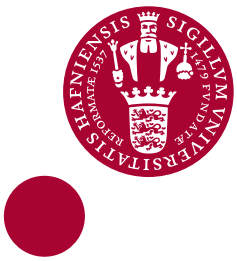

Surveillance Entanglements

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Digital Data Flows and Ageing Bodies in Motion in the Danish Welfare State

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Abstract

In recent years, new forms of self-tracking technologies, advanced algorithms and quantified measurements have increasingly become part of interventions targeting the physical improvement of elderly bodies. This has led authors to argue that the latter are not just 'busy' bodies (Katz 2000) but 'busier and smarter bodies,' as well as being nodes for data collection, monitoring and surveillance designed to promote physical functioning (Katz and Marshall 2018). The article qualifies the argument by examining concrete encounters in which frail elderly bodies are made to move and transform in digital rehabilitation programs in the Danish welfare state. The study mobilizes Bennett's (2009) notion of the 'vitality of materiality' as an analytic lens, thus highlighting the agentic capacities of technologies and the fleshy-sensual, lively force of the body itself. Drawing on ethnographic material, the article traces how movement is impacted by the links and forces generated by a specific digital rehabilitation assemblage. This emphasizes the fluidity of relational connections between bodies and digital dataflows, meanwhile demonstrating that the vital force of the aging body is expressed through sensory pain when the temporality of the metrics and the rate of bodily recovery are out of alignment. In contrast to studies focusing on surveillance as a pre-given disciplining force, the vital materialism approach invites us to think about surveillance as a vibrant, open-ended and temporally specific process whose outcome is not predetermined. Finally, it is argued that, to develop processes leading to bodily restoration rather than disruption, greater attention to sensory expression is needed – among professionals, IT workers and the elderly alike – combined with a willingness to adjust the assemblage continually to align metrics with rates of bodily recovery.

Keywords: *self-tracking; algorithm; physical rehabilitation; ageing; surveillance; assemblage; vital materialism*

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This article is concerned with the processes whereby frail or impaired elderly bodies are made to move and transform as a result of engagement with digitally arranged physical rehabilitation programs. These are cornerstones in contemporary active aging policy programs in the Global North (WHO 2011) that have become routinized elements in governments' attempts to activate and improve the physical functionality of aging bodies. Physical rehabilitation programs enact a specific progressive vision of bodily improvement, one of advancing currently disabled or impaired bodies to an imagined future stage of bodily recovery (Struhkamp, Mol, and Swierstra 2009). This transformation is effected by enrolling the aging body in a plethora of professional and expert knowledge systems which seek to calibrate and manage bodily movement, ultimately restoring a measure of the body's past functionality. In recent years, new forms of self-tracking technologies, advanced algorithms and quantified measurements have increasingly become part of these expert systems, constituting a new mode and style of 'quantified aging' in which qualitative aspects of aging life are converted into quantitative measures and used for the purpose of improvement (Oxlund and Whyte 2014; Schwennesen 2017).

The constitution nature of 'active aging' and the 'doing' of the aging subject have been recurring themes in critical aging studies. In his influential essay, 'Busy bodies: Activity, aging, and the management of everyday life' (2000), sociologist Stephen Katz argues that we are witnessing a current 'neo-liberalization' of old age which incorporates the ideal of productivity, and conflates 'successful aging' with 'active aging'. Commenting, however, on the recent revitalization of the framing of the aging body as 'busy,' Katz and a colleague argue that successfully aging bodies are no longer just 'busy bodies' but 'busier, *smarter* bodies,' as they engage in digital arrangements that seek to monitor and promote physical activity. Thus, they note, "the ageng body is emerging as a'node for data collection, monitoring and surveillance," processes that seek to promote and improve physical functioning (Katz and Marshall 2018, 63). This, they argue, reduces aging bodies to "functional, quantifiable, and exercisable molecular entities'' which "articulate human capacities through the authority of data…linked to the tyranny of health activities" (Katz and Marshall 2018, 64). In this governmentally inspired analysis of the neo-liberalization of old age, aging bodies are seen as constituted, moved and transformed by the disciplinary forces of neo-liberal surveillance technologies and the authority of digital data which, in subtle ways, shape aging bodies to move and act in compliance with the norms of health and bodily improvement.

In the following, I seek to qualify this contemporary notion of elderly bodies as 'busier and smarter bodies,' by looking at concrete encounters in which frail elderly bodies are urged to move in accordance with digitally arranged physical rehabilitation programs in the Danish welfare state. As Katz and Marshall point out, little research has so far investigated the ways in which movement data are produced and circulate through webs of technologies, relationships and expertise, impacting in turn on the movement of aging bodies (Katz and Marshall 2018, 649). This article addresses that gap by focusing on the concrete ways in which frail bodies become entangled with new digital metrics and measurements, and the processes applied to shape their movement. Hence, rather than starting from an etic notion of aging bodies as 'smart and busy' and 'surveillance' as a normative *a priori* fact, I look at the socio-material relations and procedures whereby aging bodies come to move with and through these digital arrangements.

