

Beyond the Debate on Promises and Risks in Digital Health: Analysing the Psychological Function of Wearable Devices

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Abstract

In the past years, the recording and collection of physical and physiological data from the body through wearable devices has become an increasingly common health-related practice in contemporary Western societies. The rapid development of digital self-tracking technologies has given rise to the production of different scientific discourses. The analysis of 200 published articles has led to the definition of a continuum between “technophile-promises” and “technocritical-risks” representations. However, these representations include different views of corporeality and sociality. Beyond this debate, we propose an alternative theoretical framework that links corporeality and sociality. It interrogates the psychological function that wearable devices may take (or not) for subjects to which these “tools” are addressed. We argue that such psychological function must be embraced by taking into consideration of activity done by the users of these technologies, which engages meaning: It is not the device, but the user him/herself who is confronted to the interpretation of biometric data linked to his/her own body functions on the basis of concrete lived experience. Moreover, we discuss that the activity of users can only be analysed in the sociocultural context to which the associated practices relate (health, sports, play, medicalisation). The conclusion highlights the need to further study the appropriation process of new personal experimentation instruments as to better understand the potential collaborations, risks or resistances that users may develop.

Keywords: quantified self, e-health, m-health, quantified body, self-tracking, self-monitoring, wearable devices, digital health

1. Introduction

By the mid-2000s, Internet accessibility and, more recently, the mainstreaming of mobile phone applications, fostered the rapid evolution of digital health technologies used to measure indicators linked to body conditions. Since 2010, the process of self-monitoring health activity has spread significantly to improve the management of certain chronic diseases, but also among pit-run motivated, interested or simply curious individuals. To date, there are more than 100,000 applications, including more than 30,000 developed in the health and medical information field, both by Apple Store and Google Play (Jahns, 2014; Lupton, 2015; Payne, Lister, West, & Bernhardt, 2015).

Most of these technologies involve Internet-connected wearable devices (e.g., smartwatches, wristbands, smartwatches, biomonitors, etc.) that provide advanced functionality, typically via a smartphone. The use promoted by developers is supposed to help users follow, monitor and even control their own behaviour and body, and with this, their health (Swan, 2013). To do this, devices have increasingly powerful sensors to collect physical and physiological data from the body, almost automatically and without any effort from users. Various related functions can now be “captured”, such as: number of steps, number of calories consumed, oxygen level and breathing rate, blood pressure and weight. These indicators are quantified and later classified according to scales developed by the promoters of these technologies, targeting different consumer audiences. The data collected can then be shared online within communities or social networks with other people. Moreover, these wearable devices give users feedback on the body condition measured and the level of performance compared to that of others. The sharable and retroactive nature of these applications is an unprecedented core dimension that takes the form of an “interactive loop” not only between users, but also between users and application developers. In fact, the latter can gather quantified information among any user (Swan, 2013). Indeed, the exchange of data

on private practices (e.g., sleep, nutrition, sexual activity, physical activity), closely linked to the proliferation of health applications on phones, constitutes a new social practice, promoted by key stakeholders through their advertisement. This component foreshadows potential increased sharing of biometric measures to the public health field.

Generally speaking, and regardless of the types of applications, digital health technologies follow two specific guidelines: one is the “screening of body conditions” of users and their quantification through a number of variables regarding their individual practices. This guideline mobilises a particular view of *corporeality*. The other one, which remains “optional” as of yet, includes a significant *social aspect* through the introduction of a collective level, where biometric data are compared and shared with other social networks. This collective dimension is mostly made through the confrontation of averages of other users, thus conveying a specific view of *sociality* (Ranck, 2012).

