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Special Issue

The Neoliberalization of Sleep

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Abstract: This article explores the implications of sleep apps which are sociologically significant in that they represent an attempt to colonize, exploit, and make profitable one of the last vestiges of the human lifeworld through discourses of self-subjectification, authenticity, and self-improvement. I assess the websites of two sleep tracking apps (Pillow and Sleep- Score) using critical discourse analysis (CDA), new materialism, and autoethnography. I make the case that the neoliberal values associated with the use of these apps perpetuate the logic that a better sleep makes for a more productive worker, better citizen, and ideal consumer subject. I also demonstrate how these apps function to open new sites of potential profit and reproduce a form of embodied neoliberal subjectivity generated by intra-active entanglements between identities, technologies, and discourses. Finally, I take up the issue of marginalization and intersecting subject positions as it relates to inequalities that these sleep trackers might exacerbate.

Keywords: critical discourse analysis, new materialism, sleep apps, autoethnography, neoliberalism, biopower.

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A brief political economy of sleep apps

Before beginning, a short political economy of sleep apps is necessary in order to acquaint the reader with the key players, ownership structures, user demographics, economic significance, laws/regulations, and market potentiality (Mansell 2004). These structures form the impetus for neoliberal intensification through strategies of biopower and subjectification even in sleep. Sleep is an activity that,

...binds individuals to institutions, and when disordered sleep disrupts these interactions, medicine intervenes to reorder the everyday. These everyday orders, in turn, structure American capitalism, a form of capitalism that is tied to long-standing conceptions of normalcy, medicine, and everyday life. (Wolf-Meyer 2012, 3)

Sleep apps fall under the general category of mHeath (medical health) trackers which, through their sustained use, provides users with detailed, useable, and actionable biomedical knowledge about their bodies and health. The business category of "sleep-health vectors and associated products/services," which includes sleep apps, is quite sizeable and is expected to grow by more than 8 % a year from a 2017 estimate of USD30-40bn. More granular analysis of the sleep tracker market, according to MarketWatch, sees opportunities for growth since the key drivers are already prominent actors (e. g. Apple's Fitbit, Garmin) as well as the "greying" of the population in countries like China and Japan (age tends to be positively correlated with sleep disorders) (MarketWatch 2019). There is, however, some fragmentation in the sleep app industry

with insurgent actors challenging some of the more established brands (e. g. Sleepace Sleep Dot and the Oura Ring).

The obsession with perfect sleep, often referred to as orthosomnia, has been an unfortunate outcome of the overuse of some of these apps. Barbee, Moloney, and Konrad refer to this as SIC or the Sleep Industrial Complex through which sleep has become commodified, made purchasable, and connected to the productivity imperative. The result, they argue, is a kind of "somnolent capitalism" defined as a state in which sleep is seen solely as a means of productive regeneration driven by "neoliberal expectations that require individuals engage in a hyperproductive, globalized, and profit-driven marketplace" (Barbee, Moloney, and Konrad 2018, 6).

This literature around biopolitics, neoliberalism, technology, and the quantified self is vast and well established. It spans critical work on health and health adjacent technologies, inclusive of apps and wearables (Fotopoulou and O'Riordan 2017), the critique of contemporary labour practices that center surveillance, wellness, and productivity (Moore and Robinson 2016), gender and body projects (Sanders 2017; Doshi 2018), and the embodied performance of normative citizenship (Baldwin-Philippi 2015). Deborah Lupton, the most prolific writer in this area, argues that the union of technology with biopower and neoliberalism has resulted in a culture of quantification in which health is no longer seen as the responsibility of the states, but as the domain of individuals whose behaviour and choices are dispositive (Lupton 2014).

