Self-tracking Cultures: Towards a Sociology of Personal Informatics

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ABSTRACT
A body of literature on self-tracking has been established in human-computer interaction studies. Contributors to this literature tend to take a cognitive or behavioural psychology approach to theorising and explaining self-tracking. Such an approach is limited to understanding individual behaviour. Yet self-tracking is a profoundly social practice, both in terms of the enculturated meanings with which it is invested and the social encounters and social institutions that are part of the self-tracking phenomenon. In this paper I contend that sociological perspectives can contribute some intriguing possibilities for human-computer interaction research, particularly in developing an understanding of the wider social, cultural and political dimensions of what I refer to as 'self-tracking cultures'. The discussion focuses on the following topics: self-optimisation and governing the self; entanglements of bodies and technologies; the valorisation of data; data doubles; and social inequalities and self-tracking. The paper ends with outlining some directions for future research on self-tracking cultures that goes beyond the individual to the social.

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Self-tracking; Personal Informatics: Sociology; Culture; Selfhood; Theory

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INTRODUCTION

The concepts of 'self-tracking' and the 'quantified self' (also referred to as life-logging, personal analytics and personal informatics) have recently begun to emerge in discussions of how best to optimise one's life. These concepts refer to the practice of gathering data about oneself on a regular basis and then recording and analysing the data to produce statistics and other data (such as images) relating to regular habits, behaviours and feelings.

The advent of digital technologies able to assist in the collecting, measuring, computation and display of these data has been vitally important in promoting the cause of self-tracking. Mobile and wearable digital devices connected to the internet have facilitated the ever more detailed measurement and monitoring of the body and everyday life in real time and the analysis, presentation and sharing of these data. Hundreds of apps have been developed for achieving digitised self-tracking. The Quantified Self website lists over 500 self-tracking tools (Quantified Self guide to self-tracking tools, 2014), including in addition to geolocation, health, fitness, weight, sleep, diet and mood or feeling tracking apps, services and devices those that record social interactions, emails, networks and social media status updates and comments as well as meditation practices, television watching, computer use and driving habits, financial expenses, time use, beneficial habits and work productivity and monitor environmental conditions, progress towards learning or the achievement of goals.

There are an increasing number of specifically designed devices such as the Fitbit, Jawbone's Up, Nike Fuelband and various brands of adhesive patches that are available for self-tracking. All of these are designed to be worn upon the body to automatically collect data on bodily functions such as physical activity, pulse, heart rate, body temperature, calories burned, brain waves and sleep patterns. Some can be worn 24 hours a day to provide constant readings of body metrics. Digital body weight scales, blood oxygen saturation monitors and blood pressure monitors that link to smartphones are also on the market. Some devices collect environmental conditions such as air temperature, humidity, air quality and UV, while others generate information on home energy use.

In addition to these technologies are the growing range of 'smart ' objects: digitised gadgets, shoes, clothing or furniture embedded with sensors (including forks, toothbrushes and watering cans) and small wearable cameras that are equipped to take hundreds of photos automatically each day. Web platforms and services are available to aggregate data and compare them with

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others' data. To motivate users, several self-tracking technologies include 'gamification' strategies. These use built-in reward or docking systems so that points or real money can be collected or paid if various commitments (to regular exercise or weight loss goals, for example) are either met or unmet, as well as websites where users' data can be competitively compared with other self-trackers (for example the cycling platform Strava). Apps are even available that allow people to track their sexual activities, rate their partners and compare their stamina and performance with other users (Lupton, 2014a).

A growing literature is developing in human-computer interaction (HCI) studies by researchers addressing elements of self-tracking. This research has been valuable in identifying such factors as the personal benefits and rewards that people gain from engaging in self-tracking and the reasons why people take up, discard or continue these practices (Kamal et al., 2010; Li et al., 2010; Li et al., 2011; MacLeod et al., 2013; Rooksby et al., 2014). Some researchers in HCI have also investigated design features and assessed prototypes of novel self-tracking technologies (Bentley et al., 2013; Epstein et al., 2014; Fan et al., 2012; Khot et al., 2013; Khovanskaya et al., 2013). Researchers in persuasive computing focus their studies on the use of self-tracking technologies in persuading people to change their behaviours in the interests of their health or wellbeing. Self-tracking in this literature is represented as a means of motivation, encouraging self-reflection or emotional responses such as fear, guilt or shame that will lead to such changes (MacLeod et al., 2013; Purpura et al., 2011; Thieme et al., 2012).

