Ageing as a Boundary Object
Thinking Differently of Ageing and Care

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Abstract: Ageing is not only a chronological matter. The following contributions at the crossroad of STS, material gerontology, design, and medical sociology offer alternative views on ageing and care. Ageing emerges as a boundary object through which authors explore the relationship with technologies and technology-based processes and practices. Authors point out that becoming older is a sociomaterial process and emphasize the importance of thinking with care when designing technology as well as the relevance of the socio-technical imaginary in conceptualizing older people.

Keywords: age studies; material gerontology; care; co-design; frailty.

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Introduction

Michela Cozza

In one of her foundational articles, Susan Leigh Star (2010, 604) says: "I am invariably asked the question, '*well, but what is NOT a boundary object?*' (or, along the same lines, 'Couldn't *anything* be a boundary ob-

ject?')."). In this article as well as in other contributions, Star has always refrained from normative statements about the true and proper meaning and use of boundary objects despite she has provided a definition that reminds us of their plasticity and robustness (Star 2015).

In the same article, she continues by pointing out one dimension that we deem relevant to this special issue on ageing and technology and, all the more, in this Crossing Boundaries section of *Tecnoscienza*. Star thinks of standards and boundary objects as inextricably related, especially over time, in so far as what was a boundary object at one time may become standardized later on. When this movement happens, as Star highlights, the standard as such throws off or generates residual categories. Such a deep interconnection between boundary objects and standards, and the relationship(s) between standards and residual categories are key to the study of ageing and technology, in particular by noticing that "[c]ertainly, our society makes age – precise chronological age – something that no one should be without (…) chronological age became a privileged standard for classifying individuals" (Treas 2009, 65).

By referring back to Star where she clarifies that the term 'boundary object' embodies both a pragmatist sense and a material one – so that we should go beyond the common idea of object as (exclusively) a thing – it seems quite reasonable to assume 'age' as a boundary object, "something people (...) act toward and with. Its materiality derives from action, not from a sense of prefabricated stuff or 'thing' -ness" (Star 2010, 603) as material gerontology has recently foregrounded with regard to how technologies and objects in general embody and foster a specific view of age(ing) (Höppner 2017; Höppner and Urban 2018; Wanka and Gallistl 2018). Yet, age as boundary object turns out to be a problematic standard depending on which actions are undertaken in relation to it and which are the associated meanings, as well as material and symbolic implications that many STS and other critical scholars have discussed in relation to technology design in care settings (Maller 2015; Mol, Moser and Pols 2010; Buse, Martyn and Nettleton 2018).

Today, the chronological age is remarkably wide in the scope of its coverage and classifications relying on this standard are as many as the related organizing purposes. On the basis of chronological age (among other relevant standards), individuals are referred for medical tests, children are admitted to different grades, and seniors qualify for dining discounts or are entitled to get specific welfare services (Cozza et al. 2019). So far it does not seem that the effects of taking age as an 'ordering principle' is producing the dramatic effects that the above-mentioned relation between standards and categorisation was heralding. However, by crossing several boundaries like, for example, that between medical sociology and

STS we discover that ageing is quite often associated with a sociotechnical imaginary of vulnerability and frailty that – at least in the countries of the Global North – leaves very little space to a romanticised idea of the later life as the age of wisdom and inactivity. On one hand, there is an idea of older people as 'people in need' whose being and doing is marked by age-associated decline as a condition that homogeneously concerns all elderly (WHO 2017); on the other, and in sharp contrast with the previous frame, there is a huge emphasis on activity in later life as proved by an incredible amount of scientific and business initiatives falling under the concept of "active ageing" (Katz 2000).

In this section of the special issue, ageing is the boundary object through which authors explore the relationship with technologies and technology-based processes and practices by crossing multiple disciplinary boundaries and pointing us towards alternative views of later life, older people, age and ageing.