Contemporary work in the area of health, bodies, and wellness connects this biopolitical critique with a robust theory of neoliberalism to describe the transformation of our economy into one driven by market forces, beginning in the 1970s, and the more granular transformation of everyday life by neoliberal modes of logic and reasoning (Foucault 2008; Urry 2012). This has led to a cascade of socio-cultural changes in which self-generating responsible agents, oriented towards autonomy, choice, competition, productivity, and perfectibility, are seen as citizens par excellence. This form of neoliberalism, according to Catlaw and Sandberg (2018, 6), relies heavily on technologies of performance to "construct market type relations where non previously existed" using data and information to do so. Modes of governmentality associated with neoliberalism draw attention to how discipline is exerted by these digital trackers (Crawshaw 2012). Chun (2016) describes sleep apps as indicative of this "prevailing neoliberal, if not bioliberal... mandate associated with identity and selfhood, individualisation and responsibilization" (Williams, Coveney, and Meadows 2015, 1040). Also of note is a study of sleep app discourses by Fage-Butler who draws on Foucauldian discourse analysis to identify common themes in sleep app marketing. Discourses inclusive of disempowerment, responsibilization, mindfulness, and empowerment are shown to be making a significant mark on users and on a growing app culture in which the problem and solution are clearly identified (Fage-Butler 2018).

Sleeping apps thus represent an ideal instantiation of neoliberal governmentality and biopower since they work to collect data on living beings and are able to present that data in a manner that integrates individual with population level knowledge. As will be shown, their objective is to effectively and efficiently "instrumentalize the self-regulating propensities of individuals in order to ally them with socio-political objectives" (Miller and Rose 1990, 28). To do so, I focus in the following section on how the neoliberal and biopolitical discursive frames of wellness, transformation, optimization, productivity, self-knowledge, and efficiency are used by sleeping app companies, SleepScore and Pillow, to sell an ideational package of self and life-image that aligns with the larger objectives of capitalism.

CDA allows for the critical examination of texts for "social inequality as it is expressed, signaled, constituted, legitimized and so on by language use (or in discourse)" (Van Dijk 2003, 352). Using an adapted form of critical discourse analysis, I demonstrate how these discourses are used to cultivate forms of neoliberal subjectivity through the purchase and use of these products. Methodologically, the textual content has been parcelled out and subjected to a microanalysis of description, focusing on the meaning of the text itself in a denotative sense; interpretation, in which norms, relations of power, and values were extracted; and explanation, in which the socially constative effects of language were identified and elaborated on (Fairclough 1992; 2013). Cumulatively this approach provides a multi-layered analysis that "incorporates textual, processing and social levels of discourse analysis…" while also reading for "linguistic evidence for claims made out of the discourse analytical work" (Wang 2006, 68).

Following the application of CDA, this analysis of discourse is then combined with more recent work in materialist studies to produce a robust analysis of sleep apps as discursive *and* material objects of nature-culture that, in the context of sleep, works to cultivate forms of subjectivity oriented to self-knowledge, authenticity, and efficiency as well as insights, using a materialist lens, into the phenomenon of data doubles, materially evoked user experience, and user agency.

Pillow and SleepScore

Pillow's website incorporates a sleek purple background with images of iPhone and iWatches around which the text incorporated expounds the benefits of the app. Ease of use is common theme ("No buttons to push, no need to install,…"), as is the ability to exert "complete control" by reverting to manual mode. The SleepScore website is similarly minimal in its aesthetic featuring comparable images of iPhones displaying the open app. The basic, max, and do I snore? versions are depicted together with text claiming that SleepScore is "the world's most accurate non-contact app," and that it, "measure[s] the quality and quantity of your sleep" thereby improving "your sleep using only your smartphone." The SleepScore tag line is "Good sleep can be life-changing."

Both Pillow and SleepScore purport to use the closely tracked metrics of heart rate, sleep cycle, and audio recording to provide users with a deeper understanding of how they sleep allowing Pillow users to "wake up refreshed" and SleepScore subscribers to "unlock your [their] true potential." They both reassure users of their accuracy – with SleepScore claiming the "most accurate sleep app" designation mentioned above and Pillow drawing on a discourse of precision and detail to make a similar claim. What unites the discourse surrounding both apps is their deployment of the three central discursive frames of self-knowledge, authenticity, and self-optimization discussed below and identified using CDA.