Most of these researchers take a cognitive or social psychological approach which focuses on the individual's response to self-tracking. In their review of how online social networks for personal informatics can be used to promote health behavioural change, for example, Kamal et al. (2010) draw on psychological models of behaviour such as the uses and gratification theory, organisational commitment theory, social identity theory, the health belief model, the theory of reasoned action and diffusion of innovation. In a well-cited paper in the personal informatics literature, Li et al. (2010) use what they call a 'stage-based model of personal informatics systems' to outline five psychological stages that they identify in the process of engaging in self-tracking: preparation, collection integration, reflection and action.

While psychological processes are an integral dimension of how people respond to self-tracking devices, in their focus on the individual they do not explain the wider dimensions of the practice, or what I call 'self-tracking cultures'. Such a perspective does not elucidate the meanings that position the practice of self-tracking in specific ways and explain the particular resonances and power of these meanings. Even at the individual level, the reasons why a person may choose to take up self-tracking and the meanings she or he gives to the practice are socially enculturated. Self-tracking as a phenomenon has no meaning in itself. It is endowed with meaning by wider discourses on technology, selfhood, the body and social relations that circulate within the cultural context in which the practice is carried out.

This paper seeks to offer a different perspective: one from a sociological lens, in which the broader social, cultural and political implications of self-tracking are identified and explored. This juxtaposition of the personal with the sociocultural aspects of computer informatics has yet to be fully explored and articulated in relation to self-tracking. While self-tracking, in its very name and focus on the 'self' may appear to be an individualistic practice, many self-trackers view themselves as part of community of trackers (Boesel, 2013; Lupton, 2013a, 2014b; Nafus and Sherman, 2014). They use social media, platforms designed for comparing and sharing personal data and sites such as the Quantified Self to engage with and learn from other self-trackers. Some attend meetups or conferences to meet face-to-face with other self-trackers and share their data and evaluations of the value of different techniques and devices for self-tracking.

Self-tracking is moving from purely personal use to becoming incorporated into many areas of social life and social institutions. Educational institutions, medical and health promotion professionals and agencies and some workplaces have begun to encourage people to engage in self-tracking as part of health and fitness and worker productivity enhancement programs. Insurance companies are investigating ways of using the personal data from self-tracking to develop fine-grained risk assessment profiles for their clients and tailor individualised policies. Schools are introducing wearable tech and other self-monitoring devices in physical education lessons. As I have discussed elsewhere (Lupton 2014b) five modes of self-tracking can be identified. These include private (for one's own purposes only); communal (sharing data with other self-trackers); pushed (encouraged by others); imposed (foisted upon people); and exploited (where people's personal data are repurposed for the use of others).

There are many aspects of self-tracking cultures that can be analysed from a sociological perspective. The discussion in this paper draws on the findings of a larger project I am undertaking (culminating in a book) which involves a sociological analysis of self-tracking cultures using accounts of self-tracking in blog posts, websites, social media platforms such as LinkedIn, Facebook and Twitter and news reports and product reviews and descriptions. Rather than undertaking a comprehensive content analysis of such material, I use these sources as illustrative examples. I access this material using such strategies as regularly checking new posts on relevant websites, searching the Factiva international database, Twitter hashtags and conducting Google searches using the terms 'self-tracking', 'quantified self', 'life logging', 'personal analytics' and 'personal informatics' and subscribing to the Quantified Self LinkedIn interest group and the 'What We are Reading' weekly newsletter from the Quantified Self website.

The current discussion extends my previous work on self-tracking cultures (Lupton, 2012a, 2103a, 2013b, 2013c, 2014a, 2014b). In what follows I focus on the following dimensions: self-optimisation and governing the self; entanglements of bodies, technologies and selves; the valorisation of data; data doubles; and social inequalities and self-tracking cultures. At this point in my research these dimensions are emerging as among the most integral in understanding self-tracking cultures.

