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Tracked and fit: FitBits, brain games, and the quantified aging body

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ABSTRACT

This paper explores the technical turn to new ways of quantifying and standardizing measurements of age as these intersect with discourses of anti-aging and speculative futures of 'smart' quantified aging bodies. Often couched in a metaphorical language of 'smart', 'fit', 'boosting' and 'optimizing', the aging body is emerging as a node for data collection, monitoring, and surveillance. The research is located in the current literature that links aging, bodies and technologies, with specific extended examples of wearable devices such as fitness trackers and digital exercises such as brain games designed for memory performance. Conclusions suggest that new technologies around aging and quantifiable fitness create an ambiguous image of the aging body and brain as both improvable and 'plastic' but also inevitably in decline.

Introduction

As many societies attempt to deal with aging populations by increasingly shifting responsibility for maintaining health to the individual, and promoting new forms of 'DIY' (Do It Yourself) healthcare, the role of health-related wearable digital technologies, gaming devices and software has become prominent (Vesnic-Alujevic, Breitegger, & Guimarães Pereira, 2016). Their popularity is in large part due to their attractive and 'smart' capacities that allow users to self-track and become self-knowledgeable about their well-being. Critiquing these technologies and raising important sociological and ethical questions about the meanings of their measurement and standardization, and politics of their surveillance and risk-management, is a new field of studies focusing on the body (Klauser & Albrechtslund, 2014; Lomborg & Frandsen, 2016; Lupton, 2013, 2014; Nafus, 2016; Ruckenstein & Pantzar, 2015; Till, 2014). However, despite this expanding network of researchers, the connection between these self-tracking consumer technologies and aging bodies has been largely been neglected (Marshall & Katz, 2016). Thus, in this article we explore how the body and the embodiment of activity data have become implicated in a process of quantifying aging through dedicated digital technologies developed both to track health measures and create new fitness standards that define older, health-literate subjects. We focus on two illustrative examples of current exercise technologies marketed to aging individuals: wearable digital fitness trackers, such as the FitBit, with their associated apps and digital languages, and brain-games and their associated notions of cognitive fitness and memory protection.

Key to these explorations, as we have argued in previous work, is the gerontological reconceptualization of aging bodies as measurable and manageable according to a logic of *functionality*, supplanting an earlier emphasis on normality in the life sciences (Katz & Marshall, 2004). Functionality does not require a correlate of normality — in fact, what is statistically normal may routinely be reframed as dysfunctional in health enhancement initiatives. Above all, functional states are quantifiable states which can be stabilized as endpoints for evaluating interventions. Functional quantifiable states are also materialized through an assemblage of instruments, knowledges, and practices that supports aging individuals in projects of self-care and forms of knowing as they strive to meet neo-liberal mandates of activity, enablement, and independence. On a broader level, the functional and quantifiable aging body is a component of a biosocial order characterized through a reversal between culture and nature (see Gibbon & Novas, 2008; Rabinow, 1996), whereby biomedical, pharmacological, and cosmetic technologies, aimed at improvement and enhancement, are endowing the aging body with an expansive plasticity. Plasticity, the idea that the body's 'nature' itself is open to change and modification, is based on the arrival of technologies of molecularization that are deepening the visualization of the body at increasingly micro-levels of function. According to Nikolas Rose, molecularization is a "'style of thought' of contemporary biomedicine that envisages life at the molecular level, as a set of intelligible vital mechanisms among molecular entities that can be identified, isolated, manipulated, mobilized, recombined, in new practices of intervention, which are no longer constrained by the apparent normativity of a natural vital order" (Rose, 2007, pp. 5–6). In our case, this molecularizing style of thought is built into the designs of self-tracking technologies and their algorithmic programming that

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reduce aging bodies and minds to functional, quantifiable, and exercisable 'molecular entities' for the sake of their improvement. Indeed, we find it fascinating that self-tracking technologies are growing in popularity far beyond their producers' original goals, to become biosocial resources that articulate human capacities to cultural health ideals through the authority of data. And while the technologies appear to offer up a diverse model of bodily aging that liberates it from the constraints of traditional chronological biomarkers and ageist stereotypes, the terrain of quantified age-measuring which they promote, whether self-tracked at work or at play, is bound to specific sets of numbers, standards, and profiles linked to a tyranny of healthy activities and lifestyle expectations.

Self-tracked: the quantified aging body in the 'internet of things'

Self-monitoring for self-improvement and health enhancement is not new (Crawford, Lingel, & Karppi, 2015), and older people have long been expected to 'live by numbers' through measuring and monitoring things like weight, blood pressure, cholesterol levels, and other bodily indicators associated with age-related health management (Oxlund, 2012; Pickard, 2011). What is new, however, is the extent of quantification permitted by wearable and digital technologies, along with the connective technologies and practices which pool, visualize, share, and increasingly capitalize on individual biodata. While one US survey found that adults over the age of 65 were the *most* likely to track their weight, diet, and other vital signs, they were the *least* likely to use digital technologies to do so (Fox & Duggan, 2013). This apparent consumer gap has created a significant market opportunity, and a growing and lucrative industry, supported by public health initiatives that promote activity (and avoidance of inactivity) as an anti-aging strategy. Industry reports suggest that as tech-savvy boomers embrace the message of risk-aversion embodied by 'active aging', they will increasingly turn to "personal technologies" to "maintain a healthy, yet active lifestyle" (Bowman, 2014).