The purpose of this article is to analyse representations of corporeality and sociality conveyed in scientific literature (Santiago-Delefosse, 2011, 2015) in the specific field of digital health. Beyond these representations, we propose an alternative theoretical framework to study the link between corporeality and sociality. It thus also interrogates a third entity: the psychological one. In other words, we explore the potential psychological functions which could take these “new” digital health devices produced within the current biotechnological culture and under what conditions. The first section of the article briefly describes the methodological approach used. The second part outlines the results of this analysis of the representations in the literature of the last few years. It highlights a continuum between “technophile” and “technocritical” representations. The first group is characterised by its certainty that the promises accompanying wearable devices will be kept and profit the future of humanity. The second group of representations, more heterogeneous, is characterised by a critical look that questions the socio-economic implications of these technologies. This criticism can lead to “techno-scepticism”, or a warning against the risks of data manipulation and widespread surveillance. The third section questions the possible “psychological function(s)” of these wearable devices as they are at crossroads between “technical tools” and “self-transformation tools”. We hence conclude on the need to study the psychological stance of the uses and to analyse the psychological contributions, and obstacles or risks, linked to these uses.

2. Method

We conducted a bibliographical research on the scientific literature published in the field of digital health between the turn of the 21st century, when the first articles were published on the topic, and 2015, the year during which we conducted our study. During the months of September and October 2015, we searched databases that were representative of scientific research in psychology, human sciences and health sciences: PsychInfo, Web of Science, Science Direct. More generally, we used Google Scholar after having identified digital health professional journals. The keywords used as part of the searches were: quantified self, e-health, m-health, quantified body, self-tracking, self-monitoring, wearables and digital health, as well as: santé digitale, objets connectés and corps connecté.

Our analysis corpus was built on the basis of the following inclusion criteria: a) published in a recognised journal and subject to a peer evaluation; b) article in English or French, c) theoretical and/or empirical research on wearable devices, mobile applications and/or their uses. In all, 200 articles were selected, stemming from social and human sciences: sociology, anthropology, psychology, education sciences, information and communication sciences, and philosophy; or other fields: medicine, public health, nursing sciences, and engineering and technology design.

The articles selected were sorted by discipline and publication date. A thematic content analysis was conducted by three authors from this study. This analysis helped to identify a number of representations conveyed by these articles in each discipline, as well as their evolution over time. This analytical approach was applied while taking into account the problem raised by each selected article, its methodology, results and conclusions. The analyses conducted by each researcher were then the subject of consensus among the group composed of the four authors of this study.

3. Results: Continuum between “Technophile” and “Technocritical” Representations

The thematic content analysis enabled us to identify two major trends regarding promises in the digital health field: the first one fosters the use of wearable devices in an almost unconditional way and the second one takes a more critical stand. Within each trend we then identified representations dealing, on the one hand, with specific conceptions of corporeality, apparently defined by a biomedical view of the body, and on the other hand, with specific conceptions of sociality, mainly considered in terms of competitive relationships (that can be more or less “friendly”).

3.1 Representations That Foster the Use of Wearable Devices for Health Monitoring

A major part of the articles that were analysed reflect the underlying “hope” of improving the health and well-being of individuals through the incorporation of digital health technologies in daily life. As part of this trend, the ultimate goal is self-improvement by a better understanding of one’s body through physiological measurements. This quantification is deemed to become more successful than perception, introspection or language, because it is supposed to be less subjective than the latter (Gicquel & Guyot, 2015). Wearable devices would provide the benefit of an objective measurement, having become the topic of an internal debate on the validity and precision of these measurements.

First, generally speaking, this trend of “technophile representations” is based on one of the main concerns of contemporary societies: health improvement. To do this, they put forward a specific conception of health promotion. According to these representations, better health could be obtained through the educational virtues fostered by wearable sensor-based systems to screen and monitor body conditions. Many applied studies examine various patient populations and different types of conditions. Most of them focus on improving the management of chronic diseases by using wearable devices to monitor them (Note 1). This part of the literature insists on the gain of connected practices compared to the more traditional “pen and paper” type disease monitoring practices. Pre-existing practices are thus transposed to more electronic behavioural follow-ups. Although medical uses lead to expected behaviour changes among patients, the recommendations also deal with, to a lesser extent, promoting the health of healthy lay people. Regardless the case, the project seems to remain the same: that of hoping for a positive impact on the efficiency of existing health programs, and a sustainable change to individual health behaviours (Swan, 2009, 2012, 2013). This trend of representations conveys the idea that the measurements related to wearable devices enable and enhance behavioural change.