SELF-OPTIMISATION AND GOVERNING THE SELF

The American television program PBS Newshour aired a news story on self-tracking on 28 September 2013 (PBS Newshour, 2013). The reporter begins with an interview with Bob Troia, an enthusiastic self-tracker who measures his sleep patterns, pulse, blood pressure, blood glucose, cognitive performance, heart rate, sweat levels, skin temperature and stress levels using a range of devices including his iPhone and wearable computing technologies. In the interview Troia says that he does all this as part of attempting to achieve a a healthy, enjoyable and productive life: 'Personally, like, my goal is to basically be – an optimal human being in every aspect of my life.'

Some further quotes from this news story included the following from another keen self-tracker: David Pogue, technology columnist for *The New York Times*.

> 'You want to be your best self. You want to put your best foot forward.'
>
> 'It's absolutely narcissism. Or more healthfully, ego. It's studying yourself as an interesting topic in ways that you couldn't study yourself before, I mean this is just giving you self-awareness into previously invisible aspects of your life.'

From the interviews with self-trackers quoted in this brief news report, a number of discourses that give meaning to self-tracking cultures are apparent. These include those about selfhood: the importance of self-awareness and self-improvement (the attempt to be 'an optimal human being' and 'your best self') and also the role played by self-interest ('studying yourself as an interesting topic').

While there is constant reference among members of the Quantified Self movement to the 'Quantified Self community', this community largely refers to sharing personal data with each other, or learning from others' data or self-tracking or data visualisation methods so that one's own data project may be improved. According to the Quantified Self Institute, a research body that is part of the Hanze University of Applied Sciences in the Netherlands, self-tracking 'is a functionally "selfish" activity, which is a result of a personal motivation. "Me and my data", that is the point of the Quantified Self' (de Groot, 2014).

There is a large literature on the ways in which self-identity is enacted via digital technologies. However little attention has been paid to the ways in which the specific types of hardware and software that are used as part of contemporary self-tracking cultures draw on, reproduce, and in some cases reconfigure concepts of selfhood.

One perspective that may be adopted uses the philosophy of Michel Foucault. Foucault's (1988) writings on the practices and care of the self in western societies are pertinent to understanding self-tracking as a particular mode of governing the self. Foucault studied the various ways in which humans develop knowledge about themselves: economics, biology, psychiatry, medicine and penology. His objective was not to accept these knowledges at face value but to investigate the rationalities that underpin the techniques that people use to understand themselves. Foucault argues that one of the principal techniques for self-understanding is that which involves people engaging in the practices of selfhood in pursuit of their own interests. He argues that as a moral and ethical project individuals are required to take up certain practices to achieve happiness, wisdom, health and wellbeing. These practices are directed at their bodies, souls, thoughts, conduct and way of being.

Several sociologists have taken up Foucauldian perspectives to argue that contemporary political rationales, or neoliberalism, promote self-responsibility as part of a governmental strategy that exerts 'soft' rather than 'hard' authority. Citizens are encouraged to engage in certain practices voluntarily as an effective and non-coercive way of rendering them manageable and productive, assets rather than burdens to the social polity. Citizens act in their own self-interests but these self-interests and outcomes are also aligned to the rationales and interests of the state (Lupton, 1995a; Rose, 1990, 2007).

From the Foucauldian perspective self-tracking may viewed as one of many heterogeneous strategies and discourses that position the ideal individual as a responsible citizen, willing and able to take care of her or his self-interest and welfare. Nikolas Rose refers to 'biological citizenship' in his influential book *The Politics of Life Itself* (Rose, 2007). Extending this concept, one could also refer to 'self-tracking citizenship' as part of the panoply of strategies for the government of the self. Part of engaging in data collection as part of practices of selfhood is the idea that the self-knowledge that will eventuate will allow self-trackers to exert greater control over their destinies. The data and the knowledge contained therein will help them achieve better health, higher quality sleep, greater control over mood swings, improved management of chronic conditions, less stress, increased work productivity, better relationships with others and so on.