An array of wearable digital fitness trackers has been central to the development of this market. Estimated worldwide sales topped $48 million in 2015, a figure expected to more than double in the next few years (Gibbs, 2016). FitBit, the best known of several popular brands and the one which has maintained the largest share of the market, offers a suite of products, including a relatively inexpensive clip-on that measures steps, distance, and calories burned ($69.95)[1], a range of bracelets that may also track sleep time/quality, flights of stairs climbed, active/inactive minutes and in some models, heart rate (from $129 to $199) and 'fitness watches' that may include GPS and other 'smart' functions ($249–$329). All connect and sync, via Bluetooth and/or wifi, to personal computers and mobile devices (such as tablets and smart phones). The accompanying apps on these devices also allow the user to set goals, and to record information like food intake and types of exercise, such as yoga, that are not captured by the tracker. While some things like steps are immediately visible on the tracking device, most data need to be synced and converted to visual reports on the accompanying 'dashboard' of the computer or mobile. Once synced to the device, an individual's data can be shared with others ('friends') who can 'cheer' or 'taunt' them as desired, and provide the basis for system-generated motivational prompts ('Only 2,657 steps more to meet your goal!') or reward 'badges' ('you've climbed the equivalent of Everest this month!').

Two measurements in particular align with the imperatives of age-related activity governance as outlined above. The most basic output of all commercially-available devices is the counting of 'steps', with the common goal of 10,000 steps per day tied to state-promoted fitness initiatives, such as those associated with 'Shape up America', 'ParticipACTION Canada', '10,000 steps' (Australia) and '10,000 steps challenge' (UK). These initiatives have been popular and influential in promoting walking as a key fitness activity, particularly for older people, and an emphasis on quantifying it has increased (Copelton, 2010). Researchers in kinesiology and preventative medicine who use fitness trackers as interventions aimed at increasing exercise among at-risk older people, conceptualize data such as daily number of steps as a proxy measure of success (see Cadmus-Bertram, Marcus, Patterson, Parker, & Morey, 2015a,b; Mercer et al., 2016; Tiedemann, Hassett, & Sherrington, 2016). In addition to counting 'steps', new benchmarks have emerged for gauging success in mitigating the risks of inactivity, creating guidelines suggesting that older adults should "accumulate at least 150 minutes of moderate-to vigorous intensity aerobic physical activity per week, in bouts of 10 minutes or more" (Public Health Agency of Canada, 2011). Thus, the biosensors of wearable devices provide measures of 'active minutes', a term drawn from sport science and health promotion that constructs total number of steps and minutes of moderate-to-vigorous activity as independent measures. FitBit, for example, offers both the total number of steps and an account of how many 'active' minutes are racked up each day, as well as an appealing graphic of how many waking hours included at least 250 steps, to encourage constant activity across the day. Activity so measured is linked to the biomedical calculation of present and, most importantly, future health risk, often conflated with age-related decline. In this way FitBits track, materialize, digitize, and informate risk factors so one can "manage future health risk through attention and action in the present" (Mort, Roberts, Furbo, Wilkinson, & Mackenzie, 2016, p. 606). As such, the devices co-produce what it is they measure as part of a network of interactions between users, designers, and professionals.

Bodily quantification also involves a certain level of technological literacy on behalf of device users. As a number of researchers have demonstrated, the outputs of monitoring devices need to be interpreted and made meaningful to their users, which implicates a complex web of expert and lay discourses, relational contexts, other technologies, and public policies (Adams & Niezen, 2016; Fox, 2015; Lomborg & Frandsen, 2016; Lupton, 2014, 2016; Lynch & Cohn, 2015; Mort et al., 2016). Thus, critiques of quantifying technologies need to attend carefully to the context for self-tracking and the ways in which the data produced circulate through these networks and webs of technologies, relationships, and expertise. The almost exclusive association of activity and its monitoring in older adults with risk-management in relation to health has resulted in a rather singular focus on this context for understanding measurement. These technologies may include wearables connected to ambient monitoring systems, such as those designed to prevent wandering in dementia patients, alarm pendants that the wearer can use to summon help, or wearable trackers that resemble fitness trackers, but are designed primarily to transmit activity patterns to caregivers (see for example www.mylively.com, or www.carepredict.com). Quantification is also important here, as these devices locate individuals within measured parameters both spatially and functionally. For example, Oxlund and Whyte (2014) suggest three roles for measurement in relation to aging bodies: to reveal 'truth' about bodies in relation to treatment decisions, to assess care needs, and to manage aging in place. On their account, measurement is "a prerequisite to intervention and management" (p. 221); as such, measurements generated by wearable self-trackers are positioned by health promoters as potentially important in behavior modification, as they furnish easily obtainable measurements to assist in goal-setting and feedback in a program of self-monitoring. The rational response of the 'smart' body in such a program, according to this model, is to act as both the beginning and endpoint of a closed, recurring loop, where outputs are assessed against goals, and behavior is modified (Lyons, Lewis, Mayrsohn, &

[1] All figures are from the FitBit website, in Canadian dollars, as of April 2016. FitBit is used as the example of wearable self-trackers here for several reasons. It has the largest share of the market, has the greatest range of devices, is the commercially-available tracker most likely to be used in exercise science studies on self-tracking, and one of the authors has experience with this particular device. Other devices include Garmin Vivosmart, Misfit Shine, Samsung Gear, Nike Fuelband and the Apple Watch (and other smart watches).