Given that these objectives are linked to body-condition measurements, they lead to specific representations of corporeality. In this respect, the indicators selected depend on the possibilities of the technique, so indicators are reduced to physiological signs (e.g., heart rate, electro-dermal response, etc.). Other than the issue of the measurement accuracy, the meanings given to these indicators are rarely straightforward and stable, as they emerge from the context where the measuring process takes place. Out of this context, it is indeed very difficult to ascribe causal links between measurement and behaviour. Yet, the representations of corporeality identified in our corpus of articles seldom seem to take into account the context, nor definitions about corporeality and related psychological implications. The body is designed as a machine with a set of information that can be modified by changing one’s behavioural programming.

While there seems to be a certain acknowledgement of the context across technophile representations, it seems defined by the network of social ties determined by the wearable technology. Therefore, in terms of sociality, technophile representations foster the systematic sharing of biometric data collected. Many authors examine this data sharing on social networks, online communities and discussion forums on sites such as *Patients Like Me* or *Cure Together* (Salamati & Pasek, 2014). Exchanges between users, either cooperatively, but more often competitively or comparatively, are fostered to influence behavioural changes in a positive way (Chib, 2013; Donner & Mechael, 2012; Kaplan & Stone, 2013; Kratzke & Cox, 2012).

Technophile representations mainly focus on behavioural changes by linking the concept of self-tracking to that of individual empowerment. Wearable devices are presented as preferred tools for better self-monitoring, whether it is chosen in the health promotion field, or rather incurred in the case of a chronic disease needing monitoring. Nevertheless, in both cases, the focus is on the positive value placed on the individual aspect of control. These devices are deemed to improve the patient’s empowerment by fostering better compliance with treatment (Dennison, Morrison, Conway, & Yardley, 2013; Samoocha, Bruinvels, Elbers, Anema, & van der Beek, 2010; Yardley, Ainsworth, Arden-Close, & Muller, 2015a).

Paired with the high hopes linked to the promises of well-being and disease treatment through self-tracking, this group of representations also contains an affirmation of the potential of wearable devices to reduce health costs at a social level (Note 2).

It is interesting to note that a certain number of beliefs are conveyed by these technophile representations. First, there is the belief in long-term health behaviour changes at the individual level. Although psychologists are aware of the well-known obstacles to these changes in the health field (Dennison, Morrison, Conway, & Yardley, 2013; Yardley et al., 2015a), they still hope that wearable devices will be the sought-after solution to this problem. Second, there is a belief in the ongoing interest and sustainable motivation of individuals, while it has been shown that the latter actually get bored with wearable devices rather quickly (Ledger & McCaffrey, 2014; Gadenne, 2014). Finally, there is a belief in the passivity of users toward a certain standardization of behaviours.

Yet, this belief minimises the subjective ability to develop forms of individual and/or collective resistance to the attempt to standardise health conducts.

Furthermore, this mainstream hardly mobilises any representations that question the potential psychological implications resulting from the use of digital health technologies. For example, such representations are scarcely permeable to the possibility of an increase in health costs rather than a reduction, through an increase in medical consultations and cases of hypochondria for instance. Also, the literature does not take into account the possible cost linked to disorders stemming from the primacy of the comparative approach, for example psychological consequences among more fragile populations such as teenagers. The reduction made through the simplification of health or disease through quantification within technophile representations makes it difficult to interrogate the complexity of the corporeality experienced, the consequences in sociality of being reduced to comparative human ties or finally, the psychological processes involved.

3.2 Representations That Are More Critical toward Promises

Alongside technophile representations, there is a smaller movement that distances itself from the mainstream trend. This group of representations, especially present in sociology, anthropology and philosophy, can be defined by a critical attitude toward the widespread promotion of wearable devices to monitor health and illness. This group of representations, although non-homogenous, is presented as a “mirror” that questions technophile representations. These “technocritical representations” interrogate socio-political issues introduced by the use of wearable devices, as well as the consequences of this technology on the definitions of health, disease and well-being. This critical look is mobilised via notions of: monitoring, surveillance, healthism, and empowerment.