Self-knowledge

The Pillow and SleepScore websites draw heavily on the neoliberal claim of productive self-knowledge through, for Pillow, its appeal to the transformational force of just knowing "health metrics like weight caffeine, blood pressure, and more" and, for SleepScore, giving customers the ability to "track and measure your breathing rate and body movement" and provide "insight into your sleep environment and delivers an in-depth analysis into every stage of your sleep." Hardey (2019) refers to this claim of self-understanding as somatic or corporeal knowledge production in which a new kind of self-awareness is revealed through digital data leading to the accumulation of biocapital that can be used to further neoliberal objectives. It is the idea that one can know oneself more fully for purposes of productive control and manipulation, particularly in the case of sleep – a domain customarily inaccessible to such manipulation, that is expressed by the claim that SleepScore affords users with "unique insight[s] into your sleep." Pillow's colourful images breaking down sleep according to wake, REM, Light Sleep and Deep Sleep gives users a visual representation of time spent in each region and a percentage scoring sleep quality. SleepScore makes a similar offering with respect to the visual tracking of sleep trends and the thematization of "scoring," "learning," and "comparison" as three of its five primary objectives.

The ability to algorithmically score and cross reference sleep metrics with "weight, caffeine, blood pressure and more" (Pillow), is a key feature of the Quantified Self (QS), a Silicon Valley based social movement turned cognitive worldview in which technologies are used to self-surveil life processes and produce numerical outputs that can then be productively manipulated and/or hacked in ways that facilitate normative behavioural change. Their motto, "self-knowledge through numbers," has permeated popular, workplace, economic, and political discourse (Lupton 2016). SleepScore draws on this frame by ensuring users that the data they accumulate will allow them to "optimize" and "improve" their lives through, for example, the reduction of sleep to "32 parameters" and an 0-100 sleep score. Very detailed claims of enhanced sleep quality, "in one week," and improved sleep, "by an average of

45 minutes," it is claimed, come from the sustained use of the app and, in particular, in light of the data it provides. The QS, according to Btihaj Ajana, turns "bodies and minds ... into measurable machines and information dispensers in the quest for personal development, productivity, health and better performance" (Ajana 2018, 2). Sleep, until now, has been spared by this datafied instrumentalization even though it has been a locus of analogue forms of manipulation for decades. SleepScore is particularly adept in the optimization qua information/data/statistics front with sections dedicated to teaching customers about sleep and providing them with "tips and ideas for improving your sleep to perform your best everyday," while also offering users access to basic information about the algorithm, cutting-edge sleep science, and the latest data about "how America's sleeping." Self-optimization through self-knowledge is essential to the production of a neoliberal subjectivity desired by capitalist societies where productivity, efficiency, and the exertion of agential power over life processes is key. Williamson refers to this as the "data-driven life" characterized by biopedagogies that are part of a "solutionist obsession with 'tuning' and 'perfecting' the body with the right algorithms" (Williamson 2015, 142).

