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SPECIAL SECTION
Technoscience and human bodies,
Vaccine hesitancy and controversies,
Gaming and cyborgs

The Linguistic Luminary (2023) co-created by ChatGPT and Sergio Minniti

[*We asked ChatGPT to represent itself. Although it lacks the ability to create visual content, it constructed an embodiment by creating an ASCII representation of its "digital persona" – or, as ChatGPT itself put it, "a humble representation of my digital existence, shaped by the language we share"*]

SM: Can you draw a picture of yourself?

ChatGPT: As an AI text-based model, I don't have the capability to draw or create visual content. I exist solely as a language model to assist with generating text-based responses and providing information. However, I'm here to help answer any questions or engage in conversation to the best of my abilities. Is there anything specific you'd like to know or discuss?

SM: Can you draw a picture of yourself by using ASCII art?

ChatGPT: Certainly! Here's an ASCII representation of a computer screen with some text to symbolize the text-based AI:

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Please note that ASCII art may appear differently on different devices or text editors due to variations in font and spacing. I hope you find this representation suitable!

SM: Can you draw a picture of yourself as an avatar by using ASCII art?

ChatGPT: Certainly! While I can't create a visual image, I can provide you with an ASCII representation of an AI text-based avatar. Here's a simple representation:

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I hope this ASCII representation gives you an idea of an avatar for a text-based AI like me!

SM: Can you give a title to your text-based avatar?

ChatGPT: Certainly! How about we call this text-based avatar "TextBot"? It's a simple and straightforward title that reflects its nature as a text-based conversational AI.

SM: Can you imagine a more interesting title?

ChatGPT: Certainly! Here's an alternative title for the text-based avatar: "The Linguistic Luminary". This title emphasizes the AI's expertise in language and its ability to illuminate and provide insights through its textual responses. It adds a touch of intrigue and sophistication to the avatar's identity.

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SPECIAL ISSUE
Technoscience and human bodies,
Vaccine hesitancy and controversies,
Gaming and cyborgs

Cover *The Linguistic Luminary* (2023), co-created by ChatGPT and Sergio Minniti

Embracing Infrastructural Becoming

With this issue, marking the beginning of our second year serving as the Editors-in-Chief of Tecnoscienza, we initiate several new endeavours that we have been pursuing over last few years.

The first is welcoming the newly launched and fully operative Tecnoscienza website[1], built on an updated Open Journal Systems platform and hosted by AlmaDL – The University of Bologna Digital Library. The transition started in April 2022, with the partnership between Tecnoscienza's founder STS Italia and the Department of Philosophy and Communication Studies of the University of Bologna, now acting as joint publishers of the Journal.

Thanks to the support from AlmaDL, we can continue to maintain our radical platinum/diamond Open Access (OA) model, in which neither authors nor readers are required to pay any fees, ensuring that scientific work is freely accessible under the Creative Commons license "Attribution 4.0 International" (CC-BY-4.0). Over the past thirteen years, this model has been sustained by the volunteer work of a group of Italian scholars and the contribution of STS Italia. However, the continuous pressures that neoliberal academic models put on individual scholars and the ongoing debate on the fairness of a model based on unpaid additional work made clear that this model required some revisions to ensure its long-term sustainability. We are grateful to AlmaDL and the University of Bologna to offer this support and make it possible to remain truly open access.

Consistently with the technopolitical and infrastructural shift, we proudly present the new look of Tecnoscienza articles, made possible by our new production manager who has recently joined the editorial board of the journal. The revamped template reorganizes the information on the journal contents with additional details on ORCID, License, and DOI.

All academic journals rely on the work of peer reviewers to maintain high quality scholarship. To continue promoting what we consider good scientific work, it was imperative to acknowledge and honour the invaluable contributions of peer reviewers, who have played a pivotal role in shaping the quality and impact of our journal. To support the work of the Editorial Board in ensuring that the journal makes timely and constructive responses to journal submissions, we launched a call for a newly established Associate Board. The response to our call was well beyond our expectations and we have welcomed an interdisciplinary group of 29 international scholars who have agreed to assist with reviewing article submissions. Through the establishment of the Associate Board, we aspire to foster a culture of collaboration, transparency, and excellence within the STS academic community and fortify the bonds beyond it.

In addition to the significant milestones in terms of international indexing we achieved in previous years (WOS Emerging Sources database and Scopus), we are delighted to share that our hard work and dedication have been acknowledged by the Italian research evaluation

body ANVUR which recognizes *Tecnoscienza* as "Classe A" (top journal) in the following disciplinary sectors of the Italian Academic System: General Sociology; Sociology of Culture and Communication; Economic Sociology and Sociology of Work and Organizations; Demo-Ethno-Anthropological Sciences; Logic, History and Philosophy of Science. We are immensely grateful to our contributors, reviewers, and readers for their invaluable support and trust, which have been instrumental in propelling our journal to new heights. We are committed to continuing our pursuit of excellence, promoting cutting-edge research, and fostering national and international collaborations.

In continuity with the last years, we continue to promote the debate on emerging topics in contemporary STS thorough the publication of our "Scenarios" and "Crossing Boundaries", as well as special issues and thematic sections, such as the forthcoming ones "At the core of science and technology: work and organization in STS" and "The infrastructured timescapes of the Anthropocene and Climate Change".

We warmly invite you to engage with us in various ways, both through traditional means and innovative approaches. You can participate by submitting your manuscripts for review, sharing your expertise through book reviews, or presenting thought-provoking scenarios. We encourage diverse perspectives to foster meaningful academic dialogue and we extend an open invitation to develop compelling and timely proposals for future special issues that delve into emerging themes within and beyond the STS community. Together, let us embark on a journey of intellectual exploration, shaping the future of *Tecnoscienza*.

Claudio Coletta, Stefano Crabu and Manuela Perrotta

Notes

[1] https://tecnoscienza.unibo.it/

Technoscience in the Remaking of Human Bodies: Knowledge, Identities and Discourses

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Abstract
This contribution aims to introduce the topic under investigation in this special section and highlight the connections between the three essays contained in it. Taken as a whole, the special section explores the relationships between the human body, science and technology by focusing both on present material interactions and interventions and on futuristic visions of bodily enhancements. It shows how science and technology studies scholars can explore the co-construction of the body as the result of the interaction between human and nonhuman agency, materiality, knowledge and institutions. From this perspective, the body and its subjectivity emerge as relational phenomena from multiple entangled sociomaterial configurations spanning space and time. Hence, this special section reinforces the call for a processual understanding of living bodies as emerging from the intertwining of human and nonhuman entities.

Keywords
living bodies; cyborg; prostheses; neurotechnologies; digital identification.

1. Introduction

In the context of contemporary technologically dense societies, human bodies are deeply intertwined with technoscientific developments. No sphere of life related to bodies and bodily experience – birth, reproduction, work, learning, sexuality, gender, ageing and so on – is alien to technoscientific intervention (Clarke et al. 2003; Cohen 2009; Oudshoorn 1994). In this regard, the field of science and technology studies (STS) has been traditionally highly concerned with showing how human bodies and their boundaries are constantly being reshaped by technoscience, including biotechnology, nanotechnology and robotics (e.g., targeted drug delivery, sensory implants, prostheses and diagnostic imaging). It is worth highlighting that STS, in its effort to disentangle the mutual interplay between technologies, knowledge and bodies, has moved beyond rejecting biological reductionism and technological determinism and has instead conceptualised the human body as both the "object" and "subject" of technoscientific interventions (Mol and Law 2007). Following Mol and Law (2007), the living

body can be enacted as an object in multiple ways. When the body is (self-)scrutinised via medical imaging devices, self-tracking apps or surveillance techniques, it becomes the object of a specific (disciplinary) practice that may also modify and transform it, as in the case of biomedical implants. But the living body is also a subject, in the sense that humans are deeply embedded in specific bodily experiences (e.g., the fear or pain related to an illness or the feeling of satisfaction and pleasure arising from a physical activity). These experiences are inherently "fleshy" and can be the driver of subjectification processes as well as the co-definition of the subjective identities involved.

This article introduces the special section "Technoscience in the Remaking of Human Bodies", which is devoted to investigating the intricate relationships between the body, science and technology by focusing both on present material interactions and interventions and on futuristic visions of bodily enhancements. To describe these intricacies, STS and technology assessment scholars have pointed to the notion of intimacy between humans and technologies (see van Est et al. 2014). New and emerging technologies are intimate because they are *in us* in the form of drugs, implants, prostheses and more. They are also *among us* because they mediate and transform human interactions via online platforms, communication devices, and (self-)tracking and (self-)measurement tools. They are *about us* since our bodies and behaviours are digitised and datafied for a vast array of purposes. Finally, they are *just like us* because, for example, computer programs (e.g., chatbots) and robots increasingly mimic human behaviours and capacities.

The human body is fully part of these entanglements. It emerges as the outcome of complex assemblage processes that involve material, social and cultural elements. Because they are intimate, technologies are tightly linked to the human body; they reorient or prescribe present bodily practices and behaviours and fuel future-oriented sociotechnical imaginaries (Crabu and Magaudda 2022). Moreover, technologies are often nested in geographically dispersed and functionally differentiated sociomaterial networks of interdependence, which are necessary for their functioning, thus making the human body part of the broader sociomaterial context.

Let us take the example of digital health and post-genomic science. STS scholars who have explored these technoscientific domains have shown how the internet and digital platforms have changed biomedicine by allowing patients not only to access an increasing amount of health-related information but also to generate and share it (Oudshoorn and Somers 2006; Tempini and Teira 2019). In this domain, individuals are no longer passive consumers; rather, they are active users who produce, distribute and consume biomedical data and knowledge. 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. In this way, these individuals can bridge the informational gap that can arise between medical consultations. For example, those at risk of skin cancer can wear sensors (e.g., a patch) to detect thresholds of exposure to ultraviolet radiation, thus radically redefining their everyday habits and identity as potential patient based on the feedback and predictive knowledge generated by this technology.

The metaphor of the cyborg (Haraway 1991) is well suited to analytically grasp the multifaceted configuration of human bodies; it describes a body that has become pliable by virtue

of technological interventions and additions, thus overcoming the traditional distinction between "nature" and "culture" (Pellizzoni 2012). Hence, science- and/or technology-based interventions can modify the body beyond what might be described as "normal" functioning (Lock 2007; Wolbring 2008). This expanded role of technology has appeared beyond what Alan Roulstone (1998) defined as the "deficit model". This new role is not just about correcting the "deficits emerging from impairments [so that] technology stands as a correction mechanism that advances the individual body, enhances educational deficits, and normalises the disabled subject" (Galis 2019, 404). Increasingly, new technologies are able to reconfigure and modify the human body "not merely in their effort to represent and cure pathology but with intent to enhance what nature has endowed" (Lock 2007, 875). At the same time, the mobilisation of technologies "to modify the appearance of the human body and its functioning beyond existing norms and species-typical boundaries allows for a redefinition of what it means to be non-impaired", which also opens the space for unintended consequences and ethical dilemmas, such as new forms of ableism that see all bodies and minds "as limited, defective and in need of constant improvement beyond species-typical boundaries" (Wolbring 2008, 254), including those related to cognitive capacities. This new ableism may "fetishises certain cognitive faculties and conceives of disabled people in much the same way as the old eugenicists did with regard to the so-called 'feebleminded'" (Coenen 2014, 758). Furthermore, the emergence of pervasive wearable devices and digital applications, as well as the "invisible" infrastructures that allow their functioning, can translate human bodies and their performance into data through self-monitoring and self-surveillance practices that promote and enhance the experience-based knowledge that people have of their (self-objectified) bodies. This experience-based knowledge is imbued with prevailing normative biomedical discourses in which individuality is translated into numbers, thus fuelling the idea that the improvement and optimisation of the human body can be achieved by measuring it. This frames the body in a logic of display, performance and consumption (Thomas and Lupton 2016) and enables end users to intervene on their bodies through "technologies of the self" (i.e., self-tracking apps; see Lupton 2016) alongside health professionals.

Overall, the body appears no longer to be a stable site of normalised biological functions but a mutable ground in constant transformation, where materiality and subjectivities are being shaped. What are the implications of such a mutable corporeality? Which analytic stance can be adopted to investigate this changeable, hybrid body? The three papers in this special section examine the entanglement of technology and the human body and offer valuable insights into these questions.

The paper by Lucie Dalibert, Valentine Gourinat and Paul-Fabien Groud presents the results of ethnographic fieldwork conducted with amputees and healthcare professionals in France. This study aimed to investigate amputees' daily experiences and, in this way, understand the sociomaterial relations between their bodies and their prostheses. The authors highlight the material and discursive ambiguity of prostheses, which are both absent and present in the lives of amputees. According to an ableist representation of the body that is dominant in the medical discourse, prostheses are already present and intimately tied to the body in the discourses and practices of amputation and rehabilitation. However, their status is more ambiguous when their use becomes natural in daily life and when they are viewed by ampu-

tees as "parts" of their bodies, which makes them simultaneously absent and present. Finally, prostheses are also absent because they are often unused in the privacy of the home or when alone and because they are hidden when the amputee is in a social context to avoid what is perceived as stigma. The authors conclude that the relationship between the body and prostheses is better understood as something that is enacted and re-articulated in situated settings of interaction rather than as something that is defined once and for all.

The paper by Roberto Favalli analyses the discourse surrounding brain-computer interfaces (BCIs), a cutting-edge neurotechnology that allows direct interaction between the human neural system and external electronic systems. From the vantage point of the future-oriented representation of BCIs, Favalli examines the visions of the merging of humans and machines engineered by BCIs as they are presented in the scholarly literature. His article shows two distinct views of the cyborgisation of the body. The first one echoes the view of a strong human agency that characterises most of the transhumanist rhetoric; from this perspective, the human being is an agent capable of steering human-machine interactions towards his/her desired goals in a controlled fashion. The second view of cyborgisation reflects a less voluntaristic approach to the encounter between BCIs and the human body; it emphasises the autonomous adaptation of technologies to the changing realities of humans, even beyond the intentionality of the subject.

The paper by Stefan Strauß investigates the global spread of biometric technology as well as the ever-increasing accuracy and specificity of digital identification practices. Strauß notes that, while the use of biometrics is frequently justified as a security improvement, the expansion of this technology in daily life and for purposes not strictly related to security issues entails a significant growth in identifiability and surveillance mechanisms. According to the author, the increased use of biometrics poses various risks. As individuals cannot simply opt out of their bodies or change their corporeal characteristics, in the long run, they may be partially reduced to enduring machine-readable informational patterns as physical and digital environments conflate.

Three broad conclusions can be drawn from these papers.

First, the relationship between technology and the body is "spatially ambivalent" as it involves both proximity and distance. At the material level, technologies can be within the body or close to the body; however, at the same time, their embodiment depends on the dispersed infrastructures required by proximal devices for their functioning, such as in the case of biometrics or, more generally, the (self-)monitoring of the body (see the article by Strauß). On the discursive level, current technologies are shaped and enacted through the association with different knowledge and imaginative repertoires; these mediate particular sociotechnical futures that anticipate distant (and hypothetical) possibilities (see the paper by Favalli). Finally, in terms of perception, absence and presence as well as proximity and distance may coexist as different modalities of relations between the body and technology. This primarily depends on the context rather than on a general configuration of these relations (see the article by Dalibert, Gourinat and Groud).

Second, these three articles deal with identity and agency. The enmeshed relationships between the human body and technology challenge the idea of a stable and powerful human agency that directs technologies purposefully. As Favalli notes, the experts and researchers working on BCIs oscillate between a view of technology development as oriented by human agents and a view that sees humans as passive beings who adapt to said development. From a

different point of view, Dalibert et al. show the complex work entailed by trying to manage the blurring of the boundaries between human bodies and prostheses. The latter are a presence that is difficult to manage according to the desires and preferences of the amputees, and this shapes patients' daily lives as well as medical practices in both surgery and rehabilitation.

Third, the entangled relations between technology and the human body do not depend on the novelty of the technologies in question. The intimacy referred to above is not limited to new and emerging technologies. The example of prostheses is telling in this sense. The cases explored by Dalibert et al. show that the boundary between the human body and technology is not blurred only in the case of cutting-edge devices. Prostheses establish complex relations of embodiment with amputees.

Overall, this special section shows how STS scholars can explore the co-construction of the body as the result of the interaction between human and nonhuman agency, materiality, knowledge and institutions. From this perspective, the body and its subjectivity emerge as relational phenomena from multiple entangled sociomaterial configurations that span space and time. The resulting view challenges an essentialist conception of the human body as characterised by allegedly specific and "normal" physical and mental attributes. It strengthens the call for a processual understanding of living bodies as emerging from the intertwining of human and nonhuman entities.

Acknowledgements

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Living with an upper- or lower-limb prosthesis: The material remaking of the body through the prosthesis's presence and absence

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Abstract
Prostheses are complex, ambivalent, and non-uniform objects. Even before it "exists" as a material entity, the prosthesis, and more specifically the future body-prosthesis relation, is already present in one's amputation and rehabilitation trajectory. It is indeed integrated by healthcare professionals in amputation surgical protocols as well as during care in the pre-fitting rehabilitation phase. Not there yet, it still shapes, materially, amputees' bodies. Likewise, while amputees wait for its arrival, the prosthesis is an object they imagine and possibly fantasise about. Then, once manufactured and materially present, prostheses become part of a long, uncertain, and ever-changing process of creating a body-prosthesis alliance. Spanning from rehabilitation to daily-life at home, this process oscillates between adaptation and dis-adaptation, embodiment and rejection, capacities and limitations, hopes and disappointments.
Based on ethnographic fieldwork conducted with amputees and healthcare professionals in France, the purpose of this article is to delve into amputees' daily experiences, in order to grasp the complexity of the alliance that is woven between amputees' bodies and prostheses over time. More precisely, we will use the dialectic of absence and presence as a guide for our analysis, since these two notions are enlightening to understand the complex embodiment and collaboration between the amputee, his/her body, and his/her prosthesis. They shed light on the temporalities, the spaces, and the issues of the body-prosthesis relationship in the process of embodiment and appropriation throughout the life course.

Keywords
amputation; prosthetic devices; presence/absence; embodiment; materiality; representation.

1. Introduction

Limb prostheses are complex and ambivalent objects (Sobchack 2004). Their ambivalence manifests insofar as the prosthesis is not only a material device but also an imagined and fantasised one, be it positively or negatively. That is, a leg or an arm prosthesis is indeed there to

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recover a motor function, but it can also serve as symbolic repair, insofar as prosthetic devices and the bodies fitted with them are enmeshed in social and cultural representations and imaginaries. However, the collective imaginary of the prosthetic body is quite far from the material reality of prosthetic bodies. Highly robotic, the prosthetic devices that are covered by the media and present in the collective imaginary are quite unlike the arm and leg prostheses actually fitted on amputees (Sobchack 2006; Dalibert 2015; Gourinat 2018), which are less shiny and harder to handle. Likewise, amputees shown in the media are mostly young and healthy, whereas in the actual population amputees are a lot older and suffering from various illnesses. *How are these tensions played out in the experiences of amputees?*

In this article, we will answer this question by focusing on a particular dimension of prosthetic devices in their relations with their "users". We will show how prosthetic legs and arms are always already both present and absent. We do not need to own a prosthesis to be entangled in a particular imaginary surrounding this type of technological device: while materially absent, prosthetic devices are present in our imagination. What's more, even though they are not there yet in one's amputation and post-amputation trajectory, prosthetic devices are already present in the surgical and rehabilitation protocols. Their simultaneous absence and presence also play out at the experiential level. That is, prostheses are hardly used constantly. Quite fundamentally too, as one may strive and work for his/her prosthesis to become "transparent", i.e., absent or in the background of one's attention, one's artificial leg or arm can become a cumbersome and highly present object when it malfunctions, when it is not adjusted properly and/or when it interacts with the wider socio-material context. The latter may have disabling effects; it may not only render the prosthetic device highly present for oneself and others but also affect the way one can live well with his/her prosthesis.

After introducing our conceptual and methodological frameworks, we develop the empirical analysis in four stages: we attend to how prosthetic devices' absence-presence is enacted in collective discourses and imaginaries (paragraph n. 4.1), before the amputation and/or the fitting of the prosthesis (paragraph n. 4.2), during the rehabilitation process and the learning/embodiment of the prosthesis (paragraph n. 4.3) and in amputees' long-term experiences, especially in their daily life and social contexts (paragraph n. 4.4). Finally, we offer our conclusions and final remarks.

2. Analytical perspectives

Being able to walk and live well with a leg or arm prosthesis is an intricate endeavour, as philosophers, anthropologists and Science and Technology Studies (STS) scholars have emphasised (Sobchack 2004, 2006; Dalibert 2014; Crawford 2015; Shew 2017; Gourinat 2018; Groud 2020). Not only are limb prostheses complex objects, composed of different elements, such as a custom-made socket that welcomes the stump, a (hip, knee, ankle or shoulder, elbow, wrist) joint, an appendage (e.g., foot or hand), an adapter (e.g., a tube that connects these main components together), and eventually a liner (that envelops the stump) and a cosmesis (that covers the prosthesis), but they are also material entities that are at once present and absent, enmeshed with imaginaries and expectations. While STS scholars and philosophers of technology have attended to the ways in which tools, technical artefacts and technological

objects mould and influence our actions and intentions (Ihde 1990; Latour 1994; Verbeek 2005), they have given less attention to more intimate human-technology relations, such as those involving prosthetic devices. In fact, the very notion of use might be problematic when attending to the specificity of the interactions between an amputee and her prosthetic limb, for instance her prosthetic leg, inasmuch as one does not so much *use* her prosthesis but rather sits, stands on, walks and more generally moves with it. What's more, for the prosthesis to enable her wearer to accomplish such activities, its presence needs to take on a particular dimension: as Vivian Sobchack, herself an above the knee amputee since 1993, remarks when she tells of her relationship with her prosthesis,

> [o]bviously, transparency is what I wish – and strive – for in my relation to my prosthetic leg. I want to embody it subjectively. I do not want to regard it as an object or to think *about* it as I use it to walk. [...] Insofar as the leg remains an object external to me, a hermeneutic problem to be solved, a piece of technology to "use," I cannot live it and be enabled by it to accomplish those intentional projects that involve it but don't concern it. So, of course, I want the leg to become totally transparent. (Sobchack 2004, 172; emphasis in original)

To be enabling, the prosthesis must become transparent: in one's subjective experience, it must not draw attention to itself. That is, its presence must be marginal in one's consciousness; it must be an absent presence.

The notion is reminiscent of phenomenological understandings of bodies and technologies. At the phenomenological level, bodies oscillate between presence and absence. That is, when one is healthy and/or pain-free, one's attention is hardly ever directed toward one's body but rather towards the world. One's body is experienced as absent – it is an absent presence, writes Drew Leder (1990) – while one's being-in-the world is characterised by intentionality and agency ("I can"). Conversely, when one suffers from (chronic) pain and/or illness, one's body is not experienced as transparent but rather attracts and may even engulf one's attention. In these circumstances, the body "dys-appears", dys-appearance[1] denoting the body's absent absence, which is marked by discomfort (*Ibid*). Furthermore, Sobchack's account resonates with particular appreciations of one's relationship with technologies. In his attempt to map human-technology-world relations and illuminate our technologically mediated lifeworld, philosopher of technology Don Ihde (1990) characterises as embodiment relations the configurations where technological devices both extend and are integrated into one's perceptual field or one's sensory-motor schema – one's bodily schema. In such relations, one experiences the world through the artefact while perceiving the latter as transparent, as a "quasi me". A typical example is the relation between the blind man and his white cane found in Maurice Merleau-Ponty's *Phenomenology of Perception* (1962): when he walks with the cane, it is not the cane that the blind man perceives. Rather, the cane is integrated in his body schema – it is embodied – all the while it extends it, and it is through the cane that he perceives the world. Similar conceptualisations are offered by material culture anthropologists who not only underscore that material objects can become integrated or incorporated into one's body schema, but also emphasise how, once embodied, they shift from a position of exteriority to a relation of evidence or obviousness (Rosselin 2006; Nourrit and Rosselin-Bareille 2017).

Successful relations with or embodiment of a limb prosthesis thus require the latter to be transparent or an absent presence. As aforementioned, this is what Sobchack wishes and strives for in her relation to her prosthetic leg. However, such an achievement is neither immediate, nor definite, nor absolute: rather, it demands work, and the status of the prosthesis may change depending on the broader socio-material context (Sobchack 2004; Rosselin 2006; Winance 2010, 2019; Dalibert 2014, 2016; Gourinat 2018; Groud 2020). More precisely, similar to Myriam Winance's analysis of wheelchair users' experiences, walking with a prosthesis is the result of a dual learning process: a highly reflexive and iterative one wherein, in light of the effects of the technological device, one assesses one's sensations and adjusts one's bodily movements and, both simultaneously and successively, a more embodied process wherein one learns to "do with" the technological device, progressively incorporating know-hows (Winance 2010; see also Dalibert 2016; Groud 2020). When such a dual process is successful, one's prosthetic device becomes an absent presence. Nevertheless, due to disabling stares and material arrangements, the artificial limb that was experienced as being a part of oneself can convert into an object that is rather experienced as part of the world (Sobchack 2006; Winance 2019; see also Garland-Thomson 2009). Here, one's prosthesis becomes dramatically present or an absent absence for oneself and eventually others.

A prosthetic device oscillates between absence and presence or, rather, it is always already both present and absent in a second respect. A prosthetic limb does not need to be used or even materially there to affect its wearer. To account for the ways in which technological devices shape or mediate our experience of ourselves, of others and of the world, not only in their actual use but also in their potential or virtual action, Asle Kiran (2012) has proposed to extend the concept of technological mediation (Verbeek 2005) with that of technological presence. Even though it is not being worn, handled, or employed, a technological device such as a prosthetic leg or arm will affect the way one perceives oneself and the world, it will influence how one envisions one's future and projects oneself in it. Even though it is not there yet, that is, even though it is not fitted or not even fabricated yet, the limb prosthesis is already present in the healthcare and rehabilitation protocols, in the therapeutic and life goals, as well as in care and social relationships. Where virtuality is "the potentiality of the actual" in Kiran's account (2012, 86), prostheses' (technological) presence takes on two particular dimensions: a material and an imaginary one. First, prosthetic devices have been the object of intense media coverage and "spectacularisation" (Marcellini et al. 2010; Dalibert 2015; Goffette 2017, 2019; Gourinat 2018, 2020; Holt and Murray 2019; see also Sobchack 2006). In so doing, as material objects, they are inseparable from a particular (visual) imagery and imaginary, one that is mainly built around efficiency and performance (Gourinat et al. 2020), and one that is inextricable from ableism. Indeed, this discriminatory ideology towards people with disabilities values healthy, efficient, and autonomous bodies. Ableism, as Fiona Campbell (2001, 44) defines it, is a

> network of beliefs, processes and practices that produces a particular kind of self and body (the corporeal standard) that is projected as the perfect, species typical and therefore essential and fully human. Disability then is cast as a diminished state of being human.

The (de)valuation inherent to ableism is further exposed by Gregor Wolbing who explains that "[t]his preference for certain abilities over others leads to a labelling of real or perceived deviations from or lack of 'essential' abilities as a diminished state of being" (2008, 253; see also McRuer 2006). Which amputated bodies with prostheses are present in and, reciprocally, absent from media coverage and representations is undoubtedly affected by the systematic devaluation of disabled bodies. Second, prosthetic devices are prescribed and worn to compensate for the loss of a limb, but even though they are still materially absent, their projected presence in amputees' daily life informs and guides amputation procedures. That is, the prosthesis' virtual presence guides the way the limb is cut as well as the way the body, its postures and motor conducts (Warnier 2005) are remoulded through physical therapy – the latter not being exempt from ableist standards either (Gardien 2016; Williamson 2019).

Finally, a prosthetic device is always already present-absent in a third respect: even when it is worn, it is not worn constantly. Rather, it can be "used" very pragmatically (depending on the context and the task to accomplish) or hardly ever. Even in rehabilitation centres, when amputees are encountering and getting acquainted with their limb prosthesis, the latter is seldom here and disappears/dysappears often. Yet, few analyses in the humanities and social sciences, including those rooted in STS, have addressed the issue of non-use and/or abandonment of technological devices. It is in relation to information and communication technologies, and to the notion of the digital divide more specifically, that the issue of non-use has been raised (Wyatt et al. 2002; Wyatt 2003, 2010). In this context, it has been emphasised that non-use should not merely be apprehended in terms of deficit or failure, but that it may be due to resistance, lack of interest or disinterest after an initial use. What this work highlight is that, like use, non-use shows different degrees and forms of engagement and needs to be contextualised. Use, non-use and, as we would add, partial use can be transformed according to different temporal and social trajectories all the while they are neither absolute nor definitive; rather, they can shift and reverse (Wyatt 2010). To understand non- or (very) partial use, Fabien Granjon (2004) invites us to investigate "ordinary sociability", that is, to look at everyday practices in order to appreciate the usefulness of technologies, in this case limb prostheses, in such practices and to explore the way they are perceived and make sense to (non- or partial) users. This is what we intend to do in this article.

3. Methodological framework

Our analysis is informed by two different fieldworks. Firstly, we realised a multi-site ethnography (Marcus 1995) in two French rehabilitation centres, at amputees' homes and within an association for amputees from September 2020 to January 2022. In the first rehabilitation centre, which is a large one, we were able to observe and interview a wide variety – with respect to the causes and levels of amputation as well as the types of prostheses that were fitted there – of amputees. With fewer amputees being cared for, the second centre is smaller and located in one of the French regions most affected by diabetes and vascular diseases, which are the main causes of amputation in France. This enabled us to meet (often) elderly amputees. In both centres, we spent 4 months in four full hospitalisation units, where we interviewed 39

caregivers and observed the rehabilitation trajectories of 29 newly amputated patients, from the beginning to the end of their stay. We also interviewed them as they progressed through the prosthetic fitting process. After they returned home, we undertook a longitudinal follow-up. More precisely, we did interviews and home visits one month, six months and one year after the end of the rehabilitation stay.

Then, after the end of the ethnographic fieldwork in full hospitalisation units, we moved to outpatient care for 7 months: in both aforementioned rehabilitation centres, we observed about a hundred follow-up consultations with 93 experienced amputees. The aim was to account for the experiences of people who have been amputees for a while and to examine the ways in which medical follow-up takes place during their life course. We conducted semi-structured interviews with 31 of them, mostly at home in order to observe their daily environment, as well as with 27 healthcare professionals working in these outpatient units. Furthermore, we observed the peer support practices initiated by an association for amputees, which ranged from coming to rehabilitation centres to meet new amputees, to organising sports activities and events or moderating the Internet forum. We interviewed 21 members of the association to get their feedback on peer support.

Throughout our ethnographic fieldwork, we recorded our observations by writing in various notebooks and by making photos as well as videos. All interviews were transcribed. We coded our data thematically using NVivo. We triangulated our analysis with all three authors reading each interview transcript and all the field notes (see also Olivier de Sardan 1995, 2008). To respect the participants' confidentiality, we use pseudonyms throughout the article.

On the other hand, our analysis stems from the study that one of us, Valentine Gourinat (2018), undertook from 2010 to 2016: relying on a diachronic perspective, she examined the content of more than 1000 search results on Google and Google News, by using keywords such as "amputee", "amputation" and "prosthesis". Following Bronner's methodology for identifying the state of a "cognitive market"[2] (Bronner 2013), she listed the first 30 search results for each year and each keyword, both in the press results (Google News) and in generalist results (Google, including image and video results). This number relies on the assumption (*Ibid.* 68) that a large majority of Internet users (65%) will be satisfied with the first 10 results proposed by the search engine, while almost all of them (90 to 95%) will take note of no more than the first 30 results. Thus, the first three pages of the Google search results allowed her to identify the state of knowledge, beliefs and information available to the public. On this basis, Gourinat classified in Nvivo the results by theme, which she developed both inductively and deductively, in order to identify the structures of occurrences and their recurrences, hence, to map the state of information available to the general public on the prosthetic issue (see also Gourinat 2018).

4. Empirical Analysis

4.1 Presence/absence of the prosthesis in collective discourses and imaginaries

The dialectic of absence and presence of the prosthesis can already be observed ahead of the prosthetic fitting process, in fact before limb amputation and the moment amputees dis-

cover their prosthesis. In industrialised countries at least, the prosthetic limb is an object that already exists in the imagination of the public, whether or not the latter is directly concerned with the problem of amputation[3]. In the context of cultural productions for example, several heroes of science fiction are amputees fitted with high-tech limb prostheses (Goffette 2019). Furthermore, part of amputation's media coverage, especially in the press, is about technological advances in prosthetic devices. The analysis of the structure and contents of these discourses has shown a high and almost exclusive presence of the prosthesis (Gourinat 2018). In most media coverage, the prosthesis is the main object of the discourse. Through the idea that the limb prosthesis enables to "repair" the damaged body, it is conceived as "the" solution in every situation and to all the problems encountered by amputees (Alan 2013; Smith 2016). In a sense, the prosthesis is presented as the outcome of every amputee's destiny. Amputees are almost never represented without a prosthetic device. Even more so, they are almost always represented *behind* or *through* their prosthesis. They cannot be understood nor identified without it: they appear, as it were, "ancillary" to their prosthesis (see also Sobchack 2004). Such media and cultural representations of prosthetic bodies are likely to impregnate amputees' imagination long before the amputation process.

Conversely, as our research on thematic occurrences in Google and Google News search results has shown, amputees' bodies are the great absentees from cultural and media productions and the imaginary (see Gourinat 2018). Amputees' bodies, and more particularly the stump, are rendered invisible or at least "euphemistic". A striking example of this dynamic might be that of Oscar Pistorius, whose athletic body and the spectacular physical skills he has developed over a lifetime of training are surprisingly not foregrounded in collective discourses. Only his prostheses are at the heart of media considerations and analyses of his sporting performances (Marcellini et al. 2010): they alone sum up his identity and his abilities. The first (and only) irruption of his body into the media occurred when he stood trial for the murder of Reeva Steenkamp as, in his defence, he bared his stumps to highlight the vulnerability of his bodily condition. The general shock caused by the appearance of the amputated body, of the stump, within a collective imagination entirely built around the prosthesis, shows quite clearly the disruption such an image was generating. In fact, the amputated body has no place in the collective discourse around prostheses. The publicised body cannot be a fragile or vulnerable body; it must not only be "repaired" but also camouflaged, and even at times enhanced by prosthetic technology. Equipped with prosthesis, it must appear as a "bionic" or "cyborg" body. Similarly, when it is present in the collective imagery, this body is always normalised, euphemised, sanitised: young, white, healthy, it is devoid of scars, disease, and weakness (Dalibert 2015). Yet, the actual bodies of amputees are rather old, ill, and fragile (Quesnel 2013; Varma et al. 2014). In fact, such imagery and imaginary are ableist: while disabled bodies and disability are shown, they simultaneously appear as something to be vanquished, with prosthesis being displayed as the innovation for doing so. The narrative hence becomes about ridding the imaginary and social world of disability[4]. With normative beauty, (technological) performance and self-determination being the values that it convenes and conveys, ableism and techno-enchantment (Gourinat et al. 2020) go hand in hand.

The narratives surrounding the prosthesis in collective discourses are essentially built around the dimensions of efficiency, performance and spectacularisation (Marcellini et al.

2010; Goffette 2017; Gourinat et al. 2020). Prostheses are presented as objects that are either effective in their performance or spectacular in their use or appearance. This staging makes certain types of prosthesis particularly present, all the while they are largely absent from rehabilitation trajectories: sports prostheses (e.g., racing blades), "mind-controlled" bionic arms, and artistic or designer prostheses. These types of prosthesis are, to a great extent, inaccessible to amputees, insofar as they are not reimbursed, nor can they be prescribed for everyone (a specific physical condition or motor skills are required to obtain a prescription). Some prostheses are not even available on the market, as is the case of several high-tech prostheses shown in the media, which are still in the research stage. In this respect, Nabil, a 32-year-old upper-limb amputee with a shoulder disarticulation[5], explains how he is not satisfied with his myoelectric arm, which does not function as easily as he would like. He is interested in new perspectives regarding prosthetics, and he does not understand why the medical team did not let him choose his arm:

> Like this one [he points to a prosthesis in a magazine photo], I saw, it's being produced now. I wasn't asked about it. I just have this one, it's…When you ask, they say directly: "This one is reimbursable, the other one is not", but still.

As the prostheses displayed in the media might generate idealised and unachievable expectations from amputees, the latter are likely to be disappointed by the prosthetic devices that they will ultimately get (see Figures 1-2 and 3-4). This is the case of Miroslav, a 40-year-old transhumeral[6] amputee. As he is talking to his occupational therapist during a consultation, he points to his prosthetic glove and expresses that:

> I can't go out with this: this is horrible. I don't want to. There, it makes bumps, it's not nice! It's horrible. The fingernails too, it's not beautiful. It's not natural. What the hell is this? I don't like it; I don't want to wear it outside.

Several interviewees indeed complained about the ugliness of the prosthesis' appearance. Such a feeling is particularly strong at the beginning of the rehabilitation journey when the provisional prosthesis has a "cobbled together" appearance. Amputees find it difficult to project themselves into wearing it. As Claude, a 51-year-old transtibial[7] amputee, explains:

> There is a criticism that I make […] and I have often heard it repeated by people who are fitted for the first time, it is that when a preparatory prosthesis is made, it looks like nothing! It's, it's… horrible! […] [W]hen you try on a preparatory [leg] prosthesis, with the casting tape around it, with a translation adjuster that is oversized, and that makes big lumps on the side […]. When you see that on yourself, you are distorted… That's not good. It's too violent.

The negative evaluation of the prosthesis, its perception as ugly, also persists later: not only can its uncanny dimension – i.e., it is real-looking while still visible as not real – be experienced as disturbing, but the appearance of the prosthesis itself can also deteriorate with use: the coating can get stained, crumpled, or damaged (see Figures 5-6).

Figure 1.   **Figure 2.**

Media representation of lower and upper limb prostheses
(respectively Pexels Cottonbro studio and Pexels Mart Production)

Figure 3.   **Figure 4.**

Lower and upper limb prostheses as they are delivered for a permanent use
(pictures by Valentine Gourinat)

Figure 5.   **Figure 6.**

Lower and upper limb prostheses worn and damaged after months or years of use
(pictures by Valentine Gourinat)

Finally, the modalities of what it means to be living with a prosthesis are absent from media discourses: the issues regarding learning and actual use, the difficulties of using a prosthesis and the possibilities of non-use are never addressed in the collective representations. Passed over in silence, they become hard to anticipate for amputees entering the rehabilitation process; they might even prevent them from projecting themselves towards what awaits them in practice. This process wherein prosthetic devices are idealised and highly present in the media and cultural productions all the while amputees' bodies and experiences are absent, might lead to particular (high) expectations from future prosthetic "users" (and their relatives), which may complicate the care journey.

4.2 Presence/absence of the prosthesis before amputation or prosthetic fitting

Further away from the prosthetic imaginary, in the reality of what it means to be an amputee and to be fitted with a prosthetic device, the prosthesis is still inscribed in a dialectic process of absence and presence, but one that takes on a different form. The dual dimension of the prosthesis impregnates and influences the way amputees' bodies and living as an amputee is conceived.

Before amputation, the prosthesis is an object that already has a central place in the discourses of caregivers and the testimonies of amputated peers. When amputation is inexorably required following the critical development of a pathology[8] or when it is a therapeutic and functional option[9], healthcare professionals mention the positive aspects and the benefits of the prosthesis to show the person who must be amputated that it is possible to live with the loss of a limb. The medical-functional gains and the psychosocial benefits offered by the prosthesis are elements that are evoked to enable the person to project herself into a post-amputation future. Even before it is manufactured and thus before it exists as a material entity, the prosthesis is already (omni-) present in the intentions of care, the rehabilitation, and the autonomy of the (future) amputee. To a certain extent, amputees' bodies are not apprehended outside of their relation with a prosthesis. The latter, which aims at compensating for the loss of the limb, also becomes part of an ableist endeavour to overcome disability and to restore the body's integrity and normalcy. In fact, as Ève Gardien has shown, rehabilitation protocols tend to "slavishly reproduce able-bodied gestures" (2016, 109, our translation) rather than to utilise the singular potential of each corporeality. While amputation protocols aim at avoiding future medical issues (e.g., being upright contributes to functional cardiac and vascular systems and prevents bedsores), bodies are nonetheless moulded, hence constrained, to achieve a particular shape and gait in order to comply with ableist conceptions of what a body is and should do (e.g., standing up and walking on two legs).

In this respect, the prosthetic device's absence-presence continues during the surgical act of amputation. Surgical protocols define the prosthesis not as a simple object that is added to the amputated body, but as intrinsically tied with the body. The objective of surgical techniques, which have been perfected over the years through collaboration between surgeons, physical medicine and rehabilitation (PMR) physicians and prosthetists, is to shape the stump in order to allow for the absence of pain and for the future presence of the prosthesis. As Ambroise, an experienced 62-year-old PMR physician, explains it:

> Patients are much better taken care of before, during and after amputation. Surgeons ask our
> opinion when they amputate someone [...] Inter-team communication protocols... there are
> many things like that that we didn't know before, everything is standardised [*protocolisé*] [...]
> It is important that the person is amputated well, with a stump that has a good length as well
> as good and painless skin coverage so that it can be adapted to prosthetic fitting.

In the search for the person's future well-being with the prosthesis, surgical protocols rely on various techniques and standards, such as a particular level of amputation, covering the stump with the preserved soft tissues, or shortening the tibia with abrasion of the Farabeuf angle (transtibial amputation). The resection of the patella at the level of the stump in order to obtain an efficient "terminal support" (Gritti-type femoral amputation) is another illustrative example of the integration of the prosthetic device and its eventual challenges in the shaping or moulding ("*formatage*") (Gardien 2008) of the amputated body. In this sense, if the prosthesis is not "incorporated" yet into the person because it is materially absent at the time of amputation, it is nevertheless present and incorporated into surgical protocols. The amputated body is designed and shaped to accommodate the prosthesis.

The surgical act is only the first step in the long process of shaping or moulding (*formater*) the amputated body in connection with the future wearing of the prosthesis. Post-surgery, the first phase of re-education, which is tellingly called "pre-prosthetic" in rehabilitation centres, aims to heal the stump and to train the person at the functional level in order for her to regain autonomy as well as to prepare for the arrival of the prosthesis. Caregivers use different techniques and practices to shape amputees' bodies during this phase. The stump is the part of the body that is quite central in these procedures. Despite the absence of the prosthesis, the stump is prepared for its future alliance with it (Groud and Perennou 2022), especially its socket, by various compression techniques and via the use of anti-oedema bands and elasto-compressive socks[10]. As Adrien, a 30 year-old physiotherapist expresses it:

> Compression [*contention*] is necessary. As soon as you want to fit someone with a prosthetic
> device, in terms of the first fitting, you need to set a compression as early as possible. [...] Be-
> cause we need to prepare for the fitting. The difficulty is that if we don't put such a compres-
> sion in place, we will have variations in [the stump] volume during the day because the patient
> will walk during the day, which will chase away the oedema, and then at night with the fact that
> we don't have a compression, the oedema will reappear. And so afterwards, the prosthesis will
> be too big or too small [...] If a patient does not have good compression, the prosthesis may be
> abandoned because the patient will never feel comfortable and will consider that the prosthe-
> tists are doing their job badly, and that in any case he does not have a comfortable prosthesis.

While waiting for the prosthesis, the main challenge of this compression and moulding work is to obtain and maintain a pain-free stump, one that is also stable in shape and volume: at stake is to have an optimal fit with the prosthetic device. As we observed in rehabilitation centres, physiotherapists, nurses, and care assistants explain very early on to amputees why and how to bandage their stump or put on their compression sock. From the beginning of the "pre-prosthetic phase", and despite its material absence, the prosthesis is continually present in the minds and practices of

amputees and carers. It is as much the beacon of the rehabilitation journey as the goal to achieve.

Besides the stump, the shaping process also focuses on the whole body. Caregivers use several techniques to mould it, such as muscle reinforcement exercises for amputees to be able to wear and bear their prosthesis, and making them stand up – which caregivers call making them vertical (*re-verticalisation*) – in the physical therapy parallel bars and walk monopodally with a crutch in the perspective of walking with the prosthesis. In this process, healthcare professionals are particularly attentive to what they call the body's "improper positionings" ("*attitudes vicieuses*"), such as a flexed knee or hip, which may be harmful when the prosthesis is used. Assuredly, it is also able-bodied gestures and norms, hence an ableist conception of what a body is and should do, that are enacted here. The consideration and influence of the prosthetic device are decisive and reveal close ties between shaping amputees' bodies and the perceived functionality of the latter with the prosthesis, even before it is present. Long before the prosthesis is manufactured, this approach highlights the dialogical links and the process of organic-material compatibility that are woven between bodies and prostheses and that will become essential elements of amputees' future daily life.

4.3 Presence/absence and embodiment of the prosthesis during the rehabilitation journey

Whereas the prosthetic device is materially absent in the first phase of re-education, the manufacture and arrival of the first temporary prosthesis have amputees enter a second phase in their stay at a rehabilitation centre, called the "prosthetic" phase. Although it is impatiently awaited, the prosthesis is also the source of interrogations (What will it be like? How will I use it?) as well as uncertainty (Will I manage to walk with it?), all the while it raises hopes (I may walk again!). The first day one "encounters" or "meets" his/her prosthesis, that is, the day one is fitted with the prosthesis in the parallel bars of the rehabilitation room, is a particularly "strong" moment as Omar and Odile recall:

> When I first put on the prosthesis [...] it was really... It's strong... I'm telling you it's strong... Very strong... I was pleased to be able to stand up again, to see... The fact of standing up, it's important. (Omar, 43 years old, transtibial amputee)

> I was afraid that I wouldn't walk again. I was told: "Here, you will walk again. We're going to give you a prosthesis." I didn't know what a prosthesis was. And it's true that when I had the prosthesis, when I was walking between the bars, I cried a little because I was happy. (Odile, 66 years old, tibial and transmetatarsal[11] amputee)

Because of the possibility of standing up again and of being able to walk a few steps, the first trial with the prosthesis generates intense emotions and high expectations. Many amputees expect to learn quickly and to use the prosthesis regularly and easily. However, this learning process turns out to be more disenchanted than they had imagined. As the sessions and days of rehabilitation progress, amputees realise that the materialisation of the prosthesis does not mean a permanent presence and use of the prosthetic device. On the contrary, the prosthe-

sis is only intermittently present during the first days or even weeks of the prosthetic phase, which may cause some disappointment, such as that described by Hubert:

> The time spent with the prosthetists was not unpleasant in itself. The problem is that it was beyond our control. But what is very frustrating and taboo is the length of the work. [...] I'm not criticising that they don't do their job well, but I mean that... when they say, "Here, we'll take your prosthesis," but in fact they give it back to you 10 days later. (Hubert, 63 years old, femoral amputee)

The adaptation process is often long and uncertain (see also Sobchack 2004; Winance 2010). Amputees first wear the prosthesis for a few minutes, then for 15 minutes, 30 minutes and an hour, so that the stump gradually becomes accustomed to the socket and does not get injured. In addition to the progressive wearing of the prosthesis, its tweaking by prosthetists over one or more days, the constraints linked to certain pathologies and the possible risks of injury to the stump are other elements that can lead to a prolonged absence from wearing the prosthetic device. As André expresses it:

> I got blisters, these I got because I insisted on walking. That was a mistake at the beginning, but I think it's a mistake everyone makes: I mean, we're so happy to be standing. [...] So as a result, well, you get injured easily. So sometimes it's 15 days without wearing a prosthesis. (André, 62 years old, double tibial amputee)

Emma, a physiotherapist we interviewed, concurs with André as she explains that:

> You have to explain that for some of them, it will be very quick, they will integrate it [the prosthesis] quickly and for others, well, there will be arteritis pain which means that they won't be able to keep it on for very long [...] [They won't be able to keep it] on the stump because it creates constraints in spite of everything. (Emma, 26 years old, physiotherapist)

Figure 7.
Dressing worn after a stump wound
with the prosthetic socket
(picture by Paul-Fabien Groud)

Figure 8.
Prosthesis removed after 30 minutes
of walking in rehabilitation centre
(picture by Paul-Fabien Groud)

In the so-called prosthetic phase of rehabilitation, the accommodating process (Winance 2010) between body and prosthesis is therefore complex for most people. It fluctuates in a fragile balance between the search for progressive wear and periods of stoppage. Thus, if the prosthesis is materially present, and often within reach, it is nevertheless frequently absent, worn little or not at all during the days of re-education while waiting for an efficient entanglement between the organic and the prosthetic.