Rowland, 2014). Yet as Lomborg and Frandsen (2016) remind us, the most frequently tracked facts (for example, those around diet and exercise) are also "cultural and social practices that, for the individual user, are utterly mundane and reside in an experiential realm of everyday life" (p. 1016). Their point raises important questions about potential conflicts between expert discourses and user experiences. For instance, when one researcher studied the lack of interest in using pedometers in an organized walking group for older people, she found that the emphasis on 'counting' was perceived by participants as anathema to the sociality and camaraderie that they enjoyed about the activity (Copelton, 2010). In a similar vein, Phoenix and Orr (2015) suggest that understanding physical activity in later life in strictly measureable and instrumental terms may miss a rich understanding of activity as *pleasure*. Furthermore, while tracking and quantifying may be reductive in some ways, they may be productive in others. For example, digital devices may provide their users with new opportunities for networked sociality – and potentially new sources of pleasure in activity – that researchers of digital culture have barely begun to explore.

In summary, biosocializing fitness tracking technologies and aging bodies are linked in three emergent ways relevant to cultural projects of quantifying functionality. First, they are part of the 'internet of things', an idea which originated in electrical engineering in the late 1990s and has become widely used to capture the increasing ubiquity and interconnectivity of digital devices though information and communication networks (ICT) networks (Gershenfeld, Krikorian, & Cohen, 2004). Some predict that in the future "virtually every object will be somehow visible" (Lahlou, 2008, p. 301), and the proliferation of wearable tracking and biosensing technologies suggests increasing inclusion of bodies as visible nodes in these networks (Lupton, 2016; Mort et al., 2016; Nafus, 2016; Viseu & Suchman, 2010). According to data analytics firm Vivametrica, "wearable activity monitors produce more biometric data than the combined public health surveys of every nation on the planet" (www.vivametrica.com), and an entire industry has developed around capitalizing on the ability of digital tracking devices to transform bodies into collections of data points.

Second, while wearable tracking technologies are increasingly called upon as solutions to the challenges of aging, they also contribute to new ways of distinguishing and embodying aging. Much has been written on the increasing diversity of 'older adults', and on the binary of 'third age'/'fourth age' as a division between independence and dependence, with sensationalizing apocalyptic language of 'silver tsunamis' or 'grey tides' as an indication of public anxiety about growing dependent populations aging into the future (Zeilig, 2013). Yet as van Dyk reminds us, the "distinction between midlife and old age is constantly (re)produced and institutionalized" (Van Dyk, 2014, p. 99). And we would argue that such contingent age distinctions are aided today by a differentiation of wearable tracking technologies that replicate a cultural separation of subject bodies into, on the one hand, those which are risk-averse/independent/active and, on the other hand, those which are risk-prone/dependent/passive. The former group is epitomized by fitness trackers as described above, where the output produced may be used for self-knowledge and self-improvement, or as part of prescribed health-related behavior modification initiatives. The latter include remote sensor technologies that permit the monitoring of dependent, potentially problematic others such as children, patients, or aging parents. By way of contrast, fitness tracking and wearable marketing to younger individuals tends to be framed more in terms of performance in sports or fitness activities as opposed to health-related risk management.

Third, as physical activity is promoted as a key strategy to prevent many age-related problems, from falls to dementia (see World Health Organization, 2010), there is an increasing attention paid to activity measurement, monitoring, and management. As Katz comments, "activity is not just something people do, but … is a measurable behavior whose significance connects the worlds of elderly people to the largesse of expertise" (2005, p. 129). However, activity governance has recently been extended through the measurement of *inactivity*, a problem inviting new disciplinary strategies in response. In her review of the problematization of 'sedentary behavior' in health promotion and exercise science, Tulle (2015) shows how sedentariness is framed as more than a deficit of physical activity such that one can meet or even exceed minimum physical activity recommendations, but still be at risk, as 'physical activity' and 'sedentariness' are constructed as independent issues. This framing makes the measurement of activity and inactivity important both as technical problems of 'how to' and functional problems of 'what for' (Tulle, 2015, p. 16). The risks of *in*activity, in addition to indicating irresponsibility, ground an ethical imperative for aging bodies to move, be active, and be tracked by wearable devices that both measure and motivate. To cite Tulle again: "The everyday life of the aged body is colonized, known and monitored by measurement, given the proverbial kick up the backside using digital devices" (Tulle, 2015, p. 17).

All three of these developments promote, through their power of quantification and authority of their data, the potential optimization of aging bodies and the promise of extended independence and agency into later life, and even longevity itself. In these ways, as the next section argues, there is a strong congruence between the age discourses of physical and mental health within the new technological spaces of digital engagement, molecular vision, data exchange, and health-literate subjectivity created by the internet of things.