Authenticity

Another frame deployed by Pillow and SleepScore that attends to the objectives of late capitalist, data driven governmental neoliberalism is that of authenticity. Authenticity, defined as resonant with "the real," the inherent, the natural, is discursively deployed both with respect to the apps (i. e. claims that they are working towards the betterment of you, the user), and the users themselves (e. g. by helping them realize their true, well rested, selves). It involves the promise that these technologies will result in a move toward a more true and in-control self-subject and they "will result in a transformation of one's relationship to one's health and further to one's body, psyche, and self, based on data that can reflect back a truer or more authentic self" (Sharon 2017, 107). Williams refers to this as the cultivation of the "neoliberal spiritual subject" which, while traditionally gendered, in the context of sleep has a much wider remit (Williams 2014). For Genz (2015, 545), this kind of commodification of authenticity involves elements of "(self)branding, entrepreneurship and ... agency" deployed for the benefit of product brands as well as, it is claimed, for the users. Gill and Kanai (2019) demonstrate how forms of "intimate psychological governance," through the promotion "of self-esteem, happiness, positive mental attitude," are used by cultural technologies like apps in instrumental ways. SleepScore deploys this discourse effectively through a claim of providing "personalized advice and recommendations" that are "science-backed" (with links to published studies and experts), and, significantly, through the inclusion of an entire section on wellness. Wellness culture, it should be noted, has an intimate connection to the discourse of neoliberal authenticity through the motif of empowerment which propels the further entrenchment of self-

governance wherein the "personal, obligatory, and moral achievement to both self and community" is seen as essential (Lavrance and Lozanski 2014, 78).

Pillow, in addition to providing users with personalized "statistics and analysis," also offers expertise, support, and other personalized elements that are presented as effective in helping users to make "the right decisions" for them in their journey towards "the best sleep ever." The manufacturing of an enduring connection based on user-brand relationships that feel "authentic" is a central feature of intensified consumer capitalism. The app is thus presented as an interface between a service that promises a better life and a more connected self, but which requires labour *on both sides* to reach this objective (Lury 2004). This "work" functions as a stand in for an authentic relationship while also promising the user a service that will provide access to a more actualized, effective, and authentic self (Ekman 2013; Harding 2013). This neoliberal ethos presents consumer products as signifiers of identity wherein "the kind of people we are" is "based upon manifestly meaningless things like what kind of car we drive or brand of shoes we wear, and are encouraged to enjoy and create our own authentic selves, in part through consumption" (Catlaw and Marshall 2018, 4).

Consumer feedback on the Pillow website furthers this claim to effective authenticity through technologies of control with comments lauding how they have aided users in better ing themselves by helping them to "feel energized" and "more rested" through "actionable advice." While SleepScore does not include readily accessible comments on their website, they do have a section lauding their "Sleeping Children Around the World Initiative" which provides underprivileged children around the world with a "bedkit for a restful night and a happier tomorrow" through donations and proceeds from purchases. There is a rich history of companies using charity as a means by which to certify their own authenticity and virtuousness while also providing customers with a similar feeling of personal integrity. What is masked, however, is how this ethos of authenticity, care, and "emotional citizenship" is often used to temper the harsh "neoliberal logic of 'fact'-based rationality, individual enterprise and market efficiency" (Mitchell 2016, 290). This rather cynical reading is not helped by the fact that the images of the charity feature exclusively smiling Black children (likely from a country in Africa) with the one non-racialized person handing a mattress to a young Black child.

Self-improvement/optimization

Finally, both Pillow and SleepScore make claims to agential, individualized self-improvement, a key theme in neoliberal discourse. For Pillow, this is done through an appeal to how the use of the app "can improve your mental operations, performance, reaction times and alertness." Self-improvement through self-surveillance is a prime example of "the workings of neoliberal-biopower" in which the self is

seen as in need of constant correction through regimes of control and discipline made possible by the provision of "choice, empowerment, and a celebration of consumerism" (Chen 2010, 62–64). This logic is also present in Pillow's recommendations which provides tips, feedback, and personalized experiments so that users will be equipped to "make the right decisions to improve your sleep" while assuring customers that the benefits of a good nights' sleep will be "life-changing." This framing overlooks the labour and investment that is required for such an endeavour such that it becomes "the individual's moral responsibility to embody, practice, and ultimately *consume* healthist practices and ideologies," rather than the collective responsibility of communities or that of the State (via the social safety net) (Wiest, Andrews, and Giardina 2015, 22).