Technocritical representations question the absence of a unified psychosocial theory that is likely to guide developments in digital health to bring about an efficient behavioural change (Yardley et al., 2015a; Yardley, Morrison, Bradbury, & Muller, 2015b). In the absence of a complete theoretical model on human experience and human conduct, technophile representations tend to reduce the complexity affecting corporeality, sociality and subjectivity, according to certain authors (Rice & Katz, 2001; Yardley et al., 2015a, 2015b). Similarly, the practical and material aspects, linked to ethical issues, are slowly becoming the subject of research efforts in the field of wearable devices: their funding, accessibility, long-term management and underuse or the reliability of the data (Becker, Miron-Shatz, Schumacher, Krocza, Diamantidis, & Albrecht, 2014; Byrne, 2014; Ranck, 2012; van Velsen, Beaujean, & van Gemert-Pijnen, 2013).

Another major group of critical issues concerns representations dealing with the monitoring of populations. Self-tracking practices are analysed as part of biopowers (Foucault, 2004a, 2004b) involving political objectives to discipline individuals and bodies (Beer, 2009; Casper & Morrison, 2010; Cheney-Lippold, 2011; Mort, Finch, & May, 2009; Nettleton, 2004). Empowerment stemming from technophile literature has thus been strongly questioned. Following these authors, the concept of empowerment cannot be reduced to an individual conception of self-control for normative purposes, imposed by the objectives of health policies. Such definition would lead to the ideological policy of healthism, imposing standardised lifestyles to promote health as a common and universal good (Buse, 2010; Crawford, 2006; Crawford, Lingel, & Karppi, 2015; Maturó, 2014).

Moreover, technocritical representations include a distrust of the individualistic culture fostered by technophiles, as it may lead to the normalization of life (Besnier, 2012; Buin, 2003; Rouvroy, 2014). “Good health” defined by the internalization of prevention messages would lead to a simplistic definition of life and human practices. Self-tracking health behaviours valuing performance and efficiency would largely contribute to such normalization. Thus, technocritical representations are opposed to the technophile vision according to which the individual is solely responsible for his health, at the expense of a more community-based and global vision and a contextualised conception of health (Pharabod et al., 2013).

At present, the theoretical framework that best articulates these various issues is proposed by Lupton (2012, 2013a, 2013b, 2014a, 2014b, 2015) who criticises the lack of distance regarding the ways in which digital health technologies are mobilised in mainstream literature (technophile). She problematises the human being as a “man-machine” (cyborg) in relation to such devices, which give rise to unprecedented modifications of corporeality and sociality. In terms of corporeality, quantifying bodily functions would lead to a new set of reference values linked to the production of biometric data, where the standard would be defined by algorithms, arbitrarily and vaguely. Defining wearable devices as technological extensions of the body stresses the blurring of boundaries between the technique of a quantified body and that of a lived human body (Freund, 2004; Lupton, 1995, 2013a, 2014; Kapitan, 2009). Within this framework, users of these technologies become actors who are caught in complex power relationships (Mort & Smith, 2009; Rich & Miah, 2009; Casper & Morrison, 2010).

To conclude our literature analysis and further study the implications related the digital health phenomenon, we believe that it is extremely important to examine the existing literature and to interrogate technophile and technocritical representations. To do this, we suggest to consider underlying beliefs and technoscientific promises: it is true that on the one hand, technophile representations begin to include more moderate statements where accessibility of these technologies and confidentiality and reliability of data are being questioned (Barcena, Wueest, & Lau, 2014; Eysenbach, 2001). Nevertheless, their representations tend to show a consistent proselytism to encourage users, since authors seem convinced of the potential of such devices to improve health. On the other hand, we note that the most critical representations, despite the reluctance voiced, also seem to support the belief according to which digital technologies constitute a true “revolution” to improve health, with feared consequences and risks. Thereofre, our literature review suggests that both trends adhere to the promises made by promoters of health-related mobile digital technologies. In both identified trends, the latter represent unprecedented body and self-control devices in the health field, either to bring about behavioural changes for health improvement, or to monitor and discipline individuals, giving rise to societal risks of surveillance, “normopathy”, and over-responsabilisation of individuals to the detriment of institutional forms of health care.

