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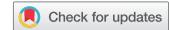
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RESEARCH PAPER



Technologies of the self in public health: insights from public deliberations on cognitive and behavioural enhancement

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ABSTRACT

The aim of this paper is to examine how members of the public define the legitimacy of cognitive and behavioural enhancement. Our study involved a two-step multimedia-based deliberative intervention in which participants of different age groups pondered the desirability of a fictional enhancement technology: a sweater made of 'smart' textiles that provide 'bio-psycho-feedback' (PBF) to its user. A 3-min video clip presenting the fictional technology was used to stimulate deliberations in four face-to-face workshops ($n = 38$). A larger group of participants ($n = 57$) then discussed, in an online forum, two short stories illustrating dilemmas raised by the PBF sweater. Qualitative analysis of transcripts of the workshops and the forum identified patterns of moral argumentation in the reasoning processes by which participants challenge the PBF sweater's legitimacy: (1) when a shift in purpose occurs – from therapeutic to enhancement – and (2) when it engenders a shift in the user's sense of self – from an autonomous self to a socially coerced individual. These findings add nuance to current knowledge on public perceptions of cognitive and behavioural enhancement, providing insight into the ways that people conceive of the tension between autonomy and social coercion.

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Public health ethics; responsibility; public deliberations; health innovation; prospective analyses; online forum; qualitative research

Human enhancement and public health

Human enhancement refers to the use of health products, medical procedures or technologies by healthy individuals to improve an attribute or ability (Evans-Brown, McVeigh, Perkins, & Bellis, 2012). In its *Health futures* horizon scanning report, the United Kingdom North West Public Health Observatory described enhancement practices as an 'emerging threat to health' (Evans-Brown et al., 2012, p. 16). Public health concerns include not only physiological, social and psychological harms, but also the more or less subtle moral changes that unfold over time and which render the use of certain enhancement technologies less reprehensible, i.e. normalized. In the past decades, ethics scholars have indeed called on public health practitioners and researchers to pay greater attention to the illicit and/or non-therapeutic use of pharmaceuticals by teenagers and young adults who wish to improve their cognitive functions, mood or social behaviours (Bell, Partridge, Lucke, & Hall, 2013; Lucke & Partridge, 2013; Outram & Racine, 2011; Racine, Waldman, Rosenberg, & Illes, 2010). In a similar vein, several wearable devices that 'collect data on one's bodily functions and everyday activities' (Lupton, 2013, p. 394) are

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now marketed directly to consumers in order to support or encourage a similar form of 'self-betterment' (Millington, 2016). The ease with which a growing number of people access such technologies and the sociocultural value attributed to having a better body, increasing one's well-being or empowering oneself could have a powerful influence on collective behaviour.

Acknowledging the moral and social underpinnings of new technologies that value 'good health above many other aspects of life and features of one's identity' (Lupton, 2013, p. 397), the aim of this paper is to examine how members of the public ponder the legitimacy of cognitive and behavioural enhancement. Using a combination of prospective multimedia material (i.e. videos and short stories taking place in 2030–2040), we conducted four face-to-face deliberative workshops with participants who later joined other participants in an asynchronous online forum to discuss a fictional 'smart' sweater that provides users with psycho-bio-feedback (PBF). Considering its potential to help adolescents to learn about and improve their cognitive, emotional and social skills, participants were invited to make explicit the desirable and undesirable aspects of the PBF sweater.

We first clarify the theoretical premises of our study and its qualitative methodology. Then, drawing on Swierstra and Rip's (2007) moral argumentation framework, our findings clarify participants' reasoning processes. These findings bring nuance to current work on public perception of enhancement technologies, while providing new insights into the way non-experts conceive of autonomy and social coercion.

