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Title: Emotions toward cognitive enhancement technologies and the body : Attitudes and willingness to use

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Title: Emotions toward Cognitive Enhancement Technologies and the body – attitudes and willingness to use

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Abstract

While technological development is becoming more integrated into our surrounding environments, it is also moving closer towards the human body. In fact, numerous examples can be seen in which information technology (IT) is being designed not just for use on the body, but also inside it. Technologies dominating this domain can be described as ‘cognitive enhancement technologies’ (CETs). These technologies are intended to enhance people’s cognitive capabilities, and can be viewed in the forms of implants, lens, drugs, and then moving outward, smart clothing, watches and physical environments to name some. The present study focused on measuring peoples’ (*N*=104) emotions towards and willingness to use various types of CETs. The study expands on current scholarship on technology and the extension of cognition, yet this actively empirically explores people’s emotions towards certain types of CETs and their relationship to the body. Results of the study revealed correlations between attitudes, emotions and whether or not the CETs were to be used internal or external to the body, and surprisingly, there was a significant difference in gender as reflected in attitudes towards these application types.

1. Introduction

Information technology is everywhere. These days people interact with digital spaces regardless of whether they are willing to or conscious of them or not. Digital systems are implicated in all areas of life, from driving a car, to banking and health care. Over the years it has become more integrated within our environments and lifestyles, rendering it near invisible or at least, unnoticed. Often times, we are not aware of our devices and digital systems until they are either malfunctioning or missing. While little over a decade ago many may have left their mobile phone at home, these days upon discovering that one is without their smartphone, general reactions are to return home or panic (Demirci, Akgönül & Akpinar, 2015; Lee, Chang, Lin & Cheng, 2014; Seunghee, Joon & Hyun, 2017). There is, however, also a vicious circle that is tending to arise during these times and can be the cause for panic induced by an absent smartphone – this is the reliance on information technology (IT) to perform cognitive functions such as thinking, calculating, remembering, evaluation and forecasting (e.g., weather). As such, people are becoming ever more dependent on their devices, compromising their capabilities to perform cognitive functions such as remembering, negotiating etc. Thus, internal information processing is being outsourced, while at the same time, the amount of information from various sources (at work, school, leisure time) has multiplied by thousands. Therefore, a paradox and conundrum is generated through weakened (not exercised) cognitive capacity, combined with the need for more.

Added to the outsourcing of cognition combined with the influx of various types of information individuals need to negotiate on a daily basis, today's world is characterized by ruthless competitiveness and hyper productivity. People are experiencing ever more pressure in daily life to produce flawless, if not, superhuman performance, whether at work or at leisure. Even based physiological health has been optimized through, e.g., bio-hacking and the instrumentalisation of the quantified self – self-improvement through a systems thinking approach to personal biology – are increasingly popular (Nafus & Sherman, 2014; Ruckentein & Pantzar, 2015; Swan, 2013, 2012).

Along with the pressures of aiming to be the best, come the challenges of keeping up with and filtering the often thousands of data sources one encounters on a daily basis. Or, in some professional cases (medical, emergency and air traffic control etc.), negotiating and processing vital information that is now confounded through new break-through technological capabilities seen in, e.g., big data and other complex systems.

Ironically, the technologies that are intended to make life easier seem to be making it more complex, and/or they make life easier, but at the expense of reducing people's engagement in cognitive practice (learning, problem-solving and remembering) – thus, rendering actions such as maintaining attention, and calculation also difficult. To help alleviate the experience of cognitive load, and in many cases, reduce the likelihood of human error by artificially increasing cognitive capacity, a myriad of technologies are being developed to aid people in their actions and processes. Thus, cognitive enhancement technologies (CETs) are being developed for application in a range of areas. These areas include cognitively demanding work environments such as surgical operating theatres (Lingard et al., 2004; Sexton et al., 2018), trauma teams (Sarcevic, Marsic & Burd, 2012; White et al., 2018), commercial aircraft cockpits (Miller & Holley, 2018; Sarter & Woods, 1992), shopping (physical and online, e.g., Desrochers et al., 2019; Schwartz, 2004), driving (manual and automated see, Lamble, Kauranen, Laakso, and Summala, 1999; Lundqvist & Eriksson, 2019; Stapel, Mullalakkal-Babu & Happee, 2019), and the home (e.g., see Rahal, Mabilleau, & Pigot, 2007).