Sleep scores, offered by both apps, are even more explicit in their use of the self-improvement frame by providing users with an overall sleep score, improvement notifications, comparative analytics, and aspirational targets. SleepScore's promise of achieving and "maintain[ing] restful nights so that you feel better, look better, live better" is an essential part of self-improvement through a neoliberal lens. Tinkering with this "improved self," as one would do a machine, and doing so based on algorithmically sourced advice, is indicative of the exponential quantification of the self often referred to as the "algorithmic self" wherein algorithmic self-regulation and discipline is practiced in pursuit of ideal personhood (Pasquale 2015). On the other hand, there is the possibility that, having internalized neoliberalism, users of these apps are trying to find a way to reenchant their lifeworld and cultivate a sense of wonder through consumer delight and play (Berman 1981). While this argument is applicable as it relates to health apps that incorporate interactive gamification, it is perhaps not as salient as it relates to sleep apps which monitor its users in an unconscious state. However, this desire does speak to a felt desire to reimagine biological processes that have been alienated by capitalism by making them meaningful, even if it is through gadgets.

Pillow's claims of facilitating self-improvement through deep analytics and the ability to "synchronize securely all your sleep data … across your devices," situates these particular technologies of the self as one part in a larger technical and discursive ecosystem of tools aimed at facilitating personal progress and betterment. Remember that under neoliberalism, people are consistently encouraged to become "autonomous, choosing, self-managing and self-improving subjects who are reliable, responsible and accountable" (Gill and Donaghue 2016, 93). Sleep has become one in another line of everyday practices, inclusive of diet, maternity, and exercise, subject to this kind of instrumentalization.

These neoliberal frames of self-knowledge, authenticity, and self-optimization buttress the apps' objective of "induce[ing] an enterprising subjectivity" and "…increase[ing] [ones] capacity to make calculative choices" (Ong 2007, 6). This is accomplished through the use of

technology rather than via an analysis of the labour, economic, and political structures that might contribute to a lack of sleep.

Auto-ethnography: SleepScore and Pillow

My own experiences of the apps were largely ambivalent to negative. I found that I preferred the SleepScore app since it was easy to use – requiring nothing in the way of wires or sensors. I positioned it on my bedside table (using my iphone) which felt much less intrusive than Pillow which I experienced using a (borrowed) Apple Watch. While I only used each for a week, I did so with an eye towards my experience of the frames of self-knowledge, authenticity, and self-improvement. Using the SleepScore app, I received an overall sleep score of 86 on the first night and 82 on the second (the others were within the same range) which led to an internal, embodied desire to "improve." This was heightened by Pillow whose breakdown of the quality of sleep and audio recordings was much more granular and resulted in some time spent finding out if my score was "normal" and listening to the audio recordings for "anomalies."

Both apps made me feel somewhat superior upon learning that my sleep score was "above average" which resonates with the frame of self-knowledge and competitive self-awareness identified above. This made me want to "do better," to progress, to increase these stats, and thus to reach a more authentic or natural relationship with sleep. I found myself fluctuating on the "to what end" question – was it, like the apps said, to feel better, be healthier, and more productive? Or was it more in line with personalized neoliberal finetuning in pursuit of economic productivity?

Both apps also performed a relational familiarity that mitigated its remove as a technology. For SleepScore, this stood out in how it elicited detailed sleep goals while for Pillow it was the request to reflect on and record my mood when I got up in the middle of the night (it was just to go the bathroom, nothing that required intimate self-reflection). There was also an element of internalised abstraction I felt wherein in my "sleeping self" was packaged, quantified, and externalized in the form of statistics that I could examine, scrutinize, and reflect on upon waking. Like Elmer's data double (2003), the manipulability this engendered made me feel as though I was not really part of or related to these daily numbers or the reports I downloaded at the end of the week. This ethos of individual self-improvement and the pres sure to work towards this as a moral task connected with "good health" was palpable. The awareness that I was a transparent, readable person reducible to numbers was particularly off-putting and made me feel as though my agency could only be productively filtered through behavioural change. In this sense the technology, and its algorithms, were in charge and a wider more contextual consideration of *my life within a wider social world* were of little consequence. This made me consider my own socio-economic privilege reflected in my sleep stats and which were a product own general good health and access to healthcare as well as the fact that I live in house on a quiet street without the kinds of occupational stresses that might have lowered this number.