Moral and social accounts of cognitive and behavioural enhancement technologies

Current research on public perceptions of cognitive and behavioural enhancement is mostly focused on the use of pharmaceuticals, e.g. methylphenidate (Ritalin®), mixed amphetamine salts (Adderall®) and modafinil (Provigil®). It sheds light on perceived risks and benefits (Bell et al., 2013; Thoer & Robitaille, 2011), media portrayal (Partridge, Bell, Lucke, Yeates, & Hall, 2011; Racine et al., 2010) and peer attitudes (DeSantis, Noar, & Webb, 2010; Dijkstra & Schuijff, 2016) that affect the perceptions and behaviours of users and non-users (typically, students or young adults) and of stakeholders (i.e. parents, health care providers, physicians; Hotze, Shah, Anderson, & Wynia, 2011). This body of research exposes the many ethical concerns underlying the distribution, consumption and regulation of cognitive and behavioural enhancement products, including rather novel ethical issues such as the shifting boundaries around what constitutes an authentic self (i.e. the value of one's genuine efforts devoted to self-development) (Schelle, Faulmüller, Caviola, & Hewstone, 2014). Yet, the illicit nature of the behaviour, alongside the fact that the available evidence mostly refers to students, limits our understanding of the meaning that individuals and groups attribute to such enhancement practices.

Few empirical studies have examined how users perceive and use wearable technologies (e.g. goggles, wristbands, sports shoes, weight scales), which through sensors 'woven into clothing or laminated onto ultrathin skin interfaces', provide a range of biometric data such as 'blood glucose, body temperature, breathing rate, blood chemistry readings, body weight, blood pressure, heart rate, sleep patterns, cardiac output readings and even brain activity' (Lupton, 2013, p. 397). According to Millington (2016, p. 408), technologies that 'automatically (or passively) register data with little effort required from people themselves' embody a 'healthism imperative' by making the body knowable in new ways and engaging users into personalized health surveillance. For Lupton (2013, p. 400), because such devices provide objectified data 'regardless of how well an individual may actually feel', they deserve in-depth research and analysis.

The theoretical premises of this paper sit at the interface between ethics, public health and Science and Technology Studies (STS). As Blaxter (1997) underscores, the way that lay people think and talk about health and illness not only differs from experts' conceptual frameworks, but it is also embedded in broad moral and social accounts that draw on shared identities. Aiming to clarify how society and technology coevolve, STS emphasize the linkages between experts' and non-experts' understandings of what counts as scientific and technological progress, of the boundaries between orthodox and non-orthodox health practices, and of what makes public policies legitimate or not (Boenink, Swierstra, & Stemerding, 2010; Calnan, Montaner, & Horne, 2005; Swierstra & Rip, 2007). STS also bring to the fore the

way 'non-humans' (e.g. technical entities, systems, artifacts, etc.) make certain moral and social arrangements more persistent than others (Rock, Degeling, & Blue, 2014). Within this perspective, Millington (2016, p. 414) argued in favour of a critical public health scholarship that addresses how new forms of interaction between humans and non-humans give rise to 'posthuman optimization', wherein connected technologies become active health promotion agents.

To contribute such new insights to public health research on human enhancement, this paper draws on an analytical framework that emphasizes public reasoning processes, that is, the moral and social accounts through which people decide whether or not cognitive and behavioural enhancement practices are desirable. For Swierstra and Rip (2007, p. 5), four categories of argument underpin moral debates around emerging technologies: (1) *consequentialist* arguments emphasizing benefits and risks; (2) arguments about *principles, duties and rights* that reflect deeply felt duty-based moral convictions; (3) arguments using theories of *justice* to question the social distribution of risks and benefits; and (4) arguments from *virtue ethics* conceptualizing the *good life*, i.e. 'who we are' and 'what we want to be'. These categories are distinct but accommodate both arguments in favour of or against a new technology (see Supplementary material, Table 1). For instance, although people may disagree on whether fair access to a given technology can be safeguarded, they may use the same moral argument (justice). This analytical framework thus highlights not only what people think, but also their moral reasoning processes, thereby clarifying the basis for attitudes towards an innovation (Stemerding, Swierstra, & Boenink, 2010).