The current article describes CETs in light of human performance enhancement technologies and human-technology philosophy such as the extended mind theory (Clark & Chalmers, 1998). It moves into discussing ethical considerations of human enhancement and specifically cognitive enhancement, and then reports on an empirical study that inquired about people's attitudes and emotions towards CETs. In the study respondents were asked to express their feelings and opinions towards a variety of CETs ranging from those which are located in the environment, to wearable and also those for use internal to the body (implants). The results reported here reflect both differences in attitudes towards the technologies depending on where they are located in relation to the body, as well as differences between genders.

2. Human enhancement technologies

Authors such as Andy Clark (2001; 2008) and colleague David Chalmers (Clark & Chalmers, 1998) argue that CETs for professional or daily living purposes are nothing new. In fact, in their work on the extended mind theory, the scholars posit that people's minds extend through place and space, being present and operationalised in technologies from notepads and pens, phones, to other instruments, environments and people. In other words, the human mind is not and has never been limited to the biological brain, but has always operated in a network of systems and objects surrounding the human to aid in thinking. Thus, Clark and Chalmers (1998) advocate that in terms of the extended mind "cognition is often taken to be continuous with processes in the environment" (p. 11), and in doing so, Clark (2001) argues that humans are natural born cyborgs – organisms that are pre-dispositioned to using objects and other agents as tools to aid in thought, memory and actions. Thus, objects, environments and even other people, are not separate to an individual and their mind, but instead are a part of the mind (the extended mind).

In a similar vein, these days academia and media alike often discuss the popularity of high tech enhancement solutions as being on the rise. Yet, an evolution can be seen in the progression and usage of enhancement or augmenting technologies throughout human history. In fact, researchers claim that striving for enhancement and improvement is a natural component of human beings and an organic part of human evolution (Andersen, 2012). This is reflected in the human mind, culture and the integral nature of tool (technology) development (Shaffer & Clinton, 2006). John Dewey (1953) describes this in his theory of instrumentalism and its connection to the 'process of knowing'. This process of knowing occurs through physical action, and mental interaction with tools, that sees these tools as gradually and seamlessly integrating with an individual. We may also observe this through the philosophical work of Martin Heidegger (1962) who refers to tools in conjunction with the concepts of ‘ready-to-hand’ and ‘present-to-hand’. Whereby, tools objects are designed with use and the body (ergonomics) in mind, and the individual with their body and perception understand objects through what they afford in terms of actions and goals (Gibson, 1977).

Clark (2003) talks of this predisposition of the brain to use and indeed mold itself towards external aids. Thus, in tangent with the body and what it grows accustomed to using (the body’s movements and action mediators - e.g., hammers, tennis rackets, shoes and game controls etc.), the brain structure also forms itself to include these instruments. In light of current debate regarding the deterioration of cognition in correlation to the rise of information technology use (e.g., Carr, 2010; Greenfield, 2008) this means perhaps that our natural cognitive abilities are not after all declining. Rather, in conjunction with Clark’s (2003) argument, our cognition may be extending and improving, the greatest difference being that the instruments that were housed within our head - brain (i.e., the learning and conditioning that enabled humans to perform mental arithmetic and spelling etc., which in themselves are human technologies - symbols, constructions and designs) - are now located in our pockets, on our wrists, in our car dashboards. As Clark so curiously queries, are we “dumb thinkers in a smart world, or smart thinkers whose boundaries are simply not those of skin and skull?” (p. 5)

These concepts and discussions describe relationships between people and things in which certain objects and phenomena are used instrumentally as tools without thinking (‘ready-to-hand’ - extensions of bodies), as opposed to phenomena or ways of understanding phenomena through observation and reflection (‘present-to-hand’ - as scientific points of interest). Indeed, in reference to Heidegger (1962), through this way of thinking, it may be considered that as interaction between humans and computers become more fluent, not only are the interactions less noticed, or more natural (only being noticed when the devices are missing), but the computers themselves are more commonly accepted to be a part of people's cognition - the computers are people's minds.

