, its future "pose" already anticipates a beholder's view and engages it explicitly in the process of preparation whilst representative muscle groups, organs, tissues, blood vessels, or impressive implants are released from disposable material. Though this endeavour is less dramatic in the case of plastinated body-parts, organs, systems, or for bodies infused with polyurethane and sawn into approximately 1/8 inch-thick slices, it turns out to be the dominant issue for the whole-body specimens, or "gestalt plastinates". Therefore, a new approach to plastinates and their postures is needed that combines both anatomical and aesthetic claims: arteries, nerves, veins, capillaries, their joints and angles must be positioned «anatomically correct» (von Hagens 2001: 42) before being disposed properly in appealing postures.

> It is surprising that many visitors of BODY WORLDS consider some exhibits to be works of art. As an anatomist, I can attest to the fact that the specimen called the *Chess Player* or *The Thinker* was dissected with a high degree of skill and artistic craftsmanship and that the objective, namely of presenting the peripheral nervous system, has been achieved in an exceptionally brilliant and professional fashion as well as in a highly appealing manner. (Kriz 2009: 7)

The positioning «brings the plastinates back in the living world» (von Hagens 2001: 55), whereby forming the plastinates is an «intellectual and artistic achievement, that

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odour that, just like the corpse sent, one can hardly get rid off. During the first exhibition in Mannheim this smell was still present, even if the bodies were supposed to be odourless". (Hermes da Fonseca 2006: 13) has to be strategically planned and thought through again and again during implementation to be coordinated with the overall image» (Institute for Plastination 2011, 7'45''). In the «overall image», for which one must have «the ability to see the finished specimen in the mind's eye just like a sculptor envisions the completed statue while he is carving it» (von Hagens 2019: 36), the body is never reduced to its parts (Jones and Whitaker 2009: 96): skin, sexual organs, bones are expended, are hanging loose, or are just so much cut off as to intensify the plastinates' photogenic and enable an optimal view on the entire corpse, its parts, and details. Some whole-body plastinates acquire additional special settings: e.g., *The Chess Player* receives a chessboard, while others land in artificial garden-landscapes. By employing such artifacts, as Tanassi shows, the whole-body plastinates gain – as in Willard Gaylin's project of "neomorts" or François Dagognet's "faux vivants" – «ad hoc invented identities» (Tanassi 2009: 233). The artistic staging of the plastinates is prolonged through a «posthumous change in identity» of a «shift in value from a useless corpse to a plastinated specimen, which is useful, aesthetically instructive and produced by nature» (von Hagens 2019: 34). The exhibits are paradoxically "living corpses" (Roth 1998: 52), «relieved as real bodies» (Emmrich 1998), helping to arrange "gravity experiments" (Roth 1998: 52), and «presenting their athletic abilities» (Linke 2006: 164).

A new dimension of showing imposes itself in the exhibition, while plastinates' uniqueness is evident when «the plastinates loose their bare character as anatomical specimen» and «become aesthetic exhibits»; then only under these circumstances can they «gain "substance" and be meaningful» (Kriz 2001: 38f). In other words, the technique *and* the exhibition merge into one another and mutual highlight each other: the exhibition artistically reveals the technical subtleties of plastination in so much as the technique of plastination firstly enables the exhibition. Yet, this transformation in handling corpses grounds in the salient diffuseness of the *Body Worlds*: placed at the crossroad between "science", "art", and "morals", the plastinate becomes the expression of a technical enhanced hybrid of "aesthetic", "lively", and "instructive" claims.

«It is true», notes Kriz, «that the pose of the new specimens receives a more prominent part, but it stems from the relationship to the preparation's purpose, from the creation of a "possible insight"» (ibid. 38). This enabled "insight" further justifies the bracketing of any moral tabus, sometimes even pointing at original art works that served as references for the exhibits: in the tandem *Surgery in Still Life* (2007) «the plastinate refers to Rembrandt's famous painting "The Anatomy Lesson of Dr. Nicolaes Tulp"» (Whalley 2019: 165), *The Basketball Player* (2002) «demonstrates the skin modelling muscles of our body in a very dynamic posture» (ibid. 172), while *The Limber Gymnast with Organs* (2006) «presents its internal organs [taken up from behind] with lungs, heart, liver, and intestinal tract» (ibid. 184). «The aesthetic pose […] is what helps dispel revulsion», counters von Hagens any moral doubts, and «because it is so powerful, it also promotes emotional awareness» (von Hagens 2019: 37).

The right ambient, an illustrative requisite, and the dramaturgy of staging «the beautiful and sensational of a plastinate» (ibid. 19) concludes the technical work on the human body. *Body Worlds* thus retains the technical finesse of plastination and (re)enacts it in an aesthetically fashion, yet going beyond a simple display of plastinated human bodies. It produces rather a living-dead hybrid of human flesh and technology, in which *science*, *moral*, and *art* collide and intermingle. The following repertoires render this image on a discursive level.

«I love books, but no book comes even near to this!» – The repertoire of science

Plastinates cannot be detached from their scientific relevance. Drawing on their study, education, the need to be informed, or their sheer scientific curiosity, users of internet forums discursively placed the plastinates in a context of an ongoing progress of mediating scientific knowledge. In this respect, they show how plastinates help them reach «insights» in the inner realm of human anatomy, how plastination brings forward the technique of preparation, or how the presentation of human specimens serves the laypersons, the professional public, and beyond all that: the science. Plastinates are thus imagined and discussed as scientific and study objects, whereby their particular scientific character remains highly disputed.

For many users plastination reached the ultimate level of technically enhanced *visibility* of the human body. Fine structures as blood vessels, tissues, organs, fetuses are now «real», «original» –or, as Robert writes, it is «nature without make-up» (T1: 8189). "Real science" must then be transparent, go beyond copies, refrain from any interpretations, and look only for the original, for the authenticity of the human body, that the medical books cannot render properly: «I love books», Daniel cautiously mentions, «but no book comes even near to this!» (T10: 1241f). On the contrary, books may even make the reader «dumb», as they are usually «boring», Martin puts it (T1: 14928), whilst the plastinates are «thrilling» and available in «3D», Oliver adds (T1: 1236).

Yet, the scientific claim of authenticity resolves not only in the contrast to the written word or images of anatomical manuals. Moreover, the plastinates do not offer a falsified, but a truthful contact with the human body. «It is important», as Benjamin argues, «that one not only studies things, but one "gets" them in the purest sense of the word» (T1: 7635f). Authentic science should make things *palpable*, and in this case not just metaphorically. "Feeling" and "touching" the plastinates offers a unique experience, as Christoph recalls after holding one of them in his hands: «the plastinated liver feels like leather and the lung is really like a sponge» (T1: 14283f.). Thus, the plastinates not only show the «fine traits of the human body», as Irina acknowledges (T6: 193), but the visitors of the *Body Worlds* can practically «look directly in the "machine" body» (T1: 10753), notes Olaf.

Reclaiming this particular kind of visibility, more valued in contrast to anatomical drawings, pictures, or on-line animations, the *Body Worlds*-Exhibition also induces salient reflections on the *political implications* of science. Then such an unmediated contact with the objects of science makes science *accessible* to everyone. Mary recognises, for instance, a «scientific factor for the community» (T1: 3098) that plastination brings up, as it simultaneously addresses different ranges of scientific expertise. In this respect, Gunther von Hagens stands forth as the messianic figure of this unheard democratisation of scientific knowledge: «He is a plastinator», argues Stefan, «and wants to teach the body and the anatomy to the people» (T1: 9012f.). Nevertheless, how far this momentum of scientific enlightenment should rich remains contentious. Sometimes the users point at a personal demand. Maurice, for instance, confesses that «using unusual and scary techniques, von Hagens conveyed to me a better understanding and knowledge» (T1: 8144). But the transition from an addressed "I" to a much larger "we" of scientific knowledge unveils a more poignant calibration of the public. "We" are undoubtedly «the folks», «the average people», or as Sue mentions, «the normalos» (T1: 12888) lacking intense scientific training, but also medical doctors, students, professors, or nurses – or even more amalgamated, as in Sebastian's hint to general «scientific research and teaching» (T1: 14605). Regardless of the previously attained expertise, plastination is overall fancied as a key, unlocking a fairy-tale world populated by mysterious appearances that obey unearthly meanings and time structures, as Alice explains:

> Should you step inside the *Body Worlds*-Exhibition, then a brand new cosmos unveils itself. You see fantastic specimens and structures you could only wish to have seen in the anatomy-class. I cannot claim I could escape this fascination, because one basically feels oneself as a ten-year old child celebrating Christmas and birthday at once. (T1: 7642f.)

The expectation of a general accessibility of science requires an adequate technique of producing scientific knowledge that deeply cares for the *correct* presentation of anatomical structures. Then, as Lucas warns, «what can you learn when a corpse holds its organs in its hand?» (T1: 3701). In this respect, Lucia is even more direct:

> Most of the exhibits are so posing that entire muscles are ripped off and hanged up on steel wires. For what purpose? Just because it is "cool" and it looks like "art", then I see neither the anatomical utility, nor its use for knowledge mediation. (T10: 1729-1732)

Indeed, when deviating from their natural design, the plastinates leave behind the safe grounds of science: they do not contribute to the growth of scientific knowledge anymore, as Noah regrets: «they are not making the human body more comprehensible when I look at several objects in abstract poses» (T1: 3962f.). Beyond the *techno-scientific enhanced visibility* of the human body lies the equally disputed realm of *art*.

While the pose of the plastinates enters the scene, their use for mediating scientific knowledge faints: *Body Worlds* is judged as a curated art exhibition. However, just pointing at the artistic dimension of plastinates would not transform them into artworks – at stake is rather the very meaning of art and the limits of *artistic performance*. And especially this aspect finds Andrew quite hard to formulate: «it provokes, it is unique, it is impressive… therefore it appears to be art», he reckons, and shortly after concedes: «well, one can really argue about the artistic claim. This might sound "schizophrenic": about this I could even fight with myself» (T6: 195-201). Yet Finn is more inclusive in his judgements of art, as he writes: «art cannot be reduced to anything, art is undefinable, everything and nothing at once» (T1: 14756f.).

The plastinates are «fascinating» and «breathtaking», and in certain regard, they seem to resemble a «modern portrait», Lucas thinks (T1: 598), even if some users, as, for instance, Lena, agree that «the prepared corpses are so arranged that one cannot recognise who s/he was during her/his life, even if one might have known her/him» (T1: 4152f.). Whether the identity of the plastinates is known and accessible or not, they surely point at renowned artistic techniques. Different schools or art movements thus bear witness as sources of inspiration for the artistic staging of the exhibition. Annabel argues, e.g., that plastinates are actually «surreal sculptures» made of dead bodies (T1: 2731), while Erika goes as far as to put exactly the human source of the specimens into question:

> This exhibition is not as dreadful as it is usually presented. I think the plastinated corpses have not much left from a corpse, they are somehow… abstract! (T1: 208-210)

As artworks, the plastinates recalibrate the attention from the *interior* of the human body towards its *appearance* as an outcome of plastinators' creative confrontation with organic material. Johanna, for instance, thinks that mostly the artistic skills are underlined in the exhibition and identifies them as a central feature of art: «art has to do with skill and creativity and one must simply acknowledges this for Mr Hagens» (T9: 826) – not least because von Hagens simply «"burns" for his work […] [and does not] pile up luxurious limousines or huge villas», as Alina puts it (T6: 291). Thus the idea of *l'art pour art*, made possible by a creator more interested in the rewards of the artistic performance rather than in financial gains or social recognition, is often considered as the dominant reference in the definition of art, fully accomplished in the *Body Worlds*. Bianca formulates it straightforwardly:

> To put it more precisely, art is not a product, but a process. The process of ripening and enlarging the horizons. Accordingly, the art serves primarily the artist. And only secondary the society. Summarising, one can say that the art is reclaiming itself, which becomes manifest when one attaints a certain level. For me, this level decides whether something should be called an artwork or not. (T: 346-351)

Guarding its autarchic meaning, art draws on its own criteria. For instance, art chooses uniqueness against mass-production. Then «the corpses», sets Laura the discussion straight, «are not prepared in assembly lines, as, for example, in the industry» (T1: 8233), rather, as Sophia realises, the plastinators use an «insane amount of handwork with a love for detail» (T8: 183). Also in contrast to the industrial production, «some art is not beautiful or aesthetic», as James thinks, but something like the «freedom of art and artist», Diana remembers (T9: 811), must be guaranteed. Yet just as much as the plastinates cease to serve as scientific study objects when their visibility breaks with the anatomical correctness, they lose their artwork-character when *Body Worlds* brakes with certain *taboos* – they regain moreover their human traits behind the techno-scientific preparation. Then, as Roger writes, «they are still showing humans after all. Even if, or exactly because, they are no longer alive» (T7: 116f.). For instance, openly displayed corpses and (their) «sexual contact in death», as Ramon phrases it (T1: 13573) are just «alarming» for Ingrid (T9: 577). As such moral judgements amplify, users' exchanges on the meaning of art diminish up to the point when, for some, the exhibition «went too far» and they demand, as Sven does, that «they should finally set some limits to all this!» (T9: 541).

«Imagine your grandpa were plastinated!» – The repertoire of morals

When evaluating the moral implications of the exhibition, the question of *human dignity* entailed in handling corpses brutally erupts in the online discussions. Indeed, some users are constantly preoccupied not to veil the origin of the exhibits: the plastinates are technically transformed *dead humans*, and not simply objects made of plastic exposed for *scientific* or *artistic purposes*. The palatinates are, as Sasha argues, «dead people that really once lived their personal lives on our planet» (T1: 14249), or even «people as you and me, that once went shopping or played with their children», Jenny adds (T6: 71). Vincent points out that these same people are now «skinned off, with unwhole bodies» (T1: 4757), while Linda thinks they were just «pulled through the meat grinder» (T3: 170) and Mara reckons they look like in a «zombie-movie» (T1: 12950).

Nevertheless, the sources of moral concern are multiple. Certain historical parallels are explicitly drawn when the users reflect on manipulating cadavers during the technical process of plastination. For Eva, the plastinates resemble «Mengele's shrunken heads and lampshades made of human skin» (T1: 5092), while Deborah is sure that Gunther von Hagens is «certainly ideologically akin to Dr. Josef Mengele!!!» (T1: 4947). Moreover, plastination as a process of «manufacturing» is similarly criticised whilst the *Body Worlds* appears to revitalised proscribed practices, as Rachel observes:

> Documentaries on National Socialism in Germany play on television. On concentration camps and Auschwitz where people were manufactured to soap, strings, or leather. But then one looks

> at our society and thinks: is it not getting better? Hagens does the same as the Nazis back then. He exploits people until he drops. (T1: 2095f.)

Besides these resemblances with the past, the users judge the naked corpses and the direct presentation of their sexual organs as a distressing break with a longstanding taboo. It is, Ingrid adds, «unheard of and outrageous that these intimate things as sex presentations are exposed publicly in the *Body Worlds*» (T9: 578f.). «Do the authors really think», asks Tabea rhetorically, «that interested persons never had the chance to see the genitals of a living man?» (T1: 3369). And Caroline is even more incisive in projecting a distopic pornographic scene, in which a plastinated relative plays postmortem the leading part:

> Imagine you own grandpa were plastinated. He is standing there in your room. Sometime in the future your're gonna be yourself grandpa/grandma and you gonna have grandchildren of your own. Your grandpa still stands there plastinated in your dining room. It's Christmas Eve. Your grandchildren open their presents. It was a very nice evening. One of your grandchildren touches the dicky of your grandpa and says: Look! I'am playing around with his…! Smiling at the joke of your grandchild, you go peacefully to bed. Oh, really. I can well imagine that it's gonna look like that for a lot of folks in the future. (T1: 61-69)

A sense o *piety* regarding the human corpse accompanies a certain "economy of gaze" and an "economy of talk" while visiting the exhibition: one cannot look at the plastinates as a «voyeur» urges Jacob (T1: 7674), pointing for instance at the genitals, or searching for the «fun» and «sensational» in the exhibition, but the visitors must somehow adapt their view and «behave very respectfully» demands Patricia (T1: 13555), «just like in a cemetery», stresses Kim (T7: 115). Those visitors «feeling aroused in front of a corpse» are just «perverts», notes Clara (T1: 4614). In the same vain, the users usually defined laughing, telling jokes, or even talking laud as a definitive *faux pas*, even if, for users as Matilda, the plastinates are just «empty human sleeves» without «the human fluid-powers» (T3: 16f.). Accordingly, plastination is for Harry «a form of burial. And so is the sky-burial, just more traditional» (T1: 1540). Besides, «plastination is more dignifying as just rotting six-feet under» finds Samira (T1: 12382f.) and it relates for Michael rather to eccentric burial forms as «memorial diamond» (T1: 14698), as with more common forms of inhumation or cremation. Nonetheless, «for real religious people», comments Silvia, «the exhibition is pure horror» (T1: 11206).

But «those who don't want to see it or are considering it as a lack of piety, should stay away from the exhibition!», writes Peter (T9: 810). And yet, when the piety is suspended, «the *Body Worlds* leaves me cold, because I can switch off and see only the body as such and not as a part of a dead person» (T1: 5558f.), certifies Marvin and Adrian also confirms that «you see no blood, you see no flabby intestines, you don't see how people are screaming for their lives» (T1: 4723). In other words, the dead, lifeless human body regains the profile of an *object of scientific study*.

Evaluating objects, social phenomena, or even institutions is never a neutral endeavour. While studying the ways in which «actors assign meaning to what they do and to their transactions with things and people» (Cefaï et al. 2015: 2), the analysis of processes of valuation and evaluation thus turns the practices of asserting and assessing worth into its object (see Lamont 2012). Focusing on the question «how does evaluation work?» (Hirschauer 2015: 38), a sociological inquiry on valuation practices (Nicolae et al. 2019) does not formulate criteria for common or professional valuations and consequently does not claim for itself a prescriptive function, but looks instead at the implicit normative envelope of actors' evaluative acts. Following the analytical frame of "normative repertoires", I depicted how evaluations address plastinates (along their presentation in the *Body Worlds)* as objects of scientific (anatomical) study, as artworks, and as human corpses put on display, which engage at the same time representations of the several "goods" involved in science, art, and morals. How is *visibility* reached in science and how much visibility should science accept?; how far can the *artistic performance* go and what should not be artistically staged?; and finally: what might *human dignity* demand and what claims are formulated thereof?

Introducing the normative repertoires methodologically takes up Star's salient intuition of "boundary objects" as "intercategorical objects" (Star 2010: 609), which not only convey an intrinsic "interpretive flexibility" (ibid. 602), but also forge actors' negotiations on different normative stances, standards, or criteria. Thus, I argue that the plastinates are not simply technoscientifically configured hybrids or technically modified human bodies through postmortem procedures, but they rather directly irritate any attempt to reduce them to a simple and "clear-cut" meaning. Moreover, the normative repertoires also retrace the intense "boundary work" of the actors while trying to point at the difference between domains as different as science, art, and morals. Instead of limits marking these thematic fields, the normative repertoires render the image of a "boundary realm", in which boundaries exist only to be constantly questioned, revisited, and modified.

Barbot, J., Dodier, N.

2015 'Victims' normative repertoire of financial compensation: The tainted hGH case', *Human Studies*, *38*(1), 81-96.

Brock, B.

2009 *The educating power of the science*, in A. Whalley (ed.), *Gunther von Hagens' Body Worlds: The original exhibition on real human bodies* [Catalogue] (14th printing: 264-270), Heidelberg, Arts & Sciences.

Cefaï, C., Zimmermann, B., Nicolae, S., Endreß, M.

2015 'Introduction: Special issue on sociology of valuation and evaluation', *Human Studies*, *38*(1), 1-12.

Dodier, N., Barbot, J.

2016 'The force of dispositifs', *Annales. Histoire, Science Sociales*, *71*(2), 291-317.

Emmrich, M.

1998, February 28 'Sich selbst begreifen [To Know Oneself]', *Frankfurter Rundschau*, 6.

Hermes da Fonseca, L.

2006 *"Lifeseeing" in den "Körperwelten": Entwicklungsgeschichte "schöner Leichen ohne Verfallsdatum"*, in L. Hermes da Fonseca, Th. Kliche (eds.), *Verführerische Leichen – verbotener Verfall: „Körperwelten" als gesellschaftliches Schlüsselereignis* (pp. 7-25), Lengerich, Pabst Science Publishers.

Hirschauer, S.

2002 'Scheinlebendige: Die Verkörperung des letzten Willens in einer anatomischen Ausstellung', *Soziale Welt*, *53*(1), 5-29.

Hirschauer, S.

2015 'How editors decide: Oral communication in peer review', *Human Studies*, *38*(1), 37-55.

Höhn, H.-J.

2001 *Vergängliche Würde?*, in F. J. Wetz, B. Tag (eds.), *Schöne neue Körperwelten: Der Streit um die Ausstellung* (pp. 215-240), Stuttgart, Klett-Cotta Verlag.

Institute for Plastination (Producer)

2011 *Gunther von Hagens' Body Worlds. The original exhibition of real human bodies* [DVD].

Jasanoff, S.

2015 *Future imperfect: Science, technology and the imaginations of modernity*, in S. Jasanoff, S.-H. Kim (eds.), *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power* (pp. 1-33), Chicago (IL), University of Chicago Press.

Jones, G. D., Whitaker, M. I.

2009 *Speaking for the death: The human body in biology and medicine*, Farnham, Ashgate.

Koser, W.

2014 *From the beginning*, in A. Whalley (ed.), *Pushing the limits: Encounters with the BODY WORLDS creator Gunther von Hagens* (pp. 78-85), Heidelberg, Arts & Sciences.

Kriz, W.

2001 *Der Weg zum Ganzkörperplastinat*, in F. J. Wetz, B. Tag (eds.), *Schöne neue Körperwelten: Der Streit um die Ausstellung* (pp. 33-39), Stuttgart, Klett-Cotta Verlag.

Kriz, W.

2009 *Foreword*, in A. Whalley (ed.), *Gunther von Hagens' Body Worlds: The original exhibition on real human bodies* [Catalogue] (14th printing: 1-9), Heidelberg, Arts & Sciences.

Lamont, M.

1992 *Money, morals and manners: The culture of the French and American upper-middle class*, Chicago, Chicago University Press.

Lamont, M.

2009 *Critère d'evaluation et structures culturelles*, in M. Breviglieri, C. Lafaye, D. Trom (eds.), *Compétences critiques et sens de la justice: Colloque de Cerisy* (pp. 437-446), Paris, Economica.

Lamont, M.

2012 'Towards a comparative sociology of valuation and evaluation', *Annual Review of Sociology*, *38*(1), 201-221.

Lamont, M., Thévenot, L. (eds.)

2000 *Introduction: Toward a renewed comparative cultural sociology*, in *Rethinking comparative cultural sociology: Repertoires of evaluation in France and the United States* (pp. 1-22), Cambridge, Cambridge University Press.

Lantos, J. D. (ed.)

2011 *Controversial bodies: Thoughts on the public display of plastinated corpses*, Baltimore, John Hopkins University Press.

Linke, U.

2006 *Theatrum anatomicum: Zur Dramaturgie einer Körperöffentlichkeit*, in L. Hermes da Fonseca, Th. Kliche (eds.), *Verführerische Leichen – verbotener Verfall: „Körperwelten“ als gesellschaftliches Schlüsselereignis* (pp. 140-182), Lengerich, Pabst Science Publishers.

Maestrutti, M.

2011a ‘Cyborg identities and contemporary techno-utopias: Adaptations and transformations of the body in the age of nanotechnology’, *Journal international de bioéthique*, *22*(1-2), 71-88.

Maestrutti, M.

2011b ‘Techno-imaginaires du corps à l’ère des technosciences: Art contemporain et utopie de la transformation’, *Cahiers de recherche sociologique*, *50*, 77-95.

Nicolae, S.

(forthcoming) *Im Grenzbereich des Menschlichen. Zu einer Soziologie der Plastination*, Wiesbaden, Springer VS.

Nicolae, S.

2013 *Zukunftserinnerungen: Plastination als Inszenierung von Erinnerung*, in R. Lehmann, F. Öchsner, G. Sebald (eds.), *Formen und Funktionen sozialen Erinnerns: Sozial- und kulturwissenschaftliche Analysen* (pp. 153-167), Wiesbaden, Springer VS.

Nicolae, S., Endreß, M., Berli, O., Bischur, D.

2019 *Soziologie des Wertens und Bewertens*, in S. Nicolae, M. Endreß, O. Berli, D. Bischur (eds.), *(Be)Werten: Beiträge zur sozialen Konstruktion der Wertigkeit* (pp. 3-20), Wiesbaden, Springer VS.

Oevermann, U., Allert, T., Konau, E., Krambeck, J.

1987 *Structures of meaning and objective hermeneutics*, in V. Meja, D. Misgeld, N. Stehr (eds.), *Modern German sociology* (pp. 436-447), New York, Columbia University Press.

Roth, J.

1998 ‘Body counts’, *Konkret*, *4*, 50-52.

Star, S. L.

2010 ‘This is not a boundary object: Reflections on the origin of a concept’, *Science, Technology, & Human Values*, *35*(5), 601-617.

Star, S. L., Griesemer, J.

1989 ‘Institutional ecology, “translations”, and boundary objects: Amateurs and professionals on Berkeley’s Museum of Vertebrate Zoology’, *Social Studies of Science*, *19*, 387-420.