Study design

Our multimedia-based deliberative study took place in Quebec (Canada) and was designed following Boenink and colleagues, for whom prospective scenarios are 'historically informed speculations' describing possible futures (2010, p. 6). In our broader study, participants discussed three fictional technologies, including the PBF sweater. For each technology, we created a video clip that was discussed in four face-to-face deliberative workshops and two scenarios that were discussed through an asynchronous online forum with additional participants. For a detailed explanation of the development process of the fictional technologies and their multimedia material see the full protocol (Lehoux et al., 2014).

Multiple recruitment tools and strategies were deployed in parallel to constitute a purposeful study sample (Marshall & Rossman, 2011), targeting more specifically young adults (18–25), adults (30–55) and people over 60 years old. From the pool of interested participants, four groups were assembled: one group of young adults, one group of adults, one group of people over 60 years old and one mixed group. Using diversification criteria such as occupational profiles and hobbies, our goal was to obtain sufficient homogeneity in socio-economic status to ensure that the exchanges were comfortable and lively, yet diversified. A total of 38 participants attended the workshops and were invited to participate in

Table 1. Participant characteristics.

		<i>n</i>	%
Age	18–29	9	20
	30–39	6	13
	40–49	3	7
	50–59	7	15
	60–69	17	37
	>70	4	8
Gender	Female	33	72
	Male	13	28
Education	High school	4	9
	Collegial	5	11
	University	37	80
Household income	<\$20,000	4	9
	\$20,000 to \$39,999	9	19
	\$40,000 to \$59,999	17	37
	>\$60,000	16	35

the online forum (6 declined). Those people not available for the workshops were invited to the forum, to which a total of 57 participants contributed. Table 1 summarizes participant demographic profiles for the 46 participants who completed our survey.

The workshops were facilitated by a professional moderator. The video describing the PBF sweater was shown and then each participant was asked to share two to three desirable and two to three undesirable features with the group. A discussion ensued focusing on ways to improve the PBF sweater. The online forum – which ran over a five-week period, starting after the last workshop – was hosted on a login/password-secured blog platform (WordPress®) and facilitated by the same moderator. Participants were invited to read the scenarios and respond to questions to start the online deliberations. Box 1 summarizes the PBF sweater scenarios.

Box 1. A summary of how the PBF sweater and scenarios were presented to the participants.



Fictional technology's video presentation

- A sweater made of smart textiles with embedded sensors that provides, through an electronic device, real-time feedback about the mental state and cognitive performance of the person wearing it.
- When used in conjunction with meditation techniques, the sweater has the potential to help adolescents to learn about, and improve their cognitive abilities and social behaviours.
- In the video clip, an expert explains how the sweater has been used by students with learning difficulties and reduced dropout rates.

2030 scenario

- The sweater is now widely used by teenagers and integrated in school curricula as a learning tool for all students.
- Some experts call for prudence, estimating that it may negatively interfere with the user's perception of reality and identity.

2040 scenario

- The sweater use is mandatory during exams and enables the school to identify students' potential career paths as well as the classes they should follow.
- A student defies the school system by taking an exam without the PBF. Even if he successfully passed the exam, the school considers the results to be null since the procedure was not respected.
- To his parents' and friends' dismay, the student chooses to abandon the use of the PBF sweater and his initial career orientation.

The qualitative analysis software Dedoose™ facilitated the coding of the workshop transcripts (4 × 3.5 h) and online forum comments ($n = 355$). Swierstra and Rip's categories were used to identify the reasoning processes underlying the participants' appraisals of the (un)desirability of the PBF sweater. Examining code co-occurrence, many perceived qualities of the PBF were based on consequentialist arguments whereas arguments from the good life mostly emphasized criticisms (see Supplementary material, Table 2). Fewer accounts relied on the other two categories and emphasized as many desirable as undesirable features of the technology. Applying a constant comparative strategy (Strauss & Corbin, 1998) to further explore these variations, we observed that participants' reasoning processes challenged the PBF sweater's legitimacy: (1) when a shift in *purpose* occurred (therapy vs. enhancement); and (2) when it engendered a shift in the *user's sense of self* (autonomous person vs. socially coerced individual). Below, our findings clarify and illustrate why and how these two shifts in legitimacy occur. Quotes were translated from French to English and pseudonyms are used throughout the text.