As a consequence of the perplex relationship between humans and technology the types of technological enhancements available in themselves are also vast and exhaustive. With this said, the topic of CETs can often arouse feelings of controversy and doubt, particularly from the perspective of ethics (Bostrom & Roache, 2008; Bostrom & Sandberg, 2009). Intentional, conscious and perhaps more particularly, commercialized cognitive performance enhancement, has attracted much criticism on numerous levels from socio-economic (Fitz, Nadler, Manogaran, Chong, & Reiner, 2014; Sahakian & Morein-Zamir, 2015; Turner & Sahakian, 2006) and equity-related (Heersmink, 2017; Outram, 2012; Outram & Racine, 2011; Singh, Filipe, Bard, Bergey, & Baker, 2013), to humanist and post-humanist (Eaton & Illes, 2007; Fox, 2008; Lee, 2016; Wolbring, 2009). Yet, despite the controversies, for the above mentioned reasons, performance or human enhancement technologies are fast developing and becoming increasingly attractive from numerous societal perspectives.

2.1 Human performance enhancement: from PETs to CETs

Two of the main types of human performance enhancement technologies can be classified as: physical and cognitive (Leis & Sandberg, 2010). Physical enhancement technologies (PETs) focus on enhancing functions including physical strength, mobility, health and ageing. Cognitive enhancement technologies (CETs) focus on enhancing an individual's capacity for rationality, creativity, extending psychological borders[1], and ideal emotions. Additionally, these technologies can be seen to: improve or extend (augment) existing capabilities; and 'outsource' e.g. mental tasks; or add new capabilities (Leis, 2010). On a deeper level, these various types of performance enhancement solutions can be sorted into: *social technologies* - learning, training, communication;

[1] Artist and cyborg, Neil Harbisson (2016), described how people could hack into the software that enables an antenna attached to his skull to detect color and communicate with his brain. He ultimately stated that people have sent him images, and in effect also have hacked his dreams.

bio-neural - meditation, coffee, nicotine, prescription drugs, implants, nanotech, brain computer interfaces (BCI), transcranial direct current stimulation (TDCS) etc.; or *hardware/software* - training technologies, gaming, implants and other neuro prostheses. These technologies have further been classified against two main categories (see Figure 1): *exo*, or external to the body, such as a wearable and mobile technologies; *endo*, or internal to the body, such as ICT implants, DBS and drugs; and external, utilized externally to the body such as, magnifying glasses, hearing trumpets, and smart environments (Clark 2011).

Relevant to this current study are CETs. CETs, also known as *digital wisdom* and *wisdom enhancement* (Prensky, 2009), have existed in one form or another for thousands of years. Earlier forms of these technologies can be seen in, for example, primitive markings intended to assist in remembering events and facilitating calculations (Sandberg & Bostrom, 2006). These markings also resulted in the development of written language, which still serves as a primary source of cognitive enhancement (Andersen, 2012; Leis, 2011). CETs promote and augment the intensification of the brain's ability to receive and process new information. The ways in which CETs assist the brain include: increasing memory capacity, intelligence (or 'SMART' capabilities), decision-making, perception and judgment (Sandberg & Bostrom, 2006; Fitz, Nadler, Manogaran, Chong & Reiner, 2013).

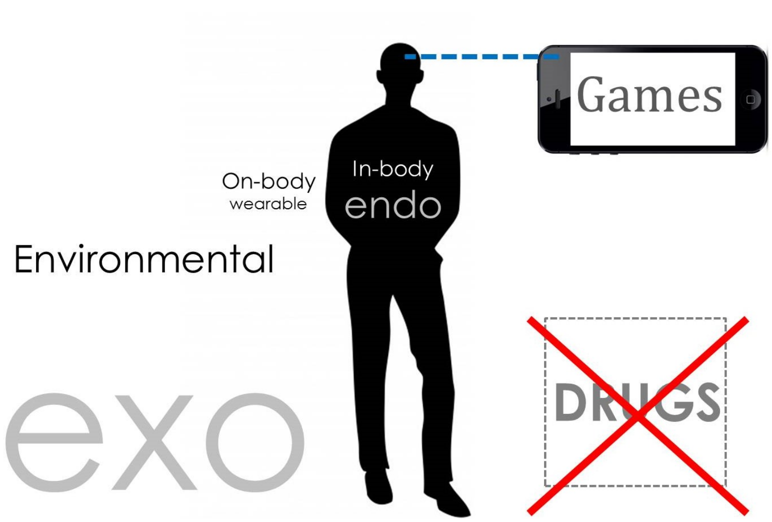

Fig. 1. Cognitive enhancement technologies referred to in the current study – exo (external to the body), endo (in-body), environmental and cognitive enhancement games, excluding drugs.