Swidler, A.
1986 'Culture in action: Symbols and strategies', *American Sociological Review*, *51*(2), 273-286.

Tanassi, L.
2009 *Twilife: The art and science of consuming death,* in T. C. Jespersen, A. Rodriguez, J. Starr (eds.), *The anatomy of Body Worlds. Critical essays on the plastinated cadavers of Gunther von Hagens* (pp. 228-239), Jefferson, McFarland.

Tilly, C.
1984 'Les origines du répertoire d'action collective contemporaine en France et en Grande-Bretagne: Vingtième Siècle', *Revue d'histoire*, *4*, 89-108.

Tilly, C.
2006 *Regimes and repertoires*, Chicago (IL), Chicago University Press.

Troyer, J.
2020 *Technologies of the human corpse*, Cambridge (MA), The MIT Press.

vom Lehn, D.
2008 'Körper(Welten) in Interaktion: Eine video-basierte Untersuchung zur interaktiven Produktion von Erlebniswelten', *Zeitschrift für Qualitative Forschung*, *1-2*, 165-188.

von Hagens, G.
2001 *Gruselleichen, Gestaltplastinate und Bestattungszwang*, in F. J. Wetz, B. Tag (eds.), *Schöne neue Körperwelten: Der Streit um die Ausstellung* (pp. 40-84), Stuttgart, Klett-Cotta Verlag.

von Hagens, G.
2019 *Anatomy and plastination*, in A. Whalley (ed.), *Gunther von Hagens' Body Worlds: The original exhibition on real human bodies* (18th printing: 9-43), Heidelberg, Arts & Sciences.

von Hagens, G., Tiedemann, K., Kriz, W.
1987 'The current potential of Plastination', *Anatomy and Embryology*, *175*, 411-421.

Walter, T.
2004 'Body Worlds: Clinical detachment and anatomical awe', *Sociology of Health and Illness*, *26*(4), 464-488.

Whalley, A.
2019 *The human body – Anatomy and function,* in *Gunther von Hagens' Body Worlds: The original exhibition on real human bodies* [Catalogue] (18th printing: 45-211), Heidelberg, Arts & Sciences.

Ziegler, E.
1998, October 8 'Kommentar – Gruselplastinate', *Die Tageszeitung*.

Part IV.
The Digitised Body

10. Technological Practices of Multiple Bodies: Self-tracking in an Overworking Culture

ELISE LI ZHENG

Introduction

On February 23rd, 2022, a 28-year-old software engineer from the Chinese tech giant ByteDance was sent to the emergency room after collapsing in the company's fitness gym and died from cardiac arrest shortly after. The tragedy happened after his strenuous workday – not in his office but in the corporate gym. It is hard to say whether it was the long hours of his office work, his strenuous workout, or a combination of both that led to the immature death of a young man. Discussions on the Chinese social media, filled with sympathy, anger, and anxiety, treated this incident as an instantiation of the "996" (9 a.m. to 9 p.m., 6 days a week) overworking scheme in contemporary China. This overworking culture, defined by the pursuit of productivity, demands a body that bears such ordeals. It epitomises the fetishisation of a healthy, capable, and hardworking self through the management of good health, but the pursuit of health itself leads to unmanageable and sometimes tragic outcomes.

Notably, the use of self-tracking technologies, such as smartwatches, wristbands, and mobile applications (apps), fueled by commercial investment and individualised focus on design and data collection, demonstrates the intensity of personal health management. The expanding health-tech market and availability of cheap devices make it possible to track bodily metrics and behaviors, assisting such strenuous self-management in a fast-paced society with vast scales of collection of personal data. Self-tracking technologies play a critical part in framing and transforming health perceptions and behaviors, especially around the neoliberal ideas of self-responsibilities and self-surveillance (Ajana 2018; Lupton 2016). However, the current scholarship rarely situates the analysis in specific social settings and lacks perspectives from diverse cultural and social backgrounds with conflicting narratives. Most importantly, the questions of "how" are less investigated – through what mechanisms are norms, ideas, and beliefs passed down onto users and waived (or fail to be) into day-to-day routines? Do technologies instantiate neoliberal ideas or serve as interfaces between individual experiences and societal structures and values?

The recent overworking culture in China, which has a tremendous impact on personal health and exacerbates the tension between individuals and society, provides a rich ground for such investigations. This chapter, therefore, offers a unique perspective and approach by examining self-tracking and the use of wearables in an overworking culture. Using interviews on users' experiences and reflections over collected personal data from self-tracking devices, this chapter shows how the idea of "work" – both as on-going bodily practices and a dominating discourse of productivity and personal responsibility – is mediated through technological practices through the enactment of material and social elements. The technological and commercial designs of engagements, rewards, and habituations are interpreted as work/productivity with neoliberal and tech-saturated languages of growth, performance, and self-management. The social and material environments in the workplace blur the boundaries of personal and workspaces and accentuate the need for self-responsibilities and adaptive strategies. Users internalise, reflect, and/or negotiate a work-self relationship through multiple and different practices of personal data and frame their own health narratives that correspond with current social and political structures. In examining the multiplicity of data practices, this chapter unveils personal technologies' health impact in a complex and ambivalent social context and power mechanisms. Furthermore, this chapter discusses innovative approaches to study health-tech designs to involve critical social contexts through examining users' technological and health narratives.

Neoliberal health, work, and self-tracking in China

In *Health China 2030 Strategic Plan Outline* released by the Chinese State Council (Chinese State Council 2016), the promotion of «self-initiated and self-discipline behaviors» became the top priority, placed ahead of the improvement of healthcare services. Cultivating neoliberal, "civil citizens" requires personal responsibilities – a revamp of ideologies about governance. Diverting public health responsibilities to personal practices as "freedom of choice" is the ideological core of neoliberal health. Self-tracking, the new form of know-your-self through personal data collection of biometrics and behaviors, exemplifies the responsibility of managing one's own health. In the process, the power of bodily biometrics is subjectivised as responsible biological citizens' agency (Rabinow and Rose 2006; Rose 1999, 2007; see also Foucault 1988, 1990, 1991). Another notable component of neoliberal health is the idea of "value". Self-tracking through data directs people towards desired bodily values, thereby becoming constitutive of their identity. It speaks to biomedicine's trend towards optimisation (Rose 2007) and anticipation in value (Adams et al. 2009; Cooper 2008). Following Clarke and colleagues (2003), bodily value can entail the commercialisation of data, privatisation of health services, assemblages for surveillance and treatment, and the production of technoscientific identities.

The neoliberal power and value systems correspond with the trends in China, where decades of rapid economic growth gave rise to a well-off middle-class workforce. They are shouldered with the image of patriotic, future-oriented new Chinese citizens, who are globalised and individualised in their approach, but also represent the spirit of hardworking and dedication that President Xi has characterised as essential for the realisation of the "Chinese Dream" – an ambivalent combination of neoliberal values and nationalist imaginary (Gow 2017; Harvey 2005; Rofel 2007; Yan 2010). Hardworking and self-entrepreneurship as an ethical code of Chinese citizens have been ingrained into the neoliberal language of technological development (Lindtner 2020). The struggle to remain in the game is exemplified in the self-management of work/life balance and health with inward-looking and self-disciplinary technologies – especially among the mid-30s and 40s, who are burdened with economic pressures, health risks and mental and physical burnout.

The neoliberal framework of value provides a theoretical ground for studying technological phenomena, yet those phenomena shall be analysed and dissected with material perspectives and societal nuances – how self-tracking encompasses the language of self-surveillance. Lupton argues that digital data circulates as a new form of knowledge by creating a «sociomaterial approach and assemblage», where technology embodies the meaning and significance of self (Lupton 2016: 40-41). People's lives and bodies are reduced to a collection of facts and figures without context, and such a regime is imposed on the user by invisible forms of tracking (Ruffino 2017). Societies and our bodies are perceived and governed as «a modulation of control» (Cheney-Lippold 2011: 5) or broken down and managed in a powerful «dataistic paradigm» (Ruckenstein and Pantzar 2017). Other nonhuman agents such as algorithms, gamification strategies, and data visualisation tools also mediate the human experience by enticing affective experience and subconscious "nudges" geared towards behavioral changes (Choe et al. 2017; Etkin 2016; Fogg 2002; Kelders et al. 2012; Lister et al. 2014). Values are reinforced and expressed through design and interface (Heyes 2006; Zaidan and Roehrer 2016; Zheng 2021). Tech companies can harvest user-generated data for a data-driven "ecosystem" that favors the future vision of optimizable life in a biomedical gaze (Alam 2016; Millington 2016; Millington and Millington 2015). By all means, self-tracking technologies express identity (Ajana 2018) and cultural ideals of individual responsibility and self-regulation for better care (Schüll 2016; Sanders 2017).

Self-tracking technologies also reconfigure the relationship between work and self. Well-being is increasingly linked to work and productivity and is seen as trackable and manageable, which introduced a range of ethical questions of accountability and control (Moore and Piwek 2017; Moore 2018; Saukko and Weedon 2020; Till 2018). The intrusion of technologies challenges the boundaries of work/life, personal/social, and body/artifacts, changing the sense of time and space (Sharma 2014; Wajcman 2015) and transferring bodies into productive and fit subjects (Esmonde 2021).

As boundaries are blurred, and productivities are embodied, the relationship between life, work, and self-tracking extend into a set of connected ideas and practices overshadowed by an overworking culture. However, the current self-tracking studies fell short in explaining such connections and addressing the social context from users' work/life narratives (e.g., life becomes means of reproduction for work). The neoliberal ideas embedded in the technological practices must be investigated empirically among experiences in certain social settings; conflicts and ambivalences are not to be ignored. Therefore, it is necessary to study the situatedness of self-tracking practices to reveal the process of neoliberal power.

Methodology and empirical investigation

Distinct from traditional sociological analyses that focus on structures (e.g., classes and power hierarchies) and interpersonal relations (e.g., communities and networks), as well as from design studies that primarily center on material design and its embedded human intentions, this chapter examines the entanglement of technology, individuals, and social contexts using the concept of sociomaterial "practices". Actors – humans and nonhumans – carry their assumptions, discourses and habits and attach meanings throughout embodied actions and responses, sometimes collectively, in heterogeneous performances (Berg and Akrich 2004; Latour 1996, 2005). Powers are operational in a network of relations and connections rather than a static, overarching structure. As proposed in Deleuze and Guattari's idea of "assemblages", bodies are connected with other human and nonhuman elements, linking biological processes to material objects and social practices. This approach refuses to subordinate the body to homogeneity (Currier 2003; Deleuze 2017) – in the case of self-tracking, the regulatory forces are never one-way and defining but in a constant process of enacting and negotiating. STS scholars have examined the complexity and multiplicity of bodily practices (Berg and Mol 1998; Mol 2003, 2008; Mol and Berg 1994) and the reconfiguration of bodies and machines through performative and situated actions (Suchman 2007). Phenomenons and experiences are, therefore, framed through a constellation of meaning-making, skill-building, and habit-forming practices, interplaying with material and social engagements (Shove et al. 2012).

More recent studies of self-tracking also address the mundane, specific, and situated practices, delineating the process of knowledge-making, for example, in negotiating meanings of weight-losing (Didžiokaitė et al. 2018), constructing narratives in runner's community (Hardey 2019), and appropriating and aggregating bodily data in competing interests (Esmonde and Jette 2021). Technological designs reveal distinct yet interwoven values in different lived experiences (Lyall and Robards 2018). Different practices highlighted some extent of interpretive flexibility as users become situated in different contexts of use (Marent and Henwood 2021) or different «ethico-psychological subjects» (Pols et al. 2019) when it comes to personal choices.

By investigating the articulations of technological practices, this chapter dissects the micro-macro connections of self-tracking practices. It reveals how values, meanings, and human-technology relationships are configured through sociomaterial practices in a broader social and cultural context. The empirical materials are drawn from 49 semi-structured interviews with 37 interviewees conducted by the Author. The interviewees were recruited voluntarily through WeChat groups and the Author's WeChat Moments posts and snowball sampled through existing contacts. The selection criteria are those who experience overworking, stress and/or burnout in workplaces and have regularly used at least one type of self-tracking device/application to monitor health. 17 self-identified as working in the tech sector[1], and 16 self-reported on a "996" or similar scheme on a regular basis (weekly hours > 50).

Gender		**Age**		**Work placement**		**Job Title**		**Overworking**	
Male	20	18-29	11	Tech	17	Engineer	8	On a regular basis	16
Female	17	30-40	24	Other	20	Product	5	Occasional overwork	9
		>41	2			Market	7	No overwork, but stress	12
						Content	7		
						Consultant	3		
						Other	7		

Table 1 – Interviewee background

[1] There is a certain extent of vagueness when someone describe their job placement. Here, tech sector includes companies who makes revenue by selling technological/internet devices, services, or digital contents; the workforce is commonly described as "knowledge workers", distinct from manufacture or service sector jobs. Those tech workers are typically software engineers/developers, designers, product managers, marketers, content managers, among other job titles. As the tech sector projects exponential growth, the "996" scheme was firstly popularised by big-tech companies in China such as Huawei and Alibaba, and the tech sector work in China is characterised as growth-oriented, highly competitive, self-initiative and with potential of upward mobility. However, such overworking culture is not exclusive to the tech sector. See Li 2022.

Questions about their daily routines, workloads, self-tracking behaviors, data interpretation, and health perceptions were asked during online video interview sessions over WeChat. Recordings were transcribed and coded in nVivo for qualitative, thematic analysis. The first round of coding was focused on the theme and topics of life routines, workplaces, and self-tracking data; the second round was to draw connections to show the composition of technological practices and how they are situated in their work/life settings. Aside from the interviews, other materials such as news releases from wearable and app makers, news reports, and design features are critically examined to triangulate users' experiences. Drawing on theoretical concepts of sociotechnical assemblages and technological practices, which address the dynamic, evoloving entanglement of human behaviors and technological designs (e.g., Mol 2003, 2008; Müller 2015; Shove et al. 2012), this chapter seeks to answer:

1. how are work/productivity interpreted during self-tracking engagements with the technological design?
2. how are such practices embedded, enacted, and reinforced through the network of productivity?
3. how are different and multiple practices enacted through alternative explanations of health and resistance against the culture of productivity and overworking?

Work/productivity in design and self-tracking practice

> If I am a few steps short of closing the rings, I will go downstairs to make a few more steps. (Interviewee #2-2, female, works in digital media)

The idea of work/productivity is frequently recognised, perceived, and narrated by the users in their self-tracking practices with wearables and fitness applications. The data collection and reading processes make it convenient to know themselves and provide related information throughout daily use. Other than simply having records, users describe their experience with affective elements during data collection and reading. It is sometimes followed by behavioral changes driven by these experiences, as the quote above from a female digital media worker after finishing her day of work. The Apple Watch has a daily goal visualisation feature in which three important metrics (exercise, calories and standing hours) deemed by Apple Health are shown as three "rings" that one needs to "close" every day as activity goals, with sound and visual effects as "celebration". Users are not usually strange to this type of gamification[2] design, which is common in wearables and fitness app interfaces. These so-called «persuasive technologies» (Fogg 2002) configured

[2] Among a variety of such features, gamification designs have been examined extensively yet, however, the results are mixed especially over its long-term effects (Hamari et al. 2014; Lister et al. 2014; Maturo and Setiffi 2016; Hassan et al. 2019).

within technological interfaces are geared towards promoting physical activities. During the process, the visualisations and interactive features are more often made to embody the technological experiences with affective elements and to incentivise continuous use and engagements. Etkin et al. (2016) argue against the affective elements in gamification of exercises and fitness activities since such design transforms enjoyment into the language of work and damages long-term outcomes.

However, looking beyond the affective reactions towards design features, the actual practices of users' engagement with gamification designs gravitate towards performing work/productivity more than enjoying entertainment and engagements. The practices are centered around personal plans and goals to stimulate a sense of achievement, especially when seeing performance screenshots right after exercise sessions or when scrolling back to summarise a certain period. Aside from one gamer who addressed the resemblance of fitness to gaming, most interviewees connected and interpreted the visualisations as accumulated hard work and achievement. An interviewee who works in digital media addressed making numbers as making progress and matching performance:

> I will scroll back to see how long I rode my bike, how far I ran… the change in bodies such as my heart rate, is hard to see; it's slow. But the accumulated running and cycling distance is easy to see… It's also a kind of self-incentive, like, I exercised that much last month; should I at least reach my average this month? Should I try harder? (#2-10, male, uses Apple Watch)

Moreover, meanings of selected healthy behaviors (such as steps) are produced by interpreting actions in a reward system where quantified/quantifiable fitness achievements and behaviors become external validations of work. For example, interviewees frequently deploy the action "refresh" (*shua*, 刷), which originally means the refresh key (F5) on the keyboard, indicating getting credits by repeating a fixed action. The term "refresh" was originally used by the gaming community yet adopted in various scenarios where people make repetitive actions for external validation of work. Interviewees used this term when referring to getting steps and exercise time on their wearables as a productive way to accumulate numbers – such as turning on the exercise record when running errands with a bike (#2-16).

> - There is an impulse to "refresh" my steps [when I have my wristband on]… I would walk out for lunch on purpose.
> - For "refreshing" steps?
> - Yes.
> (#2-19, male, uses Apple Watch)

Some applications encourage users to "clock-in" (*daka*, 打卡, sometimes translated as "check-in") daily, shown as crossing off certain tasks. The action of "clock-in" derives from a term that is originally used to describe work – workers use a punch card to record their presence. It has been appropriated by technological designs to indicate the validation of having something done.

> I will clock-in every time I finish an exercise, giving myself some achievement, posting on my timeline and stuff… I feel great as if I have finished something great. (#1-2, female, uses Keep)

This speaks to the assumption that as part of datafication, all activities can be broken down into routine, standard, sequential tasks and could be self-automated with the help of technology (Pharabod et al. 2013; Wajcman 2019). However, it does not mean that it undermines internal motivation. Quite the contrary, the culture of productivity – non-stopping growth and improvement – is internalised and manifested through numbers and tracking records, and work/productivity is both the means and ends. To "refresh" and "clock-in" is to reach goals and accomplishments productively and efficiently. This type of language is observed in most users, regardless of their overworking status.

> [after seeing social media posts] I bought the smart rope-jumping thing to refresh some numbers. 3000+(counts) means good fat-burning. It is definitely faster than running. (#1-20, uses a smart rope-jumping device)

Another element connected with the achievement features is the habituation of healthy behaviors, and such habituation demands extra work and sometimes meticulous self-management rather than smooth, smart interactions embedded in "nudging" designs such as notifications. Popular self-tracking applications, such as *Keep* in China, carry plan-making functions tailored to losing weight or gaining muscles. Apple Watch gives daily "suggestion" of calorie consumption and frequently adjust goals according to the user's daily physical activities – usually pushes towards higher goals (again, a persistent idea of improvement). Users thought the automated settings made things more convenient (#1-12, #2-3, #2-16), yet it doesn't suggest a smooth or automated decision-making process. Interviewees talked about how they consciously choose a metric to "work on", continuously strive to "make room" for certain activities and create stable habits according to the arrangements or plans. The struggles are especially common among those who overwork, as the plans are frequently interrupted, sometimes inducing a sense of anxiety and self-shame.

> The plan is every Mon, Wed and Fri… [due to disruptions], I will have to make up the amount of exercise on the weekend. (#2-21, male, works overtime in a tech company)

> For me, everything is built on routine. Once the routine is interrupted it was difficult… around 2018 I moved to Beijing, and had a period of unstable time. I didn't have time to think about [the plans]… I needed strong self-discipline to open [the app]. It is stressful to stick to a higher standard. (#1-1, female, was on a tight diet while working in digital media)

> I installed the app so that I can exercise any time… [I worked] until 11 p.m. and realised that today's exercise plan hasn't been carried out… there's a frustration that why someone else can do but I can't? (#1-18, male, works in the supply chain)

With the annotations of hard work and productivity, interviewees mentioned that the accumulation of activity data is a series of self-initiated work metrics that gives a sense of self-affirmation, control, and empowerment rather than a simple "nudge" towards behavioral changes. Besides, the accumulated personal data creates a profile or identity that one would not easily let go of, which again corresponds with the validation of productive work that one has done, giving meaning to the collected data as a process of self-building.

> I don't care about the rewards [in the fitness app]… I do not care about other people telling me what I have done. I care about if I have built the habit of exercising… [when I can do more intense exercises], I feel myself becoming strong. (#1-20, female, works in digital media, uses Keep to track exercise)

> You see, the rings are closed, and this month's rings are all closed; you feel you have completed the plan even if you don't care about the actual numbers and feedback. (#2-9, male, works in a tech company, uses Apple Watch)

Enacting productivity

As people frame self-tracking data as work and productive activities, it is critical to see how certain practices are enacted, how certain elements are involved in the networks of productivity, and how the networks are reinforced.

The practice of work/productivity is framed in the health-tech "ecosystem", where users act as well-informed consumers who practice their free choices and seek ways to improve health performance (Hardey 2019). More notably, this practice aligns with the business models of wearable devices and services – the need to expand scales, accumulate users, and intensify engagements. Users use and produce data as ways of "presumption" (Millington 2016) and provide value to the companies. The work/productivity practices also imply the desired path of progress from novices to well-trained, well-informed consumers – transferring casual users into users of all-around services such as online courses, plan subscriptions, offline gyms, fitness attires and healthy food packages. It is critical for the commercialisation of health tech, a still new and emerging field that attracts venture capital (VC) with the promise of a potential market and scalable business model.

Most app makers and service providers in this allegedly fast-growing market have not lived up to a profit-winning business. In China, the company which makes the most popular fitness app *Keep* went public in January 2022 without current profit but a developing ecosystem the company proposed in their IPO. Intensified and productive self-tracking is seen as materialising the network of profit-seeking stakeholders, including

VCs and health-tech start-ups that make up most of China's health-tech market. In this sense, the self-tracking practices – from an imagined, dedicated user – inevitably point towards productivity out of well-planned personal time (in and out of workplaces) for the assumed goal of fitness and health, which generate potential business revenues.

In addition to the productivity-oriented designs, the practices of recognising bodily achievements are also deeply embedded in the productivity culture, reinforced by the social and material environment around the users. There is an on-going blurring of boundaries between game and work as the design of gamification becomes increasingly popular in the automatisation of behaviors, most notably the application of reward and reflective design to incentivise users and promote self-efficacy (Lister et al. 2014). Workplaces adopt such elements to boost engagement levels and motivation of employees as well as to streamline and automate mundane tasks (Ferreira et al. 2017). The production of work, as well as an ideal employee, blurs work and personal lives (Cederström and Spicer 2015). As work becomes more individualised and precarious, productivity becomes a measurement of both products and aspects of self and bodily states (Moore 2018; Wajcman 2019). The idea of work and productivity become aligned with the management of health and fitness, and bodies being quantifiable and optimizable under the overarching ideology of neoliberal selfhood – bodies are seen as "workable" projects of one's own (Ciccone 2021). Work-related languages, workplace culture, and constant overwork highlight the demand for effective measures to perform self-care as maintenance and reproduction work. Work-related languages are common in describing bodily work, as well as the management of daily routines. Some interviewees describe such bodily work as «making oneself a KPI» (Key Performance Index), a widely used term in workplaces. One interviewee (#2-21, works in a tech company) defines exercise as "an assignment" that needs to be planned and accomplished regularly. For him, fitness apps help record exercise time performed through the wearables, and he tries to "make up" with other activities in and around his workplace if a weekly goal is not met. It is also common for tech companies to encourage workers to perform self-growth with productivity goals. One interviewee (#2-17) said that in her team, it is possible to define fitness goals into personal OKRs (Objectives and Key Results, another framework to measure performance). Workplaces encourage sharing fitness records in "clock-in groups" (*daka qun*, 打卡群), where people show their actions of "clock-in" and get supervised by their peers. Self-tracking records are proof of performances in those groups.

The habituation of health-related plan-making is incorporated into the workplace, too. This phenomenon is more common in tech companies than in non-tech sectors, as the popular notion of work-life balance from Silicon Valley is adapted by Chinese tech companies by installing workplace gyms, massage rooms, and even fitness meal services. They are provided as part of wellness programs (*fuli*, 福利) in parallel with monetary bonuses. It weirdly fits within an overworking culture – employees have certain "freedom" to arrange their own work out by making time during lunch break, after dinner before overtime work, in the late night or extremely early morning to utilise the services. They also navigate wellness options during flexible working hours or working-from-home periods. Interviewees associated such practices of "arrangements" when talked about how they can integrate their self-tracking practices such as steps, exercising plans, and sleeping patterns into life and how it creates predicaments:

> The reason I bought wristbands is to structure my life… the primary thing is to put exercise into my schedule, and then think about how to improve it. Data will help me improve it, but first, I have to have it first. (#2-18, female, work from home in digital media)

Aside from gym workouts, users who are dedicated to achieving fitness goals will respond to notifications to alert sedentary seating pop out during work, perform micro exercises during meetings, and accumulate step goals during lunch breaks. In the users' narratives, the boundaries between personal life and work have been blurred, and individuals must take extra responsibilities to "manage" the intricate relationship between personal spaces and workplaces, and the need to manage is more imperative among those who work from home, or during COVID-19 lockdowns. Such scenarios are reinforced by the use of technologies, as they are integrated with social norms, creating the intricately overlapping space and time as an «ubiquitous technoscope» (Wajcman 2015) that normalises multitasking. An interviewee working in a medium-sized tech company said that she often incorporates fitness app's exercise into her daily schedule (#1-13). Two interviewees (#2-14, #1-3) told that they "block off" a certain time, so that they could be shielded from work messages and meetings while going for arranged exercises.