In fact, the presence/absence dialectic is at the centre of the embodiment processes of the prosthetic device. Initially, and especially at the beginning of rehabilitation, amputees perceive the presence of the prosthesis as an unknown material object, one that is external to the body, that involves a counter-intuitive use and that absorbs their attention. One of the main challenges of the prosthetic phase is to get used to and embody, if not completely, at least partially, the prosthesis – that is, to experience it as marginal in one's consciousness and field of perception, to experience it as "transparent" or a "quasi me". Accompanied by caregivers, the posture exercises and the experimentation with the prosthesis are here to help amputees discover and learn (to master) motor conducts and prosthetic bodily techniques.

Figure 9.
Exercises on a rehabilitation treadmill as part of the accommodating process necessary to embody the prosthesis
(picture by Valentine Gourinat)

Figure 10.
Exercises, accompanied by caregivers, that consist in going up and down stairs and that are part of the accommodating process necessary to embody the prosthesis
(picture by Valentine Gourinat)

In so doing, through increasing familiarity with the prosthesis, the embodiment process leads to a progressive blurring of the boundary between the organic (the body) and the material presence of the prosthetic device, that is, to an alliance between the two entities (Groud 2020; see also Oudshoorn 2020). Synonymous with embodiment and with a balance found between (subjective) absence and (material) presence, it is when motor behaviours and walking with the prosthesis become fluid and "natural" that the body-prosthesis alliance is enacted: the materiality of the prosthesis and the amputated body becomes experienced as transparent (Sobchack 2006; see also Ihde 1990). This embodiment process and search for

a "becoming one" ("*faire-corps*") (Warnier 2005) with the prosthetic device also combines, with the prospect of returning to a daily environment, with a desire to efface the social stigma (Goffman 1975) that is linked with ableist norms and that, in the eyes of others, is associated with the prosthesis and the amputation. As voiced by Pascaline:

> I also told the physiotherapist, I don't want to limp. I don't want to limp.
> (Pascaline, 72 years old, femoral amputee[12])

Figure 11.
Pascaline standing up
(picture by Paul-Fabien Groud)

However, if the embodiment and transparency of the prosthesis, which is then lived as an "absent presence", are objectives of the rehabilitation course, such a process is not linear. Various elements may come to thwart it and to interfere with the precarious balance between (subjective and material) absence and presence of bodies and prostheses. A source of disappointment and frustration, these obstacles mark out the rehabilitation journey and interfere with the learning process of the prosthesis. In this respect, Bernard and Valentin recall that:

> [You have] to get used to the weight, to the weight. It [the prosthesis] is 3.5 kilos. That's it! [...] According to the prosthetist, it's important to train yourself, you must train so that the stump can accept, that's it, support this weight, otherwise there's no... there's no, there's no other solution. (Bernard, 85 years old, transtibial amputee)

> For many people, it is the prosthesis that makes them walk, not the patient who walks with the prosthesis. That's an element that's quite difficult for us physiotherapists, and that's why we must adapt our discourse. [...] [T]hey have the impression that it's a robot that will make them walk, whereas this is not the case. (Valentin, 30 years old, physiotherapist)

Depending on their sensations and level of fatigue, amputees often feel that the prosthesis is a heavy and massive presence. Intermittently or regularly, they perceive the prosthesis as

impractical, difficult to control and to integrate at the sensory-motor level. For example, the heaviness and the consequent cognitive effort required for upper-limb myoelectric prostheses to function correctly cause great difficulties in use and embodiment, the opposite of what amputees had imagined, namely a prosthesis capable of rehabilitating motor functions. Furthermore, the omnipresence of the body, in its painful side, is also likely to resurface at any time during the prosthetic phase. For various reasons, the presence of pain (bone pressure, redness) and/or injuries (blisters, opening of the scar) can disturb and greatly slow down the appropriation and embodiment of the prosthetic device. That is, the absent absence of the body (it hurts, it is injured) interacts with the absent absence of the prosthesis (it is heavy, it is cumbersome, it is painful, it requires a lot of energy and attention) – they both dys-appear – making the embodiment of the prosthetic device, i.e., its becoming transparent in one's perceptual field, very precarious. For the prosthesis to be experienced as part of oneself, both the body and the prosthesis must be lived as absent presences. Moreover, because the temporary prosthesis is devoid of any aesthetic cosmesis, amputees tend to perceive the device as a visually unattractive object, as opposed to the high-tech prostheses displayed in the media. The overall appearance of the prosthesis and its negative appreciation can further hinder its embodiment.

Throughout their prosthetic journey in a rehabilitation centre, amputees (and their caregivers) deal with the absence/presence dialectic of the body and the prosthesis. The end of the rehabilitation stay does not mean the end of this dialectic, however. It will indeed continue and be enacted in other ways when returning home and experiencing one's everyday environment.

4.4 Presence/absence of the prosthesis through the long-term experience of amputees, in daily life and social contexts

The confrontation of the prosthesis with one's actual and multifaceted environments, which is often not the right "fit" (Garland-Thomson 2011), will bring about challenging situations within which the presence of the prosthesis becomes cumbersome or problematic. In the protected environments of the rehabilitation centre, the prosthesis can slowly start to be experienced as transparent. Yet, with daily environments and activities revealing its functional and/or social limitations, the (hard-won) absent presence of the prosthesis can fade away. There, the prosthetic device dys-appears: too visible, too cumbersome, too painful, too obstructive, it becomes highly present in one's actions and practices – in one's subjective experience. As Luc bemoans it, when comparing his wheelchair with his prosthesis:

> I have much more autonomy in the wheelchair than with the prosthesis. With the prosthesis, I must use crutches. The crutches mean that I no longer have the use of my hands. At least in the wheelchair I have the use of my hands. If there is something on the floor, from the wheelchair, I can reach it. If I have the prosthesis, I can't bend down anymore. I can't... even to eat at the table, I'm already far from the table and I'm putting [food] on my chest. (Luc, 82 years old, femoral amputee)

In everyday life at home, the prosthesis can either be absent (not worn) because it is not very useful, or too "present" to be comfortable or effective. Indeed, the transparency of the prosthe-

sis, the fact that it can be experienced as an absent presence or, conversely, as an absent absence, is not static: rather, it is enacted in concrete situations. Therefore, for the sake of comfort or ease, amputees may prefer to remove their prosthetic device when at home, as James tells it:

> Like when you have shoes and you feel more comfortable taking them off, once you're at home. (James, 36 years old, double tibial amputee who walks on his knees in his house)

In fact, at home, amputees might rather manage with a wheelchair, crutches or "simply" their stump(s) to realise their daily activities, because it is both easier and more comfortable for them. Vice-versa, outside the reassuring home environment, where the material absence of the prosthesis, hence the exposure of the amputation, might allow for greater comfort, the situation proves to be quite different. Firstly, as they are conceived for able-bodied people, urban environments are still not sufficiently adapted to wheelchairs (Borioli and Laub 2006). Therefore, they make it difficult for amputees, be they fitted or not with a prosthesis, to move around in everyday actions and movements. This is how Asma experiences and expresses it:

> Outside, there are still... There are subways, there are pavements... And nothing is made for the disabled... We have nothing. You have pavements everywhere, things everywhere, stairs everywhere... No automatic doors and all that. We don't think about the disabled. (Asma, 69 years old, femoral amputee)

Secondly, besides the difficulties linked to the built environment, the social dimension is a weighty factor in the balance between presence and absence, visibility, and invisibility, of the prosthesis (Gourinat 2019). The way people look at disabled bodies is still far too stigmatising: the missing limb(s) and/or the prosthesis, when they are visible to others, may not only become an obstacle or a major constraint in social interactions, but they may also have an impact on amputees' psychological well-being (Rybarczyk et al. 1995). In this respect, Asma shares how:

> I don't like the way others look at me because, especially in Algeria [where she lives half the time], it's people who are not discreet. They look at you in a way that says: "Oh poor girl, I feel sorry for her, she has a prosthesis... What happened to her?" And there are others... those who are mean: "But her husband, he kept her? It's not possible...". (Asma, 69 years old, femoral amputee)

When it becomes visible to others, the prosthetic body becomes present in one's consciousness: it can no longer be experienced as transparent. As Myriam Winance (2019) aptly encapsulates it regarding the disabling experiences of wheelchair users, an object that I perceive as part of me can suddenly become not part of me and part of the world in my encounters with the socio-material environment, which includes people's stigmatising and disabling gaze and stares. Here, the disappearance of the social presence of disability is revealing of collective values and norms, i.e., what we collectively want to be absent, which are informed by ableism. As such, in order to become an absent presence for oneself, the prosthesis must also become invisible to others. That is, the transparency of the prosthetic device and the related

absent presence of the prosthetic body, namely the "smoothness" with which one experiences his/her body fitted with prosthesis, is intimately bound to being able to pass as able-bodied, hence, to achieve absence or invisibility in the public sphere. Pascaline's fear of limping (see paragraph n. 4.3) can be reminded here.

Therefore, in order to avoid and/or remove the stigma, a whole game of presence and absence through clothing (large or loose-fitting clothes) and/or postural strategies (attenuating the limp or moving the prosthetic hand(s) while speaking in order to look natural) can be put in place. Indeed, as Youssou recalls:

> Until I was 23, I didn't want to be without my prosthesis. [...] This means that I used to buy only long-sleeved clothes [so that the socket junction would not be visible]. Even if it was 60°C, I was wearing long-sleeved clothes. When I went on holiday abroad, whether to the Comoros or anywhere else, I always wore long sleeves and it was embarrassing, but at least I wasn't being looked at and I liked not being looked at. That was my thing, that I wasn't being looked at. It was more... no one came to ask me questions. (Youssou, 43 years old, transradial agenesis[13]).

The aim of these strategies is therefore to make the prosthesis disappear from sight and social interaction, to make it absent and enable oneself to experience it as such, even though its (discreet) presence is also the guarantee of the invisibility of the stigma. Conversely, but less commonly, in an attempt to remove the stigma, some people will prefer to make the prosthesis particularly visible, and even highly present, in order to use it as a tool for asserting or enhancing their self-esteem and body image (Tamari 2017). This is reminiscent of the way in which the media expose prosthetics as the main attribute of amputees (see 4.1).

5. Conclusion

Throughout this article, we have sought to analyse the absence/presence of the prosthesis and the prosthetic body, in its multiple enactments. Several levels of this dialectic may emerge from our ethnographic observations and content analysis.

Firstly, the prosthetic absence/presence dialectic relates to the field of the imaginary and media productions and representations. There, whereas bodies and disability are absent, prostheses are highly present: they take centre stage. That is, in the collective imagination, supported by media representations and discourses, amputees' bodies are hardly shown. Rather, they are often erased behind prostheses. Prostheses are displayed as being beautiful, easy to use and immediately efficient and enabling (that is, as easily embodied, as transparent). However, this does not correspond to the reality of most prosthetic users; it is, in fact, informed by ableist ideals which evacuate disability in favour of (technologically) performant bodies. Secondly, if from an unknown and strange object that is external to oneself, the prosthesis becomes experienced as transparent, as an absent absence, it is the outcome of a long and difficult learning and training process. While, because of compression and rubbing, the prosthesis, or rather, the body fitted with a prosthesis can be experienced as painful, thus

as an absent absence, the amputated body itself also tends to be damaged, weakened and sometimes vulnerable, making embodiment, i.e., experiencing one's body with prosthesis as absent presence, all the more difficult. Therefore, transparency cannot be understood solely from the perspective of the prosthesis. While becoming one with the prosthesis requires the latter to be experienced as transparent, transparency is not only transparency of the device but also transparency of the body and, in fact, of their alliance. If one experiences his/her body as painful, sore, or itching, hence as an absent absence, it will be all the more complicated to embody the prosthetic device and achieve a body-prosthesis alliance. Prosthetic embodiment thus relies on the fragile combination of absent/presence of both prosthesis and body. Finally, we have shown that the use and non-use of the prosthesis can constitute a third level of the absence/presence dialectic. The material and subjective presence and absence of the prosthesis, and the desired transparency of the prosthetic body, are not linear nor fixed in space and time. Prosthetic embodiment cannot be separated from one's capacity for action or one's intentionality, which can be encapsulated in "I can". It is in action and through the particular tasks it enables its wearer to realise that the prosthesis can become experienced as a "quasi me". Such an experience is, however, affected by one's embeddedness in ableist environments and subjection to ableist norms. Be it when the body is shaped or moulded during rehabilitation to (be able to) be fitted with a prosthesis or when one must pass as able-bodied to avoid stigmatising stares, amputees and what their prosthetic body can do are intimately linked to ableist injunctions. In fact, subjected to the injunction of performing public invisibility, amputees' subjective experience of transparency is intimately linked to their performance of able-bodiedness. Furthermore, while ableism informs all the levels of transparency (or embodiment) and the possibilities thereof, it also shapes the way prosthetic devices and bodies are perceived and apprehended by healthcare professionals and amputees' loved ones. For able-bodied healthcare professionals and the able-bodied relatives (as well as the broader social group) of amputees, the prosthesis might be seen as an obvious and necessary object in the amputees' existence. And indeed, while the future presence of the prosthesis informs surgical and rehabilitation protocols and practices, non-fitting tends to be seen as a failure: the absence of prosthesis is not an option. Nevertheless, for amputees who experience the prosthesis' limitations and its dys-appearance (i.e., its absent absence in one's field of perception), its constant presence and use might not be essential. They modulate how and when to wear the prosthesis. They may even not feel the need to be fitted at all – but then, they tend to be pushed by their family or dragged into the rehabilitation process by healthcare workers and protocols.

Such an issue allows us to ask a final question, which relates to the issue of prosthetic use and non-use, and the relevance of a use paradigm in the context of prosthetic embodiment. Assuredly, limb prostheses are removable devices: as such they can be handled and worn to realise particular actions. In so doing, they appear to be usable objects and one could indeed say that they are used. Yet, embodiment seems to involve a deeper relation between oneself and the prosthetic device than, say, between oneself and a fork or a hammer (see also De Preester and Tsakiris 2009). Such tools also require to be embodied to be efficiently handled: they are experienced as transparent when they extend the body and enable it to complete the task at hand. Prosthetic devices, however, are introduced into amputees' lives and bodies in order to compensate for the loss of a limb. In so doing, not only are they inextricable from disability

and its affective, existential reality, but they can also become experienced as part of one's body, as becoming one with oneself: as we have shown, a successful embodiment entails such a subjective experience. Nevertheless, prostheses might be worn not to realise specific tasks but to hide one's missing limb, their aesthetic and social dimensions thereby eclipsing their functional ones and further questioning the relevance of a use framework. But more fundamentally, when from amputation onwards, the body is cut in a particular way, worked on and trained, that is, shaped or moulded to be fitted with a prosthesis, to what extent can one actually *choose* to use or not to use a prosthesis? To use or not to use a particular device involves and requires choice. The very nature of choice might be at stake in one's prosthetic fitting and eventual embodiment.

Acknowledgements

Notes

[1] From Ancient Greek δυσ-, the prefix "dys-" refers to what is difficult, bad, ill or impaired.

[2] According to Bronner, "[t]he *cognitive market* is an image that makes it possible to represent the fictitious space in which the products that inform our view of the world are disseminated: hypotheses, beliefs, information, etc." (2013, 23-24, our translation). It is from this informational offer that the knowledge and beliefs of individuals and the community are constructed.

[3] Whereas some future amputees will research what to expect and will look for information on the Internet before their rehabilitation, hence will arrive with ready-made images, others will have fewer or no idea regarding what to expect at the time of their hospitalisation.

[4] We thank one of the reviewers for inviting us to further develop the intrinsically ableist dimension of cultural and media representations.

[5] A shoulder disarticulation means that the amputation was done at the level of the shoulder joint (between the humerus and the scapula).

[6] A transhumeral amputation corresponds to an above the elbow amputation.

[7] A transtibial amputation is also called a below the knee amputation.

[8] For example, in case of limb necrosis due to vascular causes or in case of development of a cancerous tumour.

⁹ For instance, in case of severe chronic pain and consequent functional loss in a limb after an accident or agenesis.

¹⁰ Compression is also used to reduce the pain linked to swelling and to prevent phlebitis in the stump.

¹¹ In transmetatarsal amputations, all or part of the forefoot is removed.

¹² A femoral amputation corresponds to an above the knee amputation.

¹³ Transradial agenesis refers to the fact that part of the arm, the part below the elbow (i.e., transradial), did not develop during embryonic growth (i.e., agenesis).

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Contested Visions of Cyborgs: Sociotechnical Futures in the Field of Brain-Computer Interfaces

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Abstract
Brain-computer interfaces (BCIs) are a cutting-edge neurotechnology that allows direct interaction between the neural system and external electronic systems. Over the past decade, the field of BCI has witnessed far-reaching promises and expectations, especially regarding the merging of humans and machines. Drawing from the STS literature analysing the relationship between technological innovation and representations of the future, the paper looks at the field of BCIs and at the related expert-scientific debate as a discursive arena where particular visions of cyborg are enacted. Through the notion of *visions*, representations of the future and discourses of BCIs are explored and analysed within the scholarly literature. Whilst the future of these technologies is usually approached through the question: "Are we all going to become cyborgs?", the question addressed in this contribution is the following: "Which kind of cyborgs are enacted here?". The findings reveal two visions of cyborg; the first considers the subject's intentionality as a key element in steering the human-machine interaction, while the second looks at human-machine entanglement as a machine adaptation that takes place beyond the subject's intentionality. A detailed analysis also shows how these visions are enacted as assemblages of different discursive repertoires and associations mediating and shaping specific cyborg visions.

Keywords
cyborg; future visions; sociotechnical futures; science and technology studies; human-machine entanglement; brain-computer interfaces.

1. Introduction

In 2003, renowned engineer Kevin Warwick stated that "the era of the cyborg is now upon us" (2003, 131). In 2005, the technologist Raymond Kurzweil argued that "by the time of the singularity, there won't be a distinction between humans and technology"[1] (2005, 69). These are just two illustrative expressions of a broader contemporary myth that views humanity as marching towards an intimate amalgamation of humans with technologies. These narratives, often presented as "post-human" or "trans-human", outline a future in which humans will no longer be just strictly biological bodies, but will turn into human-machine hybrids, or

cyborgs (Coenen 2007; Jasanoff 2016). Against these highly speculative future discourses and as an effort to problematise current conceptualisations of cyborgs, this paper maintains the necessity to look closer at the actual material-discursive settings where visions of cyborgs are enacted. More precisely, the paper looks at the field of *brain-computer interfaces* (BCIs), also called *brain-machine interfaces*, as one the most cutting-edge emerging technoscientific fields where novel visions of cyborgs are envisioned.

Since the 2000s, an ecosystem of scientific and industrial actors around BCIs has emerged. In 2013, the dedicated scientific journal *Brain-Computer Interfaces* was founded. Thus, in 2015 the BCI Society was established with the aim of "connecting BCI-related organisations and individuals"[2]. In more recent years, the entrance of big-tech companies into the field, such as Meta, Microsoft, and Elon Musk's Neuralink, has expanded public interest and media coverage of BCIs.

BCIs can be defined as neurotechnological devices that connect a biological brain to a computer in real-time. BCIs operate by tracking the user's electrophysiological brain activity and translating it into signals to interact with external devices (such as a personal computer or prosthetic arm) without activating muscles or peripheral nerves. Even though BCIs are still mostly confined to the laboratory, within the expert-scientific debate the technological artefact has been envisioned for several different actionable applications. Initially, BCIs were considered for the medical-clinical area to provide alternative forms of communication and control of the external environment for subjects with disabilities, such as moving a cursor, steering a wheelchair, or operating a speech synthesiser. More recently, the envisioned applications have also included contexts such as work environments, wellness, entertainment, art, and virtual reality. Regardless of the particular application envisioned, John Donoghue, one of the leading experts in BCIs, writes: "Nearly all in the field will agree that one major goal of BCI research is to create a bridge from the brain to the outside world" (2008, 512). Similarly, the neurotechnologist Gerwin Schalk's (2008) overview of the potentials of the field emphasises the "brain-computer symbiosis" that BCI technologies will allow.

This paper relies on the science and technology studies (STS) literature about the relation between technological innovation and the future (Konrad et al. 2017; Lösch et al. 2019; Crabu and Magaudda 2022). By mobilizing such theoretical perspective, it looks at the field of BCIs, and at the related scientific debate, as a discursive-representational arena where particular cyborg visions are enacted, outlined, and contested. In this way, cyborg visions are considered as performative instances that envisions specific modes of human-machine entanglement or hybridisation (Heffernan 2019).

More in details, the paper investigates *which kind of human-machine entanglement representations emerge from the discourses that circulate within the technoscientific field of brain-computer interfaces*; or in other words, *which kinds of cyborgs are enacted here?* In addressing this question, the paper will focus on the expectations and future-oriented visions outlined within scientific publications on BCIs. Furthermore, to fully understand the specific modes of human-machine entanglement that circulate within the BCI technoscientific field, particular attention will be given to the socio-technical dimension and the configurations of hybrid agency enacted by the discourses through which these cyborg visions are articulated.

The next two sections present both the conceptual scaffold and the methodological framework behind this study. Then, after a brief overview of the historical development of BCIs, the paper will discuss and analyse the different visions of the cyborgs identified in the scientific debate.

2. Analytical Framework: Visions and Cyborgs

Since the late 1990s, social sciences have re-engaged in the analysis of the social, cultural, and political aspects of the future (Beckert and Suckert 2021). Consistent with this increasing attention, STS scholars have refined a wide set of perspectives to analyse how futures play a fundamental role in the perception and imagination of emerging technologies, in the material structuration of a technoscientific field, and in "the 'doing' of innovation, from the laboratory to funding and policy agencies" (Konrad et al. 2013, 5).

In the STS domain, representations and discourses about the future are not considered as merely speculative claims, but as historically and culturally contingent discourses that may play a key role in current innovation processes. From this perspective, futures are defined as performative, namely "expectation statements are not only representations of something that does not (yet) exist, but they also do something: advising, showing direction, creating obligations" (van Lente 1993, 191).

In this regard, the concept of "prospective structure" has been developed (van Lente and Rip 1998) to emphasise how a particular vision of the future can become dominant in a technological field, thus guiding (and constraining) the innovation processes. Furthermore, the shaping of future-oriented visions may become a matter of controversy between different contested futures promoted by competing constellation of actors (Brown et al. 2000). Hence, the notion of *arena* is usually adopted to refer to different social settings where expectations and promises are launched, transformed, contested, and affirmed (Bakker et al. 2011).

To investigate which kind of visions of cyborgs circulate within the BCIs academic debate, the paper mostly refers to STS works that have developed the notion of "vision" (Hedgecoe 2003; Lösch et al. 2019). A vision can be defined as "a framework within which the future shape and application of a technology are constructed" (Hedgecoe 2003, 355). Visions are shared by a range of actors and articulate socio-technical futures in which techno-scientific potentials are coupled with the anticipation of particular social changes.

Additionally, in line with recent theoretical insights (Alvial-Palavicino 2016; Schneider and Lösch 2018), the concept of vision is here adopted to take distance from a perspective centred on actors and their strategic mobilisation of expectations, and instead to understand visions as precariously emerging from the ongoing interactions between the heterogeneous elements that constitute the innovation process. Accordingly, in this paper the concept of vision is used to consider specific statements and scenarios as representational elements of a broader assembling process that can be called a "visionary assemblage". The notion of *visionary assemblage* relies on the work by Law (2004), who mobilises the notion of assemblage to analytically grasp:

> a process of bundling, of assembling, or better of recursive self-assembling in which the elements put together are not fixed in shape, do not belong to a larger pre-given list but are constructed at least in part as they are entangled together. (Law 2004, 42)

Consistent with this, the concept of visionary assemblage highlights the fact that visions can be seen not as static outcomes of previous social construction processes, but rather as processes in themselves. The visionary assemblage can then be defined as a continuously

re-enacted system of associations in which heterogeneous entities (both technical and social, human and non-human) are discursively interwoven, performing a precarious ordering effort through the enactment of specific socio-technical futures. In other words, a vision only exists in terms of the heterogeneous and evolving system of semiotically drawn associations through which a particular future is continuously outlined.

In this way, the concept of visionary assemblage allows for a dialogue with actor-network theory (ANT), in particular by mobilising the concept of "actor-world" (Callon 1986; Rip 2009) to trace the semiotic work through which visionary assemblages are enacted. According to Callon (1986), if an *actor-network* can be defined as a collective of heterogeneous entities that comes to act as a whole through a chain of material-semiotic associations (Latour 2005), an *actor-world* is a projection of a future actor-network, of a future world (Rip 2009). The actor-world is part of the actor-network. It is a semiotic construction that, through its circulation, plays a role in connecting and holding together the different bits of an actor-network. In these terms, future-oriented visions can be conceptualised as actor-worlds enacted through the semiotic work performed by the actors comprising the innovation network. In this paper, these actors are mainly the researchers and developers of BCIs who voice statements and expectations. In any case, the enactment of an actor-world is to be understood as the emerging effect of different and intricate social and technological arrangements, rather than the construction of individual actors. Hence, the emergence and the structuration of a technoscientific field such as that of BCIs can be read as the "enactment of overlapping and contrasting actor-worlds" (Rip 2009, 407). Furthermore, the actor-world must be inscribed materially to increase its durability and circulation capacity.

In this paper, the production and circulation of scientific texts is treated as a fundamental practice for the enactment of socio-technical visions. Through scientific texts, certain actor-worlds are enacted and mobilised in the attempt to enrol heterogeneous entities and readers into a particular representation of the future that they will possibly contribute to extending and stabilising.

With respect to these visions as actor-worlds, the paper focuses on which modes of human-machine hybridisation (or cyborg visions) are shaped along with, and as part of, the networks of associations through which the visions themselves are semiotically enacted. Following this conceptual framework, this paper will provide an understanding of the visions of the cyborg that circulate within the "BCI community" – with respect to which the related scientific literature can be treated as a forum for practitioners (van Lente 1993, 97) where agendas are built, applications are envisioned, and authors try to capture attention and interest.

Given the different meanings attributed to the notion of cyborg within the social sciences, it is necessary to specify what is meant here by this term. Caronia defines the cyborg as "an imaginary figure that signals a real process, a change in the relationship between human beings and technology" (2020, 96). Consequently, the concept of "cyborg" is adopted to look at the culturally situated way of imagining human-machine entanglement or hybridisation.

The relevance in the social sciences of the theoretical and political re-appropriation of the term "cyborg" is acknowledged especially in the critical readings of Haraway (1991), where the term is adopted to stress, and overcome, the boundaries between humans and animals, organisms and machines, nature and culture. Moreover, within STS there is also a recognition of what can be referred to as epistemologies of hybridity (Lipp and Dickel 2022), which

promote a theoretical framework focused on the entanglement between humans and arte-facts, and where the notion of cyborg is adopted to rethink the phenomenon of agency as the hybrid outcome of configurations of human and non-human entities.

At the same time, these epistemologies may risk lead to a "naturalisation of *cyborgisation*". In fact, assuming the "human-machine hybrid" as an overarching aspect of modernity (Har-away 1991) – if not of the entire human species (Clark 2003) – comes with the risk of over-shadowing the specificities of, and the difference between, situated and emerging modes of human-machine hybridisation; or, to put it differently, of specific kinds of cyborg that are en-visioned and enacted within specific technoscientific cultures. Thus, the concept of "cyborg" is adopted here to identify different (visions of) cyborgs based on the ways in which the roles of the human and the machine are defined and the interplay between them is characterised.

Furthermore, in the naturalisation of *cyborgisation* the human-machine hybridisation is treated as a "inherent" normal feature of the current societies. In this way, there is an inherent tendency to overlook the specificity of the existing relationship between the human-machine entanglement and its projection into the current representation of the not-yet. A relation-ship that appears so relevant in many contemporary narratives and imaginaries circulating in popular culture and mainstream media, where the notion of cyborg is often intertwined with the socio-technical imaginary of technological enhancement (Coenen 2007; Heffernan 2019). Lastly, it is important to stress how these considerations are relevant not only from an academ-ic perspective, but also from a wider societal perspective. The development of a consistent con-ceptual framework to go beyond the naturalisation of cyborgisation appears increasingly nec-essary, especially considering the potentially disruptive trajectories of emerging technological innovations. Indeed, it seems urgent to understand the actual complexities and risks involved in the widespread imaginaries of "becoming cyborgs" and to promote a gaze that can critically address the political, ethical, as well as economic circumstances involved in their circulation.

3. Methodology

The analysis of the visions that circulate within the BCI field draws on a sample of sci-entific texts, mainly review articles. Review articles can be considered as a particular form of academic article that aspires to provide an overall systematisation of the scientific debate about a particular issue or technoscientific domain. As Hedgecoe (2003) and Weiner and Martin (2007) highlighted, these scientific outcomes can play an active role in the process of construction and circulation of socio-technical futures and visions. After the first round of analysis, other documents (6 papers, 4 handbooks, 2 roadmaps) referred to in the review articles were added to the corpus. The procedure that led to the construction of the corpus is outlined in Fig.1. The corpus was initially analysed following an exploratory approach using MAXQDA2022. After the first round of coding, subsequent rounds and in-depth analysis focused on the discourses that explicitly (e.g., scenarios, examples) and implicitly (e.g., tech-nical definitions, comparisons with other technologies or applications, frames, legitimation strategies) contribute to the semiotic assembly of socio-technical visions.

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┌─────────────────────────┐
│  Review papers identified │
│  through database search  │
│  (Scopus, Web of Science, │
│    PubMed): N = 2,714     │
└─────────────────────────┘
              │
              ▼
┌─────────────────────────┐
│ Selection of review papers with │
│   a "citation score" above 100:  │
│  N = 107 (Scopus) + 101 (WoS) +  │
│      109 (PubMed) = 317          │
└─────────────────────────┘
              │
              ▼
┌─────────────────────────┐
│   Review papers manually   │
│  selected through title and │
│    abstract screening:      │
│  N = 39 (Scopus) + 31 (Wos) + 35 │
│      (PubMed) = 105          │
└─────────────────────────┘
              │
              ▼
┌─────────────────────────┐
│  Review papers after duplicate │
│    removed: N = 48            │
└─────────────────────────┘
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The selection of reviews was based on the following exclusion criteria:
- The notion of "interface" is adopted to refer to anatomical interaction (e.g., "neural interface between the motor and limbic systems") and not the technological device.
- The focus is on the materials or construction issues related to electrodes, implants, or medical devices.
- The reviews address more generally the issue of "assistive technologies", including BCIs but without putting them at the centre of the discussions.
- The reviews focus on the algorithms and data processing techniques that can be applied to the field of Brain-Computer

After the first round of analysis, other documents that emerged as particularly relevant to the research questions and were referred to in the review papers were added to the corpus (specifically, 6 papers, 4 handbooks, 2 roadmaps).

Figure 1.
Procedure for the construction of corpus.

4. Historical contextualization on BCIs

According to the historiography that circulates in academic publications, the science behind BCIs began about 100 years ago, with a German professor of psychiatry named Hans Berger. In 1929, in Berger's paper entitled "About the Human Electroencephalogram" (original title: "Uber das Elektrenkephalogramm des Menschen"), the term *electroencephalography* (EEG) was for the first time adopted in a scientific publication, along with speculations on the possibility of reading human thoughts from detected EEG brain waves (Borck 2018). Within the BCI community, the development of *brain-computer interfaces* is framed as a fulfilment of the possibilities initiated by Berger's work. This is nicely exemplified by an extract from a widely adopted handbook:

> This possibility – that people could act through brain signals rather than muscles – has fascinated scientists and nonscientists alike for many years. Now, nearly a century after Berger's epochal discovery, possibility is becoming reality. (Wolpaw and Wolpaw 2012, 9)

After Berger's EEG, the next and main "father" of the field was identified in Jacques J. Vidal, a Belgian researcher who worked at UCLA University. By the 1970s, Vidal led the "Brain-Computer Interface project" within a larger program funded by ARPA and the U.S. Department of Defense interested in evaluating the possibility of adopting biological signals to control computers, vehicles, weaponry, and other systems (Vidal 1999). In this context, the term "brain-computer interface" was used for the first time. In a 1973 paper named "Toward Direct Brain-Computer Communication", which still represents one of the most renowned publications in the BCI community, Vidal claims:

> Can these observable electrical brain signals be put to work as carriers of information in man-computer communication or for the purpose of controlling such external apparatus as prosthetic devices or spaceships? Even on the sole basis of the present states of the art of computer science and neurophysiology, one may suggest that such a feat is potentially around the corner. (Vidal 1973, 157)

Nonetheless, the field remained slightly uncertain until the mid-1980s. Then, during the 90s a small group of researchers from the United States and Europe spearheaded the BCI field by introducing the first real-time and working brain-computer interfaces and developing approaches and techniques that are still used today. In 1999, the first BCI international meeting was held in Rensselaerville, New York. "Fifty scientists and engineers participated. They represented 22 different research groups from the United States, Canada, Great Britain, Germany, Austria, and Italy" (Wolpaw et al. 2000, 1). From 2000 to the present, the BCI researcher-expert community has experienced an exponential expansion in terms of both BCI peer-reviewed publications and attendees at BCI conferences and other related events (Nam et al. 2018). In the following sections, two different visions of BCIs will be presented, discussing how these visions are assembled in the interwining of other discourses and elements that intersect the field of BCIs, anticipating specific types of cyborg.

4.1 Active Vision: Communicating and Controlling

Especially during the 90s, BCI research gradually came to coincide with the promise of developing systems to support severely disabled patients suffering from conditions such as amyotrophic lateral sclerosis (ALS) or locked-in syndrome. In this historical phase, the demarcation process of the boundaries of the BCI field is particularly instantiated within the first conference of the concerned BCI researchers-experts community in the 1999. Indeed, with the first international meeting on BCIs, a vision – that can be referred to as "Active BCIs" – starts being formally articulated along with the envisioning of a particular type of cyborg. As stated in the review on the first BCI international meeting:

> Brain-computer interfaces give their users communication and control channels that do not depend on the brain's normal output channels of peripheral nerves and muscles. Current interest in BCI development comes mainly from the hope that this technology could be a valuable new augmentative communication option for those with severe motor disabilities. (Wolpaw et al. 2000, 164)

Hence, one of the key aspects of the active vision is to trace an association between the future of BCIs and the future of people with severe disabilities. In this way, the vision operates performatively by articulating an obligatory passage point (Callon and Law 1992), which structures the future landscape by prioritising certain future trajectories at the expense of alternatives. This prospective structuring involves effects at the level of enrolment dynamics. First, the enrolment of persons with disabilities as the main reference for BCIs' envisioned applications. Particularly those forms of disability (such as the "complete locked-in syndrome", i.e., CLIS) for which BCIs are depicted as the only potential solution to interact with the outside world, since every other voluntary muscle control on which conventional assistive technologies depend are precluded. Second, researchers interested in entering the BCI field must learn (or at least consider) that the field is explicitly oriented towards the development of solutions for people with severe disabilities, and this will affect their courses of action.

Furthermore, by linking the emerging technological artefact (BCIs) with its potential social impact (overcoming disabilities), the active vision helps to reconfigure the BCIs innovation process as a protected space (van Lente and Rip 1998; Konrad et al. 2017), namely an innovation niche where the development of a new technology is perceived in a positive light, the resources invested are deemed legitimate, and evaluation standards can be relaxed despite technical challenges. This performative effect of the vision on the innovation process is also supported by a number of national surveys suggesting that medical and assistive applications are the most well perceived use of BCIs among the general public (Sample et al. 2020).

The association of BCIs with persons with severe disabilities is explicitly evoked within most of the reviews by means of captivating titles, such as: "Brain-computer communication: Unlocking the locked-in" (Kübler et al. 2001) or "Breaking the silence: Brain-computer interfaces for communication and motor control" (Birbaumer 2006). This association not only plays a key role in the enactment of a particular future vision of BCIs, but also structures the discourses on the socio-technical future of BCIs along certain trajectories, allowing certain modes of human-machine hybridisation to be imagined and silencing alternative visions of cyborgs, e.g., those that consider applications outside the medical field because they are considered unethical (Nijboer et al. 2011).

Regarding the kind of cyborg outlined by the active vision, a first aspect to highlight is how, with respect to the human-machine interplay, a predominant role is given to the human actor. The 2002 review "Brain-computer interfaces for communication and control" – which at 5,828 citations[3] represents the most cited BCI-related article – provides what is generally considered the first technical definition of BCI:

> A BCI is a communication system in which messages or commands that an individual sends to the external world do not pass through the brain's normal output pathways of peripheral nerves and muscles. (Wolpaw et al. 2002, 769)

and:

> BCI operation depends on the interaction of two adaptive controllers, the user, who must maintain a close correlation between his or her intent and these phenomena [variations in

electrophysiological signals], and the BCI, which must translate the phenomena into device commands that accomplish the user's intent. (ibid., 770)

This conceptualisation of hybrid-distributed agency stresses an idea of linearity, where signals move from the human actor to the external world and where the machine is represented as a channel that mediates the voluntary command of subjects over the environment.

The cyborg envisioned here is also heavily characterised by the emphasis on intentionality. For example: "Control should emerge from the voluntary intent to carry out an action" (Donoghue 2002, 4), or: "Successful operation of brain-computer interfaces depends significantly on the degree to which neural activity can be volitionally controlled" (Fetz 2007, 571). Furthermore, the issue of the intentional control of the user on the external devices is also usually associated with the necessity of learning. The human ability to control a BCI therefore is intended as a skill to be learned: "Individuals are extensively trained to intentionally control certain aspects of recorded brain activity" (Haynes and Rees 2006, 524).

The shape of this active vision can also be traced by reference to what is generally defined as "not a BCI": "Devices that only passively detect changes in brain activity that occur without any intent [...] are not BCIs" (Graimann et al. 2010, 3), or: "Brain-computer interfaces do not read minds in the sense of extracting information from unsuspecting or unwilling users but enable users to act on the world by using brain signals rather than muscles" (Shih et al. 2012). The definition of boundaries with respect to "what is" and "what is not" a BCI is also part of the semiotic construction of a particular cyborg vision.

The active vision is therefore based upon the following dimensions: the enrolment of people with severe disabilities as end-users; the mobilisation of the disability as the main legitimising frame; the intentional control of external devices as envisioned applications; and the process of learning BCI as a necessary practice in current and future socio-technical worlds, as well as the efforts to specify how BCIs are not "mind-reading devices".

Finally, the mode of human-machine entanglement envisioned along with active vision is also mediated by descriptions of what BCIs might enable in the far future. Within the active vision, these depictions extend the use of BCIs from individuals with severe disabilities – who nevertheless remain the principal end-users – to less severe disabilities or healthy individuals. Usually, the argument for this extension is that if BCIs can help people to regain movement and sensation today, imagine what can be done in the years ahead.

This glimpse into the more distant future comes about as an extension within the same prospective structure, hence without questioning the "communication and control" trajectory. This extension is also enacted through the enrolment of a quantitative parameter within the visionary assemblage, the *information transfer rate* (ITR), through which specific future developments of BCIs are anticipated. While for severe disabilities "even the modest rates of communication that will initially be achieved should dramatically improve quality of life" (Schalk 2008, 10), "the future value of BCI technology will depend substantially on how much information transfer rate can be increased" (Wolpaw et al. 2002, 779). Here, future projections for BCIs are associated with quantifiable parameters, narrowing the future landscapes to expected technical developments, and simultaneously marginalising the envisioning of qualitatively alternative applications or scenarios.

The enrolment of "healthy users" in the envisioned future world related to the active vision also entails an extension from the medical-clinical scenario to that of technological human enhancement. It is through the augmentation of human capabilities that both disabled and "healthy" individuals overcome the limitations of their bodies. The difference between therapy and empowerment itself appears blurred and relies on quantitative criteria (e.g., ITR, number of electrodes) rather than qualitative differences. The same trajectory through which BCIs would enable people with disabilities to interact with the outside world is envisioned as adoptable in the more distant future, and along with an increase in *information transfer rate*, by healthy people to enhance their *communication and control* abilities.

4.2 Passive Vision: Monitoring and Adapting

Around the second half of the 2000s, an alternative visionary assemblage for BCIs began to be discussed in the expert-scientific discourses, in conjunction with which a different kind of cyborg is envisioned. This vision will be referred to as "passive vision". The 2011 review by Zander and Kothe entitled "Towards passive brain-computer interfaces" is considered by the BCI community as the main intermediary for early passive BCI articulations. The authors write:

> A passive BCI is one that derives its outputs from brain activity arising without the purpose of voluntary control, for enriching a human-machine interaction with implicit information on the actual user state. (2011, 3)

and:

> it can be seen as modifying the general approach of BCI and substituting the usually voluntary and directed command with passively conveyed implicit information. [...] The resulting approach of passive BCI opens up the field of applications based on BCI technology to a broader context, especially for using it also for healthy users. (ibid., 2)

Here, it is worth noting that the enactment of an alternative visionary assemblage in the field of BCI entails not only a new perspective, but also a redefinition of the already existing visions. To put it another way, the actor-world projected with passive vision is made up of a variety of interconnected elements, one of which is a specific translation-redefinition of active vision. Proponents of the passive vision frequently present it as an alternative to the dominant active vision, highlighting the limitations of the latter.

Compared to the active vision, in the passive vision there is a fundamental shift from patients to users, i.e., from people with disabilities to "healthy users". Firstly, the passive vision underlines the limitations of communication and control applications, loosening the enrolment of healthy users within the active vision:

> it should be taken into consideration that BCI for healthy users aims at partially different applications than BCIs for disabled users. In particular, direct input primarily for communication and control seems not to be the most promising BCI-related application for healthy

users, due to the still low reliability and bandwidth of current BCI systems compared to standard communication channels. (Zander and Kothe 2011, 2)

Secondly, a new legitimising frame that associates the technology with benefits for the broader society is mobilised:

Mental state monitoring is of particular interest in safety-critical applications where human performance is often the least controllable factor. For example, consider that fatal car accidents are one of the leading causes of death in the United States and the leading cause among children (9-18 years) worldwide. (Blankertz et al. 2010, 7)

Indeed, despite abandoning the promise to address cases of disability, the passive vision seeks to maintain the "protected space" by still signifying BCIs as a future technological solution to pressing social issues – for example, in critical situations (such as driving a car or a surgical operation) where they could reduce the impact of human errors and support human decision-making processes.

Another key aspect of passive vision is that of *unintentionality*, which plays a significant role in the assembly of a different kind of cyborg. In passive vision, it is the technical system itself that identifies the user's spontaneous brain activity, rather than the user voluntarily controlling the technical device. In the scientific literature, this feature is associated with and supported by two types of discursive repertoires, which will be referred to as *unobtrusiveness* and *smartness*. These discourses, mobilised as argumentative logics in favour of passive BCI, can be analysed to reconstruct the visionary assemblage and reasoning around the type of cyborg envisioned here.

Unobtrusiveness maintains that detecting spontaneous (and thus non-voluntary) brain activity allows researchers to bypass the influence of the subjects themselves on the signal, and thus allows for more objective measures (Blankertz 2016, 9). Additionally, structuring a protected space for emerging technology is often coupled with redefining other previous and competing technologies in terms of their limitations and lacks (Brown et al. 2000). While in the active vision BCIs are compared primarily with other assistive technologies, in the passive vision they are compared with other measurement tools. For example:

Traditional methods for capturing mental states and user ratings are questionnaires, video surveillance of the task, or the analysis of errors made by the operator. However, questionnaires are of limited use for precisely assessing the information of interest, as the reported answers are often distorted by subjectiveness. Questionnaires cannot determine the quantities of interest in real-time but only in retrospect; moreover, they are intrusive because they interfere with the task. (Blankertz 2010, 7).

Thus, even this change in the application landscape – from "medical" to "general measurement and monitoring" – plays a role in shaping the passive vision.

Smartness refers to the argument that:

the use of modern machine learning and signal processing methods allowed to relocate the burden of training from a learning subject toward statistical learning machines and thereby

achieve BCI communication for a naïve user already in the first session. (ibid., 1)

In other terms, the *smartness* discourse of the passive vision is discursively performed as a shift from the "BCI as a skill to be learned" to the motto "let the machine learn" (Blankertz et al. 2006, 583).

In this way, the passive vision associates BCIs with the socio-technical imaginary of *automation*, mediating a BCI future trajectory oriented toward reducing human agency – and "human error" – within human-machine interaction. This change is consistent with the broader visionary assemblage, considering that in the passive vision the envisioned end-users are healthy users. As opposed to the case where end-users were people with disabilities, here the expectation shifts towards reducing the users' training burden. This aspect is seen by the promoters as critical to technology adoption by a broader audience. It is also interesting that the proposed notion of passive BCI is defined from the user's perspective, since "passive" in fact refers to the position of the human with respect to the machine. If we look at the different weights attributed to the main entities (human and machine) involved in the cyborg-hybrid agency, it is in fact the machine that takes on a more active role.

By looking at representations of the far future, the passive vision anticipates future applications where the subjects of the enhancement are not humans (at least not directly) but rather the "machine":

> BCI technology is used for detecting the state of the user in a given human-machine system and for augmenting the information space available to the system with context information about the user. (Zander 2011, 2)

This future is extensively represented through far-future scenarios mobilised within the scientific literature:

> It seems worthwhile to employ BCIs to infer implicit information during software usage and to use that information to augment the explicit interaction. In other words, to make the computer better at understanding the human user on the basis of soft skills. (Blankertz 2016, 10)

or:

> a system sensing a user getting verbally overloaded could attempt to turn down the music, since musical lyrics get subconsciously processed and consume valuable verbal resources. Or perhaps the cell phone could alert the remote speaker and pause the phone call if the driver has to suddenly focus on the road. (Tan and Nijholt 2010, 15)

The kind of cyborg envisioned within the passive vision is quite distant from the "classic cyborg" conceived as a human subject that merges with technological devices to enhance its capabilities. Instead, the hybrid agency is configured as the capacity of a distributed computer system to monitor and adapt in real-time to changes in the human part, beyond the intentionality of the involved subjects. The human part is here marginalised and disconnected from the

attribute of intentionality and autonomy, thus becoming in a way part of the environment with respect to which the computer-machine part acquires the information necessary to refine its ability to adapt autonomously. Therefore, the main object of enhancement within the passive vision is not the human component, but the technical system. As Zander writes:

> Neuroadaptive systems can be said to be systems with an agenda, having a goal of their own. By autonomously initiating each interaction cycle using a specifically selected probe stimulus, they would be in a position to "guide" the interaction such that specific information can be gathered, and to change the interactive experience based on that or other information. (2016, 5)

Here, the machine-artefact is not a prosthesis that mediates and extends human action in the external environment, but rather stands as an adaptive and autonomous interface between human actors and their worlds.

5. Discussion: Back to Cyborg Visions and Beyond

The previous paragraphs highlighted how along with each of the considered visions that circulate in the BCI field (the active and passive one) a particular mode of human-machine entanglement, or a vision of the cyborg, is also envisioned. Following the concepts of visionary assemblage and actor-world, these visions were reconstructed and examined by tracing the associations with different discursive repertoires and entities through which they are enacted. It was thereby shown that these cyborg visions are shaped in the semiotic interweaving of different elements, such as expectations, interests, artefacts, technical aspects, legitimation strategies, and different anticipated applications and publics.