For the purposes of this study, we refer to *endo-exo* CETs, in terms of: in-body (*endo*); on-body (or wearable - *exo*), social and environmental (*external*). Focus is placed on information technology-based CETs. Thus, cognitive enhancement drugs are not included in the study. The current study observes people's attitudes towards specific types of CETs and whether or not they could see themselves using them. Due to its social-psychological nature, the study is framed against the backdrop of ethical discussions in the field. For this reason we describe various ethical issues implicated in the existence and use of these technologies, and also refer to them in our analysis of the empirical study. The empirical part of the study utilized a questionnaire in which participants (*N*=128) were asked to express their opinions towards, and willingness to use CETs belonging to the above mentioned categories is then introduced. The paper's contribution rests in its demonstration of a significant difference in the results between female and male participants in their attitudes towards not just CETs in general, but specific types of CETs - in-body as opposed to on-body, social and environmental. Discussion is then opened regarding these results and what they mean from the perspective of the relationship between emotional appraisal and ethics. The paper concludes by eliciting future steps to extend this research.

3. Related Research

Research in cognitive enhancement and CETs is steadily increasing and the list of perspectives placed on the topic is already extensive. Specific areas of cognitive enhancement discussion that are especially popular are ethics, values and morals (cognitive enhancement and cyborg related – see e.g., Heersmink, 2016, 2017; Jotterand & Dubljevic Eds., 2016; Warwick, 2003, 2014a), privacy, security and national security (e.g., Baldini et al., 2018; Crimmins, 2019), as well as benefits and challenges (e.g., Ienca, Shaw & Elger, 2018; Sandberg & Savulescu, 2011), and simply understanding the nature of CETs and human attitudes (e.g., Farah, 2015; Fitz et al., 2014;

Hohenberger, Spörrle & Welpe, 2017). Smart environments, for instance, have been studied by Streitz and Nixon (2005), who draw our attention to the paradox of the 'disappearing computer' - information technology becoming less visible while it increasingly infiltrates every area of our lives. Sandberg and Bostrom (2006) highlight the converging nature of CETs, and the ability of smart environments to extend the natural capacity of objects in their environments. They give Weiser's (1991) example of ubiquitous computer vision, whereby individual identities are given to various objects, possessing the aptitude to support and communicate with the user. This is often seen these days in environments equipped with radio frequency identification device (RFID) tags and subsequently the Internet of Things (IoT) (Heersmink, 2016; Hussain, Schaffner & Moseychuck, 2009; Kortuem, Kawsar, Fitton & Subdramoorthy, 2010). Sellen, Louie, Harris and Wilkins (1996) look at the ways in which smart environments can assist in strengthening prospective memory – remembering information for the future (McDaniel & Einstein, 2007) – by actively referring to, retrieving and recalling earlier intentions and thoughts in the appropriate context (Sellen et al., 1996). This has more recently been applied to the study of memory and smart environments in relation to rehabilitation settings (see, Seelye, et al., 2012).

Cook and Das (2007), take a state-of-the-art approach to reviewing smart environments research. They outline the basic structure of a smart environment and its components, and emphasize enthusiasm within the field (also seen in e.g. Swan (2012)), based on its convergent characteristics of combining numerous fields of information technology. Yet, most of their focus is on technical capabilities and challenges. This is not uncommon in this area of research, as a review approach is taken towards smart cities and smart homes that incorporate the isolation of technical factors, with more general ethical and application queries implicated in constructs such as smart governence, smart living and smart mobility (Arroub et al., 2016; Song et al., 2017). Crotty and associates (2009), as well as Hanada and associates (2010), observe the ways in which smart environments are self-learning, user reactive and adaptive, while being relatively unnoticeable to the user. Thus, while smart environments aid people (users) in terms of reducing cognitive load and optimizing resources, they are in themselves self-learning. These technologies additionally enable users (people) to continue with their daily flow without interrupting interactions or drawing attention to the technical characteristics of the systems. The challenges of smart environments, however, are that there are always questions regarding information privacy and security protection (Baig et al. 2017; Zhang et al., 2017). Issues of privacy and security regarding smart environments are also closely intertwined with research on crime, ethics, morals and techno-political interrelations (see, e.g., Conti et al., 2018; Ijaz et al. 2016; Sholla, Naaz & Chishti, 2017).