This is all achieved voluntarily, as part of the quest for self-optimisation and as an often pleasurable and playful mode of self-surveillance (Lupton, 2012a, 2013a, 2013b, 2014a; Nafus and Sherman, 2014; Ruckensein, 2014; Whitson, 2013). This perspective is evident in the words of self-tracking cyclist Andrea Parrish. On her blog

Parrish observed that she enjoys tracking her rides and her weight and calorie input and output because she views these activities as playful, thus enhancing her motivation:

> Tracking what I am doing and the effects those actions have appeals to the data-loving, game-making, goal-oriented part of my brain. Tracking keeps me accountable to myself and allows me to turn what might otherwise be a chore into a challenge. (Parrish, 2012)

Self-tracking can help people feel more in control of their lives (Li et al. 2010; Choe et al. 2014; Nafus and Sherman, 2014; Ruckenstein 2014). This can be important for people in a world in which fixed social structures and social ties have dissolved and far more choices for conducting one's life are available. Other sociologists have identified the loss of traditional social structures (rigid gender roles, religion, the nuclear family, the workplace where one stays for a lifetime) as contributing to a sense that people are responsible for maximising their life chances in the context of uncertainty and unpredictability of contemporary life. People must choose among an array of options when deciding how to shape their lives, rather than conforming to established traditions. In doing so their life courses have become much more open, but also much more subject to threats and uncertainties. Their successes and failures are deemed to be their own responsibility as a result of their decisions and behaviours.

In his work on risk society, Ulrich Beck (1992, 2009) describes the concept of self-reflexivity, which involves actively seeking information and making choices about one's life. Zygmunt Bauman (2000) employs the term liquid modernity to describe similar aspects of contemporary western societies. According to Elliott (2013a, 2013b) one aspect of late modern societies is a new individualism, which involves the reinvention of the self and the body. He contends that the concept and practices of reinvention have become central to both private lives and organisations, and it is generally accepted that they are important endeavours. Reinvention is about transformation for the sake of personal growth, achievement, career success, health or wellbeing. This new individualism involves concentrating on the self to the exclusion of social groups, organisations or communities.

Self-tracking, therefore, at least as it is undertaken as a private enterprise, may be understood the apotheosis of self-reflexivity in its intense focus on the self and using data about the self to make choices about future behaviours. As part of the new individualism, self-reflection and critical self-examination are encouraged, viewed as ways of improving the self via therapeutic discourses and practices. Self-tracking practices are frequently represented as ways of achieving reinvention. They conform both to the notion of self-work and self-improvement that are part of the reinvention paradigm, and to the new individualism in their focus on the self.

ENTANGLEMENTS OF BODIES, TECHNOLOGIES AND SELVES

Perspectives developed in the sociology of science and technology offer a further theoretical approach to think about the ways in which humans interact with their technologies. Such perspectives address such issues as the ontological nature of the human/technology interaction, the ways in which technologies are incorporated into concepts of embodiment and selfhood and how they extend or enhance these and how social relations are configured through, with and by technologies.

In this literature it has been suggested that the blurring between the online and off-line self has become so advanced that it is now suggested that we can no longer distinguish between the two. Instead we are living in augmented reality (Jurgenson, 2012), and categories of flesh, identity and technology are porous and intermeshed (Elwell, 2014). For many commentators writing on these issues, the notion of the posthuman, or the idea that humans are inextricably intertwined with technologies is articulated. The concept of the cyborg, or the cybernetic organisation that is the human-machine assemblage, is also often used in this literature (Gray, 2002; Haraway, 1991, 2008; Lupton, 1995b, 2015). In recent years some scholars have contended that we are living in a post-cyborg world and have gone so far as to argue for technogenesis, the idea that humans and technologies such as digital devices are co-evolving (Hayles, 2008, 2012).

Sociologists of science and technology emphasise the multiplicity and constantly changing aspects of the human-technology relationship. They draw attention to the nonhuman actors that contribute to the hybrid assemblages that are configured when humans and technical devices come together. This perspective seeks to identify the large and complex network lies behind the digital devices that people use for such purposes as self-tracking. Computer software and hardware developers, manufacturers and retailers, software coders, algorithms, computer servers and archives, the computing cloud, websites, platforms and social media sites are all part of the network of actors that configure and enact the self-tracking assemblage. As Williams (2013: no page number given) notes, an analysis of self-tracking should 'incorporate and question how our personhood and our work is increasingly being defined not just by ourselves, but by a complex of others … that are building on our desire to optimize our selves'.