My point of departure is an ethnographic study of the Danish use of a smartphone application that monitors home training remotely, one designed to assist in the physical rehabilitation of patients who have undergone hip replacement surgery. The technology works through the production and flow of movement data that constitute the aging body as both the object and receiver of data production. This reflects a recent ambition among designers in the field of physical rehabilitation to develop self-tracking sensors and software with the ability to provide 'intelligent' digital guidance for patients doing their rehabilitation exercises at home. Such digital arrangements are seen as having the potential to provide cost-effective solutions to the expected rise in numbers of frail elderly people in need of physical rehabilitation in the future (Danish Government 2013), and the so-called 'problem' of non-adherence to exercise programs among post-surgery patients after hospitalization (Jovanov 2005). Thus, the questions I ask of my ethnographic data include the following: What is the epistemology of digital movement data, and what images of the aging body are thus enacted? What are the processes implicated in the flow of movement data through the digital programs, and how do the program configure and interact with aging bodies and the wider arrangement of physical rehabilitation?

In my analysis, I draw on the work of post-humanist theorists who have examined the agentic capabilities of non-human actors (Barad 2007, Bennett 2010, Latour 2005), particularly political philosopher Jane Bennett's notion of the 'vitality of materiality' (Bennett 2010, Bennett 2005, Bennett 2004). This is a useful tool, as it encompasses an understanding of non-humans as potentially lively forces. In relation to the theme of energy in this special issue, it provides a fruitful analytical lens with which to explore how energy and force are produced in digital physical rehabilitation programs in Denmark, and the active involvement of non-human agencies in the constitution of bodily movement. Whereas contemporary studies of aging and surveillance have until recently mainly focused on the *social* and *discursive* construction of the aging body (Andrews and Duff 2019), Bennett's work allows us to include in our analysis not only artefacts such as technologies, algorithms and measurements, but also the body itself as a fleshy-sensual, lively force. Applying Bennett's (2005) notion of vital materialism, I suggest that surveillance operates through a wide assemblage of human and non-human actors, and is better understood as a complex accomplishment than an *a priori* fact. This understanding invites us to think about surveillance in the context of digital rehabilitation as a specific, vibrant and temporal process through which frail bodies, metrics and technologies are assembled together and produce various bodily sensations. As we shall see, however, such sensations might be articulated as harmful and controlling as well as caring and restoring. Indeed, I argue that in the Danish practice of digital rehabilitation, more attention should be given to the bodily sensations created by different links between human and non-human actors over time. Also called for is a greater capacity for response to such sensations by adjusting and rearranging the assembled components in order to align the temporality of the metrics and technologies with the (non-predictable) temporality of bodily recovery.

Vital Materialism and the Surveillance Assemblage

Using the lens of the 'vitality of materiality' (Bennet 2010, Bennett 2005, Bennet 2004) to analyze how bodies and digital data are entangled and constituted in digital physical rehabilitation programs, I place the strongest emphasis on two points that I find particularly fruitful. First, Bennett develops the concept of 'thing-power' to describe the vital capabilities of non-humans, thereby illuminating the sensory and embodied encounters of the lived experience of humans when they engage with non-humans. She describes thing-power as "the curious ability of inanimate things to animate, to act, to produce effects" (Bennett 2004, 349). In relation to the digital arrangement of physical rehabilitation, the notion of thing-power draws attention to the agentic capabilities of artefacts and their potentially active role in the generation of bodily movement. Moreover, Bennett emphasizes that 'non-human forces' can operate through objects and nature, as well as the bodily interior, by means of intrinsic elements including hormones, chemicals and micro-

organisms (Khan 2009, 95). In this view, the biological body is considered a fleshy-sensual lively force with agentic capacities, rather than a passive entity upon which digital data is inscribed.

Second, vital materialism has implications for how we understand agency. Following Deleuze and Guattari (1987), Bennett suggests that we think of agency as an emergent and dynamic outcome of temporal *assemblages* of human and non-human actors, in opposition to an understanding of agency as an intrinsic outcome of human intentionality. She defines an assemblage as "an ad hoc grouping of an ontologically diverse range of…vital materialities of various sorts" (Khan 2009, 92). Hence, an assemblage has no sovereignty in the classical sense. Rather, as Bennett notes:

> The effects generated by an assemblage are…emergent properties, emergent in that their ability to make something happen…is distinct from the sum of the vital force of each materiality considered alone. …An assemblage thus not only has a distinctive history of formation but a finite life span" (2010, 24).