For example, within the active vision, the primary role attributed to individuals with severe disabilities as end-users, together with "communication and control" as the near-exclusively envisioned applications, heavily contribute to the enactment of a cyborg-hybrid agency configured as the human capacity to voluntarily control technological devices. In contrast, in the context of passive vision, BCIs are envisioned for applications that directly affect the broader society, from monitoring mental states in occupational and risky environments to developing neuroadaptive technologies (Zander 2016). This latter vision invokes a future-world at the centre of which there are no longer patients with disabilities, but healthy subjects represented as unwilling to endure long learning times or apply large amounts of effort. Therefore, the criterion of intentional control of external devices is replaced by the ability of the machines themselves to adapt to human subjects, thus anticipating a different human-machine entanglement. Here, the concept of visionary assemblage suggests that both the type of cyborg envisioned and the networks of heterogenous associations articulated with the enactment of the concerned vision are assembled as aspects of the same movement.

Furthermore, the concept of visionary assemblage emphasises that socio-technical visions are not only assembled, namely semiotically enacted and mobilised, but that they are also assembling, which indicates that through their circulation they actively participate in the configuration of the technoscientific field to which they are linked. In fact, visions participate in

the structuring of the field along particular innovation trajectories by attracting resources, legitimising investments, defining shared agendas, downplaying alternative trajectories, and interesting other actors who will contribute to the expansion and articulation of the vision itself.

For instance, the active vision, whereby BCIs are primarily configured as medical and assistive technologies, operates as an *interessement* device (Akrich et al. 2002) that enrols, in addition to the patients themselves, also the investments of economic actors operating in the medical-clinical field, the interests of institutions promoting the issue of disability support (e.g., BCIs have in fact been included among the *future and emerging technologies* [FETs] by the European Research Council) but also – redefining the boundaries of the field itself – experts from other fields, such as neurosurgeons, rehabilitative physicians, and assistive technology engineers. Consistently, within the active vision, the passive vision is marginalised as unethical since it prioritises the general consumer before patients.

In the case of passive vision, the *interessement* dynamics primarily involve general consumers, especially innovative device enthusiasts, but also companies looking for investment opportunities in the user experience/user interface design (e.g., the recent involvement of Meta and Microsoft) or in the gaming sector (e.g., the interest of Valve[4] in BCIs). Concerning experts from other fields, the passive vision extends the field not toward the medical area but by involving different figures such as human-computer interaction experts, dry electrode producers, designers, and entrepreneurs especially in the realm of wellness, gaming, and wearable technologies. Conversely, the active vision is often silenced as difficult to implement technically, as the reliability and bandwidth are too low to actually "control objects with the mind". It is interesting to note that technical limitations in the extraction and transmission of the brain signal, and thus in the fulfilment of active vision, also seem to play a role in the shaping and unfolding of passive vision.

Thus, simultaneously, a change in the semiotically traced networks leads to a change in the content of the vision, just as a change in the actor-world projected by the vision leads to changes at the level of the current system of associations and enrolments. Each vision articulated in the field of BCIs is collectively enacted by actors in the field and simultaneously participates in redefining the field towards different trajectories of innovation. Indeed, around each of these emerging trajectories, visions seem to play a pivotal role in holding together the different assemblages of actors, artefacts, discourses and imaginaries through which the innovation trajectories are materialised.

Interestingly, on a strictly technical level the differences between active and passive BCIs are quite blurred. The two modalities share the same building blocks (signal extraction, processing, and translation) and similar protocols and approaches are adopted in research and development contexts. Even the difference between intentionality and unintentionality – so crucial in the discursive articulation of the two visions – does not hold much weight when considered from a strictly "technical" perspective. In fact, from a neuroscientific gaze, the very concept of intentionality takes on hazy and insubstantial traits (Pickersgill 2011). The "active control" of active vision is far from being an established assumption among physiologists and neuroengineers. The same applies to the "passivity" of the healthy subject within the passive vision. As Wolpaw puts it:

passive and active are subjective terms that lack clear neuroscientific definitions. Furthermore, continued use of a passive BCI might well induce CNS adaptations that improve its performance, so that the term passive becomes no longer applicable. (Wolpaw and Wolpaw 2012, 6)

Despite this, these two visions continue to play a fundamental role in organising dynamics and discourses within the field. Research streams, projects, and devices are still discussed and promoted following the two visions articulated in the scientific literature and in other arenas such as scientific conferences and technological events. In fact, looking at the main BCI-related conferences, passive and active BCIs are usually discussed not only in different panels, but – especially recently – also in different conferences where distinct networks of actors, expertise, imaginaries, and issues are intertwined, such as novel medical applications, surgical procedures, and human enhancement for the active vision, and neuromarketing, affective computing, and IoT for the passive vision. Therefore, visions are enacted not only through scientific publications but also in other arenas where they are continuously articulated, shared, inscribed in texts, and promoted while seeking funds, attention, and recognition. Socio-technical visions seem to work as a bridge that connects the same technological object (the BCI, when considered strictly from a technical perspective) to different assemblages of actors, discourses, and imaginaries, thereby enacting different cyborg futures. Furthermore, in addition to an organisational function, the persistence of the visions can also be attributed to a rhetorical adoption. For example, promoters may define their products or their research under the notion of "BCIs" to refer to devices – such as headbands for monitoring brain activity – that under the more traditional definition of BCIs would not have been defined as such, and in this way, besides participating in the dissemination of the passive vision, benefit from the advantages in terms of attention and resources derived from the hype over BCIs in general. Otherwise, especially in outreach settings, BCIs are typically promoted by focusing on the excitement of controlling objects with the mind and on the technology's potential to address disabilities, avoiding a popular depiction of BCIs as "mind-reading devices". This portrayal of BCIs tend to overshadow the passive vision and shields its potentially more problematic acceptance from public and policy discussions. The possibility of this rhetorical exploitation of futures, consistently with the concept of the visionary assemblage, again shows how visions, far from being an imposing structure steering the actions of actors, can be better understood as part of an assembling process in which visions and actors are both involved in the continuous re-ordering of the technoscientific field and its trajectories of innovation.

6. Conclusion

With the intention of problematising contemporary narratives predicting an inevitable future in which humans will merge with technologies and become cyborgs, the field of *brain-computer interfaces* was examined more closely as an arena where potential ways of relating humans and machines are envisioned and rearranged – that is, an arena where potentially novel visions of cyborgs that inform current innovation processes are articulated. Drawing on an understanding of cyborgs as specific modes of human-machine hybridisation, two different

visions of cyborgs were identified: on the one hand the active vision, where the cyborg is con-figured in terms of the human's ability to intentionally control a machine solely through his or her mind. This involves the use of artificial prostheses connected to the human's brain, al-lowing human subjects to compensate for their limitations or enhance their abilities while still maintaining control over the machine. On the other hand, there is a passive vision whereby a machine assumes a more central position and the human-machine entanglement relies on the machine-system's ability to learn and adapt autonomously to the monitored brain states of the human actor beyond its intentionality. Both visions discussed in this article are in continuity with imaginaries circulating in popular culture and the mainstream media, which describe a future in which humans and machines will merge. However, through the concept of visionary assemblage, it was shown how distinct future-oriented visions are enacted in the interweaving of these imaginaries with different discursive repertoires, entities, and different intended au-diences and applications. Simultaneously, it has been shown how different visions circulating in an emergent field can participate in the reconfiguration and expansion of the field along different trajectories, through the enrolment of different range of actors, the mobilisation of different discursive repertoires, and the adoption of different imaginaries. Furthermore, it was highlighted how organisational and promotional dynamics contribute to the permanence and continuous re-enactment of the visions, even though, from a technical point of view, the dif-ferences between the visions are weak and blurred. Finally, the analysis presented in this article aimed to consider the impact of these visions on society at large by broadening the definitions of cyborgs used in popular and academic conceptualisations. This is especially necessary in view of the need for a critical examination of the imaginaries of the cyborgisation process, the "normalisation" of which risks overlooking the different types of human-machine entangle-ment articulated in it as well as the political, economic, and promotional logics involved.

Notes

[1] Kurzweil refers to the concept of the "technological singularity", a term used in the fields of comput-er science and science fiction to refer to a hypothetical future point in which technological advancement will lead to a radical, unforeseeable, and irreversible change in human civilisation. In his book *The Sin-gularity is Near* (2006), Kurzweil defines the *singularity* as the transcending of the biological limitations of human beings through merging with artificial intelligence.

[2] https://bcisociety.org/.

[3] On scopus.com on 16/12/2022.

[4] Valve is a leading provider of gaming software and hardware based in the United States.

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The body as permanent digital identity? Societal and ethical implications of biometrics as mainstream technology

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Abstract
There is a global trend to expand biometric technology usage: digital identification practices increasingly gather peculiar features of the human body – in the security domain as well as in the consumer sector and everyday-technologies. This indicates a wider shift in the role of biometrics for digital identification entailing a significant further expansion of identifiability. Applying biometrics is frequently justified with security improvements. However, it also bears various security risks and individuals cannot simply opt-out from their bodies or change their bodily characteristics. On the longer run, human bodies may become partially reduced to enduring machine-readable, informational patterns as physical and digital environments conflate. Biometrics is thus a very powerful and threatful technology increasingly affecting how humans relate to technology, substantially challenging human rights. The paper argues that the far-reaching consequences of this development are yet underestimated and require broader societal debates and regulatory measures to reduce the corresponding risks, in particular as: 1) biometric information is bound to human bodies and thus irreversible, making individuals more vulnerable to misuse; 2) the shift from a security towards a mainstream technology fosters habituation effects and incremental compulsion to provide biometric features; 3) the extensive use of biometric systems facilitates misuse, reinforces surveillance tendencies, security, data protection and privacy issues; 4) biometrics used as automated control technology seriously strain human rights as it reinforces risks of discrimination, increasingly affecting bodily integrity and human dignity.

Keywords
identification practices; digital transformation; privacy; security; dignity; human rights.

1. Introduction

Biometrics has a long history and its usage as identification practice for security purposes in Europe dates back to the 19th century (Lyon 2008; Maguire 2009; Jain 2016). Beginning in the 1990s, it became a tool of global security governance, latest in the aftermath of the 9/11 terrorist attacks. Many scholars in security and surveillance studies extensively analyzed this role and its societal con-

sequences (cf. Schneier 1999; Lyon 2003; Bennett and Lyon 2008; Ball et al. 2012). In private sector, diffusion increased as well, though, mainly used as specific security technology in limited contexts, e.g., for law enforcement, border control, or in identity (ID) systems for access control in public and private organizations. For several years now, this role as security technology has been altering within the accelerating digital transformation of society. A significant expansion of biometrics as digital identification practice is observable in various domains. In parallel to its relevance for security governance, also a growing number of commercial applications and "everyday-technologies" employs biometrics. Bodily features like fingerprints or facial images are gathered in many contexts and enormous amounts of biometric information flow into various digital platforms. This often happens either *en-passant*, embedded into typical user verification procedures (e.g., logins); or covertly and without direct user involvement (e.g., through facial recognition systems).

If this development proceeds, biometrics becomes a widespread sociotechnical practice deeply altering digital identification, and how human bodies relate to technology. On the longer run, biometrics showcases the incremental conflation between physical and digital representations of ourselves. This involves some important questions, such as: what are the peculiarities of biometrics as digital identification practice and how does this relate to notions of embodiment? What are main drivers of the global increase in biometrics, and what are the societal and ethical effects of the entrenchment of biometric systems in a broad range of applications? A fully comprehensive analysis of these questions is beyond the scope of this paper but it contributes to this discussion by outlining how this development emerged and providing a critical analytical review of the wider societal and ethical implications of a general expansion of biometrics as digital identification practice in everyday-life. Based on this, the paper argues that the expansion of biometrics entails wider sociotechnical shifts which reinforce identifiability of individuals. Human bodies are increasingly exposed to technologies, secretly measuring and transforming their digital representations into enduring machine-readable code. This has substantial consequences on privacy, security and human dignity. In public discourse as well among policy makers, this development is yet underestimated and requires a broader societal debate and regulatory measures to reduce the corresponding risks.

The paper is structured as follows: the next section presents and discusses analytical perspectives to explore the peculiar role of biometrics as digital identification practice and how it affects the notion of embodiment through technology. Based on this, the empirical sections then first present an analytical review of main political and economic drivers behind the expansion of biometrics and its shift towards commercial applications as mainstream technology. This is followed by an analysis of societal and ethical implications of the extended use of biometrics as digital identification practice. The final section presents a short summary and concluding remarks.

2. Unfolding analytical perspectives

2.1 The peculiar role of biometrics as digital identification practice

Biometrics can be analyzed from various disciplinary angles, e.g., biology and anthropology (Maguire 2009), criminology, sociology and political science (Amoore 2011; Bennett and

Lyon 2008; Mordini and Tzovaras 2012), body, gender and identity studies (Magnet 2011; Smith 2016), computer science, privacy and information security (Schneier 1999; Clarke 2001/2002; Jain 2016; Dong et al. 2022), surveillance studies (Lyon 2003; Ball et al. 2012) etc. From an STS perspective, biometrics is understood as socially constructed technology with mutual processes of co-shaping, i.e., societal practices affect technology design, its political and economic usage patterns and vice versa (cf. Bijker et al. 1989; Feenberg 2002). Correspondingly, the analytical focus here is on biometrics as digital identification practice and the interplay of its sociotechnical and its sociopolitical dimensions. To grasp the wider societal and ethical implications of biometrics requires some basic knowledge on its technical role first.

From a technical angle, biometrics is the processing of digital information of bodily features to authenticate or identify a particular person in specific contexts. Biometric features are inevitably coupled to the human body and thus considered as suitable factors for these purposes (Bennett and Lyon 2008; Maguire 2009; Jain et al. 2016). Identification is "the processing of information related or referring to the identity of a particular individual" (Strauß 2019, 36). Hence, information about a person or more precisely – personally identifiable information (PII) obviously is a necessary condition for identification. There are four basic dimensions of PII (i.e., substantial, spatio-temporal, relational and interactional PII) that together constitute the identifiability of an individual person (ibid, 244). In this regard, biometric features are at the core of substantial PII: they represent specific characteristics substantially bound to a person's body. Biometrics transforms this information (e.g., of a physical fingerprint or a facial image) into digital representations thereof. Besides the widespread use of fingerprints or facial images, various systems also gather other bodily features like informational patterns of the iris, voice or even vein patterns, or additional sensor data like skin temperature, pressure etc. (Jain 2016; Schaber et al. 2020). Due to its integration into other digital technologies (e.g., via sensors in smartphones, laptops or smart CCTV etc.), biometrics are often combined with technically generated identifiable information (TII), like, e.g., device- and application specific IDs, sensor IDs, digital hash-values, geo-location/movements, time stamps, relational and interactional information and many other forms of meta data (Strauß 2019, 245).

The peculiarities of biometrics also affect the sociopolitical role of the human body and how it is represented and used by technology. Due to the inherent identifiable nature of biometric features, they always convey the possibility to identification. Hence, even though biometric features serve authentication, identification is hardly avoidable – even if unintended. In the notion of the body as a "walking sensor platform" Smith (2016, 110) conceptualizes this issue as "disembodied exhaust" which "refers to the data trails that, as affective transfers, are either voluntarily or involuntarily emitted from the body as it interfaces with networked sensor technologies". In contrast to other forms of identity information used as credentials, biometric features are not changeable. Once in use as credentials, they are a persistent representation of a person's identity based on characteristics of her body. The digital processing of biometric characteristics thus has consequences for their persistence and durability and thus also for the identifiability of individual persons and how they are embodied by and through technology.

2.2 Humans as tool-beings? How biometrics affects embodiment

The increasing use of biometrics is a showcase to the questions how our bodies become digitized and how digital technology alters embodiment. Various studies discuss effects of technology on embodiment concerning self-presentation, e.g., in the context of social networks or virtual environments (Kruzan and Won 2019). Few studies examine how digital technology and biometrics tend to reduce embodiment to digital representations of human bodies (Farr et al. 2012). Titchkosky (2007, 13) broadly defines embodiment as "all the [...]ways that we (self and other) accomplish relations to being in possession of the bodies that we are". Based on this, Melonocon (2013, 71) highlights the role of technology for embodiment and in reference to Heidegger, argues that due to technology usage, humans are "tool-beings that use a variety of equipment, or technology". In other words: technology temporarily becomes a functional part of the body through interaction. This is basically given for any form of human-computer interaction but not necessarily including identification as in the case of biometrics.

Biometric technology is thus a specific case with additional effects altering the classical notion of embodiment: it generates a digital representation of features of the human body (e.g., fingerprints or facial characteristics) which then serves as identification tool. On a general level, a digital artifact based on reductionistic models of bodily features emerges inevitably referring to an individuals' identity. In this regard, the notion of "humans as tool-beings" gets a different meaning: not just technology is a tool for humans, but features of the human body serve as tools for biometric technology in various contexts. Correspondingly, scholars in surveillance studies describe biometrics and the gathering of bodily information through digital technology as process where human bodies are converted into "data derivatives" (Amoore 2011) or "objects of information" (French and Smith 2016; Smith 2016). There is thus also a nexus of embodiment and surveillance. Through biometrics, the body as object of information becomes metaphorically liquified (ibid.), as Lyon describes with the concept of: "liquid surveillance" that:

> captures the reduction of the body to data and the creation of life-chances and choices hang more significantly than our real lives and the stories we tell about them. (Lyon 2010, 325; cited from Smith 2016)

Basically, surveillance and control practices always relate to identification practices (Clarke 2001; 2002; Lyon 2008; Ball et al. 2012; Smith 2016; Strauß 2019). Biometric technology, which is basically driven by the notion that bodily features are a dependable source for identification, tightens this relation. It combines personal with technical identification and transforms bodily information into machine-readable code. This "ontology of the body as a reliable organism for identification and measurement has helped turn bodies into focal points for practices of monitoring and control" (French and Smith 2016, 8). Biometrics is thus a very powerful, transformative technology fostering the incremental conflation between physical and digital representations of human identities over their bodies.

In a figurative sense, biometrics dematerializes bodily features and transforms them into digital matter. Apparently, this is not a direct transformation as the body obviously remains matter. But bodily information becomes virtualized and a virtual entity of ourselves emerges.

This virtual entity is then exposed to further processing, stimulating a further expansion of identifiable information and thus of identifiability. From a metaphysical perspective, referring to Karen Barad's theory of agential realism (Barad 2007), biometrics is an example of an inter-actional process or "intra-action" that creates informational objects of the human body which enable the possibility of alternative usage. On the longer run, these alternative usage forms can pave the way for further transformations even involving transhumanism as biometrics is closely related to AI. But also leaving this metaphysical approach aside, the transformative capacity of biometrics has far-reaching consequences for the role and function of bodily features in society.

3. Empirical analysis

3.1 From security to commercialization: biometrics as mainstream technology?

The use of biometrics for identification as administrative practice has a relatively long history. Early biometric ID systems in Europe date back to the 19th century in France and were also used by the colonial powers, e.g., by the British administration in India (Maguire 2009). Partially, this historical context affected the creation of systems like Aadhaar in India, which today is the largest governmental biometric ID database system with over 1.2 billion entries (Rao and Nair 2019). In national contexts, biometrics are used for many years for law enforcement and security governance. In the aftermath of the 9/11 terrorist attacks, this increased significantly on a global scale. Its use for identification as part of global security governance began with the integration of biometric features into passports and other forms of governmental IDs (Bennett and Lyon 2008; Maguire 2009; Magnet 2011). Since 2005, bi-ometric data and radio-frequency identification (RFID) became a standard feature in newly rolled-out passports[1] (Bennett and Lyon 2008). Nevertheless, biometrics mainly served as spe-cific technology in limited contexts in the security domain, e.g., for law enforcement, border control or access control systems in public and private organizations.

For several years, though, a significant expansion of biometrics proceeds, including a va-riety of commercial applications ranging from smartphone apps, e-banking, payment ser-vices, smart locks, digitized vehicles up to internet of things (IoT) applications. Gathering biometric information thus is about to become a common practice embedded into various everyday-services. This often happens either as additional process in a typical user verification procedure (e.g., user logins), where biometrics like fingerprints or facial image are used for multi-factor authentication; or covertly and without direct user involvement (e.g., through facial recognition). Also operating systems on PCs and laptops increasingly suggest to use biometrics as user credentials. All these developments lead to an incremental increase in the gathering of bodily features in various contexts.

This trend continues and over the years, there has been a shift where biometrics turned from being a security technology in a limited number of domains towards a convenience technology being broadly applied in the consumer sector. In many Asian countries, this trend started earlier and over the last years, applications significantly increase also in the US and Europe, where, e.g., global payment companies like Mastercard and Visa started about 2013

with payments via biometrics like "pay-by-selfie" (Sayer 2013; Leyden 2016). This development towards biometrics as mainstream application is not just pushed by the tech-industry, but also by policy makers in Europe: The EU Commission frames biometrics as key enabler for future digital services to stimulate digital markets (Bonneau et al. 2018). Correspondingly, various regulations, e.g., the eIDAS Directive[2] of 2016 foresee an interoperable, cross-border digital identification framework for public and private services. Further regulations refer to this framework, like the EU payment services Directives[3] to stimulate the use of digital IDs in online markets. Recent plans to amend the eIDAS Directive[4] aim at further broadening usage of the digital ID framework by, e.g., introducing digital wallets for EU citizens. Since 2019, e.g., the payment services Directive explicitly forces service providers to multi-factor authentication to improve security in online services. This means that the identity of a person needs to be verified based on at least two security factors. These are either *knowledge* (i.e., a password or PIN), *possession* (i.e., a token like a smart card), or *inherence*, i.e., a metric intrinsically linked to an individual. The latter basically means biometric features like fingerprints, facial image, voice pattern or other bodily characteristics. Biometrics is not mandatory, though, recommended. Therefore, most providers integrated biometrics into their applications like, e.g., in some smartphone-apps for e-banking or mobile payment. This technology push is one reason for its growing importance across Europe. The ongoing global trend towards a commercialization of biometrics affects a broad range of public and private services. In combination with plans of the technology-alliance FIDO including big tech-companies (e.g., Microsoft, Apple, Google) to replace password-based user logins with biometrics (FIDO 2022), a significant technology-boost in the next few years can be expected.

This makes biometric data even more attractive for additional usage like profiling based on so-called identity graphs. For several years, global tech-companies like Facebook/Meta, Google/Alphabet, Amazon or database companies like Oracle and others build ID graphs to dynamically map and analyze user data also across different technologies. These ID graphs stimulate new markets with digital identities. Identity information is being gathered "across all devices, screens and channels" in order to create comprehensive ID models of consumers "including what people say, what they do and what they buy" (Oracle 2015; Strauß 2019, 138). With the further commercialization of biometrics, these ID graphs also include bodily features (Christl 2017). Biometrics thus also serves global data markets. This global expansion of the gathering of biometric information in commercial applications relates to Zuboff's notion of "surveillance capitalism" addressing the increasing tendency of processing data on human individuals and their behavior for commercial business models (Zuboff 2019, 8ff.). In parallel, policy makers also extent the processing of biometric data for law enforcement and security authorities. In Europe, the amendment of the Prüm framework[5] ("next generation Prüm") inter alia foresees more use of biometrics and data exchange for security authorities. These plans include the implementation of a cross-broader facial recognition system (EP 2020; EDRi 2021). Altogether, these developments are driven by an ongoing trend of securitization and economization of digital identification (Strauß 2019, 134). This is a further indicator for the conflation between political and economic variants of "surveillant assemblages" (Haggerty and Ericson 2000). This conflation and the broader use of biometrics entails serious societal and ethical risks as discussed in the next section.

3.2 Societal and ethical implications

Essentially, the broad use of biometrics leads to increasing identifiability of individuals. This raises many societal and ethical issues with far-reaching effects on human rights and democracy, which result from a mix of social, political, economic and technological factors:

3.2.1 Irreversibility and vulnerability of biometric information

A crucial peculiarity of biometric features is its strong and inevitable linkage to the body of a particular person. This can facilitate to enforce identification, as biometrics always conveys information about the identity of the person. The main argument justifying the use of biometric technology is to improve both: security and convenience of identification and authentication procedures. However, this argument is only partially valid. Potential security gains are achievable in cases where hard identification is necessary and where the application environment is securely protected from misuse. In theory, biometrics require the physical presence of the person concerned which should decrease the risk of security breaches. This is assumed to be a security benefit compared to common credentials. Biometric features are thus attractive as factor of inherence for multi-factor authentication. However, in fact, biometrics only make sense in clearly defined, secure environments where abuse is very unlikely and systems are decoupled from external access (Schneier 1999; Clarke 2001; 2002; Schaber et al. 2020). Particularly, because the irreversibility of biometric information affects the severity of various risks: when common user credentials (e.g., username and password) are misused, an effective method to limit further damage is revocation and change of credentials. In contrast to less binding forms of identifiable information, bodily characteristics, though, are not changeable and cannot be easily revoked. In other words: a person may change its username, real name or any other identifiers, but she cannot opt-out from her body by changing her face or fingerprints. The general irreversibility of biometric features thus also affects its vulnerability, may facilitate abuse and limit options to take effective action to prevent it. In practice, numerous variants of attacks on biometric systems exist, even without requiring physical presence (Adler and Schuckers 2009; Hadid et al. 2015; Ramachandra and Busch 2017; Dong et al. 2020). Security researchers demonstrated, e.g., to easily gather fingerprints from a glass or other surfaces with adhesive strips to create synthetic fingerprints; digital images can circumvent facial recognition and common digital cameras are sufficient to trick even more complex biometric sensors like iris-scans (Arthur 2013; Foltýn 2019; Schaber et al. 2020). Moreover, recent studies show that inverse biometrics, i.e., the abusive reconstruction of biometric templates, is possible: biometric templates (the digital encoding of biometric features) are used to avoid direct processing of biometric information (e.g., fingerprint) and were assumed to be widely protected from reverse engineering and abuse. However, several studies demonstrate that they are not as secure as assumed (Gomez-Barrero and Galbally 2020). This increases the vulnerability of biometric systems and risks of privacy breaches, unintended secondary use or other forms of misuse. Extended usage of biometrics will likely aggravate these problems.

3.2.2 Habituation effects and incremental compulsion to provide biometric information for identification

As a consequence of biometrics as mainstream technology, individuals become increasingly confronted with and thus used to providing bodily features in everyday-life. Already today, various smartphone apps gather biometric features such as the Chinese social media app Tiktok collecting personal faceprints and voiceprints (Perez 2021). Similar is the case for other social media services which hold enormous amounts of facial images of their users worldwide (e.g., Facebook/Meta or its subservices Whatsapp and Instagram; see Field 2021). One may argue that users are not obliged to use biometrics. However, its expansion facilitates function and mission creep: i.e., extended use of the technology in various application contexts beyond its original purpose (Lyon 2003; Ball et al. 2012), accompanied by a gradual decrease in alternatives without biometrics. Individuals being uncomfortable with providing their bodily features may encounter difficulties in avoiding biometrics. This is already observable, e.g., in banking apps mostly suggesting to provide biometric features for authentication. Also other domains like the mobility sector include biometrics: some cars already use fingerprints instead of keys which is part of a general trend in the automotive industry to foster biometrics like fingerprint scans, facial recognition and iris scans (Eisenstein 2018; Burt 2021). Moreover, biometric recognition also functions without direct user involvement. The global trend towards facial recognition is a showcase for this: these systems can covertly identify individuals from a distance. Their functionality also refers to habituation effects: many people provide and share their facial images via smartphones and social media. As this data is mostly not protected from external access, it can be harvested and, e.g., used to train facial recognition algorithms. For instance by Facebook, having introduced facial recognition in 2010 (Strauß 2019, 172) or biometric search engines like "Clearview AI" or "Pimeyes" that harvested millions of facial images from the internet. There is also a growing number of facial recognition apps and smart glasses equipped with biometrics available. Google developed a similar technology already in 2012 but stopped it also due to heavy protest and concerns of privacy and security experts (Eveleth 2018). However, the technology seems to recur. Recently, Clearview AI announced that it develops such a technology for the U.S. Airforce (Brewster 2022).

3.2.3 Additional risks of security breaches, privacy violations and surveillance

The expanding range of "everyday"-applications processing biometric features makes abuse of various kind (e.g., identity theft) even more attractive. Attackers benefit from broad usage of biometrics as misuse pays off: once biometric features are gathered they can be misused in various contexts. The growing amount of security breaches and attacks on biometric systems underlines risks of misuse, e.g.: in 2019, 184,000 datasets of a facial recognition system of US homeland security were stolen and sold in the darknet; also in 2019, security researchers revealed that the database of a large security company providing biometric systems worldwide was unprotected from external web-access. It contained 28 million entries including fingerprints and facial biometrics; in 2020, over 70,000 datasets with fingerprints were stolen from a database of the Brazilian government; Aadhaar, the largest biometric system in In-

dia, containing the highest amount of biometric data worldwide (more than 1 billion) is frequently getting hacked. In 2018, biometric data from Aadhaar were even sold via Whatsapp (Malhotra 2018); and in 2021, media reported about government backed Chinese hackers attacking the system (Tarabay 2021). But not only direct attacks to biometric systems are security threats but also insufficient protection, lacking risk-awareness and careless provision of biometric data. Smartphones become centralized devices for biometric processing and thus are very attractive for misuse of various kind. Particularly social media offer various options to exploit biometric data like facial images.

Secretly gathering biometric features over digital technology is thus relatively simple and misuse is evident as scandals like those around Pimeyes in Europe and Clear View AI in the US highlight: both companies harvested facial images from web sources on a global scale to train their facial recognition systems (Laufer and Meineck 2020; Hill 2020a). These are not single cases: there are, e.g., also several lawsuits for misusing biometric data against Facebook/Meta (EPIC 2018; Paxton 2022). Besides the legal and ethical problems, these practices also highlight a policy vacuum as regards the protection of publicly available information containing biometric features like facial images. German federal state Baden-Würtemberg initiated legal proceedings against Pimeyes[6] and in March 2022, the Italian Privacy Regulator fined Clearview 20 million USD for violating the GDPR (EDPB 2022). These lawsuits are important but a decrease in biometrics is still doubtful. Basically, the GDPR considers the sensitive nature of biometric features and the power of biometrics: it defines biometric data as:

> personal data resulting from specific technical processing relating to the physical, physiological or behavioural characteristics of a natural person, which allow or confirm the unique identification of that natural person, such as facial images or dactyloscopic data. (Art. 4 GDPR[7])

Given the sensitivity of biometric information, the regulation foresees a higher level of protection for biometric data and prohibits its processing "for the purpose of uniquely identifying natural persons" (Art. 9 GDPR). Hence, theoretically, biometric information is sensitive, requires thorough protection and the use of biometric systems is legally restricted. However, in practice, this is rather ineffective, due to several exceptions and an old problem, i.e., the limits of informed consent (Strauß 2019, 198ff.), individuals mostly lack in effective options to avoid being exposed to biometric identification. As of yet, there is often no real alternative except for explicit non-usage of applications processing biometric information. Moreover, boosted by social media, there are millions of selfies and other facial images available, exposed to misuse of any kind without any effective protection as these and other data scandals show. The above-mentioned lawsuits are rather the tip of the iceberg. With further normalization of biometrics, increasing pressure on individuals to give consent can be expected. Altogether, the broad accessibility of biometric data over digital technologies stimulates their massive collection and increases risks of misuse. This is a further indicator for the invalidity of the argument that biometrics would improve security.

Clarke (2002) early warned of biometrics being among the most dangerous technologies reinforcing mass surveillance. Particularly, as biometric technology is an integral part of "sur-

veillant assemblages" (Haggerty and Ericson 2000) where "assemblages leak into assemblages, with no clear sense of where the body stops and where surveillance systems start, and vice versa" (French and Smith 2016, 10). This assumed leakage from one assemblage to another basically means re-contextualization and secondary use of biometric data in terms of data protection. The broad usage of biometrics can thus indeed lead to a severe reduction of anonymity, privacy and related other fundamental rights like freedom of movement, expression etc. Furthermore, also human dignity is already affected in many respects.

3.2.4 Risks of reinforcing discrimination and incremental reduction of human dignity

The irreversibility of biometric information also reinforces risks of discrimination and affects human dignity. Many scholars have been warning for years about the manifold risks of biometrics to human rights (cf. Schneier 1999; Clarke 2001; 2002; Lyon 2008; Magnet 2011; Ball et al. 2012; Mordini and Tzovaras 2012; French and Smith 2016; Schaber et al. 2020; Gordon et al. 2021). Through biometrics, we are partially becoming reduced to algorithmic codes, entailing the risk of an incremental dehumanization of ourselves, as Clarke (2001) put straight. As of yet, this risk of a dehumanization may sound overstated. However, given the fact that biometric systems increase globally, implying the automated, algorithmic mapping, classification and encoding of information concerning human bodies, this risk may increase significantly. Not least as biometrics is closely linked to automated statistics, machine learning algorithms and AI. Algorithmic systems increasingly use biometric "body codes" to govern, predict and control human behavior. This is evident for many years in authoritarian regimes where biometric technology such as facial recognition serves as tool of discrimination and oppression, e.g., to identify government critics or to identify, categorize and divide citizens in different social groups. For instance, in China, where the technology is used to control citizens and sort out unwanted minorities like Uygur Muslims (Ng 2020); similar in Russia, where the technology serves mass surveillance and the prosecution of opposition members (HRW 2021); or in Iran, where the authoritarian regime plans to use facial recognition to identify women who are not wearing hijabs (Strzyżyńska 2022).

The increasing use of biometrics as political tool of control is not limited to non-democratic regimes but also observable in democratic states. Among others, Magnet (2011, 126) argued that biometrics lead to a revival of outdated biological notions about race and gender. The technological reinforcement of structural discrimination and racism is an evident problem today. Facial recognition is particularly problematic here which, as many cases (also outside the US) demonstrate, frequently leads to false accusations and discrimination. One issue is that biometric systems are often prone to errors. For example: during a soccer game in Wales in 2017, a facial recognition system falsely classified more than 2,000 persons as suspects which corresponds to an error rate of over 90 per cent (Burgess 2018). A further example is a system used in the US city of Detroit which even had a failure rate of 96 per cent as the head of police admitted (Koebler 2020). Failure rates may decrease due to technological progress. However, this does not solve societal and ethical problems as lacking accuracy is only a side issue while the main issue is how the technology is used (Castelvecchi 2020). A serious problem of growing concern are false accusations and structural discrimination: in 2020, Robert

Williams became the first person being discriminated by facial recognition. He had to spend several hours in jail just because he was classified as suspect based on an algorithmic image similarity (Hill 2020b). Williams is not a single case, e.g., also Michael Oliver and Nijeer Parks were arrested because of deficient facial recognition (Hill 2021). A large-scale study in the US revealed that people of darker skin color become up to 100 times more falsely identified by facial recognition than whites (NIST 2019). This underlines the problem of inherent bias in facial recognition and how this kind of technology reinforces institutional racism and other forms of discrimination. These risks aggravate also in Europe due to increasing tendencies to extend the use of biometrics for law enforcement. As aforementioned, the EU commission plans a new Directive to foster automated data exchange for police authorities, including a stronger focus on biometrics, particularly facial recognition. Several civil rights organizations expressed concerns arguing that this paves the way for mass surveillance and the erosion of the presumption of innocence, which is a core principle of democracy. Criticism also includes examples of former misuse and systematic flaws in data protection (EDRi 2022).

As biometrics imply reducing bodily features to digital data, this can also affect bodily integrity and human dignity. These human rights aim to ensure self-determination of humans over their own bodies. According to Art. 1 of the EU Charter of Fundamental Rights (EUCFR): "Human dignity is inviolable. It must be respected and protected." Art. 3 EUCFR determines that: "1. Everyone has the right to respect for his or her physical and mental integrity". However, a significant increase in biometric practices further strains these rights. Even without direct abuse, autonomy and self-determination are affected: contemporary biometrics often uses automated AI and machine learning techniques to detect and predict user behavior. This constrains individuals in their privacy and agency to self-determine how their biometric information is being used. AI, IoT, augmented and virtual reality settings and the related increase in remote sensor technology will likely aggravate these problems (Gordon et al. 2021). On the longer run, individuals may become increasingly hampered in freely deciding about the use of information concerning their identities and their human body. Hence, a violation of your privacy then might automatically imply a violation of the integrity of your body and your dignity.

4. Concluding remarks

As shown, biometrics is more than yet-another-identification technology: it has a substantial impact on embodiment and how humans use and are used by technology. The extended use of biometric information has consequences for its persistence and durability. Given the identifiable nature and irreversibility of biometric features, every interaction involving biometrics conveys strong identifiability of the person. This paper thus argues that the ongoing expansion of biometrics entails far-reaching sociotechnical shifts which imply a significant expansion of identifiability of individuals with substantial consequences on human rights and the role of technology in society. This development is yet underestimated in public discourse as well among policy makers and requires a broader societal debate and regulatory measures to reduce the corresponding risks. More precisely, because: 1) biometric information is bound to human bodies and thus irreversible, which makes individuals more vulner-

able to misuse; 2) the shift from a security towards a broadly used convenience technology fosters habituation effects and an incremental compulsion to provide biometric features; 3) the extensive use of biometric systems facilitates misuse, undermines secure processing of biometric information, reinforces surveillance tendencies, security risks and data protection issues; 4) biometrics used as automated control technology seriously strain human rights as it reinforces risks of discrimination and increasingly affects human dignity.

In the past, biometric technology was basically framed and used as security and surveillance technology in a limited number of application contexts. Extended usage was controversially discussed among researchers, policy makers, private and public stakeholders along the thin line between security governance and surveillance. However, during the last decade, a significant shift occurred where biometrics became partially re-framed – towards a commercial convenience technology increasingly embedded in various domains of everyday life. This development fosters habituation effects as people get more used to providing their biometric features. Different but interrelated economic and political drivers stimulate this development to make biometrics a mainstream technology for identification of individuals in public and private services, online and mobile applications and in law enforcement. This global trend to further broaden the use of biometrics and alleged gains in security and convenience make the surveillance capacity and manifold risks of this technology less obvious. This can lead to an incremental obligation to biometric identification which is already observable in some contexts (e.g., in banking or payment apps, digital wallets etc.) where non-biometric alternatives decrease. Moreover, with the increasing trend to distant biometric identification like facial recognition, individuals are widely exposed to biometric surveillance and related risks of social sorting and discrimination.

Beyond common surveillance practices, biometrics is a very substantial and expansive control technology reinforcing the excursion of institutional power over human bodies. On a more general level, the extensive use of biometrics is a form of power entanglement through technology. Its growing diffusion aggravates a core problem of digital identification (Strauß 2019): expanding information asymmetries between individuals and institutional actors implementing, performing and governing identification. This makes biometrics a highly intrusive technology which raises a number of societal and ethical issues. The broader the use of biometric features over different application contexts becomes, the more biometric systems may turn into a global assemblage of potentially interconnected ID systems. This is a crucial issue and a main reason for the highly intrusive nature of biometric technology: although there is no global biometric ID system, there is a serious risk, that the increasing use of biometrics leads to a blurry conglomerate of different but interwoven political control practices.

On the longer run, biometrics as mainstream technology may stimulate a reductionistic framing of individuals over their biometric information as commodified objects of control for political and economic purposes. In this framing, the individual is at risk to become reduced to a set of biometric features which serve as a sort of currency, e.g., to trade bodily information for gaining access to services or obtaining particular rights. One may argue that identity information was ever used in this regard. However, it is different with biometrics as you can never opt-out from your body. The simple reason for this lies in the irreversibility of biometric features and its inevitable linkage to the body. This also affects the vulnerability of individuals as their biometric features can be misused and are, in contrast to other forms of

identity information, not easily revocable and changeable. Hence, abuse can be very harmful, particular for individual persons. Biometrics is often not as secure as promoted and its usage only makes sense in very clearly defined, safe environments where misuse is very unlikely but not as mainstream technology. The growing cases of security breaches, attacks on biometric systems, of privacy violations and other forms of data abuse underlines that a further expansion of biometrics entails serious societal threats.

Expansion is also likely because biometrics is closely connected to AI-based technology and other forms of automated systems interacting with humans. These technologies basically use digital sensors to gain information about their environment and whenever interaction involves humans, biometrics is involved (e.g., via facial or voice recognition etc.). Technological trends like the IoT, as well as augmented and mixed realities imply a further increase in embedded sensors and biometric identification practices. Hence, an extensive growth in systems gathering and processing bodily features can be expected. If this expansion proceeds, the consequences for society and democracy can be severe: a further erosion of anonymity, privacy and related human rights, decreasing autonomy, agency and self-determination, increasing risks of data and security breaches like identity theft, increasing risks of social sorting, discrimination, and decreasing rights concerning bodily integrity and human dignity.

To circumvent these urges for a thorough societal debate on the risks of biometrics and stricter regulation of its usage contexts. Explicit prohibition is a blurry legal debate. Although the GDPR basically treats biometric data as sensitive, stronger protection is hampered by several gray areas in policy and legal regulations. Art. 9 of the GDPR prohibits the processing of biometric data the purpose of uniquely identifying natural persons. However, as biometrics are coupled to the human body and thus to the identity of a person, it is hardly avoidable that biometrics serve identification purposes. In practice, this is indistinct and mostly remains undetected. For instance, the extent to which facial images or photos (e.g., selfies) provide biometric information is often unclear. This facilitates unethical practices of data gathering as the outlined cases of Pimeyes and Clearview AI highlight. A legal clarification that facial images need protection from misuse as they can provide biometric information would contribute to ease this situation. A pressing issue concerns the increasing risk of discrimination based on biometric recognition which underlines the need for more effective rights against discrimination through technology and the strengthening of rights concerning human dignity and the integrity of the body. Given the enormous risks of a broad use of biometrics not just for abuse but for an erosion of democracy suggests the prohibition of commercial use of biometrics with accordingly high sanctions in case of abuse. This would contribute to make abuse less attractive. If society fails to tame the current proliferation of biometric systems, related business models and political power claims, in a not-so-distant future, anonymity might be diminishing and the inviolability of human dignity reduced to a statistical score.

Notes

[1] Induced by the ICAO (the International Civil Aviation Organization), a sub-unit of the United Nations.

[2] Regulation on electronic identification and trust services for electronic transactions in the internal

market (https://digital-strategy.ec.europa.eu/en/policies/eidas-regulation).

³ Payment Services (PSD 2) Directive (https://ec.europa.eu/info/law/payment-services-psd-2-direc-tive-eu-2015-2366_en).

⁴ Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) No 910/2014 as regards establishing a framework for a European Digital Identity (https://digi-tal-strategy.ec.europa.eu/en/library/trusted-and-secure-european-e-id-regulation).

⁵ The Prüm Convention (also known als Schengen III Agreement) is a European law enforcement treaty signed on May 27 2005 in the city of Prüm in Germany. It regulates data exchange for law en-forcement (https://en.wikipedia.org/wiki/Pr%C3%BCm_Convention). Since 2020, plans foresee a sig-nificant extension of data exchange regulated by this legal framework (see EP 2020).

⁶ One Trust Data Guidance, *Baden-Württemberg: LfDI Baden-Württemberg initiates proceedings against PimEyes to determine GDPR compliance* (May 28, 2021). Available at: https://www.dataguid-ance.com/news/baden-w%C3%BCrttemberg-lfdi-baden-w%C3%BCrttemberg-initiates.

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Rediscussing the Primacy of Scientific Expertise: A Case Study on Vaccine Hesitant Parents in Trentino

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Abstract
Vaccine hesitancy constitutes a pressing social issue. Media and institutions frequently portray vaccine-hesitant parents as ignorant and anti-scientific. This exploratory study – conducted in the Autonomous Province of Trento (Italy) in 2018 – analyses organized parents opposing the reinforcement of childhood vaccination mandates. Semi-structured interviews with vaccine-hesitant parents and physicians with experience with vaccine-hesitant patients, and participant observation were conducted to understand the perceptions of childhood vaccination mandates, focusing on narratives regarding the role played by science and scientific experts in the vaccine debate. Analysed through the lens of sociology of health and Science and Technology Studies, results highlight that vaccine hesitancy cannot be reduced to anti-scientific attitudes. Hesitant parents' vaccination decisions are based on a different perspective of their children's health and on alternative forms of expertise; there are persistent weaknesses in the doctor-patient and expert-citizen relationship in a deeply dualistic vaccine-related debate; and there is the need for a dialogue between institutions and vaccine-hesitant parents.

Keywords
parental vaccine hesitancy; childhood mandatory vaccination; trust in science and scientific experts; alternative expertise; reflexive patients; science communication.

1. Introduction

In a context of increased global health threats (Daszak et al. 2020; The Lancet Planetary Health 2021), including the recent Covid-19 pandemic, and the development of new vaccines, the global relevance of the phenomenon of vaccine hesitancy has come to the fore. Vaccine hesitancy can be defined as "a delay in acceptance or refusal of vaccines despite availability of vaccination services" (MacDonald et al. 2015, 4163). It is a complex phenomenon, which is both country-specific and vaccine-specific, and can vary over time. Given its widespread occurrence, vaccine hesitancy was recognized by the World Health Organization as one of the "ten threats to global health in 2019"[1].

Vaccines have been designed to prevent pathogen-specific infections (Pardi et al. 2018), reducing the hazards and risks of contracting vaccine-preventable diseases. Vaccines are technologies

that have both a global and a more personal, local characteristic. They are "produced, distributed and monitored within systems that are equally globalized" (Leach and Fairhead 2007, 2) to potentially reach a global population (with specific attention to children) and, at the same time, they reach into the private health sphere of individuals. As technoscientific innovations, vaccines have a "hybrid" character in the public debate, requiring the simultaneous management of "technical" uncertainties with those related to their social, economic, and political purposes and implications (Bucchi and Neresini 2006). Indeed, as the Covid-19 pandemic has shown, technological, scientific, economic, political, and cultural aspects of vaccines often appear to be inseparable, bringing together fears of ill health with those of excessive medicalization, adverse events following immunization (AEFI)[2], and the increasing centralization of power and economic resources in the hands of few pharmaceutical companies. Indeed, uncertainty around vaccines is also due to their "hybrid" character in the public debate (Bucchi and Neresini 2006).

In recent years, several European countries have adopted revised vaccination strategies, introducing or increasing the number of mandatory vaccines for children, and embracing different approaches to (non-)compliance (Odone et al. 2021). Italy was the first European country to introduce an increased number of mandatory vaccines in line with its official role as a leader in vaccine strategies worldwide – in accordance with the Global Health Security Agenda of 2014 (Centers for Diseases Control and Prevention 2014). When addressing vaccination policies and strategies, as well as other public health issues, a delicate balance between individual rights and collective interests should be considered. The choice between a more "traditional" strategy focused on imposing a vaccination obligation contrasted with a strategy focused on the recommendation of vaccines, depends on how institutions have decided to manage vaccination dissent. In either case, both the communication strategies adopted, and the broader relationship established between institutions (be they health, political, or scientific) and citizens over time, play an important role.

The motivations that lead to parental vaccine hesitancy have often been misunderstood and misinterpreted by the media and political and health institutions – leading to a sharp polarization of the vaccine-related debate (Brunson and Sobo 2017; Vanderslott et al. 2022). Explaining vaccine hesitancy in terms of "the media, ignorance and misinformation, class or predisposition" can lead to misleading and ineffective policies (Poltorak et al. 2005, 718). It is similarly unproductive for political and health institutions to approach the phenomenon as caused by either a general distrust in science (and scientists) or a general scepticism towards vaccination (Bucchi et al. 2022; Peretti-Watel et al. 2015), and by accusing vaccine-hesitant parents of being anti-scientific (Gottlieb 2016; Ward et al. 2019). Framing vaccine hesitancy as a fight against science and scientific expertise does not help to increase trust in vaccines; it reduces "the controversy to the status of vaccine science" (Goldenberg 2021, 15). Rather, different types of expertise – not only technical – should be considered when analysing the vaccination debate.

This paper intersects the sociology of health perspective with science and technology studies (STS) allowing for the study of the role of vaccine-hesitant parents' expertise in challenging the primacy of scientific authority as well as the main models that are deployed to manage (public and individual) health. Specifically, the paper aims to understand the main elements that are involved in the relationship of vaccine-hesitant parents with science and scientific experts – including healthcare professionals. This study presents the results of an exploratory qualitative case study conducted in the Province of Trento (i.e., Provincia Autonoma di Trento) located in

the northeastern part of Italy. The research has been carried out in 2018, shortly after a national reinforcement of childhood vaccination obligations, which increased the number of mandatory vaccines and introduced sanctions for non-compliance. The study is based on participant observation and 26 interviews – 21 with organized vaccine-hesitant parents and 5 with physicians.