Humans have always used material objects as technologies. As these technologies have transmuted into digital forms, particularly into smaller and more easily wearable and even ingestible forms (in the case of digital tablets), it becomes less obvious where the body ends and the technology begins. This blurring of boundaries is most overtly the case of such technologies as heart pace-makers, insulin pumps and cochlear implants, all of which are inserted into the body in unobtrusive ways. But it is also now an element of the types of digital technologies that we use for communication, such as

smartphones, or for self-tracking of bodily functions and activities, such as armbands, clothing or watches embedded with sensors. We not only wear self-tracking technologies but we move around in spaces, both public and private, that are equipped with sensors for monitoring human bodies. Our bodies' location is digitised by a plethora of sensor-based technologies: either our own or those that are embedded in the built environment. Our knowledges of our bodies, therefore, are increasingly digitised and rendered into data (Lupton, 2015).

This is not to say, however, that self-trackers necessarily experience monitoring devices as part of themselves, or that they do not find these technologies sometimes annoying or irritating. The use of tracking devices for collecting biometric data can make people even more aware of their fleshly bodies by constantly alerting to their capacities and limitations, and this may be discomforting (Buse, 2010; Freund, 2004; Lupton, 2012a; Ruckenstein, 2014). As Freund (2004) so vividly put it, there may be 'seams in the cyborg'.

Some people find wearable self-tracking devices not fashionable enough, or not water-proof enough, or too clunky or heavy, or not comfortable enough to wear, or find that they get destroyed in the washing machine when the user forgets to remove them from their clothing. For example, Ruckenstein's (2014) interviews with Finnish users of heart-rate and physical activity digital monitors found that some remarked on their consciousness of the devices. As one woman commented, 'Last night, I noticed that the measuring equipment suddenly started physically annoying me quite a lot. I would have liked to have ripped if off, even if just for the night' (2014: 75).

Designer Jennifer Darmour (2013) has argued that the aesthetic dimensions of wearable technologies have been little addressed. If these technologies remain too obvious, she argues, 'bolting' these devices to our bodies (an unlikely Frankenstein metaphor) and therefore obviously proclaiming ourselves as cyborgs will 'distract, disrupt, and ultimately disengage us from others, ultimately degrading our human experience' (2013: no page number given). Darmour asserts that these objects need to be designed more carefully so that they may be 'seamlessly' integrated into the 'fabric of our lives' (2013: no page number given). Her suggested ways of doing this include making self-tracking devices look more beautiful, like jewellery (broaches, necklaces, bracelets, rings), incorporating them into fashionable garments, making them peripheral and making them meaningful: and using colours or vibrations rather than numbers to display data readings from these devices.

On her blog, Carol Torgan (2012), a health strategist and educator, has remarked upon the emotions that wearing digital self-tracking devices may provoke in people. She notes that putting on a self-tracking device makes some people feel athletic, some fashionable, others fat and self-conscious about their bodies. Others feel safer and develop a greater sense of security about having their health monitored by these devices. Here again it was observed that the design of the device – its 'look', its conspicuousness or lack thereof – may be integral to how people feel when they wear it. Design features, emotions, bodies, selves and data are entangled in the digitised self-tracking experience.

THE VALORISATION OF DATA

Data is a keyword in discourses on self-tracking. The aim of the Quantified Self movement, suggest its inventors Gary Wolf and Kevin Kelly on their website, 'is to help people get meaning out of their personal data' (About the Quantified Self, 2014). In his seminal article on the quantified self for *The New York Times*, Wolf (2010) asserts that: 'If you want to replace the vagaries of intuition with something more reliable, you first need to gather data. Once you know the facts, you can live by them.' He then expounds on the virtues of numbers:

> We tolerate the pathologies of quantification — a dry, abstract, mechanical type of knowledge — because the results are so powerful. Numbering things allows tests, comparisons, experiments. Numbers make problems less resonant emotionally but more tractable intellectually. In science, in business and in the more reasonable sectors of government, numbers have won fair and square.

Another example of the valorisation of data is the term 'the data-driven lifestyle'. This was used as the headline for Wolf's *The New York Times* article. It has been employed several times in the popular media since that article was published, including in a recent article about Chris Dancy, an American who has used 700 gadgets, sensors, apps and other software to collect data about his body and his habits (Pullar-Strecker, 2014).