As an example of an assemblage, Bennett suggests the electrical power grid, which comprises both human and non-human elements, such as coal, sweat, electromagnetic fields, computer programs, electron streams, profit motives, heat, lifestyles and so on. Despite run-of-the-mill events and the various forms of energy that threaten the grid (damage from animals, trees or wind, human mistakes, electromagnetic fields), it largely functions effectively due to the relational connections between the various elements in the assemblage. Hence, the agentic capabilities of the power grid are constituted—not by discrete entities—but through the composite achievement of the fluid system as a whole. Applying the frame of vital materialism, we can likewise think of digital rehabilitation as constituted through temporal assemblages of human (bodies, professionals) and non-human actors (smartphones, sensors, exercise programs, algorithms, digital interfaces, imaginaries of aging bodies, visions of automatization and cost-efficiency) that are interlinked by the goal of moving and transforming bodies in order to rebuild their functionality. In this view, bodily movement and processes of recovery must be considered fluid effects of the ways in which the different parts of the assemblage are connected, and the vital energies and affective relations the assemblage creates as a whole.

In the following I provide a situated account of the entanglement of aging bodies and digital data in a specific digital rehabilitation assemblage in Denmark, viewed through the analytical lens of vital materialism. As we shall see, the relational connections between the various elements in digital rehabilitation programs are assembled, disassembled and reassembled over time, which allows us to think about surveillance as a specific, open-ended and temporal process whose outcome is not predetermined.

Background and Methodology

Like many countries in the world, Denmark faces the challenge of demographic aging due to the increasing longevity of its citizens; consequently, it is expected that the cost of care for the elderly and those with chronic diseases will rise significantly in the future (Danish Government 2016). As a potential solution to the 'problem', the Danish government has increasingly invested in the development of innovative public-private partnerships, with the aim of transforming its know-how in the field of care services into the design of innovative welfare technologies. By exploring and investing in the development of such solutions, the intention is not only to render care work more efficient by making the products available for use by the Danish welfare state, but also to export them to a global market, thereby providing the basis for an economically sustainable welfare state in the future. This future includes the transformation of Denmark, whose welfare provisions were previously 'fueled' by its agricultural economy, into a nation sustained by the export of high-tech digital welfare solutions. In this sense, welfare technologies are

positioned as 'curators' of the economic sustainability of the Danish welfare state. Physical rehabilitation has been mentioned as being particularly well suited to further digitalization, and municipalities have been encouraged to invest in new digital technologies in this field (Danish Government 2017). Following this call, several have complied and the technologies are now being offered to an increasing number of patients who are referred to municipal physical rehabilitation units after hip replacement surgery.

The technology is a smartphone application that offers a digital training program with physical exercises and five sensors – two on each leg and one around the stomach, attached with elasticized Velcro bands – that monitor bodily movement during home training. Based on pre-programmed parameters and algorithms, the sensors translate data on bodily movements into digital feedback and guidance, which is delivered immediately after each exercise by a digital voice correcting the subject's performance (e.g., "Lift your right knee to a higher position"). After each training session, the overall quality of the training is evaluated and visualized on the smartphone interface in the form of stars (between one and three stars) and text messages. The digital movement data are transferred in real time to the physiotherapist through a digital program which color codes the quality of movement (green = well done; red = not well done; yellow = in between).

Since the beginning of 2016, an increasing number of patients in Denmark who are refered to undergo physical rehabilitation after hip replacement surgery have been offered the technology as an element of it, thus reconfiguring such programs in time and space. Whereas they were previously organized around an eight-week time span during which patients had to attend group training at a rehabilitation center for an hour twice a week, the technology has legitimated the substitution of one of the weekly training sessions, meaning patients only have to attend a single weekly session at the center. Thus, while guided training in previous programs of rehabilitation was located in a clinical setting and articulated through relationships between health professionals and patients, the role of providing guidance in the home of patients through the production of movement data has been delegated to technology. This provides a new distribution of responsibility wherein professional guidance during home training is the province of algorithms and measurements, while patients are expected to engage with and respond to movement data unsupervised.

The present work is based on an ethnographic study of the implementation of the technology at two rehabilitation centers in Denmark. From spring 2016 to spring 2017, I followed 20 people undergoing physical rehabilitation using the technology, attending weekly one-hour training sessions, observing physiotherapist-patient conversations on the technology and engaging in informal conversations with physiotherapists and patients. I interviewed and observed 15 participants in their homes twice, separated by periods of four to six weeks, and 7 physiotherapists who were primarily responsible for the training sessions at the rehabilitation centers. In addition, I interviewed a health consultant engaged in the development of the technology and an implementation consultant from the municipality. Extensive fieldnotes were taken in clinical encounters at the rehabilitation center and during participants' home sessions with the technology, and they were written up immediately after leaving the sites. Interviews were transcribed and general themes were identified across the field notes and the transcripts. As I was specifically concerned with bodily movement and the connections made between professionals, aging bodies and technologies, I traced these themes in particular situations and across the sites. Early in my fieldwork, I found that the entanglement between bodies and technologies transformed and co-evolved over time and have, therefore, thematically coded the material to grasp the multifaceted character of the linkages that were made across sites and over time.