In sum, the doing and practices of fitness and wearable data provide a lens through which the users understand healthy behaviors, making self-tracking context-dependent and linked with the norms of work/productivity. Meanings are given around a dominant discourse (productivity through hard work), artifacts are stabilised (for measuring productivity), skills are trained (to quantify and record metrics effectively, such as "refresh"), and habits are formulated (arranging life accordingly through monitoring not only bodily metrics but also related behaviors in everyday lives). By treating health, life, and recreation as work, health concerns and responsibilities are translated into the language of productivity and are situated in the increasingly blurred space of work and personal lives.

Bodies as sites of productivity and resistance: multiple practices

As mentioned above, the reward system in self-tracking and wearable applications plays a central part in the design. The reward and achievement elements in self-tracking devices and apps align the practices of recreation and work – which seem to be on the two ends of a spectrum but are increasingly overlapping by the process of self-building. However, there are more nuances in situating these productivity-oriented practices in an overworking culture. The multiplicity of practices reveals different networks involved in the self-tracking design and use and sometimes creates paradoxes in making a productive body, revealing the struggles between overworking and overworked-out selves.

From the maker's and market's point of view, the work/productivity practices of self-tracking imagine goal-driven individuals developing habits and profiles during engagement with the technological interfaces. Nevertheless, the long-lasting vision of continuous use does not quite pan out. The growth of *Keep* slowed down, and the loss of users indicates the difficulty of "cultivating" well-disciplined, dedicated individuals with a «higher standard of health and fitness» (Huang 2022). In fact, users of self-tracking devices do not share the same goals and behavioral logic. Their selective use of services and alternative interpretations of data exemplify the multiplicity of self-tracking practices. Previous studies have identified various modes of self-quantification to create «situated subjectivity» (Pantzar and Ruckenstein 2017). Data values are defined by active engagement as mindfulness, resistance, narrative aid (Sharon and Zandbergen 2017) and different «data valences» across different social settings (Fiore-Gartland and Neff 2015). Uses' living experiences lead to a situational interpretation of self-tracking data, especially in an overworking culture under anxieties and time stress.

There is a fundamental conflict in managing health: health for work or health as extra work. On the one hand, fitness for work is regarded as a social truth of health (Hull and Pasquale 2018), and such body is being readily watched and monitored with self-tracking devices to increase productivity. However, considering the empirical material presented in this chapter about users' experiences, the work/productivity-oriented practices call for additional attention and resources, creating tension in users' daily lives as they struggle to manage stress and time to cope with a body already at burnout. In the practices of self-tracking with various wearable devices and applications, the data collection and interpretation processes entail a negotiation between the three distinct practices: i) body as a subject/site of continuous work, ii) body as a source of productivity/work, iii) body as a vulnerable victim of productivity/work. The first indicates working towards improvement and optimisation, aligned with the logic of engagement and wearable's business model. Health is interpreted as a desirable achievement and a source of self-actualisation. A healthy body is also a disembodied one, translated into quantified progress and accomplishment. However, the second and third practices are sometimes more relevant in an overworking context. Fitness and exercise serve as sources of reproduction against stress and a fix for the vulnerable body, in which the productivity-oriented metrics are less important than the actual experience of relief and distraction from work, such as sleeping, relaxation, and recreational exercises; on some occasions, the vulnerable body shall be hidden away from strenuous, demanding work, suggesting radically different interpretations of bodily data from self-tracking.

For example, the maintenance and restoration of health are, in many cases, a descriptive "status-being" (*zhuangtai*, 状态) – being able to keep a stable energy level, both physically and mentally, in order to work and live stress-free. The performance numbers serve as proxies of such status-being or a benchmark to gauge their physical and mental senses.

> For example, if I have quite a few inactive days, I would feel not right and comfortable, then I'll look at the numbers. If the number proves my feelings and thoughts, I'll start to think about how to be more active… I'll treat it as a reference… My workloads are not stable, and I remember I have once worked 12 days in a row, all until 1-2 a.m. It tests my physical capacity; I need to remind myself I need to rest, sleep, and make time for a small run. I'll feel much better. (#2-10, male, works in digital media)

> I need to make some adjustments to get a better status-being… I hope not just to cut my diet but to let my body move and to avoid staying static for too long… for me, [maintaining] health is to keep things regular and rely on my body to do many things. (#2-13, female, works in digital media, currently on a diet)

> I sometimes look at my sleep tracking as a mindfulness practice… staying up too late will affect my work, and delay at work will lead to staying up late; I'll (use the watch to) notice myself and avoid the vicious cycle. (#2-18, female, works from home in digital media)

Although users actively engage with the health-tech ecosystem by purchasing and continuously using self-tracking devices, applications and devices, the multiplicity of practices allows users to navigate a multitude of resources and regimes to agree with their bodies, sometimes even resisting the existing regime of self-tracking.

> I won't quantify anything other than work, as it costs energy and increases stress… it's like project management. Once something goes wrong, you have to figure out ways to fix it. (Interviewee #2-22, male, recently quit a job in a tech company)

> Wearing my watch is just a ritual [of minding my health], while the data doesn't matter that much. When it reminds me to do things and close the rings, I feel cared about, but won't do it. (Interviewee #1-3, female, works in a tech company)

> I am sick of objectives, always external standard that Chinese are obsessed with… I gave up stringent management. My weight does change due to some environmental factors. I must come to terms with those changes. [#2-14, female, works as a consultant]

As shown in the interviews, in contrast to the imaginaries of flexibility and self-disciplined hard work, the lack of actual freedom due to heavy workloads and tight scheduling pull users out of the imaginaries. The environmental and social factors are pulled into the overall narratives of data interpretation against the unrealistic demands of being a productive self. In this sense, self-tracking and data collection serve as multiple ways of reflection on, informing about, and sometimes even resistance against overwork.

Self-tracking as work can be understood as a series of multiple practices – the ethics of good work and citizens, the material design and interpretation of productivity and optimisation, and the cultivation of certain skills and habits as both healthy and productive. Work/productivity is both a neoliberal norm and a mode of understanding body and health. The term "work" serves as both rhetoric of productivity and invisible labor of tracking, interpreting, and arranging. The multiplicity of the practices shows the (dis) connections between work and various components of neoliberal health networks (e.g., political economy, market, and selfhood). It delineates the power relations between individuals in a precarious status and the Chinese neoliberal regime: organisations, the market, and the overworking culture embed the idea of hard work in the self-tracking technologies, shaping the technological networks around productivity. Health is framed as responsibilities and achievements and, at the same time, an ideal status that individuals struggle to maintain.

The phenomenon of self-tracking entangles with the materiality of devices, with which meanings are produced and interpreted through a series of small, scattered daily actions – recording, "refreshing", looking back, and "clocking-in", many of which can be seen as an intrinsic part of systemic bodily work. The cultural and social context enacts through mundane practices with technological artifacts (devices, applications, and data) as sites of meaning-making and habituation. Users' interactions with the design are shaped by the relational network of practices – a network of work/productivity, where bodies are producing not only personal achievements but also growth and revenues. Nevertheless, individuals make meanings and habits while engaging with technologies to create multiple or alternative interpretations as they navigate the risk-ridden social environment and negotiate with the materialised power. Their precarious states are addressed through the practices, suggesting that self-tracking is not only the instantiation of neoliberal ideals but also a critical interface through which people read and understand their social contexts and bodily connections with them. Users are constantly creating new connections during self-tracking practices between their bodies, devices and social factors, and those connections make up their own health narratives.

This chapter contributes to the literature on self-tracking by engaging by dissecting technological practices. Through understanding the practices in the networks of artifacts, meanings, skills, and habits, the design elements are connected to a broader social context, where different networks are aligned or in conflict. Here, different institutions and their value systems – workplaces, individuals, health-tech markets, etc. – are inscribed through practices onto technological artifacts and seemingly individual choices. Through the analysis of practices and networks, it is easier to see various stakeholders and their engagement with their agendas, interests, and imperatives in making a certain technological phenomenon.

Future research shall further address the political implications of self-tracking – how different the institutional powers reinforce each other by materialising values, imaginaries, and assumptions and recruiting users into their networks of practices. Besides, by connecting designs and practices, it is possible to address users' capabilities in terms of agency and control – how technological design can foster meaningful interactions and co-create practices and narratives with users. How positive, diverse, and inclusive engagement can be made and how design can take on social responsibilities shall be explored beyond the critique of self-surveillance and productivity culture.

Adams, V., Murphy, M., Clarke, A. E.
2009 'Anticipation: Technoscience, life, affect, temporality', *Subjectivity*, *28*(1), 246-265.

Ajana B.
2018 *Metric Culture (intro)*, in B. Ajana (ed.), *Metric Culture: Ontologies of Self-Tracking Practices*, Leeds, Emerald Publishing Limited.

Alam, S. Y. R.
2016 *Promissory Failures: How Consumer Health Technologies Build Value, Infrastructure, and the Future in the Present* [PhD dissertation], University of California, San Francisco.

Berg, M., Akrich, M.
2004 'Introduction – Bodies on Trial: Performances and Politics in Medicine and Biology', *Body & Society*, *10*(2-3), 1-12.

Berg, M., Mol, A.
1998 *Differences in Medicine: Unraveling Practices, Techniques, and Bodies*, Durham, Duke University Press.

Cederström, C., Spicer, A.
2015 *The Wellness Syndrome,* Cambridge, Polity.

Cheney-Lippold, J.
2011 'A New Algorithmic Identity Soft Biopolitics and the Modulation of Control', *Culture & Society*, *28*(6), 164-181.

Chinese State Council
2016 *中共中央 国务院印发《"健康中国2030"规划纲要》*. Gov.cn. Available at: <http://www.gov.cn/zhengce/2016-10/25/content_5124174.htm>; Last retrieved 27/09/2022.

Choe, E. K., Lee, B., Zhu, H., Riche, N. H.

2017 'Understanding self-reflection: How people reflect on personal data through visual data exploration'', *ACM International Conference Proceeding Series*, 173-182.

Ciccone, V.

2021 'Technology of optimization: An emerging configuration of productivity among professional software employees', *European Journal of Cultural Studies*, 136754942110302.

Clarke, A. E., Mamo, L., Fishman, J. R., Shim, J. K., Fosket, J. R.

2003 ''Biomedicalization: Technoscientific Transformations of Health, Illness, and U.S. Biomedicine', *American Sociological Review*, *68*(2), 161.

Cooper, M.

2008 *Life as Surplus: Biotechnology and Capitalism in the Neoliberal Era*, Seattle, University of Washington Press.

Currier, D.

2003 'Feminist technological futures Deleuze and body/technology assemblages', *Feminist Theory*, *4*(3), 321-338.

Deleuze, G.

2017 *Postscript on the Societies of Control*, in D. Wilson, C. Norris (eds.), *Surveillance, Crime and Social Control* (pp. 35-39), London, Routledge.

Didžiokaitė, G., Saukko, P., Greiffenhagen, C.

2018 'The mundane experience of everyday calorie trackers: Beyond the metaphor of Quantified Self', *New Media & Society*, *20*(4), 1470-1487.

Esmonde, K.

2021 '"From fat and frazzled to fit and happy": Governing the unhealthy employee through quantification and wearable technologies', *Qualitative Research in Sport, Exercise and Health*, *13*(1), 113-127.

Esmonde, K., Jette, S.

2021 '"We are Not a Nation of Softies, But We Could Become One": Exploring the Materiality of Fitness Testing in the President's Council on Youth Fitness', *Somatechnics*, *11*(3), 395-412.

Etkin, J.

2016 'The Hidden Cost of Personal Quantification', *Journal of Consumer Research*, *42*(6), 967-984.

Ferreira, A. T., Araújo, A. M., Fernandes, S., Miguel, I. C.

2017 'Gamification in the workplace: A systematic literature review', *Advances in Intelligent Systems and Computing*, *571*, 28-292.

Fiore-Gartland, B., Neff, G.

2015 ‘Communication, Mediation, and the Expectations of Data: Data Valences Across Health and Wellness Communities’, *International Journal of Communication*, *9*, 1466-1484.

Fogg, B. J.

2002 ‘Persuasive technology’, *Ubiquity*, *200*(December), 2.

Focault, M.

1988 *Technologies of the Self*, in L. H. Martin, H. Gutman, P. H. Hutton (eds.), *Technologies of the Self: A seminar with Michel Foucault* (pp. 16-49), Amherst, University of Massachusetts Press.

Foucault, M.

1990 ‘The History of Sexuality – Volume 1: An Introduction’, *Contemporary Sociology*, *8*(4). Vintage.

Foucault, M.

1991 *Governmentality*, in G. Burchell, C. Gordon, P. Miller (eds.), *The Foucault Effect: Studies in Governmentality* (pp. 87-104), Chicago, University of Chicago Press.

Gow, M.

2017 ‘The Core Socialist Values of the Chinese Dream: Towards a Chinese integral state’, *Critical Asian Studies*, *49*(1), 92-116.

Hamari, J., Koivisto, J., Sarsa, H.

2014 ‘Does gamification work? – A literature review of empirical studies on gamification’, *Proceedings of the Annual Hawaii International Conference on System Sciences*, 3025-3034.

Hardey, M.

2019 ‘On the body of the consumer: Performance-seeking with wearables and health and fitness apps’, *Sociology of Health & Illness*, *41*(6), 991-1004

Harvey, D.

2005 *A Brief Hisotry of Neoliberalism*, Oxford, Oxford University Press.

Hassan, L., Dias, A., Hamari, J.

2019 ‘How motivational feedback increases user’s benefits and continued use: A study on gamification, quantified-self and social networking’, *International Journal of Information Management*, *46*, 151-162.

Heyes, C. J.

2006 ‘Foucault Goes to Weight Watchers’, *Hypatia*, *21*(2), 126-149.

Huang, X.
2022 *Keep招股书拆解：不到3年亏损超11亿，流血冲刺IPO*. Sohu.com. Available at: <https://www.sohu.com/a/525777811_115565>; Last retrieved 27/09/2022.

Hull, G., Pasquale, F.
2018 'Toward a critical theory of corporate wellness', *BioSocieties*, *13*(1), 190-212.

Kelders, S. M., Kok, R. N., Ossebaard, H. C., van Gemert-Pijnen, J. EWC.
2012 'Persuasive System Design Does Matter: A Systematic Review of Adherence to Web-Based Interventions', *Journal of Medical Internet Research*, *14*(6), e152.

Latour, B.
1996 'On Actor-Network Theory: A Few Clarifications', *Soziale Welt*, *47*(4), 369-381.

Latour, B.
2005 *Reassembling the Social: An Introduction to Actor-Network-Theory,* Oxford, Oxford University Press.

Li, X.
2022 'Managerial Technique and Worker Subjectivity in Dialogue: Understanding Overwork in China's Internet Industry', *Work, Employment and Society*, *37*(6), 1699-1716.

Lindtner, S.
2020 *Prototype Nation: China and the Contested Promise of Innovation,* Princeton (NJ), Princeton University Press.

Lister, C., West, J. H., Cannon, B., Sax, T., Brodegard, D.
2014 'Just a Fad? Gamification in Health and Fitness Apps', *JMIR Serious Games*, *2*(2), e9.

Lupton, D.
2016 *The Quantified Self*, Hoboken, Wiley.

Lyall, B., Robards, B.
2018 'Tool, toy and tutor: Subjective experiences of digital self-tracking', *Journal of Sociology*, *54*(1), 108-124.

Marent, B., Henwood, F.
2021 *Digital Health*, in K. Chamberlain, A. Lyons (eds.), *Routledge International Handbook of Critical Issues in Health and Illness* (pp. 261-275), London, Routledge.

Maturo, A., Setiffi, F.
2016 'The gamification of risk: How health apps foster self-confidence and why this is not enough', *Health, Risk & Society*, *17*(7–8), 477-494.

Millington, B.
2016 'Fit for prosumption: Interactivity and the second fitness boom', *Media, Culture and Society*, *38*(8), 1184-1200.

Millington, B., Millington, R.
2015 '"The datafication of everything": Toward a sociology of sport and big data', *Sociology of Sport Journal*, *32*(2), 140-160.

Mol, A.
2003 *The Body Multiple: Ontology in Medical Practice,* Durham, Duke University Press.

Mol, A.
2008 *The Logic of Care: Health and the Problem of Patient Choice,* London, Routledge.

Mol, A., Berg, M.
1994 'Principles and Practices of Medicine: The Co-existence of Various Anemias', *Culture, Medicine and Psychiatry*, *18*, 247-265.

Moore, P. V.
2018 *The Quantified Self in Precarity: Work, Technology and What Counts,* London, Routledge.

Moore, P., Piwek, L.
2017 'Regulating wellbeing in the brave new quantified workplace', *Employee Relations*, *39*(3), 308-316.

Müller, M.
2015 'Assemblages and Actor-networks: Rethinking Socio-material Power, Politics and Space', *Geography Compass*, *9*(1), 27-41.

Pantzar, M., Ruckenstein, M.
2017 'Living the metrics: Self-tracking and situated objectivity', *Digital Health*, *3*, 1-10.

Pharabod, A.-S., Nikolski, V., Fabien, F., Libbrecht, L. C.
2013 'Setting oneself in figures: An empirical approach to early self-tracking practices', *Réseaux*, *177*(1), 97-129.

Pols, J., Willems, D., Aanestad, M.
2019 'Making sense with numbers: Unravelling ethico-psychological subjects in practices of self-quantification', *Sociology of Health & Illness*, *41*(S1), 98-115.

Rabinow, P., Rose, N.
2006 *Biopower Today*, *1*, 195-217.

Rofel, L.
2007 *Desiring China: Experiments in Neoliberalism, Sexuality, and Public Culture*, Durham, Duke University Press.

Rose, N.
1999 *Powers of Freedom: Reframing political thought*, Cambridge (UK), Cambridge University Press.

Rose, N.

2007 *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century*, Princeton (NJ), Princeton University Press.

Ruckenstein, M., Pantzar, M.

2017 'Beyond the Quantified Self: Thematic exploration of a dataistic paradigm', *New Media and Society*, *19*(3), 401-418.

Ruffino, P.

2017 *Engagement and the Quantified Self: Uneventful Relationships with Ghostly Companions*, in B. Ajana (ed.), *Self-Tracking: Empirical and Philosophical Investigations* (pp. 11-25), London, Palgrave Macmillan.

Sanders, R.

2017 'Self-tracking in the Digital Era: Biopower, patriarchy, and the new biometric body projects', *Body & Society*, *23*(1), 36-63.

Saukko, P., Weedon, A.

2020 'Self-tracking of/and time: From technological to biographical and political temporalities of work and sitting', *New Media and Society*, *24*(8), 1813-1829.

Schüll, N. D.

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

Sharma, S.

2014 *In the Meantime: Temporality and Cultural Politics,* Durham, Duke University Press.

Sharon, T., Zandbergen, D.

2017 'From data fetishism to quantifying selves: Self-tracking practices and the other values of data', *New Media and Society*, *19*(11), 1695-1709.

Shove, E., Pantzar, M., Watson, M.

2012 *The Dynamics of Social Practice: Everyday Life and How it Changes,* Thousand Oaks, Sage.

Suchman, L. A.

2007 *Human-Machine Reconfigurations: Plans and Situated Actions*, Cambridge (UK), Cambridge University Press.

Till, C.

2018 *Working bodies: Work, exercise and the valorization of productivity in neoliberalism*, in B. Ajana (ed.), *Self-Tracking: Empirical and Philosophical Investigations* (pp. 77-91), London, Palgrave Macmillan.

Wajcman, J.
2015 *Pressed for time: The acceleration of life in digital capitalism,* Chicago, University of Chicago Press.

Wajcman, J.
2019 *"Fitter, happier, more productive": Optimising time with technology*, in V. King, B. Gerisch, H. Rosa (eds.), *Lost in Perfection: Impacts of Optimisation on Culture and Psyche* (pp. 51-60), London, Routledge.

Yan, Y.
2010 'The Chinese path to individualization', *British Journal of Sociology*, *61*(3), 489-512.

Zaidan, S., Roehrer, E.
2016 'Popular Mobile Phone Apps for Diet and Weight Loss: A Content Analysis', *JMIR mHealth and uHealth*, *4*(3), e80.

Zheng, E. L.
2021 'Interpreting fitness: Self-tracking with fitness apps through a postphenomenology lens', *AI & Society*, Feb 7, 1-12.

11. Digitamorphosis of female bodies on affective dating applications

JESSICA PIDOUX, PASCALE KUNTZ

Introduction

Published in the mid-1980s, during which time we witnessed the rise of personal computers and polymorphic information systems, Donna Haraway's "Cyborg Manifesto" profoundly reorganised our thinking when it came to the multiplicity of forms of *encorporation*[1]. Several of these shape parts of the passage «from the cyborg and the digital to the animal, passing through women's bodies», where «the fading of the bodily envelope and the undermining of classic dichotomies (inside/outside; self/world; nature/culture) do not prevent the presence of the living, of flesh and blood, in Haraway's machines» (Gardey 2009: 211). This multiplicity of forms of encorporation converges with the possibilities that social actors are offered when stepping into pluriverses on the Internet (Boullier 2009), without necessarily obtaining a single and universal embodied form of their identity. Various scholars (Détrez 2002, Froidevaux-Metterie 2018) chose to move away from the digital dimensions of the body and its enveloping experience in online platforms, while focusing on clarifying other material, symbolic, and normative aspects offline. Other scholars, however, continued to explore the anchoring of the body in digi-

[1] Taken from French, we use *encorporation* herein to mean that putative bodies do not entail *incorporation* into something specific and affixed.

tal environments and to assert that it is present and modifiable as a way of *manifesting*[2] (Queval 2008 in Casilli 2009) according to the platform type, e.g., video games and dating apps. The ever-increasing use of algorithms in dating applications (apps) is helping to shape the notion of the digital body and its possibilities for encorporation. Online dating is a paradigmatic example of the construction of relational and bodily experiences within programming practices. Digitised body representations adhere to three main mechanisms: i) when individuals register on a dating app, they are required to create a profile page where they describe their body through pre-defined templates in order to present themselves to others; ii) these profile pages assist users in evaluating others' bodies to find a potential date online, before being able to meet offline; iii) these representations are taken into account by the dating-app algorithms so as to recommend profiles to a pair of users (profile A to B, and profile B to A).

The female body as a digitamorphosis for matching algorithms

Dating apps, being digital infrastructures, embed body representations in specific sociotechnical arrangements. They shape how one perceives one's body and how to find a partner through the resulting representations encoded into the computing framework by means of variables (e.g., gender, weight and hairstyle). Additionally, these variables present predefined input values (e.g., female, 60 kg, wavy hair) in natural language that are part of the algorithmic input of a sequence of instructions coded into a machine language, which is destined to provide an output of matching recommendations. Variables are thus components of an essential chain of material mediations: users-interfaces-bodies-languages-variables-algorithms. That is to say that they enable users to tell the machine who they are, and based on which values they can be matched with others. They play a dual role. They are the first elements presented to users in terms of providing a description of themselves as well as the partner they are looking for. They thus serve as textual signals that establish a link between the human and the machine. As input for algorithms, variables also contribute to defining the mathematical space within which sequences of computer instructions are applied in order to determine which profiles (or "matches") can be recommended between users. They thus serve to establish a second link: human-machine-human. Therefore, these profile forms produce a «sexual datafication» which «codify users' desires into a visual, structural, and linguistic order» while directing the audience's gaze (Saunders 2020). This is a «coded gaze», associated with embedded and propagated views by coding systems that make users recognizable to algorithms via categories, and that enable individuals to be understood in relation to how they are seen by others (Cotter et al. 2021). The founder of the MIT Media Lab, Negroponte (1996), employed the term «digitisation» in reference to the material transformation «of atoms into

[2] We propose the translation of *mise en puissance* as *manifesting* in reference to the Cyborg Manifesto as a way to describe how the multiple possibilities of embodiment can be combined and projected with the intention of becoming them.

bits». The philosopher, Rouvroy (2013), while analyzing the governance of algorithms, refers to the «statistical body» that reduces the body to a set of numerical descriptors. Herein, we choose to favor the term "digitamorphosis", which has been borrowed from the communication scientist, Le Guern (2017), who used it to analise the transformation of musical listening practices during the digital turn. This term accounts for the translation of the continuous (a body) into the discrete (its representation within a machine), which conditions the possibility for computational calculation (Berry 2011). The purpose of our paper is to put forward a distinct theoretical argument, and show through empirical data that programming practices and the associated dispositifs for online dating contribute to a reduction of encorporation. These are central objects of study in order to provide an analysis of the knowledge production mechanisms of algorithms and Big Data.

In this article we focus on the upstream phase of digitamorphosis, i.e., on the definition of the variables that are provided as input for the algorithms. Generally speaking, two types of variables can be distinguished: i) the declarative ones, such as weight, whose values are filled in by users via certain interfaces when creating their profile, and ii) the non-declarative ones, such as number of times that the app has been opened, associated with usage traces collected during users' online activity on the platform or via other exogenous sources such as social networks. As Cheney-Lippold (2017) notes in her book, *We are data*, «the process by which algorithms produce knowledge about us is unwieldy and often unknowable». However, declarative variables are accessible, as they are made visible to users so as to describe their bodies to form profiles. Herein, we specifically focus on identifying the declarative variables used in the interfaces of dating apps in order to describe the morphology of "female" bodies, for which the binary categorisation of female/male is taken from our field observations, since the vast majority of the applications studied only offer this option.