Debating the (Un)desirability of the PBF sweater

Shift in purpose: from a remedy for learning deficits to performance enhancement

The problem the PBF sweater was meant to address – dropping out of school – was largely considered worthy of attention by participants, but their views regarding the technology's capacity to actually solve the problem diverged. For instance, Penelope wondered whether its effects would be sustained over time:

When I heard 'to support reintegration' I thought, well ... wow! Why not? And train the mind ... there are aspects I found appealing, there's a playful side to it, but will its effect last? That remains to be seen. (Penelope, Workshop 1)

Because he saw the PBF sweater 'as a solution to a medical problem', Malik was 'really in favor':

Dropping out of school, learning problems, that's medical to some extent. There are people who have dysphasia, people who have concentration problems, who have problems with stress and there are solutions to these problems; medical solutions in some cases, which helps a lot. Because when your personal stress prevents you from succeeding, I mean ... it's not just because you're not interested in school: there's a barrier, it doesn't work, and that product gives you a chance. (Malik, Workshop 3)

Such consequentialist arguments were in general positive, emphasizing the value participants attribute to a technology that can remedy learning deficits or difficulties in managing one's emotions. For Karine, the idea that meditation techniques would be used alongside the PBF sweater 'could be interesting from a therapeutic point of view' considering that 'there's no one else within us'. It could also help 'someone who has panic attacks' (Karine, Workshop 2). In fact, when sharing ideas about ways to improve the PBF sweater, participants easily envisaged other potential therapeutic purposes. Charles was inspired by technological developments he knew about, including the remote monitoring of astronauts' vital signs:

It would be brilliant [to use the PBF sweater] in a hospital after heart surgery, when the sternum has been cut in half, and the person is coughing too hard, which may imply risk of tear [laughs]. If sensors like that could support monitoring and coaching, such as 'listen, the data tell us that you're not careful, you don't put your pillow on your chest when coughing' it could avoid plenty of stuff. (Charles, Workshop 4)

Behavioural issues were also seen as candidate applications. Mary thought the PBF sweater would be 'extraordinary' for people with compulsive disorders:

How many spend beyond their line of credit? I know of someone who ripped off \$35,000 from his parents, just like that, last week. This person has to be controlled, *really* controlled. She'll get another credit card elsewhere, and elsewhere, and elsewhere. How do banks get to know? There should be a chip or I don't know what, that detects ... And addictions ... alcohol, gambling, all that. It'd be amazing to help the person, not just to control, but to help this person. I'm against profiling, but ... those concerned such as banks, should have the means to detect these types of people. (Mary, Workshop 1)

Although it conflicts with the principle of autonomy, using the PBF sweater to restrain one's behaviour was a worthy purpose for Mary. In her account, intervening against a person's will could serve this person's best interests by minimizing the consequences of the compulsive disorder. For Simon, who was

in the same group as Mary, using the PBF sweater with school dropouts was not considered therapeutic and thus deemed undesirable. But in 'listening to everyone' in the group, the application that he could see was for 'bullying and suicide'. He assumed that the technology could predict its user's mental distress:

Someone who gets bullied wears this garment, then a signal will be sent to the school right away: 'ok, look he or she is being intimidated, we know he's on his way to suicide, we'll provide close support ... because there's a risk of suicide!' (Simon, Workshop 1)

The purpose of improving student performance, which was introduced in the online scenarios (see Box 1), was rejected by all participants. Such a shift in purpose made clearer where participants drew a line between legitimate and illegitimate use of the PBF sweater: 'to blindly approve the daily wearing of a sweater that'll help [students] know themselves better, to live better with others, to always do better in their studies, that's the margin that I won't cross' (Line, Forum 2030). Schools were seen as competitive environments, driven by the quest for 'excellence' where one sees 'all that you do' and pervaded by a 'pressure to perform' (Homer, Workshop 4). Arguments about individual rights were used to criticize such a context of use; the PBF sweater could become a 'prerequisite' and 'anyone who did not use the PBF would be discriminated' (Baptiste, Forum 2030). From a justice perspective, the technology would be valuable to remedy learning deficits that handicap *certain* students and should be only used by 'those in need (learning disorders, anxiety, lack of confidence, etc.)' and who 'struggle at school' (Malik, Forum 2030).