The Epistemology of Digital Movement Data and Imaginaries of the Aging Body

The constitution of digital data in digital physical rehabilitation programs is the result of a particular way of observing and representing bodily movement. As material feminism scholars argue, vision is always limited, situated and constituted in specific ways (Barad 2007; Haraway 1988). In this light, the all-encompassing vision implied, for example, in the Orwellian notion of Big Brother is unachievable. Rather, we must consider data as an apparatus of knowledge production which generates a particular way of seeing and evaluating bodily movement. Yet, interestingly, it emerged that the worth of the digital apparatus which is the subject of this study was contested by the health professionals who were engaged in its design. Indeed, one health consultant who participated in the process of developing the device told me of the contested nature of the parameters and algorithms that transform digital data on bodily movement into digital feedback. She explained that health professionals were at first invited to identify the parameters that they saw as important in their assessment of whether or not particular exercises were adequately carried out; they were also asked to define their professional vision of bodily movement. She went on to say that the developers then had to prioritize and exclude parameters:

> We had to sit down and be pretty tough in setting priorities in relation to the kind of parameters feedback should be given on. […]I mean, I think we've sometimes sat down with 20 to 25 [parameters] and ended with 4 to 5. So, we have actually cut it down quite a bit.

This process of exclusion was also defined by the set-up of the digital arrangement itself, as she explains:

> With the sensor set-up we have – for this target group it's on the legs – then it's only the lower extremities that we can say anything about. So, for example, if there were some parameters that dealt with what one does with the arms or something else, then of course, we could say, "The sensors can't say anything about that."

The digital data and the feedback did not merely stem from the health professionals and their priorities, but also from the materiality of the sensors and their ability to measure some forms of bodily movement but not others. Whereas professional assessment of bodily movement would be based on a more holistic approach – taking into consideration the whole body and how different parts of the body moves in relation to the body as a whole – the digital apparatus, by transforming movement data into digital feedback, enacts a particular form of professional vision, focusing only on the movement of the lower extremities of the body. Moreover, the thresholds deciding whether or not a movement would be assessed as 'right' or 'wrong,' and whether the feedback would appear as corrective (in red as corrective feedback) or encouraging (in green as a motivating text message), were also subjects of contestation among the professionals. As another health consultant explained, "Every exercise has been designed in three levels, and we have sort of sat around and had these very loud discussions about how many degrees it takes before it's accepted as a good performance." By deciding on the particular intervals of angles between what is considered as right and wrong bodily movement, the physiotherapists enact a performative 'agentic cut' (Barad 2007) whereby bodily movement is evaluated and assessed, ultimately deciding the evaluative digital feedback to the patient.

Not only the boundaries of evaluative thresholds were decided in the designing process, the speed of bodily recovery and progression in processes of rehabilitation were likewise set and inscribed into the technology. Reflecting a vision of efficiency, the digital arrangement is programed to progress automatically with new and more demanding exercises when a number of exercises have been performed correctly. The combined agreed parameters, algorithms and thresholds decide the manner in which the

exercise program adapts to the movement of bodies, and the speed with which the progression occurs. This adaptability enacts a vision of 'automated efficiency,' expressed through the functionality of 'auto-progression,' as a physiotherapist explained:

> We wanted from the outset to design a technology which could replace physical attendance at rehabilitation centers with a digital solution that would promote home training. …Clearly, there is this economic rationality to it. …If the main idea is to save time, well then it doesn't make sense if the professional has to use it to upgrade exercise programs for the patients. So we decided to incorporate auto-progression and we made some templates; so you can easily and quickly push the template button and then you don't have to spend time on adding to and changing the exercises yourself.

This vision of 'automated efficiency,' involving digital adaptation of the technology to the user, evinces the imaginary and the desire to fast forward the training and the rehabilitation process towards recovery.