The statistical aspect of the practice of self-tracking – the ability to produce quantifiable information measuring aspects of one's life – is integral to the approach. It is assumed that the production of such data is the best way of assessing and representing the value of one's life and that better 'self-knowledge' will result. This perspective recurs in popular media accounts and posts on websites such as the Quantified Self, where the motto is 'self knowledge through numbers'.

In an online article, Duncan Watts, a social scientist at Microsoft Research and long-term self-tracker, argues for the importance of collecting personal data by contrasting instinct, tradition and received wisdom with the more reliable evidence provided by self-tracking data:

> "If you had to choose between a world in which you do everything based on instinct, tradition or some vague, received wisdom, or you do something based on evidence, I would say the latter is the way to go," … The challenge is coming up with the proper interpretation of the data, he said. (quoted in Feiler, 2014: no page number given)

As Watt's words suggest, the lure of 'numbers' is that they appear scientifically neutral and exact compared to the less reliable data that one's instincts or physical sensations may generate. The body/self as it is produced through self-tracking, therefore, is both subject and product of scientific measurement and interpretation.

The ideal for many self-trackers is technologies that automatically sense and collect data on their lives without needing direct intervention from users. Blumtritt (2014: no page number given), for example, has expressed his contemplations on the future of the quanitified self thus: 'Data will become integral with our sensory, biological self. And as we get more and more connected, our feeling of being tied into one body will also fade, as we become data creatures, bodiless, angelized'.

The notion that digital self-tracking devices render visible elements of one's self and body that are not otherwise perceptible is also expressed in many accounts of self-tracking. In the Newshour report referred to earlier, interviewee Bob Troia talks about checking his smartphone app to see how stressed he is: 'I can look down at my phone at any point in the day and see, kind of, how stressed I am'. Another interviewee for this report, David Pogue, discusses the awareness that may be gained from self-tracking 'into previously invisible aspects of your life'.

According to Apple's announcement of its new Health app, '"How are you?" now has a really accurate answer … Heart rate, calories burned, blood sugar, cholesterol — your health and fitness apps are great at collecting all that data. The new Health app puts that data in one place, accessible with a tap, giving you a clear and current overview of your health'. As with many other health-related self-tracking apps the Health app provides 'dashboards' that visualise body data such as sleep patterns and calories burned. It is these data, as presented in this way, which are portrayed as denoting what 'health' means. As this description suggests, understanding and articulating how healthy one feels is more accurate if digital data are employed rather than relying on one's subjective sense of wellbeing.

Related to the concept of the posthuman is the idea that human bodies and selves are now experienced and produced as information systems (Haraway, 1991; Hayles, 2012). The body becomes represented as a repository of identifiable, storable and processable data, constituted by data flows and circulations. Indeed the body and the data it represents become central to concepts of identity. In many accounts of self-tracking the human body is represented as a chaotic producer of masses of data that need to be disciplined by monitoring, measuring and management. It is not until the data are recorded and produced into some kind of visual form that they can be interpreted, and then understood and acted upon. While the body may be represented as a computerised information system, therefore, in these types of discussions such a system is flawed compared with literal computerised technologies. The human computer, in its inevitably fleshly humanness, can never achieve the capabilities offered by real digitised technologies. Humans require the assistance of machines to extend their capabilities and provide accuracy and enhanced interpretation and memory of information.

DATA DOUBLES

The concept of data doubles is a useful way to think about these entanglements of bodies, technologies and selves in digital self-tracking. Data doubles are configured when digital data are collected on individuals, serving to configure a certain representation of a person (Haggerty and Ericson, 2000). They have their own social lives and materiality, quite apart from the fleshy bodies from which they are developed.

Self-trackers are drawing on the capacities of new technologies to generate increasing quantities and diverse forms of information about their bodies and selves. While self-tracking was once achieved via such practices as journal keeping or writing down numbers, it was difficult to analyse these data for their patterns. Digitised data devices and apps and other software provide the opportunity to access and analyse the numbers efficiently and quickly. Different data sets may now be combined to identify patterns in ways that were not achievable in the past.

The diversity of approaches to self-tracking results in a range of data doubles being configured on the body and self. The physical activity monitor produces some forms of data, as does the productivity app or the mood tracker, for example. Each configures a different and constantly changing data double of the user, and may intersect or not. Indeed the difficulty now faced by self-trackers is the overwhelming mass of data that they may have to deal with, given the infinite number of ways in which data sets may be combined with the aim of generating insights (Li et al., 2011; Choe et al., 2014; Lupton, 2014b).