Participants disapproved of using the PBF sweater to increase student performance, but not necessarily of improving human capacities in general. Samuel, from a good life perspective, was 'in favour of improving our capabilities through technology' and unwilling to 'go back and live without what the Internet and its search engines provide our youth'. He nonetheless found the race for performance illogical: 'I agree with Baptiste. If this sweater can help everyone, then every student who wants to become a physician will wear it and then the weakest will again be just as weak by comparison' (Samuel, Forum 2030). Relying on a justice argument, Adele pointed out that the value of the PBF sweater should be considered in light of its ability to protect those worst-off:

What if tomorrow future employers force employees to wear this garment to increase their performance and access their brain? The idea gives me chills. An innovation must answer the question of its relevance – what problem does it fix? – and also address its social utility, i.e. how will relationships between humans be improved, how are those most vulnerable better protected. (Adele, Forum 2030)

Martin echoed the view of several participants when he argued that other solutions were needed to tackle the problem raised by dropouts, which 'can be fixed very differently by using our resources and by being creative' (Martin, Workshop 3). Like other participants who relied on good life arguments, Clemence proposed to put 'the human factor at the centre of life', which 'seems absolutely necessary to enable teens to live harmoniously' (Clemence, Forum 2030). The ubiquity of the Internet and its array of connected devices were seen as detrimental to the formation of human bonds, especially in a generation who grew up surrounded by such electronic devices.

To summarize, while participants voiced different opinions regarding the desirability of the PBF sweater, their reasoning processes emphasized that it could be medically justified if its purpose were to remedy a learning deficit but unwarranted if it primarily served an imperative of performance.

Shift in sense of self: from user self-development to coercive social uniformity

A second shift in participant accounts emerged when examining how they envisaged the nature of the PBF sweater's impact on its users. In contrast to medical technologies that address the physical dimension of diseases, the PBF sweater can shape the user's mind and behaviour. Hence, participants queried whether it would support self-development or coerce individuals into social uniformity.

Good life arguments stressed that the PBF sweater added an intermediary between one's feelings and one's inherent capacity to grasp such feelings, thereby reinforcing a hyper-rational sense of self. Both Jacques and Martin criticized this interference:

This product really has the quality ... the qualities of his defects actually. It's interesting to see the data it can give us access to, and on the other hand, it puts an interface between our feelings, our mental, physical state, etc. and our capacity to feel ... having to read in a Cartesian way, rationally on a screen, with schematized data versus just [asking myself] how I feel? (Jacques, Workshop 3)

It's a technology that prevents us from feeling ourselves, to be introspective, to take a moment to think about who we are, what we do, why we do it. We'll have beautiful indicators on a chart. And currently there are technologies like Fitbit that exist and which prevent people from realizing that when they run, they actually have pleasure while running. Rather, they have stats about their running. It disgusts me frankly! [laughs]. (Martin, Workshop 3)

Wondering 'who decides these social imperatives', Martin described the PBF sweater as 'a great social indoctrination method that should be used in all dictatorial societies of the world! [laughs]' (Workshop 3). Interestingly, Magalie drew on her previous experience as a teacher to make the counterpoint that the ability to develop oneself does require, at times, an external support and may entail a form of conditioning.