Digital data in the context of physical rehabilitation are used not only to monitor bodily movement, but also to shape and modify behavior. The design principles of the technology are based on cognitive, behaviorist elements, with the consciousness of the user seen as the primary target of intervention. Inscribed in the technology is a rather simple version of human behaviorism, wherein behavior is seen as a response to certain stimuli in the environment: the digital voice correcting a movement provides punishment whereas the three stars and the text messages provide reinforcement. There is clear inspiration for the design of the technology in the growing self-tracking industry, which offers individuals various forms of tracking devices designed to monitor and measure health and behavior (e.g., Fitbit, Vivofit, Endomondo, Apple Watch, etc.). In her study on self-tracking technologies, anthropologist Natasha Schull offers a detailed account of how they are designed to govern users through real-time 'micro-nudging' (Schull 2016). Nudging is a strategic method for guiding human behavior and decision-making in a specific direction through positive reinforcement, in contrast with other ways of achieving compliance, such as legislation or enforcement (Sunstein and Thaler 2008). This new 'behavioral-informatics mode of regulation' is designed to 'hook' (Lomborg, Thylstrup and Schwartz 2018) the user into complying with the daily training program. Similarly, the algorithmic processing of data has its foundations in human anticipations and assumptions about human behavior and how to keep bodies hooked when they are training at home. Specific rules were added to regulate the temporal flow of data (at least 15 seconds between corrections; only repeated 'bad' movements will trigger a correction; the same correction can only occur twice etc.). These rules reflect an attempt to add sensitivity to the flow of feedback data in order to keep the elderly motivated during training and provide a balance between judgement and re-enforcement.

Overall, there is a remarkable gap between the conclusive manner in which movement data are presented to elderly during exercises (oral, textual, visual) and the complex and contested processes which created the digital apparatus of movement data. As mentioned earlier, digital data do more than just observe bodily movement, they also transform observations of bodily movement into digital feedback, thereby articulating a particular version of the body being measured. As Van den Eede argues, technologies operate as 'epistemology engines' through which a particular version of the body is articulated (2015, 151). Therefore, the digital apparatus must be considered both productive and part of the very phenomenon (the body) it seeks to measure (Barad 2007, 115). The aging body articulated through the digital apparatus of knowledge production in this context is a universal and standardized body that moves in predictable ways. It is a body which progresses and recovers with the same speed over time and which makes itself available to the governance rationality of the nudge in its interaction with the digital data.

Encounters between Aging Bodies and Digital Data

The participants who became part of the digital rehabilitation assemblage described themselves as extremely motivated about doing their exercises at home. After hip replacement surgery, many patients experienced pain and found it physically demanding to move around. Most lived in small apartments close to the city center, and traveling to the rehabilitation center would often involve a challenging walk up and down stairs and coordination with public transport. They saw the possibility of training with the technology at home as a welcome opportunity to be released from a demanding weekly trip to the center and the chance to decide for themselves when and where to do their exercises. As one woman said,

> And I think it was a really great idea, because then, after all, you can do it whenever it suits you; you don't have to be constantly dealing with, "Oh, now I need to be there at 9:30; now I need to be there at this time and that time." So, I thought that was great, right?

Moreover, the digital arrangement introduced a sense of proximity and closeness to the rehabilitation center and to physiotherapeutic expertise, in spite of the physical distance. The experience of expert presence in the homes of patients was generated by the expectations that professionals would monitor the movement data, and thus have control over whether or not they were actually doing their daily exercises, from a distance. Not unlike Jeremy Bentham's prison Panopticon, which allows a watcher to observe occupants without the occupants' knowing whether or not they are being watched (Foucault 1973), the digital arrangement theoretically allows health professionals to observe the patients' physical training, without the patients' knowing whether or not they are being observed. The vision behind this is one of being better able to monitor and guide behavior from a distance.

Ethical considerations in relation to remote monitoring of patient data have been debated, and concerns such as privacy loss and the risk of data commodification have been raised, among ethicists and social science scholars alike (Brigden et al. 2019; Beer 2016). However, patients emphasized that they actually wanted to be controlled and looked after by the physiotherapists. They experienced the professional monitoring of the movement data as a crucial feature in their motivation to follow the exercise program. As one woman said,

> I think if you went there, and then had to do something at home on your own, you wouldn't get it done. The fact that it will tell on you ensures that you get more done. It helps you not to think, "Nope, he's not gonna see me skip, is he?" So, it's a very different level of commitment.

Many patients explain that the digital arrangement generated a sense of obligation to the health professionals to use the technology and produce data on bodily movement which were based on a shared interest in efficient bodily recovery. In this respect, the technology constituted a relationship of reciprocity between participants and physiotherapists (Mauss 2000): patients were expected to deliver movement data, and the physiotherapists were expected to monitor those data and use them for preparation and personal guidance in their weekly training sessions at the center.

Indeed, the patients used the metaphor of 'homework' to describe the relational character of the data, and the sense that those data, like homework, bore witness to the quality and quantity of the 'work' (training) they have been doing at home. The patients, therefore, would meet up at the weekly training sessions at the center with the expectation that the physiotherapists had actually seen the data, either proudly looking forward to positive recognition of the training they have been doing at home, or embarrassed about their lack of training and expecting to be corrected. Paradoxically, all patients – adherers

and non-adherers alike – saw the distant surveillance as a positive attribute, something which worked to encourage them to exercise at home and pushed them towards a more efficient recovery process.