Cognitive fitness: brain games and memory protection

Today cognitive health status is increasingly added to other health statuses (physical, sexual, etc.) as evidenced by the growing focus on brain care in the lifestyle literature on exercise, diet, stress, and work-life balance. Such literature acts as a public pedagogy to educate readers about brain 'boosting' foods, vitamins, daily exercises, and optimizing mental 'workouts'. Even the Alzheimer Society of Canada advises to "keep your brain active every day" and "that a healthy brain can withstand illness better" (2011); but how can we really know when our brains are 'active' or 'healthy'? An interesting study summarizing 10 American public surveys on cognitive health, reported that while the great majority of respondents had heard of Alzheimer disease and strongly believed they could do something to keep their 'brains fit', most admitted their ignorance about memory disease and cognitive fitness (Anderson, Day, Beard, Reed, & Wu, 2009). Yet they, like most of us, live in a culture inundated with advice about maintaining brain health and preventing aging memory loss, even if the ultimate goal of 'cognitive fitness' has no consistently recognized or testable meaning. However, cognitive fitness has become a key discursive component of new quantifying technologies around memory games (discussed below), which, like self-tracking technology in relation to the active/inactive body, naturalize measurable functionality as evidence of the active/inactive aging mind.

Certainly there is a long-term history of mind and memory training that has deep roots in theology (Katz, 2013), philosophy, and science (Danziger, 2008).[2] Hacking coined the term 'memoro-politics' (1994)[1] to identify how the modern memory sciences emerged from this history to became powers of social control over the administration of human minds. Today we can extend Hacking's idea to a cognito-politics, particularly to military, criminological, and other regulatory practices invested in the governance of population risk (Ortega & Vidal, 2011) and what Rose and Abi-Rached (2013) call 'futurity', or the governance of the future. For example, in 2009, the American National Institutes of

[2] There is also a history of concern about failing memory with age, best exemplified in the work of American physician George Beard whose books on *Legal Responsibility in Old Age* (1874) and *American Nervousness* (1881) were poorly substantiated but influential treatises on the perils of aging decline (Ballenger, 2006).

Health (NIH) was spending nearly twenty percent of its total budget on brain-related projects (Carey, 2009). In the United States, Humana and MetLife have begun programs to encourage clients to optimize brain health (Thornton, 2011, p. 9), even as our understanding of what is cognitively 'normal' for older individuals seems absent from view. Cognito-politics are also underpinned by what Post calls a "hypercognitive society" (2000, p. 249), where public expectations for cognitive performance and boosting 'mental capital' (cf. Foresight Mental Capital and Wellbeing Project, 2008), align to other standards of productivity, efficiency, speed, and unerring memory.

Cognito-politics form the background to neurocultural consumer and lifestyle industries which have turned to brain-based explanations of human nature (Rose & Abi-Rached, 2013; Williams, Higgs, & Katz, 2012). While scientific researchers advise caution, such industries are buoyed by a metaphor of the neuroscientific frontier, where possibilities of controlling mood, regulating behaviour, storing cognitive reserve, and preventing brain decline are part of the wondrous transformations of the neuroscientific territorialization of humanity. And despite the lack of clear distinctions between health, improvement, enhancement, optimization, and wellness, these standards constitute a new discourse of cognitive performance used to promote 'neuro' commodities (e.g., brain-stimulants and exercises), 'neuro' knowledges (e.g., neuroethics, neuro-marketing), and 'neuro' subjectivities, or what Fernando Vidal (2009) calls 'cerebral subjects' who learn to express their identity in neuroscientific terms (see Pickersgill & Van Keulen, 2011). The underlying theme of neurocultural enterprises is *brain plasticity*, a poorly understood yet attractive idea that the brain can change itself, which may not be surprising on a synaptic level, but inflated to a neurocultural project, plasticity becomes the latest measure of successful aging. If the brain can change itself then it is also permeable, as indicated by the positive plasticity language prefixed with 're's': rewiring, regenerating, rebooting, recovering, retraining, reserving, as opposed to the negative geriatric language prefixed with 'de's: decline, decrepitude, degeneration, dementia, decease. Thus, human character is becoming brain-signified as plural, flexible, mobile, dynamic, and adaptable — traits of plasticity that also articulate human labor of all forms with neoliberal and global capitalist strategies (Pitts-Taylor, 2010, 2016).

The image of the plastic brain-as-muscle permeates the neurocultural commercial field of cognitive advice (Friedman, 2010), 'neuro' stimulants and protectors (e.g., LifeExtension's *Cognitex*, BrainStrong's *Memory Support*), 'brain-boosting' programs (e.g., BrainAge 2, HAPPYNeuron), and brain 'gym' and 'spa' memberships (e.g., Mindspa). This is a hugely lucrative field forecast to become a $6 billion market by 2020 (Fernandez, 2013) and expected to attract increasingly more consumers interested in developing the self-disciplining skills to manage neuro-related cognitive fitness. Hence, it is no surprise that technological performance activities associated with online brain-training games or what Millington (2014) refers to as 'bio-games' fit well within current neurocultural and cognito-political spheres. As with physical fitness training and its measurement, brain-training "is based mainly on recent neuroscientific findings that the brain is less like a blank slate or a computer-processing center (as metaphors of old would have it) and more like a muscle that can undergo atrophy or hypertrophy depending on its stimulation" (Millington, 2014, p. 495). For example, Vibrant B, which is promoted as 'A Health Club for Your Brain', boasts 'Where the Sweat is Figurative, but the Results are Real' (www.vibrantbrains.com/). Thus, various video/internet games and Wii-type exergames are united around the imperative to 'use it or lose it' (Millington, 2012, 2015), the assumption being that physical aging is always accompanied by cognitive decline unless an individual does something about it.