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Connecting the Dots of New Materialist Approaches in the Study of Age(ing): The Landscape of Material Gerontology

Vera Gallistl and Anna Wanka

Gerontology – the discipline concerned with questions surrounding age and ageing in the broadest sense – has increasingly turned to technology use in later life as a topic of research. Whereas many gerontological studies on ageing and technologies are rather applied and techno-optimist, asking how technology can improve older adults' lives, more critical and cultural approaches have developed rather recently (Kolland et al. 2019). They voice two types of critique: First, they criticize Gerontology's blindness when it comes to the discourses and imaginaries of age and ageing that shape technological development and design. This criticism, often elaborated by researchers working at the intersection of Science and Technology Studies (STS) and Gerontology, targets, on the one hand, ageist stereotypes about technology use in later life in design processes and the paternalist stance towards older adults resulting from it (Peine and Neven 2019), and, on the other, the techno-optimism of gerontological research itself (Neven and Peine 2017; Peine 2019). Second, critique from new materialist approaches in Gerontology questions the underdeveloped role materialities play in researching ageing and technol-

ogy. Such approaches argue to take the materialities that constitute human life worlds, like the ageing body, the spaces we are in, and the things that surround us – including technologies – more seriously when we aim to better understand age and ageing.

For studying ageing and technologies this implies to grant those materialities their own agency - technologies are not just being *used by* but *interact with* older adults.

Following this strand of critique, several scholars within the study of age(ing) have started to think about materialities in more depth (for example: Calasanti 2003; Gubrium and Holstein 2008; Buse and Twigg 2016; Artner et al. 2017). One approach developed from these endeavors is *material gerontology* (Höppner and Urban 2018). Material gerontology has been heavily influenced by both cultural gerontology (cf. Twigg and Martin 2015) and new materialism (cf. Barad, 2003). New materialism is an umbrella term for a nexus of theories formulated mainly in gender studies and feminist STS and bringing together concepts such as "agential realism" of Karen Barad (2003), "Deleuzian materialism" of Rosi Braidotti ([1994] 2011), or "posthumanism" of Donna Haraway (2007). These approaches understand discourses and materialities as inextricably linked within "material-discursive practices" (Barad 2003, 818). This implies that we do no longer look at how older adults use or act with technologies - how they *inter-act* with technologies -, but how ageing and technologies *intra-act*: hence, how the constellations of discourses (like discourses and imaginaries of ageing) and materialities (like ageing bodies) that constitute ageing are linked to the discourses (like technological innovation discourses) and materialities (like the devices themselves) that constitute technological innovation in discursive-material practices and, accordingly, form *processes of entangled becoming*.

For the study of ageing and technologies, looking at these socio-material processes of *becoming* can enable a fuller and more exciting picture of how age and ageing is socio-materially co-constituted and can also enable a more nuanced discussion about the role diverse materialities (from technologies to other objects) play in this process. For STS, such approaches can enable a fuller and more differentiated understanding of the particularities of age and ageing as a socio-material phenomenon. In the following, we illustrate how material gerontology approaches questions around ageing and technologies and discuss which insights such a perspective yields for STS.

Connecting the dots: material gerontology

In this section, we want to take a broader look at the concepts and approaches within material gerontology by answering the following three questions from a material gerontological perspective: (1) *Who and what is involved* in ageing processes? (2) *Where and when* do ageing processes take place? (3) Where are the *boundaries* of ageing processes located and who defines them?

From a material gerontology perspective, ageing processes are co-constituted in a nexus of discursive-material practices. This then, first and foremost, means acknowledging that (human) ageing itself is not a phenomenon that takes place *within* or happens *to* a human being, but that ageing emerges as a phenomenon through the entanglement of diverse materialities, discourses and subjectivities. The process of ageing is therefore not only a biological, but a symbolic, discursive, cultural and – most importantly - material phenomenon (Wanka and Gallistl 2018), in which a variety of human and non-human actors, humans, things, technologies, animals and much more are entangled (Höppner and Urban 2018). Material gerontology therefore does not center ageing processes in one human actor but acknowledges a variety of – human and non-human – actors of ageing processes. Ageing is therefore understood as distributed (Höppner 2021). The processes of *becoming* old is therefore an assemblage of materialities – from human bodies, things, technologies, spaces and their relations. Studies within material gerontology have consequently analyzed the role of things, objects and technologies in ageing processes (Kollewe 2020), and have significantly gone beyond viewing them as 'passive' participants in research projects, but rather granted them agency in shaping experiences and identities in later life (Lovatt 2018). However, material gerontology does not only focus on technological innovation, but also engages with more mundane and ordinary objects of later life, such as dress (Buse and Twigg 2016) or furniture (Depner 2015), which enables material gerontology to not only look for innovative or new technologies in later life, but also to provide tools for making the ordinary, tacit and non-verbal aspects of materialities of age and ageing more visible.