Overall, much of my experience of these two apps resonated with the frames identified by my application of CDA. I experienced, firsthand, the frames of self-knowledge, authenticity, and self-improvement as well that of technological and algorithmic agency that produced particular kinds of idealized subjectivities and emotional states. One thing I did not experience was the pleasure of self-tracking over and above my underlying fixation on perfection – which these apps intensified. I suggest that coupling the discursive study of sleep apps with a materialist approach opens up space for a more situated and relational analysis of human-tech interactions. Taken together, this brief auto-ethnographical addendum provides from the perspective of me, the researcher, an exegesis on how these apps work in practice. This experiential knowledge is important in that it taps "into unique personal experiences to illuminate those small spaces where understanding has not yet reached" in ways that are sociologically significant and deserve further study (Stahlke Wall 2016, 7).

In the next section I turn to a materialist critique. New materialism sees a focus on discourse as insufficient in its ability to provide a robust accounting of the impact of sleep apps on the self where the self is defined through the lens of relationality and interconnected networks. Through new materialism the traditional binaries of nature-culture, discourse-material, male-female are challenged. After offering analysis of sleep apps through new materialism, I close the essay with a discussion about the implications that new materialism could have in future research with respect to arguments around marginalization by exploring the intersections of gender, race, and childhood.

New materialism

In what follows, I explore some of the insights a materialist methodology reveals that a purely discursive or semiotic approach does not. With respect to mHealth apps and trackers like Pillow and SleepScore, according to Lupton, it is their "thing-power," inclusive of the experiences, affects, relations, and cultural imaginaries they cultivate, that is critical. I begin by unpacking the significance of an important neologism used in materialist thinking to discuss emergent interrelatedness before engaging in a few choice applications of this approach. It should be noted that this analysis is executed by describing sleep apps in a singular sense rather than focusing on particular products, since doing so would require an empirical study of app use, while also allowing for a commodious discussion of sleep trackers as performing objects with iterative properties that can be productively generalized.

The key neologisms that are most useful in applying a materialist method of analysis to the study of sleep trackers are Karen Barad's conception of intra-actions and agential cuts (Barad 2007). Intra-actions, similar to assemblages and networks – and drawing on agential realism (Fox and Alldred 2015; Van der Tuin and Dolphijn 2010), posits that the world is made up of material configurations

(inclusive of objects, discourses, laws, values etc.) that exist as inseparable components or apparatuses. These apparatuses are open-ended and "dynamic (re)configurings of the world, specific agential practices/intra actions/performances through which specific exclusionary boundaries are enacted" (Barad 2003, 816– 817). It is through agential intra-actions that elements of the apparatus (i. e. boundary properties) become meaningful. Scholars make deliberate agential cuts in order to render subject-objects intelligible and transparent enough for study. As Barad argues, "the world can never characterize itself in its entirety; it is only through different enactments of agential cuts, different differences, that it can come to know different aspects of 'itself '" (Barad 2003, 432). Applying this to sleep apps and trackers, the cuts I make and discuss below have to do with data doubles and algorithms, materially evoked user experience, and user agency.