Collective consciousness, as seen through e.g. collective consciousness mobile Apps (see e.g. Weinkauf, 2014), has been discussed in terms of its implementation potential: in business settings as knowledge storage, transfer and innovation resources (Haseman, 2005; Bonabeau, 2009); making tacit knowledge explicit (Lewis et al., 2007); and reducing cognitive load (Lewis et al., 2007). Bonabeau (2009). Through referring to collective intelligence, drawbacks have been identified in this technology regarding information security issues as well as possible loss of control of information. Other references have been made to this phenomenon in studies that focus on, for instance, crowd sourcing (Pedersen et al., 2013), whereby the collective wisdom, provided by people-centric web technologies are prime creative sources of ideas and possess saving potential. Equally, in the space of information literacy collective consciousness has been identified as a core trait of the connected information era (Bruce, 2016). Similarly, user-centered work has been carried out regarding distributed cognition, and teamwork error classifications intended to provide information support structures for the development of solutions which aid in the reduction of collaboration errors in safety critical situations (Fahssi, Martinie & Palanque, 2015; Sarcevic et al., 2012).

Research into wearable technology has shown its benefits in terms of eliminating the need for separate devices (Muaremi et al., 2013), and technology which supports and/or monitors natural interactions while exceeding the limits of normal abilities (Montanari, 2019; Warwick, 2003). However, while improvements are being made (Chen et al., 2015), it has also been criticized in terms of its high costs and poor battery life (Swan, 2012). Implants on the other hand have been studied in terms of their ability to restore previously lost senses and abilities (Topol, 2012), and in terms of how they allow users to go beyond the limitations of normal abilities (Prensky, 2009). On this note scholars have looked at: the ethical issues associated with implants (Hays, Miller and Cobb, 2013) in addition to their high prices (Hays et al., 2013) - meaning that not everyone is and will be able to afford the technology; the human body and possible rejection of implants (Marcus and Koch 2014); and electrical currents (Marcus and Koch, 2014; Swan 2012).

Following on from these issues are other social and cognitive-affective matters regarding the subject that pertain to attitudes, ethics and morals that are currently being explored in the fields of philosophy, cognitive science, psychology and consumer studies. In regards to attitudes in general, Fitz et al. (2014) conducted a study comprising four experiments in which vignettes were utilized to understand how people reacted to cognitive enhancement in alternative situations. The results of their study revealed that people by and large were aware of the four major concerns (safety, pressure (social), fairness and authenticity) regarding CETs. Moreover, there was express favour shown towards non-enhanced individuals who achieved success due to hard work, over those who achieved success while enhanced (authenticity). From the market perspective, Castello, Schmitt & Savary (2019) reveal a social stigma that arises in relation to consumers who radically enhance their cognitive abilities. In their studies that both explored attitudes towards CETs that either enhanced normal abilities or corrected disabilities, in addition to pro-social CET and advertising experiments, showed that there is a tendency to view people who are cognitively enhanced in a dehumanized way. Finally, another study by Hohenberger, Spörrle & Welpe (2017) measured the impact of anxiety on the willingness to use autonomous cars, in relation to self-enhancement. Their study showed a positive correlation between self-enhancement, decreased anxiety and willingness to engage with autonomous vehicles. In reflection of these two latter articles, there seems to be an interaction between how others see those who are cognitively enhanced (dehumanized, transhumanised and/or controversial), and how those who are enhanced view themselves (increased confidence and willingness to engage in other autonomous technologies, decreased anxiety). These findings are quite interesting from the perspective of this current paper, as here the authors explore the 'other's' perspective towards various types of technologies. However, what these previous papers do not do is investigate people's reactions to a spectrum of CETs. Thus, this article contributes to the discussion on attitudes towards CETs through highlighting the hybrid nature of cognitive enhancement technologies and examining the ways in which people's attitudes differ from one technology to the next. Here, particular attention is placed on the technologies' relationship to the body (internal or external) and how that affects participants' reactions.