In reality, even where brain games and memory products may be fun to use, they are not necessarily related to cognitive fitness or brain plasticity and, as with the other areas explored in this article, extend an ambiguous image of the aging body as both positive and improvable, and negative and inevitable. In fact, brain-training products and games exaggerate their benefits as a recent CBC News 'Marketplace' report indicated (Griffith-Greene, 2015). The brain-training company Lumosity was also fined $2M to settle American federal allegations that it misled consumers about the positive benefits of its programs (The Associated Press, 2016). Benefits are a rhetorical construction in brain games, which, along with the values and vocabularies of improvement, enhancement, optimization, or fitness, are constituted through compelling techniques of score-keeping, shared profiles, testimonials by experts, program coaching, and user self-tracking. As with FitBit standards and scores, they are invented by the product manufacturers themselves (with claims to scientific validity); otherwise, a user could never really know their cognitive status. Furthermore, the brain training narratives not only isolate the brain from the rest of the body, as if it could act on its own, but also atomize the individual apart from the social and environmental determinants of real cognitive health. As George and Whitehouse say, "testing a brain fitness video game or computer program is also much easier than testing a complex social intervention" (2011, p. 594).

The quantification of age through brain-training technologies and other neurocultural products are aided by the popularity of brain scan images which create a sense that 'we are our brains.' For example, looking at schizophrenia, depression, or Alzheimers in a brain scan, can make it seem, as Davi Johnson says, that we are "looking at the ultimate depths of one's true self, or psychic interior" (Johnson, 2008, p. 156). Critics argue, however, that correlations between brain, function, and personhood also result in misidentification (Dumit, 2004; Vidal, 2009) and, in the case of the dementia and the aging brain, scans are interpreted to signify a supposedly non-self whose brain is cluttered with amyloid and hollowed out by Alzheimers disease. It takes work such as David Snowden's award-winning study of nuns (Snowden, 2001), that found insufficient clinical and behavioural indicators of Alzheimer disease, despite later evidence of symptoms in the brain, to shake up essentializing correlations between brain and person. Nevertheless, the image of the color-coded scanned brain that appears to 'light up' the mind's neuronal activities in real time, is a favorite neurocultural icon representing a type of personhood defined by its tractability to therapeutic and commercial intervention. Thus brain-training marketing language "renders the 3-pound organ in our heads both an object of alterity and veneration" (George & Whitehouse, 2011, p. 591).

The connection between cognito-politics and the quantifying games and technologies of cognitive fitness lies within the public anxieties about aging with dementia. The dire consequences of a growing aging population are headlined in the media, as mentioned above, by apocalyptic images of 'tides', 'tsunamis', 'storms', and 'bombs', along with zombie scenarios of 'never-ending funerals' and lost souls, fill our daily media (Behuniak, 2011). The fear of dementia has become as explosive as the number of diagnoses reported for it. Thus, for aging individuals who choose not to buy into the promise of brain-work, they become stigmatized as vulnerable to cognitive decline, poor health outcomes, and entry into the 'fourth age' (Gilleard & Higgs, 2010), just as those who refuse to be physically 'active' and remain sedentary. Furthermore, the public is aware that the drugs, treatments, and tests, despite the inflation of research funding and pharmaceutical investment in dementia-related diseases, are hardly proving effective to prevent them, let alone provide definitive cures. Due in part as a response to these anxieties, debates about acceptable levels of normal forgetfulness and memory deficits have surfaced in models of pre- or early-dementia, such as Mild Cognitive Impairment (MCI). MCI was first used as an independent category by Ronald Petersen of the Mayo Clinic in 1995. However, MCI has, in effect, become a convergence point for the neurocultural, pharmaceutical, and gerontological communities (see Katz & Peters, 2015; Lock, 2013; Moreira, May, & Bond, 2009; Whitehouse & Moody, 2006). MCI and other pre- and early-dementia models redistribute the risk of cognitive health problems at increasingly earlier ages at increasingly molecular levels, along with a confusing intermingling of normal and abnormal cognitive states. In this sense, we all live in the

shadow of dementia as cognitive decline is migrated across the entire life course; thus, the call to engage in quantifying forms of play and performance as cerebral subjects and become skilled at self-knowledge technologies, affects us all at every age.

In summary to this section, we can say that the quantification of the aging brain reveals two limits that inform the quantification of aging in general. First, the proponents and commercial agents of brain-training enterprises can only understand memory *as if* it was measurable, even though our memory goes far beyond its measurability. Indeed, memory is one of the oldest ideas in the world and has been conceptualized in many different ways, but only recently has it become a clinical object where neural networks, scanning technology, and laboratory experimentation dominate research. Where the research overspills into neurocultural consumerism results in a false image of the brain as an exercisable 'muscle' akin to other parts of the aging body that can be protected and improved. Second, brain plasticity also involves the management of forgetting; one can both 'use it' *and* 'lose it' and this is a reality which true brain care should acknowledge. Our ability to remember *with* forgetting should be valued, as Nietzsche long ago argued (1874) and could today be extended to critique modern hypercognitive narratives that equate successful personhood with continuous memory, activity, and mutability. Thus, technologies of play around the brain and the proliferation of online personal profiles and data around cognitive fitness are not merely instrumental forms of amusement, because embedded within their digital architecture and subjectivities are wider cultural and historical narratives around aging, anti-aging, subjectivity, and risk.