Data doubles and algorithms

The affordances of sleep apps, while enforcing hierarchical relations of control, optimization, bodily manipulation, and perfectibility consistent with the neoliberal ethos of liberalization and responsibilization, also externalizes the body into veritable "data-doubles." The body, in all its vitality, becomes data by enactments elicited by the app itself. For Elmer, this means that,

The observed body is of a distinctly hybrid composition. First it is broken down by being abstracted from its territorial setting. It is then reassembled in different settings through a series of data flows. The result is a decorporealized body, a " data-double" of pure virtuality. (Elmer 2003, 611)

Sleep apps accomplish this out of what has heretofore been seen as a liminal space inaccessible to this kind of manipulation. This is particularly the case with respect to the kinds of granular manipulations required of neoliberalism apart from the tinkering of routines or the corporate deification of non-sleep (i. e. the "I'll sleep when I'm dead" mantra of the business elite). Rather, the app, in conjunction with the body, co-produces a surveillant cyberbody which is intended to "encourage the user's body to act in certain ways" (Lupton 2012, 237). Questions related to who has access to these technologies? (the affluent? the educated? the abled?), how is this information used? (for health? efficiency?), who has access to its out- puts? (employers? insurance companies? corporations?), and is how the informational body categorized (is the sorted and extrapolated in ways that further gender, racialize, and stigmatize?) have to be answered. As it stands, both apps analyzed in this article (Pillow and SleepScore) are programmed to facilitate and engender the kinds of neoliberal subjectivities set out in the earlier part of the piece.

In concrete terms, and using a materialist lens, this means that the configuration of these apps – down to their algorithms as they interact with other objects, discourses, and institutions – permits the tracker to exert agency on the physical body in ways that transform our understanding of the body as an object that is readable, transparent,

passive, and something to be controlled. It also engenders a relation to sleep in which rest is filtered through the lens of science and expertise. This is accomplished "through the 'objectivity' of numbers and the codification and routinization of algorithms – into clear-cut, 'reified', 'scientific' diagnosis" (Fullagar, Richand, and Francombe-Webb 2017, 135). For a fully materialist analysis, it would be useful to perform a study of these algorithms by tracing how information moves, forms, and is understood over time; monitoring the entanglements of expert knowledge, embodied experience, and technical affordances in situ; and accounting for the intra-actions between Big Data, small data, and institutional priorities (Sharon and Zandbergen 2017).

User experience and user agency

A further level of materialist analysis, requiring extensive empirical and/or ethnographic work, would engage in a detailed study of the experiences of users themselves. Similar work has been done in relation to mHealth (Lupton 2019; Nygren, Olofsson, and Öhman 2020), and mental health technologies (Trnka 2016). For example, Fullagar, Richand, and Francombe-Webb perform a materialist-ethnographic analysis of how mental health tracking apps, together with institutional knowledge, public policy, medications, and regimes of authority, "mediate how young people articulate their experiences of distress via categories of depression, anxiety, disordered eating etc." (Fullagar, Richand, and Francombe-Webb 2017, 99).

Questions related to how sleep apps and trackers change behaviours, exert norms, and reify values like efficiency, control, and manipulation are essential, as is how they make users feel with respect to privacy (particularly with those that require the phone to be placed under a pillow), as well how they might elicit feelings of shame, guilt, self-doubt, and stress if sleep goals are not met or behaviours do not change as the technology asserts they should (Boyd 2008). Addressing issues of intrusiveness, feelings of failure, and the implications of a device that aims to determine bodily patterns and behaviours traditionally thought of as intuitive require further study.

However, one of the most important contributions of new materialism is that it makes room for the reconfiguration of the "affect economy" in which technological affordances and forces, coupled with human agential desire, power, and resistance (and moderated by structural and contextual factors), are able to excite user resistance and subversion (Clough 2004). Studies of the users of other kinds of technologies inclusive of, but not limited to, health apps and trackers have found innovative ways in which customers have challenged the technology's intended uses. This includes, for example, the democratic appropriation of the Internet by academics, the open source movement, and political activist communities (Feenberg and Friesen 2012; Lessig 1998). With respect to apps, recent research suggests a variety of ways in which the neoliberal discourses and material constraints of digital trackers can be subverted. This includes

the cultivation of forms of synchronous and asynchronous community that, allows users to share, connect, discuss, vent, and get support from others; fosters forms of self-care; exerts power over aspects of everyday life that might feel unmanageable; and encourages the "enjoyment, fun, and ludic aspects of self-tracking" (Gimpel, Nißen, and Görlitz 2013). With regard to sleep apps, the empowerment and pleasure that might be elicited from sharing, the soothing promise of a solution to sleep disruption, and the pleasures associated with manipulating the numbers, data, and visual information via health app gamification are fundamental (Thomas and Lupton 2015).