Second, material gerontology approaches question *where and when* ageing processes take place. While ageing processes have traditionally been located within, or close to the ageing body, not only by medical or psychological, but also by social gerontology (Öberg 1996; Martin and Twigg 2018), material gerontology significantly expands thinking on *where* ageing processes take place, making the ageing body no longer the central *place* of ageing (Höppner and Urban 2018). Studies instead highlight the close connection between the materiality of bodies, artefacts, and aspects of space in the becoming of age and ageing (Buse et al. 2018), hence considering bodies, technologies and spaces as interrelated parts of

socio-material assemblages of ageing (Jarke 2020). Studies have, inter alia, explored the architectures of care and health of later life, highlighted how imaginaries of ageing bodies are (re)produced through architectural spaces (Nettleton, Buse and Martin 2018) or studied how understandings of a central place of ageing – the home – is constituted through the entanglement between objects, spaces and embodied practices in processual manners (Lovatt 2018). This has also enabled material gerontology to see how age and ageing are shaped through spaces in unusual and unexpected ways, e.g. looking at constellations of ageing in mountains (Gallistl and Parisot 2020; Höppner 2015), or at materializations of ageing in benches in public spaces (Moulaert and Wanka 2019). Age(ing), from a perspective of material gerontology, therefore is not only shaped by and through spaces, it itself emerges as a spatial phenomenon, as it "'spatialises', that is, it produces its respective spares as three-dimensional arrangements comprising artefacts and bodies" (Reckwitz 2012, 252).

Such a perspective also enables material gerontology approaches to question *when* ageing processes take place. Understanding ageing as a distributed phenomenon with multiple actors (Höppner 2021) also means acknowledging the multiplicity of intersecting temporalities that age and ageing is built through. While ageing is often associated with a particular kind of time, namely (scarce) life-course time (Kottmann 2008), research in material gerontology has significantly expanded this view, and shown how multiple temporalities of age and ageing can become conflicted or stand in contrast to each other, e.g. in innovation discourses of the arts (Gallistl 2020) or technological development (Peine and Neven 2020). From a material gerontology perspective, ageing therefore not only spatializes, it also temporalizes, as it produces diverse (and sometimes conflicting) temporalities.

Third and consequently, material gerontological enables a new perspective on how boundaries are drawn in the processes of *becoming old*: boundaries between diverse actors of ageing – like ageing human bodies and the things that 'surround' them -, boundaries between what is 'old' and what is 'young', or boundaries between what is 'normal' and 'deviant' ageing. One central discussion concerns the boundaries of the ageing body, which, in gerontology, has often been conceptualized through a medical gaze, as a distinct, rational and – most importantly – enclosed entity (Martin and Twigg 2018; Höppner and Urban 2018). Despite the fact that body boundaries have been remarkably expanded in the last years, for example through the diffusion of new care technologies, implants and mobile devices, the 'ageing body-entity' is still often perceived as the foundation of gerontological knowledge (Martin and Twigg 2018). Material gerontology, on the contrary, highlights that humans are aged in ac-

tor-networks, entanglements, assemblages and that the boundaries between actors in these relationships are made in *practice*, rather than being pre-defined. Drawing on Barad's (2003) conceptualization of agential cuts, research within material gerontology has, for example, asked how the often taken-for-granted boundary between human and non-human actors of ageing are made through processes of *becoming with things* (Höppner 2015).

Establishing boundaries, making connections: material gerontology and STS

Finally, we discuss where and how a material gerontology perspective overlaps with other approaches aimed to better understand ageing and technology, especially with those at the intersection of Science and Technology Studies (STS) and gerontology, and which insights a material gerontology perspective could bring to STS.