Yet opposed to one another, both identified trends refer to a same mirror image: the technocritical representations question the basis of technophile enthusiastic beliefs, and question the “negative” aspects of digital health technologies. Yet, little work has examined the concrete scope of these promises and their robustness: is what is promised achievable, and to what extent, in addition to questioning what is desirable or needed by different populations or communities. Beyond the promises, it becomes necessary to focus mainly on the “subjects” to which they are addressed (Audétat, 2015) and the reasons underlying their acts (or not). This is why it has become imperative to move beyond the existing debate. We intend to introduce an alternate way of considering wearable devices, from the standpoint of their psychological function(s) to subjects who accept, buy and use them, and to those who resist to adopt them. We suggest to envisage these devices simply as tools invented by human civilisation to make lives easier (or more complicated).

4. Discussion: Beyond Technophilia and Technocritical Discourses in Digital Health, the Psychological Function of Wearable Devices

Through their operating methods, digital health technologies seek to externalise body and physiological states to observe, monitor and even control them. Data produced can be shared and compared to standards generated by algorithms. Yet, such an externalisation of body functions corresponds to a particular version of corporeality which does not succeed to provide the acces to subjectivity and experience. On the contrary, it gives simplified information based on numerical criteria defined by engineers and designers. Behind these indicators underlies a specific vision of corporeality, and consequently of health, reduced to these measurements. Thus, it can be argued that while wearable devices work by quantifying physiological and physical functions, it is not the device but rather the user him/herself, who is confronted to the interpretation of such data. Furthermore, this interpretation is undertaken according to his/her own lived experience and in a specific sociocultural and historical context. Aside from the return of the social aspect through the feedback loop that digital technologies allow, it is according to the meaning given by each user that the latter will respond or take a given action (or not). Faced with the biometric data collected, the subject adopts a specific and singular use of wearable devices, based on emotional and affective tones, depending on the specific living environments in which he evolves and his culture, personal history and life course. To better understand the digital health “phenomenon”, it therefore becomes essential to understand what special psychological function(s) they may play in our contemporary Western culture. To do so, we consider a historical and cultural perspective of wearable devices as psychological instruments (Note 3).

Following Vygotsky (1930, 1986), psychological instruments are a mediation between the individual and the world. Their nature is neither organic nor individual, but rather societal. They are “artificial developments” that make up complex systems mobilising various sets of signs. Furthermore, psychological instruments are used to manage and control processes regarding one’s own behaviour or that of others, just like the technique is used to control processes of nature (Rabardel, 1999; Rivière, 1990; Wertch, 1985). The most prominent examples of this specific type of tool are: language, art, mathematics, mnemonic means, etc. (Vygotsky, 1930, 1986).

Yet, it seems to us that wearable devices are destined, by their promoters, to control processes of one’s own behaviour or that of others (increased activity, change in eating habits, control of different physiological indicators, exchanges and comparisons on social networks, etc.). On these bases, we question whether these devices can be considered psychological instruments, and if so, under what conditions. Indeed, this is how many designers and promoters present them to us: they must change the way in which psychic functions are carried out (during the course of a given activity, the individual stops to control a physiological indicator, or analyses his/her

activity in a differed mode) and create a new instrumental act on this basis (for instance, change the behaviour according to the interpretation of such measurement).

The representations highlighted in our analysis, however, seem to generate confusion in terms of their underlying perspectives, confusion that is not without consequences. It concerns two notions that should be distinguished: the “technical tool” and “psychological instrument”. The technical tool is an intermediate component between human activity and an external object; the individual can act on the world by working on this object with the help of a tool (through an action on the physical world). On the other hand, the psychological instrument acts as a mediator aimed at both, behaviour and the psyche; psychological instruments allow the individual to act on his/her own transformation, but also on the psychology and behaviours of others (an action that is conducted upon psychological and behavioural processes) (Vygotsky, 1930, 1986).