As such, and taken together, this layered analysis of sleep apps using CDA and new materialism reveals, first, how the ideological force of neoliberal frames like self-understanding, authenticity, and self-improvement, which construct subjectivities and behaviours in line with "the flexible individual who acts responsibly in relation to the market and who is valued in market terms," works to fulfil larger objectives under capitalism (Davies et al. 2005, 347). Second, this framework also highlights how a materialist approach that attends to the often overlooked force and inter-relatedness of matter, technologies, objects, and things can be "cut" in a myriad of different ways resulting in new opportunities for engagement. The cuts I have made with respect to data-doubles and algorithms as well as user experience and agency are only two such examples.

Conclusion

In concluding this piece, I want to leave readers with a vigorous call for subsequent analyses of sleep apps and related technologies to include race, gender, and childhood as central categories of analysis. Traditionally, the granular analysis of subject positions are left out of studies of this sort – particularly with respect to how neoliberal subjectification, the profit motive, and processes of dataveillance work to exacerbate material, social, and cultural inequalities on a micro level.

The implications of the biopolitical regulation of sleep via trackers like SleepScore and Pillow on racialized communities, gendered minorities, and the intersectionally marginalized (inclusive of children and those who identify as fat), need to be centred in future quantitative and qualitative research. With respect to race and gender, focus needs to be on the impact of collected data coupled with, for example, research demonstrating that women and racialized communities suffer from less sleep and more sleep-related disorders than white men (Fuller-Rowell et al 2017; Mai, Jacobs, and Schieman 2019).

Access to health care, education, stable employment, a clean environment, and healthy food, in addition to the impact of misogyny and structural racism, need to be a central part of accounting for these disparities, as does a robust discussion of how investment in apps and trackers might discourage the further study of socio-economic, labour-

related, and environmental factors that give rise to these inequalities in the first place.

Moreover, forthcoming studies on sleep trackers must also engage in the study of their material impact on public health systems in order to obviate the danger that they might function to prise open a new locus of inequality wherein action on health is relegated solely to individuals rather than being addressed as a collective action (Grandner et al. 2010). Additionally, it is important to point out the significance of these technologies as they extend to more vulnerable demographics like children. Lack of sleep, primarily as a result of caffeine intake and technology use, have been correlated to behavioural difficulties, asthma, and a host of other pathologies amongst children of which childhood obesity is given primacy in much of the medical literature (Calamaro et al. 2012; Aparicio et al. 2016). The moral panic around childhood obesity inculcated by the media has produced an easily exploitable discourse deployed by companies selling sleep apps for kids (Patel, Kim, and Brooks 2017). Sleep apps might thus not only open the door for major profits to be accumulated through advertising, data collection, and medicalization, beginning at the earliest stages of life, but also play into and perpetuate dangerous forms of discrimination, disordered eating, healthism, and ableism (Webster 2019; Bitman and John 2019).

Taken together, this analysis provides a discursive, materialist, and autoethnographic study of sleep apps which I contend are part in parcel of a long line of subjectifying health and wellness technologies that are programmed to encourage the adoption of neoliberal behaviours and ideologies. Significantly, I have performed this analysis so that material agency and entanglement is also realized and avenues for material re-articulations are left open. Sleep, until recently, has been under-researched in this particular way with the majority of analysis concentrating on health, wellness, and diet. Because we spend decades of our life asleep – the appification of such an important area of our lives deserves further study using methods that are not only material-discursive, but also attend to the structural and felt inequalities of marginalized groups and individuals.

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