In concrete encounters with the technology during their exercise programs, patients initially trusted it and saw it as a competent stand-in for the physiotherapist. They willingly engaged in data production, were affected by the data and acted according to the feedback. In this relational process patients animated the technology by describing it as a 'friend' that would help them to do their exercises at home and by ascribing a gender to it. Moreover, they would at times have little discussions with it, if they did not agree with the feedback they were receiving.

> Kirsten: I mean, I can have a discussion with her and say, listen, I really don't think she was fair, right? Because she kept saying, "Stretch your knees, keep your knees stretched," and I thought that I was stretching and stretching. And then I only got two stars. And then other times, it might say, "That was a good technique, keep doing that," and then you get a kind of emotional high, right? Because you received praise [laughs]. And other times it was just two stars, right? And that was because I wasn't stretching out my knee, and I just couldn't stretch it out anymore.
>
> NS: Did you yell at her?
>
> Kirsten: I yell at her a lot. She's not always right. I mean, sometimes when she's given me just one star I'll say, "That's not fair! I know I've done that exercise correctly today."

As this encounter indicates, this woman is affected by the different forms of feedback she receives from the technology (oral, textual, visual) and strives to perform her exercises correctly so as to achieve positive feedback. She scolds the technology if it continues to make corrections when she believes she has done an exercise correctly. This 'squabble' indicates the affective relationship that emerges as the patient and the technology interact during training. Another woman described her connection with the technology as a love and hate relationship,

> It's a love-hate relationship, really. It's great that it reminds you that when you do a certain thing, then remember to straighten your back - that's perfect. But it's also annoying that it – especially with the step exercise where you need to take a step up. I can't do that; not once have I been able to do it without it saying, "Don't twist your knees." So there, at the end, I was honestly really annoyed with it. Be quiet!

These are examples of the working of 'thing-power' that Bennett references with the notion of 'vital materiality.' As a result of their engagement with the feedback, the patients become entangled in a dynamic flow of data production; subsequently, the digital technology and the governance rationality of nudging become agentive and forceful elements in the surveillance assemblage.

When the Body Strikes Back: Temporality, Friction and Pain in Pathways to Rehabilitation

Whereas most patients initially trusted the technology and engaged in data flows through the relational workings of affective thing-power, this relationship often changed over time. As the above comments suggest, occasionally patients experienced a gap between how they moved their body and the digital assessment and feedback from the technology. Moreover, patients who followed the exercise program

every day would often experience an increase in bodily pain over time. Mary, for example, was very enthusiastic about the technology from the beginning; she followed the program and acted according to the digital feedback on her movements, but nevertheless came to experience serious pain in her body over time. She said,

> In the beginning I was really excited. It was perfect; I could do my exercises at home, at a time and a place that suited me. I was so enthusiastic. did my exercises every day, I was motivated like never before…But then it started to hurt in my body, and I got anxious…I had so much pain, I could hardly walk, and ended up in my bed for five days.

In Mary's case, the standardized training program, the linear temporality of auto-progression and the more cyclical and unpredictable temporality of her body were not aligned. As a health consultant explained, the company and the designers are well aware that patients might be pushed to move too much when they engage in the digital rehabilitation assemblage, and that the elderly might become 'over-compliant.' The consultant said,

> The patients are extremely motivated to do their exercises; they really do train a lot. We have had some who actually trained too much, so clearly there is this risk to it.[…] The patients know that the physiotherapists can see what they are doing at home and they want to live up to that. And they do it as best as they can.

While someone who undergoes rehabilitation after hip replacement surgery will most often recover, the time frame and the extent to which this happens is uncertain.

We might think of bodily pain as the body's sensory way of articulating friction and resistance to the relational movement pathway constituted by the digital rehabilitation assemblage. The term friction is derived from descriptions of the physical world, where it refers to the resistance to relative motion between bodies in contact (Feynman 1970). Anthropologist Anna Tsing uses the concept of friction to describe the encounter between the image of globalization as a universal flow of movement (of goods, money and people) and the particular ways in which events emerge through specific regional-to-global networks of power, trade and meaning. She suggests that we think about roads as a metaphorical image of how friction works: "Roads create pathways that make motion easier and more efficient, but in doing so, they limit where we go. The ease of travel that facilitates movement is also a structure of confinement" (Tsing 2011, 5). We can think of the digital rehabilitation assemblage as a prescribed pathway along which bodies are made to move in physical rehabilitation. Like roads, the intention of the assemblage is to induce the patient to follow the ordained route to reach its final destination of bodily recovery. Yet, as we have seen, the assemblage, like pathways, might also work as a limitation by structuring movement in ways which might effectuate friction and bodily decline.