Conclusions

In this paper, we have highlighted certain questions about embodiment which are being raised in the current research about the tracked, quantified body in digital culture; in particular, how about this body is central to understanding aging bodies in the contemporary landscape where technology, health, consumerism, and risk intersect. We have provided two examples of the ways in which aging bodies have been reconceptualized as measurable, manageable, and optimizable in function. Wearable fitness trackers extend the neo-liberal imperative to avoid inactivity and improve one's fitness as part of the management of future health risks. As metaphors of physical fitness are extended to cognitive fitness, they bring with them an expansive language of activity, health, exercise, and muscularity not just to the body but to the brain itself. Digital tracking of both physical and mental activity enjoins users of these technologies to generate measures, monitor progress, and find meaning about themselves, their bodies and their health statuses in assemblages of data. Both, too, are ultimately rooted in cultural anxiety about aging, and the derision of the 'fourth age' that makes strategies for its avoidance so compelling.

Yet little research has so far investigated the technical construction of digital and algorithmic quantifying design, the marketing schematics aimed at older individuals, and the discursive construction of 'futurity' associated with self-tracking. With this paper, we hope to encourage researchers to take up some of the critical questions regarding the impact of quantifying assemblages on bodily and embodied aging. In addition to qualitative research with older users of these technologies, field research at technology and consumer electronic trade shows and interviews with digital device and game engineers and marketers would be productive ways to expand our understanding of how population aging has been framed as a problem amenable to technological solutions and the assumptions about aging bodies that underpin them.

Ruppert et al. (2013, p. 35) suggest that the devices central to digital culture are those that "track the *doing* subject" (emphasis in the original). The 'doing' subject is central to contemporary agendas of active aging, and to constructions of the ethical aging subject. As we have claimed, 'successfully' aging bodies are no longer just 'busy bodies' (Katz, 2005), but busier, *smarter* bodies. The technologies we have described here are part of an expanding biosocial order that integrates populational surveillance, agential policies such as 'active aging', marketable DIY health products, and the production of risk-averse social strata. At the same time, we are reminded that as they engage with these technologies, older people themselves contribute to the constitution and re-calibration of age and age-related characteristics: that is, to the reshaping of age itself as a social and cultural category

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References

Adams, S., & Niezen, M. (2016). Digital 'solutions' to unhealthy lifestyle 'problems': The construction of social and personal risks in the development of eCoaches. *Health, Risk & Society, 17*(7-8), 530–546.
Alzheimer Society of Canada (2011). *Heads up for healthier brains.* Toronto: Alzheimer Society of Canada.
Anderson, L. A., Day, K. L., Beard, R. L., Reed, P. S., & Wu, B. (2009). The public's perceptions about cognitive health and Alzheimer's disease among the U.S. population: A national review. *The Gerontologist*(49) (S1, S3-S11).
Ballenger, J. F. (2006). *Self, senility, and Alzheimer's disease in modern America: A history.* Baltimore: Johns Hopkins University Press.
Behuniak, S. M. (2011). The living dead? The construction of people with Alzheimer's disease as zombies. *Ageing and Society, 31*, 70–92.
Bowman, D. (2014). CES: Remote monitoring, self-tracking tools among trending health tech. *FierceHealthIT* (Retrieved: October 1, 2014 (www.fiercehealth.com/node/22081/print)).
Cadmus-Bertram, L. A., Marcus, B. H., Patterson, R. E., Parker, B. A., & Morey, B. L. (2015a). Randomized trial of a Fitbit-based physical activity intervention for women. *American Journal of Preventive Medicine, 49*(3), 414–418.
Cadmus-Bertram, L. A., Marcus, B. H., Patterson, R. E., Parker, B. A., & Morey, B. L. (2015b). Use of the Fitbit to measure adherence to a physical activity intervention among overweight or obese, postmenopausal women: Self-monitoring trajectory during 16 weeks. *JMIR mHealth and uHealth, 3*(4), e96.
Carey, B. (2009). Brain researchers open door to editing memory. *The New York Times* (April 6, 2009. Accessed by internet, www.nytimes.com October 27, 2009).
Copelton, D. A. (2010). Output that counts: Pedometers, sociability and the contested terrain of older adult fitness walking. *Sociology of Health & Illness, 32*(2), 304–318.
Crawford, K., Lingel, J., & Karppi, T. (2015). Our metrics, ourselves: A hundred years of self-tracking from the weight scale to the wrist wearable device. *European Journal of Cultural Studies, 18*(4-5), 479–496.
Danziger, K. (2008). *Marking the mind: A history of memory.* Cambridge University Press.
Dumit, J. (2004). *Picturing personhood: Brain scans and biomedical identity.* Princeton: Princeton University Press.
Fernandez, A. (2013). *New market report analyzing the growing digital brain health market 2012–2020.* San Francisco CA: Sharp Brains.
Foresight Mental Capital and Wellbeing Project (2008). *Final project report — Executive summary.* London: The Government Office for Science.
Fox, N. J. (2015). Personal health technologies, micropolitics and resistance: A new materialist analysis. *Health.* http://dx.doi.org/10.1177/1363459315590248.
Fox, S., & Duggan, M. (2013). *Tracking for health.* Washington: Pew Research Centre (http://pewinternet.org/Reports/2013/Tracking-for-Health.aspx).
Friedman, T. (2010). *The senior moments memory workout: Improve your memory and brain fitness before you forget!.* New York: Sterling Innovation.
George, D. R., & Whitehouse, P. J. (2011). Marketplace of memory: What the brain fitness technology industry says about us and how we can do better. *The Gerontologist, 51*(5), 590–596.
Gershenfeld, N., Krikorian, R., & Cohen, D. (2004). The internet of things. *Scientific American, 291*(October), 76–81.
Gibbon, S., & Novas, C. (Eds.). (2008). *Biosocialities, genetics and the social sciences.* London and New York: Routledge.
Gibbs, S. (2016). Fitness monitoring: Gimmick or game-changer for the NHS? *The Guardian* (January 28. http://www.theguardian.com/society/2016/jan/28/fitness-monitoring-health-service-data-patients-trackers-fitbit).
Gilleard, C., & Higgs, P. (2010). Theorizing the fourth age: Ageing without agency. *Aging & Mental Health, 14*(2), 121–128.
Griffith-Greene, M. (2015). Mind games. *Marketplace, CBC News* (posted online April 9, 2015).
Hacking, I. (1994). Memoro-politics, trauma and the soul. *History of the Human Sciences, 7*(2), 29–52.
Johnson, D. (2008). "How do you know unless you look?": Brain imaging, biopower and practical neuroscience. *The Journal of Medical Humanities, 29*, 147–161.
Katz, S. (2005). *Cultural aging: Life course, lifestyle and senior worlds.* Peterborough: Broadview Press.
Katz, S. (2013). Dementia, personhood and embodiment: What can we learn from the