At first sight, the similarities between the material gerontology and other approaches towards ageing and technology within STS are striking: Both understand ageing as a processual constellation of practices that is distributed between humans and non-humans (Höppner 2021; Moreira 2016); and that these practices co-constitute both ageing and other actors involved in it (Höppner and Urban 2018; Peine and Neven 2019). Moreover, both perspectives stress the importance of materialities and their spatial distribution in this process of co-constitution (Wanka and Gallistl 2018), at the same time acknowledging that the boundaries between the material and the non-material, the human and non-human, are themselves drawn in the course of it (Höppner 2017; Irni 2010).

However, a material gerontology perspective demarcates from traditional STS perspective in one crucial aspect: in how seriously it takes the centrality of age and ageing. For STS, age tends to be treated as a social phenomenon alike any other, and a STS perspective could be applied approach the co-constitution of age(ing) and technologies just as it could be applied to approach the co-constitution of health/illness and technologies, or gender and technologies – all with quite a similar design and theoretical background. A material gerontology perspective, however, cannot so easily be applied to other phenomena than age(ing) - despite its influences from gender studies and (feminist) new materialism. For STS, age(ing) tends to be seen as a case, whereas for material gerontology, it is a concept – as age is not a blank canvas to be 'filled' with empirical data, but an analytical approach.

Borrowing from Nicolini's metaphor of "zooming in and zooming out" (2009) makes this distinction more explicit: When STS and material

gerontology 'zoom in' at their research phenomenon, both perspectives 'meet' at the 'intersection' of co-constitution of age(ing) and technologies, where they are both concerned with practices, processes and materialities. However, they 'separate' when they 'zoom out': Here, STS refers back to and takes into account a broader 'non-age related' picture, comprising, for example, technology design processes and the discourses, narratives and images around age and ageing, but also technologies and innovation, that are (re-)-produced in them. Material gerontology, on the other hand, 'zooms out' to consider and refer back to the life-worlds of age(ing), including the situation of older adults in a political economy of ageing, their structural and symbolic disadvantage in society, their generational socialization, their life-courses and biographies, and the range of materialities and materialized temporalities that characterize their life worlds: from fancy and 'new' to mundane and 'old' devices, artefacts and objects.

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Careful Co-Design: Working with Feminist Accounts of Care in Co-Design

Helen Manchester

Technologies and their effects have become increasingly implicated in our everyday lives, loves and caring practices (Matthewmann 2011), including those of older people living in care facilities. To date mainstream technologies designed for the ageing market have been less than successful, often due to ageist stereotypes that perceive ageing as a 'problem' and technologies as potential easy win solutions (Vines et al. 2015; Peine and Neven 2019). In design processes the 'problem' has often been defined by designers at the outset, echoing cultural tropes of older people as frail and lacking agency (Boyle 2014).

More recently there has been a growing focus on consideration of the social and everyday lives of older people and the emergence of new methods of co-designing alongside older adults (Vines et al. 2015; Rodgers 2018). These methods have tended to foreground power relations between humans, in particular the dichotomous relationship between those

with power (e.g. designers) and those without (e.g. older adults). However, this approach has often had the effect of sidelining the material and more than human actors participating in these processes and can fail to account for the entanglement of social and material worlds. In order to intervene in design practice, Science and Technology (STS) scholars have suggested that problems should be worked on within human collectives who gather around particular 'matters of concern' related to ageing (Latour 2005). These matters of concern are considered to be entangled in social and material processes and practices.

STS and feminist materialist thinking in co-design

In my own co-design work in care settings for older people I bring an approach that draws on some of these ideas from STS but also combining them with feminist materialist thinking concerning the relationality between care and technology (Mol, Moser and Pols 2010). These scholars argue of the 'absurdity of disentangling human and non-human relations of care' (Bellacasa 2017, 2; Mol, Moser and Pols 2010) suggesting that paying attention to the relational, affective and interdependent effects of technologies, alongside other care practices, is vital in technological design processes. Taking this stance into processes of co-design in care settings involves rejecting more instrumental, economic accounts of the world and increasing awareness and visibility of the networks of actors that are taken for granted in everyday practices of care (Mol, Moser and Pols 2010; Barad 2007; Bellacasa 2011). The co-design process here involves making visible, and tangible, sociomaterial relations of care and how they contribute to social well-being. The process of technology design proceeds as an open-ended innovation process where technologies are considered unfinished projects which are open to adjustment or tinkering (Akrich 1992; Mol, Moser and Pols 2010).