A sexualised yet ancillary body on dating apps

Concerning the analysis of dating-app profile pages, Illouz (2006) argues that, in the process of self-presentation, the self becomes an ontology open to an unknown general public that separates the body and the mind because «the use of written language accentuates the uniformity, standardisation and reification» of the individual on the Internet. Saunders (2020) shows that, particularly when it comes to the analysis of pornographic sites, the sexual datafication is crafted by the industry via a hyper-categorisation of mainly the female's body, her behavior, and her race. Lemeilleur (2014b) highlights the idea that the profiles offered by dating apps translate the body «generally into four questions (Your height? Your figure? The color of your hair? The color of your eyes?)», but the author also finds that the body is animated by «the eye of the other that gives life to this inert form that has lost its capacity to move in time and space» (Ivi : 98). In this sense, Lemeilleur (2014b) goes beyond other studies as she considers a second point of view with respect to the body, namely that of the observer. She revisits Haraway's Cyborg Manifesto and sees therein an opportunity for subjectivation to be experienced and renewed on dating apps. She defines this subjectivation as an «interstitial space» wherein the virtual body is an «ancillary» body at the service of becoming a subject, with its multiple physical and symbolic dimensions. In another study, Lemeilleur (2014a) exposes these possibilities on the dating website, Meetic, through the way in which women craft their utterances to present to men, and inversely, men to women. From a perspective that is complementary to single case studies, a quantitative study (Olgado et al. 2020) shows that the ten most popular dating apps with worldwide access in the United States preconfigure a «casting mold» to build a profile with predefined fields (i.e., variables). This study does not provide an exhaustive analysis of the variables used, although, in those listed by the study, only height appears in the description of the user's body. Very recently, Pidoux et al. (2021) compared 30 dating apps on the market and revealed that there are nine categories of variables for representing a user. Of those categories, "individual capital" is the first and most representative category (32%). It refers to individual psychological, morphological, and health factors such as body parts for sexual excitation, sexually transmitted diseases and hair length. This individual capital varies from one app to another and it has yet to be established to what extent those variables, created with an alphabet interpretable by algorithms, shape the narrative of women's possibilities for being encorporated within the digital, as well as offline from the other side of the machine (at the interface's front-end).

A digital actor-network analysis of declarative body variables

The literature on dating apps is scattered across various disciplines in the human and social sciences, and more recently in computer science. While the former focuses on usage targeting couple formation (e.g., Bergström and Pasquier 2019) or the agency of media design development (e.g., MacLeod and McArthur 2019), the latter focuses on developing matching algorithms based on the study of user preferences with a view to computing profile recommendations (e.g., Tu et al. 2014). However, little work has been devoted to an interdisciplinary analysis of the variables feeding these algorithms and, to our knowledge, there are no studies specifically dedicated to analyzing the declarative variables of female bodies. Body description is often conflated with demographic, sociological or psychological variables (Zytko et al. 2021) in order to analise users' practices from an anthropocentric perspective, while ignoring the fact that variables influence the possibility of user interactions as defined by algorithms (e.g., who can be found online, who is available to chat).

This paper goes beyond state-of-the-art research by investigating a reciprocal perspective on variables, which are at the interface of algorithmic and human processes. It is shown that a reciprocal perspective on digital actants portraying the body is necessary for a deeper understanding of the feedback loop: variables assist algorithms in learning users' representations, while at the same time allowing users to learn more about themselves. A study (Rodriguez et al. 2016) of three platforms has confirmed that although the predefined variables on profile forms restrict the range of body descriptions that users can fill in, they refer to them during their interactions online and in free-text fields like the personal description. Moreover, interviews with users on Meetic demonstrate the role of profile declarative fields in establishing an initial online contact with a user, as well as for further assessment of the person during an offline meeting (Kessous 2011).

To clarify our perspective, we pose the following question here: *how do variables that are embedded in a specific computing materiality contribute to propagating a dominant view that shapes the attractiveness of women through their bodies in the dating market?* In order to answer this, we carried out an empirical analysis of 18 Francophone and Anglophone websites and dating apps with worldwide access. Herein, we firstly examine the observed declarative variables and input values describing the morphology of "female" bodies. We then develop a reciprocal perspective on variables from the actor-network theory (ANT) taken from science and technology studies (STS) and extend it with the complementary «digital ANT framework of replications», recently developed by Boullier (2018), as well as the STS-feminist approach proposed by Gardey (2002). In this analysis, those variables that are part of a historical continuity of heteronormative stereotypes in relationships are identified. It is clear from these findings that there is much importance attached to the conventional role of height and to the «upper body» (Perrot 2006), as well as to the hair in particular, as it has been considered an eroticised gendered feature of the body throughout the centuries. The results illustrate the significance, in dating apps, of replicating entities that convey normativity and provoke a reduction and standardisation of users' representations. In particular, they reveal the manner in which the coding process of the body affects how women are erotically perceived by men, and this through relatively few variables and their associated input values, which actually have a much broader impact since they are replicated from one platform to another. Our research shows that the definition of variables in algorithmic programming and the reduction of dimensionality are two combined mechanisms that contribute to the reproduction and amplification of stereotypes in society. These findings provide a valid contribution to furthering research on gender and algorithmic studies hinging on the materiality of GUIs that mediate users' dating experiences and influence couple formation.

Female body descriptions in dating app interfaces: exploratory data analysis

Variables that allow users to describe their profiles and their preferences in dating app interfaces are at the heart of a network of "translations"; i.e., transformations or changes that produce relations between one actant and another – both human and nonhuman – (Akrich et al. 2006). However, as detailed by Boullier (2017, 2018) in terms of research practice, the variety of elements involved within the network can be very difficult to ascertain given the massive amounts of digital traces that are now available, and this complexity limits the use of the ethnographic approach. In an attempt to overcome this limitation, Boullier (2018) suggests putting the networks aside and creating a new «digital ANT framework» based on the concept of «replication processes». By way of example, Boullier (2018) mentions memes that have the ability – via specific features of an image or a semiotic material – to replicate ideas across actants, between one platform and another, between one user and another, as well as between a platform and a user at the intersection of both online and offline situations. Consequently, «the agency of these entities becomes the purpose of the investigation, and must be demonstrated comparatively» (Boullier 2018: 10). In this sense, scholars should «confer a voice to entities that are active co-creators in the knowledge process» (Haraway 2007). It is important to understand what actually holds the sociotechnical arrangement together, even if the associated network is not deployed. Boullier (2018), however, ignores gender dominance issues. Situations where techniques can inherit a sex, and can thus contribute to the solidification of social relations, were explored by Gardey (2002) using the STS approach. Her approach helps to reconcile the analysis of social structures and that of techniques and practices (Ivi: 240). In the online dating literature, two types of sociological analyses are frequently followed: while some scholars consider dating platforms as a technique (STS approach), others consider dating platforms as a space for couple formation (Sociology of Bourdieu, see e.g., Bergström 2019). Gardey's (2002) empirical research demonstrates how her approach contributes toward a better understanding of the entanglement of human reasoning with objects, like a machine. She focuses on the way in which «technical practices – those multiple times and spaces where the interaction of people and things take place – build, stabilise, reconfigure and reproduce social and gender relations», and she scrutinises the agency of objects, humans, and historical usages, as well as advertisement material, in order to understand the sexualisation process of various technical artefacts.

We based our research on this theoretical framework, and developed a mixed data analysis which combines quantitative and qualitative approaches. Firstly, we identified the human and non-human actants present in online dating, and selected the entities at the interface of users and algorithms. Secondly, we identified the variables describing morphologies from among those over a wide range of platforms in order to study their replication processes. Lastly, we analised the ways in which these variables build narratives about women's attractiveness at the intersection of contemporary digital infrastructures and social norms.

Data-collection

The data-collection required prior specification of the scope of variables associated with the category "body". This category refers not only to the human organism or the «visceral body» (Murray 2018), as described by the life sciences, but also to the organism that, *in situ*, is inserted into networks (Détrez 2002). The variables in dating apps focus on both the biological dimension and a broad system of associated symbolic and cultural values. We focus on those morphological variables that describe the external apparent structure of the body. This polarisation enables us to position our analysis in line with the work of historians such as M. Perrot (2006), who writes about the representations of different parts of the female body, and to question the impact of the shift to digitamorphosis. We constructed a corpus of 18 dating apps, chosen for their diversity with respect to target populations. This diversity is based on the choice of sex available, i.e., the options available to users registering to declare their sex, and the sex of other users they are interested in finding. The sex options are binary and have a limited combination of constraints: seeking women (homo) AND men (bi) OR women seeking men (hetero). The vast majority of apps are defined for heterosexual persons (Bergström 2019), and we excluded those dating apps that are exclusively for men seeking men, such as Planetromeo (ROMEO). In this corpus, we identified the morphological variables that are provided to women so as to present themselves to either women, men, or both sexes, depending on the options available during registration[3] (see Table 1). We also took the availability of gender identity (beyond sex) into account, with only five apps extending the binary male/female categorisation, even though their morphological variables remain the same regardless of the value chosen. The variables collected from these apps were extracted manually by following the same process of creating a woman's profile on each of the platforms, without affecting other user's personal data. Finally, to assign a location as to where these apps are designed, the country of the companies' headquarters is noted.

Qty. Variables Body	App Name	Gender Available	Version	Platform Type	Language chosen/ unique*	Company's Headquarter
8	**AdopteunMec**	No	June 2020	website	French*	France
6	**Meetic**	No	June 2020	website	French	France
6	**MeeticAffiny**	No	June 2020	website	French	France
6	**AdultFriendFinder (AFF)**	Yes	June 2020	website	French	U.S.A.
5	**Badoo**	No	5.158.1	Android	French	Russia-U.K.
4	**Casuallounge**	No	Nov 2019	website	French	Germany
3	**Passions - Meet over 50**	No	v2.16.3(205)	Android	French	France
2	**Parship**	No	June 2020	website	French	Austria
1	**Bumble**	Yes	5.173.0	Android	French	U.S.A.
1	**happn**	No	24.28.02	Android	French	France
1	**Hinge**	Yes	7.9.2	Android	English*	U.S.A.
1	**Once**	No	2.91.2104	Android	French	France

3 The declaration of sex in binary mode is mandatory to access the platform in order to determine the type of subscription and the results to be displayed. For example, on Meetic, a woman's account can only search for women OR men – whereas, on happn, men and women can be searched for simultaneously. These options pre-establish to whom a woman's body is made visible.

1	**Her**	Yes	3.5.11 (Build 472)	Android	French	U.S.A.
1	**Lovoo**	No	Nov 2019	website	English	Germany
0	**Tinder**	No	11.17.0	Android	French	U.S.A.
0	**Pure**	No	2.28.102	Android	French	Cyprus-Portugal
0	**Feeld**	Yes	5.7.7	Android	French	U.K.
0	**Tomorrow**	No	2.0.4	Android	French	France

Table 1 – App list sample for the analysis of morphological variables and input values

Women's alphabet: normative digitamorphosis of female morphologies

Women narratives to describe their bodies are written in a mathematical space created by a computing system for matching users. This space is shaped by the algorithms' alphabet, which is defined by the set of the proposed variables and the associated values (variable modalities) within a limited number of possible combinations. These alphabets vary from app to app, displaying certain similarities and differences. Four of the apps (Tinder, Pure, Feel and Tomorrow) do not contain any morphological variables, whatsoever. As concerns the 14 remaining apps, these variables are given a special status: they are very few in number but are presented on the registration page for the creation of a profile and for access to the service. More precisely, the morphological variables represent only 2.7% of the total of 298 variables identified over all of the apps in the corpus but, since they are placed on the initial pages of those apps, where filling in is compulsory for some of them, their response rate bears a much higher probability than others. The GUIs are indeed designed to encourage answering certain questions as a matter of priority (Dror et al. 2013). It is worth noting that the results of a study (on other types of platforms) combining eye-tracking and surveys show that both men and women agree that textual information is important, but that women pay more attention to the textual information when browsing (Schießl et al. 2003). The positioning of morphological variables confirms their importance in the mediation human-machine.

The 14 apps concerned, contain between 1 and 8 variables: *height, eye color, hair length, hair color, hairstyle, body shape, weight* and *bra size*. The distribution of these variables across the apps reveals three classes that can be positioned on a scale. At the beginning of the scale is the first class of apps (Passions, Her, Bumble, happn, Hinge and Once) that describe the body solely in terms of its *height*. The second class includes *height, body shape* (Parship) and *weight* (Passions). The third class (Adopteunmec, Meetic, MeeticAffiny, Badoo and Casuallounge) adds the upper body to the above variables: *hair* and *eyes*, as well as *bra size* for AdultFriendFinder (AFF).

A distinction is made between *numerical* variables (height, weight, bra size) and *categorical* variables (eye color, hair length, hair color and hairstyle). The numerical ones are described on a prefixed numerical scale whose minimum and maximum values vary from one app to another, with the exception of Parship that has a free field for height. For example, the weight scale on Passions, which targets people over 50, is 40-200 kg, whereas that on Adopteunmec, which targets a younger audience, is 30-115 kg. Bra size on AFF is defined according to a set of eight measurements (from 32/70 to 46+/105+). The categorical variables are limited to a restricted number of values. For example, body shape is described as *slim, athletic, normal, generous* and *BBW-BigBeautifulWoman*. Note that hair length is not entered as a numeric variable, and that the apps offer only between 4 and 8 values from the following list: *prefer not to say* (in French, *"ne se prononce pas"), bald, shaved, very short, short, medium-length, long, very long, crewcut* (in French, *"en brosse")* and *balding* (in French, *"dégarni")*.

The *hair* plays a significant role in the transcription of the body into the digital spaces studied. Hair appears among the top body elements in six of the dating apps, where there are three variables are associated with it: *length, color* and *style*. Their values vary in number, order and statement, depending on the app (see Table 2).

Variable	AdopteUnMec values	Meetic values	MeeticAffiny values	Badoo values	AFF values	CasualLounge values
Hair length	Shaved, short, mid-length, long	Short, mid-length, long, shaved, bald	Shaved, very short, short, mid-length, long, very long, bald		Long, mid-length, short, crew-cut, shaved, balding, bald, not determined	Shaved, short, mid-length long
Hair color	White, grey, salt and pepper, platinum blonde, blonde, chestnut, ginger, brown, black (erased: vivid colors) (added: colored, rainbow, tie & dye)	Auburn, brown, black, blond, salt and pepper, ginger, other	White, blond, brown, chestnut, grey, black, ginger, other	Black, blond, brown, colored, grey, ginger, shaved head, white, bald	White, blond, platinum blonde, brown, grey, black, salt and pepper, ginger/ chestnut, other, hair? What hair?, not determined	Ask me!, black, brown, blond, other, ginger, grey/white, bald
Hairstyle	Straight, wavy, curly, frizzy, afro, dreadlocks, spikes, african braids, bangs					

Table 2 – Values of hair variables in French as stated in the apps

1. *length* has ordered values from *short* to *long*; only AFF has *long hair* at the top of the list. Note the presence of *shaved* or *bald* values for women on all apps; these are placed

at the end of the list, except for Adopteunmec. One possible assumption warranting further investigation is that these cuts are currently fashionable, or used as a form of militancy in the current feminist movement.

2. *color* is present on all apps with different values. The largest number is proposed by Adopteunmec and AFF (12 and 11, resp.), and some values display a symbolic meaning by referring to communities (e.g., *rainbow*) and modern aesthetic coloring techniques (e.g., *tie & dye, platinum blonde*). The order of values also differs, including for Meetic and MeeticAffiny that belong to the same business group but target different ages – whereas *white* is in first position on MeeticAffiny, it is last on Meetic.
3. *style* is present only on Adopteunmec, where nine values represent a mix of hairstyles from mainly European and African origins. This could be explained by the fact that the site was designed in France while targeting the French, Belgian, Swiss, and Luxembourgish markets.

We note that these attributes were already present in the baseline French national benchmark survey on spouse choice (Bozon 2006). This survey merits a mention, since half of the sample (7 apps) were created in France, and among the six dating apps highlighting women's hair, three were created in France. Marketing and economic surveys by IPSOS (a multinational market research and consulting firm, with its headquarters in Paris, France) (Ipsos 2013) and INSEE (The National Institute of Statistics and Economic Studies in France) (Insee 2017) confirm the importance attributed to hair when assessing a person's value in the market: the proportion of the average French household budget devoted to personal care and goods, which includes hairstyling, has been growing consistently since 1960. Dating apps incorporate this market logic into their functioning, and then produce an emotional commodification in the form of evaluative and comparative dynamics of body and sexuality that lead to a "non-engagement" in romantic relationships according to Illouz (2020). Illouz (2020) refers to Mirzoeff's work (2009) to show that normalised images about humans – in our study, the female bodies in digital space – have been a part of the continuity of the construction of visual culture for centuries. Mirzoeff (2009) reiterates the importance given to the eyes and hair in the definition of aesthetics, from as early as the ninth century in the East as influenced by Ibn al-Haytham's camera obscura technique, which is often attributed to Western scientists such as Leonardo Da Vinci (Ivi: 24). In the same work, Mirzoeff (Ivi: 159) also refers to an account of a marriage proposal, ten centuries later, in which the male gaze focuses on these two elements specifically. As historians point out, the importance given to female hair is linked to the history of pilosity: «Hair is the woman, flesh, femininity, temptation, seduction, sin. There is an eroticisation of women's hair, especially in the nineteenth century» (Perrot 2006: 71). These stereotyped signals traverse the centuries by adapting their transcriptions according to the nature of the media that propagate them. Nowadays, we find them coded into the interfaces of dating apps.

Discussion

In this final section, we firstly discuss the way in which computer science practices constraints women's narratives about their bodies, by reducing the dimensions that represent them. Secondly, we create an opportunity for developing "Interface Studies" anchored in STS based on an interdisciplinary approach.

Computer science's reduction

A set of variables in dating apps define a list of attributes regarding what is attractive in a woman, for her to declare to a presupposed man or woman according to their sexuality. For the computing system, this list forms an alphabet which shapes the description of bodies. We have here shown that the dating app's alphabet is very reduced, which oblige women to choose among a restricted number of options. This restriction in options is known in computer science as "dimensionality reduction" and the process is antagonist to the widespread understanding of Big Data: Chris Anderson stated in 2008 that «petabyte scale» of information is the new age where tech companies explain social behavior better than science; the article has been quoted 3,152 times[4] and computer scientists, as much as social scientists, are attracted to this massive data collection process. We show, to the contrary, that a reduction of the social world prevails in the digitised representation of women's body for algorithmic recommendations in online dating. Two different mechanisms contribute to explain it. The first one is inherent to the materiality of digital platforms. Variables have a certain materiality in the memory of digital machines. In other words, the machine allocates a physical place in its memory for each of the variables whose values are coded by a sequence of 0s and 1s that constitute the basic alphabet of the computer. These values are then successively modified by the execution of programs, which are the transcriptions of the algorithms in a language that is interpretable by the computer. Consequently, the finite number of variables processed by the computer does not allow the continuity of a body to be fully transcribed onto a digital medium within a scale that can be processed in human perception scales. Moreover, for dating applications, matching algorithms require significant available computational capacities for the numerous operations on variables (see Xia et al. 2016). The material specificity of digital media therefore, leads to a loss of information in the transcription of attributes for human singularity. But these technical artefacts do not fully explain the very small number of variables we have identified in our study.

A major explanation comes from the second reduction mechanism: the human decisions that govern the coding of dating-app algorithms. As we recently raised in a study on dating-app developers' practices (Pidoux et al. 2021), these social actors establish how to define users and their preferences for the development of the relevant algorithms following

4 Statistics of Google Scholar citations about Anderson (2008).

three main factors: the economic and sociotechnical framework of coding practices, the development methodologies including user traces analysis, and the developers' personal dating experiences. We call this a «human-algorithmic decision system» that incorporates little or no expertise on the sociology and psychology of dating, nor couple formation, even though there is a vast literature on the subject in the social sciences (see Bergström 2019). For example, at Tinder, which is one of the most downloaded applications after Netflix, we found that a sociologist was working there for a short time, conducting a scope-limited study about picture-centred presentations. The interviews we conducted (Pidoux et al. 2021) confirmed the lack of social science knowledge in the definition of variables as apps are mainly developed as standalone technological innovations. These are not considered «sociotechnical infrastructures», as Bowker and Star (2000) would coin them. The variable choice is guided in part by the "I-methodology" (Akrich 1995) where app producers rely on informal and self-based experience as they mirror their attributes to define their own target audience. The variables we analised are generally defined according to a sense of normality which recalls the Quetelet's «average man». However, here, the average values which shape women are not defined from statistics, but they emerge from a heteronormative narrative about beauty norms in society regarding the attractiveness of women. On dating apps, a woman's body is coded mainly by capitalising on the eroticisation of their upper body in a cis-heterosexual way. Additionally, we have shown that the variables are defined according to the market targeted by each app, and that they also reproduce stereotypes pertaining to a social community. This counteracts the numerous possibilities for a fluid encorporation that Haraway envisioned in her manifesto, as well as the subjectivation mentioned by Lemeilleur (2014a). In the near future, complementary research will be directed towards a comparison of female and male body representations, as well as beyond the non-binary comparison to include a queer perspective. A first comparison of profile pages on the Adopteunmec site show that there is clear evidence of discrepancies in the reduction of dimensionality for each body respectively.

Consequently, online dating platforms contribute to the reproduction, and more critically to the amplification, of gender stereotypes which have been observed in other dispositifs, e.g., televideo cybersex (Waskul 2011). More precisely, the use of online questionnaires for defining user profiles and preferences is far beyond the framework of dating apps: they also constitute a major algorithmic input for the current perspectives under development in immersive video game experience, virtual reality and artificial intelligence (see, e.g., Pirker et al. 2022; Safikhani et al. 2021). To our knowledge, our study is the first one in online dating literature that identifies the double mechanism of reduction and amplification of information in digitised contexts via "propagation" dynamics (Boullier 2009). It allows us to show empirically how the dating industry codes the gaze in the attention economy. Research in information and cognitive sciences show the effect on memory of small visual cues in the information transmission (*ibid.*). Such stimuli guide users' perception in what is called «an attentional regime of reactivity»

(Boullier 2009). This attentional regime creates excitation and accelerated interactions with interfaces without allowing reflexivity as shown in a recent study of the design of dating app interfaces (Pidoux 2021) Consequently, dating apps strengthen stereotypes. By imposing a limited alphabet in computer systems, interface-mediated encounters drastically restrict a possible regime of exploration (in the sense of Nicolas Auray) about women's diversity, both on individual and collective scales for the sake of the efficiency of the computing system's design.

STS contribution toward a broader phenomenon: Interface Studies

The reduction and amplification questions at the heart of the matching systems that we investigated here are not restricted to online dating platforms. They may apply to any AI phenomena where representations of the human body, sexuality and emotions are translated into a computer language that is embedded in the system. The creation of avatars in virtual realities such as the metaverse, where users select preferences for the representation of their avatars, entails addressing similar questions to those we have explored herein. While avatars have been around for a very long time, such as in Second Life (video game), the former Facebook Inc. company, now Meta Platforms Inc., is expanding the development of avatars so that they will also be able to represent a person's environment and interactions happening in their physical world. Another paradigmatic example concerns sexual robotics, such as AI sex dolls, which continue to advance at a rapid rate. Customers are required to select from a range of options in certain categories (e.g., face, eye color, breast, skin, vagina types, bikini waxing, etc.), thereby resulting in realistic, personalised dolls programmed with AI that are able to converse and engage in sexual intercourse with humans[5]. The extent of the imaginaries offered, even with respect to high tech, remains restricted to a very normative set of choices. The analysis of the emerging trends within digital and connected technologies are increasingly attracting the attention of investors, as portrayed in the media (Goldapple 2021), and are likely to have an impact on the future of social relations. This scenario serves as motivation for the development of "interface studies" from the perspective of interdisciplinary STS. At the core of interface studies reside both the human (developers or users) and the declarative actions at the interface of algorithmic systems. These declarative actions could, for instance, be the variables required: to represent oneself on a profile page, as an avatar or in a doll; to interact with

[5] Avis Vérifiés, *AI Tech Real Doll Robot Girl IA - Naellane - 157cm*. Available at: <https://latex-sexy-doll.com/robot-sexuel-sex-doll-ia/1539-ai-tech-real-doll-robot-girl-ia-naellane-157cm.html#/choix_de_la_couleur_des_yeux-bleu/choix_du_type_de_manucure-french_manucure/choix_du_type_vagin-moule_built_in/choix_du_type_d_epilation_du_maillot-epilation_totale/choix_du_type_de_squelette-squelette_classique/doll_forever_fermete_des_seins-souple_hollow/ai_perruque-1/ai_visage-1/ai_peau-blanche_white>; Last retrieved on 14/04/2022.

others in digital and physical spaces; as input for algorithmic profiling, or as labels that categorise databases for establishing ground truths. The interest in developing a new STS approach lies in identifying and exploring the key mediations between the design and use of infrastructures. As previously explained concerning the human-algorithmic loop, data input and automated feedback from user activity could benefit from exploring new questions in research. We should perhaps be asking: which user inputs are considered and which are ignored by app providers, which data is recovered and interpreted by app providers and for what purposes, and are users concerned by the same inputs as app providers? This novel approach should endeavor to include the various relational dynamics involved in the network, especially considering the fact that the feedback in the human-algorithmic loop is permanent and thus leads to a self-renewal of the digital technologies in relation to their uses at different timescales.