medieval history of memory? *Dementia: Journal of Social Research and Practice, 12*(3), 303–314.
Katz, S., & Marshall, B. L. (2004). Is the functional 'normal'? Aging, sexuality and the biomarking of successful living. *History of the Human Sciences, 17*(1), 53–75.
Katz, S., & Peters, K. R. (Eds.). (2015). Voices from the field: Expert reflections on mild cognitive impairment, *Dementia: Journal of Social Research and Practice, 14*(3).
Klauser, F. R., & Albrechtslund, A. (2014). From self-tracking to smart urban infrastructures: Towards an interdisciplinary research agenda on Big Data. *Surveillance & Society, 12*(2), 273–286.
Lahlou, S. (2008). Identity, social status, privacy and face-keeping in digital society. *Social Science Information, 47*(3), 299–330.
Lock, M. (2013). *The Alzheimer conundrum: Entanglements of dementia and aging.* Princeton: Princeton University Press.
Lomborg, S., & Frandsen, K. (2016). Self-tracking as communication. *Information, Communication & Society, 19*(7), 1015–1027.
Lupton, D. (2013). The digitally engaged patient: Self-monitoring and self-care in the digital health era. *Social Theory & Health, 11*, 256–270.
Lupton, D. (2014). Critical perspectives on digital health technologies. *Sociology Compass, 8*(12), 1344–1359.
Lupton, D. (2016). Digitised health, medicine and risk. *Health, Risk & Society, 17*(7-8), 473–476.
Lynch, R., & Cohn, S. (2016). In the loop: Practices of self-monitoring from accounts by trial participants. *Health, 20*(5), 523–538.
Lyons, E. J., Lewis, Z. H., Mayrsohn, B. G., & Rowland, J. L. (2014). Behavior change techniques implemented in electronic lifestyle activity monitors: A systematic content analysis. *Journal of Medical Internet Research, 16*(8), e192.
Marshall, B. L., & Katz, S. (2016). How old am I? Digital culture and quantified aging. *Digital Culture & Society, 2*(1), 145–152.
Mercer, K., Giangregorio, L., Schneider, E., Chilana, P., Li, M., & Grindrod, K. (2016). Acceptance of commercially available wearable activity trackers among adults aged over 50 and with chronic illness: A mixed-method evaluation. *JMIR mHealth and uHealth, 4*(1), e7.
Millington, B. (2012). Use it or lose it: Ageing and the politics of brain training. *Leisure Studies, 31*(4), 429–446.
Millington, B. (2014). Amusing ourselves to life: Fitness consumerism and the birth of biogames. *Journal of Sport & Social Issues, 38*(6), 491–508.
Millington, B. (2015). Exergaming in retirement centres and the integration of media and physical literacies. *Journal of Aging Studies, 35*, 160–168.
Moreira, T., May, C., & Bond, J. (2009). Regulatory objectivity in action: Mild cognitive impairment and the collective production of uncertainty. *Social Studies of Science, 39*, 665–690.
Mort, M., Roberts, C. M., Furbo, M. K., Wilkinson, J., & Mackenzie, A. (2016). Biosensing: How citizens' views illuminate emerging health and social risks. *Health, Risk & Society, 17*(7-8), 605–623.
Nafus, D. (Ed.). (2016). *Quantified: Biosensing technologies in everyday life*. Cambridge MA: MIT Press.
Nietzsche, F. (1874). On the uses and disadvantages of history for life. *Untimely meditations* (pp. 57–123). Cambridge: Cambridge University Press (Trans. R. J. Hollingdale, 1983).
Ortega, F., & Vidal, F. (Eds.). (2011). *Neurocultures: Glimpses into an expanding universe*. Frankfurt: Peter Lang.
Oxlund, B. (2012). Living by numbers: The dynamic interplay of asymptomatic conditions and low cost measurement technologies in the cases of two women in the Danish provinces. *Suomen Antropologi: Journal of the Finnish Anthropological Society, 37*(3), 42–56.
Oxlund, B., & Whyte, S. R. (2014). Measuring and managing bodies in the later life course. *Journal of Population Ageing, 7*(3), 217–230.
Phoenix, C., & Orr, N. (2015). The multidimensionality of pleasure in later life physical activity. In E. Tulle, & C. Phoenix (Eds.). *Physical activity and sport in later life: Critical perspectives* (pp. 101–112). London: Palgrave Macmillan.