Data doubles representing aspects of the body and self are continually re-enacted and reconfigured. The physical activity tracking device produces some forms of data that may or may not be acted on by the user, as does the productivity app or the mood tracker, for example. Each configures a different and constantly changing data double of the user (Lupton, 2013c, 2014b; Ruckenstein, 2014). Central to the process of self-tracking, therefore, is the concept of change. Data doubles never stand still. As soon as they are generated they are subject to change when more data are added. Data doubles are constantly open to reconfiguration and hence re-interpretation.

Data doubles are also recursive and reflexive. Self-trackers reflect upon their data and seek to make sense of them. A feedback loop is established, in which personal data are produced from digital technologies which then are used by the individual to assess her or his activities and behaviour and modify them accordingly (Lupton, 2012a, 2013a, 2014a, 2014b; Ruckenstein, 2014; Whitson, 2013). Data doubles, therefore, are both

constituted by the body and self and in turn serve to re-constitute the body and self.

One of the most interesting accounts of self-tracking using digital devices is an autoethnographic account by Kaiton Williams, a technologist and designer. Williams notes that he found that self-tracking using digital devices was effective. He employed smartphone apps to track his weight loss, diet and exercise. However while he was pleased to lose weight, he found that non-weight-related aspects of his life began to be re-interpreted through the lens of these devices. He disliked the perspective on his body that the data derived from self-tracking gave him:

> I do not enjoy contemplating my self as blood and sinews and electrical signals … I might have preferred to accomplish my self transformation within broader measures, and I still long for that; to comprehend my body in longer and longer scales: seasons instead of hours, some other, coarser, property than calories. (Williams, 2013: no page number given)

Williams goes on to discuss how rendering his life more calculable using tracking apps changed his eating habits to fit the technical requirements of the apps. 'I prioritized certain foods and recipes, and avoided others to work best within the capabilities of the food database'. He notes that he began to trust the digital data over his own physical sensations, and that the data also began to shape how he felt:

> We (the Apps and I) had co-constructed a digital model of my self, and here I was, managing myself, it seems, by proxy. The feedback from that digital model often took precedence over how I physically felt. When I didn't eat 'enough' protein I felt weaker, and when I had too much sugar I felt fatter. These were delayed reactions; a re-reading of my body from the model. I've yet to decide: is this model pushing me closer in contact or further away from my self and my world?

Some of the self-tracking interviewees in Nafus and Sherman's study (2014) also articulated an interesting negotiation between making sense of the data doubles that their devices were producing in the light of their own physical interpretations of their bodies. As these comments suggest, an important dimension of the lived experience of self-tracking is the ambivalence people may feel about investing their trust in the numbers and altering their perceptions to fit the demands of the technologies they use.

SOCIAL INEQUALITIES AND SELF-TRACKING CULTURES

Little attention is paid either in self-tracking cultures or in the human-computer interaction literature to the ways in which such social factors as gender, place of residence, social class, race or ethnicity serve to shape people's opportunities and life chances. Instead the self is understood as an atomised individual, shaped by personal life experiences and empowered to manipulate her or his destiny by acquiring self-knowledge and acting rationally upon this knowledge.

As I noted earlier, educational institutions, healthcare and health promotion professionals and agencies and workplaces have begun to encourage people to engage in self-tracking, and therefore are also participating as actors in self-tracking cultures. There are major social justice issues that are emerging from the enrolment of such agencies and institutions into self-tracking. Failure to participate in wellness programs at work may lead to higher health insurance premiums, as is happening in some workplaces in the United States where employers are responsible for covering healthcare costs for their employees and therefore have a vested interest in their employees' health (Olson, 2014). Wearable technology manufacturers are brokering deals with employers and insurance companies to sell their fitness and activity trackers and data analytics software as part of these wellness programs. Employees must give their consent to wearing the devices and allowing employers to view their activity data. However when incentives such as lower health insurance premiums are offered, such consent becomes less voluntary. So too, wearing tracking devices may be required as part of workers' productivity monitoring and linked to pay and promotion opportunities (Lohr, 2014).