Akrich, M., Callon, M., Latour, B.
2006 *Sociologie de la traduction: Textes fondateurs,* Paris, Presses des Mines.

Anderson, C.
2008, June 23 'The end of theory: The data deluge makes the scientific method obsolete', *WIRED*. Available at: <https://www.wired.com/2008/06/pb-theory/>; Last retrieved in October 2022.

Bergström, M.
2019 *Les nouvelles lois de l'amour: Sexualité, couple et rencontres au temps du numérique*, Paris, La Découverte.

Bergström, M., Pasquier, D.
2019 'Genre & Internet. Sous les imaginaires, les usages ordinaires: Introduction', *RESET: Social Science Research on the Internet*, *8.*

Berry, D. M.
2011 *The philosophy of software: Code and mediation in the digital age,* Basingstoke, Palgrave Macmillan.

Boullier, D.
2009 'Les industries de l'attention: Fidélisation, alerte ou immersion', *Reseaux*, *154*(2), 231-246.

Boullier, D.
2017 'Big Data Challenge for Social Sciences: From Society and Opinion to Replications', *ISA Esymposium for Sociology*, *7*(2), 1-17.

Boullier, D.
2018 'Médialab Stories: How to Align Actor Network Theory and Digital Methods', *Big Data & Society*, *5*(2), 1-13.

Bowker, G. C., Star, S. L.
2000 *Sorting Things Out: Classification and Its Consequences,* Cambridge (MA), The MIT Press.

Casilli, A. A.
2009 'Introduction. Culture numérique: L'adieu au corps n'a jamais eu lieu', *Esprit*, *Mars/avril*(3), 151-153.

Cheney-Lippold, J.
2017 *We are Data: Algorithms and the Making of Our Digital Selves*, New York, New York University Press.

Cotter, K., Medeiros, M., Pak, C., Thorson, K.
2021 '"Reach the Right People": The Politics of "Interests" in Facebook's Classification System for Ad Targeting', *Big Data & Society*, *8*(1), 1-16.

Détrez, C.
2002 *La construction sociale du corps.* Paris: Editions du Seuil.

Dror, G., Maarek, Y., Szpektor, I.
2013 'Will My Question Be Answered? Predicting "Question Answerability" in Community Question-Answering Sites', *Proceedings of the 2013th European Conference on Machine Learning and Knowledge Discovery in Databases*, *3*, 499-514.

Froidevaux-Metterie, C.
2018 *Le corps des femmes: La bataille de l'intime,* Paris, Philosophie Magazine.

Gardey, D.
2002 *Humains et objets en action: Essai sur la réification de la domination masculine*, in D. Chabaud-Rychter, D. Gardey (eds.), *L'engendrement des choses: Des hommes, des femmes et des techniques* (pp. 239-300), Paris, EAC.

Gardey, D.
2009 'Au cœur à corps avec le Manifeste Cyborg de Donna Haraway', *Esprit*, *Mars/avril*(3-4), 208-217.

Goldapple, L.
2021, December 9 'The sex robots are coming… the future of sextech', *Atlas of the Future*. Available at: <https://atlasofthefuture.org/the-sex-robots-are-coming/>; Last retrieved 21/04/2022.

Haraway, D.
2007 *Situated Knowledges: The Science Question in Feminism and The Privilege of Partial Perspective*, in K. Asdal, B. Brenna, I. Moser (eds.), *Technoscience: The Politics of Interventions* (pp. 109-134), Oslo, Unipub.

Illouz, E.
2006 ‘Réseaux amoureux sur Internet’, *Réseaux*, *138*(4), 269-272.

Illouz, E.
2020 *La fin de l’amour: Enquête sur un désarroi contemporain,* Paris, Editions du Seuil.

Insee
2017, January 10 *Les dépenses des Français pour leur apparence physique*. Available at: <https://www.insee.fr/fr/statistiques/2550287>; Last retrieved in January 2017.

Ipsos
(2013, May 27). *Les Français et le bien-être: quoi de neuf?* Available at: <https://www.ipsos.com/fr-fr/les-francais-et-le-bien-etre-quoi-de-neuf>; Last retrieved in May 2013.

Kessous, E.
2011 ‘L’amour en projet’, *Reseaux*, *166*(2), 191-223.

Le Guern, P. (ed.)
2017 *En quête de musique: Questions de méthode à l’ère de la numérimorphose*, Paris, Éditions Hermann.

Lemeilleur, S.
2014a ‘Agencement de désir, stéréotypes de genre et altérité moyenne dans les sites de rencontre’, *Annals of the Faculty of Foreign Languages and Literature – Dimitrie Cantemir Christian University*, 2: 73-82.

Lemeilleur, S.
2014b *Corps Virtuel: Corps ancillaire support de subjectivation*, in A. Rodionoff (ed.), *Les territoires du virtuel: Mondes de synthèse (MMORPG), univers virtuels (Second Life), serious games, sites de rencontre…* (pp. 95-104), Paris, Éditions L’Harmattan.

MacLeod, C., McArthur, V.
2019 ‘The construction of gender in dating apps: An interface analysis of Tinder and Bumble’, *Feminist Media Studies*, *19*(6), 822-840.

Mirzoeff, N.
2009 *An introduction to visual culture* (2nd ed.), London & New York, Routledge.

Murray, P. R.
2018 *Bringing Up the Bodies: The Visceral, the Virtual, and the Visible*, in E. Losh, J. Wernimont (eds.), *Bodies of Information* (pp. 185-200), Minneapolis, University of Minnesota Press.

Negroponte, N.
1996 *Being digital,* New York, Vintage Books.

Olgado, B. S., Pei, L., Crooks, R.
2020, April ‘Determining the Extractive Casting Mold of Intimate Platforms through Document Theory’, *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, Honolulu (USA), 1-10.

Perrot, M.
2006 Mon *histoire des femmes*, Paris, Éditions du Seuil.

Pidoux, J. C.
2021 *Online Dating Quantification Practices: A Human-Machine Learning Process* [PhD dissertation], Lausanne, École polytechnique fédérale de Lausanne.

Pidoux, J., Kuntz, P., Gatica-Perez, D.
2021 ‘Declarative Variables in Online Dating: A Mixed-Method Analysis of a Mimetic-Distinctive Mechanism’, *Proceedings of the ACM on Human-Computer Interaction*, *5*(CSCW1), 100-132.

Pirker, J., Loria, E., Safikhani, S., Kunz, A., Rosmann, S.
2022, March ‘Immersive Virtual Reality for Virtual and Digital Twins: A Literature Review to Identify State Of The Art and Perspectives’, *2022 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, Christchurch (NZ), 114-115.

Rodriguez, N. S., Huemmer, J., Blumell, L. E.
2016 ‘Mobile Masculinities: An Investigation of Networked Masculinities in Gay Dating Apps’, *Masculinities & Social Change*, *5*(3), 241-267.

Rouvroy, A.
2013 *The end(s) of critique: Data behaviourism versus due process*, in M. Hildebrandt, K. de Vries (eds.), *Privacy, Due Process and the Computational Turn: The Philosophy of Law Meets the Philosophy of Technology* (pp. 157-182), London, Routledge.

Safikhani, S., Holly, M., Kainz, A., Pirker, J.
2021, December ‘The Influence of in-VR Questionnaire Design on the User Experience’, *Proceedings of the 27th ACM Symposium on Virtual Reality Software and Technology*, New York (USA), 1-8.

Saunders, R.
2020 *Sexual Datafication*, in R. Saunders (ed.), *Bodies of Work: The Labour of Sex in the Digital Age* (pp. 57-94), Cham, Springer International Publishing,

Schießl, M., Duda, S., Thölke, A., Fischer, R.
2003 ‘Eye tracking and its application in usability and media research’, *MMI Interaktiv – Eye Tracking*, 1(6), 41-50.

Tu, K., Ribeiro, B., Jensen, D., Towsley, D., Liu, B., Jiang, H., Wang, X.
2014, April 'Online dating recommendations: Matching markets and learning preferences', *Proceedings of the 23rd International Conference on World Wide Web*, Seoul (KR), 787-792.

Xia, P., Zhai, S., Liu, B., Sun, Y., Chen, C.
2016 'Design of Reciprocal Recommendation Systems for Online Dating', *Social Network Analysis and Mining*, *6*(32), 1-16.

Zytko, D., Furlo, N., Carlin, B., Archer, M.
2021 'Computer-Mediated Consent to Sex: The Context of Tinder', *Proceedings of the ACM on Human-Computer Interaction*, *5*(CSCW1), 1-26.

Part V.
The Body In and Beyond Science

12. Bodies by other means: Challenging the prevailing biomedical discourses within refused knowledge-based communities

STEFANO CRABU, BARBARA MORSELLO

Introduction

Western biomedicine and related health agencies and institutions identify a relevant domain of expertise in (re)configuring the potentialities, meaning and public representations of the human living body as well as orientating how individuals perceive their bodily experiences (Webster 2002; Rose 2007; Cohen 2009). By means of health technologies, institutional and regulatory arrangements and knowledge assemblages, biomedicine has been scrutinising the body increasingly deeply (e.g., generally with X-rays and medical imaging technologies; see Perrotta 2012) and defining the socio-technical scaffold for localising human beings and their biographical trajectories within epidermal and biological boundaries. These technologically mediated ways of understanding and representing the human body can be framed as an emerging outcome of the long-term processes of reconfiguring the relationship between scientific research and medical practice that are leading to a «technoscientisation of biomedicine» (Clarke et al. 2003: 173; see also Crabu 2016, 2018; Felder et al. 2016). Recently, the crux of these processes has encompassed the large deployment of biomedical technologies along with computer and information sciences. Such deployment is leading to a radical turn towards both proactive biomedical interventions in health (in addition to injury, illness and disease) and a redefinition of the risk and surveillance techniques in biomedicine. Within this technologically dense scenario, health is increasingly being conceived of as a moral obligation and an individual goal that ought to be pursued through not only appropriate lifestyles but also technical means (see Clarke et al. 2010).

It is well recognised that nowadays, biomedical technoscience accounts for many of the biopolitical signatures of Western countries, such as the commodification of health, the development of new risk forecasting models, the increasing relevance of molecular diagnostic tests and an even closer relationship between scientific laboratories, clinical settings and the marketplace. At the same time, the development of so-called alternative scientific and medical facts about human bodies and health issues continues to be a relevant phenomenon in contemporary societies (Brosnan et al. 2018). Such counter-facts are engendered by groups of people contesting the monopoly of institutional science, life scientists, medical authorities and professionals in defining how living bodies should be managed as well as how related health and illness conditions should be identified and addressed (Crabu et al. 2023). Recent research on practices contesting scientific knowledge has highlighted how such groups enact the development of claims and knowledge about how to address health and well-being that are partially or totally refused by institutional biomedical and scientific authorities (Desta and Mulgeta 2020; Bory et al. 2022a, 2022b). Such refused knowledge enacts new meaning and understanding of the complexity of health, illness and well-being issues and can orientate people who distrust institutional science to renegotiate their relationship with prevailing biomedical advice and expertise.

This phenomenon seemed to become more relevant during the recent Covid-19 pandemic, in the context of which, diverse groups of people asserted that "true" and "useful knowledge" does not solely reside within the realm of prevailing biomedical institutions. Indeed, some segments of society developed their own "lay" knowledge, refused by scientific institutions and health practitioners, on how to manage everyday life in the context of the Covid-19 pandemic (Desta and Mulgeta 2020). In doing so, these groups, who can be analytically labelled as communities based on refused knowledge' or, in short, 'refused knowledge communities' (RKCs)" (see Neresini et al. 2024; Crabu et al. 2023; Bory et al. 2022a, 2022b), have also reshaped and strengthened counter discourses and narratives as a means to critically challenge public health measures and gain legitimacy and public recognition for their claims.

Given the state of affairs, the aim of this chapter is to examine how people engaged within two Italian RKCs try to discursively and practically challenge the biomedical gaze by developing refused-knowledge claims about their own bodies, paying special attention to immune system-centred discourses.

Indeed, the immune system is a well-established and relevant object of attention in diverse biomedical domains. Issues related to the immune system and immunisation have attracted the attention of public debate since the release of the earliest compulsory public vaccination programmes and other preventive public health measures, of which, refused knowledge–based communities have traditionally been highly critical (see Blume 2016).

The chapter draws on primary data gathered through in-depth web ethnography carried out during the Covid-19 pandemic, particularly between January 2020 and December 2021. In this regard, recent research has demonstrated that a distrustful stance towards medical knowledge and advice cannot be reduced to a contingent prejudicial or irrational reaction of the groups of people concerned about the containment policies and restrictions implemented by public authorities to manage the spread of SARS-CoV-2 (Prasad 2022; Butter and Knight 2023; Crabu et al. 2023). Rather, during the Covid-19 pandemic, the unexpected public visibility gained by groups of people mobilising knowledge claims refused by scientific institution conferred more relevance to the already existing demand for considering alternative forms of knowledge, beyond scientific knowledge, to address the health and illness issues of human beings. Indeed, in the last decade, this demand has gained support among both ordinary citizens and various healthcare practitioners, as evidenced by the increasing consensus on alternative models of caring and healing (Gale 2014; Vuolanto et al. 2020).

This chapter considers the following two Italian RKCs:

i) the Five Biological Laws (5BLs) community, a heterogeneous milieu gathering the followers of so-called Germanic New Medicine (GNM), a complex system of knowledge – refused by allopathic practitioners for having no scientific basis – that purports to be able to cure cancer, among many other diseases;
ii) the pro-vaccine choice community[1], composed of a variety of groups claiming the right to refuse vaccination as a public health policy, that promotes information and knowledge about the alleged risks of vaccinations and supports families suffering alleged vaccine damage.

The analytical focus of this contribution centres initially on the ways RKCs seek to challenge the well-known military metaphors (see Tanner 2007; Nie et al. 2016) usually mobilised in public and professional biomedicine discourse to describe the human body and immune system as a battleground upon which health practitioners wage their battles using therapeutic paraphernalia to defeat diseases. Hence, it highlights how, in addressing prevailing biomedical discourses and the related military metaphors, the communities concerned shape counter-imaginaries and conceptions of the immune system and reframe the living body as a matter of self-management practices located outside the epistemic borders of biomedicine.

In so doing, the chapter shows how the critical scrutiny of biomedical metaphorical operations is not merely a discursive critique but serves as a backbone for developing spe-

[1] In Italy, this community self-identifies in English as “free vax”. While in other research (see Bory et al. 2022b; Morsello and Giardullo 2022), the label “free vax” has been used to avoid obfuscating the emic jargon, in this volume, we prefer the label “pro-vaccine choice”, since the term “free vax” is not commonly used in English and is potentially misleading.

cific knowledge claims aimed at defining an actionable health and well-being model that rejects the biomedical interventions.

(Re)defining living bodies: The biomedical gaze and their opponents

In recent decades, scholars engaged in exploring the nexus between science and society have highlighted how biomedicine identifies a complex assemblage of knowledge and techniques that play a relevant role in the institutionalisation and technological transformation of human bodies and bodily experiences (Oudshoorn 1994; Mol 2002; van Dijck 2005). According to this research stream, biomedical knowledge is shaped and mobilised by practitioners engaged in various domains (e.g., pathology, molecular biology, anatomy) not only to understand and classify different body conditions but also to (re)align the normal and the pathological so as to define the illness and disease conditions that may entail a biomedical intervention (Keating and Cambrosio 2003). Far from being a neutral space in which to apply scientific facts and evidence, biomedicine co-shapes human bodies by defining their time and space of acting and the existence and legitimacy of specific sociobiological conditions. In this respect, the biomedical construction of the body implies work to sort out different body-related issues that are not only strictly biological but also social (e.g., pregnancy, childbirth, dietary regimens) in terms of diagnoses. Under this perspective, the body is not something ahistorical or merely biologically grounded. The body is "done" via, and connected to, an ensemble of practices, medical technologies, expertise and rhetorical repertories that also encompass the ways a specific body can relate to other bodies as well as to contingent social and institutional processes.

The increasingly technoscientific nature of the practices and innovations of biomedicine (e.g., digital health devices, genome-wide screening, brain scans) can reshape the boundaries of the body in such a way as «to find disease at earlier and earlier stages» (Prior 2001: 252). In this regard, current biomedical practices entail a kind of «premonitory knowledge» (Lock 2005) based on future-orientated information and evidence suggesting (and calculating) the risk of future disease. Hence, premonitory knowledge enacts a shift from «actual patient» to «potential patients» at risk (Timmermans and Buchbinder 2010; Gillespie 2015; Novas and Rose 2000), namely those without symptoms but who are susceptible to develop a disease. By framing the body as susceptible to manifest a disease, biomedical practitioners can translate potential futures into the present, managing them as an object of surveillance and medical preventive interventions, such as vaccinations.

As Clarke et al. (2010) highlighted, the notions of "risk" and "surveillance" are pivotally dispositive in leading current biomedicalisation engines. In this respect, biomedicalisation unfolds through embodied everyday experiences and practices of (self-)surveilling "health" and to minimise, manage and eventually treat "risk". Here, surveillance expands biomedical knowledge and technologies into new dimensions of human life and experiences by extending the surveillance techniques across the population and dissolving the boundary between healthy and sick bodies. In doing so, biomedical technoscience

> begins to focus more on the grid of interactions between people in the community. This multifaceted population space encompasses the physical gap between bodies that needs constant monitoring to guard against transmission of contagious diseases, such as tuberculosis, venereal disease and childhood infection. (Armstrong 1995: 401)

Surveillance in the context of current biomedical technoscience opens the way to preventive intervention on the body, from the management of potentially risky behaviours and lifestyles to mass immunisation policies (Scott et al. 2005).

Here, it is worth noting that although such developments clearly show the extent to which biomedicine has succeeded in establishing its epistemic authority and moral force in the understanding and management of human bodies, the technoscientisation of biomedicine has also managed to

> increase the range of social interests that are affected by and implicated in the field of health and medicine, and thus increase both the potential for public controversy and range of actors prepared to intervene in it. (Hallin et al. 2013: 121)

In such context, public discourses circulating across various media settings can play a pivotal role not only in popularising or driving biomedical interventions but also in vehiculating specific biomedical discourses and metaphorical operations (e.g., the military discourse of the war on diseases, with regard to attacking the external biological enemies that threaten the immune system, which frames the human body as a battlefield; see Neresini et al. 2019). In this respect, as highlighted by Tanner (2007):

> since medical systems and practices are very complex and are subject to many contradictory influences and divergent requirements, their description shows a strong inclination to rely upon metaphorical operations. (p. 35)

Hence, biomedical metaphorical operations are an element at stake in imbuing everyday conversations about human living bodies and in constructing the public legitimacy of the prevailing biomedical paradigms on which the biomedicalisation of the body relies. Put differently, biomedical knowledge is often articulated around metaphors as rhetorical tools for exposing new hypotheses, communicating advice and stabilising and popularising complex scientific facts (see Latour and Woolgar 1986).

Despite the undeniable centrality of institutional biomedical research agendas and policies in shaping the everyday bodily experience of people, the distrust or rejection of the prevailing biomedical knowledge and clinical treatments is still a relevant phenomenon. The forms and practices of refusal and/or contestation of biomedicine have recently assumed intense public visibility in the context of the Covid-19 pandemic. Concerned groups of people mobilised the media, especially those online, as potential settings for sharing experiential-based knowledge and claims not fully compatible with – if not totally opposing – the dominant biomedical paradigms (see Crabu et al. 2023). Such communities are especially concerned with challenging the prevailing biomedical discourses and related metaphors, especially those grounded in the military frame, for depicting a different sociopolitical landscape and power relations between institutionally recognised experts and societal groups.

In this regard, the ongoing prevailing understanding of such phenomena seems to hastily liquidate the emergence of refused knowledge in terms of hoaxes or fake news. On the one hand, such hoaxes would feed scientific mis/disinformation, and on the other, they would sustain the emergence of novel forms of science-based populism, which offer a cognitive scaffold for pseudoscience and conspiracy theories to propagate within the political arena (Desta and Mulgeta 2020; Earnshaw and Katz 2020).

This chapter proposes a different perspective to contribute to the ongoing debate on the shaping of claims about health, illness and well-being that are partially or totally rejected by biomedical authorities. It adopts an agnostic analytical stance that requires judgment not to be passed on the ethical and social value of refused knowledge or for it to be assessed in terms of "rationality" or "truth" according to scientific demarcation criteria. Following this perspective, the chapter examines the ways in which refused-knowledge claims are co-produced to overcome biomedical interventions over the body. In this way, the chapter contributes to the debate on the building of a health and well-being model diverging from the biomedical paradigm, offering critical insights into the current form of resistance towards scientific and biomedical models and explanations.

Methodological note

This research is based on qualitative case studies of two Italian communities engaging in the production of refused knowledge of how to take care of the human body. The first concerns the 5BLs community, a heterogeneous group of followers of GNM, a complex system of knowledge that purports to be able to cure cancer, among many other diseases, and is rejected by allopathic practitioners for having no scientific basis. GNM is a self-vindicated medical paradigm developed in the 1980s by Ryke Geerd Hamer, a German ex-physician whose licence to practice medicine was revoked in 1986 because he treated several patients using methods that resulted in irreversible damage or death. Despite serious concerns about the reliability and safety of GNM, the 5BLs approach has gained momentum in Italy. For example, before his death, Hamer recognised Italy as one of the countries with the greatest penetration of GNM users and practitioners (D'Amato 2019).

The second case study concerns the pro-vaccine choice community, a complex group of people opposed to mandatory vaccination. The Italian pro-vaccine choice community is mainly involved in promoting information on the risks of vaccinations, supporting families who have supposedly suffered vaccine-related damage and lobbying for the withdrawal of compulsory vaccination policy. The main Italian pro-vaccine choice associations are Corvelva and Comilva, both engaged at the national and local levels and privileged interlocutors with other European pro-vaccine choice associations. Corvelva and Comilva have a long history of militancy that can be traced back to the 1980s, during the first wave of demonstrations against vaccination practice in Italy. The data collection for this study began in January 2020, when SARS-CoV-2 entered the online discursive arena and ended in December 2021. Due to the lockdown policy for combating the Covid-19 pandemic, the studied communities strongly reinforced their presence on social media (Morsello and Giardullo 2022). Hence, the data considered in this chapter were collected following the principles of web ethnography outlined by Hine (2000, 2004). To select the appropriate online settings, we performed preliminary queries on search engines and social networks concerning the two communities. This allowed us to identify the most relevant sites, such as blogs, instant messaging groups and Facebook groups, characterised by high levels of interactivity. During non-participant observations, we iteratively and recursively refined the study setting further to retain the more interactional online settings and exclude the less active ones. Having followed publicly available conversations, reposted content and public invitation links to social media-based groups, we finally obtained a sample of more than 30 online spaces (including open personal Facebook profiles, Facebook pages, Facebook groups, YouTube channels, online blogs/websites, video lessons and Zoom webinars). To collect ethnographic field notes, we used a shared template to draft weekly diaries that enabled constant comparisons, for example, of health-related practices or discourses on public health measures. We coded the empirical material during and after the fieldwork according to the principles of constructivist grounded theory (Charmaz 2009), which facilitated an iterative and reflexive process of data analysis. In presenting our findings, we have followed the approach proposed by scholars such as Jackson (1990), Rapp (2011) and, more recently, Lewis et al. (2014). According to this approach, in this chapter, empirical data are not merely treated as free-standing pieces of information, but as empirical triggers used to describe and analyse online settings.

This study is part of a broader project on the social conditions and processes affecting the acceptance of knowledge partially or entirely refused by institutional biomedical and scientific authorities. It has been approved by the Ethics Review Board of the University of Padova (approval no. 2020-Ill/13.41.1).

Communities endorsing knowledge refused by scientific institutions put in the foreground intersubjective experiences as a driver for developing knowledge claims to be mobilised for managing the body properly (Vuolanto et al. 2020; Mahr 2021; Picardi and Agodi 2021; Crabu et al. 2022a, 2023). Therefore, the forms of questioning the current biomedical gaze do not have a merely oppositional dimension; rather, they imply the production of experiential knowledge-based claims by performing a self-scrutiny of the body as well as by intervening in it following such refused knowledge.

As will be highlighted in the next two paragraphs, within the perspective of the RKCs, the immune system has been identified as a relevant discursive object for counteracting biomedical discourses and metaphors that are mobilised in mainstream media and in the public sphere at large for legitimising technoscientific biomedicine. By discursively redefining the meaning and characteristics of the immune system, RKCs are especially concerned with contesting the widely accepted idea that vaccinations, antibiotics, pharmaceutical compounds and other (bio)technologies in general are suitable tools for sustaining the immune system in defending the human body against illnesses. Moving from this assumption, they especially dispute the legitimacy of the military metaphors recurring in the discourses of biomedicine that depict the human body and immune system as a well-bounded biological space defensible via technical means. Hence, RKCs try to elicit a rejection of such a defensive biomedical view by promoting a conception that humans can live in harmony with nature and its (micro)organisms and that what biomedicine considers to be pathogenic external enemies (e.g., viruses, bacteria) are useful commensal entities to be welcomed and protected and not repressed with biomedical technologies and drugs. In the perspective of RKCs, biomedicine mobilises knowledge of and assumptions about the immune system and the living body in general that both depend on and shape unwanted political arrangements that deleteriously affect organisms and public health.