Bringing feminist materialist ideas of care to the practice of co-designing technologies means engaging with care in all its sociomaterial complexity. To simplify some complex historical arguments, feminist scholars ask us to reconsider care in four key respects: firstly, seeing care as an everyday, messy, material practice; secondly, seeing care as political (and often overlooked); thirdly, understanding care as going beyond language to encompass embodied materialities of care including touch and bodies and finally care as a dynamic process being about diligent attention to detail, involving repair and maintenance (Tronto 1993; Bellacasa 2017).

Careful co-design

Drawing on these ideas of care Bellacasa (2011; 2017) has suggested that STS scholars might consider moving beyond the Latourian call to gather around matters of concern to consider intervening in 'matters of care'. In my own work I have been interested in bringing Bellacasa's rather theoretical ideas to the practice of co-design. I have begun to think about co-design as a matter of care or as a care practice which, I believe, supports more ethical, sustainable design in the ageing sector. Below I will outline how taking this approach might change practices of co-design and will argue that this approach is of particular value when working in settings where questions of care are predominant.

Firstly, moving from 'I am concerned' to 'I care' draws attention to affective aspects of technology design practices that have often been ignored. It involves paying attention to the networks of actors that are often taken for granted in technology design processes, including making visible how bodies, space, aesthetics and intangible concerns come together as we co-design technologies. For instance, noticing how the touch of a hand or the view out of window, might be important elements to consider in both the design practice and in relation to the object of the design.

Working with co-design as a care practice also highlights co-design as a material, vital doing. It suggests the need for diligent attention to detail, for constant repair and maintenance and attention to humans but also things and materialities as we co-design together and with the material world around us. I have always found the below quote from Miriam Winance particularly helpful in thinking about good co-design practices – if we substituted the word 'care' with 'design' the quote gets to the heart of how careful co-design processes work in practice:

> to care is to meticulously explore, quibble, test, touch, adapt, adjust, pay attention to details and change them, until a suitable arrangement (material, emotional, relational) is achieved. (Winance 2010, 111)

So matters of care are doings, they cannot help but therefore involve the social and the material world and the more than human.

Careful co-design also involves a critical approach that questions why certain practices of care have been invisible and de-valued and looks to enable new actors and tools to align in trying out a more democratic and holistic future making approach to the design of technologies. The contention here is that open ended, careful design projects are necessary in order to make 'good' care practices, exemplified by approaches that acknowledge the ethical/political, the affective and the material/ mainte-

nance of care (involving our bodies, ourselves, and our environment) more viable and present in new technological designs and approaches to care.

So what does this mean for co-design practices and outcomes? It involves us attending to *sociomaterial arrangements* as matters of care in co-design processes. For instance, recognising the role of material culture, such as aspects of the built environment and everyday objects, in care settings in order to illuminate and develop their role in caring practices (Maller 2015; Buse, Martyn and Nettleton 2018).

Careful co-design in practice

In order to provide an example, the next section of this short paper explores our co-design process in care homes in which we conducted a process of technology co-design focused on democratic community building through storytelling. We spent time observing in the settings as part of the 'discovery' phase of our design work and instead of focussing only on the human care practices and relations we instead specifically attended to the material and more than human world and the importance of these elements to the older people we were working with. For instance, we observed the blackbird that sings outside the window that was given a name by some of the residents, the touching and grooming activities such as nail painting that care staff engaged in, the long and deserted corridor through which residents must walk in order to reach the beautiful garden room and the sound of the tea trolley that provided a familiar and comforting rhythm to the day. We were then able to build on these often invisible elements of caring practices in our co-design work, bringing in different material and sensory design interventions such as object orientated sessions where residents told stories about their favourite objects to other residents, and sensory sessions involving smells and an array of fabrics (velvets and silks and furs) for residents to touch and smell.

In adopting this approach we found that, as designers, we were able to identify some key tensions or problems related to how assemblages of care often worked to diminish the relational, emotional and embodied aspects of care. Relationally we found that older residents struggled to make connections with each other but also that care staff often felt anxious about having one to one conversation with residents. Emotional issues included those related to living with loss; of objects, relationships, and homes. Embodied/material problems emerged, for instance, around the particular aesthetics in the care settings, the constant noise of the TV, and the noticed disconnect with the natural world and the world 'outside' the care setting.