We believe that this distinction is useful to better grasp the ways in which wearable devices have been problematised so far. In scientific literature, this device is presented as a technical tool, but whose goal would be to change an internal stance: the body and/or behaviour. It seems that this process takes place through an activity defined by “the work” done by the user: number of steps, exercise, etc. Nevertheless, if the goal is to change an internal process (behaviour), the device is no longer a mere technical tool, unless the body and behaviour are perceived as physical objects that are “external” to the user. With no distinction made between the two types of tools (technical vs. psychological), there is a great deal of confusion in the analysis of the functions of these objects.

As psychologists, we would be wrong to consider these objects as technical tools “only” (that need to be approved or criticised). In fact, these objects do not enable direct change. They are designed with the intent to influence the psyche and behaviour by using the “measurement” as a mediator that can bring about a specific change in behaviour (or not). Their use is expressed by an instrumental act by the user through a given activity mobilising the wearable device, activity which the individual carries out within him/herself (through thought, will, or representation), and not on his body as an “object” that is external to him. As underlined by Vygotsky (1930, p. 43): “As part of the instrumental act, man controls himself from the outside, using psychological instruments”. It would thus be necessary to study wearable devices as special forms of the instrumental act to better understand their psychological specificity (Santiago-Delefosse, 2004). These acts stem from historical and human development. Controlling psychological instruments may transform the operating methods and structure of superior psychic functions. This process raises a given function (observable behaviour, for example) to a higher level (changing what has been experienced, for example) and enhances the ability to act (Wertch, 1985; Vygotsky, 1986, 1999). Therefore, a new thought structure and mechanism can be integrated.

This is why the study of wearable devices is of main interest. Yet, existing research has overlooked the study of changes in relationships that the subject may develop with regard to the device, or the conflicting thoughts that its use may entail. Also, until now, little attention has been given to the meaning given to the data collected, the interest in sharing data and the constituents of this sharing mode. This type of research would namely help to better understand an observation made by a number of designers: the rapid weariness of users toward these devices. More than 40% of users no longer use them passed a trial period of approximately 3 to 6 months (Beatty, Fukuoka, & Whooley, 2013; Dennison et al., 2013). This abandonment can indicate the object’s return to the state of technical object, “with no psychological value added”, which may thus put most technophile hopes and technocritical fears into perspective.

We feel that the activity of wearable device users can only be analysed in the sociocultural context to which their practices relate: sports, play, medicalisation, etc. Their psychological functions seem inseparable from the latter: fun, preventive, curative. The meaning of the users’ activity also depends on the stakeholders participating in this context. At this time, these are engineers who make wearable devices, the insurers and the medical world that propose incentives. Within these major actors from the political and economical world, it is important to analyse how “subject users” will collaborate, resist, divert and act on the rules or grow weary. A study on wearable devices that only takes into account behavioural change seems reductive. Human activity must be considered in relation to a more complex system in which the sequence of actions takes on meaning and not in a way that is focused solely on observable behaviour.

With wearable devices thus emerge a new field of study in social and human sciences. This new phenomenon will help to better understand the development and integration of new psychological instruments, via the historical experience (transmission of information), social experience (sharing with others) and redoubled experience (form of creative adaptation to these new devices). This is how we interpret the (relative) interest of a number of subject users. Far from being just a “passion for the quantitative evaluation of oneself”, the goal is to

better understand this appropriation of new personal experimentation instruments and their psychological function(s).

5. Conclusion

Our analysis of 200 scientific literature articles on wearable devices used to screen body conditions revealed two major sets of representations. One contains technophile representations fostering the use of these devices and promising improvements in health promotion, wellbeing, and disease monitoring. The other, a minority in our corpus, contains technocritical representations that mostly deal with reflections on the possible negative social, economic and ethical impacts of digital health technology uses. These two representation trends share a common characteristic: their adherence to biotechnological promises, either to promote them or to be concerned about them. As of yet, little interest has been shown in the real uses and the particular psychological function(s) that these devices may acquire for users. Similarly, few avenues provide a way out of the biotechnological design of human beings reflected by the designers' program, which leads to human-machine criticism. But do users accept this design and how do they perceive it, how do they create alternative uses of this tool, etc.