Overcoming the biomedical military metaphor, (re)defining the immune system within refused knowledge-based communities

The military metaphor in the field of medicine (dating back to the institutionalisation of the germ theory by Louis Pasteur in the second half of the nineteenth century) has spanned two centuries of history (Nie et al. 2016). Indeed, it is still widely adopted and promoted both in the public and professional discourse of biomedicine and finds wide use in public health policy documents (see Annas 1995). In this regard, it has been highlighted that the living human body, and in particular the immune system, identifies a relevant discursive anchor point within such a metaphorical operation. Emily Martin (1994), in her seminal work "Flexible Bodies: Tracking Immunity in American Culture", in fact stated that «the immune system has moved to the very center of our culture's conception of health» (p. 186). Scholars such as Haraway (1989), Treichler (1987), Patton (1990) and Waldby (1996) have been interested in analysing the biopolitical implications of the metaphors circulating in the public discourse for framing and legitimising the extension of the biomedical gaze. By mobilising the military metaphors, biomedicine describes the immune system as a bodily tool for defending the (biological) self from pathogenic enemies such as viruses and bacteria that may provoke specific diseases (see Sontag 1990; Bleakley et al. 2014; Nie et al. 2016). Hence, within public and professional biomedical discourses, the image of biomedicine has historically been highly recurrent as an ensemble of expert practitioners and sophisticated technologies allied to declare "wars" to fight diseases (e.g., acute infectious diseases, cancer, diabetes, obesity; see Nie et al. 2016) for the sake of public health and society. In the context of these biomedical metaphorical operations, such wars against a wide range of diseases are intended to be systematically conducted via curative, preventive and recovery weapons (e.g., antibiotics, anti-retroviral drugs, vaccination, other public health measures) that directly boost, help or reinforce the immune system as a battleground. In the view of medical communities, metaphorical operations are intended to offer interpretative resources about the ways biomedicine distinguishes and realigns the normal and the pathological. But analytically speaking, biomedical metaphors are not merely discursive entities for publicly disseminating biomedical knowledge but also performative objects that contribute to legitimising actionable biomedical interventions for protecting the integrity of the self and the body when threatened by pathogen entities (Lerner 2001; Fuks 2010). Accordingly, individuals should be ethically and morally responsible for their own commitment and compliance with the available biomedical technoscience that is depicted as the legitimate apparatus for defending the self, the human body and society at large. Within such a defensive frame, the human body is not only a biological domain pertaining to biomedical knowledge and technique but also a biopolitical terrain susceptible to ethical and juridical negotiations about the legitimacy of biomedical interventions.

If we look at the current forms of contestation of biomedicine among RKCs, it is not uncommon to observe the critical scrutiny of biomedical metaphorical operations that surround the public construction of the human body and the immune system. The two communities considered in this chapter target the military metaphors as a discursive entry point for contesting the conception of immunity in relation to virulence factors and microbial pathogens for what they represent within the prevailing biomedical epistemic culture.

In the case of the 5BLs-based community, the immune system is not a strictly biological fact but a "bio-emotional" terrain for managing what they call "Dirk Hamer syndrome", which is an unexpected shock or conflict (e.g., a psychological trauma following a job loss, the death of a family member or the fear of failing at work) that strikes the individual suddenly and may cause an unconscious reaction with biological consequences (e.g., fever, headache, bone pains, breast pain). According to the 5BLs system of knowledge, a shock or conflict is the major, if not the only, cause of a concerned state of malaise, as illustrated in the following quotation from the *Attivazioni Biologiche* [Biological Activation] blog, a major Italian online platform disseminating the 5BLs-based approach:

> Basically, it is a bio-emotional-perceptive immunity on at least two levels (emotional and bodily) that allows the individual to evolve. Individuals can "learn holistically" to not relapse into the same conflict [that caused the malaise]. (Attivazioni Biologiche 2020)

5BLs followers provide a "holistic" conception of the immune system as an ensemble of psychological (e.g., emotional) and biological interrelated dimensions that configure a space in which symptoms of malaise (e.g., fever) are distinguished by inferring an ongoing conflict, which can affect a specific, predetermined area in the brain, causing a "biological lesion" that then generates the symptom in question (see Hamer 2005). 5BLs claim-makers argue that "diseases" and "pathogen entities", as they are framed within the military view of institutional biomedicine, as well as their clinical and pathological understandings, are fundamentally based on erroneous knowledge about the human body and the immune system, as shown in the following quotation from the public Facebook group *Dossier Hamer – Un libro pieno di menzogne. Ecco la verità per gli onesti* [Hamer Dossier – A book full of lies. Here is the truth for the honest], posted on 10 April, 2021:

> In the dominant official medicine, the "disease" in general is considered an "error of nature", a collapse of the so-called "immune system" or something "malignant", which tries to destroy the organism and therefore must be fought and eliminated with all the tools available in a military medical strategy. […] The immune system, conceived as a kind of army defending the body, was weakened, so that the small malignant cells of cancer or microbes could find a breach, invade the tissue and expand. And therefore, it was important to mobilise our body defence army, the so-called "immune system", against the malignant army of aggressors, microbes or even cancer cells that wanted to destroy us. German New Medicine, on the other hand, has discovered that these are not "diseases" in the sense that had been believed until now but are the symptoms, which we had called "diseases", and are a "meaningful special biological program of nature". […] The so-called immune system, which we had imagined as a kind of army of our organism and annihilated malignant cancer cells or malignant microbes in a great battle, does not exist in this sense.

Within the frame of the 5BLs, every malaise is the manifestation of a "Meaningful Special Biological Program of Nature" (see Hamer 2005: 2) and does not need to be addressed through therapeutic protocols and other biomedical interventions (e.g., taking medications). Instead, a malaise should be left to run its course because it always has the virtuous biological purpose of putting the individual into a healthy status, resolving the conflict in the body. 5BLs followers argue that what evokes a state of malaise cannot be related to external virulence factors, pathogenic agents or degenerative processes occurring at the biological level of the body (e.g., a cancer). The malaise is a matter of an ongoing conflict, and as such, it is necessary to let the symptoms run naturally, try to identify the origin of the shock to resolve it (e.g., job loss, death of a family member, fear of failing at work) and let the body "self-manage" the condition of discomfort until the resolution of the shock. According to 5BLs followers, the immune system is a sort of hybrid terrain that relates the body to the brain and to the contingent psychological mindset. They frame the biomedical military metaphor as a strategy for enacting a kind of biological reductionism that separates the materiality of the body from the immateriality of the mind. Hence, by criticising the military metaphor that is mobilised in the biomedical discourses for accounting the technologically assisted bodywork (e.g., taking medications or vaccines) against external pathogen enemies, the 5BLs followers frame the immune system not as a "defence system" but as a locus in which microbes and viruses are suitable and spontaneously activated by the brain to restore the proper functioning of the body (see the next paragraph for a deep analysis of this issue).

This last point has also been widely shared within the pro-vaccine choice community, which criticises the idea that virulent factors can be harmful for the human body, as illustrated by the following quotation from the public Facebook page of Corvelva, an association promoting the Italian pro-vaccine choice community, published on 19 February, 2021:

> The immune system has two separate and balanced functions, T1 and T2. T1 denotes cellular immunity, the primary defence against fungi, viruses and protozoa; T2 denotes serological immunity, which produces specific antibodies. T1 is the process of direct elimination of agents. T2 represents functional immunity and immunological recognition. At the root of every immunological problem is an imbalance between T1 and T2 functions.
> One single vaccine can decrease lymphocyte-mediated immunity (T1) by 50%, and two different vaccines together by 70%. By now, three vaccines in the same injection, repeated in three successive doses a few months apart, is the norm. Vaccines reduce the number of white blood cells, the vitality of lymphocytes and the segmentation of neutrophils. The level of IgE production is under the tight control of T2 lymphocytes. The imbalance of T2 is a predisposing factor for allergies (colds, asthma, skin rash, etc.).

As pointed out by the members of the pro-vaccine choice milieu, vaccination is interpreted as an uncertain and potentially dangerous practice responsible for immune imbalances. Although within the biomedical military metaphor, vaccines are considered to be among the main weapons for waging preventive wars against diseases, in the case of RKCs, this evidence is strongly questioned. In fact, they see vaccines as harmful entities external to the body that can alter the natural functioning of the immune system. In this regard, pro-vaccine choice followers, in scrutinising the military metaphors, aim to question the epistemic, professional and economic roots of the prevailing biomedicine; they argue that knowledge elaborated in the context of immune biology and then rendered actionable via vaccines is entangled with political and economic interests and is therefore not to be believed, or at least to be considered with scepticism. In this regard, pro-vaccine choice claim-makers frame health researchers and medical experts, such as immunologists and epidemiologists, as a body of practitioners mainly operating under the control of, and in collusion with, political elites and global biotech corporations. Accordingly, such an alleged collusion would prevent physicians, and public health authorities more generally, from pursuing public health.

In more general terms, biomedical metaphor operations are among the main critical targets of the discursive production of the RKCs. Questioning such metaphorical operations is a discursive strategy to promote a well-being counter-narrative in the public sphere to provide different imaginaries and meanings of the human living body, locating health and illness narratives outside the boundaries traced by the prevailing biomedical intervention.

Immunisation: A matter of living naturally

RKCs are especially concerned with criticising the military metaphor behind biomedical public discourses as a way to offer an alternative view to the defensive paradigm surrounding biomedical intervention over living bodies. In doing so, they shape a discursive frame for further developing and orientating an actionable refused model of health and well-being located outside the jurisdiction of medical practitioners.

Despite the differences between the two communities concerned with understanding the immune system and human bodily immunity, they share the conception according to which bacteria and viruses are "commensal allied" entities rather than pathogen enemies to be eradicated via medical technologies. In this respect, as highlighted in the previous paragraph, both the pro-vaccine choice community and the 5BLs-based community consider it crucial to live peacefully with viruses and bacteria, whereas biomedicine instead considers that pathogenic entities should be eliminated via curative, preventive or recovery weapons according to the specific onset of symptoms related to the state of malaise. In the case of the 5BL community, microbes are crucial allies for ensuring a state of health and well-being. Hence, they believe that people are required to accept them and to live with them, since they are part of an alleged "natural" body and environment, as illustrated in the following quotation from the *5LB Magazine – La rivista sulle 5 leggi biologiche* [The magazine on the 5 biological laws] blog:

> Viruses are the microbes that Dr Hamer assumed were coordinated by the cerebral cortex of the mesencephalon. Microbes would come into play in the stages of ulcer repair and tissue necrosis. In essence, the presence of microbes in conjunction with disease gives the illusion that they themselves are the "pathogens" – i.e., the cause of the symptom – when, on the contrary,

> they are important players in the biological process of tissue repair. […] They act when needed and if needed, and they are guided by our brain, which creates the proper conditions for them to do their duty. In tumours with tissue accretion, they act when there is a need to dismantle tumour tissue no longer needed to resolve the conflict. In ulcers and lesions, on the other hand, the bacteria help to repair the tissue. (Sartorio 2017)

According to this view, microbes do not contribute to the onset of a disease; rather, they promote the maintenance and repair of the body. 5BLs claim-makers consider disease to be the result of a conflict, rather than an infection, due to contact with external virulent factors. The so-called Meaningful Special Biological Program of Nature indeed refers to the body's ability to self-repair itself (see paragraph 4.1 of this chapter) through the active intervention of microbes. Thus, microbes are the natural agents that form the basis for the health and well-being model endorsed by 5BLs followers; that is, microbes should not be fought but allowed to act naturally in our bodies. Hence, drugs and other therapeutic protocols developed in the context of biomedicine to prevent pathogens from invading and affecting the health of the human body are essentially considered to be tools against an alleged natural order. In the following quotation from the public Facebook page "Dossier Hamer", published on 10 April, 2021, nature is conceived as an inherently benevolent force:

> "Mother Nature" […] does not make mistakes; perhaps it may appear a mistake at first glance, but it makes sense, even if sometimes with concomitant negative symptoms for the individual, but always for the good of the larger group.

According to the 5BLs-based community, healing practices should be primarily related to the psychological process of managing a conflict (e.g., recognising past traumas or unpleasant events experienced by the individual). In this sense, there is a centrality of the brain (spontaneously activating microbes to repair a biological lesion caused by a conflict) and the psyche (affected by a conflict and engaged in elaborating it) in relation to the body's biology. Healing should occur spontaneously thanks to the natural action of microbes that are guided by the brain to trigger a biological reaction that can repair the body. For the followers of the 5BLs, therefore, the suffering of the body is useful for the body to repairs itself. In fact, nature is portrayed as infallible, a mother who acts only for the individual's good. In such a system of refused knowledge, accepting living peacefully with microbes means to embrace the intrinsic healing power of nature without the interference of artificial/non-natural biomedical interventions. This implies that the symptoms will not be counteracted by medication, since they represent the evidence of an ongoing healing process.

The pro-vaccine choice community endorses the same attitude towards microbes as a natural tool for reaching immunity; in its health and well-being model, contracting a disease is a suitable strategy for strengthening the immune system. In this regard, as has been highlighted in previous research on the pro-vaccine choice communities (see Reich 2016a, 2016b), immunisation through vaccines symbolises a potential danger for public health, since such artificial compounds would be capable of shattering the natural balance between human bodies and the natural agents, such as microbes, that can help the human body to stay healthy. For the pro-vaccine choice community, microbes and viruses that are available in the environment naturally strengthen the immune system – especially that of babies and children – in contrast to the artificial inoculation of vaccines.

Hence, vaccines are framed as risky, artificially contaminated with other chemical compounds and able to compromise the well-being of human beings. Other research on the pro-vaccine choice movement has in fact deeply explored the point related to the belief that vaccines are contaminated by risky and dangerous adjuvants (see Yaqub et al. 2014; Gross et al. 2015). In the logic of the pro-vaccine choice community, diseases are in fact not perceived as a threat or risky per se but as the constitutive dimension of a health and well-being model unfolding in harmony with nature. Accordingly, they consider the exposure to natural infectious agents that may cause disease as a strategy for building and reinforcing the immune system (Yaqub et al. 2014; Blume 2016). Hence, the pro-vaccine choice community considers the natural immunity derived from contracting a disease to be a safer and more effective means to stay healthy than taking vaccines, which they consider to be an artificial tool that can irreparably degrade the body (on this point, see the research of Leach and Fairhead 2007). This can be seen in the following quotation from the Facebook page of Comilva, an association promoting the Italian pro-vaccine choice community, published on 5 May, 2019:

> Naturally immunised women transmit significantly more antibodies than vaccinated women. The difference in the presence of measles antibodies in children born to mothers who have been infected versus those born to vaccinated women is stark and traceable at least up to the age of 5 months. Thus, women who, in their childhood, have been vaccinated against measles may not transmit adequate antibody protection to their children during the first years, unlike women who have been naturally immunised.

As described in the quotation above, the pro-vaccine choice community believes that natural immunity can also be achieved by breastfeeding, which is considered precisely the natural and correct way of taking care of children. Breastfeeding, it is argued, allows the transmission of antibodies from the mother to the child. For this reason, a shared practice among the pro-vaccine choice community is the self-performing of antibody testing with the aim to quantify the immunity of the child as a result of breastfeeding (see Figure 12.1).

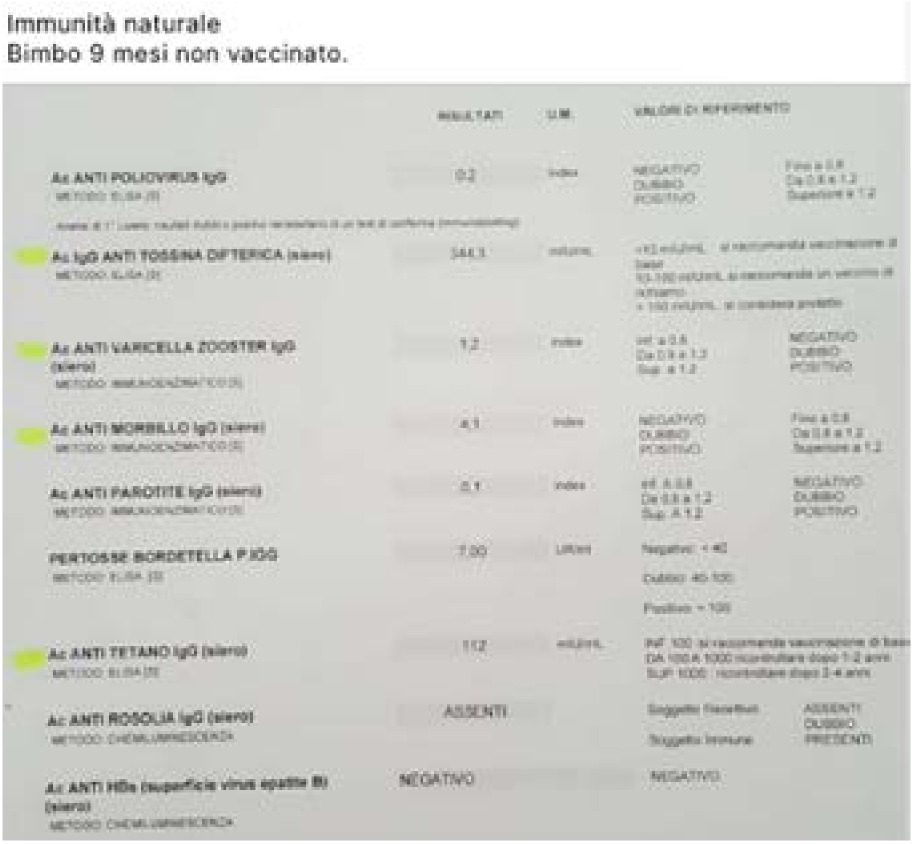

Fig. 12.1 – Antibody test results shared by a member of the Facebook page of Comilva, published on 21 September, 2021. Title of the post: “Natural Immunity. Non-vaccinated 9-month child”.

The pro-vaccine choice community often uses digital platforms (e.g., social media) to share antibody test results and exchange experiences and opinions with other community members. Here, the online media ecosystem appears to be an interactional space in which health and illness experiences can be collectively elaborated through self-disclosure practices such as the online sharing of personal information with others (e.g., health status, antibody test results, symptoms of potential diseases). Through antibody testing, the pro-vaccine choice followers produce what they frame as “evidence” supporting the idea that “naturally” immunised women can transmit a considerably greater number of antibodies than vaccinated women. Accordingly, women are morally responsible for breastfeeding as part of a natural model of health and well-being. Analytically speaking, such a model of addressing immunisation issues centres on a kind of “somatic ethics” (see Rose 2007) that restores centrality to experiential knowledge as a form of re-appropriation of individual health agency (Mahr 2021). Here, somatic ethics refers not to abstract moral principles but to social values shared by the RKCs that accord a central place to the self as the origin of all truth about one's body. In this way, a clear discontinuity can be traced with the epistemological roots of the biomedical paradigm; instead of mobilising clinical or laboratory evidence, RKCs allocate a privileged status to the personal experience and peer interactions considered to be the source of reliable knowledge for addressing health issues (Attwell et al. 2018). This aspect is also visible in the practice of seeking advice by interacting with other followers of the community concerned on how to boost the children's immune systems by relying on substances that are considered natural, as shown in the following quotation from the Facebook page of Comilva, published on 31 January, 2020:

> *[Post by a member A of Comilva]* My 8-year-old son is a non-severe asthmatic. I was thinking of starting to give him vitamin C, the potential of which I have only recently discovered, in the hope of getting rid of the bronchial dilator and cortisone. I was wondering what other vitamin or supplement could I combine with vitamin C to improve his immune system? I'm also asking you, in addition to the advice of the paediatrician and the info I've already found on the internet, because I think your direct experiences could be just as enlightening. Thank you.
>
> *[Comment by member B to the original post]* I have a disease of the immune system. In addition to vitamin C, I take capsules with powdered Cordyceps mushrooms. It is wonderful in general but especially for tonsil problems.
>
> *[Comment by member C to the original post]* Personal experience… the first thing to do is to eliminate milk and dairy products, and you will immediately see strong improvements. If I had known before, I would have avoided many drugs, cortisone and bronchodilators.
>
> *[Comment by member C to the original post]* I started last winter with vitamin C for my baby and for us, and this has been the first year without cortisone, antibiotics and dilators. I hope it will be the same for you.

Dietary supplements such as vitamin C are considered to be natural compounds for managing health and illness. In this regard, pro-vaccine choice followers are usually engaged in experiential-based mutual learning interactions aimed at validating the relevance of "natural" substances that can support healing processes without interfering with bacteria and viruses in the process of naturally immunising the body.

Overall, this paragraph has highlighted how RKCs try to perform a model of health and well-being that is antithetical, in their view, to the military paradigm endorsed by institutional biomedicine, which would imply the use of artificial technologies and agents harmful to the body. By their logic, nature already offers living beings the "tools" to stay healthy and manage the conditions of malaise. Therefore, their model of health and well-being is a matter of mobilising these natural tools and verifying their effectiveness through personal experience to limit as far as possible the use of artificial interventions that would hamper the natural self-healing capacity of the human body. By exploring the practices related to their models of health and well-being, it emerges how refused-knowledge followers see self-experienced knowledge as a particular way of knowing about their bodies and health. To render such refused knowledge "actionable" in daily life, living bodies become both the objects and the subjects of knowledge-making processes.

Final remarks

This chapter has highlighted how the followers of two RKCs, by challenging the prevailing biomedical discourses and related military metaphors, engage in a collective effort aimed at outlining what they consider to be an actionable model of health and well-being that overcomes the jurisdiction of medical authorities and practitioners. In so doing, the chapter explored the following two dimensions at stake in the process of contesting the monopoly of research scientists and medical professionals in defining how health and illness conditions should be identified and managed:

- counteracting the defensive view of the human body and immune system that public and professional discourses of biomedicine have popularised through the military metaphor;
- shaping actionable refused knowledge about the human immune system, especially for what concerns the relationship between humans and other biological entities (e.g., viruses, bacteria) that the prevailing biomedicine considers to be dangerous for humans.

The first dimension relates to the discursive production by RKCs aimed at contesting the legitimacy of the military metaphors that frame the human body and the immune system as a biological boundary to be protected via technical means, which, in the view of the communities concerned, can jeopardise public health.

The second dimension, strictly interrelated with the first, concerns the effort of shaping a model of health and well-being in which diverse biological entities are reframed as natural, useful, commensal allied agents for staying healthy, rather than pathogen enemies to be eradicated via medical technologies. In this way, RKCs try to counteract the defensive view of biomedicine, which would imply resorting to artificial agents (e.g., vaccines, antibiotics). According to such refused models of health and well-being, it is crucial – even if for different substantive reasons among the communities considered in this study – to accept living peacefully with microbes as a way to embrace the intrinsic healing power of nature. Indeed, as was highlighted in the analysis of the pro-vaccine choice community, voluntary exposure to natural infectious agents is considered a suitable way to achieve more effective immunisation. This is due, in their view, to the compliance of this strategy with an alleged natural order that biomedicine, on the contrary, would threaten through its technoscientific developments (e.g., vaccines), which have been popularised in public discourses through military metaphors and then implemented through a defensive approach to the body-nature relationship. For what concerns the 5BLs-based community, viruses and microbes in general play the same useful role, since their action is regulated by a "Meaningful Special Biological Program of Nature" for repairing a biological lesion provoked by a psychological conflict (e.g., psychological trauma).

In overcoming the prevalent biomedical discourses, RKCs elaborate a conception of the human body as a terrain in which one can experience the individual agency's reappropriation over health decision-making. Hence, refused-knowledge followers try to establish a lay epistemic autonomy not only by questioning certain scientific facts, medical evidence and their public communication via metaphors, but also by developing their practices of body management. What is crucial to consider is that refused models of health and well-being shape and establish novel objects and forms of explanation (e.g., viruses as allies of humans, or the immune system as a body-mind hybrid; thus, circumscribing the set of problems, issues and phenomena that the RKCs attempt to elucidate by mobilising their own experiential expertise.

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Contribution statements

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- Barbara Morsello: Conceptualisation (equal); methodology (equal); writing – original draft (equal); data curation (equal); formal analysis (equal); editing (supporting); Writing – Review & Editing (supporting).

Annas, G. J.
1995 'Reframing the debate on health care reform by replacing our metaphors', *The New England Journal of Medicine*, *332*(11), 744-747.

Armstrong, D.
1995 'The rise of surveillance medicine', *Sociology of Health & Illness*, *17*(3), 393-404.

Attwell, K., Ward, P. R., Meyer, S. B., Rokkas, P. J., Leask, J.
2018 '"Do-it-yourself": Vaccine rejection and complementary and alternative medicine (CAM)', *Social Science & Medicine*, 196, 106-114.

Attivazioni Biologiche
2020, May 8 *Sistema Immunitario e 5LB*. Available at: <https://www.attivazionibiologiche.info/articoli/immunita-5lb.html>; Last retrieved on 08/04/2024.

Bleakley, A., Marshall, R., Levine, D.
2014 'He drove forward with a yell: Anger in medicine and Homer', *Medical Humanities*, *40*(1), 22-30.

Blume, S.
2016 'Anti-vaccination movements and their interpretations', *Social Science & Medicine*, *62*(3), 628-42.

Bory, P., Crabu, S., Morsello, B., Tomasi, M., Tosoni, S.
2022a 'Rethinking the nexus between science, politics and society in the age of the SARS-CoV-2 pandemic', *TECNOSCIENZA: Italian Journal of Science & Technology Studies*, *12*(2), 141-188.