In identifying these key tensions we felt we were able to move from a focus on problem solving and towards thinking about our co-design process as joint problem making as the matters of care, outlined above, emerged through doing the designing together. In order to identify these tensions we had explicitly engaged with how human and non-human entities emerge, shift and fuse together during our co-design process. This helped us to understand, through a relation lens, what entities become, do and produce when they are associated together and the different problems or matters of care that therefore emerge.

In order to ensure this joint problem making approach we discovered the importance of recording, mapping and playing back the different entities and their relations, to our co-designers in multiple ways, bringing material and immaterial aspects of matters of care, that are not always visible or tangible, into the open.

We found that the outcome of the co-design process also then changes as we were then engaged, not in simply co-designing technologies to solve the problem of lack of community in care settings, rather we needed to co-design care arrangements or sociomaterial arrangements (Criado and Rodriguez-Giralt 2017). This might require 'technology' designs that make adjustments to intangible aspects of culture and re-designs of space, but it might also mean working alongside care staff to develop their confidence to deliver care differently, or alongside policy makers to challenge the current economic models around social care provision.

Conclusion

So up to now I've suggested that the social and the human has often been foregrounded in co-design work - a focus has often been on power relations between humans and the design of more democratic processes, bringing diverse publics together around matters of concern. This is important. However, in my work I have found that thinking about co-design as gatherings around matters of care helps us to focus in on the material and the more than human in co-design processes, to consider the political and ethical issues that have various everyday effects in care settings. It helps us to think about co-design as problem making rather than problem solving and leads us to co-design technologies as sociomaterial care arrangements.

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Frailing Technology: Ageing between STS and Medical Sociology

Tiago Moreira

In this short essay, I explore how vulnerability could be embedded in technological design in the ageing domain and beyond. My point of departure is the suggestion that health and activity/mobility play a central role in the sociotechnical imaginary of ageing societies. I suggest that crossing the boundaries between medical sociology and science and technology studies enables us to question this configuration, and to re-think the socio-materialities of ageing. To do this, I draw on empirical data from a set of interrelated projects conducted in last 5 years, starting with a reflection on a fieldnote written in 2017.

Between the molecular and the experiential

I think it was the fact that I was understanding most of Jennifer's presentation about her doctoral research to the other lab members that I first remarked in my notebook. Contrary to other research progress oral reports to the Thread Lab – a cell biology of ageing laboratory where I conducted ethnographic fieldwork between 2015 and 2019 –, Jennifer's touched on a subject I knew something about: frailty. In the two years before I had been involved as a collaborator in a randomised controlled clinical trial of muscle strength training and protein supplementation as a means to delay frailty and its musculoskeletal component - sarcopenia - in older individuals. In the process, I had become interested in the on-going controversy about the concept age-associated frailty (e.g. Pickard 2018), its prevalence in the population, and aware of debates about the complicated relationship between frailty and sarcopenia in the ageing population.

What I had recognised in Jennifer's presentation was not only the use of a commonly used definition of frailty – as a "state in which the ability of older people to cope with […] stressors is compromised by an increased vulnerability brought by age-associated declines in physiological reserve and function" (WHO, 2017) – but more importantly her drawing on a specific standard, the Frailty Index (Mitnitski, Mogilner and Rockwood 2001) – also used in the sarcopenia trial on which I was a collaborator –, to measure 'health deficits' in the aged mouse. In an operation that cell biologist of ageing von Zglinicki and colleagues (2016) described as "reverse translation", Jennifer's aim was to draw and validate equivalenc-

es between deficit indicators used for humans in the Frailty Index and markers of health in the laboratory mouse. In practice, 'reverse translation' was a difficult undertaking, because it required knowing and caring for lab mice in highly specific, detailed ways (Friese 2019) – e.g. assessing, scoring and maintaining fur shade, texture, grain and general condition. This process was intended to establish a biomarker baseline to explore the value of senolytic therapies – "agents that selectively induce apoptosis [cell death] of senescent cells" (Kirkland et al. 2017, 2297) - in the reversal of frailty, which was the key objective of Jennifer's research project.