Pickard, S. (2011). Health, illness and normality: The case of old age. *BioSocieties, 6*(3), 323–341.
Pickersgill, M., & Van Keulen, I. (2011). Sociological reflections on the neurosciences. *Advances in medical sociology. Vol. 13*. Bingley, UK: Emerald.
Pitts-Taylor, V. (2010). The plastic brain: Neoliberalism and the neuronal self. *Health, 14*(6), 635–652.
Pitts-Taylor, V. (2016). *The brain's body: Neuroscience and corporeal politics.* Durham, NC: Duke University Press.
Post, S. G. (2000). The concept of Alzheimer disease in a hypercognitive society. In P. J. Whitehouse, K. Maurer, & J. F. Ballenger (Eds.). *Concepts of Alzheimer disease: Biological, clinical, and cultural perspectives* (pp. 235–256). Baltimore: Johns Hopkins University Press.
Public Health Agency of Canada (2011). Physical Activity Tips for Older Adults Congress. http://www.phac-aspc.gc.ca/hp-ps/hl-mvs/pa-ap/08paap-eng.php.
Rabinow, P. (1996). *Essays on the anthropology of reason.* Princeton: Princeton University Press.
Rose, N. (2007). *The politics of life itself: Biomedicine, power, and subjectivity in the Twenty-first Century.* Princeton: Princeton University Press.
Rose, N., & Abi-Rached, J. M. (2013). *Neuro: The new brain sciences and the management of the mind.* Princeton: Princeton University Press.
Ruckenstein, M., & Pantzar, M. (2015). Beyond the quantified self: Thematic exploration of a dataistic paradigm. *New Media & Society*. http://dx.doi.org/10.1177/1461444815609081 (Online first, October 7).
Ruppert, E., Law, J., & Savage, M. (2013). Reassembling social science methods: The challenge of digital devices. *Theory, Culture & Society, 30*(4), 22–46.
Snowden, D. (2001). *Aging with grace: What the Nun study teaches us about leading longer, healthier, and more meaningful lives.* New York: Bantam Books.
The Associated Press (2016). *Lumosity to refund $2M for unproven 'brain training' apps in U.S.* (Posted online, January 5, 2016).
Thornton, D. J. (2011). *Brain culture: Neuroscience and popular media.* New Brunswick, NJ: Rutgers University Press.
Tiedemann, A., Hassett, L., & Sherrington, C. (2016). A novel approach to the issue of physical inactivity in older age. *Preventive Medicine Reports, 2*(Complete), 595–597.
Till, C. (2014). Exercise as labour: Quantified self and the transformation of exercise into labour. *Society, 4*(3), 446–462 (Retrieved from http://www.mdpi.com/2075-4698/4/3/446).
Tulle, E. (2015). Physical activity and sedentary behaviour: A vital politics of old age? In E. Tulle, & C. Phoenix (Eds.). *Physical activity and sport in later life: Critical perspectives* (pp. 9–12). London: Palgrave Macmillan.
Van Dyk, S. (2014). The appraisal of difference: Critical gerontology and the active-ageing-paradigm. *Journal of Aging Studies, 31*, 93–103.
Vesnic-Alujevic, L., Breitegger, M., & Guimarães Pereira, A. (2016). 'Do-it-yourself' healthcare? Quality of health and healthcare through wearable sensors. *Science and Engineering Ethics,* 1–18. http://dx.doi.org/10.1007/s11948-016-9771-4.
Vidal, F. (2009). Brainhood, anthropological figure of modernity. *History of the Human Sciences, 22*(1), 5–36.
Viseu, A., & Suchman, L. (2010). Wearable augmentations: Imaginaries of the informed body. In J. Edwards, P. Harvey, & P. Wade (Eds.). *Technologized images, technologized bodies* (pp. 161–184). New York: Berghahn Books.
Whitehouse, P. J., & Moody, H. R. (2006). Mild cognitive impairment: A 'hardening of the categories'? *Dementia: The International Journal of Social Research and Practice, 5*(1), 11–25.
Williams, S., Higgs, P., & Katz, S. (2012). Neuroculture, active ageing and the older brain: Problems, promises and prospects. *Sociology of Health & Illness, 34*(1), 64–78.
World Health Organization (2010). *Global recommendations on physical activity for health.* Geneva: World Health Organisation.
Zeilig, H. (2013). Dementia as a cultural metaphor. *The Gerontologist, 54*(2), 258–267.