Bory, P., Giardullo, P., Tosoni, S., Turrini, V.
2022b '"We will multiply the fires of resistance": The catalysts of dissent against institutional science and their interplay with refused knowledge communities', *Public*

Understanding of Science, *32*(1), 2-19.

Brosnan, C., Vuolanto, P., Brodin Danell, J.-A. (eds.)
2018 *Complementary and Alternative Medicine: Knowledge Production and Social Transformation*, London, Palgrave Macmillan.

Butter, M., Knight, P. (eds.)
2023 *Covid Conspiracy Theories in Global Perspective,* London, Routledge.

Charmaz, K.
2009 *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*, Los Angeles & London, Sage.

Clarke, A. E., Shim, J. K., Mamo, L., Fosket, J. R., Fishman, J. R.
2003 'Biomedicalization: Technoscientific Transformations of Health, Illness, and U.S. Biomedicine', *American Sociological Review*, *68*(2), 161-194.

Cohen, E.
2009 *A Body Worth Defending: Immunity, Biopolitics, and the Apotheosis of the Modern Body*, Durham, Duke University Press.

Crabu, S.
2016 'Translational biomedicine in action: Constructing biomarkers across laboratory and benchside', *Social Theory & Health*, *14*, 312-331.

Crabu, S.
2018 'Rethinking biomedicine in the age of translational research: Organisational, professional, and epistemic encounters', *Sociology Compass*, *12*(10), e12623.

Crabu, S., Picardi, I., Turrini, V.
2023 'Refused-knowledge during the COVID-19 Pandemic: Mobilising experiential expertise for care and well-being', *Science as Culture*, *32*(1), 132-155.

D'Amato, I.
2019 *Dossier Hamer: The role of investigative journalism in exposing pseudomedicine*, in A. Lavorgna, A. Di Ronco (eds.), *Medical Misinformation and Social Harm in Non-Science-Based Health Practices* (pp. 162-177), London, Routledge.

Desta, T., Mulgeta, T.
2020 'Living with COVID-19-triggered pseudoscience and conspiracies'', *International Journal of Public Health*, *65*(6), 713-714.

Felder, K., Felt, U., Penkler, M.
2016 'Caring for evidence: Research and care in an obesity outpatient clinic', *Medical Anthropology*, *35*(5), 404-418.

Fuks, A.
2010 *The military metaphors of modern medicine*, in Z. Li, T. L. Long (eds.), *The*

Meaning Management Challenge: Making Sense of Health, Illness, and Disease (pp. 57-68), Oxford, Inter-Disciplinary Press.

Gale, N. K.
2014 'The sociology of traditional, complementary and alternative medicine', *Sociology Compass*, *8*(6), 805-822.

Gillespie, C.
2015 'The risk experience: The social effects of health screening and the emergence of a proto-illness', *Sociology of Health & Illness*, *37*(7), 973-987.

Gross, K., Hartmann, K., Zemp, E., Merten, S.
2015 '"I know it has worked for millions of years": The role of the "natural" in parental reasoning against child immunization in a qualitative study in Switzerland', *BMC Public Health*, *15*(1), 373.

Hallin, D. C., Brandt, M., Briggs, C. L.
2013 'Biomedicalization and the public sphere: Newspaper coverage of health and medicine, 1960s-2000s', *Social Science & Medicine*, *96*, 121-128.

Hamer, R. G.
2005 *The Five Biological Laws of the New Medicine*, Malaga, Amici di Dirk – Ediciones de la Nueva Medicina.

Haraway, D.
1989 'The biopolitics of postmodern bodies: Determinations of self in immune system discourse', *Differences: A Journal of Feminist Cultural Studies*, *1*(1), 3-43.

Hine, C.
2000 *Virtual Ethnography*, London, Sage.

Hine, C.
2004 *Virtual Ethnography Revisited: Paper Summary Prepared for Session on Online Research Methods*, Oxford, Research Methods Festival.

Jackson, J. E.
1990 *"I Am a Fieldnote": Fieldnotes as a Symbol of Professional Identity*, in R. Sanjek (ed.), *Fieldnotes: The Makings of Anthropology* (pp. 3-33), Ithaca & London, Cornell University Press.

Keating, P., Cambrosio, A.
2003 *Biomedical Platforms: Realigning the Normal and the Pathological in Late-Twentieth Century Medicine,* Cambridge (MA), The MIT Press.

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

Leach, M., Fairhead, J.
2007 *Vaccine Anxieties: Global Science, Child Health, and Society*, London, Earthscan.

Lerner, B. H.
2001 *The Breast Cancer Wars: Fear, Hope, and the Pursuit of a Cure in Twentieth-Century America*, Oxford, Oxford University Press.

Lewis, J., Hughes, J., Atkinson, P.
2014 'Relocation, realignment and standardisation: Circuits of translation in Huntington's disease', *Social Theory & Health*, *12*(4), 396-415.

Lock, M.
2005 'The Eclipse of the Gene and the Return of Divination', *Current Anthropology*, *46*, 547-570.

Mahr, D.
2021 *The Knowledge of Experience: Exploring Epistemic Diversity in Digital Health, Participatory Medicine, and Environmental Research*, Singapore, Springer.

Martin, E.
1994 *Flexible Bodies: Tracking Immunity in American Culture – From the Days of Polio to the Age of AIDS*, Boston (MA), Beacon Press.

Mol, A.
2002 *The Body Multiple: Ontology in Medical Practice*, Durham (NC), Duke University Press.

Morsello, B., Giardullo, P.
2022 'Free choice in the making: Vaccine-related activism as an alternative form of citizenship during the Covid-19 pandemic', *PaCo – Partecipazione & Conflitto*, *15*(3), 697-719.

Neresini, F., Agodi, M.C., Crabu, S., Tosoni, S.,
2024 *Manufacturing Refused Knowledge in the Age of Epistemic Pluralism. Discourses, Imaginaries, and Practices on the Border of Science*, Palgrave, London.

Neresini, F., Crabu, S., Di Buccio, E.
2019 'Tracking biomedicalization in the media: Public discourses on health and medicine in the UK and Italy, 1984-2017', *Social Science & Medicine*, 1982(243), 112621.

Nie, J. B., Gilbertson, A., De Roubaix, M., Staunton, C., van Niekerk, A., Tucker, J. D., Rennie, S.
2016 'Healing without waging war: Beyond military metaphors in medicine and HIV cure research', *The American Journal of Bioethics*, *16*(10), 3-11.

Novas, C., Rose, N.
2000 'Genetic risk and the birth of the somatic individual', *Economy and Society*, *29*(4), 485-513.

Oudshoorn, N.
1994 *Beyond the Natural Body: An Archeology of Sex Hormones,* New York, Routledge.

Patton, C.
1990 *Inventing AIDS*, New York, Routledge.

Perrotta, M.
2012 'The study of technoscientific imaging in STS', *TECNOSCIENZA: Italian Journal of Science & Technology*, *3*(2), 163-175.

Picardi, I., Agodi, M. C.
2021 'Ageing and anti-ageing discourses in refused knowledge communities: The alkaline water case', *Rassegna Italiana di Sociologia*, *2*, 377-402.

Prasad, A.
2021 'Anti-science Misinformation and Conspiracies: COVID-19, Post-truth, and Science & Technology Studies (STS)', *Science, Technology and Society*, *7*(1), 88-112.

Prior, L.
2001 M. Lock, A. Young, A. Cambrosio (eds.), Living and working with the new medical technologies: Intersections of inquiry [Book review]. *Sociology of Health and Illness*, *23*(2), 251-252.

Rapp, R.
2011 'Chasing science: Children's brains, scientific inquiries and family labors', *Science, Technology, & Human Values*, *36*(5), 662-684.

Reich, J. A.
2016a *Calling the Shots: Why Parents Reject Vaccines*, New York, New York University Press.

Reich, J. A.
2016b 'Of natural bodies and antibodies: Parents' vaccine refusal and the dichotomies of natural and artificial', *Social Science & Medicine*, *157*, 103-110.

Rose, N.
2007 *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century*, Princeton (NJ), Princeton University Press.

Sartorio, M.
2022, July 30 'Vaccini: la corsa al mercato della "medicalizzazione preventiva totale"', *5LB Magazine – La rivista sulle 5 Leggi Biologiche*. Available at: <https://magazine.5lb.

eu/2017/07/vaccini-corsa-cultura-medicalizzazione-preventiva-totale-5226.html>; Last retrieved on XX/YY/ZZZZ.

Scott, S., Prior, L., Wood, F., Gray, J.
2005 'Repositioning the patient: The implications of being "at risk"', *Social Science & Medicine*, *60*(8), 1869-1879.

Sontag, S.
1990 *Illness as metaphor and AIDS and Its metaphors*, New York, Anchor.

Tanner, J.
2007 *Metaphors of medicine and the culture of healing historical perspectives*, in R. V. Burri, J. Dumit (eds.), *Biomedicine as Culture: Instrumental Practices, Technoscientific Knowledge, and New Modes of Life* (pp. 35-46), London, Routledge.

Timmermans, S., Buchbinder, M.
2010 'Patients-in-waiting: Living between sickness and health in the genomics era', *Journal of Health and Social Behavior*, *51*(4), 408-423.

Treichler, P.
1987 'AIDS, homophobia and biomedical discourse: An epidemic of signification', *Cultural Studies*, *1*(3), 263-305.

van Dijck, J.
2005 *The Transparent Body: A Cultural Analysis of Medical Imaging,* Seattle & London, University of Washington Press.

Vuolanto, P., Bergroth, H., Nurmi, J., Salmenniemi, S.
2020 'Reconfiguring health knowledges? Contemporary modes of self-care as "everyday fringe medicine"'. *Public Understanding of Science*, *29*(5), 508-523.

Waldby, C.
1996 *AIDS and the Body Politic: Biomedicine and Sexual Difference*, London, Routledge.

Webster, A.
2002 'Innovative health technologies and the social: Redefining health, medicine and the body', *Current Sociology*, *50*(3), 443-457.

Yaqub, O., Castle-Clarke, S., Sevdalis, N., Chataway, J.
2014 'Attitudes to vaccination: A critical review', *Social Science & Medicine*, *112*, 1-11.

13. Designing life in the (in) visible world: Stem-cells as epistemic objects and bio-objects in the interpretive flexibility perspective

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Introduction

The stem cell field is explicitly multivalent. It combines ethical, political, legal, social and cultural forces together with the biological processes. In 2008, two Special Issue published in Science as Culture brought the STS debate on stem cells to the international stage (Geesink et al. 2008). Those specials discuss the history of stem cells underlying the ambivalence of expectations and illusions. It is a long story, still ongoing, full of successes and failures, but also of promises kept and others that will never be maintained or are still waiting to be fulfilled.

Stem cells are materially visible due to the development of molecular imaging, which also makes them modifiable and combinable into new life architectures. To observe the "naturalness" of cells, it is necessary to make them visible, thanks in part to the power of microscopy technology, which has fostered the concept of making the invisible visible in many fields (Maestrutti 2008). Microscopes (from optical to confocal microscopy) makes cells observable and visible in the laboratory and also in the public debate space (Nowotny and Testa 2011). The cells are extracted, removed, separated from their environment and they become artificial to be seen by placing them on a plate, and only then do they move back into "natural" territory. The «invisible natural» is seen as a powerful design action, as Knorr-Cetina (1999) said, biological science draws the "artificial" design action that makes cells "natural" elements.

Particularly, in mammals there are two types of stem cells: embryonic, isolated from the inner cell mass of blastocysts; and adult, found in the various tissues of fully developed mammals. In a developing embryo, stem cells are responsible for differentiating into all specialised cells; adult stem cells are responsible for maintaining the normal turnover of regenerative organs, such as blood and skin or intestinal organs. The differentiation between embryonic and adult is enriched with further attributes that make stem cells an object of knowledge still being explored. There are many diseases and conditions in which stem cell treatment is being investigated: diabetes, arthritis, Parkinson's disease, Alzheimer's disease, osteoarthritis, stroke repair, spinal cord injury repair, heart attacks, anti-cancer treatment, vision repair, skin repair.

The basis of biological science is founded on knowledge of cellular life, which becomes one of the objects of study in the biomedical field in relation to the possibility of biotechnological manipulation and observation of stem cells (Franklin 2006). Current research is moving in this direction to find out how cell reprogramming takes place in order to closely investigate the differences with stem cells and find possible clinical applications. This is a field in constant evolution, extremely competitive and ethically sensitive in the social and scientific debate. Internationally accepted terminology distinguishes stem cells as totipotent, pluripotent and multipotent (Eriksson and Webster 2008).

In the last 20 years, and particularly in the last decade, significant knowledge developments have driven basic, translational and clinical advances in the field of stem cells and regenerative medicine. The most relevant experimental advances have occurred in the generation and differentiation of pluripotent stem cells and in the field of stem cell maintenance in different types of culture to three-dimensional (3D) cell technologies (Liu et al. 2020). An introductory distinction can be made between adult stem cells, which are characterised by a multipotency level as they can produce functional derivatives of the original tissue and precursors, and embryonic stem cells, which are totipotent as they can differentiate into all cell lineages. Particularly, embryonic stem cells are derived from the internal cell mass of blastocysts that make up an embryo at the 5-6-day stage of development. The cell mass at this stage of development contains pluripotent cells, meaning that they could differentiate into any cell lineage and any tissue.

To visualise stem cells, it is necessary to develop a molecular insight in order to intervene at the biological level, raising ethical, legal and political issues. Biological science bases its assumptions on the life of cells, becoming, even in the common imagination, a vital world with its own rules, behaviours and roles. In the scientific debate, they emerge as an autonomous entity with a life of its own, becoming a subject of controversy even in the public and political debate. The chapter sees stem cells as heterogeneous objects that undertake different natures and forms in relation to the contexts they pass through, where the question of *visibility* remains constant (Nowotny and Testa 2011; Cattaneo et al. 2013) because science needs to know them.

Observing the relationships that make cells visible and materially manipulable the chapter proposes to adopt the perspective of Science and Technology Studies to examine the different modes and meanings that stem cells acquire in crossing different techno-scientific worlds. The concept of interpretive flexibility is used to investigate how stem cells could be interpreted by different conceptions and by different social and scientific groups. The concept of interpretive flexibility, initially theorised by Social Construction of Technologies (SCOT) scholars (Pinch and Bijker 1984; Bijker 1995), allows us to capture the process of the ongoing construction of scientific process until its closure in a stable form of knowledge. Scientific research processes related to the differentiation, production, cultivation, use of stem cells in and out the labs fit well to becoming an empirical case study of use of interpretive flexibility concept as they continue to be the subject of lively scientific in the lab and in many spheres of the social world. The concept of interpretive flexibility was originally illustrated by Pinch and Bijker (1984) – pioneering exponents of the SCOT – in their classic study on the bicycle, which noted that the stabilisation of the object as we know it today was the result of extensive and complex co-construction processes between different relevant social groups, such as designers, users, markets, etc. The SCOT was criticised for closing the user problem too early and not showing how users could actively modify stable technologies (Mackay and Gillespie 1992). Later studies have expanded the concept of interpretive flexibility to pay more attention to the internal diversity of social groups themselves, the exclusion of certain groups, as well as political restrictions and constraints (MacKenzie and Wajcman 1999; Williams et al. 2005).

With this in mind, the chapter proposes to apply this articulated concept to the observation and study of stem cells, a complex scientific object that becomes visible in the making: extracted, cultivated, and materially manipulated in the laboratory, they become codified knowledge not only in scientific discourses but also in ethical and public ones. They have been travelling for some 40 years towards greater forms of stabilisation, through adaptations and negotiations sustained and connected to expert knowledge networks inside and outside the laboratory. They are scientific objects that from fluid and malleable seek forms of stabilisation in different clinical fields. The aid and guidance of the concept of interpretative flexibility can make it possible to observe how stem cells – in the complex journey that leads from scientific practice in laboratories to the transition into clinical practice – take on various forms and are gradually adapted into diversified and more stable knowledge.

Extracted from tissue and blood (human and animal) and manipulated in the lab, stem cells act visibly (Nowotny and Testa 2011) in laboratory practice in various forms. They are daily partners to be cared for, they are relevant partners in the processes of cultivation, differentiation, and cell reproduction, they become actors to scientific practice in articles, become intermediaries in gene therapy treatments in different areas of clinical practice, and encounter controversy in the public space. They are complex biological objects that from lab to clinical practice seek and find forms of interpretative stabilisation.

In the perspective of approaching stem cells as complex partners of scientific practice, this article proposes below to observe them as epistemic objects (Knorr-Cetina 1999) and as bio-objects (Vermeulen et al. 2012).

The chapter is divided as follows: a focus on the story and the representation of stem cells in the public and scientific debate; some methodological notes; a section on the theoretically oriented analysis of the findings.

Short history of stem cells and public debate

The history of stem cells begins in the mid-19th century with the German biologist Ernst Haeckel who first used the term stem cells ("stamzell" in German) in scientific literature. Other scientists began to use the term to refer to single parent cells of a cell lineage. This hypothesis remained unproven until 1963, when Ernest McCulloch and James Till showed the presence of progenitor cells capable of renewal in mouse bone marrow. Specifically, they cultivated the mouse blastocyst (i.e., the set of cells obtained after fertilisation) obtaining pluripotent embryonic stem cells. A few years later, in 1981, with the improvement of laboratory techniques, Martin Evans (Nobel Prize winner in 2007) succeeded in isolating and growing the first stem cells from mouse embryos until thousands were obtained. In 1998 at the University of Wisconsin-Madison, scientist James Thomson and his collaborators derived the first embryonic stem cell line using embryos donated for fertility treatments that had gone unused. For the first time, embryonic stem cells are isolated and cultured from human blastocysts, creating stable cell lines over time. The publication fuels the ethical debate on what blastocysts are: a murder for those who consider the blastocyst a person, an ethically legitimate act for those who see in supernumerary blastocysts, derived from assisted fertilisation or abortions, small cell structures useful to understand biology and genetics and for regenerative medicine. The situation is different for adult stem cells (blood, tissue, cord blood, etc.), which from a legislative point of view are not used for the purpose of fertility treatments. Adult stem cells already have many therapeutic uses for leukaemia, retina and skin and some cancer therapies (Eriksson et al. 2008).

The history of stem cell research found a turning point in 2006 with the discovery of IPSCs (Induced Pluripotent Stem Cells), which earned scientist Yamanaka a Nobel Prize for medicine in 2012. These are induced reprogrammed stem cells that enrich the picture of promise and therapeutic possibilities. Cells that can be grown indefinitely in vitro and, depending on artificially modifiable culture conditions, can generate different types of differentiated cells. It is a type of stem cell generated by the addition of four genes and it is able to induce a cellular differentiation. iPSs are so called because they can induce the differentiation of most cell types in an organ (such as pancreatic and neural cells). iPS cells and embryonic stem cells share the ability – cultured under precise conditions in the laboratory – to divide and produce all kinds of specialised cells with the hope that they can be used to replace cells or tissues in patients who have incurable diseases or damaged genes (Takahashi and Yamanaka 2006). What makes iPS a promising research object is the ethical aspect because the generation of iPS does not use embryos in the early stages. However, there are still obstacles to the production of iPS, as they behave differently from stem cells, possibly due to incomplete reprogramming of the cells and/or genetic changes acquired by iPS cells during their growth.

The use of these new cellular objects is being pushed in the conservative and Catholic public debate as it mitigates the issue of using embryos. In 2014, this is how Yamanaka himself presented them after winning the Nobel Prize:

> The induced pluripotent stem cell (iPSC) technology is instrumental in advancing the fields of disease modeling and cell transplantation. We herein discuss the various issues regarding disease modeling and cell transplantation presented in previous reports, and also describe new iPSC-based medicine including iPSC clinical trials. […]. The use of iPSCs in disease modeling, cell transplantation, and clinical trials could therefore lead to significant changes in the future of medicine. (Inoue et al. 2014)

Yamanaka himself in 2020, however, does not hide the problems still present in research on IPSCs, which makes them perhaps less promising than hoped for:

> Human pluripotent stem cells such as embryonic stem cells (ESCs) and induced pluripotent stem cells (IPSCS) provide unprecedented opportunities for cell therapies against intractable diseases and injuries. Both ESCs and iPSCs are already being used in clinical trials. However, we continue to encounter practical issues that limit their use, including their inherent properties of tumorigenicity, immunogenicity and heterogeneity. (Yamanaka 2020)

The two strands, human embryonic stem cells and induced pluripotent stem cells, find applications but retain risks and do not resolve controversies. The potential of stem research, whether embryonic, IPS or adult, is as enormous as the accompanying ethical debates. Embryonic stem cells became a central object of policy choices for research funding in all developed countries, starting with the USA, the country where they were first isolated. In the USA, the possibility of using them in government laboratories fluctuates, a pattern that is also repeated in the more general international scene in Europe and other continents. In 1995, Bill Clinton made federal funds legal for research on stem cells obtained from embryos. The decision came at the end of a heated debate on the ethics of cloning human embryos for therapeutic purposes, a decision firmly rejected by many religious groups and the pro-life movement. Instead, many scientists believed that this research could bring new treatments for diseases. Scientists were only allowed to study stem cells taken from frozen embryos that remained unused after in-vitro fertilisation. George Bush vetoed embryonic stem cell research in the early 2000s and then in 2009 President

Barack Obama again removed the limits on that funding. Donald Trump decides to zero out federal funding for medical experimentation involving the use of tissue from aborted foetuses. Recently, Biden's Democratic administration overturned Trump's decision by lifting the ban on government researchers conducting research with embryonic stem cells, emphasising the importance of fetal tissue research for the creation of models of the human immune system, essential for vaccine development, as was the case for Covid-19, and promising for imagining treatments against cancer and AIDS.

The world scene reflects this same ambivalence of positions. In Italy, the sector is regulated by Law 40 of 19 February 2004 on "Regulations on medically assisted procreation". This law recognises the embryo as a subject of rights from the moment of fertilisation, avoiding the use of embryos for any research. In 2005, Italians voted in a referendum to repeal this law, but the quorum was not reached. Few laboratories used human embryonic stem cells, others used them unofficially. However, over the years, the law has been amended several times concerning the production and cryopreservation of embryos (Perrotta 2013).

Research questions and methodological notes

This chapter uses the concept of interpretive flexibility to observe how processes of stem cell interpretation move towards greater stabilisation inside and outside of laboratories. Stem cells have a twofold trend: on the one hand they remain open and controversial objects of knowledge, a typical state of epistemic objects in the networks of different social groups, on the other hand they try to follow the process of greater interpretive closure towards bio-objectification (Webster et al. 2011) when they become more stable research objects and more ready for therapeutic uses. The process of bio-objectification brings stem cells into the realm of commercialisation (Waldby and Mitchell 2006; Rajan 2006) and exploitation for reproductive and clinical work (Waldby and Cooper 2008) and produces new classifications and different biological artefacts.

The analysis proposed in the article develops a reflection started within a broader ethnography carried out between 2008 and 2013. Various methods and techniques were used: field notes, interviews with researchers, focus groups, autonomy of researchers. The data were collected in a cellular biotechnology lab at the University of Milan. The laboratory comprises 25 researchers (senior and junior) with expertise in molecular biology, biotechnology, pharmacology, bio-informatics, and works on international projects in an extensive network of collaborations with laboratories of excellence in Europe, the USA and other parts of the world. During the observational work, twenty-five semi-structured interviews were conducted with the aim of narrating and observing scientists at work among microscopes, chemical hoods, computers, notebooks, and among cells. The interviews and observational work made it possible to look at how stem cells are discussed in the lab, how the cells are treated, monitored and how they are moved towards therapeutic trajectories. In the laboratory under investigation, the working section dedicated to stem cells, also in relation to restrictions due to Italian legislation, involves few people and no public research funds can be used for this type of research. The use of human embryonic stem cells is aimed at the derivation of neurons that become diseased in Huntington's disease.

Cells in the laboratory must be made visible – through complex technical procedures of extraction, purification, cultivation differentiation – in order to become objects with which to dialogue and to keep healthy. In some cases, they are allies, in other cases, they are problematic companions, but nevertheless part of the sociomaterial life of the laboratory. The under investigation laboratory studies pluripotent stem cells with the aim of finding uses in molecular and pharmacological screening and identifying strategies for therapeutic intervention in the molecular alterations evoked by the diseased gene of Huntington's Korea. They do research with embryonic stem cells from abortion or supernumerary cells (which derive from blastocysts from in-vitro fertilisation not implanted in the uterus) purchased abroad (in Italy legislation prohibits their production). The aim is to develop research strategies capable of transforming pluripotent cells with general capacities into neural cells with particular abilities in order to study diagnostic and/or therapeutic potential.

Stem cells as epistemic object

The concept of epistemic object from the perspective of Karin Knorr-Cetina (2007) focuses on the social, ordinary and everyday mechanisms of knowledge construction, located in the micro-practices of laboratories or other delimited habitats of knowledge production practice. Scientific knowledge in the various disciplinary fields is thus inscribed both within narrow networks and also within wider networks that constitute epistemic cultures that produce beliefs, ways of doing things and negotiated practices. Knorr-Cetina defines the concept of epistemic cultures as a diversity of scientific activities, depending on the different scientific fields, not only in methods and tools, but also in types of reasoning, ways of establishing evidence and relations between theory and empirics. The concept of epistemic culture helps us to grasp those practical processes that are internalised in the way knowledge is created and practised.