Underpinning the parallels across sites is a common approach to technoscientific innovation, supported by a shared standard (Frailty Index). In the sarcopenia trial, the focus was on designing exercise routines and protein-rich food products, testing their acceptability in the older population and their efficacy in countering loss of skeletal muscle mass, and frailty more widely. In Jennifer's study, the idea was to design and test therapeutic agents to reverse the accumulation of cells which have lost their capacity to divide (senescent cells), and thus to prevent the development of age-associated conditions such as frailty. This rationale is also evident in the design of 'healthy ageing' interventions aiming to involve older people in urban cycling in many contemporary cities (Lassen and Moreira 2020). In all these instances, innovation is justified by alignment with the promise to address a specific socio-economic problem, research projects and initiatives hinging on the possible impact of technological intervention on the frailty of older populations, where prevalence is estimated to be up to 60% (Collard et al. 2012).

The choice of frailty as a target of technological intervention is significant beyond its prevalence and is intimately linked to how this syndrome has come to embody the predicaments of growing old in contemporary societies. As Gilleard and Higgs (2014) have argued, frailty is the defining condition of the Fourth Age, a collectively imagined last phase of life characterized by ill health and dependency. They suggest that, contrary to other stigmatising conditions, the labelling mechanics of 'frailing' does not enact a concrete spoiled identity, as expected by models of stigma inspired by Goffman (1963), but rather a sense of abjection towards older people, thus marked by "a future unspecified adverse outcome". In this, research and innovation program to prevent frailty can be seen to deploy a central sociotechnical imaginary that links health and activity/mobility to technology in the ageing society.

It is useful to think of health, activity and technology as being in a three-way relationship (Moreira 2016, 47-49). In this triangle, practices of health production and measurement – e.g. exercise routines - become linked to technoeconomic promises of re-activation of the ageing body

(e.g. reversing frailty). Relatedly, valuations of activity/mobility become closely associated with health measurement (e.g. Frailty Index), on the one hand, and the effects of technologies, on the other. Interestingly, such technologies are not confined to one single domain, ranging from biocellular therapies, to assistive robotics to the design of protein-rich foods. The range of possible interventions on the frail ageing body blurs the distinction between computing, biomedicine, public health, sport, food science and technology, and other fields. Technoscientific practices, in domain of ageing, as the example of frailty makes clear, offer to modify health and activity through a set of converging tools and forms of knowledge that align the "molecular and the experiential" (Lappé and Landecker 2015, 152).

Frailty at the crossroads

Understanding and investigating empirically this specific configuration of ageing-related technological practices requires a careful but equally inventive combination of theories from both science and technology studies and medical sociology. Using the example of frailty, again, will help to clarify this argument. In both the clinical trial and the Thread Lab, technological design and testing relied on a workable category of frailty, made conspicuously visible in Jennifer's attempts to 'reverse translate' the deficit accumulation model of frailty to the lab mouse. Committing to a specific formatting of frailty had consequences, for example, for how exercise protocols were designed in the clinical trial, and in turn, for the recruitment criteria used. Thus, it was sometimes the case that potential participants became classified as 'too frail' or 'too vigorous' to be included in the trial (Otto and Moreira 2018), making their situation potentially excluded from the networks of health production the trial was precisely attempting to build (Star 1991).

Attending to these situations is one of medical sociology's unique strengths, taking the point of view of the 'patient' and exploring the dynamic relationship between identity and the person's social world (e.g. Charmaz 1983). In distinction from the deficit accumulation model of frailty (see above), medical sociology's analysis of the experience of frailty focuses on how bodily disruption – e.g. a fall –calls into question the person's habitual, socially grounded way of being and unsettles her hitherto unproblematic relation to the world (Pickard 2018; Bury 1982). In this process, reconstructing one's identity does not necessarily entail identifying fully with the label of frailty, but might lead to a reconstruction of one's activities and social networks, so that physical limitations can be contained, and a sense of continuity maintained, despite increased aware-

ness of decline. What, in the deficit accumulation model, is cast as risk, is experienced by older people as uncertainty, enacted in a cautious and continuously re-invented navigation of their socio-material world.