Under these types of schemes, surveillance using self-tracking devices becomes required of the user by others. While these devices still monitor and measure personal data on an individual basis, they are no longer participating in private self-tracking but rather responding to pushed or imposed self-tracking (Lupton, 2012a, 2013b, 2013c; Whitson, 2013). Indeed it can be difficult in some of these instances to distinguish between pushed and imposed self-tracking, particularly when financial incentives or penalties or employment prospects are implicated.

Self-tracking discourses and cultures can be moralistic and judgemental, building on wider and long-established ideas about personal responsibility for good health, physical fitness and productivity (Lupton, 1995a, 2012a, 2012b, 2013b). When notions of health, wellbeing and productivity are produced via data drawn from self-monitoring, the social determinants of these attributes are obscured. Illness, emotional distress, lack of happiness or lack of achievement in the workplace become represented primarily as failures of individual self-control or efficiency, and therefore as requiring greater or more effective efforts, including perhaps increased intensity of self-tracking regimens, to produce a 'better self'.

This is perhaps most evident in the ways in which self-tracking practices have been taken up in the medical and public health domains, where self-management of individuals' health and an emphasis on personal responsibility for taking steps to prevent disease and early death have long featured (Lupton, 1995a). Concepts of

'patient engagement' now frequently include reference to the importance of patients undertaking self-monitoring and self-care, often using digitised devices (Lupton, 2013b). Writers in the preventive medicine and health promotion literatures have also begun to refer to the importance of self-tracking bodily activities as a way of preventing disease that is believed to be self-imposed (see, for example, Swan, 2012). Those people who participate as self-tracking citizens are able to demonstrate their adherence to these ideals, while those who do not may be regarded as falling short of achieving their 'best selves'.

These positions on self-tracking again position people as ideally self-managing and possessing enough knowledge and self-control to successfully participate in such schemes and gain benefits from them. Little acknowledgement is made of the relative influence of socioeconomic advantage on people's opportunities to engage in self-tracking and the continuing social inequalities that limit people's digital technology use. People who possess socioeconomic privilege are able to exert far more control over their lives than the disadvantaged. Many studies have shown that older people, those with less education, lower incomes, people with disabilities and chronic health problems and people living in rural and remote areas have less access to and skills in using digital technologies (Broadbent and Papadopoulos, 2013; Hargittai and Hinnant, 2008; Olphert and Damodaran, 2013). Yet in the overwhelming focus on the atomised, self-autonomous individual that pervades self-tracking cultures, the issues of socioeconomic disadvantage and the social determinants that shape people's willingness or capacity to engage in self-tracking are ignored.

CONCLUSIONS

In this paper I have discussed the discourses that have come together to give meaning to self-tracking cultures. I have argued that self-tracking cultures have emerged in the context of the current cultural moment of the belief that data are superior forms of knowledge, combined with the affordances of contemporary digital technologies that allow individuals to produce large masses of data about themselves. These discourses and practices intersect with others concerning individualisation, reinvention, the neoliberalist privileging of self-responsibility and the importance of attaining knowledge about the self as part of working upon and improving the self.

I have also highlighted the importance of identifying the complexity of the multitude of human and nonhuman actors that work together to configure self-tracking assemblages. Further investigation is required of how these interactions operate and the ways in which people construct, make sense of and negotiate the data doubles that are generated by self-tracking assemblages. So too the ways in which the incorporation of the self-tracking ethos and practices into commercial and governmental enterprises is operating is a topic worthy of more detailed examination.

Finally, I have contended that despite the focus on the individual that is commonly articulated in self-tracking cultures, there are wider political and social justice implications. The self-impelled and voluntary aspects of self-tracking (what I term 'private self-tracking') are becoming harnessed to broader collective commercial, economic or social imperatives. While some elements of self-interest may still operate, people may not always have full choice over whether or not they engage in self-tracking and may be coerced into taking part.

In a social context in which self-management for optimising one's life is idealised and rewarded, those who fail to do so are disadvantaged both in terms of financial costs and in attracting moral judgements from others. Acknowledging the role of cultural meanings and social structural factors in shaping human lives and fortunes is a key sociological perspective that could be productively incorporated into further research on self-tracking and the design of future prototypes of self-tracking devices.

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