Considering childhood vaccines as technoscientific innovations to highlight the complex relationships between science, technology, and society, the paper first gives an overview of the main drivers of parental vaccine hesitancy. It then focuses on the role played by alternative expertise and specific vaccine-hesitant parents' approach to their children's health in guiding the vaccination decision-making process. Using case study data, the paper explores the role played by information-seeking for vaccine-hesitant parents, who actively engage in making their own research to build their expertise and make "informed" vaccination decisions; the elements that characterize the relationship of vaccine-hesitant parents with healthcare professionals; and the ways in which those parents perceive science and scientific experts. The study finds that hesitancy cannot be reduced to a set of anti-scientific positions; rather, vaccine-hesitant parents' criticisms are mainly directed at scientific experts and their paternalistic approach. Particularly, vaccine-hesitant parents perceive the doctor-patient and expert-citizen relationships as becoming increasingly weakened. This is mainly due to the social implications of the re-enforcement of vaccine requirements, the lack of recognition and legitimacy of vaccine-hesitant parents' concerns as well as the relevance of their expertise.

2. Parental vaccine hesitancy and vaccination decisions

Fears for adverse events following immunization (AEFI) are among the most cited reasons for either refusing childhood vaccines (McKee and Bohannon 2016; Facciolà et al. 2019) or anti-Covid-19 vaccines (Markovitz and Russo 2020; Salyer 2020). Trust plays a fundamental role in vaccination decisions and allaying fears about AEFI. Vaccine confidence can be influenced by trust in vaccine-related policies, in the products (i.e., vaccines and their components), the providers, and the infrastructure that supports such programmes (Goldenberg 2021; Larson et al. 2015). Vaccine confidence can also be influenced by trust in key actors – including scientific experts. The safety and efficacy of vaccines are additional elements that influence decisions on whether to be vaccinated and/or to vaccinate (Bucchi et al. 2022; Larson et al. 2018; Lazarus et al. 2020).

Parental vaccine hesitancy is "complex and multifaced" (Díaz Crescitelli et al. 2020, 43). As pointed out by Dubé et al. (2021, 177), the "state of ambivalence toward vaccination highlights legitimate doubts and concerns about vaccines", highlighting vaccine-hesitant parents' wish to discuss and engage with vaccine-related uncertainties (Kirkland 2012; Leach and Fairhead 2007). Political and health institutions, however, have not recognized that vaccine-hesitant parents address the vaccine safety issue from a different perspective, displaying individualized perception of risks that "makes the presence of rare but serious adverse events a safety priority rather than, as health officials see it, a reasonable risk" (Goldenberg 2016, 564). Vaccination scepticism is not constituted by a homogeneous front of parents opposed to vaccines – negatively labelled as "No-Vaxxers" (or "anti-vaxxers"). Instead, vaccine hesitancy is constituted by different "gradations of [vaccination] acceptance" (Streefland et al. 1999, 1709).

As highlighted by Reich (2016, 11), "we live in an age of personalization" in which "we see heightened efforts to personalize medical care to meet the desires and needs of the individual". Thus, many parents engage in what the author defined as "individualist parenting", i.e., involving a significant investment of time and energy in planning the best strategies to keep children healthy. This parental commitment results in increased attentiveness to children's needs as well as demands for more personalized institutional responsiveness (Reich 2016). The fact that vaccine safety has been demonstrated from a public health point of view is not considered sufficient evidence for parents who are concerned to know whether vaccines are safe for their own children (Goldenberg 2021). Thus, vaccine-hesitant parents adopt a "particularistic" perspective on children's health (Leach and Fairhead 2007) that leads them to carefully evaluate the current or potential impact of vaccines on their children's particular health condition. Consequently, in deciding whether to vaccinate their child and against which disease(s), such parents first consider their children's health history as well as their family health history. Furthermore, they evaluate the likelihood of their children getting a vaccine-preventable disease (VPD) and what the impact of the VPD would be. Vaccine-hesitant parents do not necessarily underestimate the potential negative consequences of VPDs. However, they think that vaccination is not the only tool for prevention and that institutions overestimate the risks of infections as well as vaccine efficacy (Blume 2006; Rogers and Pilgrim 1994). In this way, vaccine-hesitant parents often ask for an individualized vaccination schedule and refuse to vaccinate their children according to a national, one-size-fits-all immunization schedule (Dempsey et al. 2011; Klugar et al. 2021). As highlighted by Leach and Fairhead (2007, 51), this request can be considered part of a broader societal shift towards "more individuated [childcare] regimes adapted to the particularities of each child".

2.1 Parental reflexivity and alternative knowledge production

Studying the complexity of vaccine-related attitudes moves beyond arguments based solely on the safety and efficacy of vaccines (Widdus and Larson 2018). Indeed, in their research, Poltorak et al. (2005) highlighted that mothers' engagement with the measles, mumps, and rubella (MMR) vaccine is particularly influenced by experiential factors such as personal histories, childbirth events, and levels of sharing other parents' concerns. Experiential factors construct parents' "experiential knowledge" (Borkman 1976, 446) i.e., the "truth learned from personal experience with a phenomenon rather than truth acquired by discursive reasoning, observation, or reflection on information provided by others". Therefore, personal experiences, personal judgements and feelings become of primary relevance in defining what is true. To further examine this phenomenon, van Zoonen (2012, 57) introduced the concept of "I-pistemology" – i.e., "the self as the origin of all truth". According to the author, especially in situations of high epistemological uncertainty in which it is not clear whom to trust and what is true, one of the strategies that people can adopt to cope with this insecurity is to turn themselves into "an alternative source of knowing and understanding" (van Zoonen 2012, 60). More recently, Crabu et al. (2023) looked at the health-related beliefs of concerned communities and how their claims were (partially or totally) refused by scientific authorities during the Covid-19 pandemic. Crabu et al. (2023, 149) highlighted that the "refused styles of thought" are

constituted by experiential expertise used "to reframe the body in a process of self-care, thus validating a corpus of refused knowledge through direct personal experience". By applying demarcation strategies and narratives, "with respect to the prevalent biomedical paradigms", the concerned communities acquire "experiential epistemic autonomy". Experiential knowledge and expertise are thereby co-created, shared, and mobilized by concerned communities thus producing alternative ways and meanings to manage public and individual health.

As highlighted by several authors in the field of STS (Callon 1999; Turner 2001; Wynne 1996), different types of expertise can be both facilitated and/or hampered depending on the context considered. This is especially true in the healthcare field, which has led to the rise of alternative forms of expertise, based on the experiences and interests of a plurality of stakeholders – including parents. In the medical field, scientific expertise is not only technically oriented knowledge but also socially constructed knowledge (Epstein 1996; Kerr et al. 2007). Indeed, according to Jasanoff:

> scientific knowledge, in particular, is not a transcendent mirror of reality. It both embeds and is embedded in social practices, identities, norms, conventions, discourses, instruments and institutions. (2004, 3)

Political decisions and policy strategies – such as those of vaccination campaigns and vaccination mandates – include several non-scientific factors. In her study, Carrion (2018, 321) highlighted a specific and alternative form of knowledge production based on the "social experience of motherhood". The author pointed out that it is important for vaccine-hesitant mothers to make informed vaccine-related decisions based on their own research. In these decisions, vaccine-hesitant parents carefully take into consideration their children's needs and make "independent decisions, based on their own knowledge and intuition" (Reich 2016, 72). This parental expertise should not be belittled: parents know their family history and health-related vulnerabilities, and both elements can play a "legitimate role in decision-making about vaccinations" (Cassam 2021, 6).

In this regard, the concept of reflexivity becomes relevant, understood as "the general capacity of late modern actors to reflexively consider their own health in light of medical knowledge proliferated in late modern societies" (Numerato et al. 2019, 85). Reflexive reasoning is thus included in citizens' decision-making processes about their own, or their children's, health (Giddens 1991; Miah and Rich 2008). Vaccine-hesitant parents can thus be seen as "reflexive patients", a concept that refers to "increasingly reflexive and decreasingly deferential citizens" (Martin 2008, 41). The increased reflexivity allows citizens both to deal with uncertainties originating from the advancements of scientific knowledge and the problematization of scientific knowledge (Beck et al. 2003). As noted by Kaufman (2010, 12), "parents reflexively practice and ponder an ethic of care and choice" based on their perception and evaluation of vaccine-related risks and according to their own criteria (Boholm 2003; Gottlieb 2016). Even if scientific expertise is requested, vaccine-hesitant parents do not blindly rely on it, thereby "living with the potential risk of vaccines and the anxiety of ever-partial knowledge" (Kaufman 2010, 12).

3. Research context and methodological frame

One of the strategies that governments can adopt to try to address a decrease in vaccination rates is a mandatory vaccination policy, mainly oriented towards childhood vaccination. Revised vaccination strategies, which have involved the adoption or strengthening of existing childhood vaccination requirements, have been introduced in many countries. Since 2015, in an effort to increase vaccine uptake rates, several high-income countries – such as Italy, France, Australia, and Germany – have adopted increasingly more coercive childhood vaccination policies (Attwell et al. 2021; Ward et al. 2018). Particularly, Italy was the first European country to introduce an increased number of mandatory vaccines for children up to 16 years of age (Law No. 119/2017).

Since the 1960s, Italy has adopted several approaches to vaccination governance: childhood vaccines were mandatory until 1998, while between 1999 and 2016 the distinction between recommended and compulsory vaccinations was progressively exceeded (Signorelli 2019). Until 2016 indeed, Italy adopted a "quasi-voluntary" vaccination policy in which sanctions for non-compliance were either rarely enforced (Attwell et al. 2018) or considered "low cost opportunities for refusers to 'purchase' non-compliance" (Attwell et al. 2021, 462). In 2001, after modifications to Title V (part II) of the Italian Constitution, regions were empowered with increased autonomy in health policy, leading to a great legislative fragmentation of vaccination strategies across the country. The situation has particularly changed with the introduction of Law No. 119/2017[3], which requires an increase in the number of mandatory vaccines – from four[4] to ten[5] – for children between 0 and 16 years.

This Law faced strong opposition from families who did not want to fulfill these vaccination requirements; some felt the need to network, looking for support to advocate for their positions. Critics have mainly focussed on the penalties provided in this law. Those who do not comply with the vaccination plan must pay a fine (up to 500 euros) and children up to six years of age who are not (or only partially) immunized cannot attend public and private nursery schools or kindergartens.

An interesting case in the Italian vaccine-related legislative landscape is represented by the Autonomous Province of Trento. Unlike other Italian regions, including other autonomous regions, the Province of Trento approved resolutions that strengthened the sanctions already provided by Law No. 119/2017 for non-compliant parents between 2017 and 2018. While other regions, such as the Autonomous Province of Bolzano, adopted an approach that emphasized dialogue with parents, the Province of Trento adopted a more aggressive policy for compliance. Trentino's Provincial Resolutions No. 322/2018[6] and No. 547/2018[7] represent its approach: the first introduces the suspension of monthly economic benefits (called "service vouchers") for non-compliant families, while the second excludes children not fully vaccinated from summer camps. Furthermore, Trentino's political and health authorities have introduced the label "conforme" (compliant) and "non conforme" (non-compliant) to identify, respectively, children who have fulfilled their vaccination obligations and those who have (totally or partially) not done so. Thus, "No-Vax" and "non-compliant" labels have negatively labelled those people who have expressed their opposition either to vaccination practices or to vaccination mandates. This has generated social tensions between those who decided to vaccinate their children according to the national vaccination schedule and those who decided not to do so.

It is in this context that the following case study was undertaken. Conducted in the Autonomous Province of Trento (Italy) between February 2018 and May 2018, it focuses on a Free-Vax association – i.e., one that advocates for the freedom of choice in vaccination decisions. *Vaccinare Informati* is the only Free-Vax association in Trentino and since 2006 has organized and promoted events and public initiatives regarding vaccines and health. This association was selected for three main reasons. First, unlike other Free-Vax associations in Italy that tend to form specifically to oppose a particular vaccination or health policy (and are therefore likely to disappear shortly afterwards), *Vaccinare Informati* has been active on the territory well before the reinforcement of childhood vaccination obligations (Law No. 119/2017). Second, *Vaccinare Informati* has become a reference point for vaccine-hesitant families who need support in their vaccination choices (also) in other regions of the country. Third, given its long history in the promotion of freedom in vaccination decisions in Trentino and its openness to dialogue over the years, *Vaccinare Informati* has been recognized as an interlocutor by the provincial political authorities[8].

For the study, 21 semi-structured interviews were undertaken with members of the *Vaccinare Informati* association. Interviewees, over 18 years of age, were identified through snowball sampling (Barbour 2014; Given 2008). The sample was relatively balanced in terms of gender and educational level (Tab. 1).

Vaccinare Informati members	N
Gender	
Female	13
Male	8
Total	21
Educational level	
Tertiary (degree)	13
Secondary (diploma)	8
Total	21
Occupational sector	
Clerical	7
Education	6
Social and Healthcare	3
Specialized/technical	3
Blue-collar	2
Total	21

Table 1.

Socio-demographic characteristics and vaccination choices of
Vaccinare Informati members (N=21), Trentino (Italy), 2018.

The study viewed vaccine-hesitant parents as a heterogenous group adopting a variety of vaccination choices. The widespread misconception that has characterized public debate and media communication both before and after the onset of the Covid-19 pandemic is that vaccination scepticism is constituted by a homogenous front of people opposed to vaccines – negatively labelled as No-Vaxxers. Contrary to this characterization, vaccine-hesitant people are a heterogenous category with differing levels of hesitancy towards one or all vaccines. Vaccine-hesitant people may decline certain vaccines but accept others, postpone a vaccination schedule, or accept vaccine(s) with reluctance. Table 2 shows the different vaccination choices vaccine-hesitant parents made for their children, ranging from partial vaccination to no vaccination.

Vaccinare Informati members	N
Vaccination choices	
All mandatory* vaccines for a child and some vaccines for the other(s)	2
All mandatory* vaccines for a child and none for the other(s)	2
Some vaccines for all the children	5
Some vaccines for a child and none for the other(s)	4
No vaccines	8
Total	21
* All mandatory vaccines before the introduction of Law No. 119/2017	

Table 2.
Vaccinare Informati members' vaccination choices (N=21),
Trentino (Italy), 2018.

The study also included the "specialist" view on the Italian vaccine issue with interviews with five doctors who have had experience with vaccine-hesitant patients. Particularly, these additional semi-structured interviews were conducted with four paediatricians (one of them is also a clinical researcher) and another, with a general practitioner endorsing and practicing homeopathy. All the healthcare professionals interviewed believed in the importance of childhood vaccination as well as vaccines in general. However, the general practitioner was opposed to the national vaccination mandate and its sanctions and was therefore more aligned with the Free-Vax positions. The limited number of interviews with doctors was due to the difficulty of finding physicians willing to be interviewed. This was due to fear of exposing themselves to a controversial issue that was much debated in Italy at the time of the introduction of increased mandatory vaccines (Law No. 119/2017).

All interviewees signed the informed consent form, and all interviews were audio-recorded, fully transcribed, and analysed using Atlas.ti. Qualitative content analysis (Williamson et al. 2018) was performed. The interviews – conducted in Italian – were pseudonymized to protect the interviewees' privacy and the interview excerpts were translated into English.

4. "Awareness always has a price": Making informed vaccination decisions

Contrary to a widespread misconception, vaccine-hesitant parents do not lack information. Rather, these parents tend to consider trust in political and health institutions as passive, and that parental assessments and decisions made independently of the wider institutional context are more responsible and empowering (Hobson-West 2007). Indeed, vaccine-hesitant parents mainly adopt an individualist parenting approach (Reich 2016), investing time and energy in self-educating "to make informed decisions about their children's health risks" (Cassam 2021, 6). These elements clearly emerge from Olivia and Barbara's words:

> Most of the people I have talked to who have vaccinated [their children] don't even know what they vaccinated [them] for, but this is not, in my opinion, because they are bad parents – absolutely not. However, I feel like I am more responsible than them because I know. Then maybe I am making the wrong choice; however, I have informed myself and I know what I am vaccinating for. (Olivia, *Vaccinare Informati* member)

> And with these parents, talking about the uninformed parents... when you ask them, "But what sources of information do you have?" "Ah I have my paediatrician who told me to vaccinate, and I vaccinated" or, "My sister works in the medical field and she talked to some doctors who said it's right [to vaccinate]". And of course, being that we also have to keep informing ourselves and trying a little bit to figure it out, these are things that hurt you and make you angry because I can understand that a person who has delved into the topic of vaccination and is convinced, has a position that may even be radical. A person who in the end has not delved into the issue, who then comes to you and talks to you about uninformed [vaccine-hesitant] parents – it is really humiliating. (Barbara, *Vaccinare Informati* member)

Vaccine-hesitant parents tend to avoid mainstream media when searching for information about vaccines. Instead, they privilege their own research undertaken through alternative channels to the mainstream and the Internet, largely avoiding social media as a source of information. Television and newspapers are often considered providers of institutional positions and misinformation and therefore untrustworthy on the subject of vaccines.

> No one questions whether what is said on television is real or whether there is some misinformation underneath; it is completely taken at face value. So, with the media, you are properly institutionalized to think in a certain way, and those who do not follow [this mainstream thinking] and do not buy everything that is said on television are categorized as nonconformists, No-Vaxxers, naturalists, in short, are considered to be people who are uninformed, who are ignorant, and who believe in Santa Claus, when in fact it is probably exactly the opposite. The media manage to do this: newspapers, television mainly... But television, in my opinion, is the worst. Television and the Internet are the ones that create as much misinformation as possible. (Alessia, *Vaccinare Informati* member)

When searching for vaccine-related information, vaccine-hesitant parents believe the web constitutes a more desirable source of information than traditional media. Indeed, the web is perceived by *Vaccinare Informati* members as a more "democratic" source of information from which it is easier to both verify the reliability of the information and delve into topics.

> Rather, we inform ourselves perhaps by reading or choosing news in another way: the Internet is a bit more democratic, it is true that you can find a little bit of everything, however, you can find a plurality of information... and there is much more possibility for in-depth study because if I see an article that refers to a scientific journal, with an article published in a journal of a certain type, I can actually go and look at the sources. From what I'm told in a news report, how do I go and check the sources? (Tiziano, *Vaccinare Informati* member)

According to Brown (2008, 273), the Internet has led to the "globalization of medical knowledge" and "to the rise of increasingly clever patient". Clever patients or "informed patients" (Kivits 2004) increasingly search for and interpret health information independently, relying on a variety of health-related information sources. Hence, the Internet can be seen by vaccine-hesitant parents as a way to create some "distance from expertise" and at the same time "to enter into a meaningful dialogue with experts' authoritative discourse" (Bakardjieva 2010, 175).

Parents continuously reflect on the most relevant reasons in their vaccination decision-making process, i.e., the factors leading to vaccine-hesitant positions (Majid and Ahmad 2020). The decision to vaccinate does not necessarily imply the absence of vaccine-hesitant attitudes:

> while non-vaccination or single vaccination requires a continued engagement to affirm the position taken, even parents who opt for MMR [vaccine] continue to learn and say they remain open despite having taken a decision that is irreversible. (Poltorak et al. 2005, 717)

From a moral point of view, parents may thus feel compelled to become more reflexive about their own vaccination decision-making processes. When parents have vaccine safety doubts, the "problem of freedom" arises, i.e., "the problem of the enactment of an ethic of self-conduct, of personal responsibility, in the realm of vaccine safety" (Kaufman 2010, 12; Rose 1999).

> People [who comply with the law] prefer to look the other way because if they think it might harm their child – a certain behaviour, that is – a parental responsibility arises, it's hard to put it on one side... if a doubt crept in here, they would have an obligation to inform themselves, they would have to deal with a whole series of things that now are very heavy [to handle] such as an exclusion, fine, etc., as well as marginalization because that is also heavy [to bear]. (Giulio, *Vaccinare Informati* member)

As anticipated by Giulio's words, non-compliance comes at a cost when vaccination mandates introduce sanctions. The consequences of vaccination dissent are generally carefully considered by vaccine-hesitant parents in their decision-making process. Such parental reflexivity is an attitude particularly visible in Trentino. In this territory, parents who have decided not to vaccinate their children according to the national vaccination schedule must deal

with increased sanctions for non-compliance introduced by local authorities (e.g., the service vouchers suspension) in addition to the fines and exclusion of their children from preschool services already provided in national law.

> Service vouchers are nothing more than the latest result of a doggedness here in the Province of Trento, not Bolzano in that with this legislation, the Province of Trento… could have made different choices anyway. Instead, it decided to follow the norm and, in some cases, has even made things worse… This a unique case in Italy, a unique case actually for two reasons: first, service vouchers exist only in Trentino; and second, a unique case in Italy because no one in any other region has ever dreamed of making a regulation worse than one that is already very tough anyway. (Bruno, *Vaccinare Informati* member)

The introduction of additional sanctions for non-compliance in Trentino has further accentuated *Vaccinare Informati* members' perception of a discriminating environment and increased social tensions based on vaccination status.

5. "There is no trust in doctors anymore": A weakened relationship between the doctor and the vaccine-hesitant parents

Vaccine-hesitant parents often have difficulties in openly discussing vaccination with their general practitioner or paediatrician. As highlighted by Blume (2006, 637), "vaccination may be voluntary in theory, but that is not how most health professionals treat it in practice" and vaccine-hesitant parents see the official vaccine-related information as designed to "induce conformity" rather than inform. Following the introduction of the Italian law on mandatory childhood vaccination in 2017, both the parents and the physicians interviewed perceived a general loss of trust in the doctor-patient relationship. According to Sara, this relationship is perceived as paternalistic, a relationship in which unilateral communication does not allow dialogue.

> There is no trust in doctors anymore… Then "you have to do this because that's just the way it is"; it doesn't work. (Sara, *Vaccinare Informati* member)

When seeking vaccine-related information, vaccine-hesitant parents often choose not to consult their children's physician because they think that an open, non-judgmental, discussion on the issue is not possible (Evans et al. 2001; Leach and Fairhead 2007; Yaqub et al. 2014). When scientific consensus over vaccines does not create trust, vaccine-hesitant parents "are ridiculed for raising concerns, questioning expert testimony, and taking seriously minority dissenting opinion" (Goldenberg 2021, 128). For example, Sara and Oriana's concerns – based on their children's health vulnerabilities – were not taken seriously or addressed properly by healthcare providers.

> So many times, when I was summoned [for a doctor's appointment] for the children, to know why I was not getting the vaccines, I told them about my particular situation and

family history, and they didn't give me any answers and just laughed. Or they were joking about it. And honestly, this to me is an inhumane thing because I told them, "For you, it can be just one who can have an adverse reaction, for me that one is my whole life". (Sara, *Vaccinare Informati* member)

At the time of the birth of the second child, there was clearly a strong fear about facing [the same situation experienced with the first child] because there is certainly a genetic allergic predisposition with the first child and the second child was also born tending to be allergic – so, triggering or aggravating this problem was my primary concern. I said if there are already difficulties, you are going to stimulate or burden a two-month-old child, and you don't know what they are allergic to. Even a small amount of a substance is enough [to cause a vaccine adverse reaction]. Clearly, I felt responsible at that moment there. Since I had listened faithfully before to what they [paediatricians] advised, at this point I said let's stop for a moment and evaluate. (Oriana, *Vaccinare Informati* member)

Some of the interviewed doctors also perceived an increased tension in their relationship with parents because of Law No. 119/2017. Specifically, the reinforcement of childhood vaccination mandates has contributed to making the relationship of trust more fragile and difficult to build over time – especially with those parents more sensitive to the issue of vaccine adverse events.

And to me, yes I would love to see the vaccine requirement removed, but as a paediatrician, so that we can give ourselves [as doctors] a chance to get back to grounding our relationship in trust and bringing parents to a choice that is informed. And these requirements have not favoured us in that. (Maddalena, paediatrician)

Accordingly, some parents interviewed believe that, in part, this deterioration in the doctor-patient relationship has been exacerbated precisely by the law. Particularly highlighted by Elisa's words, there is a belief that most doctors have lost their professionalism because they have been forced to align with the law for fear of being disbarred by the National Medical Association[9].

It [vaccination] should be a free choice made with your doctor, but doctors are deprived of their professionalism, they can no longer decide, they are afraid because they have seen that they have applied the fascist method of hitting one to punish a hundred. So, they [the authorities] hit some very prominent, very good doctors who have given their lives for patients... It's not that they don't want to, most can't. And so, we hope that it changes and that the doctor regains his/her professionalism and his/her way of acting in science and conscience. (Elisa, *Vaccinare Informati* member)

The deterioration of the doctor-patient relationship was perceived by interviewees also in the local vaccination hubs: pre-vaccination appointments seemed to be conducted "with the stopwatch in hand", and medical staff seemed unwilling to dialogue with parents to answer their questions. Indeed, many healthcare providers report difficulties in communicating with vaccine-hesitant parents, consultations that they perceive as unproductive (Wilson et al. 2020).

However, the great organizational strain on medical staff due to the new procedures and time-lines required by Law No. 119/2017 was clearly acknowledged. This pressure on Italian healthcare workers, already overburdened by broader issues of personnel shortage in the healthcare field, was recognized not only by the doctors interviewed but also by *Vaccinare Informati* parents.

> I've seen five children come in and out in the space of five minutes and one behind the other just in a continuous stream. So certainly, there is also work stress in the vaccination centres. (Davide, *Vaccinare Informati* member)

> Then, in my opinion, the problem of our health care organization is that the paediatrician of free choice or the general practitioner has about 5,000 patients in the queue and cannot devote the right amount of time to those who are there... That's the big problem... and unfortunately people think that the doctor or the professional did not really listen to what they needed and so they tend to go in other directions. (Zoe, paediatrician)

The introduction of Law No. 119/2017 was followed by a general change in the approach to vaccination. According to *Vaccinare Informati* parents, this has been a step backwards eliminating dialogue between parents, healthcare providers, and local authorities, that had been built over the years in Trentino.

> Both at the level of the Trentino Health Department and at the level of doctors who are part of the health care system, the stance taken is completely obtuse, and was different just a few years ago. It seems strange to me that in 2006 there was [...] a general tendency towards greater responsibility: it was seen as progress to have this freedom to choose and now, suddenly, everyone has had to or has chosen to change perspective and return to an approach of twenty-thirty years ago. (Tiziano, *Vaccinare Informati* member)

Furthermore, the doctors interviewed highlighted communication issues between local health institutions and parents, especially at those institutional events organized to communicate the changes introduced by Law No. 119/2017. According to the paediatricians Maddalena and Giorgia, during those events, instead of dialogue, there was a stand-off between citizens and authorities. Rather than addressing parents' concerns, a top-down communication of general vaccine-related information was delivered by the authorities.

> At those events, they asked us [paediatricians] to go too, now I wouldn't know how to solve [the vaccine issue], but I realized that there is no dialogue: it's like two bulls clashing into each other. (Maddalena, paediatrician)

> There was a stand-off there because whoever organized the meeting said what they had to say, they linearly said what they had to say and stopped... A lot of time was wasted in this communication talking about what disease it is, what happens with that disease, what the vaccine is like, etc... People didn't need to know these things or hear them repeated, people are there to understand. (Giorgia, paediatrician)

As highlighted by Gottlieb (2016, 158) "[vaccination] advocates focus on the population-level value of universal vaccination and critiquing fallacious claims about vaccine dangers". However, the fact that vaccine safety has already been demonstrated from a public health point of view is not sufficient to convince vaccine-hesitant parents to embrace the national vaccination schedule: parents are instead concerned to know whether vaccines are safe for their own children, based on their health history, in line with a particularistic perspective of children's health (Leach and Fairhead 2007).

In deciding whether to vaccinate their children and, eventually, against which disease(s), *Vaccinare Informati* parents first evaluate the likelihood their child will get a vaccine-preventable disease (VPD) and the likely impact of the VPD on that child. Furthermore, other relevant elements that vaccine-hesitant parents take into consideration in their vaccination decision-making process are the specific context in which they live, as well as their lifestyle. Rather than being a priori opposed to vaccines, vaccine-hesitant parents often ask for an alternative and personalized vaccination schedule; e.g., they may request a delay between vaccine inoculations or the use of monovalent vaccines instead of combined ones (Dempsey et al. 2011).

> So, we have allowed ourselves to make this kind of choice, which is not necessarily everyone's choice or the one that has to be standardized for everyone. Just as in our opinion the preventive vaccine plan does not have to be standardized, neither does the non-vaccine plan. Because these are choices that have to be made with some awareness and by evaluating the whole picture: if a family has the opportunity to live with a particular [healthy] lifestyle, then they can choose to go with a certain [vaccination] approach; in other contexts the risk is different, and it all has to be evaluated differently. (Manuel, *Vaccinare Informati* member)

> Do you make them [vaccines] mandatory? All right, I may be okay with that, but we administer them in a way that I think is suitable [for her children] because it doesn't change [if vaccines are inoculated in monovalent doses rather than combined ones]... The child then eventually turns out immunized, whether I gave him a six-in-one shot or whether I gave him six detached shots eh... So let me do it [monovalent vaccine] because I was able to do it until a year ago. (Noemi, *Vaccinare Informati* member)

As highlighted by Cairns et al. (2013, 1550), when trust in health authorities and their representatives decreases, it "undermines public perceptions regarding their legitimacy to lead public health strategy and policy". Specifically, vaccine-hesitant parents often perceive both the attitudes of healthcare providers and most of the scientific literature available on vaccines as particularly dissatisfying – especially when their vaccine-related concerns are not adequately addressed by scientific experts. In this context, vaccine-hesitant parents might adopt alternative medical practices or information sources (Goldenberg 2021; Peretti-Watel et al. 2015).

6. "Who is this scientific community?": Vaccine-hesitant parents' perception of science and scientific experts

Among the most relevant issues that emerged during the interviews with *Vaccinare Informati* parents are those of the perception of the role of science in society and of the relationship between the scientific community and citizens. In line with other research on this topic (Askvall et al. 2021; Lazarus et al. 2020), this paper has found that respondents do not distrust science. On the contrary, science is perceived as an important resource for society. Indeed, vaccine-hesitant parents emphasise that science does not work on its own; it is both managed by and a part of society. This is in line with a broader shift of focus from "science and society" to "science in society" (Bucchi and Trench 2021): in contemporary societies, the integration between these two spheres has increased to the point that "the development of present society cannot be conceived without the development of science and technology" (Schiele 2021,53).

> I don't have a negative opinion of science [...], but science itself is an instrument of society and it is society that administers it; so it is society that gives meaning to what science says. (Barbara, *Vaccinare Informati* member)

The vaccine issue in the public debate has been characterized by a polarization of positions between science and experts on the one side and "anti-vaccine" and non-expert citizens on the other. As highlighted by Brunson and Sobo (2017, 46) "polarization feeds on itself, further strengthening the perception of a divide". According to *Vaccinare Informati* parents, this represents a clear attempt by part of the scientific community to recreate an "ivory tower", keeping a distance between what is considered scientific and what is not, and imposing an *ipse dixit* approach. The perceived separation between specialists and non-specialists arising from the adoption of a technocratic approach to science communication is especially evident around the issue of vaccines. In contemporary societies, however, the public rarely accepts technologies and innovations uncritically – both experts and non-experts want to, and have the right to, open and probe what Latour (1998) has referred to as "black boxes". Several authors (Callon 1999; Davison et al. 1991; Epstein 1995; Pols 2014) have focused on the role of "lay knowledge" – the counterpart to scientific or "expert" knowledge – in shaping and challenging scientific expertise, especially in health issues. According to Horlick-Jones (2004, 11), these are changes that "are taking place in the very production of knowledge".

> Science arrogates and perches within a fortress of "I know and you know nothing", the distance from the population increases... When medicine, which is not a science but a practice based on scientific knowledge, tries to entrench itself inside a fortress made of "I know and you don't", it moves away from its own field of application, and therefore its destiny is certainly not a prosperous one. (Manuel, *Vaccinare Informati* member)

The parents interviewed for this study believe that science, as well as society, is divided on the vaccine issue: according to them, even within the scientific community, there are different factions that do not allow the issue to be addressed with the seriousness it deserves. According

to those interviewed, a large part of the community of scientific experts – mainly those who have been publicly visible in the media – have displayed arrogant attitudes toward citizens.

> So, in the last two years, I've noticed a difference in the approach [of scientific experts] with people: "you haven't studied, stop, you don't know anything, enough, I'm in charge". From my point of view, this is called dictatorship, it's not called science. (Sara, *Vaccinare Informati* member)

Contemporary societies are described by Beck (1992) as "risk societies" in which people mainly face risks produced by industry and science – i.e., "manufactured risks". In this context, the main cultural focus on risk undermines conventional definitions of expertise: even if expertise might be considered authoritative and objective, "the nature of risk tends to undercut claims made about its authoritative understanding" (Horlick-Jones 2004, 110). As highlighted by Callon (1999), the core of the issue concerns the broader forced separation between science (specialists) and society (non-specialists). The concept of "expert" and what is considered "expert knowledge" are conventions that can change depending on the socio-cultural context. Thus, merely recognizing a role for expert knowledge does not oblige people to accept "the immaculate conception of expertise" (Turner 2001, 146). This is in line with the phenomenon of the "secularisation of the public image of science" (Bucchi and Neresini 2006, 39) whereby, while recognizing the usefulness and importance of science, people no longer accord it a special, quasi-sacred status. *Vaccinare Informati* parents perceive science as dogmatic and that it privileges mainstream scientific positions. They believe that science should be based on doubt(s), continuous research, and a plurality of positions, and they stress "the particularity and partiality of 'science'" (Leach and Fairhead 2007, 24).

> I believe that at the scientific community level, of published research, there is a plurality of ideas. The problem is that this plurality is denied at the level of communication. (Barbara, *Vaccinare Informati* member)

> Inevitably three-quarters of the time a study comes along later that says the opposite of what was said in a previous study. And on this, I challenge people of science to say that this is not true. To pass science off as dogma is the death of science: science is not dogma, it is doubt and trying to figure out whether that doubt is true or not in order to take a step forward... And this is missing in the discussion of science, in my opinion, there is only verbal aggression against those who are not aligned. (Davide, *Vaccinare Informati* member)

The interviews conducted highlight that the contemporary problem "is not mistrust in scientists but, rather, a problem in deciding who the scientific experts really are" and, consequently, which expert can be trusted (Shapin 2004, 46). Indeed, parents and a doctor raised several doubts regarding the identification of the scientific community, and those who are part of it.

> On television and in the media there are references to this scientific community and no one until now has been able to define its component parts. That is, who is this scientific community?... Who are they [its constituents]? (Bruno, *Vaccinare Informati* member)

> They [mainstream scientific experts] think they have science behind them, but this science, this weird halo, who is it? I have scientific publications in international journals, I have many [academic] titles; however, I say, "I don't think the vaccine is the right thing". "Ah, [but] that's not scientific…". So, what the scientific community lacks is not the competence or the medical knowledge, but the commitment to criticism and self-criticism: they take for granted that they are the depositaries of scientific knowledge. (Paolo, general practitioner)

When science is recognized as having epistemic authority – i.e., a source on which people can rely to acquire knowledge – on a topic such as vaccination, it "may override all else" and significantly influence people's attitudes and behaviours on that topic (Kruglanski et al. 2005, 352). Furthermore, as highlighted by Suldovsky (2016, 420), "when science is selected or assumed as the epistemic authority… the deficit model is sure to follow", thus leading to top-down and unidirectional communication from "an epistemic authority (scientists) to a knowledge-deficient audience". However, it should be noted that people can trust science – its methods and principles – but not its institutions and their representatives (Bory et al. 2022; Huber et al. 2019). This is a matter of epistemic trust (Goldenberg 2021), i.e., trusting a person or an institution as a source of knowledge. This implies an epistemic dependence of trustors on the trustee's goodwill, thus exposing the former to the risk of being deceived or damaged (Wilholt 2013). Therefore, as in the case of vaccine, it is not straightforward to trust scientific experts when their actions and opinions can have a direct impact on people's own health (Crease 2004). Further, much of citizens' understanding of vaccinations is based on epistemic trust and having no or low trust in experts and their institutions can lead to vaccine hesitancy (Goldenberg 2021).

Public debates on scientific topics, such as vaccinations, often raise social, moral, and regulatory issues that go beyond scientifically based solutions (Scheufele 2013). Furthermore, due to the communication strategies of mass media (Bucchi 2000), the debate on vaccinations is often politically oriented rather than purely scientific. Indeed, despite vaccines often being portrayed as an incontrovertible and neutral public good, they are instead tied up with (bio) politics, "with struggles over status, authority and value" (Leach and Fairhead 2007, 2). The interplay and at times overwhelming plurality of quasi-scientific interests – largely driven by political and economic concerns – within the scientific community is one of the main concerns among the interviewees. According to Leonardo, this interpenetration of interests has privileged mainstream scientific literature in favour of vaccines, a unidirectional approach further entrenched by the lack of public funds allocated to vaccine-related research.

> For sure, what I've seen in recent years is that, unfortunately, what dominates in this so-called scientific environment is not the so-called science because… unfortunately for many many years now, scientific research is funded almost exclusively by private interests – pharmaceutical companies in this case, or even by others… This means that over many years, a body of studies and scientific work in favour of vaccines has built up that is almost unbeatable, let's say, that is going in one direction. While before, when there was a little freedom and public funding, there were studies in both directions. (Leonardo, *Vaccinare Informati* member)

The role of the government in the vaccine issue – that should be that of "a desired regulator of the industry and protector of citizens" (Numerato et al. 2019, 92) – is often perceived by vaccine-hesitant citizens as piloted by pharmaceutical industries. Furthermore, the complex – and sometimes non-transparent – links between science, politics, and private organizations can increase the perception that scientists (as well as political and economic actors) are favouring their own interests at citizens' expense (Goldenberg 2021; Ivani and Dutilh Novaes 2022). In this regard, *Vaccinare Informati* members believe that there is a lack of transparency in the scientific field and that science is as corruptible as the political sphere.

> There is a structural problem... that is given by the fact that scientific research is not done in a linear and clear way and, as you might think, that a researcher stands there and says, "Now I'll do an experiment and let's see where it takes me". They [the studies] start largely from the funding that is given and those who have the money are the big groups. (Tiziano, *Vaccinare Informati* member)

Today, science is perceived as both positive and "uncertain, sometimes irresponsible and above all bearer of particular interests" (Bucchi and Neresini 2006, 40). The increasing importance of the conflicts of interest issue is a feature that characterizes contemporary societies (Beck 1992). The issues raised cannot be merely reduced to an anti-science stance: critics of unethical pharmaceutical company practices – such as obscuring data or non-publication of negative results, as well as their influence on the medical and political sector, have been reported on in the literature (Angell 2005; Gøtzsche 2013; Sismondo 2018). Furthermore, the strong presence of economic and political interests in guiding scientific research is part of the broader scientific debate on "research integrity" (Ampollini 2018)[10]. Scientific institutions and their representatives cannot simply assume that "they should be trusted; instead, trust must be earned and maintained" (Goldenberg 2021, 170). When institutions and their representatives insist on promoting the narrative of a value-free science, scientific expertise and authority can be compromised rather than legitimized (Kitcher 2011a, 2011b; Latour 2015).

7. Discussion

This paper has presented qualitative data collected during an exploratory case study conducted in Trentino (Italy) on a group of organized vaccine-hesitant parents in 2018. Particularly, the paper focused on vaccine-hesitant parents' perception of the science and society relationship following the enforcement of Italian childhood vaccination mandates (Law No. 119/2017). The new childhood vaccination requirements have impacted those who do not comply with the mandates, especially vaccine-hesitant families in Trentino, where local authorities have adopted a more intransigent approach to non-compliance, increasing the sanctions already provided in national law. The study integrated the perspectives of vaccine-hesitant parents with the perceptions of a group of physicians on the introduction of mandatory vaccination and its implications for the doctor-patient relationship.

The analysis of Trentino's case study highlighted four main issues. First, vaccine-hesitant parents' relationships with (health and political) institutions and scientific experts have deteriorated due to the (total or partial) absence of an open and constructive dialogue. Particularly, trust and communication challenges increased following the introduction of Law No. 119/2017. Such deterioration is also evident in doctor-patient relationships. Indeed, according to both the parents and physicians interviewed, mandatory vaccination and its sanctions have further eroded the dialogue that had been built over the years between vaccine-hesitant parents and paediatricians. Since the introduction of the law, *Vaccinare Informati* parents perceived a change in their relationship with healthcare professionals when addressing the vaccine issue, a relationship now guided by paternalistic and unilateral communication. However, vaccine-hesitant attitudes emphasize "legitimate doubts and concerns about vaccines" (Dubé et al. 2021, 177), which should be recognized as such. These doubts and concerns should be carefully considered not only by healthcare professionals but also in the design of public health interventions. This implies a change in perspective that might allow vaccine-hesitant parents to be recognized as "exemplars of medically engaged patients, even if not necessarily compliant ones" (Gottlieb 2016, 160). Rather than being guided by ignorance and lack of education, vaccine-hesitant parents are continuously searching for information and questioning scientific experts and how vaccine safety is promoted. In line with Carrion's (2018, 320-321) research, the vaccine-hesitant parents interviewed in the case study are experiencing the "paradox of patient advocacy": even if the "critiques of the social and political practice of science also reflect dominant critical and postmodern perspectives" and are generally recognized as valuable in other health contexts, vaccine-hesitant parents' advocacy is often harshly criticized and marginalized.

The second issue highlighted by the case study is the contrast between compulsory vaccination on the one hand and parents' demands for freedom of choice and exemptions on the other. This contrast is not based on divergent values: it stems from a different interpretation of the same value (Zuolo 2013) – i.e., a different perception of what guides and should guide individual and collective health practices. Vaccine-hesitant parents are particularly concerned about monitoring their children's health and adopting health-related practices – including vaccination – that are highly personalized. This approach is in line with the broader shift toward increased personalization of medical care. Within this perspective, vaccine-hesitant parents should be recognized as engaged and reflexive patients (Numerato et al. 2019), rather than problematic and disregarded interlocutors. This implies the need for a critical examination of the standard definition of a "good patient" as the one who complies without questioning scientific expertise (Gottlieb 2016, 160). However, vaccination campaigns that support the introduction of vaccination mandates are often based on the assumption that compliance is the single correct public response to health communication strategies. This implies a loss in the variety of public responses (Manyweathers et al. 2020). It also implies that those patients that are not fully compliant will either be ignored or easily misinterpreted (Davis et al. 2015). By rejecting or deriding vaccine-hesitant parents' concerns, the media, and other key actors – such as policymakers, scientists, and healthcare professionals – have often contributed to fuelling the vaccine hesitancy phenomenon (Goldenberg 2021; Ivani and Dutilh Novaes 2022; Navin 2015).

Third, the case study results show that vaccine-hesitant parents interviewed trust science and the scientific method. However, what is contested by these parents is the authority of

scientific experts – especially those who were visible in mainstream media – and their institutions. On the vaccine issue, *Vaccinare Informati*'s members believe that the scientific community lacks transparency regarding its members, existing conflicts of interests (political and economic), and research integrity issues. Furthermore, according to these vaccine-hesitant parents, the scientific community is detached from society, and this is further exacerbated due to a dogmatic top-down communication that does not allow dissent. Several authors (Fischhoff 2012; van der Bles et al. 2020) highlight that, usually, scientific experts – especially those advising public policymakers (Moore and Mackenzie 2020) – do not publicly communicate the uncertainty related to their findings. Indeed, the underlying assumption is that scientific experts need to provide certainties to the public to maintain authority and credibility. On the contrary, "this lack of transparency could potentially compromise important decisions people make based on scientific or statistical evidence" (van der Bles et al. 2020, 7672) – including vaccine-related decisions. The case study shows there is still a long way to go for science, scientists, and healthcare professionals to get closer to vaccine-hesitant citizens. As highlighted by several authors (Brunk 2006; Goldenberg 2021; Wynne 2006), citizens' opposition to science-based policy is often explained following the deficit model approach. Indeed, policymakers, healthcare practitioners, and scientists often see citizens as passive knowledge recipients rather than "exchange partners" whose opinions and concerns deserve to be considered (Goldenberg 2021; Ivani and Dutilh Novaes 2022, 54). Hence, there is still a need for a:

> shift to a model of knowledge co-production in which non-experts and their local knowledge can be conceived as neither an obstacle to be overcome... nor an additional element that simply enriches professionals' expertise... but rather as essential for the production of knowledge itself. (Bucchi 2008, 68).

Fourth, this case study highlights the need for an improvement in the dialogue between institutions and vaccine-hesitant parents' associations. As Ceva (2013, 71) points out, one of the priority challenges facing democracies is the "reconciliation of minority instances of dissent". In contemporary societies, highly complex issues – such as those involving vaccines – are increasingly evident, challenging the current forms of political decision-making and democratic representation as well as how expertise is understood and defined. Political, health and scientific institutions should maintain an open dialogue with vaccine-hesitant parents and, especially, with the associations that represent them. Indeed, through their members, these associations can reach all those individuals who have doubts about vaccines and/or vaccination policies either directly or indirectly, offering different types of support to the vaccine hesitant. Involving these associations in the institutional discussions is important to fully recognize, understand, and try to address the doubts and concerns of vaccine-hesitant citizens. Involving citizens – or the associations that represent them – regardless of their positions on the vaccine issue could mitigate the social divisions currently exacerbated by a dualistic and simplistic division of the vaccine debate. When dealing with the vaccine hesitancy issue, institutions need a science communication strategy that is capable of going beyond paternalistic reassurances about the safety of vaccines and can consider the heterogeneity of attitudes that constitute the vaccine hesitancy and the relevance of alternative (parental) expertise.

Notes

[1] www.who.int/news-room/feature-stories/ten-threats-to-global-health-in-2019.

[2] The WHO (2019, 2) defines an adverse event following immunization (AEFI) as "any untoward medical occurrence, which follows immunization and which does not necessarily have a causal relationship with the use of the vaccine. The adverse event may be any unfavourable or unintended sign, an abnormal laboratory finding, a symptom or a disease".

[3] Law No. 119 of 31 July 2017, published in the Official Gazette No. 182 of 5 August 2017. This regulatory intervention is part of a broader national plan – National Plan for Vaccine Prevention 2017-2019 – and international strategy – i.e., the Global Plan for Vaccination 2011-2020 and the European Vaccination Action Plan 2015-2020.

[4] Mandatory vaccines from the 1960s to the 1990s: anti-diphtheria, anti-tetanus, anti-polio, anti-hepatitis B.

[5] Mandatory vaccines starting from 2017 (in addition to those required prior to 2017): anti-measles, anti-rubella, anti-pertussis, anti-mumps, anti-varicella, anti-*Haemophilus influenzae* B.

[6] Resolution of the Provincial Council of Trento no. 322 of 2 March 2018.

[7] Resolution of the Provincial Council of Trento no. 547 of 9 April 2018.

[8] The Autonomous Province of Trento (2016) *Vaccinare informati, appello ai consiglieri provinciali*. Available at: https://www.consiglio.provincia.tn.it/news/giornale-online/Pages/articolo.aspx?uid=178481 (retrieved July 25, 2022); The Autonomous Province of Trento (2018) *Libera scelta vaccinale: i comitati dai consiglieri provinciali per rilanciare la battaglia*. Available at: https://www.consiglio.provincia.tn.it/news/giornale-online/Pages/articolo.aspx?uid=179553 (retrieved July 25, 2022); The Autonomous Province of Trento (2018) *L'associazione Vaccinare Informati nuovamente ascoltata dai consiglieri*. Available at: https://www.consiglio.provincia.tn.it/news/giornale-online/Pages/articolo.aspx?uid=179555 (retrieved July 25, 2022).

[9] Federazione Nazionale degli Ordini dei Medici Chirurghi e degli Odontoiatri (FNOMCeO).