Studying epistemic cultures means renouncing the unity of a single cultural paradigm of knowledge since the various fields of scientific knowledge are the outcome of cultural and practical processes that construct research objects, models and meanings over time. The practice of these knowledge objects is an open process resulting from the resistance and adaptation of human and non-human elements intertwined in research. Around the processes of signification and sedimentation of knowledge concerning a specific object, such as the case of stem cells, categorisations and significations are produced that remain open and the agency of that object of knowledge is constructed by moving from one construct to another. The lab becomes an extended and wide-ranging space where natural and social elements move from the molecular biology bench, to writing practice, to relationships with the clinic, institutions and patients. We therefore apply the concept of epistemic object to stem cells, research objects present in a wide range of practices, from basic to applied research. The most frequently used processes concern their characterisation for specific uses in a certain field (brain, tumours, blood, etc.) and the processes of differentiation, which enable the production of different cell types, such as neural cells, skin or blood. Stem cells are also involved in basic activities but require high expertise in handling biological material. In the laboratory, pluripotent stem cells are subjected to biotechnology-mediated processes that can transform them from one state to another with the aim of producing new cell cultures, in this case neural, for future gene therapies.

Standardised procedures and experiments are put into practice to make cells epistemologically knowable. In this sense, stem cells are epistemic objects (Knorr-Cetina 1999) in relation to the role and the mobile ontology they play in the scientific practices in which they are generated and involved. They take on different natures and forms according to the context in which they are shaped. In this regard, it is reported two quotations from an interview with one of the junior researchers from the investigated laboratory who talks about the discovery of cells in his/her experience. In the following excerpt, the process of making the object visible and manageable through the experimental practice of scientific knowledge can be clearly seen:

> Pluripotent cells, embryonic stem cells, are an extremely useful tool for understanding how tissues are formed. Many wonderful papers have been published in the field of the nervous system, showing how we can obtain cortex, striatum, black matter or dopaminergic neurons from embryonic stem cells, according to the instructions we give them. This means that embryonic stem cells are plastic, capable of responding to the work that is done with them, and that neurons of a hitherto unknown cell quality can be obtained. So, it's not so much the fact that we produce neurons from stem cells in the laboratory, because over the years several articles have said that neurons are made from stem cells... no, let's say that you produce those particular neurons, perhaps those that are affected in the disease that is being studied, from stem cells. I don't know if this means that there will be a cure soon or not but based on the fact that well-guided embryonic stem cells can give us those specific neurons, we're really galloping towards the idea that this could soon become therapeutic. Programming neurons is part of the alchemy of scientists, what we do in vitro is to change the fate of the cells, yes fate is the key word in talking about stem cells. (Valentina, biologist, young researcher)

The epistemic object is defined by the variations, shifts, drifts, rotations it encounters. These objects of knowledge have power, produce effects, construct their own environment with humans, and shape the course of research. The object, despite its determination and specificity, necessarily maintains levels of openness that anticipate future and potential developments.

In the following quote, we see how the same object is produced and re-articulated in different ways. In the history of stem cells, the arrival of IPS in the experimental field turns the research field to imagine new scenarios of potential uses and future stability:

> And then there are IPS (a special type of stem cells), with these stem cells you can do other things in vitro. In this case, you start from the somatic cell and you bring it back to the stage of the stem cell, you can make a model of the pathology on the slide… it is a way to consolidate the power of the knowledge that you are building with the cells. The beauty of these cells (IPS) is that in modelling them you bring the genome of the person in vitro into the lab, and you can pressure them and turn it into a neuron following protocols. Protocols are being consolidated in order to stabilise the procedures to be done to achieve a certain result with a certain degree of quality. The ingredients are not bad at all: today we have good means of culture. Of course, you also have to imagine what you have to do to be able to see them, to understand whether these cells that you imagine you have seen on your slide really exist. With stem cells (or IPS), you can intervene in the process of cellular development in all directions, which means that you can change the direction that you make your cells take… (Marco, biologist, young researcher)

Researchers explore the different meanings stem cells take on in practice. The cells reveal different information structures and incorporate different and plural meanings. For the construction of meanings, the researcher describes the different networks of practice in which the cells are immersed. This is a nexus of interconnected practices, formed by materially mediated interdependencies between the different communities of practice in the workshops.

Narrative from the field shows the flexibility of research practices that find space in the creativity of the laboratory. In this space stem cells must be constructed as visible object and to do that they are constantly in flow, never fully formed (Knorr-Cetina 1999). It is their ability to be unstable and in motion that define cells in their epistemological representations of objects not quite understandable yet. The stabilisation of knowledge around the object of study "stem cell" is the effect of categorisation process that takes shape within actions that involves subjects and objects, pieces of cultural and material worlds such as biomedical and biotechnological research questions, grants, moral and ethical issues, microscopes, measuring devices etc.

Stem cell as bio-object

The bio-object concept (Vermeulen et al. 2012) is useful for discussing techno-scientific practices that translate the process of scientific knowledge into a visible object, as in the case of stem cells in recent decades. The term bio-object refers to all those biological artefacts, such as pluripotent cells, products of synthetic biology or genetically modified organisms, that create new forms of life with important effects on biomedical research and commercial and ethical developments. What is recognised in the literature as the process of bio-objectification occurs, that is process through which life becomes an object of research, producing at the same time new forms of life that redefine the boundaries between what is natural and what can be defined as biologically manipulable (Webster et al. 2011).

If the previous paragraph attempts to discuss stem cells as objects of knowledge under construction and, therefore, manipulable for researchers, this paragraph reflects on the biotechnological process that makes biological elements materially observable as bio-objects. The *bio* suffix captures the ability of objects to make visible biological matter, bringing about modifications, transformations and alterations. Biotechnologies shape, construct and visualise bio-objects, which are configured as material-epistemic containers that transcend boundaries and contexts, between laboratory and clinic, between patient associations and political arenas, and thus the tensions involved in stabilising standards and protocols that produce new knowledge and cultural practices (Bloomfield et al. 2010).

For the purposes of our discussion, the bio-object becomes a conceptual tool to look at the biotechnological processes that make visible the stem cell after being dealt with by scientists in the form of research questions and hypotheses, experiments, research findings, etc. The process of bio-objectification makes clear how historically available technologies co-constitute biomedical definitions of what is considered pathological and/or normal. This interdependence constitutes a fertile research ground for STS scholars, who also look at how medical science creates definitions and classifies knowledge according to standards and categories, in turn establishing scientific and normative protocols (Vermeulen et al. 2012). Stem cells understood as bio-objects configure knowledge assemblages that seek greater stability, the focus of practice shifts towards medical knowledge production and biomedical technologies. As bio-objects, stem cells become more visible, but also standardised pieces of knowledge.

Here there are three examples of this increased visibility, stable autonomy and standardisation of stem cells. In the first case the scientists engaged in the research were asked to represent the object “stem cell” of their research practices with an image or a metaphor. Researchers can see stem cells under the microscope able to fix them in snapshots. The words of the scientists reveal how the process that makes stem cells knowable and visualisable in bio-objects is constructed using biotechnologies capable of opening up definitions and leading to new closures. Thus, for example Luciano sees cells as objects with their own autonomy and beauty:

> Cells are beautiful tools when they are plump and vital, when they are healthy, when they grow regularly and can be reproduced, when they smile. Are beautiful when you observe them and they are perfectly concentric and not too confluent, when their outline is well-defined and they appear translucent, are beautiful tools when they are healthy and allow me to discover a new physiopathological mechanism, so that I can think of new therapeutic strategies. They are beautiful tools when the lines that arrive from the international biobank are easy to reproduce

> and we can find nice cells to cultivate. Cells are beautiful tools when we can think of experiments aimed at transplanting cells in view of future therapies. Cells are beautiful when we can use cells from tissues (as in IPS) and thus bring the patient's genome into the lab and conduct experiments targeting therapies, collaboration with other labs, companies, clinics, and so on. (Luciano, biotechnologist, senior researcher)

In the second case, stem cells intersect technoscientific worlds using different visualisation technologies. The researchers learn to figure out, handle and recognise stem cells through visualisation technologies. The various technoscientific processes of translation (characterisation, cultivation and differentiation) in the use of stem cells in the laboratory are combined with those of scientific communication (publications and public debates). In order to strengthen their visibility and reputation, cells must be translated into more stable knowledge in the form of data and images:

> On the one hand, we try to see the stem cells through microscopic technologies, we have to be familiar with their vision, learn and see them well, then, on the other hand, we choose the most meaningful and relevant images of the cells for publications, in relation to the objective of the paper and the journal to which it is to be submitted. (Lucia, biotechnologist, senior researcher)

In the third case the representations offered by researchers show cells as living objects with which to remain in relationship in everyday laboratory life. But stem cells, on the other hand, are also materialised and proposed by researchers as objects that begin to live almost independently because of their potential for new applications in therapeutic fields or even in the biobank market.

> It takes years to bring stem cells close to their therapeutic use. We are collaborating with other laboratories and other hospitals to strengthen the practice of using Ips. We work with groups studying Parkinson's, a disease better known than Huntington's. We believe we can transfer expertise from one disease to another. We are learning to take tissue from consenting patients to operate cellular reprogramming to neural cells. There is still much to be done but gene therapy is the goal of our work. We work for therapies, to have the possibility in the future to help patients live better with their disease. Producing healthy neural stem cells for use on Huntington's patients where the neural cells are damaged, that is our goal. (Chiara, biotechnologist, senior researcher)

Examining stem cells as bio-objects is a way to observe the visible and multiple forms performed inside and outside the labs. The laboratory is the place where stem cells become manipulable in research practices and flexible in their meanings. The flexibility of possible interpretations is revealed in the research hypotheses, procedures, and standards adopted, which in turn allow for closure in bio-objects capable of crossing different scientific, political, economic and social arenas. This is a temporary closure that brings with it a standardised form of knowledge capable of traversing different social worlds.

Stem cells are not “given things” that can be investigated as separate objects from the interactions that produce them, since they, as objects of knowledge, only emerge through expert and technological interactions. Stem cells – embryonic, adult and induced pluripotent stem cells – keep dominating the scene as new and promising material objects of knowledge.

In conclusion, we propose that stem cells are a mobile, multiple and fluid research object. From an STS perspective, it is an object that preserves a wide interpretative flexibility (Pinch and Bijker 1984; Bijker 1995). Stem cells are epistemic objects because they are relational and contextual tracts of knowledge produced in the lab. The initial interpretative flexibility, played out mainly in lab practice, gradually encounters forms of interpretive closure that can be appreciated more theoretically with the bio-object concept. This contributes to viewing stem cells as a public object that takes autonomous form in scientific communication and then in public space.

The concepts of epistemic object and bio-object captures the process of their temporary stabilisation. Particularly, the concept of epistemic objects looks at stem cells as a scientific issue in the sphere of laboratory practices (Knorr-Cetina 1999). Laboratory practices understand them as objects of knowledge in the making, seeking stabilisation between scientific practice, and the construction of research designs, questions and hypotheses. If the concept of epistemic object underline the process of knowledge construction, the concept of bio-object observes how stem cells become visible and more stable, showing standardised biomedical properties and characteristics (Vermeulen et al. 2012).

The theoretical concepts used outline a technoscientific assemblage in which stem cells become effects of epistemic cultures (Knorr-Cetina 2007). Epistemic cultures are characterised by inter-relationships between knowledge and already hybrid forms of knowledge. In this knowledgeable relationality, cells become epistemic objects that enact meanings in hybrid and flexible forms capable of crossing different social worlds. A first form of visualisation is thus found in classifications that enclose the epistemic object – thus, the stem cell – in a knowledge form such as the scientific articles and graphic representations that make biological elements otherwise invisible to the human eye. To do this, stem cells go through the process of bio-objectification. The concept of bio-objectification (Vermeulen et al. 2012) is a conceptual tool that allows us to observe how biology can only become objectively knowable through classifications that enact interpretative closures. This is the case with the description proposed by Luciano that shows how stem cells are “beautiful” if they arrive healthy after having passed through, for instance, both scientific and legal protocols and standards governing international biobanks. But they are also “beautiful”, for example, because they promise future therapies for diseases that still lack a cure. The process of bio-objectification thus has the effect of constructing a sociomaterial object that emerges outside research practices to enclose itself in scientific representations that require social and legal legitimisation (Nowotny and Testa 2011; Cattaneo et al. 2013).

The different degrees of interpretative flexibility that accompany stem cells in their design processes are defined in laboratory practices that manipulate stem cells as epistemic objects (Knorr-Cetina 1999). Laboratory practices understand them as objects of knowledge in the making, seeking stabilisation between scientific practice, and the construction of research designs, questions and hypotheses. We are dealing with how scientists assemble the material processes that make visible the artificial design tensions, growing into standards and classifications, which we can understand with the concept of bio-object (Bloomfield and Doolin 2011). The concept of bio-object observes stem cells as objects able to find out the biology that could lead to new discoveries. We have seen this in the words of scientists, showing how stem cells can become visible through snapchats encompassing human and non-human actors intersecting heterogeneous networks. Whereas in the first concept the cells are still something vulnerable, not-stable, and still under construction with regard to their definitions and conceptualisations, in the bio-object concept the stem cells become visible as autonomous configurations.

While with the concept of epistemic object we observe the social life of stem cells in the laboratory, with the bio-object we observe how the stem cell becomes a more stable object in the social and public perception inscribing possible imaginaries of future cures and therapies. Moreover, stem cells, showing a high degree of interpretative flexibility, are able to ensure cooperation between different social worlds from lab to public space.

The STS theoretical-conceptual framework allows to observe the interrelations between public, ethical and political issues. Following stem cells has made visible how the practice of science is intertwined with the public discourses. Furthermore, the different uses of stem cells will bring out more exciting developments in the fields of personalised medicine and the treatment of incurable diseases.

There are many challenges that remain open even within the scientific and therapeutic field, and in the public space, underlining the tension between the totipotency of human embryonic stem cells and the potency of other bone marrow, blood, skin and iPS stem cells. Stem cells remain still open scientific objects travelling in search of their future definitions and stabilisations.

Bijker, W.
1995 *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change,* Cambridge (MA), The MIT Press.

Bloomfield, B. P., Doolin, B.
2011 'Imagination and technoscientific innovations: Governance of transgenic cows', *New Zealand: Social Studies of Science*, *41*(1), 59-83.

Cattaneo, E., Testa, G., Viteritti, A.
2013 'The Italian Pathways of Stem Cells', *TECNOSCIENZA: Italian Journal of Science & Technology Studies*, *4*(1), 145-164.

Eriksson, L., Webster, A.
2008 'Standardizing the unknown: Practicable pluripotency as doable futures', *Science as Culture*, *17*(1), 57-69.

Eriksson, L., Stephens, N. J., Webster, A.
2008 'Stem cell spaces, places and flows', *New Genetics and Society*, *27*(2), 83-85.

Franklin, S.
2006 'Embryonic economies: The double reproductive value of stem cells', *BioSocieties*, *1*(1), 71-90.

Geesink, I., Prainsack, B., Franklin, S.
2008 'Stem cell stories 1998-2008', *Science as Culture*, *17*(1), 1-11.

Inoue, H., Nagata, N., Kurokawa, H., Yamanaka, S.
2014 'iPS cells: A game changer for future medicine', *The EMBO Journal*, *33*(5), 409-417.

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

Knorr-Cetina, K.
2007 'Culture in global knowledge societies: Knowledge cultures and epistemic cultures', *Interdisciplinary Science Reviews*, *32*(4), 361-375.

Liu, G., David, B. T., Trawczynski, M., Fessler, R. G.
2020 'Advances in pluripotent stem cells: History, mechanisms, technologies, and applications', *Stem Cell Reviews and Reports*, *16*, 3-32.

Mackay, H., Gillespie, G.
1992 'Extending the social shaping of technology approach: Ideology and appropriation', *Social Studies of Science*, *22*(4), 685-716.

MacKenzie, D., Wajcman, J.
1999 *The Social Shaping of Technology*, Maidenhead, Open University Press.

Maestrutti, M.
2008 'Rendere visibile l'invisibile: Il ruolo della visione e dell'immagine nella costruzione di una storia delle nanotecnologie', *Rassegna Italiana di Sociologia*, *49*(3), 427-450.

Nowotny, H., Testa, G.
2011 *Naked Genes: Reinventing the Human in the Molecular Age*, Cambridge (MA), The MIT Press.

Perrotta, M.
2013 'Creating Human Life Itself: The Emerging Meanings of Reproductive Cells among Science, State and Religion', *TECNOSCIENZA: Italian Journal of Science & Technology Studies*, *4*(1), 7-22.

Pinch, T. J., Bijker, W. E.
1984 'The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other', *Social Studies of Science*, *14*(3), 399-441.

Rajan, K. S.
2006 *Biocapital: The Constitution of Postgenomic Life*, Durham, Duke University Press.

Takahashi, K., Yamanaka, S.
2006 'Induction of pluripotent stem cells from mouse embryonic and adult fibroblast cultures', *Cell*, *126*(4), 663-676.

Vermeulen, N., Tamminen, S., Webster, A. (eds.)
2012 *Bio-objects: Life in the 21st Century,* Farnham, Ashgate Publishing.

Waldby, C., Cooper, M.
2008 'The biopolitics of reproduction: Post-Fordist biotechnology and women's clinical labour', *Australian Feminist Studies*, *23*(55), 57-73.

Waldby, C., Mitchell, R., Webster, A.
2006 *Tissue Economies: Blood, Organs, and Cell Lines in Late Capitalism,* Durham, Duke University Press.

Webster, A., Haddad, C., Waldby, C.
2011 'Experimental heterogeneity and standardisation: Stem cell products and the clinical trial process', *BioSocieties*, *6*(4), 401-419.

Williams, R., Stewart, J., Slack, R.
2005 *Social Learning in Technological Innovation: Experimenting with Information and Communication Technologies*, Cheltenham, Edward Elgar Publishing.

Yamanaka, S.
2020 'Pluripotent stem cell-based cell therapy-promise and challenges', *Cell Stem Cell*, *27*(4), 523-531.

Postface

GUIDO NICOLOSI

I first met Marina Maestrutti in the autumn of 2008, amidst the corridors of the Faculty of Sociology in Rome, during my first gathering with colleagues and friends of STS Italia – Società Italiana di Studi su Scienza e Tecnologia. The recollection of our initial conversation remains vivid, as our intellectual connection was instantaneous and swiftly evolved into a profound alignment both personally and scientifically.

As time unfolded, I came to comprehend the depth of immersing oneself in the intricate and multi-dimensional network meticulously woven by Marina. Her ceaseless and inquisitive journey traversing various realms of knowledge, disciplines, and connections revealed itself as a composite and multilevel tapestry. This network stands as a remarkably rich scientific, moral, and emotional legacy, characterised by immense creative prowess and the generation of substantial intellectual capital.

Marina Maestrutti's intellectual persona orbits around two pivotal concepts—mobility and the frontier. Despite their seemingly contradictory nature, these elements have played a decisive role in shaping her existential profile. Those fortunate enough to have known her are aware of Marina's profound inclination toward travel and exploration. A quality that she adeptly harmonised, with disarming and gentle ease, alongside an almost obsessive inclination to be deeply connected to the essential places in his life: Codroipo, a town in the Italian region of Friuli Venezia Giulia where her family lives, and the Marais, a historic district in Paris. The journey has consistently been the hallmark of her lifestyle, and the deliberate choice to relocate from Italy to France serves as the most explicit affirmation of this characteristic.

I have never been fond of the overtly rhetorical tone, which, in my opinion, often carries a provincial undertone, characterising the Italian public discourse on the phenomenon commonly referred to as the "brain drain." The truth is that, dating back to its ancient medieval origins, the academic realm has always thrived on the dynamic mobility of both educators and students. This should be acknowledged as a fundamental resource within the system, one that warrants robust encouragement, particularly in terms of both outbound and, more crucially, inbound mobility—the true Achilles' heel of the Italian system. The personal and academic trajectory of Marina Maestrutti aligns exemplarily within this context.

A brilliant Italian talent and academic excellence, she earned her degree in Philosophy from the University of Bologna. Subsequently, she chose to venture beyond Italy to pursue a *Diplôme d'études Approfondi* (DEA – "Diploma of Advanced Studies") in *Anthropologie des techniques contemporaines*, under the mentorship of Professor Alain Gras at the Paris 1 Panthéon-Sorbonne University. This decision marked a pivotal moment, transforming the university into her second home and serving as an exponential catalyst for her intellectual sensitivity and cultural breadth.

In particular, the meeting and relationship with Alain Gras are crucial for understanding her research path, her inclination for multidisciplinarity and, more generally, her approach, both enthusiastic and critical, towards contemporary technological developments. Alain Gras was also her mentor in the initial stage of her PhD studies in Epistemology and history of science and technology, which she will however achieve under the supervision of Prof. Bernadette Bensaude-Vincent in 2007.

Understanding Marina's profile in its entirety requires an examination of the profound significance that the concept of the frontier held in her life—a significance extending beyond the physical realm to encompass the mental and existential dimensions. Both in Italian and French, the terms "frontier" and "border" are often used interchangeably to denote a geographical limit. However, in the classical world, there existed a notable distinction between these two terms. "Border" was associated with the realm of familiar space and the known world, while "frontier" represented the demarcation threshold separating the known from the unknown, order from disorder, and civilisation from barbarism. In Marina's life, this duality was remarkably evident.

At first, the frontier represented her Friulian identity, signifying her connection to a region that serves as both a dividing and unifying force, enriching both Friuli and Italy. Marina skillfully integrated the contradictions of a global citizen deeply rooted in her community of origin into her personality, humor, and intellect. This apparent paradox, however, finds its sustenance in the relationship with a land that, like all borders—I speak as a Sicilian—compels the intertwining of roots and estrangement.

While of Friulian descent, Marina was born in Turin and spent her formative years there. Even in this distinct borderland, her recollections were consistently illuminated by the liveliness of human and social interactions in the Madonna di Campagna neighbourhood. During the 1970s, this area functioned as a "central periphery," acting as a frontier that both united and separated the countryside from the historic center. It was a space where diverse social classes converged, engaging in exchanges of perspectives amid moments of friction and solidarity.

Her connection with France mirrors this ambivalence toward the worlds she inhabited, each coexisting within her in a delicate balance. Identified by some as a Franco-French intellectual, she manifested an unmistakable Italian spirit in her scientific and cultural endeavors. In this unique position, Marina successfully sustained the richness and complexity inherent in the relationship between these two reference cultures. Achieving this task is no small feat in a country like France, which, even in its generosity, historically exhibits a tradition of cultural assimilation. The palpable "cohabitation" of her two worlds is exemplified by her deep attachment to "her" Parisian neighbourhood (the Marais) while simultaneously choosing not to pursue French citizenship—an apparent contradiction that only those privileged enough to know her well can truly comprehend and justify.

On the intellectual front, Marina's research unfolded along the uncertain and rugged frontier intersecting diverse realms of knowledge: a degree in philosophy, a DEA in anthropology of technology, a PhD in epistemology, engagement in sociology, teaching in social psychology, and a focus on gender studies, among others. This is precisely why the field of Science and Technology Studies (STS) became a privileged domain of her activity. Embracing its inherently "uncertain" status and maintaining an "undisciplined" dimension, we both consistently advocated for and valued it as a resource not to be squandered but instead, to be carefully preserved. Marina had the opportunity to manifest and nurture her passion for the transversality of knowledge at the *Centre d'Études des Techniques, des Connaissances et des Pratiques* (CETCOPRA) at the Sorbonne, an interdisciplinary research center founded by Alain Gras and currently directed by Thierry Pillon. Here, she charted a rich and original research trajectory, consistently anchored to a specific perspective—the body and its social construction. From this standpoint, she delved into studies on the imaginaries of technology (with a focus on nanotechnologies and nanoparticles), the analysis of techno-utopias, post-humanism and transhumanism, cultural disasters, and the anthropology of De Martino.

Finally, the culminating frontier in her scientific exploration focused on the hybridisation of the body and technology, particularly in the realm of medical and restorative prostheses. This research not only enabled her to synthesise earlier works but also elevated her scientific *métissage*. This transformative phase was facilitated by her delegation, a temporary assignment spanning 2018/2019, at the Institut des Systèmes Intelligents et de Robotique (ISIR), a laboratory under the Centre National de la Recherche Scientifique (CNRS). Her ambitious project, titled "Aux frontières du corps: La place de l'expérience singulière dans le processus d'innovation technologique en robotique et prosthétique," delved into the intersection of the body and technology.

Conducting fieldwork within this research initiative, Marina passionately embraced her mentorship role until the very last days before her sudden and untimely demise. As attested by the younger researchers involved in this project, she generously supported them, helping navigate the fears and uncertainties inherent in the early stages of an academic career, especially when navigating the complex terrain of interdisciplinary research.

In this aspect as well, Marina demonstrated her *force tranquille*—a serene yet resolute strength that defined her approach to work, fueled by the passion and love for knowledge that characterised her. With the same selflessness and transparency, she nurtured profound human connections, constructing and supporting them with generosity, even in instances where her Friulian background might have led those unfamiliar with her to misconstrue a certain reluctance and introversion as rudeness.

Notes on Contributors

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Mariia (Masha) Kiseleva is a research fellow at the STS department at the European University at Saint Petersburg (EUSPb), where she earned a master's degree in Sociology. Her interests include actor-network theory (ANT), user studies, contemporary reflections on subjectivity, identities, bodies and their relation with technology, as well as the epistemology of AI. From 2020 to 2023, she was a part of "Self-Driving Cars and Society" project at EUSPb. She is currently curating the program of further professional training "User Studies: UXxSTS" at EUSPb that brings the perspective of social sciences into business processes.

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