Our theoretical and epistemological positioning differs from the literature analysed. We assert that current research only rarely questions the bases underlying the operational methods and uses of wearable devices aimed at screening body conditions. The relationship between the user and the data produced and collected, in the subjective meanings assigned to it, or, to the way in which this data can be transformed into self-action, remain very little known, given the limited empirical research currently available (Lupton, 2014b).

This is why future research could study the psychological implications of digital health technologies examined as objects provided by civilization, and that could very well remain "technical tools" instead of becoming "psychological instruments". This status remains to be determined according to users, contexts and moments of life. Our future questioning will concern the role and functions of wearable devices in relation to their concrete uses and will try to move beyond the debate between the two major representation groups identified. Inseparable from social and cultural repercussions for digital health, it is essential to study the psychological functions of these devices. This study must be closely linked to subjective health and disease theories that users co-construct within tensions between corporeality and sociality. Given that individuals are always embedded in a specific social and historical context, the thorough analysis of the conditions giving rise to the psychological functions of these devices is also necessary.

By carefully examining the mirror promises within scientific debates, we propose to shift to an alternative theoretical perspective in order to look at how users actually use these devices: what meanings are ascribed to these technologies, what meanings are given to their actions or what uses will subjects develop, create or curb. In this perspective, no device or related application is provided with intentional actions capable of giving meaning to these measurements, regardless of their performance level. This is a similar observation as the one made by Searle (1980, p. 417) regarding artificial intelligence (AI) (Note 4):

"Could a machine think?" On the argument advanced here only a machine could think, and only very special kinds of machines, namely brains and machines with internal causal powers equivalent to those of brains. And that is why strong AI has little to tell us about thinking, since it is not about machines but about programs, and no program by itself is sufficient for thinking.

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Notes

Note 1. Existing research has looked at diabetes (Cafazzo, Casselman, Hamming, Katzman, & Palmert, 2012; Katz, Mesfin, & Barr, 2012; Quinn, Shardell, Terrin, Barr, Ballew, & Gruber-Baldini, 2011), cardiovascular diseases (Smith, Menon, Rajeev, Feinberg, Kumar, & Banerjee, 2015), genetic diseases (Tozzi, Carloni, Gesualdo, Russo, & Raponi, 2015), tuberculosis (Belknap, Weis, Brookens, Au-Yeung, Moon, DiCarlo, & Reves, 2013), Chronic Obstructive Pulmonary Disease (COPD) (Moy, Weston, Wilson, Hess, & Richardson, 2012; Williams, Rutter, Christy, Tarassenko, & Farmer, 2013), mental disorders (Kane, Perlis, Di Carlo, Au-Yeung, Duong, & Petrides, 2013; Naslund, Aschbrenner, Barre, & Bartels, 2015) and obesity (Burke et al., 2011).

Note 2. For example: Appelboom, LoPresti, Reginster, Connolly, & Dumont, 2014; Barrett, Humblet, Hiatt, & Adler, 2013; Becker et al., 2014; Byrne, 2014; Chiauzzi, Rodarte, & DasMahapatra, 2015; Handel, 2011; Kumar et al., 2013; Labrique, Vasudevan, Chang, & Mehl, 2013; Neuhauser & Kreps, 2003; Norris, Stockdale, & Sharma, 2009; Payne, Lister, West, & Bernhardt, 2015; Riley et al., 2011; van Velsen, Beaujean, & van Gemert-Pijnen, 2013.

Note 3. We propose a theoretical historical and cultural framework (Vygotsky, 1986, 1999; Engeström, Miettinen, & Punamäki, 1997) that helps to study wearable devices according to their material and concrete dimension within specific contexts, by bringing them back to what they are: objects designed by the civilisation and culture. This framework looks at the developing man, anchored in his daily life. It defines human activity as always being publicized and established in a historical, cultural and social context (Wertsch, 1985). Activity is therefore both individual and collective. It is always geared toward devices, in other words, publicized by artefacts such as signs, tools and instruments, provided by culture (Cole & Engeström, 1993).

Note 4. AI and the debate that followed seems paradigmatic of the promises made about the capacities of new technologies and the big data.

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