Because often the motivation must come from outside before a personal empowerment may begin. And the learning process about oneself is quite extraordinary ... the other merit I find is that it's a voluntary choice for conditioning. A person who wants to quit smoking or change his behaviour often needs this contribution, this external support ... In that sense, yes, it's a voluntary choice for conditioning. And I find it extraordinary. (Magalie, Workshop 3)

Magalie's argument reframes the basis upon which the principle of autonomy may be understood when it comes to a technology of the mind: may one freely choose to abandon his or her personal will? While participants appreciated the 'know thyself' approach (Clemence, Forum 2030) underlying the PBF sweater, many argued in favour of embedding its use within a set of coordinated services wherein adolescents are closely monitored and supported by professionals. This deontological view was supported by consequentialist arguments according to which the cost to society of a PBF sweater-centred professionalized programme could be offset 'by the savings generated by lower delinquency rates, social mischief and an increase in the employment rate and contribution to social and civic life' (Patricia, Forum 2040). A similar line of reasoning led Laura to stress that 'prevention is a must at an early age', but 'there'll always be dropouts who slip through the cracks of the school system'. Those teens for whom 'it's more difficult' to develop self-confidence, self-esteem and self-image 'need guidance, supervision and specialized help' (Laura, Forum 2030).

While participants valued a professional approach to self-development wherein the technology is used 'to develop knowledge about oneself' (Patricia, Forum 2040), they considered the many ways in which it could also threaten one's sense of self. Because 'there's a form of control in that sweater', Penelope wondered whether the teen would be 'comfortable, thinking one is trying to control me, trying to control my mind?' (Workshop 1). The feedback produced by the PBF sweater could generate adverse effects – 'I've got that sweater, it's in the red all the time and I'm good for nothing...' (Martin, Workshop 3) – and also threaten one's privacy:

Lea: I think it can traumatize the teenager.

Moderator: It might traumatize? Explanation...

Lea: Yes, when he feels controlled, 100%, as if someone is naked in front of everyone. It means he has no intimacy. It's ... I think it can traumatize the adolescent because at that age everyone has his own things and wants to keep his things personal. If everyone knows my weaknesses ... all my things in front of you...I think he will lose confidence in himself. (Lea, Workshop 4)

Participants queried whether the PBF sweater would *deprive* its users of cognitive and behavioural abilities; for instance, by inducing laziness it could reduce the 'learning capacity of the human being' (Baptiste, Forum 2030). For Gisele, the 'brain must make the effort to execute what is asked of it, otherwise it atrophies'. This is why when she was young, the use of the calculator 'was forbidden for simple multiplications and divisions' (Gisele, Forum 2030). From a good life standpoint, a technology that 'normalizes a neutral state' of mind and 'appeases everyone, whatever happens' may be 'downright dangerous' (Adele, Forum 2030). Line feared 'a generation of teens all alike, all calm, all dependent on a garment to feel good about themselves, just as they are sometimes when they consume medications or

various drugs' (Forum 2030). The capacity to experience and handle social conflicts should be preserved: 'there are times when one must feel scandalized, refuse injustice, react' (Adele, Forum 2030). Similarly, Line underscored the importance of forging one's own personality and being able to challenge certain social values:

Adolescence is a period where the values instilled are being questioned, and teens need this transitional period to find out who they really are and what they want to become. They need to be confronted with other values and different worldviews to find those that most resemble them. Of course, we all hope that these clashes happen in a non-violent manner, but sometimes one has to raise his voice, raise his arm straight to signify a disagreement. (Forum 2030)

To summarize, the fact that the PBF sweater could shape the mind and behaviour of its users led participants to ponder the ways in which it could interfere with sense of self. They appreciated the possibility of supporting a professionalized form of self-development if it fostered personal autonomy, but feared a world where everyone would be socially coerced into similar, behaviourally acceptable selves.

Discussion

We began this paper by underscoring the importance of understanding how different publics perceive human enhancement technologies since both experts' and non-experts' reasoning processes shape collective health practices (Dijkstra & Schuijff, 2016). After observing wide variation in physicians' willingness to prescribe both illicit and licit enhancement interventions (e.g. to suppress appetite, augment breast size, stimulate growth), Hotze and colleagues (2011, p. 11) concluded that 'an individual seeking an enhancement might be able to "doctor shop" to find a physician willing to prescribe almost any desired enhancement' be it pharmaceutical or technological.