Contrasting this nuanced understanding of frailty with the 'scripted' specification of technological use I encountered in the trial and the laboratory is useful for two key reasons. On the one hand, it contextualises uses of technology in a mode of pragmatic engagement – that of the activities of everyday life –, and thus helps in STS' aim to deflate technology-focused solutions to the 'problems of ageing'. From this perspective, as I observed, protein-rich food products for frail older people often merely add functionality to an already 'healthicised' meal, where ingredients are included mainly for their physiological benefits to reduce the risk of disease. Reluctance of older people to participate in this arrangement of eating should thus not be surprising and cannot be understood through the frame of therapeutic 'compliance' or 'adherence' (e.g. Conrad 1985).

On the other hand, understanding living with frailty as form of mundane work offers an alternative, diversity-focused, and embedded 'configuration of the user' to be used in technological design (Peine and Neven 2020). Medical sociology recognises living with chronic illness, disability or frailty as both a mode of practice – often conceptualised as a form of work (Corbin and Strauss 1988) - and a way of knowing: these two dimensions are inextricably connected. For medical sociologists, 'experience' is not a uniquely individual set of impressions but rather a form of socially grounded knowledge (Bury 1982), collectively produced by the interactions and negotiations of a variety of actors across formal and informal settings. This provides another point of fractional contact between medical sociology and STS in the domain of ageing. How are the forms of situated cognition that we usually see as living with and caring for frailty better supported through technological devices or processes? Addressing this question requires starting from an understanding of existing practices of frailty - a grounded theory of frailty – to identify technological needs and possible forms of user involvement. It might also invite us to reconsider technological practices in the arena of ageing.

Medical sociology direct STS further into praxiological investigations (Mol 2002) of the sociotechnical or socio-material constitution of ageing. It does so, however, by emphasising the human perspective – the 'patient', user, older person, etc. Indeed, a consistent critique of medical sociology by STS scholars has been its belief in the intrinsic character of human agency (e.g. Moreira 2004). Medical sociology's orientation to agency is problematic because of how it overlaps with calls and prompts to make older people more 'active' in society through technology intervention (see above). In this, 'active ageing' technologies have become the

target of criticisms for their inability to integrate the experience of decline, loss of function and passivity in their enactment of ageing, that is to say, to encompass the diversity and tensions inherent to a condition like frailty, as detailed in medical sociology's own empirical investigations of it. By drawing uncritically on medical sociology' humanist commitment, STS partakes uncritically in the normative aim "to reconceptualise older individuals as active users of technology rather than as passive recipients" (Czaja and Barr 1989, 128). In doing this, STS thus risks neglecting its own tradition in problematizing agency (Latour 1988; Callon and Law 1992; Gomart and Hennion 1999; Barad 2007).

Frailing technology

What would be consequences of conceptualising older people as both passive and active users of technology? To do this, we might want to start by taking frailty as an object lesson. As suggested above, frailty is interesting because it both deploys technological expectations about innovation in the ageing society and challenges the parameters on which those expectations rely. Frailty is both the defining condition of older age and the most puzzling and difficult to stabilise, define and measure both in the clinic and the lab. Its experience is marked by hesitation and uncertainty, with pragmatic engagement defined by fluctuation between inaction and careful mobility. How could technology for older people be re-imagined if frailty became its paradigm; if, instead of taking as point of departure an able bodied, active, engaged human, we would begin with vulnerability?

In this shift, vulnerability should not be conceptualised as an exceptional state but as a relationally produced human attribute (Mackenzie, Rogers and Dodds 2014), rooted in socio-technical systems (Hommels, Mesman and Bijker 2014). Frailty could thus become the model for research on technoscience in the ageing society, specifying a pragmatic and fragile balance between autonomy/activity/mobility and dependency/passivity/delicacy. Rather than aiming for technology to fix and establish the right balance between these two poles, we should try to understand how technoscience can care for the dynamic between them, enabling a continuous mutual adjustment of the capacities of ontologically heterogeneous actors. In this process, technology would undergo what we, after the process of adapting a physiological scale to lab mice describe above, could call a 'reverse frailing', where technological expectations are embedded in uncertainty and enacted in a cautious and continuously reinvented imagination of the materialities of ageing.

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