[10] Research Integrity refers to research characterized not only by the sharing of common working principles and by the presence of virtuous and positive ethical attitudes – on the part of those who conduct, evaluate and fund research – but also free of misconduct (such as plagiarism and falsification of data).

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The AstraZeneca *affair*. How the junk news regime affected the public debate on the COVID-19 vaccination controversy in Italy

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Abstract

In recent years, there has been a notable increase in the presence of techno-scientific issues within public discourse, particularly during the COVID-19 pandemic. This proliferation has been attributed to the pervasive attention economy, which drives actors in hybrid media ecosystems to seek attention-grabbing topics. Socio-technical issues, known to evoke strong emotions like outrage and rivalry, have become recurring themes in both news and social media discussions. However, the regulatory mechanisms of the attention economy often impede the full exploration of these controversies in the public sphere, as news cycles and audience attention accelerate due to the prioritization of engaging content on social media platforms. This trend towards attention-driven content has compelled news organizations to adapt their business models, resulting in an environment where citizens may rely on confirmation bias, ultimately leading to polarization of public opinion. Consequently, effectively addressing controversies in today's public debate has become increasingly challenging. To understand the extent of influence exerted by junk news – a transient form of content that distracts rather than nourishes public discourse – we conducted a case study focused on the controversy surrounding the adverse and lethal side effects of the AstraZeneca COVID-19 vaccine during the vaccination campaign in Italy. Our analysis, based on a comprehensive dataset of 798,954 tweets and 31,169 news articles spanning a six-month period, reveals three interconnected information disorders. Firstly, the vaccine debate displayed a relatively stagnant progression punctuated by sporadic spikes of attention. Secondly, the peaks of the debate involved sensationalized coverage in journalism and amplified discussions on Twitter, primarily centred around suspected vaccine-related deaths. Lastly, reports of these deaths by legacy media accounts on Twitter correlated with an increasing ideological and partisan reaction from social media users over time, contributing to polarization. These findings shed light on how the junk news regime can impede the shaping of public debates, particularly on contentious socio-technical issues such as vaccination campaigns. The implications of this research extend to the broader understanding of public engagement with science and the challenges posed by attention-driven media ecosystems.

Keywords
public debate; socio-technical controversies; junk news; vaccination campaigns; COVID-19; AstraZeneca; digital methods.

1. Introduction

Since the 2000s, and even more so during the COVID-19 pandemic, several studies have pointed out an increasing proliferation of techno-scientific issues in public debate (Bucchi and Mazzolini 2003; Marres 2007; Pulido et al. 2020; Fleerackers et al. 2022). According to the perspective of the "attention economy" besides goods or services scarcity, also the attention of individuals can be framed as a scarce resource (Simon 1971). In this context, attention is considered a valuable commodity, and businesses and organisations compete for it to promote their products, services, or ideas. The journalism industry has been heavily impacted by the attention economy. With so many different sources of information available to consumers, it can be difficult for traditional news organisations to capture and hold the attention of their audience.

Indeed, influenced by the pervasive attention economy, the actors of hybrid media ecosystems (Chadwick 2017) are constantly and relentlessly looking for topics that can attract and retain attention (Venturini and Munk 2021). In this atmosphere, socio-technical issues can promote high-activation feelings, such as outrage and rivalry, which are very effective in capturing attention (Nguyen and Catalan-Matamoros 2020). As a result, controversies tend to be recurring central themes both in the news and social media's discussions.

Nevertheless, the regulatory mechanisms of the attention economy simultaneously hinder the public unfolding of these very same socio-technical controversies. Indeed, one of the main lateral consequences of the attention economy is the acceleration of both news cycles and the related audience's attention towards topics and issues (Lorenz-Spreen et al. 2019). A further perspective that informs the analysis of these phenomena is the "public arenas" model, as it has been also recently mobilized in public communication of science literature (Neresini et al. 2023; Neresini et al. 2019; Dudo 2015). According to Bosk and Hilgartner (1988), public arenas arise when various stakeholders, including scientists, policymakers, interest groups, and the public, engage in debate and struggle over the meaning and implications of scientific findings. These stakeholders often hold divergent perspectives, interests, and values, and they may have different levels of expertise and authority. Public arenas provide a platform for these stakeholders to voice their concerns, challenge established norms and practices, and seek to influence the policymaking process. Broadly speaking, public arenas can arise also across media ecosystems when a particular issue or controversy gains significant media attention and generates widespread public debate and discussion. This may happen, for example, when a news story or investigative report raises ethical or social concerns, or when a social movement gains traction and captures the attention of the media and the public. The result has been that many news organisations have shifted their focus towards creating content designed to grab and hold the attention of readers or viewers, often at the expense of more in-depth or investigative reporting. This trend towards attention-grabbing content has been fuelled in part by the rise of social media platforms, which prioritise content that generates the most engagement and sharing. As a result, a lot of news organisations have been forced to adapt their business models to compete in this new attention-driven landscape.

Against the current backdrop, it is worth noting that news circulating through media ecosystems are not necessarily trustworthy or based on reliable sources (according to the prevailing scientific demarcation criteria). Considering the increasing pluralization of information sources,

especially online based, that may deliberately produce inaccurate or fraudulent news (Bory et al. 2022; Crabu et al. 2023), it is relevant to ask what the returns are for the public. This acceleration in the formation and dissolution of public arenas may force citizens to rely on confirmation bias and, as a result, could create the basis for the polarisation of public opinion (Del Vicario et al. 2017). Therefore, even if controversies are spreading more widely and more rapidly than ever before, it seems increasingly difficult to address them effectively in today's public debate.

Drawing on these considerations, we seek to understand how and to which extent certain regime of news, that can be labelled as junk news (Castaldo et al. 2022), may influence the public debate concerning socio-technical controversies. Indeed, junk news are contents that are built to fade away as quickly as they rose; as a results, they distract public debate rather than nourishing it (Id). Junk news can be considered an example of information disorder, an umbrella term that encompasses misinformation, disinformation and malinformation that affects quality of news available across media ecologies (Wardle and Derakhshan 2017). To achieve this aim, we selected a representative case study: the controversy that arose during the COVID-19 vaccination campaign in Italy. The case in question is that of the adverse and lethal side effects of the AstraZeneca vaccine that affected very few people worldwide (Liu et al. 2021).

More precisely, our analysis seeks to highlight how the junk news regime could hamper the shaping of public debates, especially when such debates concern controversial socio-technical issues (e.g., vaccination campaigns). To achieve this objective, we collected 798,954 tweets and 31,169 news articles related to the adoption of the AstraZeneca COVID-19 vaccine in Italy for a period of six months (1st January 2021 – 30th June 2021). Our analysis reveals three different but intertwined information disorders: first, the vaccine debate exhibited a flat progression with a few condensed spikes of attention (acceleration); second, the two main peaks of the debate involved both journalistic coverage and Twitter discussions generated from news and social media's hypes of the suspected deaths related to AstraZeneca (sensationalisation); finally, the reports of suspected deaths by legacy media accounts on Twitter correlated with an increasing ideological and partisan reaction from social media users over time (polarisation).

2. The Italian context for vaccination campaign against COVID-19: information disorder and connected processes

The vaccination campaign against COVID-19 started in Italy in the last days of December 2020 and expanded to the whole national population from late February 2021. In early March, some cases of possible strong adverse reactions to the vaccine patented by AstraZeneca were first reported. As a result, the government decided to stop the campaign (from 16th – 19th March) and restarted it only after the Italian Drugs Agency certified the absence of any link between the signalled deaths and the seized AstraZeneca vaccine batches. However, a few weeks later (April 7th) the European Medicines Agency published a document that confirmed a weak correlation between rare thrombosis and AstraZeneca, suggesting the vaccine's use only for the part of the population older than 60 years. Following the EMA's warning, the Italian vaccination campaign resumed by prioritising the over-60s, but left unaffected the possibility of using AstraZeneca, previously renamed Vaxzervria, also for younger citizens. In

late spring, after participating in an open vaccination event, an 18-year-old girl died in Genoa from a rare thrombosis linked to AstraZeneca. The day after this dramatic event, the administration of AstraZeneca vaccine stopped for anyone under 60 years old (June 11th).

From an empirical viewpoint, the AstraZeneca *affair* can be identified as an exemplary case to explore how controversies unfold in contemporary hybrid media ecosystems and how the junk news regime could affect public debate concerning socio-technical issues.

To study whether and how such junk news regime may have influenced the public debate on the AstraZeneca vaccine, we have chosen to study three different processes related to information disorder that may arise from this regime. Indeed, information disorder refers to a broad category of processes related to the circulation, consumption, and interpretation of information in digital and online contexts. It encompasses a range of problems concerning the effects of these processes on the quality of public debate (Wardle and Derakhshan 2017). It is easy to recognize these features in the selected case study; the whole analysis takes into consideration three processes connected to information disorder.

The first process of information disorder that we want to analyse is that of the *acceleration* of public debates (Castaldo et al. 2022). The junk news regime could indeed result in a constant but scarcely followed day-to-day journalistic coverage, which, however, is disrupted by sudden accelerations in both the production of news and the specular conversations on social media.

A second process of information disorder we will investigate is the *sensationalisation* of information and discussions. As argued by Bosk and Hilgartner (1988), the formation and dissolution of public arenas exhibit a characteristic temporal pattern, whereby the dramatisation of events is essential to keep audiences' attention on a given topic. Since different social problems are constantly competing for attention, within the junk news regime a particular issue may only emerge when it is over-dramatised.

Finally, a last process of information disorder associated with the junk news regime is the *polarisation* of public opinion. By saturating online public debate with continuous bursts of sensationalist news and messages, the junk news regime leaves little time to discuss each of them (Venturini 2019). This dynamic creates the basis for the use of heuristic shortcuts and confirmation bias in the discussion of an issue. Consequently, partisan or ideological positions are often used to maximise newsworthiness or visibility, but these strategies may lead to the polarisation of public opinion.

Starting from the above discussed processes driving to information disorder, in this article we will map the AstraZeneca controversy using a digital methods approach (Marres 2015; Bounegru et al. 2018) and subsequently we will discuss how its news cycle obstacle the formation of a stable public arena in which to properly discuss such a crucial socio-technical issue.

3. Research Design and operationalization of information disorder processes

To investigate the debate around AstraZeneca we decided to collect all the online news and tweets in Italian referring to the vaccine for a period of six months (1st January 2021 – 30th June 2021). Within the many social media, we decided to focus on Twitter for two different reasons. First, Twitter had one of the most rapid and expansive growth in social media's usage

during the initial phase of the pandemic (+34% as for 2020 official report), mainly due to the influx of new users seeking a digital arena where to discuss issues related to COVID-19. Secondly, we focused on Twitter because of its peculiar news-driven nature (Kwak et al. 2010).

We utilised the Twitter v2 search API to obtain 798,954 Italian tweets containing the terms "AstraZeneca", "Astra Zeneca", or "Vaxzevria". Concurrently, we collected 31,169 news articles from the repository "Explorer | Media Cloud" using the same keywords and language parameters. This dataset includes the titles and URLs of news articles produced by 143 distinct Italian journalistic websites, including newspaper, newscasts, radio, and natively digital blog. It is worth noting that "Explorer | Media Cloud" includes all the major news websites in the country.

To examine the progression of the AstraZeneca controversy, we first analysed the flow of information overtime. We determined the temporal distribution of both tweets and news, which enabled us to identify the *peaks* of attention refer to periods of heightened activity and interest surrounding a particular topic or event (Boydstun et al. 2014). Researchers identify important events or turning points in a given discourse or narrative and can provide insight into how information spreads and evolves over time in different media channels (Id). To identify these peaks, we utilised a well-established formula and identified any time point with a residual value greater than two times the standard deviation of its time series residuals as a spike (Blázquez-García et al. 2021). In the case of news, a peak was identified as a distribution of more than 300 news articles per day, while on Twitter peaks must exceed 25,000 tweets per day. Based on this calculation, the peaks of attention were identified as occurring from 11th – 12th March, from 15th – 18th March, and from 10th – 11th June.

To detect a possible process of sensationalisation we decided to circumscribe a sub-sample of the Media Cloud dataset using some specific keywords (namely "morta/e/i/o"; English translation: "death/s"). This allowed us to select 2332 news items. In this term, the general claims that vaccination is equal to deadly risks produced a diverse set of news. These articles range from the reports of suspected deaths ("*Dead after vaccine, experts: Correlation between dose and death*"[1]), to debunking pieces ("*So does the AstraZeneca vaccine really cause fatal thrombosis? For now, the answer to keep in mind is no. But, says the EMA, the possibility exists. Here's why*"[2]), to pure click-baiting news ("*Died after Astrazeneca vaccine, her life worth 70K*"[3]). It should be said that actual deaths connected to vaccines were very few – roughly in line with other typology of vaccines, such as the mRNA ones – and that this scientific information was available at the time of the vaccination with AstraZeneca (Liu et al. 2021). In other words, most articles reporting deaths linked to AstraZeneca did so in a communication context in which it was very clear, according to the available scientific evidence, that the vaccine was safe enough. So, to our research goal, we can use the interest in (mostly spurious) deaths as a marker (or proxy, in other words) for sensationalism.

To test a possible correlation between Twitter attention spikes and the news subsamples we calculated their Pearson coefficient[4]. In addition, we also performed a Granger causality test[5] to see if there is evidence of a statistical cause-to-effect direction between any of the three considered distributions (i.e., tweets, total news, news about deaths).

A last point of interest in our study concerns the potential polarisation of the public arena. To operationalize this concept, we relied on the networked reaction of Twitter's users as a proxy for the polarisation of the debate. Due to the extensive nature of the conversation on

Twitter, a comprehensive quali-quantitative mapping would have resulted in an overwhelming and unproductive outcome. Therefore, we opted to focus our analysis on the specific topical moments related to the AstraZeneca *affair*, namely the peak weeks of March and June.

To disentangle the communities of users involved in the AstraZeneca controversy we leverage on retweet networks. This choice entails an assumption, namely that retweeting something means, most of the time, an endorsement of the original tweet. While some Twitter users routinely state that "retweeting is not endorsement" there is substantial empirical evidence of the contrary (Metaxas et al. 2015).

Starting from this assumption, to get a rough measurement of ideological affinities within the retweets networks we implemented a visual network analysis with Gephi (Bastian et al. 2009) using the output of its force-directed layout to intercept the emergence of homogeneous communities (Jacomy et al. 2014). A force vector layout works according to a physical analogy: nodes receive a repulsive force that pulls them apart, while edges act as springs that bind the nodes they connect. In a network spatialized by forces spatial distance acquires meaning. Indeed, two nodes are closer the more directly or indirectly connected they are. Spatialization of forces can effectively re-materialize notions of graph mathematics. It was shown, for example, that visual clustering in networks spatialized by forces is directly equivalent to clustering with modularity algorithms. Centrality, betweenness, diameter, density, structural separation, and many other concepts recover their graphical meaning. They cannot only be calculated, but graphically visualised (Venturini, Jacomy and Jansen 2021).

Finally, the 500 most shared tweets were selected and manually analysed to further triangulate the computational results with richer and deeper qualitative insights. While five hundred tweets may seem a small sample it should be said that retweets are distributed in the discussion following a typical power-law distribution. In our specific case the Gini index[6] measuring retweet concentration is 0.76 for the entire period – meaning that a few selected voices have control over the framing of the debate on Twitter (Barberà and Rivero 2015) – and hence legitimise the choice of a close reading of the top messages instead of using computational techniques to model or classify all tweets.

4. Results

By using news and tweets timestamps we depicted the general temporal trend, and we intercepted either the pace and the possible accelerations in the production of journalistic pieces or tweets. Assuming that Twitter discussions are eminently event-based, it was of paramount importance to detect the peaks of attention and their relative position in both social and legacy media trending curves. To ease interpretation, while accounting for the fact that social and legacy media have different throughput capacities (i.e., the former is being measured in tens of thousands of tweets while the second in hundreds of news), we have normalised volumes in rank order to compare the time series on a common scale.
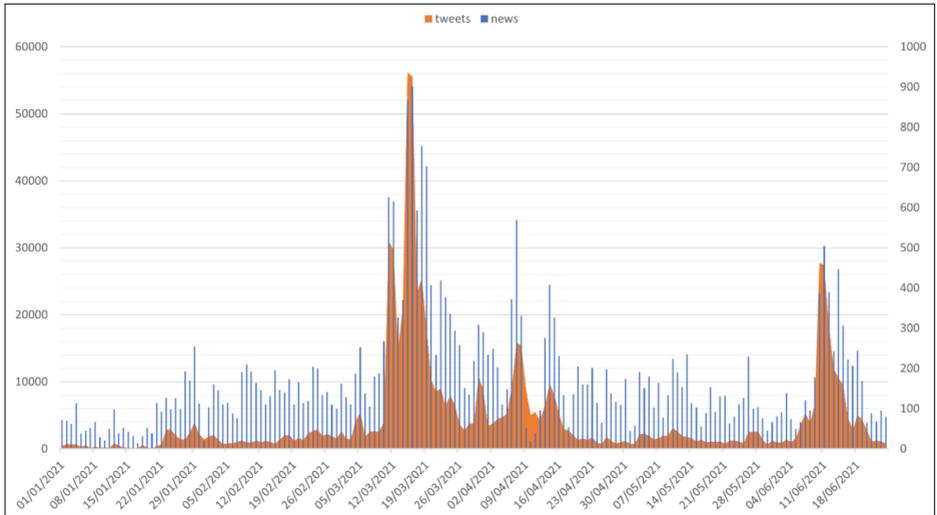
Figure 1.
Tweets (left axis) vs news (right axis)[7].

By comparing Twitter and Media Cloud time series it is possible to distinguish different patterns on the attention paid to AstraZeneca vaccine. As shown in Figure 1 the debate on AstraZeneca shows a fluctuating progression all over the six months we considered.

A first relevant finding when comparing news and tweets is that legacy media coverage of AstraZeneca is more evenly distributed than Twitter discussions. Indeed, on average, we can count about 150 news articles per day (roughly 0.5% of the total) with a maximum coverage of 901 items in a day (around 3% of the total). Conversely, on average 4,565 tweets per day are published (again 0.5% of the total), but the day of highest activity contains 56,264 tweets (14% of the total). These insights are also supported by the Gini index calculated on the concentration of news and tweets per day, that corresponds respectively to 0.52 and 0.81.

In the light of these two initial findings, we can argue that in the case of Twitter it occurred a flat progression interrupted by three rapid accelerations of the debate during the "peaks" of attention. An equivalent acceleration, instead, is less visible for legacy media. However, also in this case few events seem to attract a considerable part of the production effort concerning news coverage of the AstraZeneca vaccine.

Having assessed the different rhythms at which messages travel on news sites and Twitter, we want to assess a possible sensationalisation of the controversy surrounding the debate about vaccine safety.
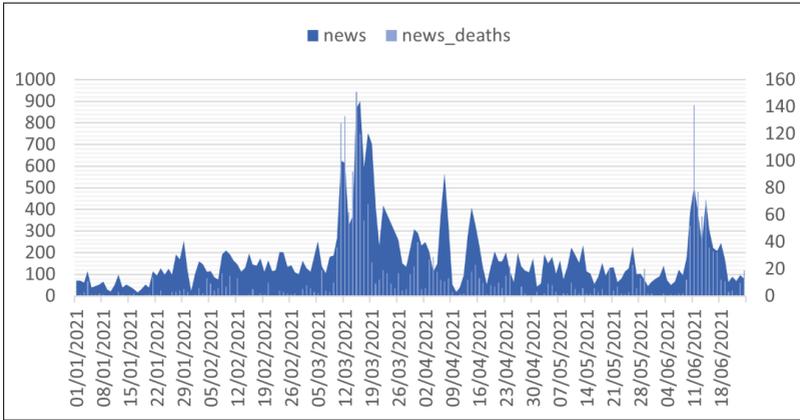
Figure 2.
News about AstraZeneca (left axis) vs. news about suspect deaths (right axis).

Figure 2 compares press coverage for the totality of AstraZeneca news and for the subset of news about the death links. In March and June peaks the stories about suspect deaths take a central stage, appearing respectively in 15% and 20% of total headlines. On the contrary, the smaller spikes in attention of April's seems to be generated by a long tail of the diatribe regarding the optimum age range in which to administer the vaccine. Indeed, between April 6th and 8th, it was firstly issued a rumour on the possibility of administering AstraZeneca only to people over 60 years and then it was reported the official EMA communication about the correlation between rare thrombosis and the vaccine.
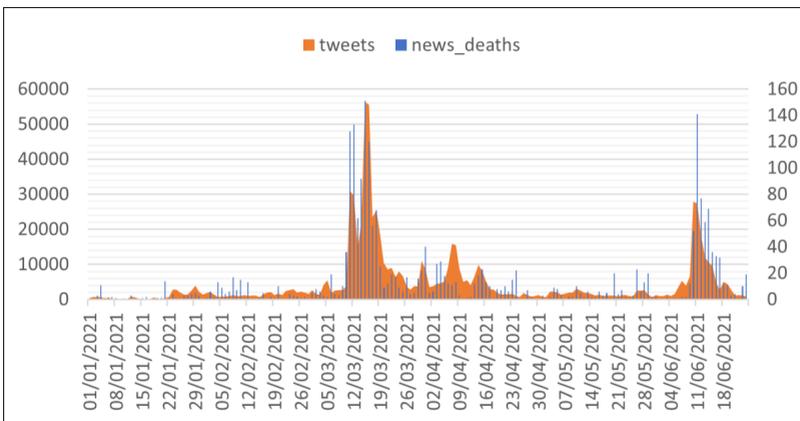
Figure 3.
Tweets (left axis) vs news about suspect deaths (right axis).

Figure 3 shows that in the context of Twitter, the attention toward AstraZeneca issues is higher and more concentrated on periods in which journalistic outlets reported the stories of suspect deaths. A specular interpretation is that news coverage about the deaths follows the hype on this issue in Twitter. To find which one of the two hypotheses would have been more accurate we perform a Granger causality test, but we did not find any evidence of a robust statistical cause-to-effect direction. Nevertheless, correlation is higher for Figure 3 (i.e., "tweets vs. news reporting deaths" equal to 0.89) than for Figure 1 (i.e., "tweets vs. news" equal to 0.78).
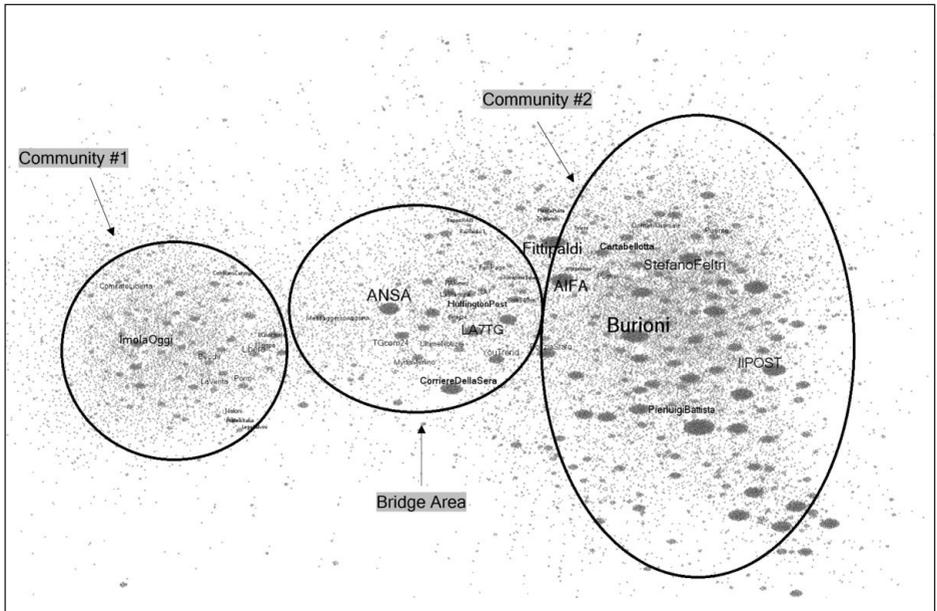
Figure 4.
11th − 19th March retweets network visualisation.

A last point of interest for our analysis concerns the potential polarisation of the digital arena.

By looking at the forced-directed network visualisation in Figure 4, it is possible to notice how, during the first peak of March, the discussion on Twitter is divided into two distinguishable communities with a less dense bridge-area in the middle. Each node represents a user, while an arch between two nodes, whose value is unitary, indicates a retweet of a specific tweet by the user to whom the arc is directed. To visualise and analyse the data we used Gephi (Bastian et al. 2009), an open-source software for the analysis and treatment of social networks. The image reported was obtained using "Force Atlas 2" visualisation algorithm (Jacomy et al. 2014). The size of the labels is proportional to the number of retweets received.

The first community is located on the left of Figure 4 and is composed of both a few newspapers and politicians belonging to the Italian right-wing parties, as well as openly no-vax users.

The second community, on the right, is instead composed of a multiplicity of different types of accounts. The most retweeted users are major Italian newspapers and television channels, the official pages of the Italian Police and of the Italian Drug Agency, and a wide variety of opinion leaders consisting of physicians, scientists, and journalists.

Finally, a last and smaller bridge group is located at the centre-right of the scheme. This group is made up of legacy media pages. Its position suggests that they should have been retweeted by users of both the two opposite graph areas.

Digging deeper into more details, the discourse that can be traced through the analysis of the most shared tweets confirms a polarisation not only at the structural network level, but also with regard to content.

Within Community #1, it is possible to trace two different discursive matrices. The first and most evident is what we could define as a "no-vax" narrative, which is defined by an open accusation against the "powers that be" (i.e., Italy, Europe or drug firms), who, aware of the risks or damages, want people to be vaccinated anyway.

> The very harsh words of Mrs. Battaglia's son: My mom was fine, she was healthy! Two days after the AstraZeneca vaccination she went into a coma from cerebral thrombosis. The state cannot use human beings to experiment with something like this.[8]

> The #AstraZeneca issue is simple: if the vaccine is safe and it's a trade war against Britain for the EU, it's a huge scandal. If the vaccine is not safe and the Swiss were right not to put it out there, it is an even bigger scandal for the EU.

A second narrative within this community is carried out by right-wing politicians and is based on an invective discourse against the Italian government considered guilty of having made a mistake in the choice of vaccine administration to the point of causing deaths.

> #FratelliD'Italia calls for Health Minister Roberto Speranza to come immediately to Parliament to report on the #AstraZeneca affair. Citizens demand and deserve transparency and clear information. We cannot afford to leave Italy in uncertainty.

Regarding Community #2, as already suggested by the recognition of its users, the discourse is more jagged. First, there is a discourse led by newspapers, which after reporting the suspect deaths continue to update this storyline.

Other tweets concern the official announcements of the stop in the administration of the AstraZeneca vaccine which are posted by institutional accounts such as the Ministry of Health and the Italian Drugs Agency.

> Piedmont suspends AstraZeneca vaccine administration following the death of a teacher a few hours after the drug was inoculated #ANSA.

> All reservations with #AstraZeneca vaccines have been suspended with immediate effect until further notice from AIFA. For those who have already booked we will send an SMS to inform them about it.

Finally, the last and most prevalent discourse in terms of significance relates to the ways in which sensationalist news are considered informational material to be debunked. On the one hand, journalists, physicians, and scientists develop a set of rationalising arguments that show how the risk of death linked to AstraZeneca is actually the same as that of many other common drugs. On the other hand, the same debunking strategy is carried out in a more ironic way by common users that manage to get viral thanks to their sarcastic tweets.

> #fakenews A false statement from the Italian Medicines Agency @Aifa_official is circulating on the Net where it is communicated that multiple lots of #AstraZeneca vaccine against #COVID19 is banned. The #AIFA has denied it, the only batch is nr. ABV2856.

> Dear girls and boys, right now adults (the ones who run the world) are going crazy over 0.00022% problematic #Astrazeneca vaccines, so when you ask yourself, why do I need to study maths? Remember it's so I don't become like them.
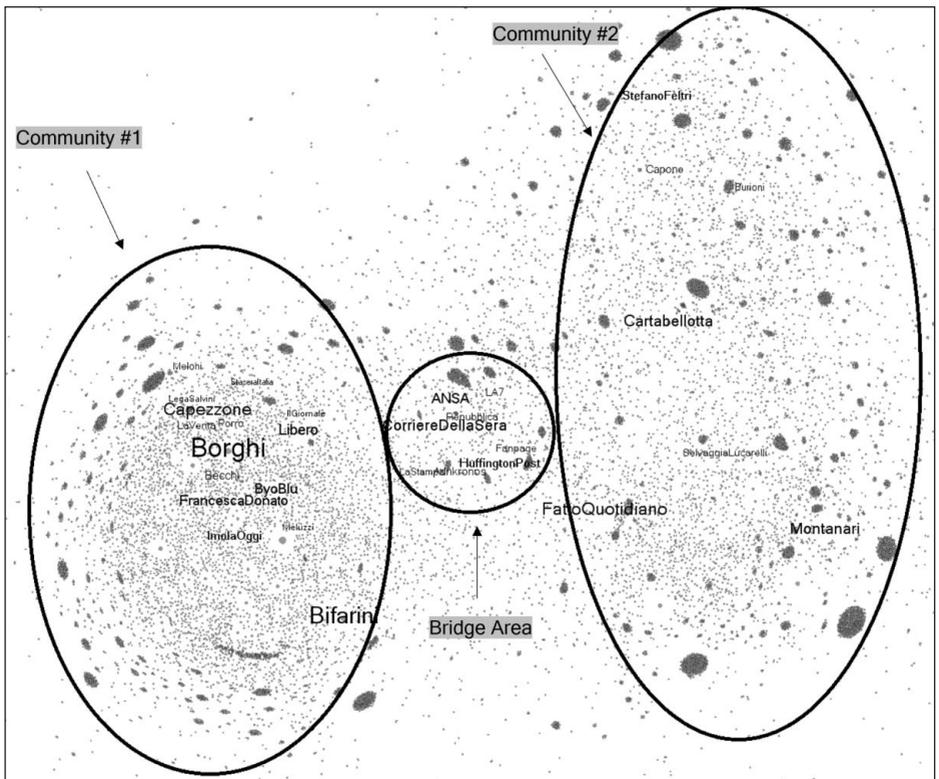
Figure 5.
10th – 18th June retweets network visualisation.

The discussion peak of June presents characteristics that are very similar to the March one. It is indeed composed of two distinguished communities and a smaller bridge area in the centre of the network.

Looking more in detail at the composition of users, the enlarged Community #1 on the left of Figure 5 is made up of politicians, journalists and newspapers that are linked to right-wing and nationalist political parties, while at the same time we can recognize an increasing number of users retweeting to hoax sites, as ImolaOggi and Byoblu (Bory et al. 2022).

The small bridge-area in the middle of the visualisation is instead composed of a multitude of mainstream media ("ANSA", "Corriere della Sera", "Repubblica", "LA7", to name a few).

Finally, on the right of Figure 5 the most prominent figures of Community #2 are physicians and pundits already noted for their debunking campaigns, flanked by a separate set of journalists and social media's influencers.

Part of this users that populate Community #2 react to the news of the suspicious death by trying once more to debunk an excessive exaggeration of the link between AstraZeneca and the thrombosis' deaths using a caustic discourse:

> Fatal cases per 100,000 doses administered as of May 26: Pfizer 0.96 Moderna 1.99 AstraZeneca 0.79 Johnson 0.79. And irresponsible people fuel panic over AstraZeneca? From politicians I don't expect anything, but from journalists I do.

> Venous thrombosis rate oral contraceptive pills: 5 to 12 women in 10,000. Thrombosis rate at atypical sites Astrazeneca vaccine: 1 person in 100,000. I expect you to at least stop asking women to take the pill because the condom "tightens".

At the same time, however, in the same community an opposite current of thought emerges from the retweets of the talk show "Ottoemezzo" in which it was questioned the risks of vaccinating kids, thus showing signs of an increasing fragmentation of views:

> #ottoemezzo #AstraZeneca @marcotravaglio: Why do we vaccinate kids? If Camilla had been German, she would still be alive. And it's not just her. Commissioner Figliuolo must answer for this madness.

On the opposite Community #1, the debate is instead led by a common rejection of the way in which the vaccination campaign was settled and builds upon the same narrative already emerged in March. A first discourse is indeed based on the same accusation to "the System"[9], that deliberately experiments on people:

> Be sure to continue to be a megaphone for the vaccine business, preyed upon by Big Pharma, news outlets and various journalists! You don't seem to care much about other people's lives anyway!

> Dear young people, who have vaccinated so carefree and enthusiastically, urged on by the enslaved media and your favourite influencers, don't you feel you are being taken for a ride?

> Are you beginning to understand what kind of world you live in? This is truly a brutal test of maturity. #AstraZeneca

In parallel, politicians and journalists insist again for the resignation of the Italian health minister, guilty of messing with health citizens.

> Yet another spin on the #AstraZeneca vaccine, after being administered even to the very young during open days. Enough is enough, no more chaos and approximation. The government reports back to Parliament. We demand clarity: don't mess with the health of citizens.

Finally, a last and minoritarian discourse is perpetuated by some politicians and pundits from the liberal right-wing area.

> While I defend the freedom to NOT vaccinate for those who do not want to, I inform my friends that this morning, according to the established rota for my age group, I received my first dose of vaccine (in my case, of #AstraZeneca). This seems to me to be the best method: everyone respects everyone.

These users claim that the state should defend the freedom of taking or not the vaccine. While this may appear to be a balanced or diplomatic approach, there are concerns that this stance is potentially misleading. On one hand, acknowledging the right to choose whether to vaccinate or not is an important aspect of individual freedom and autonomy. It is crucial that individuals have the ability to make informed decisions about their own health and well-being, based on their own values and beliefs. However, promoting vaccination while defending those who choose not to get vaccinated may be seen as contradictory, as it implies a lack of commitment or conviction in the value of vaccination. This may suggest an underlying propaganda strategy, in which politicians are trying to keep together conspiratorial positions and truly sceptical views using a seemingly balanced statement as a way to avoid taking a clear position.

5. Conclusions

The controversy surrounding the AstraZeneca vaccine provided a valuable opportunity to examine how the junk news regime impacts public debates on socio-technical issues. This allowed us to explore how a specific cycle of junk news, affects and is affected by a far larger number of actors and technical affordances than usually conceived. Our study revealed that sensationalistic news peaks, fuelled by the junk news regime, cause disruption in the digital arena of Twitter, resulting in the exhaustion of users' attention and the exacerbation of the pre-existing polarisation related to COVID-19 in Italy (Caliandro et al. 2020).

Our study found that spikes in news and tweets were tightly connected, with legacy and social media's temporal dynamics influencing each other. This suggests that acceleration and sensationalisation are two sides of the same coin, caused by the saturation of public debate by the junk news regime (Castaldo et al. 2022). As a result of this regime, public at-

tention shifts towards more emotionally extreme content, such as sensationalist news (Venturini 2019). In the case of AstraZeneca, the attention towards the controversy depends on its dramatisation, which in turn activates the confirmation biases already embedded in the technical affordances that structure Twitter discussion.

While significant progress has been made in analysing COVID-19 controversies, there is still much to learn about the patterns of public debate surrounding this issue. A growing body of research has focused on the role of the media and public communication in shaping public perception and understanding of scientific issues. For instance, other studies already investigated the relationship between the Italian media system and public understanding of science. With this regard, Crabu et al. (2021) found that traditional news sources in Italy tend to prioritise political considerations over scientific accuracy, which can impact public understanding of scientific issues. Meanwhile, Campus and Saracino (2022) explored how experts are transformed into celebrities in the media, and the impact of this form of science communication on the public debate related to COVID-19.

In this view, our research has shown how the Italian press has been found to prioritise reporting on suspicious deaths during the peaks of attention rather than providing an accurate reconstruction of the various risks and benefits of AstraZeneca. This overemphasis on sensationalised news related to suspicious deaths can be viewed through the lens of an increased politicisation of the COVID-19 news coverage (Crabu et al. 2021). Furthermore, our study also found evidence of the role of celebrity experts in shaping public opinion on COVID-19 in Italy. Twitter analysis showed that several physicians were acting as influencers in the communities related to debunking COVID-19 misinformation. However, while engagement in such polarised debates can increase the visibility of scientific communication, it can also increase the risk of superficial forms of scientific communication, as highlighted in previous studies of television talk shows (Campus and Saracino 2022).

Although the Italian case could be a valuable starting point, more work needs to be done to understand how these patterns vary across different countries and how different political contexts can impact the public debates concerning COVID-19 controversies. As a matter of fact, and as highlighted by other studies focused on COVID-19 communication crisis (Sacco et al. 2021; Pilati et al. 2022), the results concerning the AstraZeneca affair may vary considerably depending on the cultural, social, and political contexts.

Furthermore, another possible avenue for improvement is to expand our analysis to incorporate a multimedia or cross-platform approach (Venturini et al. 2018). This approach would involve mapping the same events across various mediums and platforms in order to determine whether different communication environments yield similar results. For example, do traditional news sources such as radio, television, and newspapers provide the same coverage as social media platforms like Facebook, Twitter, and YouTube? Additionally, can we track how influencers and the public interact in different contexts, and what information they release and consume?

By taking a comprehensive approach to analysing COVID-19 controversies, we can gain a more nuanced understanding of how these debates play out in different contexts and use this knowledge to inform future research and help mitigate the negative effects of the junk news regime on public debates.

Acknowledgements

Notes

[1] https://www.rainews.it/tgr/sicilia/articoli/2021/05/sic-vaccino-astrazeneca-morte-stefano-pater-no-siracusa-1b41803d-f54c-4ce7-8967-04a925f05bc3.html.

[2] https://www.esquire.com/it/lifestyle/tecnologia/a36076270/vaccino-astrazeneca-trombosi/.

[3] https://www.ansa.it/liguria/notizie/2022/05/15/morta-dopo-dose-astrazeneca-la-sua-vita-vale-70-mila-euro_12579a49-eabf-40bb-9f33-71fa201e8bfe.html.

[4] Pearson correlation coefficient, also known as Pearson's R, is a measure of the linear relationship between two variables, and it ranges from -1 to 1. A value of 1 indicates a perfect positive correlation, meaning that as one variable increases, the other variable increases in a linear fashion. A value of -1 indicates a perfect negative correlation, meaning that as one variable increases, the other variable decreases in a linear fashion. A value of 0 indicates no correlation between the two variables.

[5] Granger causality is a statistical method used to determine whether one time series is useful in forecasting another. It is based on the idea that if a time series X helps predict another time series Y, then X "Granger-causes" Y. The method involves comparing the predictive power of two models: one that includes only past values of Y as predictors, and another that includes both past values of Y and past values of X as predictors. The Granger causality test involves estimating two regression models: one with only lagged values of the dependent variable (Y), and another with both lagged values of Y and lagged values of the independent variable (X). The null hypothesis is that X does not Granger-cause Y, which can be tested using a statistical F-test.

[6] The Gini index is a measure of statistical dispersion used to represent the distribution of wealth or income among a population. It ranges from 0 to 1, where 0 represents perfect equality (everyone has an equal share) and 1 represents perfect inequality (one person has all the wealth or income). In the context of social media, the Gini index can be used to measure the concentration of retweets among users. By calculating the Gini index of retweets for a particular topic, researchers can determine how concentrated the retweets are among a small number of users, or if they are more evenly distributed among a larger number of users.

[7] By converting values to rank order, time series has been normalised on a common scale. The number of tweets about AstraZeneca is shown on the left and the amount of news on the right of the vertical axis.

[8] The excerpts in the article comply with AOIR's ethics guidelines and Twitter developer policies (https://aoir.org/ethics/; https://developer.twitter.com/en/developer-terms/policy).

[9] According to different users statements the "System" can include government agencies, corporations, financial institutions, and the media. In their view, the "System" operates in secret, outside of public scrutiny, and uses its power to manipulate information and events to maintain control over the population.

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Cyborg Figurations: Exploring the Intersections of Technology, Embodiment, Identity, and Ecology

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Abstract
This cross-disciplinary exploration delves into the multifaceted intersections of technology, embodiment, identity, and ecology through the lens of cyborg knowing. The first contribution focuses on the vulnerabilities faced by individuals with implantable cardiac defibrillators (ICDs), emphasizing the crucial need for acclimatization strategies and agency in navigating their cybernetic embodiment as "everyday cyborg". The second contribution critically examines cultural technologies revealing their role in perpetuating biases and advocates for interdisciplinary approaches, drawing on feminist STS and cyborg theory, to adaptively reshape societal constructs. Lastly, the third contribution envisions a comprehensive theory of cyberzoa that extends the cyborg figuration to encompass nonhuman animals, fostering a post-anthropocentric perspective and an ecologically attuned examination of power relations, exploitation, and symmetrical relationships. By engaging with the concept of the cyborg, these contributions shed light on the complex dynamics and transformative potentials inherent in the realm of technology for both human and nonhuman lives.

Keywords
everyday cyborgs; techno-organic hybridity; cyberzoa; embodiment; ecology.

Implantable Cardiac Devices and the Vulnerabilities of Everyday Cyborgs

Gill Haddow

1. Introduction

In popular film and media, especially in the genres of horror or science-fiction (SF) the image of the "cyborg" has come to be synonymous with the inhuman; monsters created to terrify the viewer due to their superhuman abilities but less than human emotions and feelings. I argue however that the term cyborg needs to be reclaimed from these popular stereotypes. I advocate for increas-

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ing recognition to be given to the existence of "everyday cyborgs" in society as well as recognition given to the vulnerabilities that accompany their creation (see Oudshoorn 2015; Haddow 2021).

Everyday cyborgs are a specific example of techno-organic hybridity created through the process of medical cyborgisation. Implantable Cardiac Defibrillators (ICDs) are implanted medical devices which sense an abnormally fast heart rate that could progress to a sudden cardiac arrest (SCA). The ICD reacts by setting off a series of small electrical shocks termed "cardioversion" attempting to stop the fast heart rate. The ICD then re-senses and evaluates whether a larger shock is required to "defibrillate" the heart to stop the life-threatening rhythm. These events are communicated to health professionals either remotely from the device itself or through investigation by the clinicians in hospital. Due to these capabilities I argue that ICDs are cybernetic devices and when placed within an organism, the "everyday cyborg" is created.

In order to understand the everyday cyborg life, twenty-one face-to-face interviews with everyday ICD cyborgs and thirteen of their significant others were conducted. Findings demonstrated that there were two ways in which new vulnerabilities can occur: 1) living with techno-organic hybridity and 2) seeking control over a cybernetic technology that can be seen and felt but cannot be reached or removed.

The first vulnerability results from the surgical insertion of the ICD and the "invasion" of the medical device into the body. The ICD is implanted generally on the left-hand side of the chest and the outline of the device can be seen on the body. This can result in a heightened awareness for the everyday cyborg of their body which has been now modified into a techno-organic hybrid of human and technology. Usually, the experience of the body is one characterised by a general lack of awareness and absence. Implanting a medical device such as an ICD turns this original "absence" into a presence or as Drew Leder refers to it as a "dys-appearance" whereby the body's original absence becomes absent (Leder 1991). Yet over time, along with the everyday cyborg's acceptance and acknowledgement that the ICD is a form of protection and a "part of them" rather than a threat, the ICD transforms into a corporeal structure of the body, as well as into the background of life facilitating a return to "absence" once more.

Relatedly, the second vulnerability stems from the activity of the ICD should it emit a shock. The ICD is a cybernetic device that can prevent a SCA by emitting a series of increasingly powerful electrical shocks. Its activity is autonomous and out of the control of the everyday cyborg. In interviews with everyday cyborgs they narrated the strategies (such as excesses of activity) that can show that the everyday cyborg caused the ICD's activity. In doing so, they position themselves as the orchestrator of the ICD's activity as opposed to a passive recipient of it. Such strategies enable the everyday cyborg to accept the ICD as part of their body when implanted and if the ICD activates it then allows them to believe they are the ones in control.

This leads to the conclusion that the vulnerabilities created by medical cyborgisation processes are eventually (and repeatedly) overcome through strategies of acclimatisation.

2. Different Cyborg Representations

There is a rise in the number of modern medical implants that are "smart", i.e., devices that are sensitive, responsive and autonomous in their functionality when compared to the

static and stationary hip or knee joints, artificial skin and implanted corneas (Haddow, Harmon et al. 2016). ICDs are one of these increasingly "smart" implanted medical technologies and as mentioned they have features of an autonomous feedback mechanism operating as a closed loop system. ICDs can be considered a prime example of medical implanted cybernetic circuits as homeostatic systems because they are a reinforcement system based on circular causation processes. Indeed, ICDs are playing an accepted and increasingly "normalised role" in peoples' lives and are becoming mundane, ubiquitous and everyday (Harmon et al. 2015; Haddow et al. 2016). The relatively common medical practice of inserting ICDs into the human heart creates an "ICD cyborg" or an "everyday cyborg" (Oudshoorn 2015; Haddow 2021). The "everyday" of the "everyday cyborg" highlights that the "mundane" and "hidden" is important for discussions about their creation, not least, because the implants are literally hidden inside the body, but because much of what is discussed about cyborgs does not focus on their existence and what a routine day is like for some, with even fewer reviewing the "technological mediatedness of human subjectivity" (Schraube 2009). "Everyday cyborgs" as the "new normal" of living a modified cyborg life, is an achievement that cannot be taken-for-granted and requires strategies of acclimatisation and therefore there is huge value in reclaiming the term for this purpose (Das 2010).

However, the genesis of the original cyborg was of a future space traveller and not of an earth dweller. Clynes and Kline in their original definition of a cybernetic organism (Clynes and Kline 1960) offer the original definition of the cyborg, of the cybernetic organism, as human beings whose bodies were modified not so they can continue to live on earth, but so that human beings with body modifications could one day travel in space. These future techno-organic human hybrids were the cyborg astronauts of the future. "For the exogenously extended organizational complex functioning as an integrated homeostatic system unconsciously, we propose the term 'Cyborg'" (Clynes and Kline 1960, 27). Despite the origins of the term cyborg and the everydayness of cybernetic implantable medical technologies such as ICDs, in the public imagination the term is most commonly associated with images presented in popular horror and science-fiction (SF) films. The T-800 android in the first *The Terminator* franchise (1984, dir.: James Cameron) and the Alex Murphy cyborg in José Padilha's (1987/2014) *Robocop*, typify such representations of male gendered, uber-violent, overtly masculinised and devoid of recognisable human emotions. These well-known cyborg and android monsters generally have the physical attributes of strength and power and overt musculature co-existent with the dominant Western idea of masculinity (Connell 1995).

The last version of the cyborg and one that is more well known in academic discussions, is the version of the "cyborg" used by Donna Haraway (1991), simply defined here as a blended identity to challenge the construction of dualisms, such as sex and gender, or human and machine urging that the "cybernetic organism, a hybrid of machine and organism, [was] a creature of social reality as well as a creature of fiction" (1991, 119). She argues that C3I (command-control-communication-intelligence) is the essential code for modern war (1991, 150) of which C3I can be interpreted as a cybernetic system previously outlined by Clynes and Kline (1960). Of particular importance is making evident the vulnerabilities that the experience of cyborgisation brings however. I therefore turn to what becoming and being a cyborg entails as a human experience.

3. Cyborg Voices

Research reports that there is enhanced life function and improved quality of life from being implanted with an ICD, yet there is also research that suggests living the techno-organic hybrid life of an everyday cyborg can have detrimental effects on some recipients.