Hence, in line with the call for empirical research on the ethical and technological dimensions of public health interventions (Green, 2014), our study examined the moral and social accounts through which members of the public considered the legitimacy of a fictional enhancement technology. Our participants' reasoning processes emphasized: (1) the PBF sweater's purpose, which could be considered medically justified if it remedied a learning deficit but unwarranted if it primarily served an imperative of performance; and (2) its impact on the user's sense of self, which could be desirable if it supported self-development but undesirable if it invalidated personal features by imposing social uniformity. By clarifying why and how these two shifts in legitimacy occur, our findings bring nuance to current work on public perception of enhancement technologies, while providing new insights into the way non-experts conceive of autonomy and social coercion.

First, our findings show that the legitimacy of the PBF sweater was not addressed in a vacuum: participants probed why, in what context and by whom it would be used. While they sometimes came to different conclusions, these intertwined considerations underpinned their overall judgment regarding whether or not it should be used. These findings lend support to Forlini and Racine's observation that it is important to examine the *circumstances* surrounding the use of enhancers (2012, p. 622). Using the PBF sweater to assess students' mental capacities and social skills, and to redirect their career paths, caused dismay; but the purpose of remedying learning deficits was seen as desirable. This is compatible with survey findings from Calnan and colleagues (2005) on public attitudes towards genetic technologies which revealed considerable 'ambivalence about human cloning and gene therapy to slow the ageing process but considerable support for genetic tests and stem cell therapy for the treatment of specific disorders'. In other words, 'treating or detecting diseases was valued but general interventions that aim to change "natural" processes were less acceptable' (2005, p. 1946). Drawing on a similar argument, Hotze and colleagues (2011, p. 11) explain physicians' frequent 'yes, but with reservations' survey responses: they 'might be willing to prescribe enhancement-type interventions only in limited circumstances, when those interventions might seem more like therapies'. Because our analytical framework made moral argumentation patterns more explicit, our findings clarify how consequentialist arguments highlighted the desirable features of the PBF sweater, i.e. its therapeutic virtues, whereas good life arguments underscored what made it undesirable, i.e. the social quest for performance. Participants thus expressed arguments that go beyond a clinical viewpoint, and moral nuances that contrast 'with

the often strong and clear-cut pro and con positions encountered in the bioethics literature' (Forlini & Racine, 2012, p. 620). Overall, our study shows that members of the public do not reason according to mutually exclusive moral frameworks to make sense of why, in what context and for whom enhancement may be legitimate.

Second, our findings provide insight into the way people conceive of the tension between autonomy and social coercion. When pondering how the PBF sweater could interfere with sense of self, participants found desirable the idea of fostering a form of self-development that reinforces one's personal autonomy, but undesirable the idea of socially coercing individuals into similar selves. While there is a strong consensus around the importance of deciding autonomously, Thoer and Robitaille (2011) underscore that the use of enhancers cannot be conceptualized as the result of an individual decision or action; the students and young adults they interviewed obtained a prescription for, bought or exchanged drugs such as Ritalin® and Adderall® from friends, peers, parents or colleagues. In addition, they used these drugs as a form of coping strategy for dealing with work or school environments they considered too demanding and stressful. Public health scholars already know the importance of distinguishing between 'what is held to affect the health of society in general' and 'what is perceived as influential in one's own life' (Blaxter, 1997, p. 755). Yet, our findings suggest that the key issue at play is whether individuals can *still* be conceptualized as autonomous when one considers the broader socialized system of values in which they evolve, and where actively and successfully managing one's life represents a 'social injunction' (Thoer & Robitaille, 2011). While healthism reinforces a rational form of personal responsibility towards one's health, the 'pursuit of self-betterment' and self-optimization that underlies wearable technologies implies that responsibility is being partly delegated to 'sophisticated non-human devices' (Millington, 2016, p. 413). Our findings suggest that such devices may be considered, under certain conditions, therapeutic and thus legitimate. But when such devices are understood as shaping users into similar selves, members of the public are likely to resist their spread.