Disassembling Disparate Parts: Physiotherapists' Engagement with the Digital Rehabilitation Assemblage

So far, I have highlighted the agentic capacities of movement data, the governance rationality of nudging and the affective sensing body in the digital rehabilitation assemblage. In the following I focus on physiotherapists' engagement, pointing out that, in many situations, they come to detach the patients and the digital technology from the assemblage instead of linking them. As noted, the patients attend a weekly one-hour, group-based training session at the rehabilitation center; this is overseen by two physiotherapists and organized in groups of up to ten. Yet, during the program at the center, hardly any connections are

made with the home training and the various experiences that patients have had at home. Patients express disappointment when they realize that the physiotherapists have not consulted their digital movement data or assessed their 'homework.' The expected relationship of reciprocity and data flow, with patients delivering movement data and professionals monitoring them, is interrupted because the professionals do not pay much attention to the data. Moreover, the physiotherapists explained that they had deliberately decided at the outset *not* to take an interest in the exercises that the patients do at home, guided by the technology. Instead, in order to keep participants motivated, they argue, patients are allowed to exercise on the exercise machines, or they roll a dice to decide the exercises at the center.

The physiotherapists emphasize that the new assemblage of physical rehabilitation has changed the patients; they have become more 'unruly'; they raise numerous questions about their experiences with the technology at home and ask the physiotherapists to assess the exercises, which makes it more difficult for the professionals to plan the one-hour session:

> They have a lot of questions – "Is it wrong, or right?" 'This part is hurting, what does that mean?" And also a lot of questions in relation to the technology. "That machine is constantly complaining, even though I feel like I'm doing it right." "Am I doing this right?"[…]Sometimes it's a bit, "Whoa!". It's a little hard to control.

This lack of connection to their training at home and the digital rehabilitation assemblage, however, is frustrating for the patients. As one woman says, "There aren't any links to the training we do at home because there's no time. We have some other exercises that we need to complete." Much as the patients experience a lack of connection, so do the physiotherapists, as one explains. "It can be hard to have good contact with every individual participant. There are so many in the group, so there's so much to deal with during training. It's harder to pick up on everyone during the instruction – harder than it was when we met twice per week." This disassembling between the physiotherapists, the patients and their digital movement data occasionally created a sense of being detached from professional proximity, which had previously worked as a motivating force. In addition, when patients complained that the technology kept correcting their movements even though they tried to correct their movements according to the feedback, a common answer from the physiotherapists was that the technology was "not very bright," "thick-headed" or "not able to deal with detail." This response further tended to detach the patients from the technology, causing them to start to doubt its competence instead of strengthening links with it. This led many patients to give up training with the technology or simply stop paying any attention to it. Mary, one of the most enthusiastic patients, who experienced pain after doing her exercises, came to feel that she was isolated and all alone in her endeavors to recover:

> There's no human contact, and then what is it good for? Well, you're over-training, but how can I know that? They are not involved, because I need to do it based on the technology there. You're all alone, no one is helping you. […] It's like talking to a machine. Now I've stopped training completely, I haven't trained for five days – and they don't care, no one is monitoring me. There is no contact, there is no connection to what we do at home.

Potential Energy, Cyclical Movements and Adjustment Work

Recalling Bennett's example of the electrical power grid assemblage, we might think of the digital rehabilitation assemblage as a circuit that transfers energy from one form into another. In physics, the law of energy conversion (Feynman 1970) states that every object or body has a potential level of energy which is decided by its position relative to its surroundings. In other words, a ball has potential energy when it is held in the hand, but has the capability of producing kinetic energy if these conditions change, if the ball

drops to the floor, for instance. Or, in another example, when an archer works with a bow, drawing the string back, some of the chemical energy of the archer's body is transformed into elastic potential energy in the bent limbs of the bow. When the string is released, the force between the string and the arrow works on the arrow. In this process, the potential energy in the bow's limbs is transformed into the kinetic energy of the arrow as it takes flight.

Likewise, the digital rehabilitation assemblage is directed towards the conversion of the potential energy of frail bodies into the physical movement of the bodies, transforming it into kinetic energy as they are made to move towards recovery. As we have seen, however, the digital rehabilitation assemblage does not always produce bodies that recover. There might be friction between particular patients' bodies and the anticipated universal body inscribed in the digital arrangement. As noted above, in physics friction refers to the process of two objects moving in relation to each other where resistance to movement occurs (Feynman 1970). I suggest, that in the digital rehabilitation assemblage, friction is articulated as the sensory experience of pain. If we understand the digital rehabilitation assemblage as a process of energy conversion, pain can be considered heat, an effect of friction between moving objects. Hence, much as a brake in a car that inhibits motion by absorbing energy from a moving system produces heat, physical rehabilitation might produce pain. Whereas moderate pain indicates that the training is pushing the body to regenerate over time, 'severe' pain weakens a body, in the same sense as brakes can weaken, if the friction produces too much heat.