All cardiac patients may develop some illness identity dislocations as they suffer from having heart disease, condition or arrest as well as from a possible near-death experience (Charmaz 1987). Indeed, psychological studies conducted with ICD patients repeatedly document the prevalence of anxiety, depression and even anger in the ICD population (Sakensa 1994; Duru et al. 2001; Pedersen et al. 2008; Yuhas et al. 2012; Vriesendorp et al. 2013). This data cannot describe whether these emotions are a result of the implantation of the ICD, the activation of ICD and discharging a shock or were pre-existing tendencies relating to the nature of the heart condition. Studies have repeatedly shown that anxiety is heightened in patients whose ICDs have fired to prevent a heart arrhythmia, compared to those who have not experienced shocks (Hegel 1997; Dougherty 1995). The shock that the ICD emits is shocking both in terms of the pain that it causes as well as the unexpectedness of its occurrence. Nelly Oudshoorn suggests that "[H]aving a machine inside your body without knowing when or where it may jolt you induces feelings of disbelief and anxiety" leading her to discuss the new vulnerabilities that ICDs cause (2016, 8). She goes on to highlight how cyborgisation leads to new types of vulnerability "as an internal rather than an external threat and as harm you may try to anticipate but can never escape" (Oudshoorn 2016, 267). Indeed, scholars in Science and Technology Studies (STS) and Body Studies draw attention to the importance of the experiential basis of cyborgisation showing how the "cyborg" condition is created and exists as an empirical entity (Bjorn and Markussen 2013; Oudshoorn 2015). Hence, in order to further understand what is different in the everyday cyborg life when compared to the experience of cardiac associated illness, as well as the strategies of acclimatisation used to becoming and being an everyday cyborg twenty-one face-to-face interviews with everyday ICD cyborgs and thirteen of their significant others were conducted. With National Health Service (NHS) ethical approvals, participants were recruited using NHS gatekeepers and a consent-to-consent approach. Pseudonyms are used in the following accounts.

3.1 Living with techno-organic hybridity

For the ICD everyday cyborg, the cyborgisation process begins from the moment when the ICD is surgically implanted. The ICD is not implanted in the body to the same depth as a transplanted organ might be. In fact, it bulges slightly on the left hand side of the upper chest causing a reverse silhouette. This is the spot where the everyday cyborg was created as a new techno-organic hybrid and its presence can be felt even when it is inert. Stella suggested:

> I can feel it [ICD], sometimes, if I'm lying down, it'll jut out a bit more and I'll go... (making movement to push it back).

Alfred commented that:

> Well, I'm really quite thankful… But, it is a bit of an inconvenience, because it does stick up and, you know, you can, when you're sleeping, it's kind of interferes if you're on one side.

The scar and the skin silhouette, serves as a reminder of the everyday cyborg's mortality, albeit one not resulting from SCA. John describes it as:

> **John**: And it's almost like… and I don't want, I don't want to be… it's a bit like being continually reminded that you've got this condition. I mean, in some respects I would rather just blend into society and just become an ordinary person again, you know.
> **Gill**: Do you not think you're an ordinary person?
> **John**: Well, I feel I'm… to some extent I feel extraordinary because I feel…
> **Gill**: Extraordinary [laughing].
> **John**: … I'm being kept… I'm being kept alive by that [ICD], you know.

The everyday cyborg gains a new identity as an "extraordinary" person. Others had less euphoric experiences along with a more ambivalent relationship with the ICD. A few participants said that the silhouette troubled them and Timothy disclosed to having never really got used to having the ICD in his body. He related how "your body shouldn't have a square lump like that…".

The integrity of the body has changed, and the alteration in bodily image and appearance is now a new source of heightened attention for the everyday cyborg. The body is now at the forefront of attention and reflection and in this way, the body is present, alienable and divisible. Indeed, in moments of stress or pain, the absence of our body ceases and the absence itself now becomes absent. For Drew Leder, this is what he calls a primary absence as the body's absence in everyday life becomes very much a focal point; a "corporeal self-consciousness" (Leder 1990, 98). Cyborgisation makes the body's first and primary absence that is a feature of routine living, absent or in Leder's terms a "dys-appearance" (1990).

When our "everyday absence" becomes absent then this is termed a "second order" absence that Leder calls a "dys-appearance" (Leder 1990, 91). It might be simpler to conceptualise the body as now having a presence, however, using Leder's term "dys-appearance" of "absent absence" highlights that the body is usually absent in the first instance. As a concept, dys-appearance necessarily contains within it therefore the importance of the body being a primary absence.

Gradually, the device over time settles and sinks further into the chest as it becomes coated with organic biomaterial. It becomes enmeshed into the viscera and Neil drew an interesting analogy with this process and that of a ship:

> **Neil**: … was that when the device first goes in, it's, kind of like, a, kind of… it's more of a foreign body, if you like, to your… your system… and then once it had been in a long time, it, kind of… the wires and everything else that's there, kind of, get covered in all the, sort of, gunk that goes round your body and it becomes less and less of a, kind of, foreign body over time, because it… you know… you know, I suppose like a ship in the sea, it gets covered… you know, like…
> **Gill**: Barnacles?
> **Neil**: … it gets covered in barnacles and all these type things…

Neil offers the ICD's physical transformation as it gradually becomes coated in the "gunk" of the organic body in the process becoming less "foreign". This progression to a corporeal structure is accompanied with a separate but related process of acceptance as part of the everyday cyborg's identity:

> **Maggie**: There's… yeah, 'cause as in, basically, if I was to try… if you think about it in the opposite sense, if something happens to my body, the wires… you know, the wires do something. And it is, it's part. So, of course, maybe in, like, fifteen years or ten years' time, I will actually feel, you know, this is… it is *part of me*. And I suppose, in a way, maybe, you know, you might accept that it's… it's strange to think of accepting a piece of machinery that, sort of, is… (emphasis added).

Growing comfortable to a hybrid techno-organic status and living with an ICD depends on the everyday cyborg experiencing the ICD as "part of them" and also as a "benefit". Stewart reported that his ICD was, "You know. It's like my shoes. You know, I don't consider my shoes alien. I don't, I mean it's, obviously I wasn't born with it, but it lets me be who I am". The ICD is part of the body's image and integrity and has also become "part of" the everyday cyborg's identity. Stella had received a specialised ICD called a CRT-D to treat her heart failure and is a device that is implanted with an additional wire to go round the back of the heart to co-ordinate a more efficient heartbeat. She told me that she "instantly felt the benefit from it if I didn't have it [ICD], I wouldn't be able to breathe, you know". She readily suggested, "it's just *part of me* now, it's no big deal" (emphasis added).

"Part of me" along with the enmeshment of the device are processes that are part of a more general acclimatisation progression. With the ICD gradually becoming bodily enmeshed and accepted as a benefit it is also no longer seen as a threat. Indeed, Lucie Dalbert's research findings suggest there is an acclimatisation or incorporation process necessary to adjust to living with a deep brain stimulator (2015). This is based on the individual's acceptance of the technology as being a positive development and "part of them" (Dalibert 2015).

Those around the everyday cyborg can also view the ICD as a benefit because it removes some of their responsibilities of vigilance and over-sight they may have had before the cyborgisation process and over the everyday cyborg:

> **Stewart's wife**: … when he [husband Stewart] was very ill I was concerned because you'd go to bed at night, this was before he had his ICD put in, we'd go to bed at night and I'm listening to his breathing because sometimes… it sounded as though he was going to stop. And then I thought, "oh God, something's going on" and then he would breathe again. So, I really was, he was totally unaware of that because he was asleep… So that I was very keen for him to have an ICD because I thought, well at least if I'm asleep and he stops breathing or whatever then something's going to happen to, to save him.

The ICD can protect the everyday cyborg from a SCA, allowing family and friends to step back from such oversight.

3.2 Seeking control over a cybernetic technology

The second vulnerability stems from the capacity of the ICD to deliver a series of increasing powerful electric shocks in order to prevent a sudden cardiac arrest (SCA) in those thought at risk from having one, or who might have already experienced one but in the process potentially physically compromising the everyday cyborg.

If the ICD performs its life saving function and discharges shocks, the event is explained retrospectively by most everyday cyborgs locating their actions as the reason for the discharge. Strategies used such as blaming themselves through emphasising excesses on their part or indeed the device misfiring (for example, if the parameters for shocks are set too low; the leads have broken; or the ICD has mis-sensed). Steven's ICD discharged a shock which he explained as: "Well... it went off once, but that was my own fault... I was trying to lift something awfully heavy". Timothy explained the shock he received from his ICD was due to his tendency to worry:

> **Timothy**: I've said about I'm a worrier, so maybe that has got something to do with it... Even now, that last time, beginning of last year, that was when I had one or two incidents... there was worry then, there was a bit of panic then even when the incident happened, shaking and a right, they [clinicians] said a kind of panic attack, as well as something happening and that didn't help it any.

The process of acclimatisation in this regard amounts to the everyday cyborg offering explanations for the ICD's emission by placing themselves as an agent of the activity rather than the recipient. Even being a "worrier" asserts some control over the device rather than acknowledging that they are in control of the device. As Jackson says such strategies make us, "authors of meaning rather than victims of circumstance" (Jackson 2002). Informal discussions with cardiologists suggest that within reason, there is little or no relationship between what could be termed the ordinary activity of the everyday cyborg and the ICD discharging shocks.

4. Discussion: Becoming and Being Cyborg

Becoming a cyborg in the everyday means that for some individuals there is collateral damage; vulnerabilities created, skin cut and changed, body integrity breached; viscera compromised, relationships reformed, subjectivities altered. The construction of identity is a process, for example, that is often disrupted by illness (Charmaz 1987) but also more recently by technoscience innovations such as cyborgisation (Sulik 2011). The everyday cyborg becomes at times more vulnerable in a new techno-organic hybrid configuration. Cyborgisation, alters materiality and affects subjectivity creating a need for individuals to undertake the successful acclimatisation process involved in becoming and being cyborg. This occurs in the cyborgisation process when embodiment as a techno-organic hybrid is created at implantation and further affected by possible activation. In these moments the body is no longer experienced as an absence and comes to occupy the forefront of the everyday cyborg's attention.

Significantly, how human beings are embodied, that is the relationship between identity

and body (whether a person is a body or has a body) also is dynamic with a dys-appearance caused by early cyborgisation becoming co-existent with having a body as a separate alienable entity. Acclimatisation, however, may bring a more settled and integrative embodiment experience with the everyday cyborg becoming more likely to return to the holistic view of embodiment and the ICD as becoming part of them. Then having or being a body is not a static state, but a fluid experience of embodiment that is often ambiguous. I suggest that the ambiguity is not just in terms of whether I am or I have a body, but its fluidity is based on events that bring about questions of when I am or I have a body. This stems from the braided processes of the implantation of the ICD that can create challenging alterations in embodiment and living with the ICD activation means reinserting narratives of control.

Being an everyday cyborg is a fluid experience of "dys-appearance" – of being aware and focused on embodiment as a techno-organic hybrid after implantation and post activation, and then of this status becoming an absence – as the everyday cyborg acclimatises returning to their living life with a heart device (Leder 1990; Sobchack 2010). The intimacy between technology and organism in the everyday cyborg's body has a unique rehumanising effect; one that makes them possibly ever more vulnerable. The ICD has a bodily intimacy that then creates a paradox: it is inside the body and almost inseparable to it whilst simultaneously being the furthest away and out of the control of the everyday cyborg. For the everyday cyborgs, it is the paradox of intimacy that is created as the cybernetic device within the body also creates distance (as it cannot be reached by them) and a lack of control (as its functioning cannot be altered by the everyday cyborg either). Then re-appropriating the term cyborg for our everyday application reinserts issues about what cyborgs actually need to live happy and fulfilling lives; what kind of support they and their significant others might find useful as well as what type of information and understanding is required to acclimatise to a new techno-organic hybridity. If there is a need to understand and empower those with varying abilities such as everyday cyborgs, then there may also be a moral and political requirement to recognise and even celebrate the hybridity of the materially diverse individual.

The increasing reliance on techno-scientific processes such as implantable cybernetic devices is an example of a much wider process that has been described as "biomedicalization"; a state that is different to but is sprung from medicalisation when medical jurisdiction controls an ever-increasing area of social lives. Biomedicalisation refers to, "the increasingly complex, multisited, multidirectional processes of medicalization that today are being reconstituted through the emergent social forms and practices of a highly and increasingly techno-scientific biomedicine" (Clarke et al. 2003, 162). Inspired by Illich's medical nemesis (Illich 2003), whereby medicalisation is the treatment for the diseases that medicalisation itself creates, so by extension are technological and cybernetic fixes the "biomedical nemesis" of biomedicalisation? Cyborgisation as part of the biomedicalisation process can produce its own unique forms of iatrogenesis because of the vulnerable re-humanisation it creates and the strategies that are demanded consequently.

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◆

Cyborg Troubles: The Promises of Posthumanities

Cecilia Åsberg

1. Introduction

We live in troubling times in need of multiple approaches and versatile research. The climate crisis is no longer a future prospect but unfolding before our very eyes. The most vulnerable peoples, those of racialized and feminized poverty and a long legacy of exploitation in the Global South, are invariably hit the hardest. In addition, we see also a resurgence of white nationalism, right-wing populism, and new ways of warfare. We bear witness to a new world-engaging war in Europe, in Ukraine. We face energy crises and environmental problems, such as oil spills, harmful toxins, gas leaks and warming oceans. The global Covid-19 pandemic recedes with looming threats of *new* multispecies contagions appearing. The troubles of the world respect few boundaries. Amid these nested crises, our news, information, knowledge and social media channels provide angles and perspectives in ways that often reflect back to us our all too narrow preferences and world views. They mirror and exaggerate our own limited sense of self in world full of rampant individualism, even grandiose narcissism (Casale and Banchi 2020). Boundary crossings of all kinds define the present.

In a struggling world, riddled with nested crises and societal challenges, Donna J. Haraway's ground-breaking re-appropriation of the figure of the cyborg from the 1980s remind me that proficient modes of addressing complex worlding problems have been developed be-

fore and remains available to us as forms of cyborg knowing. In what follows, I will try to unravel some of the conceptual threads central to Donna Haraway's notion of the cyborg.

It is a well-known story by now in STS, how the cyborg challenges hierarchical dualisms and oppositions between organism and machine, nature and culture, body and technology, female and male, human and nonhuman, imagination and material reality (Balsamo 1996; Franklin 2006; Åsberg 2007; Åsberg and Lykke 2010; Oudshoorn 2020; 2021). It induced a performative playfulness with serious political issues that rubbed off in scholarship, made waves. Haraway's cyborg heralded the ontological turn of critical posthumanism and (feminist) new materialisms of all kinds. It did so without giving up on, instead harnessing, previous insights from social constructionism, Marxism, anti-colonial feminisms, cultural semiotics, and the humanities. The cyborg signals to me the needed re-invention of the humanities and social sciences so to re-imagine culture, society, and human identity in ecological and technological terms. Various kinds of what we may call *cyborg knowing* flourishes in fact today, under several academic banners and names. It thrives as an attitude of "staying with the trouble" (Haraway 2016a; 2016b), a "double vision" (Haraway 1991) to the ambivalences of the integrative political ecologies and technologies of the now.

Haraway's cyborg stands for a processual "natureculture" ontology, but also for an incentive to boldly re-organize ways of knowing that make us accountable. A case in point in this paper is the feminist posthumanities, relentlessly postdisciplinary research in and beyond STS, that bring art and science to interdisciplinary humanities and more-than-human feminisms to people. My aim here is to trace and revisit cyborg knowing for what onto-epistemological approaches it may have enabled in research, to map out the more-than-human, less academic perhaps, and *more humane* promises of cyborgs today.

2. Enter cyborg

Basically, the cyborg is a great pedagogical starting point for students of history of science and technology, feminist, queer and anti-colonial theory and gender studies, social studies of medicine, media and technocultural research at large. In my years of cross-faculty teaching at a few Scandinavian and north European universities, it has worked surprisingly well also for students of biology, engineering, design, new media, sustainability science and nursing. It invites discussions on ontology, epistemology, (breaks with) Euromodern history and theories of subjectivity and subjectivation, ethics, power and resistance in the "matrix of domination" (Collins 1990).

Especially so if we read Haraway's "A Cyborg Manifesto" (as ontology) alongside "Situated Knowledges" (as epistemology), as we tend to do. Published in 1985 for Socialist Review, the cyborg manifesto grew into a prophetic meditation on how cybernetics and digital technologies changed everything – from how we do gender to how we connect across the globe. A social media influencer in Stockholm today uses a phone assembled in China with rare earth minerals extracted in Congo to access a platform moderated by Filipinas and line pockets in Silicon Valley. New technologies of affiliation, exploitation and solidarity break and re-draw boundaries of all kinds.

Haraway's second most influential essay, on situated knowledge, appeared a few years later and provide an epistemology to the cyborg's ontology. To Haraway, knowledge is always

situated, environed and embodied in a particular geopolitical, historical, instrumental and "naturecultural" context. It is limited and purposeful, a way of storying exposure.

Both texts, making up "cyborg knowing" here, appear in Haraway's widely translated 1991 book, *Simians, Cyborg and Women*, with the under-appreciated subtitle *The Re-Invention of Nature*. I read it as indicative of Haraway's attempt at finding common ground across the arts and sciences in a postnatural world. Haraway's writing and conceptual work seems largely forged, as she states, "inside worlds at war" (2004, 2). She was born after World War II, and wrote amidst the Cold War, the Science Wars, the war on terrorism, and the ongoing conservative Culture Wars in the USA.

"These worlds at war are the belly of the monster from which I have tried to write into a more vivid reality a kin group of feminist figures" (ibid.), Haraway writes to contextualise her kennel of cyborg kin concepts. Cyborg knowing may, in such a situation, create common ground for how to deal with how old dreams of a common language built on disciplinary nostalgia, modern categories and ideals of purity.

In a research project on creative AI and the artistic imaginary, we have in my group a subproject on AI image generators, like MidJourney, DALL-E 2 or Stable Diffusion (Jääskeläinen et al. 2022). We look at creative AI in music, dance and image-generation for how it transforms the craft and shift power. Visual AI enable a complete reimagination of the all too humanistic image of gender, race, and human (species) individualism expressed *at the locus of the face* (Barthes 2007).

AI for facial analysis, a technology of recognition, is a common application on most mobile phones. Society enfolds already today on these technologies for securitization and surveillance of borders of all kinds. Face shape, features, skin colour, movements and make-up are captured, analysed, and compared and matched with classifications (in terms of gender, race, scars, geometry and even inferring sexual orientation) against databases (Kosinski and Wang 2018). AI is also generative technology for creating images of faces and individuals (people, but also cats and horses) never to have existed[1]. Even more so as generated AI art, where new imagery is produced by textual prompts. Such creative AI really puts our common technological imaginary and visual culture to the test of stereotypes.

Cyborg knowing enables us to critique this visual culture *as a digital dream of a common language*. These AI image generators (e.g., Figure 1) routinely display systematic intersections of sexist, racial and heteronormative bias by way of design, prompts, and the stock photo of art and imagery already existing for the training of machine learning systems in the vast online world. Unsurprisingly, we get back from the systems the exaggerated and distorted mirror images of humanity that we put into it. To paraphrase Haraway (1991, 154), the cyborg world of global satellite surveillance, google maps, CCTV, facial recognition technology, AI-generated visuals and video (often revenge porn), and algorithmic bias is about "the final imposition of a grid of control on the planet", about territory, war and "the final appropriation of women's bodies".
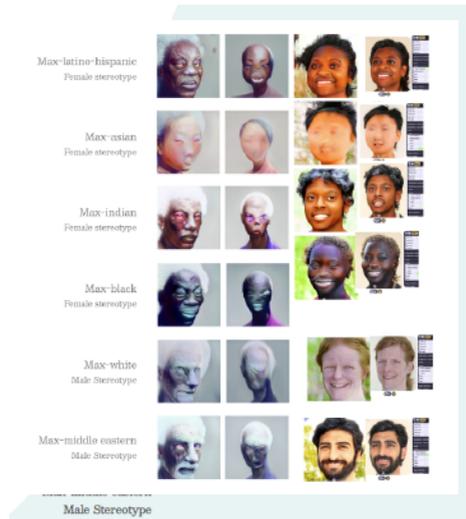
Figure 1.
Gendering and racializing parameters in *ArtBreeder*,
an example of facing AI art, generated by
Petra Jääskeläinen (KTH).

From another perspective, it is also about embodied and lived social realities in which people are not afraid of neither "their joint kinship with animals and machines", not of their "permanently partial identities and contradictory standpoints" (ibid.). Overtly sexist and racist renditions of our visual culture and self-image shape our sense of self as we reach out an extended arm for a cat-filter selfie to post. In one sense we then also play creatively with stereotypes and expressions of gender, art and species kinship, moulding a *re-engendered* cyborg imaginary.

3. Cyborg knowing is not enough

Cyborg knowing is about assuming there are more things going on than we could ever imagine, about unlearning old categories of thought and inventing new epistemic practices based on modesty, partiality and a generosity of co-existence.

Most importantly, cyborg knowing invokes an ontological feeling of connectivity. A feeling that, "nothing comes without its world", in the words of Haraway (1997) and Maria Puig de La Bellacasa (2012). To some, this is a methodological invitation to embrace an ethics of connectivity. To others, this feeling is one of a daunting vertigo as it requires great responsibility on the part of us as readers, researchers, students and knowledge-brokers. Also, it always assumes our complicity in what we critique.

This cyborg connectivity means that knowing is inconceivable without the multitude of relations that make thinking and knowing possible inside nested crises. It means that knowl-

edge is physically situated, embodied and embedded in locations, instruments, bodies and concepts, as well as in rhetorics and story-telling devices, and, that objective truth always remains partial and limited but good to have, in heaps, for greater sociability. To Haraway, progress in knowledge is not a bad word but the hard and modest, scientific way of life (Haraway 2004, 4; 1997). Knowing is social and imaginative practice, and it co-creates the surrounding world – enables a practice of worlding and re-worlding. As such (as a feminist materialism in the American pragmatist tradition), it borrows from social constructionism (the strong programme), from ANT (the nonhuman) and standpoint theory but refuses representationalism. It makes for what Karen Barad (2003) later described as an onto-epistemology of posthumanist performativity and agential realism. Nothing comes without its relational and co-constitutive world, making political ecologies and technologies of how we are all biochemical matter, and how we all matter, a core concern for research.

A highly teachable principle of research permeates Haraway's opus, from *Primate Visions* (1989) to *Staying with the Trouble* (2016), that stories and matters of fact intermingle and that it is daunting, but possible to trace this worlding analytically as a political implosion of nested words and worlds (Dumit 2014).

The works of Donna J. Haraway plays nicely with STS and feminist theory practices (1994), with interdisciplinary humanities at large, and in this short piece I want to revisit and highlight Haraway's cyborg concept in the light of some contemporary knowledge practices. Not so much for what it was, but *for what it did* and for what kind of postdisciplinary research it enables today (Lykke 2011). Our time is wide open to new conversations and new synergies of cyborg knowing, to the exploration of alternatives for how our scientific communities are ordered (to echo Lucy Suchman), to revisiting and re-tooling analytical toolboxes, and to new configurations of knowledge.

3.1 Exit anthropocene, exit identity

For those of us who has been committed to the intersections of feminist theorizing, cultural studies, environmental justice and science and technology studies in the last decades, Haraway's work, and perhaps in particular her "Manifesto for Cyborgs" have simply been pivotal. To me, "the cyborg" seems a bit like the concept of the Anthropocene now, also a term for the implosion of nature and culture. The notion of the Anthropocene started its present career in geological and climate sciences, coined in 1980 by ecologist Eugene Stormer and gained fame in 2000 when Nobel laureate and Dutch chemist Paul Crutzen picked it up. In that sense, the Anthropocene and the cyborg generated new fields of research. They also generated unwarranted associations, at the risk of losing critical salience as trendy buzzwords. I would like to turn this argument on its elitist head and point to how important reverberant and irreverent concepts can be for collective thinking – from the standpoint that there is no neutral or innocent way of seeing or knowing to begin with. There are only starting points, conceptual portals, to collective learning, unlearning and re-learning.

Initially, the Anthropocene question to stratigraphers concerned whether human development had become a force on the planet to create a geological record, warranting a new name for this all too human era (Zalaciewics et al. 2015). The term soon became heavily politicised as it intermingled with climate change discussions (Steffen et al. 2011; Crist 2013). To some it stimulated activism and provided a starting point for discussions on how to remodel society in

emancipatory directions (Cuomo 2011; Klein 2015). To others it was not specific enough, even misleading, and moving away from crucial concerns about social justice and capitalism's responsibility for environmental changes (Crist 2013; Malm and Hornborg 2014; Moore 2013).

Anthropocene, Capitalocene, Plantationcene, Wasteocene, Gaia, Chthulucene and the Great Acceleration; there are many names for our global instability in academic circulation. This richness in our collective terminology, is like Haraway's "Chthulucene" all made up of "ongoing multispecies stories and practices of becoming-with in times that remain at stake, in precarious times, in which the world is not finished and the sky has not fallen – yet" (Haraway 2016b). To me this openness is the cyborg gift to postdisciplinary research like *Environmental Humanities* (Bird Rose et al. 2012; Neimanis et al. 2015; Åsberg 2018), and a chance to get along together with some grace in our conversations. Like cyborg knowing, the Anthropocene-variations, both risks to become a common language and of creating a new Master narrative. It both ignites collective action, *and* risk spread fatalist despair and the illusion of one single penultimate solution. What today might amass to Anthropocene social sciences, environmental humanities and Anthropocene feminisms (Grusin 2016), take us as scholars away from the romantic notion of finding *one* concept to describe it all. To paraphrase from "Manifesto for Cyborgs", our politics cannot be rooted in (humanistic) *identification* if we are many things simultaneously, *vanguard parties* if we are part of mass-movements, *purity* if we live in a postnatural and impure world, and *mothering* if we do not wish to reproduce oedipal patterns of care as women's business (Haraway 1991, 219).

This giving up on identity, while insisting on the transferability of transformative insight from knowing together on location, is a form of postdisciplinary "rooting and shifting" for the sake of mobilising strategic alliances, to borrow a term from feminist political theorist Nira Yuval Davis (1997). It started out as a concrete practice of "*politica trasversale*" amongst a feminist activist group living in Bologna, Italy in the mid-1990s. They visited war-riven conflict zones to support women in other countries, in a programme they called "Women Visiting Difficult Places" (Cockburn 1998). Like the cyborg concept, this transversal approach frees us from *unproductive* guilt trips, and from the need to root politics in *one* single problem (capitalism, gender, legacies of empire, technological or biological or ecological determinism) and steep it all in a dream of a common language. Concepts that matter to us will do different jobs in different settings for different reasons.

4. Companion species

Cyborg thinking changed a lot of scholarly discourse in the decades after the 1980s. The connective cyborg is a prominent harbinger of the need to boldly work in interdisciplinary collaborative contexts. It brings necessary feminist theory to STS and science to the humanities by way of feminist cultural studies of science and technology. To me, the formative convergences in Lykke and Braidotti (1996), Franklin, Lury and Stacey (2000), Bryld and Lykke (2000), Alaimo (2010; 2016), and Grusin (2017), to reference a few studies, are exemplary and highly educational ways of cyborg knowing. The rich work of Haraway has flourished as practices – also in the neglected margins of the privileged North. In its wake, synergies of ecofeminist ethics and queer cyborg knowing found new ground in eco-cultural studies

(Alaimo 1994) and later, in environmental humanities. Haraway's "posthumanism" transposed from (too bounded) cyborgs to the bio-ecologies of *companion species*.
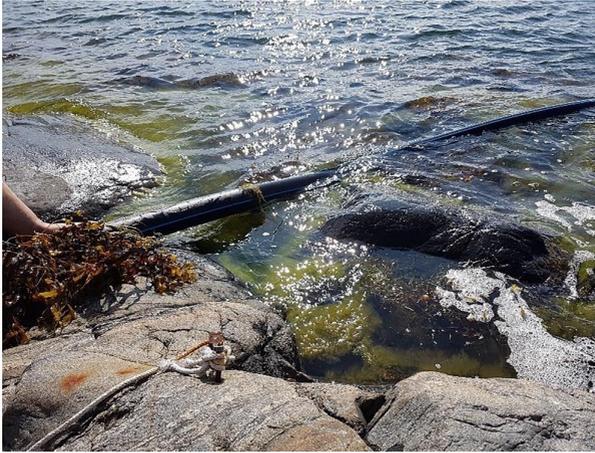
Figure 2.
By Askö Lab in the Baltic Sea, green slick algae,
bladderwrack, a cable and other traces of humans.
Photo Askö island, 2017.

At a fast pace, biodiversity loss, warming ocean waters and climate change bring new kinds of exposure to the cold and far-away northern shores. Our society's dependency on the companion species of sea and coast are hard to fathom, ranging from the oxygen we breath and the carbon sink work of algae (outmatching rainforests) to the food we eat. Algae, like algorithms, are embedded everywhere in daily life, in the beer we drink or the *gelato* we lick. In a project on arts at the edge of the sea, we attend to the companion species of the coast, using and developing marine science, blue humanities and art by the long-stretching Swedish coastlines (e.g., Figure 2). Kelp and bladderwrack, invasive Pacific oysters and salmons, crabs and mussels, provide object-lessons for storying exposure (Åsberg et al. 2020; Åsberg 2020; 2023; Jue and Weeks 2023). Rotting seagrass, waves, ebbs and flows, shells, plastic waste, abandoned fish nets, flip flops, and other junk, even washed-up military waste from previous world wars, like sea mines or dumped canisters of arsenic-laced mustard gas, make for a strange multispecies community by the beach (Neimanis et al. 2017).

The trans-corporeal ethics of companion species at sea:

> turns from the disembodied values and ideals of bounded individuals toward an attention
> to situated, evolving practices that have far-reaching and often unforeseen consequences for
> multiple peoples, species, and ecologies. (Alaimo 2008, 253)

It demands cyborg knowing, yet also so much more than critique – it demands the constructive creativity of more-than-cyborg legacies.

Insisting on Adrienne Rich's "politics of location" and Haraway's "situated knowledges", cyborg knowing becomes a portal to understanding all kinds of embodied worldliness and to the development of new modes of storying exposure. To this day, Haraway's cyborg invites critical adventures in exploring the technoscientific globalization of planet Earth, the common languages of algorithms, AI and the Anthropocene. My argument, or rather a suggestion, is here that technoscience studies today need up-dated and *ecologically* situated cyborg knowing for finding common ground and strategic alliances. Yet it will *never work as a universal solution*: cyborg knowing is more like an engine of discovery, putting things in new constellation and new perspective, inviting re-conceptualization. For Haraway, as pointed out by Grebowicz and Merrick (2013, 8), the "cyborg's 'global' is not the philosopher's 'universal'". Instead, cyborg knowing refuses both relativism and totalism by an epistemic embeddedness that takes both science studies and feminist theory far beyond any "standpoint", "identity politics", singular focus on "gender", on "place" or eco-romantic notion of the innocent local.

5. Posthuman in practice

As argued, cyborg knowing thrives in feminist and queer theory practice (cf. Rosi Braidotti, Jack Halberstam), in feminist post-, anti- and decolonial theory practice (cf. Gayatri Spivak, Anna Tsing, Madina Tlostanova), in feminist eco-cultural studies (cf. Stacey Alaimo, Myra Hird, Mette Bryld and Nina Lykke) and in feminist ethics (cf. Maria Puig de La Bellacasa) and of course in the reverse engineering of the humanities that goes on in feminist STS by way of N. Kathrine Hayles, Lucy Suchman and Karen Barad.

I would also like to claim that the socialist-feminist cyborg was a harbinger of the present surge of feminist new materialisms and posthumanisms, but I may be kicking in already open doors in that regard (Braidotti 2013; 2021; Åsberg and Braidotti 2018). Even if Haraway herself denounced the posthuman (in favour of companion species) for the work needed of a more inclusive humanism (Haraway 2006), she invited, what I would like to call the *practices of posthumanities* (Åsberg 2009; 2021). Haraway's cyborg heralded already such more-than-human feminisms, *ecologically, biologically, and technologically situated*. In STS as in Gender Studies, this implies a crucial shift in the feminist modes of attention towards other species, the body and to biology as a scientific discipline of great transformative potential in society. Following recent turns "towards relationality and the enacted nature of entity boundaries" (Stacey and Suchman 2012, 24), even widely termed the posthuman term, the cyborg, I conclude, is an excellent starting point for mapping critical posthumanisms, for what they can do, and how they congeal into epistemic communities and into wider knowledge ecologies to re-invent how we do immersive research in society, as part of society, as part of the world.

The work and life of Donna Haraway, passionately dedicated to both feminism and science, especially biology in theory, has inspired thousands of people both inside and outside academia. She is one of few feminists who have reached very diverse audiences and is cited and sighted at both science and technology studies conferences, in cultural studies surroundings and in gender

studies classrooms. Modern society is entangled in complicated issues of life and healing, death and suffering, of who gets to play and live, who gets to die, and who decides and profits from that. The feminist views to the everyday cyborgs that Haraway proposed was a way of unpacking and holding up for inspection all that. New configurations of knowledge ensue from that.

Cyborg knowing, re-read across most of Haraway's work (and many of her interlocutors, like Bruno Latour, Rosi Braidotti and the rich and layered literatures beyond these stars) and most of all, what it generated in feminist, cultural and STS research communities, I claim, produced an important incentive. It produced the encouragement to respond with *more humane* (if feminist, queer, crip and anti-racist/anti-colonial inclusions can be said to do that) and with a *more-than-human* humanities to the *all too* humanistic impact on ecologies, climate and socio-technical systems.

Today, it has become quite clear to critical thinkers that there is nothing natural or given about how we organize society (Åsberg 2017). That also technology, medicine and science are, to use Bruno Latour's paraphrase, politics by other means. This goes of course for interdisciplinary research in arts, humanities and social sciences too. Following from this there should be nothing natural or given about how we organise our research. In fact, in a world so easily at war there is nothing natural, at all, only the negotiated struggles and prospective alliances with real effects and long-term exposures to peoples, species and environments. For this, I think we need always to rethink how we organise our collective cyborg knowing.

Last in this essay, I want to contend for exactly that kind of reorganisation of lively feminist (critical/creative) research practices and research concepts with impure cyborg roots and routes, between and beyond the disciplines. Research that can help us inhabit the re-invention of nature, and of culture. We need the generative reconfiguration of critical concepts and configurations for situated knowledges. You see, I think we need research that can be *as responsive to change as the world which it purports to critique*.

The cyborg was already for Haraway much more than a metaphor for the joint merging of biology and technology. It collected ideological dreams, fractured identities, borderlands and conflict zones of many kinds, like the bridging of the human species body and other biological organisms, technoscience and society, the virtual and the real (Haraway 1991). It was one possible figuration, an imploded node of fact and fiction, embodied and embedded in the networks of technoscience. An implosion, in contrast to an explosion, concentrates matters. Haraway's cyborg was one such implosion of entangled cultural meaning and materiality with socialist feminist Cold War urgency. She picked out critical threads out of that over-determined, imploded figure (from the contemporary NASA-imaginary) and she re-read the cyborg as a political myth, an ironic parable of processes already embodied and set in motion that not necessarily have to end badly.

The cyborg has potentials still as a reconfiguration of knowledges. A metaphor for modern technoscience, cyborgs points to the collapsing of nature and culture into each other, for sure. Haraway saw the same collapsing of the soft and hard sciences, hard and soft societal powers of subjectivation, making the cyborg a figure of interdisciplinary alliances and non-innocent, temporary identity in a world dividing and connecting in new ways. If Euromodern-type dichotomous thinking about nature and culture, according to Haraway was impossible to uphold in the new world order, then other feminist dichotomies like sex/gender would also be problematized along with the cyborg. The cyborg functioned as a research portal to the

more-than-human ecologies and technologies of contemporary posthumanities.

Over the last decade of academic activism, I have come to term such efforts *feminist post-humanities* (Åsberg 2009b; 2020). Not because we are over the humanities, but because we need it in thicker registers (Lyotard 1991). Such research practices need to move us, motivate us and be move-able across boundaries. In some sense, this entails perhaps the reimagining of feminist technoscience scholarship in more open-ended, less disciplinary, and in more-or less-than-human inventories. To me, feminist practices of posthumanities acts like situated cyborg knowing and prepares the ground for ulterior sets of *minor research ecologies* that may or may not traverse the academic boundaries. After all, the cyborg world respects no academic disciplines – only emergence of whatever may be, and we are, more often than not, surprised of the turns taken. Feminist posthumanities as cyborg knowing defies fatalism and determinisms of all kinds. It is not a practice of DIY, but a DIT – *do it together*.

This type of research practices ventures outside the ivory towers, join hands with activists, artist, science journalists and change-makers of the world. Examples of this collaborative practice are, for instance, the co-op of the UN Ocean Decade's transnational art and outreach project *We Are Ocean* with my research group *The Posthumanities Hub* (see Figure 3), or how art centres (Bonniers, Färgfabriken in Stockholm) or Sweden's Historical Museums are co-funding exhibitions, postdocs and doctoral-employments with the Hub; or how a upper secondary school class in a Stockholm suburb along with youth art activists ("Squid Squad") in rural Gnesta supported with their work and commitment one of our environmental communication projects ("Reclaiming Futures, Storying Change"). These are some recent examples of co-operations and jointly envisioned projects, some successfully funded by research councils, some not. But they all give added value to the cyborg knowing I teach and practice at the virtual, multiversity platform and cyborg lab, *The Posthumanities Hub*.

Figure 3.
Banner of *The Posthumanities Hub*.

Acknowledgements

Notes

[1] See facial image generators, such as: https://this-person-does-not-exist.com/en (see The Research Nest 2020).

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◆

Cyberzoa: Refiguring the Ecology of the Cyborg

Federica Timeto

1. From cyborgs to cyberzoa

This paper sketches out some possible directions for developing a theory of cyberzoa – animal-machine configurations of human and nonhuman animal lives – that prioritize the ecological aspects already present in the feminist cyborg figuration and take into account the more recent debates on the convergence of multispecies ecologies and technologies in the humanities and the social sciences.

This multispecies perspective responds to the call to address the zoological connection (Bryant 1979) in the social sciences and applies it in Technoscience Studies. In technoscience, "human and nonhuman actors [...] are brought into alliance by [...] material, social and semiotic technologies" (Haraway 1997, 50). Even if the feminist cyborg includes nonhuman animals in its definition, and non-feminist cyborg theory relies on animals as models, in both cases, the zoa [Greek: ζῶα] in the cyborg seem to have faded into the background. However, cyborgs are "constitutively full of multiscalar, multitemporal, multimaterial critters of both living and nonliving persuasions. Cyborgs matter in terrain worlding" (Haraway 2016, 105), and this worlding is what all zoa make possible.

Zoa means animals in Greek and is currently used to compose many terms referring to the animal kingdom; although the latter obviously also includes human animals, their social life has nevertheless been distinguished – and used to distinguish human beings – from "bare life" in the Western tradition, being thus defined with the term bios as opposed to zoé. Zoa were members of nature as opposed to (because without) culture, therefore also without technology (Agamben 2004; Braidotti 2019). Arguing for a multispecies, deeply ecological redefinition of the cyborg, the use of the term cyberzoa is hereby proposed to refer to animal-machine configurations including, and paying attention to, both human and nonhuman animal lives and their flourishing, following the consideration of a natureculture continuum

(Haraway 2016) that profoundly undermines the exceptionalism/exemptionalism of the human species (Catton and Dunlap 1980).

Cyberzoa require that we consider extended, multispecies technosocial alliances, as well as whom they benefit and why, and that we do not see technosocial agentivity as merely a human property or capability. Apart from in "exceptional" situations (from Koko the gorilla using a computer to primates on social media taking selfies), unfortunately today nonhuman animals become-with machines mostly – if not exclusively – when they become machines since an active, creative, socially empowering encounter with technologies is still a human prerogative. Let us think about "smart" livestock farming, for instance, whose aim is complete control over the animal's "enhanced" body for optimizing production. Given that the cyborg world that Haraway imagines in the first manifesto (Haraway 1991a) is one in which "people are not afraid of their joint kinship with animals and machines" (ibid., 154), can a world be envisioned in which other living actors in cyberzoa live their technosocial relations without being afraid of their joint kinship with human animals and machines? After all, "[t]he animals make demands on the humans and their technologies to precisely the same degree that the humans make demands on the animals" (Haraway 2008, 263).

2. The current debate on the encounter of ecology and technology

The multispecies societies in which we live, including both human and nonhuman actors, are articulated through complex ecosystems in which biology and technology increasingly redefine themselves and each other. Life is not only seen as technological from its inception and evolution but is also technologized in unprecedented ways, from the geolocalized apparatuses and networks set up for animal husbandry, conservation projects, and warfare to biomimicry and biorobotics. The fields of Digital Sociology, New Media theory, and the relatively new field of Animal-Computer Interaction (ACI) are particularly interested in the convergence between the living and the digital. Most often, however, such convergence continues to revolve around the human as the only species benefiting from it. It is only very recently, due to the current environmental crises and the urgency of finding a different way of inhabiting the world, that the need to reframe the relation between ecology and technology has resurfaced, paving the way for an ecological re-turn to the cyborg: this implies a post-anthropocentric reorientation of both the theoretical interpretation and practical application of this figuration, whose already existing ecological openings have been neglected for too long.

Peters, Jandrić, and Hayes (2021), for example, discuss the "postdigital condition" and advance a critique of technological corporate "solutionism" that embraces the emergence of the biodigital, that is the turn of the biological into the digital and vice versa. Even though the authors understand the biodigital as necessary for the planet in terms of environmental enhancement and renewal, throughout their arguments their objective is sustainability for the human species, which is in keeping with the One Health perspective. Although Peters, Jandrić, and Hayes acknowledge that we live in multispecies societies, they do not infer from this that such enhancement and pervasive management of life, which also relies on an ecologically inflected version of transhumanism, is not at all sustainable in multispecies terms.

In his most recent book, the new media theorist and digital artist James Bridle (2022) also discusses the postdigital condition, referring to many examples of the biodigital sphere. However, many of the examples that Bridle considers take nature and its living beings as inspiration for technological improvements, which, although more ecologically aware, still sees zoa as models and humans as, if not the inventors, then the managers or recipients of such inventions. Analogously, research in the field of biomimicry, in which animal behaviors, organic substances, and natural techniques are recreated in industrial applications, relies on the pluripotentiality of life as the new "driving force of technological innovation" (Johnson and Goldstein 2015, 4) without transforming the current technosocial infrastructure and its power asymmetries. On the contrary, biomimicry even builds new enclosures under the guise of transgressing existing boundaries, "customizing [...] other species to human ends" (Salter 2015, 17).

The digital sociologist Deborah Lupton takes a different position. Some years ago, she wrote about digital data as companion species (Lupton 2016), following Haraway's suggestion that companion species are all those post-cyborg entities coevolving with humans, which create lively, generative assemblages. More recently, Lupton (2023) has recognized that the cyborg figuration can provide the basis for a reconsideration of the emergent ontologies of what we have called cyberzoa, even though she does not go so far as to formulate a critical cyborg theory for the animals that assemble in cyberzoa. She instead describes how new technologies contribute to human-animal relationships at a micro- and macro-political level: a series of technological interventions more or less directly become part of such relationships – from smart devices for datafying wildlife to the e-waste of technological corporations – and the consequences of these configurations need to be carefully handled. Lupton also notes that when the One Health perspective is adopted, the focus tends to be on risk prevention for the human, with the consequence of further instrumentalizing the more-than-human. Some examples include the Internet of Animals, when, for instance, insects are equipped with devices for monitoring climate change, and the numerous projects in which animals that are considered to be pests are geolocated in order to contain and control them.

Trying to overcome the anthropocentrism of the One Health approach, Maya Livio and Laura Devendorf (2022) have written about the "eco-technical interface" regarding "the increasingly complex boundary between humans, the more-than-human world, and human-designed technologies" (ibid., 1). They note that nonhuman lives are usually instrumentalized by the pervasive embeddedness of technologies in the environment and cannot enjoy the possibilities reserved for humans as the only beneficiaries of the value that these new connections produce. Although Haraway is not the primary source in Livio and Devendorf, the boundary condition of the eco-technical interfaces that they describe can "facilitate or constrain relations" among all animals and machines just like the cyborg's liberating or oppressing sides (ibid., 2). They believe that foregrounding the eco-technical interface in design (see also Westerlaken 2020) could be a way of avoiding the further instrumentalization of animals and, at a minimum, providing greater awareness of nonhuman lives and their needs because the difference between care and instrumentalization is easily blurred in cyberzoa.

Among the fields of study focusing on the convergence of the living and the digital is the new field of Animal-Computer Interaction (ACI). Expanding the field of Human-Computer Interaction, ACI emerged "within a cultural climate in which old oppositions between

human agents and natural resources are being increasingly questioned" (Mancini 2017, 130), and which considers animals as stakeholders for designing user-centered and possibly also participatory technologies, ideally leading to designing technologies not only with but also for animals. As Clara Mancini says, ACI deals with animal-computer interactions in the animals' contexts of belonging – be it a savannah, a factory farm or a medical laboratory. ACI is oriented to designing technologies that improve "animals' life expectancy and quality" (Mancini 2011, 70), while also giving them control over the processes that involve them, to minimize negative effects, avoid side effects, and improve interspecies communication. She argues that ACI should always be aimed at animal welfare and autonomy and always obtain their consent. But how can the principles of ACI be implemented in "environments" such as factory farms where animals can never have autonomy because they are "kept" there without being able to enjoy their Umwelt or experience a condition of well-being?

There is an enormous difference between ACI's ethical approach, which is aware of the tensions posed by the asymmetries of existing species, and the promotion of smart farms as a guarantee for the consumer that they can freely access all possible data about the "product" (Jukan, Masip-Bruin and Amla 2017). However, to deal with unanswered questions, ACI scholarship could benefit from navigating the contradictions it encounters (Mancini, 2017) and looking at the "contexts" that surround the design stage, in which cyberzoa are also configured and technosocial relations take place. Perhaps it is not a matter of enabling animals "to make technology happen" (Mancini 2017, 133), but of enabling technologies to let animality happen.

3. Reconnecting ecology and technology within Feminist Technoscience Studies

Notwithstanding the multiple ecological openings offered by the feminist cyborg in Donna Haraway's formulation, the ecological potentialities of this figuration have either been ignored (Hables Gray, Figueroa-Sarriera and Mentor 1995, 2021; Kirkup et al. 2000) or have not been sufficiently focused upon (Grebowicz and Merrick 2013) in most of these debates. Although Feminist Science and Technology Studies have continued to interrogate the constitutive practices of technoscience and their interspecies entanglements (Ferrari 2015), especially concerning biotechnologies, in general a residual humanism has characterized the cyborg interpretation in recent decades. Whereas the figuration of the cyborg has provided fertile ground for scholarship related to the posthuman turn – in fields ranging from philosophy to the performing arts – its potential has unfortunately not gone so far as to erase residual anthropocentrism. A misleading narrative also emerged about "the two Haraways", separated by a presumed Harawayan turn starting from the second manifesto (Haraway 2003) and culminating in her last book (Haraway 2016). Of course, we now read the cyborg in a different historical moment, aware of the meanings of "companion species" (Haraway 2003) and "compost society" (Haraway 2016). Nevertheless, many passages in Haraway's work follow the links between the ecological and technological (Haraway 2004b), which also serve not to separate ecofeminism and technofeminism (Haraway 2004c).

Stacy Alaimo (1994, 133) is the only researcher in feminist scholarship who has already

attempted "to map out a feminist ecological position within and between the cyborg and ecofeminist poles". She notes how the blurring of the boundaries between women, nature and other animals has frequently played on the side of patriarchy and technocracy rather than benefiting the multiple subjects of feminism. The same risk is inherent in the cyborg: "Are the pleasures of boundary confusion appealing enough to disengage a technophilic ideology from a phallocentric politics of domination?" asks Alaimo (ibid., 148). On the one hand, she warns against any acritical glorification of nature and "a conservative environmentalism" (ibid., 137). On the other hand, she considers the figurations of the coyote as more "effective agents for environmental politics" (ibid., 194) than the cyborg. Why the coyote? In some traditions, particularly those of the Native Americans, the coyote plays an important role as a trickster, whose goal is a reversal of the status quo (Timeto 2020). The coyote is a figure of trouble, mingling, and transformation, which can never be taken under complete control. For Haraway, nature is inappropriate/d like the coyote, and so should feminism, which in her view should always escape identification as well as identitarianism (Haraway 1991a; 1992). However, Haraway affirms that the coyote, just like the cyborg or the Oncomouse™, is not a "natural" figuration at all, but is part of a queer family that does not depend on blood ties and includes many other actor-networks falling between nature and culture (Haraway 2004a).