Study strengths and limitations

Our findings should be interpreted in light of our study's goals and limitations. Our sample was comprised of educated individuals, and more women than men agreed to participate; this type of sample is often found in public involvement studies (Street, Duszynski, Krawczyk, & Braunack-Mayer, 2014). Nonetheless, our study went beyond surveying student attitudes; we recruited participants aged from 19 to 72 year-old (33% were below 40 and 45% over 60). While individual interviews provide more space for participants to describe their views, our online component offered time and intimacy for participants to think about the scenarios before commenting (for a detailed assessment of the respective strengths and limitations of the multimedia components and of the two deliberative environments, see Lehoux, Jimenez-Pernett, Miller, & Williams-Jones, 2016). Our analytical framework was particularly relevant to our research goal and we reached empirical saturation around the two key themes described in this paper. While the framework did not exhaust all the empirical material (for instance, personal data privacy), it nevertheless increased the credibility of our analyses as well as its auditability (Marshall & Rossman, 2011). The transferability of our findings is limited to populations similar in terms of socio-economic and demographic composition, expectations towards publicly funded health systems and citizen engagement tradition. Overall, the key strengths of our study lie in the diversity of the participants we recruited, the use of videos and scenarios, the complementarity provided by two types of deliberative environment and the auditability of our analytical strategies.

Further research and concluding remarks

The emergence of cognitive and behavioural enhancement technologies calls for the development of new approaches to understand and tackle its implications for public health (Evans-Brown et al., 2012; Lupton, 2013). Most physicians surveyed by Hotze and colleagues believed that enhancement interventions that may 'produce discrete competitive life advantages' should be "allowed" (i.e. permitted, but not covered by insurance) but not "promoted" (i.e. covered by basic insurance plans) (2011, p. 8). For these

authors, ‘to assert that “everyone should have equal access” to legal enhancement interventions, but that “they should not be covered by insurance” entails a contradiction. Hence, further research should examine the public health underpinnings of a consequentialist appraisal of the benefits and risks of enhancement, which may indirectly reinforce its legitimacy: as long as *some* therapeutic benefits may be obtained in *some* individuals, enhancement is likely to be seen as morally acceptable. Yet, from a societal standpoint, arguments from a good life ethics would rather seek to clarify its ‘moral praiseworthiness’, i.e. is this a moral ideal to be actively supported? (Forlini & Racine, 2012, p. 621).

From a STS perspective, moral frameworks and new technological possibilities influence each other, giving rise to social and moral accounts that vary across space and time (Stemerding et al., 2010). By establishing linkages between the scholarly concerns of ethics, public health and STS, our study provides new insights into the way members of the public conceive of cognitive and behavioural enhancement and of the tension between autonomy and social coercion. The PBF sweater’s legitimacy was challenged when a shift in purpose occurred – from therapeutic to enhancement – and when it engendered a shift in sense of self – from an autonomous self to a socially coerced individual. Because technological change affects public health research and practice in many different ways, STS-oriented studies (Rock et al., 2014) like ours are important to help understand the broader social and economic forces that shape the use of new technologies by opening up the inquiry to the human and non-human entities that ‘inter-relate to produce and reproduce health and illness’ (Green, 2014, p. 251).

Author’s contributions

All authors revised the content of the manuscript and have approved the final version. PL is the principal investigator of the study; she is accountable for all aspects of the work, including the original idea behind the study and its development. BWJ, DG and SP have criticized earlier versions of the manuscript and contributed to the data analysis strategy, to the interpretation of the findings and to key conceptual and methodological decisions.

Competing interests

The authors declare that they have no competing interests.

Research ethics

The Health Research Ethics Committee of the University of Montreal approved the study and all participants provided informed consent.

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