How can we use the analogy of energy conversion and friction in our discussion about moving bodies in a digital rehabilitation assemblage? What are the possibilities for perhaps recomposing the assemblage to make it better able to transform the potential energy of frail bodies into bodies that recover? The digital rehabilitation assemblage invokes a linear temporality in which bodies are anticipated to increase their physical potential steadily over time, placing the body in a particular temporal space on a trajectory towards recovery. As we have seen, however, there might be a misalignment between the linear pathway and temporality inscribed in the technology and the more erratic and cyclical temporality of human bodies. Anthropologist Stefan Helmreich invites us to think through the concept of 'the body electric' to learn about the small-scale 'action potential' of bodies. He uses the electro-magnetic heartbeat as an example to illustrate how the potential action of the heart and the body is not about grand futures, or 'teleological' 'natural forces,' but is also at work in the ongoing present, "as a persistent operator at smaller timescales and in iterative, repetitive processes (such as heartbeats)" (Helmreich 2013, 139). If we think with Helmreich's notion of the body electric, we might think of bodies in a digital rehabilitation assemblage as evolving through smaller timescales of progression and regression and through a more cyclical time than the linear progressive temporality which is inscribed in the technology and the functionality of 'auto-progression.' If we do so, we can think of the digital rehabilitation assemblage as unfolding through the intercalation of two kinds of time: the linear and the cyclical.

Marxist philosopher Henri Lefebvre has developed a theory of social action and transformation that is concerned with the relationship between the cyclical and the linear (Lefebvre 2004). He suggests that social science analysts should draw attention to the intersection of inner bodily rhythms (respirations, pulses, circulations, assimilations) with those of social life. In the digital rehabilitation assemblage, this would imply a willingness to listen after 'disruptions,' places where the body's recovery processes fall out of step with the temporality of the digital rehabilitation assemblage. This would require joint exploration by health professionals, patients and designers of the bodily sensations that the assemblage creates over time, and the space to try out, adjust and recompose its various elements in order to make a fit between its temporality and the specificity of bodily movement and recovery.

Conclusion

In this article, my intention has been to qualify the notion of contemporary elderly bodies as 'busier and smarter,' by looking at concrete encounters in which frail elderly bodies are made to move in digital assemblages of physical rehabilitation in the Danish welfare wtate. Rather than starting from an etic notion of aging bodies as 'smart and busy,' and 'surveillance' as a normative *a priori* fact, I have looked at the socio-material relations and processes whereby aging bodies come to move with and through these digital arrangements. Drawing on Jane Bennett's notion of 'vital materialism,' I have traced the relational connections and affective forces that are generated with and through the digital rehabilitation assemblage. As we have seen, the relational connections between the various human and nonhuman actors of the assemblage (bodies, professionals, smartphone, sensors, exercise program, algorithms, digital interface, imaginaries of aging bodies, governance rationale of nudging, visions of automatization and cost-efficiency) are assembled, disassembled and reassembled over time. As bodies move and transform in non-linear progression, the digital assemblage may create friction involving processes of bodily degeneration. The vital force of the aging body particularly comes to the fore in the form of sensory expressions of pain when the temporality of the metrics and bodily recovery is not aligned. In contrast to studies focusing on surveillance as a pre-given disciplining force, the analysis of bodily movement in digital assemblages of physical rehabilitation invites us to think about surveillance as a vibrant, open-ended and temporally specific process, whose outcome is not predetermined; the bodily sensations created might be articulated as harmful and controlling as well as caring and restoring. This opens a space for possible action involving the re-composition of the surveillance assemblage, whereby it may be altered and adjusted, possibly reducing bodily pain and suffering.

Finally, ethical concerns about the remote monitoring of patient data have mainly been discussed in relation to questions such as its commodification and patients' loss of privacy. I argue, however, that there is also a need for an ethics of 'response-ability' (Martin et al. 2015; Haraway 2013), one directed towards the various sensory expressions of aging bodies as they engage in digital rehabilitation programs. This would require more attention to be paid to the bodily sensations created by different links between human and non-human actors over time, and the capacity to respond to those sensations by professionals, IT workers and patients alike. What is needed to encourage bodily restoration rather than weakening is closer collaboration between these groups, along with a willingness to articulate and respond to sensory reactions and disruptions by continually adjusting and recomposing the assemblage to accommodate the temporality of particular bodies.

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