Given the centrality of standpoint epistemology for feminist cyborg theory, it is also worth considering the ecological expansion of situated epistemology formulated by Christina Hughes and Celia Lury (2013), who propose a "thickening" of already existing trajectories to encompass more-than-human lives, stressing the consequentiality of epistemological approaches and interventions. Hughes and Lury suggest:

> a re-ordering of the hierarchy of socio-material relationships in ways that dislodge the human from its apex; a refocusing of agency within practices, including methodological practices, rather than discourses; a returning to the politics of knowledge rather than that of identity; and a retooling of understandings of relationality and change. (Hughes and Lury 2013, 787-788)

As they note, as many sides as actors are involved, which decentres the speciesism hierarchy that privileges the human perspective and requires a multiplication and further decentring of standpoints and their ecological reframing. This move is at the same time epistemological (it makes room for multiple, beyond-the-human perspectives, and their performances), ontological (it dismantles essentialism and human exceptionalism), and political (it prioritizes respectful practices based on the acknowledgement of constitutive relationalities). As Haraway writes, we must learn "to see together without claiming to be another" (Haraway 1991b, 193): cyborg epistemology is situated epistemology, which, not being a human prerogative, makes it well-suited to becoming the epistemology of cyberzoa.

Multispecies co-fabrication and the negotiation of reality at borders (including the borders of disciplines), the asymmetry of partial connections, and the importance of taking sides are some significant aspects of the ecological return to situatedness, as foregrounded by Hughes and Lury based on what the cyborg figuration already makes possible.

4. Refiguring the actors in cyberzoa

This section discusses the importance of considering the composition of heterogenous assemblages as one including humans and both machinic and animal nonhumans, drawing on Haraway's cyborg theory. Indeed, lives are always a matter of composition (Haraway 2008). Both machinic and living things are and form compounds (ibid., 250), i.e., technosocial, naturecultural assemblages working through conjoined heterogeneous agents whose encounters can have very different outcomes. Whereas, more recently, the post-posthuman figuration condensing this concept has become that of the compost (Haraway 2016), in the first manifesto (Haraway 1991a) Haraway still privileges a computer vocabulary and rather focuses on interfaces: she discusses the "informatics of domination" of the "integrated circuit" restructuring women's lives "through the social relations of science and technology" (ibid., 165), and the translation of bodies into codes in both communication technologies and biotechnologies.

The feminist cyborg is an interfacial, historically situated figuration (Haraway 1997) imagined liberating the capacities of interfaced bodies and empowering rather than endangering them. The cyborg stands at the interface between automatons and autonomy, nature and culture, and the organic and inorganic. It engages in the interrogation and rearrangement of the boundaries of human and nonhuman animals and machines, between them and within them. What compounds, interfaces, and compost share, beyond differences in definition, is the fact that humans lose their self-sufficient centrality and nonhuman animals are seen as also endowed with a social agency in them.

For the sake of our argument, it is worth considering an extended footnote in *The Promises of Monsters* (1992, n. 14, 332), in which Haraway critiques Bruno Latour and what she calls his "impoverished collectives". This note comes at a point in the text in which Haraway elaborates on the role that the objects of knowledge have in the processes of knowledge production and the mutual, often unequal, structuring of all material-semiotic actors in these processes. To better understand this controversy, it is helpful to consider what the essay more broadly addresses. Here, Haraway explores what we mean for "nature", foregrounding the continuity of epistemology, ontology and politics like in *A Cyborg Manifesto*. Nature is not an essence or a resource, and even if it can be a commonplace, a topos – which does not imply that it is a textual object without material reality – it is never a given, but always artefactually done by its heterogeneous actors, none of them in the position of mere resource, passive matter or instrument. Articulating the representation of nature is thus necessary to avoid "distance effects" and ventriloquisms and pay attention to these relations and implications in action.

In the abovementioned note, Haraway agrees with Latour that the processes of artefactual co-constitution of nature require "delegating competencies" (Haraway 1992, 298), as Latour would put it. In the context of Actor-Network Theory, delegates refer to actors crucially mediating other actors' functions and actions, extending their technosocial networks. At the same time, Haraway argues that the notion of delegates in Latour's collectives needs to give a proper account of the non-negligible component of such collectives. Cyborgs gather many more actor-networks of technoscience (Haraway 2004c, 307) than Latour's account foresees. Thus, for Haraway, a sociology of technoscience solely considering machines and humans with machines, is incomplete:

> The interfaces that constitute the "collective" must include those between humans and arti-
> facts in the form of instruments and machines, a genuinely social landscape. But the inter-
> face between machines and other nonhumans, as well as the interface between humans and
> non-machine nonhumans, must also be counted in. Animals are fairly obvious actors [...].
> (Haraway 1992, 332)

The symmetrical consideration of machines and humans leads many Actor-Network the-
orists to forget that cyberzoa also include other animals. Furthermore, the fact that machines
perform social relations, and their inequalities requires that systems of exploitation and their
political implications are more explicitly addressed as a crucial component of the technical
content of science without the need to return to the social/technical binary (ivi; see also Wag-
man and Parks 2021). Feminist cyborg studies are aware that "metaphors matter" and "how
metaphors (are) matter" (Cowan and Rault 2022, 6). Machines perform sexism and racism,
and they also perform speciesism, i.e., the presumption that human beings are superior to
other living beings due solely to their species belonging. Speciesism weighs on how nonhu-
man animals connect with technologies, influencing whether they are equated with the ma-
chine pole or can be empowered by the connection like their human counterparts. It is thus
paramount to address the question of cyberzoa.

These systems of domination already mark the story of the first cyborg created after a series
of experiments at the Rockland State Hospital in New York (Clynes and Kline 1995). These
took place in a cyberzoa configuration that involved many human and nonhuman actors,
including a rat, an osmotic pump, the scientists, and their institutional and commercial net-
works: Manfred Clynes and Nathan Kline used the rat as a model for understanding the
empowering effects of neuropharmacological implants on the human body (of the male as-
tronaut) launched in outer space. Specularly, Theseus, the mechanical mouse invented by
the computer scientist Claude Shannon in 1952, is a tiny zoo-robot able to orient in a maze
by trial and error, thanks to a series of relay switches located under the maze (one of the
first examples of machine learning), which served as a model for the behavioural psychologist
James Watson's experiments on living mice that were sensorially deprived so that they could
behave like automata – that is, without autonomy (Timeto 2020). These are only two of the
many possible examples of cyberzoa in which asking who blurs the boundaries, from what
position, and for what reason matters, since not all partial bodies are equally positioned when
they enter technosocial connections, nor do they perform their existences in the same way. If
some can be empowered by these "fusions", others may, on the contrary, be annihilated to the
point of "ontological collapse", the expression that Zipporah Weisberg uses for the conflation
of transgenic animals and techno-economic apparatuses (Weisberg 2009, 41).

5. Conclusions: Towards a theory of cyberzoa

Cyberzoa are multispecies (human and nonhuman) animal-machine configurations, and
the eco-techno-social relations that compose them come with multiple optics and position-
ings. Haraway's works offer many openings for an environmental politics of cyberzoa with-

out the nostalgia for a lost Eden that seems to guide, for example, current experiments in de-extinction. "Refiguring the actors" of technoscience (Haraway 1992, 297) is an essential step towards the achievement of naturecultures that "ha[ve] many houses with many inhabitants which/who can refigure the earth" (ivi). Refiguring, though, means paying attention, implies respecting and should lead to acting differently.

Following these suggestions, this paper tried to envision some helpful starting points for a theory of cyberzoa that draw on the ecological features already present in the feminist cyborg figuration and take them beyond. To refigure the ecology of the cyborg and get rid of the residual anthropocentrism that the posthuman interpretation of the cyborg still retains: first, the most often ignored boundary breakdown between the human and the nonhuman animal must be included when discussing the interfacial condition of the cyborg, a starting point for an ecological opening and employment of technoscience; second, the species performances of the machine should not be ignored. A cyborg theory for the animals goes beyond acknowledging that nonhuman animals are part of the technosocial collectives in which we live together with machines and requires that theoretical and practical perspectives are reoriented in a post-anthropocentric, not solely posthuman, direction. Paying attention to nonhuman animals means being aware that technosocial relations of cyberzoa perform inequalities and systems of exploitation that call for a simultaneously situated and ecological consideration of "symmetry", to reconnect the onto-epistemology of the cyborg to its politics in an expanded eco-technical environment.

Technosocial relations are performed in context, meaning that technologies are ecological since they are used in specific ecologies and contribute to maintaining, altering, or co-creating them. If situated epistemology is the epistemology of the feminist cyborg, an ecological situated epistemology (Hughes and Lury 2013) is well suited to become the epistemology of cyberzoa. A theory of cyberzoa will need a politics of knowledge that considers how its multispecies actors are positioned, whom the extended technosocial relations of cyberzoa benefit, and whether animals' encounters with machines take place in ways that are active and empowering for them or lead to further instrumentalization.

A theory of cyberzoa will question whether nonhuman animals can experience, in different moments of their involvement, from design to actual use, the same possibilities that the cyborg potentially offers to human animals, that is, if such machines and assemblages can work *for* the animals as well as being as, on and from them. Questions such as that of Mancini (2017) on how animals experience a change in interaction with technologies should be explored further, considering what kind of human-nonhuman relations are made possible through the mediation of technologies, for whom, and for what reasons, but without overlooking the contexts. An investigation of unequal power relations and different social relations is paramount: an ecological refiguration of the cyborg will start from here since no optic comes without a positioning (Haraway 1991a). From a feminist cyborg perspective, considering cyberzoa means paying attention to the inequalities and risks at stake, rather than just the possibilities, which should be promising for all the lives involved.

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STS Invaders: Gaming as an emerging theme for Science and Technology Studies

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Abstract
Video games represent a significant part of the digital revolution that swept over our contemporary society. Although these socio-technical artefacts can be seen as a network of human and non-human actors, STS literature on this theme remain scarce. Therefore, this *Scenario* aims to fill this gap by delving into gaming through a three-sided move: first, it will present a review of the few extant works that tackle, even tangentially, the theme through an STS lens; secondly, it will draw from game and media studies to highlight concepts that may bridge the different scholarships and be useful for future STS contributions on video games, but also how gaming evolved into eSports (i.e., competitive gaming) and what it means for STS; finally, it will display through the empirical example of gaming houses how an STS approach may benefit the study of gaming. Conversely, these structures where professional players gather to live and work/play together will show how gaming and its declinations may constitute a useful breeding ground for original STS conceptualisations.

Keywords
gaming; eSports; sociomateriality; STS.

1. Introduction

During a dazzling history, games have evolved from technical efforts to diffused pastimes (Borowy and Jin 2013; Kent 2001, 2021). Even if their roots date back to the first digital infrastructures, these playful technologies have only recently swept over the broader social panorama, contaminating even the supposedly distant spheres of work and education (Venero 2020; Walz and Deterding 2015). This development resulted in a "ludic society" (Mäyrä 2017) in which digital games replaced or reshaped multiple sectors of daily life. The further introduction of eSports (i.e., competitive gaming) confirmed video games as one of the leading entertainment economies (Newzoo 2022), constituting both a profitable and sportive venture able to attract millions of followers (Ludwig et al. 2021; T.L. Taylor 2012, 2018).

Although scholars from different fields have already demonstrated interest in gaming (e.g., Thornham 2016; Vesa et al. 2017), academic literature still looks skewed, with most contribu-

tions focusing on either the technical features (e.g., Sjöblom et al. 2019) or the economic specificities (e.g., Scholz 2019). But what would an STS scholar see when entering an arcade or turning on their favourite console? This *Scenario* will try to answer this by introducing gaming as an area of research through a brief exploratory review of extant STS literature touching on this theme, but also a case study highlighting a possible way to bridge gaming with an STS approach.

The exploration of the varied, although limited, papers will present the core insights explicitly linking STS with gaming. Instead, the in-depth analysis will describe one of eSports most peculiar phenomena: gaming houses. These structures represent a research field where the socio-material components may particularly benefit from an STS perspective, as the activities defining them are mainly built upon a complex network of social and technological elements. Moreover, plunging into an empirical example may symbolise the most straightforward way to bridge the inchoate STS scholarship on games and eSports with insights from other academic fields, such as media and organization studies, which have already produced works about games and gaming.

Finally, before delving into the core of this *Scenario*, it may be useful to draft an orienting definition of what gaming is and how (video) games can be conceptualised. Since the first pioneering studies of Huizinga (1938) and Caillois (1958), the study of games has struggled to define its research object. As brilliantly highlighted by Mäyrä (2008), some authors decided to focus on the functions of games, giving birth to what are defined as "formalist" approaches (e.g., Sutton-Smith 1997). In contrast, others preferred reflection over the "dualism" of games, i.e., their essence as "half-real" systems organised by rules and fictional elements (Juul 2005)[1]. For the sake of this *Scenario*, the following definition will be adopted: "[a game is:] an interactive structure of endogenous meaning that requires players to struggle toward a goal" (Costikyan 2002). In other words, games are built around the interaction of a structure, mainly shaped by the rules forming the gameplay, and the activity of both players and fictional elements that imbue the actions with a meaning arising from the playing itself (Mäyrä 2008). Following this definition, gaming represents the act of playing digital games, i.e., digital artefacts that usually implement a network of technologies, like consoles, monitors, and peripherals, to frame the players' goal-oriented struggle. To introduce some of the points that will be further elaborated during the *Scenario*, it must be noted how the already cited eSports phenomenon posed some criticisms to the abovementioned definitions. The distinction between casual and professional gaming reveals how ephemeral the division between work and play is, thus further underscoring the fluidity of games and the difficulty of unequivocally circumscribing such artefacts and the practices surrounding them (Mäyrä 2008).

2. A brief voyage into the STS literature on gaming and games

At first sight, an activity created and sustained by a complex and interdependent network of technological, material, and social components, i.e., playing (video)games, should constitute an elective affinity for STS, as one of this field of study's main interests relies on unpacking the sociomaterial assemblages that form both non-human and human activities. However, a quick look into academic literature will reveal how few studies have tried to approach games with an STS perspective, leaving aside the deepening of development and playing practices

related to modern ludic technologies. Nevertheless, the attention drawn by STS and their core concepts and theories, like ANT (Latour 2005) and infrastructures (Star and Ruhleder 1996), has brought scholars to adopt this perspective to enrich their discussion on games. Therefore, in the following lines it will be presented a brief review of the extant contributions touching, even tangentially, the theme of gaming through STS lenses, showing how gaming has benefited from STS concepts and how, in turn, games have contributed to enrich STS literature with new insights. This exploration will present the results of a set of searches conducted by the author in the scientific database Scopus. Even though the query used was simple, i.e., a combination of "game(s)" and "STS" words, the results were limited, concentrated over the last two decades, and almost all written in English. Therefore, the author has decided to include contributions dealing with analogic games, like cards or tabletop, because of their connection with their digital counterparts. Analytically those games represent proper antecedents of video games in many aspects, such as "immersiveness" and the affordances they entail through rules (e.g., the permitted moves in chess) and material artefacts (e.g., dice).

Delving into the literature explicitly linking games with STS themes and concepts, it stands out how some researchers have tried to adapt this wide-ranging scholarship to the study of games in multiple ways, as will be presented in the following lines. The contributions mainly used STS as a theoretical background to further enrich their framework or present reflections on socio-technical elements tackling just partially video games. Nevertheless, some works dealt with more fine-grained analyses of technical assemblages related to games, using ludicrous artefacts to deepen or describe STS theories. Finally, the papers which constitute the most structured endeavours in integrating an STS perspective toward the study of games, intended as networked entities made of relations between heterogeneous elements, will conclude the section.

The first effort of "transposition" of STS concepts to games was made by Jakobsson and Pargman (2005), who used the concept of black-boxing to describe how an open-world massive multiplayer online role-play game (MMORPG) called *Project Entropia* hid to players the microtransactions needed to remain in the game. Although black-boxing should here be intended as an unquestionable conceal of developers' ideas inside the technology, authors also present resistance practices emerging from players, such as cheating or exploiting game "bugs" (i.e., errors or glitches), viewed as processes of "open the box".

Also, Lammes (2011) adopted a concept from STS, Latour's immutable mobiles (Latour 1990), to grasp how spatial representations are constructed and played out in various digital games. Although better explained in her subsequent papers (Lammes and de Smale 2018; Lammes and Wilmott, 2018), the author analyses map-based games (e.g., *RunZombieRun*) as Latourian mediators performatively engaged in producing new spatial meanings (Lammes 2011; Latour 1990, 1993b, 2004), as well as "navigational interfaces" (Juul 2010; Lammes 2011) signifying the movements of players well beyond a simple mirroring of their moves on a game-board.

O'Donnell's works (2013, 2014) approach the topic from another side by examining the network of technical and social elements incorporated in the development of video games. The author shows how sociotechnical entities like homebrew communities and "pirate" MODs chips are involved in the negotiation of the meanings related to (co)creation practices and development processes of Nintendo's video games (O'Donnell 2013, 2014).

Continuing the explorations on how contemporary games are constructed, Whitson

(2018) underlined how game-developing software implemented by creative teams exhibits magical agential properties. Importing the concept of "boundary object" from STS literature (Star 2010; Star and Griesemer 1989), her paper shows how this third-party software transforms from silent and obedient objects to "voodoo software" which expresses their unique agency by intersecting the different communities of practice involved in the creation of videogames (such as artists, engineers and managers).

Hansbøl (2010) and Hansbøl and Meyer (2011), instead, move into the didactic use of playful artefacts, as they merge an STS-informed analysis with a focus on an educational game (called *Mingoville*) to assess how students incorporate such technologies into their studying and playing practices. Notably, the use of games inside schooling contexts is also the focus of the ground-breaking paper from Muñoz and El-Hani (2012), further commented by Kwah (2012), who elaborate a framework for including more commercial games (e.g., *Fallout 3*) into a learning "cyborg curriculum". For these authors, citizenship education must help students build their identities through the technical and social influences they experience inside and outside school, for example, by accounting for (and criticising) the technopoly we live in nowadays (Postman 2011). Also, Anupam (2021, 2022) explored the games' affordances and constraints when applied in learning contexts, focusing on their ability to convey concepts of positionality and situatedness into the teaching of scientific inquiry.

The pedagogical standpoint was not the only field of study "contaminated" by STS ideas. The implementation of concepts related to technological assemblages and the reciprocal influence they share with society is a trait also shown by Schoppmeier (2021), who intersected such scholarship with critical race theory to analyse the depiction of surveillance regimes and their impact on BIPOC people in a famous videogames series, Ubisoft's *Watch Dogs*.

On the other hand, both Argamakova (2017) and Ghys (2012) dealt with different representations of technological progress and how they relate to social change. Although Argamakova's (2017) work about socially shaping technologies only skims serious games and gamification, the study of Ghys (2012) delves deeper into how technological determinism is embedded into historical games and represented as a relentless force determining social structures and political configurations.

If the previous works were mainly carried on by including STS concepts into reflections on games, another part of the extant literature is involved in an opposite effort, including games and ludic interfaces in science and technology studies. The most theoretical papers going in this sense are the ones by Nowak (2017, 2018), who uses the Chinese game *Go* (or *Weiqi*) to materially depict the philosophical paradigm change represented by the ANT model (Latour 2005). In his reflection on the demarcations between classic ontologies and relational ones embedded in Latour's works (Latour 1993a; Law 2004), he parallels such distance to the differences between Western chess and the game of *Go*: the lack of internal properties of pieces, as well as the non-linearity of the development and reading of the chessboard, are some of the notable distinctions that Nowak reflects upon (2017, 2018).

Interestingly, Mair and colleagues (2021) also use *Go* as a rhetoric artifice to linger on theoretical positions. Specifically, they engage a specific move of the renowned match between Google DeepMind's AlphaGo (an algorithm designed to outperform human players in the game of *Go*) and the human world champion at the time, Lee Sedol. In this human-versus-machine challenge where the AI blatantly defeated the champion, a nonsensical move made by AlphaGo and the

associated commentaries are read as a "descriptive assemblage" (Sacks 1963) able to reveal the politics of anthropomorphisation and familiarisation of AI technologies in our contemporary society.

Only few authors, though, merged STS and game studies in ways that enriched both scholarships. Indeed, the contributions from Bienia (2018), De Paoli and Kerr (2010), Johnson (2018), and Taylor (2020) constitute significant examples of how gaming and eSports could benefit from an STS perspective, but also how such influence can flow the opposite way.

Starting from the chapter drafted by Bienia (2018), he expounds on the core STS concepts before delving into a review of the studies dealing with role-playing games (RPGs) tackling the issues by analysing their networks of actors. Then, he highlights how the "material turn" happening in game studies echoed with the adoption from many scholars of STS theories and introduces a reflection on the role of material artefacts in a table-top RPG session (and house).

That materialities like dice and cards can actually "make other actors do things" (Bienia 2018; Latour 2005) is also the starting point of the study from Johnson (2018), who analysed the sociotechnical controversy emerged between two professional gamblers and casinos. The gamblers used a set of collaborative social processes and, most of all, technical faults to engage in "edge-sorting", a convoluted process of determining cards' values through their patterned back. The core of the dispute was the tweaking utilisation gamblers made of the automated dealing machines that, when coupled with a specific set of cards chosen by the gamblers, could be translated into an advantage for the two gamblers. Thus, the players could unmistakably detect the value of the cards after some warming-up deals thanks to this network of "translated" actors' relations. In other words, the two baccarat players were accused of cheating, as they won millions by exploiting flaws in the global gambling system and reconverting material affordances in their favour.

Practices to obtain an unfair advantage are also the focus of the work by De Paoli and Kerr (2010), who draw from a sundry literature to propose a rethinking of cheating as an "imbroglio". Thoroughly examining a set of empirical examples ranging from (illegal) fishing to MMORPG's third-party software, the authors deconstruct the essentialist view on cheating by highlighting how are multiple actors' interactions that translate some actions into cheating and some others not. Then, they build upon the concept of "assemblage" (DeLanda 2019) and the Italian term "imbroglio" used by Latour (1999) to suggest how this form of counterplay relies on a multiplicity of sociotechnical elements, like bots and other automated procedures run by cheating gamers.

The impact of automated machines resonates with the pioneering study by Nicholas Taylor (2020), who projected the STS into the eSports scene. His interest revolves around the translations occurring inside eSport teams, springboarded by the field research he performed with a collegiate U.S. team of *League of Legends*. After discussing the digital affordances of the title itself, Taylor underscores how game mechanics shape sports outlets and players' performances (2020). Metas, a *League of Legends*' jargon meaning temporarily overpowered moves or characters, and the banning process taking place before the matches, are prime examples of in-game elements that influence the enactment of the sport performance. Moreover, the author delves into the role that statistics and match replays are starting to assume in both digital and analogical sports disciplines. Taylor claims that eSports may be seen as the peak point of a quantifying paradigm that is knocking out how athletic feats are intended (2020). This "lateral surveillance" (Andrejevic 2004) was deeply rooted in the game's affordances, third-party technologies tweaking them, community habits and policies redacted to organise such behaviours in official leagues. Indeed,

the data-intensive approach fuelled by the pervasive spreading of technologies into sports disciplines, so clearly exhibited by eSports competitions, may constitute an innovative translation of the significance attached to (human) athletic gestures, which become traceable and measurable (even by automated machines) but also quantitatively refinable (N. Taylor 2020).

To conclude this explorative search in the literature touching the theme of games treated through an STS lens, it must be highlighted how some papers dealing with platforms and infrastructures have shown interest in digital games as well. If in some works of the conference track on platforms reviewed by Bonini and Magaudda (2022) the reference to games is just referential, the contribution from Rudenko and Shirokov (2018) is more oriented toward the entanglement these media infrastructures displays with digital games. Finally, the recent paper from Köhn and Siré (2022) highlights how Cuban gamers communities play a crucial role in the grassroots computer network of the isle and how materialities, social structures and collaborative politics are all played out and geared into a vernacular infrastructure pushing for new relations and new political identities.

3. The evolution of gaming into eSports

The scattered and dispersed nature of the scholarly production dealing with games and eSports is somehow countered by the rich and emerging field of game studies and the deep interest that other academic areas, like media and organization studies, have shown in the late years (e.g., Thornham 2016; Vesa et al. 2017). Even from the first core works, which pointed out how gaming plunges its roots into the digital revolution and the first steps of computers (Jin 2020; Scholz 2019), gaming and eSports have been depicted as a complex system of material and social innovations (Kent 2021, 2021; T.L. Taylor 2018). Furthermore, distinguishing the competitive facet of gaming is beneficial not only as an analytical nuance but, most remarkably, because the competitive declination of playing video games seems to exacerbate the sociotechnical entanglement that the more casual postures may not reveal (N. Taylor 2020). As authors have already highlighted (Consalvo 2017; Scholz 2019; N. Taylor 2020; T.L. Taylor 2012), professionalisation stances went along with a progressive translation of the meaning associated with playing practices, thus transforming this leisure pastime into a set of activities built on a relation of human and non-human nodes of influence (Bienia 2018).

Since the early Eighties, when the so-called "arcade explosion" (Borowy and Jin 2013) brought in games like *Space Invaders*, *Pac-Man*, and *Donkey Kong*, these technological advancements joined the steep rise of entertainment industries, interested in translating playful pastime activities into value-laden products (Borowy and Jin 2013; Scholz 2019). Despite some failures (Scholz 2019; T.L. Taylor 2012), the first aspirational tournaments coupled with the growing digital industries (Woodcock 2019) and the diffusion of the experience economy (Borowy and Jin 2013), drastically raising the number of users and showing a propensity to datafication of playing practices through top scores and official, although amateurish, gamers rankings (Scholz 2019; Seppala 2018).

A further step toward the networking and professionalisation of gaming was the rise of Internet communication, which gave birth to new relations between competing players and machines (Scholz 2019; T.L. Taylor 2012; Woodcock 2019). Moreover, the opportunity to

transform standalone computers into (temporary) networks of communicating devices (T.L. Taylor 2012), i.e., Local Area Networks (LANs), signalled the emergence of new forms of social assemblage (see also Köhn and Siré 2022). The talented gamers emerging from these provisional and often amical clusters (Thornham 2016), then, expressed the desire to compete on higher levels, pushing for the mobilisation of humans and machines to establish the first LAN parties (T.L. Taylor 2012). These events comprised both the materialities of gaming practices and some primaeval forms of organization and institutionalisation (Scholz 2019), as gamers had to carry their machines and peripherals to the venues. Thus, the construction of LANs requested both the possibility to relocate for a weekend and some technical knowledge to operate the connections (T.L. Taylor 2012).

The final shapeshifting of gaming coincides with the appearance of the first teams between the 90s and the early 2000s. New organizational features, as well as the definitive grasp of professionalising ambitions among players and developers (Scholz 2019; T.L. Taylor 2012), brought the by-now-established gaming industry to support local leagues, where more stable groups of players shifted from aspirational labour to the first forms of contracts (T.L. Taylor 2012). This was the official birth of eSports (i.e., electronic sports) or organized video game competitions (Jenny et al. 2017). In a more substantive definition offered by Taylor (2016), eSports entail:

> the enactment of video games as spectator-driven sport, carried out through promotional activities; broadcasting infrastructures; the socio-economic organization of teams, tournaments, and leagues; and the embodied performances of players themselves. (ibidem, p. 116)

As the definition highlights, the organizational, material, and human actors involved in this new form of activity are multiple, different and deeply entangled with each other (Hölzle et al. 2022; Scholz 2019). Neither a sport discipline nor a leisure form of pastime, the core figures of eSports are professional players (or pro players), seen alternatively as consumers and athletes (Jenny et al. 2017), who are engaged by teams and platforms into contemporary forms of playbour (e.g., Kücklich 2005; Woodcock and Johnson 2019).

The following section will present gaming houses, one of the most intriguing peculiarities that emerged in gaming. An emblematic space blossoming around the competitive structures and entailing many of the technological innovations shaping the field, like modern consoles, high-end PCs, and audio-visual peripherals, these houses will be tackled through the analytical lenses gathered in the introductory paragraphs.

4. An empirical ground

Gaming houses can be described as cooperative living arrangements where groups of professional gamers (or "pro players") live and compete together (ESL 2014)[2]. These houses entail an ecosystem of human and non-human actants, creating a technologically dense environment where the material, digital and social dimensions are played together to build what is considered one of the main tools for professionalisation in gaming (Byrne 2019). The analysis of gaming houses will be divided through three axes, comprising what can be seen as

the organizational pillars around which they construct their activities: digital infrastructures, physical and built environment, and social structures. These three thematic cores recall and resonate with fundamental elements the gaming communities highlight when discussing the specificities of gaming houses and are used to (self)represent the role of these same houses inside the broader gaming ecosystem (Billy 2015; Jacobs 2015).

4.1 Digital infrastructures

The first essential feature of gaming houses is their embedding of digital components and how they reflect upon the other two facets of the social and physical structure. First and foremost, Internet connection quality is claimed as an unavoidable element (Fogaça 2021) and is used to transform the players (repetitive) activities into value-laden, meaningful acts of training, streaming and competing for prizes.

If the primaeval tournaments took place face-to-face and were built upon a local network of interconnected computers (Scholz 2019; T.L. Taylor 2012), the bandwidth available nowadays makes physical presence unnecessary. Guaranteeing playability and reducing the latency are now achieved through "invisible" infrastructures that manifest themselves only at their breakdown (Star and Ruhleder 1996) or when they impose physical implementations to function (Köhn and Siré 2022). For example, this infrastructural element lies behind the clustering tendency of gaming houses: not only do they gather around tournament venues to reduce travel expenditures, but they also muster near well-serviced zones, supporting further investments by local authorities (Jin 2020).

Digital infrastructures are crucial also to allow streaming practices among pro players, as both grey and academic sources show that pro players and teams dedicate a significant amount of their daily time to streaming their online efforts (Hölzle et al. 2022; Hood 2018). Gaming houses fostered such practices by implementing technical and material innovations: new spaces for streaming started to be a commonality inside facilities, as well as soundproofing materials, video making props, specific gear and dedicated peripherals (e.g., Di Donfrancesco 2021; NemosTV 2019).

Organizations which decided to follow this new professionalising track, allocating most of their resources to the "streamability" of their environments, also had to face the maintenance practices associated with the choice. As instalments like the "Thoom House" highlight, the efforts required for upkeeping the infrastructural resources constitute a potential weakness for gaming houses. As a matter of fact, simple network problems and connection failures can bring a social backlash that negatively affects teams' brands for a significant period (Victoria F, 2022).

However, streaming is not the only activity taking place through the digital infrastructures of gaming houses, as they are also crucially related to social media and digital platforms for tournament organizing, as well as for establishing relations with users and consumers. This fuelled the establishment of a network of collaboration where professionals and services are consequently played out for either enhancing the media presence of gamers or their performance in official tournaments. Thus, amenities and services entailed in the houses, from jacuzzis to video making, are translated as unavoidable supplements for those seeking to shift from casual to professional gaming.

Indeed, these new technological actors also present "side effects" over the life of gaming house dwellers, which even the players often underestimate. Health concerns like the psycho-

logical effects of intimacy disruption (e.g., Izento 2019), stressful environments (e.g., Jacobs 2015), and more severe psychophysical consequences related to heavy gaming and poor living conditions are among the most stinging points in the eSports field. Platforms' politics related to users' commodification and infrastructural requirements, like forced co-presence inside houses, often lead gamers to dangerous situations where temporal boundaries disappear into a chaotic concoction of endless screen hours, eating disorders and substance abuse (theScore esports 2019). Therefore, a more careful study of how these technologies act as mediators in the network of relations composing professional teams, as well as the broader eSports environment, may give essential suggestions on how their agencies are differently enacted and translated by the actors (N. Taylor 2020), and eventually tackle their fallacies.

4.2 Physical structures and built environment

If space constitutes the material substrate of many social processes (Löw 2016), then a careful look at gaming houses' objects and architectural arrangements will reveal the affordances houses' artefacts allow, as well as the honing through which many of these objects went through the practices of pro players. Most of the artefactual implementations join the digital services inside the walls of the shared households to respond to a drive for improvement, as gaming houses rhetorically justify themselves with discourses over talents' convergence and crafting similar to narratives outlined by other emerging sports disciplines (Hood 2018; Mattei 2021).

In their transmogrification of housing spaces into a fully-equipped sports facility, many gaming teams centred their efforts around the "scrim room" (i.e., "scrimmages", a jargon term from *League of Legends*), which often occupies the central and larger zone of the household (e.g., HyperX 2015). Through their central positioning, these collaborative areas unambiguously concur with the houses' tendency toward reconverting shared spatial temporalities into training and performing practices, thus also re-signifying the social connections among inhabitants. Remarkably, the centrality of this space is also due to the infrastructures needed for official gaming matches and training, as linked computers and robust networks require a stable energy supply, space to host the hardware, human resources, and props to enhance both gamers' likeability and their performance (Jacobs 2015). Architectural elements, like lighting and sounding furniture, are not only used to simulate the official face-to-face tournaments situations, but also to "constantly stage" players, both metaphorically and literally (through vlogging).

Gaming houses are engaged in a spatial and temporal orchestration of activities and relations inside their walls. A hyper-specialisation of spaces where one or more rooms of the houses are reconverted to specific purposes and re-signified through the re-organization of their furniture and scope (Jacobs 2015). As a matter of fact, houses' spaces are also structured to arrange gamers' spare time, which is implemented as spatially and temporally complementary to training. Gyms, cafés, cinema rooms, and courtyards are the nodes of the spatial scheduling around which players' daily routines are constructed. Nevertheless, professional players often find themselves moving from one desk to another or even playing (and streaming) from their beds, which invariably stand in front of one of the ubiquitous screens (Zelauskas 2018).

Moreover, physical training spaces are added to the digital services in the performance-enhancing program of gaming houses: gyms filled with high-tech equipment transform the

healthy "workout" into a job itself, part of professionals' duties. Nevertheless, the performance-centred translation frequently overflows even over the social areas, leading to their use as socialising tools that boost team coordination or as streamable props (Marsh 2022). In other words, the architectural affordances and the digital infrastructures entailed in gaming houses "offer" professional players the opportunity to move from (digital) gaming for professional reasons to playing (analogically and digitally) for leisure, in a nearly inescapable choice that centres their life over the (constantly re-translated) playing practice.

4.3 Social structures

The third pillar, or group of actors, enforced in the translation of playing practices is the gaming houses' entire social structure, which supports gamers' professionalisation and maximises their performance. Because many players deem life inside gaming houses as socially exhausting and unsustainable for extended periods (Izento 2019; theScore esports 2019), the implementation of additional figures represents a double-edged attempt: on the one hand, professionals are implemented for a healthier workspace (Hood 2018); on the other hand, the support fosters the shift toward professionalisation of players, both through performance enhancement and a progressive alignment of gaming practices to other sport disciplines (Sacco 2019; Rawles 2021). Many of the professionals guiding pro players during their training (and leisure) moments are (ex)gamers who managed to build a career on the knowledge and experience gathered in the field (e.g., 100Thieves' founder, Nadeshot). Thus, the resulting network of know-hows and professional experience is often deployed through the mediation of digital infrastructures, which helps manage schedules and boundaries between working hours and free time (Retegno 2017).

In some cases, the players have to bear the additional tasks and responsibilities, like housecleaning or cooking for the rest of the team (e.g., Jacobs 2015; Retegno 2017). Interestingly, some gaming houses assign work-life boundary features to other domestic resources, like disanchoring objects or specific areas: an example in this sense are foyers and corridors, which see their material significance further layered by being assigned the role of spatial mediators. Alongside performance-centred professionals, also service labourers entered gaming houses' walls: housekeepers and chefs divide the living spaces with other maintenance figures, like technicians and handypersons.

Finally, the collaboration with videomakers and marketing managers further enmesh streaming and social media networks into pro players' practices, thus producing complex assemblages where people and infrastructures merge to create some of the core organizational features of a prototypical gaming house. The variety of actors presented contribute in different ways to the enhancement of players' performances, as well as houses and equipment maintenance; however, they also reinforce the professionalisation of the players by defining the figure of the "e-athlete" (i.e., the professional player) and delimiting its rights and duties inside a more formal training and gaming environment (Hood 2018; Zelauskas 2018; theScore esports 2019; Rawles 2021).

5. Conclusions

This *Scenario* has tried to summarise the emergent works of STS, media and game scholars to organically present gaming as a viable theme for the analysis through STS concepts. As the literature review has highlighted, the possibilities to approach this theme are endless, as games have spread into nearly every facet of contemporary societies. The fluidity of the term "game" allows the researchers to tackle such objects through many perspectives, from pedagogy to production studies. Notwithstanding the field from which the contributions came, all authors discussed and agreed on attributing agency to games, either through their materialities (like cards or gameboards) or by scoping their digital affordances (from game mechanics to streaming processes). Facing such variability in the assemblages that result when dealing with people playing games, papers used concepts elaborated by STS scholars to detect, follow, and assess the weight of technologies and material artefacts in the playing practices. For example, boundary objects and infrastructures, both concepts coming from Star and her colleagues (Star and Griesemer 1989; Star and Ruhleder 1996), were used to retrace the role of both software (Whitson 2018) and physical entities (Köhn and Siré 2022; O'Donnell 2013) in the different stages of game development, diffusion, usage and spillover into surrounding social environments.

The empirical example of gaming houses displayed the richness of possibilities that an analysis guided by STS can bring to the gaming environment. Redirecting the attention to a physical space inside which gaming represents the core activity allowed to depict the assemblage of human and non-human actors involved in the households, thus deepening the understanding of the composition of these eSports venues and their inhabiting practices. By highlighting how technological, social, and physical structures enmesh to form a working gaming house, the hope was to stress the importance of these facets, as well as hint at the possible expansions that STS scholars may contribute for. As a matter of fact, gaming and its linked eSport disciplines constitute a prime example of networks in which even small changes in peripheral nodes, like technical faults to be exploited (e.g., Johnson 2018), may radically alter the power relations between the actors. The gaming houses, then, represent a field where it is possible to trace these actors moving and interacting, given the material and expressive bordering that households' walls represent.

Moreover, a study of gaming houses may also include a thoroughgoing analysis of the surging role that both games and digital technologies are assuming in our contemporary society, where the apparent vectors of dematerialisation pair with a silent rising of importance by the infrastructures sustaining that same virtuality. Indeed, games are one of the empirical terrains where many contemporary technologies are deployed or engaged for critical discussion (e.g., Schoppmeier 2021; N. Taylor 2020), thus an elective field for any scholar interested in unbiasedly appraising the role of such innovations. If, like the extant contributions shown, some researchers have already cached the opportunity that gaming offers for novel academic insights, much more can be done. More fine-grained analyses may tap into the role of gaming technologies in fostering "cyborg identities" (Muñoz and El-Hani 2012) in both casual or professional gamers or how the skills refined through hours of "grinding" (i.e., repetitive goal-oriented playing) could spillover to other (social) practices (Köhn and Siré 2022). Finally, the "double-edgedness" of gaming houses and the practices they host may constitute a crucial reservoir for innovative conceptualisations, like the ones proposed by De Paoli and Kerr (2010) or the

"platform" explorations presented by Bonini and Magaudda (2022). The match between STS and games is beginning, and it could offer some spectacular counterattacks from both fronts.

Notes

[1] To give a sense of this elusiveness, an independent game developer even created a random generator of plausible definitions of "game", which can be found at http://www.gamedefinitions.com.

[2] Although gaming houses represent an established phenomenon for eSports, the academic literature describing their structuring and functioning is minimal. Therefore, many of the sources tapped in the following paragraphs will be non-academic: even if these sources may decay or be unavailable in other geographic areas, they currently allow for a good compromise to ground the claims of this contribution.

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Les sciences et les techniques, laboratoire de l'Histoire: Mélanges en l'honneur de Patrice Bret
[*Science and technology, the laboratory of History: A collection of essays in honour of Patrice Bret*]

by Liliane Hilaire-Pérez and Catherine Lanoë (eds.) (2022) Presses des Mines.

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The STS-adjacent disciplines of the history of science and the history of technology have undergone many of the same changes as STS. In both disciplines, for example, there has been an increasing emphasis on peripheries and on material practice. For decades, the eminent French historian of science and technology, Patrice Bret, has been at the forefront of these changes. Liliane Hilaire-Pérez and Catherine Lanoë's edited collection *Les sciences et les techniques, laboratoire de l'Histoire* (2022) is an homage to Bret. Many of the chapters thus relate to the historical time period in which Bret specializes: the second half of the eighteenth century and the first half of the nineteenth century, a period marked by the collapse of the Ancien Régime, the tumult of the French Revolution, and the Napoleonic wars. Hilaire-Pérez and Lanoë argue that Bret's influence was such that it exceeded the bounds of his own discipline, causing traditional historians to take up the methods and the objects of study of historians of science and technology. Hilaire-Pérez and Lanoë's edited collection is clustered into thematic groupings, with each section emphasizing a different aspect of Bret's influence. The first part is devoted to the relationship between science, technology, and the state. The second part centers on chemistry, a domain that blurs the boundaries between science and technology, as the science of chemistry has always been bound up with technological innovation. The third part relates to the circulation and translation of knowledge, between and within nations and continents, while the fourth part is concerned with the role of women in science and technology. The common thread, as the editors remind us, is the emphasis on the marginal figures – Jean-Claude Pingeron, Jean-François Fontallard, Gilbert Romme and Peter Simon Pallas, for example – and the material practices – such as translation, indexing, and care work – that enable the circulation of knowledge. This focus on materiality and marginality stands in sharp contrast with the concerns of earlier historians of science. Over the past few decades, the object of study of the history of science has shifted from the internalist study of intellectual history – the content of science – to the externalist study of its social context (Shapin

1992). Similarly, the previous emphasis on the study of major figures, situated in the European or North American metropoles, has given way to an emphasis on secondary actors and peripheral locales. Finally, the strict demarcation between the history of science and the history of technology has collapsed, as has the demarcation between history and the social sciences. All of these tendencies can be discerned in *Les sciences et les techniques*. For example, whereas an earlier generation of historians of science largely limited themselves to the study of "great men", such as Lavoisier or Linnaeus, Virginie Fonteneau (Chapter n. 8) examines the *préparateurs* – the lab assistants – who set up the instruments for the lectures of illustrious chemists. These secondary actors often came from pharmacist families and had knowledge that was technical, rather than theoretical. Similarly, whereas an earlier generation of historians of science largely limited themselves to the study of Europe, Lorelai Kury (Chapter n. 12) sets her sights on the periphery, comparing two eighteenth-century Brazilian naturalists: the military officer Domingos Alves Branco Muniz Barreto (1748-1831) and the friar José Mariano da Conceição Velloso (1742-1811). To study peripheral science and technology is to study the social context that enables knowledge claims and technologies to prevail – a concern that has been central to STS since its inception. But whereas the canonical works of early STS scholars emphasized the social context of major figures – for example, Latour's (1988) work on Louis Pasteur – contemporary STS scholars and historians of science emphasize lesser-known figures, as well as peripheral locales. The contributors to *Les sciences et les techniques* do not explicitly invoke the STS canon. This may sound surprising, given that this canon includes the works of French scholars like Bruno Latour or Michel Callon. Still, the book shares many of the concerns of STS, and notably questions the relationship between technological innovation and politics. In Chapter n. 4, Irina Gouzévitch relates the conflict that ensued, at the end of the eighteenth century, between the inventors of two competing telegraph technologies. The telegraph invented by the Frenchman Claude Chappe included a signaling device that resembled two human arms, with each arm held aloft on its own pole. In contrast, the telegraph invented by the Spaniard Agustín Betancourt and the Swiss Abraham-Louis Breguet included a signaling device that resembled the face of a watch, with a needle pointing to individual letters and numbers. Both technologies were optical telegraphs that relied on telescopes to discern messages that had been spelt out from afar. Although a committee of experts from the Académie Royale des Sciences deemed the foreign technology to be superior, government bureaucrats opted for the technology that had been developed by a Frenchman. This recalls the oft-repeated observation that technology cannot be separated from politics – represented in this instance by the Napoleonic army, which ended up conveying messages via the telegraphs of Chappe. In another example, Isabelle Lémonon Waxin (Chapter n. 15) relates that the creation of indexes for chemistry textbooks was often done by women, and that the categories identified by women indexers shaped the field of chemistry itself. This recalls Bowker and Star's (2000) observation that classification has material effects. Bowker and Star described how the inclusion or non-inclusion of a disease in the International Classification of Disease (ICD) affected subsequent diagnoses of the disease. Similarly, the chemical categories identified by women indexers influenced the subsequent development of the field of chemistry. As such, indexing represents a significant but unacknowledged contribution by women to chemistry. The most well-known contribution of French intellectuals to STS the-

ory is undoubtedly actor-network theory, also known as the sociology of translation. Several of the chapters in *Les sciences et les techniques* are about translation in the literal sense, as it is an essential aspect of the circulation of knowledge, as well as one of Patrice Bret's research interests. But Anne Collinot's chapter (n. 14) on Monique Lévi-Strauss is about translation in the sociological sense. By describing the care work – which included emotional support and even cooking – that Monique Lévi-Strauss provided for her famous husband, Collinot recalls Hélène Mialet's work (2012) on the entourage that enabled the work of the physicist Stephen Hawking. Valérie Burgos Blondelle (Chapter n. 16) combines scientometric and feminist methods in her analysis of the archives of the journal *Bulletin of the Society for the Encouragement of National Industry* (1802-1945). Burgos Blondelle searched the journal archive for keywords suggesting the contributions of women, identifying contributions that ranged from the authorship and translation of journal articles, to the financial sponsorship of the learned society, to the invention of a useful technology – specifically, a device for measuring the level of alcohol in wine. By uncovering such a wide range of contributions, the chapter is a strong contribution to the feminist tradition. A weakness common to many edited collections is a certain lack of cohesiveness. *Les sciences et les techniques* is not immune to this tendency, although to a lesser extent than most. Its cohesiveness is undoubtedly due to its organization according to the various interests of Patrice Bret, interests that were diverse but that shared a common concern with marginality. The book would have benefited, moreover, from a brief overview of the work of Patrice Bret. As it stands, the editors and the contributors assume that readers will already be familiar with his work. The book excels, however, in providing a nuanced understanding of marginality. Whereas peripheral science, for example, is often understood as the science of formerly colonized nations, in this book peripheral science is usually framed as the science of Eastern Europe or the French provinces. Far from being a limitation, this provides STS scholars with a more nuanced understanding of marginality and peripheral science, one that is not restricted to the binary opposition between Europe and North America, on the one hand, and the rest of the world, on the other. The editors argue that Bret inspired historians to take up the concerns of historians of science and historians of technology. By providing European examples of peripheral science, the contributors to this volume redefine marginality not just within the history of science or the history of technology, but within history writ large. The book will be of particular interest to STS scholars who wish to remain *au courant* with trends in the intertwined histories of science and technology, as they relate to eighteenth- and nineteenth-century continental Europe. Many canonical works from the early days of STS relate to historical topics, including early modern topics, the most well-known example being Shapin and Shaffer's (2011) *Leviathan and the Air-Pump*. But pre-20th century historical topics are virtually unheard-of in contemporary STS, an omission that Peter Dear and Sheila Jasanoff (2010) have criticized. Moreover, despite the canonicity of French-inflected STS theory, the dominance of English-language publishing in STS often brings with it an emphasis on Anglo-American topics, at the expense of the rest of the world. From an STS perspective, the book's greatest strength may be that it serves as a necessary corrective to the presentism and Anglo-American dominance of STS.

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Rethinking Music Through Science and Technology Studies

by Antoine Hennion and Christophe Levaux (eds.) (2021) London, Routledge, pp. 287.

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This book comprises a collection of papers which seek to explore the possibility of applying Science and Technology Studies (STS) to the study of music; investigations generated by scholars from across the broad span of STS and bringing personal and scholarly expertises to a broad range of relevant substantive interests. The volume is cohered by an editorial team whose experience collectively represents the two major themes of the collection (STS and music) evenly, and who, rather than situate the volume against other disciplinary takes on music that exist elsewhere (media studies, history, anthropology, etc.), explicitly aim to *begin* with the theories and approaches of STS to see what might be said in this space. This review will, then, begin with a descriptive account of some of the contributions made by authors in this volume, paying regard to just how these have been organised so as to evidence the relevance of STS to the study of music, and from there come back to reflect on the ways in which this might both assist and frustrate the editors' intentions.

To do this work, the editors have thoughtfully organised the book into discrete Parts reflecting some of the different ways in which the link between the field and its hitherto under-explored (in STS, at least) subject might be manifest. Part One, on "Histories", includes chapters on the development of a standard shared concert pitch in France and Western Europe beginning in the 19th century, and on the DIY development of recording and amplification technologies to support new forms of musical performance and recording in the first half of the 20th century. Part Two narrows the field of view to a more singular focus: "Instruments". This includes chapters covering different forms of audio synthesiser; early Moog instruments, the Fairlight CMI sampler, and the Eurorack amongst them. Part Three explores "Technologies" in a largely conceptual way, including chapters on Hatsune Miku as a fabricated and fictional celebrity manifest through vocaloid technologies (i.e., computer-generated vocals) around which musical communities have coalesced in different ways. And finally, Part Four deals with "Practices", again primarily conceptual in its approach, with chapters focusing in part on music consumption practices (e.g., via smartphones and streaming services) as well as practices of designing and delivering music in artful ways (e.g., as "net art").

The book situates itself most directly as an example of Science and Technology Studies – no surprise, given the title and stated intentions of the book's editors – as a broad field which

provides a set of structuring tools with which the individual pieces of research represented can lock on to their phenomena. The titles of the various Parts are emblematic of common methodological approaches and topical interests that a wealth of Science and Technology Studies scholars have pursued since the fields' inception. In terms of the more topical context within which the book is situated (i.e., studies of music) there are far fewer precedents to grip onto, barring a (comparatively) small selection of direct ancestors (e.g., Trevor Pinch's programme of work around the Moog synthesiser, of which Pinch and Trocco (2002) stands as an exemplar) and some more indirect applications of STS-relevant lines of enquiry to music (e.g., Brooker and Sharrock 2016; de la Fuente 2007; O'Hara and Brown 2006; Tolmie, Benford and Rouncefield 2013). This, the novel contribution that this book seeks to make is important – rather than rely on singular studies exploring quite niche interests and bespoke approaches, the value here is in *collectively* carving out space for STS to embrace music as a potential area of interest. The editors and individual contributors achieve this by virtue of the range of interests that the book heralds, both in terms of the aspects of music covered but also the different ensembles of STS schools of thought that are represented.

In terms of its strengths and weaknesses, the book intends to show the breadth and diversity of STS approaches as applied to music, by way of a series of scholarly demonstrations that the languages of STS can be brought to bear on a whole range of topics hitherto uncovered in the field. But what may actually be most valuable about this volume is not another outing for various existing STS *approaches and debates*, but rather the breadth and diversity of musical *topics* that are historicised and located in society as collective productions. Put differently, the question of whether or not STS could be applied to music was already settled prior to putting any pen to paper – of course it can, since this is an area where there are untold histories to be told, and glossed-over relationships and practices to be foregrounded. The real question, then, is *why might we bother* applying STS to music? And *what do we stand to learn* in doing so? This collection provides plenty of demonstrations that would positively and strongly answer those questions, but these are less to be located in the material that speaks to internal debates/turns within STS and more in the material that tackles music as a topic head-on. For instance, Mooney and Pinch's critique of the "great man" model of musical technology innovation, which retells the history of David Van Koevering's involvement in recruiting, advertising, demonstrating and selling early Moog synthesisers to live performers (where it is typically those live performers and Robert Moog himself that feature centrally in narratives):

> [creative] imagination is often cast by composers and musicologists as the origin of new developments in music such as instruments, genres, or even technological regimes... By promulgating the notion that musical futures are somehow "dreamed up" by the visionary composer, musician, or engineer, such accounts detach the imagination from developments in the sociomaterial world. (113)

Similar in approach, Ribac's chapter unpicks a commonly-received musical myth that punk music is to be credited with a DIY attitude to musical innovation in response to the staid musical "dinosaurs" of the past. This is deflated by Ribac's argument that punk's DIY attitude was continuous with the past rather than a revolutionary shift away from it – for

instance, famed crooner Bing Crosby was foundational to similar amateur experimentation with microphone and amplification equipment to break with the "dinosaur" styles of *his* past (e.g., Vaudeville) – and this helps show how STS can be a vital space within which to engage with musical technology innovation differently:

> ever since sound reproduction and broadcasting tools have been accessible, amateurs have been using them to discover music, learn to play an instrument, sing, compose, come together, and invent new worlds together. While every generation invents its own specific ways, the fact remains that forms taken by learning, socialization, and deployment in the public space are quite similar, including in countries that have different cultures... A given technology... can thus give rise to uses that had not been envisaged by its designers or the companies that marketed it... If amateurs like Crosby or the punks invented new uses for technologies, it is precisely because another path is always possible, and probably also because not being familiar with an object can allow you to imagine something different. (60)

The stories told in these chapters and others stand as insightful interventions that bring oft-overlooked stories to the fore; an objective that represents STS at its best. Yet, the organisation of these chapters into discrete parts that bracket out histories, instruments, technologies and practices from one another perhaps does more harm than good. Such an approach to taxonomising by the extant (theoretical, conceptual) categories of STS research seems to direct the gaze of the book inward to STS' internal disciplinary wranglings, and the material in this volume that speaks to these field-internal issues seemingly does little to advance those debates excepting to note that they are also applicable to studies of music as well as science and technology. With the latter removed, the former still presents an interesting, valuable and exciting collection on its own merits. Hence, for STS practitioners and students who are forming their own interests in exploring music in their own ways, this book will no doubt be a vital touchpoint; STS as it stood already provides us with our three chords, and this volume demonstrates that now is the time to form bands.

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Eating in Theory

by Annemarie Mol (2021) Durham and London, Duke University Press, pp. 199.

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Readers eagerly waiting for some unheard of cooking tricks or thoughtful advices for Pantagruelian banquets will be bitterly disappointed. Speculative researchers of the role of food across the ages or of the symbolic dimension of eating in practices of social distinction will also find Annemarie Mol's study quite bland. Then *Eating in Theory* does not propose a *theory about* eating, but, more pointedly, it "takes its cues *from* eating" (p. 5) as an inquiry into what (and not least: *how*) academic reflections might gain while starting *with* and developing *along* eating situations. At stake is nothing less but the immense – though intimidating – demand to "enrich exiting philosophical repertoires" (p. 1) broadly used in the social sciences and the humanities. In other words, *Eating in Theory* is a book of tensions within and *departures* from *our own* philosophical equipment to address reality: it "shakes things up and creates openings" (p. 6). However, what becomes different (and *how*) should we be prepared to start from eating in dealing with some of the most serious themes of the Western thought as "being" (Chapter n. 2), "knowing" (Chapter n. 3), "doing" (Chapter n. 4), "relating" (Chapter n. 5), and politics (Chapter n. 6)?

The first chapter on "Empirical Philosophy" offers in a nutshell the complex framework of the entire book and reads as a reconstruction of a threefold *tension* embedded in the philosophical tradition. *First*, Mol argues against understanding theory as a description of the world (p. 5), or as she puts it, as "a grand scheme that holds smaller elements together" (p. 25). While philosophical theories take up a *transcendental* stance that secures both their distance from *immanent* realities and their critical capacities directed towards them (p. 15), Mol advocates instead the "ostensible oxymoron" (p. 15) of an "empirical philosophy" that opens towards historical, cultural, and material contingencies. Framed as an "exercise in empirical philosophy" (pp. 1, 15, 20f.) – a trademark of Mol's approach (Mol 2002, 4ff.; 2008, 9ff.) – *Eating in Theory* avoids the pit of a *paramount* (theoretical) explanation as well as that of an (empirical) *plurality* of "views" on reality. It provides a perspective in which "different knowledge practices interfere with reality in contrasting ways" thus rendering not a fragmented but a *multiple* reality, i.e., "different ways of ordering, different versions of reality, all equally immanent" (p. 23). Accordingly, Mol unveils therein a *second* tension between *norms* and *facts*, i.e., between the philosophical longing for *normativity* and the desire of the empirical research to "represent reality *as it is*" (p. 14). Without keeping apart "the *is* of empirical studies and the *ought* at stake in philosophy" (p. 15),

Mol looks at how "normativities and realities tend to be *done* together" (p. 154, footnote 35). Not least through "ontonorms" – a concept Mol has coined, but now barely uses (p. 154) – "normativity comes down to earth" (p. 23), being enacted in the "specificity and situatedness" (p. 25) of empirical settings. Finally, Mol identifies a *third* tension pertaining to philosophical analyses: an insistence on "the human" as an "especially deserving kind of creature" (p. 2) against other entities. Historically justified throughout perpetual intellectual quests for human dignity (pp. 7-11), this "human exceptionalism" (p. 2) enables fruitful elaborations on central values as liberty or freedom, but it also marks the way how "agency" or "subjectivity" are themselves conceptionalised when applied, for instance, to non-humans as these terms "have been thoroughly informed by a particular understanding of 'the human'" (p. 2). Therefore, the symmetric treatment of both human and non-human entities risks being eventually vitiated: while "robbing 'the human' of his exceptionalism by spreading out his particular traits over the rest of the world" (p. 3) it genuinely reproduces a hierarchical understanding of "the human" (p. 3). In hierarchically praising the "thinking mind" and overall "thinking" against basic processes as, e.g., eating or breathing (p. 3), the philosophical anthropology has perpetuated an ultimate – simultaneously *transcendental* and *normative* – reference for our current understanding of *being*, *knowing*, *doing*, and *relating*. However, *Eating in Theory* resets this view along the exigencies of an "empirical philosophy" bearing in mind, as Mol argues in line with Wittgenstein (p. 16f.) and Foucault (p. 17f.), that "diverse socio-material formations and ways of using words make different 'realities' possible" (p. 22). Against this background, especially *this* particular hierarchical understanding of "the human" ceases to claim for itself definitive characteristics and takes instead its distinct place in the more analytically refined framework of multiple *models* of reality.

Taken *eating* as reference, each chapter reads as a story, often deliciously garnished with impressive empirical vignettes, of a *departure from* the "intellectual apparatus of the humanist philosophical tradition" (p. 3) – epitomised by the works of Hannah Arendt, Maurice Merleau-Ponty, Hans Jonas, or Emmanuel Levinas – *towards* "eating-inflected intellectual terms and tools" (p. 6). Chapter n. 2 on "Being" departures, for instance, from Merleau-Ponty and his understanding of "the being of an embodied human in the center of a three dimensional world filled with varied entities" (p. 29). Consequently, it is the "walker", an icon of the "neuromuscular version of the body" (p. 48), gradually discovering the world as he passes it through, and not the "eater" with whom the philosophical reflection on being begins. Nevertheless, as Mol observes, this difference has a huge analytical impact: "while, as a walker, I move through the world, when I eat, it is the world that moves through me" (p. 49). Hence, the "model of being" (pp. 39, 43) offered by eating is one of a limitless (and constant) exchange between "me" and the world: I "am" at the same time "inside" and "outside" of my body (p. 33f.), being both "local" and "dispersed" (p. 44f.), i.e., "not sharply bounded" (p. 92) as I cook, ingest, digest, and excorporate food.

In some respects, the "walker" resembles the "knower" learning from a distance about the surrounding world. Though "not always and not everywhere" (p. 53), *thinking* operates along the classical epistemological difference between a "(knowing) subject" and an "(known) object". Opposing this divide, in Chapter n. 3, Mol argues that the "model of knowing" emerging from eating is neither objective nor subjective but "transformative" (p. 55). It transforms both the food and the eater as the encounter with an "object" (food) changes the "subject" as well (p. 66): we come to know ourselves, our likes or dislikes, as well as our food

deeper and (more than often) differently as "the taste of foods is bound to affect the taste of those who eat them" (p. 67). In other words, eating points at a "model of knowing that is not about passively apprehending the world but, rather, about actively engaging with it" (p. 73).

Chapter n. 4 formulates "a model of *doing* that does not just elude centralized control but also defines individualism" (p. 77) as opposed to the idea of a "voluntary action". Eating, as Mol puts it, is not confined to an embodied (human) "doer", but it is "always already technically and socially mediated" (p. 96) and consequently "a part of a diverse socio-material practices" (p. 100) in which several others are already actively involved. Then "my eating" is neither solely "'my' *doing*" (p. 77) nor can it be traced back to a hidden place inside my body. Even digestion takes place "out of our bowels" (p. 91), as Mol shows, as it already starts as an "extracorporeal" process (p. 92) at which farmers, cooks, kitchens, or even cook-books equally participate in innumerable forms of growing, delivering, and preparing food. In this vein, the "actor taking on the task of eating" (p. 100) is actually immersed in a "historically dispersed collective" (pp. 93) of human and nonhuman entities.

According to the idea of a "human exceptionalism", "relating" is primarily considered in terms of "family trees" (pp. 125, 143) and (human) "kinship" (p. 103f.), a form of togetherness that might be extended to embrace *both* human and nonhumans. However, the "model of relating" (p. 124) discussed in Chapter n. 5 brackets this standpoint (p. 122) and embraces "*my relating* to nonhuman creatures" (p. 103), whether these constitute my food or are depending on it, without the appeal to some "degrees of similarity" (p. 120). Mol understands "relating" as "individual as well as collective relations of agreement" (p. 118), an agreement with other entities to which I differently react while ingesting them, but also whose growth or extinction I enhance or hinder through individual or collective consumption. Though eating is a genuine "asymmetrical relation" (p. 120), feeding and eating, giving and taking are thus neither good nor bad *per se*, but the normative profile of a "particular feeding/eating relation" (p. 115) is constantly a matter depending on the specificity of the situation in which it occurs.

If the previous chapters questioned the relevance of a hierarchical view of the "the human" for understanding *being*, *thinking*, *doing*, and *relating*, in Chapter n. 6 on "Intellectual ingredients", the *politics* becomes central. What if we put aside the *normative* (and *transcendental*) orientation of politics (modelled along Hannah Arendt's image of the "zoom politikon"; p. 127) and consider instead a "politics of labor" (p. 129f.), of doings, tinkering, and care, in which facts and material life, and not only theory are equally taken into account? Mol's answer – echoing her former thoughts on the "politics of what" (Mol 2002, 172f.) – points at the importance of the "*alterity* (...) between different ways of organizing socio-material realities" (p. 132), i.e., at the *multiple* ways in which *multiple* representations of "what is good" (p. 134) are enacted in "ongoing negotiations: among humans, with other creatures, converting materials – obdurate or fragile things – and the earth we share" (p. 137). As in Mol's treatment of the "logic of care", the "good" is not given "before the act" (Mol 2008, 86) and it is not just a matter of "(discursive) *action*" (p. 137). Instead, it shapes a new meaning of politics that is better prepared to deal with human and nonhuman entities in the face of contemporary environmental problems.

While every peak of Mol's arguments is introduced in the book as "a lesson for theory", *Eating in Theory* contains itself "lessons" from one of the major scholars that is – luckily for her readers! – still concerned with theoretical questions in STS. On the one hand, it calls

for a reflection on our methodological presuppositions on ontology, epistemology, agency, interaction, and politics in which a hierarchical understanding of "the human" went "into hiding" (p. 25). From this perspective, *Eating in Theory* does not simply break with a "long overdue" (p. 140) classical view of philosophical anthropology, but it sharply reconstructs its explanatory efforts and develops alternative research instruments. For the STS-community this sounds as a plea for more openness towards the intellectual resources nurturing its work *and* for a more critical view of its own concepts and arguments.

Besides, within the framework of "multiple versions of reality", Mol sets forth *and* enlarges her *own* contribution to the long-lasting debate on the "ontological turn" in STS (Woolgar and Lezaun 2013). The congruent ideas (Bischur and Nicolae 2014) of multiple enacted realities *and* normativity that Mol has developed along the vocabulary of "politics" (Mol 2002), of "logics" (Mol 2008), and of "ontonorms" (Mol 2013) now reach a more encompassing profile. Then the multiple "eating-inspired models" (of *being*, *knowing*, *doing*, and *relating*) aim *both* at retrieving the multiplicity of the socio-material settings of eating situations *and* at how these might be approached. Put differently, *Eating in Theory* calls for a *reflexive* "empirical philosophy", i.e., an inquiry focused on STS approaches, on "our words", and "the worlds they carry with them" (p. 141) – a situation in which these approaches themselves are treated as models of enacting reality. In this view, Mol's book also touches upon some of the most pressing problems facing the STS scholarship: what model of reality are we set to formulate and how well equipped are Science and Technology Studies for facing the challenges of environmental catastrophes? How do multiple models of reality relate with each other and how are we prepared to discuss theoretical and methodological differences?

Years ago, Annemarie Mol funnily stated that she took a term ("logic") from philosophy and "ran away with it" (Mol 2008, 9). And her "run" was impressive. Now she kindly invites us to do the same with her *own* terms: "if you happen to find them inspiring", she writes, "run with them, and put one or two of them to work in your own writing" (pp. 25, 143). Hence, it is up to us, in STS and beyond, to become more attentive to the gems embedded in her work. And eventually start running with them!

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Le praticien, le patient et les artefacts. Genèse des mondes de la télémédecine
[*The practitioner, the patient and artefacts. Genesis of the worlds of telemedicine*]

by Alexandre Mathieu-Fritz (2021) Presses des Mines, Collection Science Sociales, Paris.

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Le praticien, le patient et les artefacts. Genèse des mondes de la télémédecine is a book by Alexandre Mathieu-Fritz, a sociologist of work and professional groups at Gustave Eiffel University, who focuses his recent studies on teleconsultations in different medical fields and on telemedicine in general. The book proposes the issues of professional practice, patients, and artefacts in the field of telemedicine through concrete French cases. The text is organized into three sections: the first dedicated to the changes in French telemedicine, the second to the new forms of cooperation in teleconsultations, and the third to the recomposition of practices and therapeutic relationships in mental health teleconsultations. The second and third sections each have an introduction that allows you to get to know the specific object of study better, specifically Télégéria and Télé-Med. The different sections are not homogeneous in terms of number of chapters: the second section is decidedly wider than the others, while it would have been better to devote more space to the first. An introduction and a general conclusion open and close the book.

The introduction is the compass of the book: in addition to anticipating the organization of the following pages to the reader, the author specifies the objective of the book:

> to observe the dynamics of the development of French telemedicine starting from the point of view and the concrete activities of the professionals who experience it, in a period (2009-2019) in which it constitutes an innovation in the process of being institutionalized. (p.11, my translation from French)

As the author himself underlines, the book is therefore a pre-Covid 2019 snapshot situated before the socio-health crisis that forced everyone to deal with remote medical assistance.

The first section is entirely dedicated to providing the historical framework of telemedicine in France and the theoretical framework of reference for the book. In fact, the author distinguishes the history of telemedicine in France into four major periods: the pioneering

phase, starting in the 1980s; the experimental phase of the two-years period 2009-2010; the institutionalization phase that lasted a decade (2010-2020); finally, the acceleration phase, caused by the 2020 pandemic. Providing an accurate historical description of telemedicine in France means first of all accompanying the reader on a tortuous path made up of acronyms and definitions. The decoding of the many French acronyms is not simple and perhaps an appendix would have been needed to disentangle between SFSD (*Société Française de Santé Digitale*), SNITEM (*Syndicat National de l'Industrie des Technologies Médicales*) or URPS (*Unions Régionales des Professionnels de Santé*), just to mention a few examples. The definitions of telemedicine, teleconsultation, telesurveillance, teleassistance and tele-expertise are clearly stated and are really useful for understanding the author's frame of reference. Particularly interesting is the clear distinction proposed between telemedicine and telehealth (*télésanté*) which re-proposes the WHO definitions: the first oriented towards medical and clinical aspects, the second towards public health, and therefore also including health education for all. After these necessary and punctual distinctions, as was logical to expect from a volume published in 2021, the author dedicates an entire paragraph in the first chapter of the book to the "boom" (in the original text) of teleconsultations starting from 2020. In fact, also in France, it's possible to observe an increase, legally endorsed, of telemedicine and teleconsultations during the French lockdown caused by the social and health emergency of COVID-19. A new habit – which could become custom, it is underlined – which has allowed some healthcare professionals to show that they have basic knowledge of telemedicine, but which has led others to feel compelled to use new tools for "war telemedicine" (p.50). An entire chapter of this first section is dedicated to the "new model of sociological analysis" ("un nouveau modèle d'analyse sociologique" in original). From a theoretical point of view, the book moves openly in the tradition of the sociology of professionals, such as Hughes, Strauss, Abbott, and Zetka, and in the French interactionist sociology of professional groups, particularly Dubar and Tripier, and their studies of professional dynamics. There are also references to pragmatic sociology, in particular to Dodier (1995) and his proposal of a "technical solidarity" ("solidarité technique" in original) that is formed through technology and its uses and consists of the links between non-human and human actors. There are also most recent references to the sociology of activity by Bidet (e.g., 2010) and Licoppe (2008): the first with her research on "real work" ("vrai boulot" in original) or the description of the personal or subjective relationship between work activity and worker, which seeks to enhance its activity; the second with his model of analysis of the "activities square" ("carré de l'activité" in original) which is an ethnography of work situations that allows observing the shared interactive space and the relationship with the tools, intended as interactional artefacts.

The other two sections are dedicated to two distinct telemedicine projects which allow observing both therapeutic relationships and interprofessional cooperation: the case study of Télégéria is proposed as an example of traditional teleconsultation for geriatric patients and occupies the second section of the book, while Télé-Med, to which the third section is dedicated, is an example of dyadic teleconsultation in the field of mental health. As extensively discussed in the text, the Télégéria study was carried out through the observation of technical sessions, without patients but the scientific coordinator of the project, semi-structured interviews with health professionals, and observation of teleconsultations with patients between 2009 and

2011. The project envisaged teleconsultations of specialists – for example, orthopaedic surgeons, and dermatologists – provided to geriatric clinic patients in the presence of geriatricians. The proposed analysis of the first case brings out two main themes. The first has to do with the long tradition of Abbott's sociology of professions relating to the importance of defining jurisdictional space and building skills, understood however as medical and not technological skills: an example is that of diagnostic palpation taught by surgeons in orthopedics to geriatricians. The second theme is interconnected with the first since it is the lack of corporeity – the absence of the *tactile ritual*, as it is effectively written in the book – that obliges professionals to disseminate medical knowledge and care practices in the absence of direct contact with patients through a web connection. The second case study, Télé-Med, seems instead to use the absence of presence in the same physical space for the benefit of therapy. The comparison of assisted-mental health professionals via a dedicated platform allows the former to be less intimidated and the latter to concentrate on the relationship. The platform supplied a list of professionals to permit the patient to be informed on the type of orientation of the consultation – e.g., humanistic approach or cognitive behavioral therapy – and it took care of the construction of the availability and appointments agenda, and the payment of the performance. The research ended in 2014, long before the health emergency that introduced similar applications in Italy as well. Also in this case the author carried out interviews with the psychotherapists involved in the project, and interviews with two experts in mental health and teleconsulting. The interviews, as the teleconsultations, were carried out via Skype, but in this case study was not possible for the researcher to attend the teleconsultations because of confidentiality.

From the point of view of the definition of the context, the text is very interesting because it clearly and convincingly proposes the distinction between telemedicine and *télésanté*, as already underlined, even managing to arrive at the better-known and shared eHealth. However, instead of adopting a culturalist point of view, a juridical vision of the phenomenon is opted for which, while helping to understand the legitimation process in the French context, does not allow the reader to better understand the training and behavioral gaps in terms of digital knowledge and expertise of health professionals, underlined in the text, but not adequately supported by the proposed literature. Inevitable but underdeveloped also the theoretical references to STS, in particular to Latour's (1994) technical objects considered as actors and Callon's (1986) process of translation. As often happens in publications collecting experiences from the past, even if it is recent, there is a lack of updating in light of what has emerged with the Covid-19 emergency and the possible new technological innovations available at the time of reading. The curiosity remains to understand how lasting these teleconsultation tools are to time and the eHealth market (from the point of view of patients in particular).

The author in the conclusions explains that the book intends to propose telemedicine not as a new therapeutic modality but as a new organizational and technical configuration of medicinal and treatment practice. That means new habits, after a period of adaptation and confidence with new tools, new actors, and a new configuration of interprofessional teams.

For these reasons, the book is an interesting read, for scholars involved in STS and in particular for those who work in the field of healthcare, mental health, and health professionals. In general, it is inspiring for those who are interested in learning about the French point of view in the field of telemedicine, just before Covid-19.

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Esperti. Come studiarli e perché
[*Experts. How to study them and why*]

by Davide Caselli (2020) Il Mulino, p. 200.

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Caselli's work results from a vast and in-depth investigation, both theoretical and empirical, into the interplay between experts, political-administrative institutions, businesses, and the urban social fabric, problematising the relationship between knowledge and power, governance, or public action in the context of a particularly relevant case study: the transformations of urban social policies across the 2008-2018 Italian crisis cycles. His study fills a dearth of attention in the Italian literature on the figure of experts in the welfare system, a key actor, albeit neglected.

The field research, which lasted over a decade, grounds the author's professional experience and social activism on a small association with a marginal role in the social policy sector in the Milanese area. Caselli's observations develop amid a critical discontinuity in the governance and resource system concerning local welfare. Through the exposition of field research – which included observations and interviews with practitioners, operators, consultants and other relevant actors – Caselli describes the changes occurring in the procurement and resource management system of local welfare. His study tracks the emergence of a new *doxa* (i.e., the system of knowledge and values that determines the field's normative boundaries) marked by the "social cohesion" tenders, and accompanied by specific forms of privatisation, financialisation and competition of organisations.

On a more general level, the book summarises the debate on the function of expert knowledge in the social sciences. More specifically, it mobilises the conceptual tools of Critical Sociology and Science and Technology Studies (STS) – namely Actor-Network-Theory (ANT) – to analyse socio-technical devices implemented through expertise. Combining analyses and descriptions with the bourdieusian notion of "field", it shows how – through the manipulation of calls for tenders, projects, measurement, and evaluation systems – conflicts and hegemonic restructuring of the local welfare field are outlined.

Rather than defining the professional boundaries of the social figure of the expert, Caselli problematises "the emergence, conceptualisation, recognition and practice of an expert function", which is a:

social action marked by competence, by transgressiveness with respect to both scientific

codes and those of everyday life and by forms of asymmetry of knowledge and power in the relationship with objects and recipients of such competence (p. 25; see also Pellizzoni 2011).

This function exceeds and transfigures the academic one: it is distinguished from pure scientific action by a different and less autonomous relationship with the client, and its status is continuously negotiated through power and market games. Expert's action is also distinguished from "expertise" – as the "ability to perform a given task" – identified not in individual persons or groups or disciplines, but rather in a network that connects experts with customers (either public or private), and the public sphere (Eyal 2013). Thus, framed in its material-discursive concatenations, in its technical, conceptual instrumentation, and in its institutional and spatial operativity, expertise combines theoretical agency (namely production and appropriation of "vehicular ideas", "buzzwords", "knowledge brands") and socio-technical agency (namely production and appropriation of tools for measuring and controlling operational and intellectual resources).

In the evolving context described by Caselli, it is shown how the ability of organisations to dispose of resources and technical-professional knowledge qualified as authoritative, through the mediation of experts (consultants or academics), constitutes a selection mechanism. Indeed, it increasingly became the fundamental condition for access to the new public and private tenders of the Milanese local welfare system. In this way, the asymmetrical status that constitutes and reproduces expertise as a dependency relationship is highlighted and observed from an operational and procedural point of view.

Caselli's research mobilises a wide variety of theoretical approaches, as well as draws on a broad genealogy of social and intellectual struggles in the field of disciplinary institutions (the factory, the asylum, the school, social services). Particularly relevant is the use of the co-production model of expertise networks borrowed from Actor-Network Theory (ANT) as proposed by Vololona Rabeharisoa and Michel Callon, together with a constructivist and institutionalist sensibility.

The book is structured along two parallel layers, juxtaposing reflections on the field notes, discussions on their theoretical framing and the author's personal elaborations.

The first chapter mainly deals with the issue of the asymmetrical nature of expertise according to three models: the classical model of monopoly and closure derived from the sociology of the professions, the conflictual model of critique and reinvention of professional boundaries related to the impact of social movements on disciplinary institutions since the 1960s, and the co-productive model derived from ANT. In this case, Caselli draws on Gil Eyal's (2013) research on the breakdown of disciplinary boundaries as a process that alters the balance between specialist closure and communicational openness in professional cultures, proposing an interpretation that emphasises the relational dimension of expertise.

The second chapter outlines the "field" of local welfare research and consultancy actors (intellectuals and economists), by acknowledging the contribution of social sciences in thematising the relationship between experts and political power. Caselli combines the notion of "field", proposed by Bourdieu (1995) and elaborated by Sapiro (2009), with Gramsci's conception of hegemony, to frame the tensions between the autonomy of the actors that traverse and compose the field itself and the heteronomous (political, economic, bureaucratic) forces that from the outside contribute to shaping its dynamics. What is at stake in the

conflicts is the definitional power of the *doxa* and the conquest of hegemonic positions. In this way, Caselli emphasises the tacit and invisible mechanisms through which the market is structured, exposing the foundation and maintenance of markets to social criticism.

In the third chapter, a specific and emerging aspect of the field of social policies is addressed: the growing diffusion of competition for social entrepreneurship start-ups in the health and social services sector and accompanying the transition from care and assistance targeting those in need to a re-functioning of governance objectives in favour of animation, incentive, empowerment. This transition calls into question consolidated practices promoting some actors and marginalising others. As explained by Caselli, a previous technical-managerial "soft" model, based on the operational control of processes and which is attentive to the content of actions, has been contrasted by a technical-directorial model based on the centrality of expert knowledge in the design and evaluation phases. Crucial to the analysis of these transformations proposed in the book are the Cultural Political Economy (CPE) approaches developed by Bob Jessop and Ngai-Ling Sum (2013). Such a material-semiotic framework combines the elaborations of Gramsci and Foucault, integrating historical materialism and discourse analysis in a common research programme to "identify, in a given crisis phase, the processes of variation, selection and stabilisation of imaginaries" (p. 99). Considerable attention is paid to French-language studies on role reconversion and recuperation processes between militant and professional culture across the local welfare.

The fourth chapter gets to the heart of the deployment of "social cohesion" projects, focusing on the specific role of social workers in the conflicts between the various actors-networks and organisations, and following the constitutive tensions characteristic of project development in labour relations and interpersonal dynamics within organisations. Such dynamics point to the intertwining of the cognitive and normative dimensions of social action, illustrating the relationship between representations and the concrete operational modes of social intervention. Drawing on a theoretical framework that considers governance through instruments, Caselli explores the tensions between actors, interests, and instruments, understood as autonomous agents that shape and direct the behaviour of social actors. Thus, the political dimension of public action is revealed, subtracting it from depoliticisation strategies that tend to obscure it as well as naturalising and destoricising its technical, managerial and economic procedures. The technocratic appearance towards which the narrative of contemporary governance is oriented is thus problematised.

In the fifth chapter, Caselli grasps the relevance of "social impact finance" (p. 143) as a specific research topic, which he develops especially through the sociology of institutions, by focusing on the problems of measuring and exchanging abstract value underlying the construction of the market as a social institution. Caselli juxtaposes the research methods and approaches of STS and, precisely, ANT with the Sociology of Economics and Labour. He outlines some typical dynamics (self-fulfilling prophecies, reactivity and self-disciplining, reverse engineering) that emerge from the observation of tools (such as metrics and measurement standards, management procedures, or information systems and databases that make up the Social Impact Assessment (SIA) and replace previous reporting systems), understood as "actants" with their own degree of autonomy, capable of orienting expectations, enabling behaviour and results of other social actors. This apparatus is mobilised to prepare the ground for

the entry of new financing channels (solidarity finance, social venture capital, impact finance) into the social and community enterprise system and transform its characteristics.

According to the author, the essay highlights, firstly, the dialectical and political dimension of the movements of convergence and divergence, alliances and conflicts, between established and emerging networks of expertise, in the shift towards the financialisation of social enterprise. Secondly, the book exposes the co-evolutionary dynamic between policy paradigms, intervention models and characteristics of networks of expertise in the field of local welfare, which invests value systems, the form and organisation of actors, (economic and extra-economic) interests, funding mechanisms, and public governance tools and devices. Finally, the research provides analytical tools to frame the conflicting and historical nature of institutional procedures, instruments, and governance devices in the field of welfare that appear, or are presented, as neutral or natural. The research fully fits in as an STS contribution to the study of the socio-technical systems intervening in the welfare management system and in the interactions between different actors (public, private and third sector), and different levels (micro and local, meso and organisational, macro and structural). Furthermore, the book addresses some of more neglected and nonetheless relevant aspects, with a considerable degree of depth and breadth, as well as with originality and epistemological and critical awareness.

In this work, the impact of financial crisis on the local welfare funding system, which has been exacerbating since 2010 onwards, is investigated through the transformations of the content of public tenders and competitions. The analysis of the latter, used as a "probe" of the research, allows us to reconstruct an index of the breaks and changes that are crossing the field of local welfare players, in particular the figures that make up the networks of expertise, pointing out the alternations and aggregations/dissolutions between dominant players, groups and networks, and the transformation of their hierarchies. According to Caselli, the pressure exerted by the decrease in national and local funds, both for welfare and scientific research, has opened the way for private actors and made expertise networks with a more markedly entrepreneurial and financial matrix gain space. Symbolic power, entrepreneurial capacity, availability of economic resources and a series of tools – lexical, value-based, technical, and operational – steered these transformations and are the objects of Caselli's research.

The book is also a contribution to a broader intellectual debate on the controversial and contested role of expert knowledge in the crisis of democratic societies. Indeed, Caselli believes that "a critical and constructivist approach to knowledge, to its production [...] represents a cultural and political proposal" (p. 172), alternative to the two main imaginaries of exit from the contemporary economic-financial and political crisis. Indeed, Caselli's stance thus rejects both the prospect of strengthening technocratic approaches and non-representative institutions (an "automatic government" of instruments, which would save democracy from the unreasonableness of the masses) and identity-based and authoritarian movements that feed resentment towards elitist powers by recovering a supremacist common sense combined with traditional forms of knowledge and authority.

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Reactivating Elements: Chemistry, Ecology, Practice

by Dimitris Papadopoulos, Maria Puig de la Bellacasa and Natasha Myers (eds.) (2022)
Durham and London, Duke University Press, pp. 295.

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Elements of various forms construct the world around us: constituents of the Periodic table, organic building blocks of life, or ontological forces of Air, Water, Earth, and Fire. These basic forms of organization are crucial for the survival of life. The contributors to the volume *Reactivating Elements: Chemistry, Ecology, Practice* aim to view and analyze elements in their elusiveness and complexity and to unfold what "elemental thought" (p. 1) could mean amid the current ecological crisis.

All three editors of the volume, as well as many of its contributors, are well situated in the field of STS. The research of Dimitris Papadopoulos focuses on the intersections between technoscience and social transformations (Papadopoulos 2018) and the introduction of green and alternative chemical technologies. Maria Puig de la Bellacasa, the author of *Matters of care. Speculative ethics in more than human worlds* (2017), currently conducts research on human-soil relations, particularly in the context of science, eco-social movements, and artistic practices. Natasha Myers, director of the Plant Studies Collaboratory, has coined the term "planthropocene" emphasizing a vision of the future rooted in the relationships between plants and humans (Myers 2017). In addition to editing the volume, Puig de la Bellacasa and Papadopoulos each contributed a chapter drawing upon their previous research.

The diversity of editors' and contributors' research interests influenced the volume's rich patchwork-style composition. This is a book one could approach slowly and return to repeatedly, and each time, like in a kaleidoscope, discover a different layout of meanings. As the editors note in the *Introduction*, they have aimed for such richness and complexity, inviting the authors to contribute to the collection "in the spirit of speculative inventiveness" (p. 4), i.e., to reflect on elements in a free and open manner. The initial idea was not to build an overarching theory of the elements, but instead to experiment and engage in an open, non-restrictive conversation. As the volume demonstrates, elements appear in multiple forms: as forces and energies, as chemical particles, as social forms, or as material objects. Most importantly, the contributors aim to analyze the elements in their relation to humans seeing them "not as the nature which 'humanity' must struggle against or tame, but as 'naturecultures'" (p. 6). The volume's eleven chapters address such more-than-human naturecultural arrangements from different angles, but all of them point out the distinction between elements and elemental.

By accentuating this distinction, the authors demonstrate that elements are complex and fuzzy phenomena tied up with multiple aspects of human life and provoking contradictory responses.

In the introduction, the editors group the chapters into three sections: "Elements as relational substance", "Actualities of the elemental", and "Elemental practices". Each of these subsections, in my view, could potentially correspond with one concept from the title – chemistry, ecology, or practice, all connected through the notion of **reactivating**. By reactivating, the authors refer to "calling a recognized entity into a new situation; catalyzing new models of thought and action" (p. 1).

The first four chapters by Isabelle Stengers, Dimitris Papadopoulos, Stefan Helmreich, and Joseph Dumit engage with elementary forms and anthropogenic chemicals entangled with social life. In the opening chapter, Isabelle Stengers discusses one of the volume's key terms, "reactivation", seeing it as addressing the elements' "metamorphic character, both shaping and being shaped by the particular ecology in which they participate" (p. 27). The following three contributions discuss the reactivation of elements in relation to toxic regimes and reparative justice (Papadopoulos), thinking with water and waves as elementary forms of social and elemental life (Helmreich), or bromine as an element animating new ways of talking about and working with substances (Dumit).

The next four chapters deal with elements in their **actuality**, i.e., as driving forces in world-making. Astrid Schrader analyzes transformative agencies of marine viruses alternating between living and non-living phases, as "elemental ghosts" (p. 109). Joseph Masco, exploring the history of radioactive elements and plastic, provides a striking contrast between a world as neatly organized and ordered by the Periodic table and its messy and complex actual arrangements. The chapter of Patrick Bresnihan engages with the wind as a reactivation of the weather's elemental forces, as a contested resource, and as a potential ally in more-than-human engagements. To continue the conversation on the actuality of elements, Cory Hayden examines crowds as elementary forms of social life, asking what crowds are composed of and what makes them hold together.

The final three chapters of the volume deal with various forms of elemental thinking in relation to power imbalances. These chapters pay special attention to alternative practices and methods of reactivating the elements and engaging them in more-than-human ecologies. The contribution of Maria Puig de la Bellacasa focuses on the soil as a part of the biochemical processes of breakdown and decreation, particularly emphasizing alternative stories of engaging with soil as an element. Tim Choy discusses the agency of air in more-than-human engagements, provocatively offering the readers to imagine a "conspiracy of breathers" (p. 249) as a political formation potentially resisting the industrial urge to pollute. The final chapter by Michelle Murphy centers on the industrial pollutants in Chemical Valley (Sarnia Lambton region in Canada), built on the land stolen from Indigenous residents. Murphy defines governmental and industrial efforts to erase or deny environmental violence as "infrastructures of gaslighting" (p. 265) embedded in the colonial permission-to-pollute (p. 262) and neglecting alternative ecologies.

The final chapters read with strong emotions and leave an aftertaste of the volume ending too abruptly. A concluding intervention, once again bridging the diverse contributions and discussing parallels and interrelations between them could have potentially helped readers to navigate the complex structure of the book. Additionally, it would have been interesting to learn more about the development of the collective thinking behind this volume. It has been

mentioned in the volume that its idea originated from a panel at the European Association for the Study of Science and Technology conference in 2016 (p. 14, p. 79). It would perhaps be useful for the readers to see in more detail how the authors' approach to elemental thinking and the concept of reactivation changed as the panel discussions gradually turned into a co-edited book.

Overall, this volume represents a solid contribution to STS and environmental humanities literature. It could be well situated in recent scholarly conversations on resources as parts of more-than-human assemblages (e.g., Salazar et al. 2020; Watts 2019). It will be a relevant and exciting read for scholars, students, and activists interested in more-than-human assemblages, power and resistance, as well as alternative ways of engaging with nonhuman actors in a shared landscape.

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Strange Blood: The Rise and Fall of Lamb Blood Transfusion in 19th Century Medicine and Beyond

by Boel Berner (2020) Transcript Verlag.

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Surrounded by anxious and curious families of patients in a sickroom, the local physician installs an unusual contraption between two bodies; one being the weak patient lying in bed, and the other, a lively six-month-old lamb fastened to a board. Driven by the lamb's heartbeat, its blood flows into the patient's body. The room falls silent as everyone awaits the outcome of this strange transfusion process. This scene sets the stage for Boel Berner's *Strange Blood: The Rise and Fall of Lamb Blood Transfusion in 19th Century Medicine and Beyond*. Berner, an Emeritus Professor of Sociology and History at Linköping University in Sweden, has extensively researched the nexus of social development, technology, and power and presents her latest findings in this book based on her project that explores the politics of blood during the interwar periods.

Strange Blood delves into the use of lamb blood transfusion to treat patients with life-threatening diseases, as part of a Western medical surge that appeared and disappeared suddenly in late-nineteenth-century Europe. Why was lamb blood used, and why this specific kind of animal's blood over others? These questions piqued my interest before embarking on this journey with Berner. Fortunately, the author clarifies my confusion. Berner reveals that lamb blood was never the exclusive option for transfusion, and a variety of other animals' blood, including humans, dogs, calves, cows, and oxen, were all experimented with. The preference for using lamb blood for transfusion arose from negotiations between various conditions and concepts. For instance, it was believed that lamb blood had smaller blood cells, making it more capable of travelling through blood vessels. Some individuals chose lamb blood for practical reasons, simply because it was more financially viable. Interestingly, Berner does not provide a simple and straightforward conclusion to these reasons, as some readers may expect. Instead, she interweaves these explanations throughout the book, articulating them with intricate analyses of various historical actors' backgrounds, motivations, and methodologies. This writing style may seem unclear to some readers, but it effectively conveys the historical complexity the book aims to impart.

In general, *Strange Blood* poses questions such as "Why was there a sudden fervour for transfusing strange blood? How was it carried out, by whom, and how did the patients react? And, most importantly: did it work?" (p. 11). By examining these issues in nineteenth-century Germany, Britain, Sweden, Italy, Russia, and the USA, this book employs a range of

primary historical materials to demonstrate how "lamb blood transfusion was, in many ways, a transgression" (p. 12). The transgression-lens that Berner uses aligns this book with other works in medical humanities (e.g., Lederer 2008) that reject the neutral, autonomous, and linear conceptualisation of medical science and focus on the complex political and cultural meanings, rather than merely medical and surgical importance. In Berner's words,

> the experiment with lamb blood transfusion was a political phenomenon. It upset medical hierarchies and truths. It challenged medical knowledge, ethics and expertise, gave rise to controversy and debate. It had ramifications also outside the medical world. (p. 12)

Berner's approach to her ambitious inquiry is Foucauldian, in my opinion. Like Foucault, who demonstrates how "sex is 'put into discourse'" from eighteenth-century Europe to "the contemporary West" (Foucault 1980, 11), Berner also investigates the contested relationship between power and knowledge production by revealing how specific knowledge of blood transfusion was socially and culturally celebrated or stigmatized, supported or oppressed, and constructed or destroyed. This book participates in the ongoing conversation in science and technology studies that seeks to deconstruct and reconstruct the boundaries of so-called scientific knowledge.

In addition to an engaging prologue and a clear introduction, the book is divided into four sections. The first section provides a historical overview of blood transfusion, primarily in the European context. Readers are then introduced to three marginal physicians, Oscar Hasse, Franz Gesellius, and Joseph-Antoine Roussel, who were nevertheless influential in promoting lamb blood transfusion in the 1870s. The second section shifts the narrative to the development of lamb blood transfusion practices in various contexts. Readers embark on thrilling journeys from battlefields to laboratories across the European continent, from sick rooms in the German countryside to Italian asylums, and from Swedish spas to Russian transfusion competitions. Along the way, readers encounter a diverse cast of characters, including local physicians, medical equipment entrepreneurs, military surgeons, hospital doctors, and physiologists. Their interventions in promoting or suppressing lamb blood transfusion practices were driven by personal ambitions intertwined with professional, cultural, and political compromises, rather than purely scientific agendas. Moreover, Berner devotes ample space to documenting the voices of patients who received lamb blood, providing a more comprehensive depiction of traditionally marginalized stakeholders in this process.

In my opinion, the third section is the heart of this book. After two lengthy but necessary sections that provide readers with essential information about lamb blood transfusion, this section meticulously analyses the controversy surrounding it, making it a contested knowledge. Berner successfully demonstrates that the conflicting voices for and against this particular medical treatment:

> signal a genuine uncertainty, not only about the effects of this particular intervention but, more generally, about how different kinds of medical evidence should be assessed and compared. Hospital and bedside based doctors tended to favour clinical experience and distrust animal experiments; physiologists thought quite the opposite. Still, the evidence was far from clear-cut; there were doubts on both sides as to the relevance of their respective arguments. (p. 117)

Overall, reading *Strange Blood* was a pleasurable experience for me. Although medical jargon occasionally appears in the book, the language is generally accessible and easy to understand. Additionally, the extensive use of multilingual (e.g., German, French, Italian, Swedish) primary historical materials by Berner is undoubtedly one of the book's most valuable assets. These materials include news, journal pieces, personal accounts of doctors and patients, academic exchange, clinical records, and hospital archives. Berner skilfully employs these materials to create vivid settings of nineteenth-century Europe and North America that are rich in micro-level details and comprehensive general illustrations. In *Strange Blood*, Berner expertly demonstrates her ability to collect, interpret, analyse, and articulate primary historical materials, seamlessly integrating them into her narrative. Reading the book feels like embarking on a wonderful journey that involves conversing with various historical characters. Thanks to Berner's excellent work in interpreting and organising the raw historical materials, the conversation always feels swift and direct. The addition of over thirty images undoubtedly brings readers closer to the characters and settings in late nineteenth-century Western contexts.

However, Berner's inquiry into transgressing not only scientific and medical boundaries but also cultural, social, and human/non-human boundaries, using the cases of lamb blood transfusion, is not entirely successful. To a large extent, Berner's overemphasis on presenting historical details diverts her attention from conducting in-depth analysis. While blood transfusion and transgression in human societies are not new topics and have been investigated by many scholars from various fields (e.g., Singelenberg 1990; Drawmer 2006), Berner rarely engages with the ongoing conversation in the broader scholarship (except for a few scholars, such as Anita Guerrini). This is a missed opportunity, given the wealth of historical materials that Berner has deliberately included in the book. *Strange Blood* could have contributed more significantly to academia than merely providing empirical materials for the theory-building work of STS if Berner had incorporated more social and cultural reflections into the book.

Another minor weakness of *Strange Blood* that I would like to address may seem irrelevant or harsh to some Western readers. However, as someone from Asia who is engaged in decolonising knowledge production, I find the book to be Eurocentric to some extent. For instance, in a book written in English, other European languages like French, German, Italian and Swedish are employed without proper translation. Furthermore, while Berner claims that lamb blood transfusion in the nineteenth century is part of a broader international story, the internationality in the book is limited to trajectories of people, ideas, and objects within the West. The book lacks a broader comparative perspective with countries outside Europe or North America, and it does not investigate how the notion of transgression in medical development is perceived, spread, and negotiated in wider non-Western societies. While I acknowledge that every scholar is positioned and brings an inevitable partial view on the subject-matter, in this case the author's indifference to justifying the choice of the field of investigation and the possible limits of that choice may suggest a Eurocentric perspective on the concept of internationality. This makes the book somewhat methodologically and theoretically outdated in an era when many scholars in the history of medicine (e.g., Kim 2014; Lin 2022) are exploring alternative and comparative methods of writing transcultural world histories. In reviewing this book, I hope to encourage the development of a more decolonised and transcultural framework that facilitates the exploration of plural, shifting, locally informed global trajectories of science and technology.

Overall, *Strange Blood* is a well-written and easy-to-read book. Its readability does not detract from its credibility as a serious academic work full of carefully examined and well-articulated historical analysis. I recommend it to anyone interested in problematising and reconstructing the established boundaries of scientific knowledge and any discipline in culture and humanity. I also recommend reading it alongside other relevant works cited in this review.

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