4. CETS and Ethics

The field of human enhancement continues to generate much controversy, particularly in areas such as sports (use of drugs and prostheses etc.) and more recently, the enhancement of cognitive abilities. Concern is demonstrated both towards the emerging cyborg phenomena (Pentland, 1998; Soh, 2014; Warwick, 2003, 2014a) as well as towards our inability to naturally cope with the pressures of the overwhelming information conditions we find ourselves living in today (Bawden and Robinson, 2008; Edmunds and Morris, 2000; Eppler and Mengis, 2004; Morozov, 2012). In particular, discussions have taken place regarding the dynamics between enhancement to correct illness and disabilities, and enhancement to augment already healthy human beings' abilities (Bostrom and Roache, 2008). Yet, neither this discussion nor the division between corrections and augmentations of already healthy abilities are clear cut (Bostrom and Roache, 2008; Outram, 2012). One ethical discourse regarding the use of CETs rests in the anticipation that those who benefit from cognitive enhancement will use this advancement to their own advantage, to manipulate and control those unable to afford and receive the enhancements (Bostrom and Roache, 2008). Thus, in extension to the digital divide, the gap between the privileged and the under privileged will become ever more broad, as is already being witnessed in relation to health care technologies (Lupton, 2013; Neter and Brainin, 2012). There is foresight into a prospective society which is divided into two human species – those with enhancements (cyborgs) and those without (Bostrom, 2003; Cakic 2009). Furthermore, particular speculation is placed on the well-intended and the ill-intended natures of people (Persson and Savulescu, 2008). Concern is made towards not just the increased physical and mental capacity of ill-intended human beings, but also towards the possibilities of using these technologies (including e.g., genetic manipulation) to undertake crimes against humanity such as breaching information security and genocide.

From the perspective of cyborgism, it has been argued as to whether or not anyone utilizing any kind of enhancement, or augmenting technology which assists in information retrieval, navigation and decision-making, should be classified as a cyborg (Bateson, 1972). This debate even extends from information technology towards those using a walking stick, or with visual impairment who navigate by cane. And, from a physical enhancement point of view, instruments such as cochlea implants, hip replacements and pace makers, which have become commonplace may also enter the cyborg discussion (Warwick, 2003). However, as Hayles (1999) points out, these technologies are developed and implemented as a matter of correction rather than enhancement to already normally functioning faculties. Circumstances change when people begin to utilize technology to enhance normally functioning faculties. In particular, Warwick (2003) states that the cause of most concern is the alteration of mental functions and especially where a person's mental functions are linked to machines – brain-nervous system machine coupling (Warwick, 2014b). Perhaps, the greatest ethical concern in this case is the violation of the boundaries between humans and machines (Bostrom and Sandberg 2009; Haraway 1985).

In cases where brain-nervous systems are linked to machines, issues of individuality and autonomy come into question (Warwick 2003, 2014b). In turn, Warwick (2003) poses the question as to whether or not the connection between human and machine mental systems will in fact change the ethical and moral stance and behavior of cyborgs. Furthermore, many may argue that evolving technology and technological adoption is conducive of human nature and culture (Donald 1991, 2001; Williamson Shaffer and Clinton, 2006), and that cyborgism is a part of this (Clark, 2003; Haraway, 1985). Yet, it may also be viewed as a threat to human kind as we know it, separating the haves (cyborgs) from the have nots (Cerqui, 2001; Soh, 2014; Warwick, 2002). And, subsequently there is the issue, that is inherent with every technology we learn to live with – once something is experienced as improving a person's life quality, it is hard to voluntarily give up (Warwick, 2003).

5. Ethics, emotional appraisal and opinion expression

In order to understand how emotions operate, and what causes people to possess and express the opinions that they do, there is the need to recognize that emotions consist of an intentional structure (de Sousa, 2014). This intentional structure plays in important role in life, for its preservation, evaluation of phenomena which are either beneficial or detrimental to our wellbeing, and in decision-making based on these premises. While there are numerous theories designed to explain emotions according to these functions, one of the better known theories is called appraisal. Appraisal theory is a cognitivist perspective towards observing the formation of and *in*formation through emotions in conjunction with conscious and unconscious cognitive processes (Frijda, 2001; Lazarus, 2001). Emotions are discussed in terms of existing as affect-laden judgments (Broad, 1971; Lyons, 1980), and are even described as sets of beliefs resulting from the evaluation of circumstances and information implicated in those circumstances (Neu, 2000; Nussbaum, 2001; Solomon, 1980).

Thus, when endeavoring on a questionnaire study requesting participants to state their opinions towards technologies they may or may not have encountered. We are relying on them to express their judgments, supposedly affect-laden, based on their beliefs resulting from an evaluation (conscious and unconscious) regarding several dimensions of the technologies in question - personal (do I want this? Will it harm me? Will others who use it harm me? etc.) and ethical (how does this impact society on a broader level? What are the implications for equity? And, how does this affect human-kind as we know it?). Ultimately, what is seen in a study of this kind is the merging of these dimensions, entailing the understanding that ethics are present and sensitive due to the fact that they do involve all individuals in one way or another. This provides people with a rational conscience and an understanding that in fact ethics themselves are contingent upon emotions (Arpaly, 2002; Bennett, 1974; McIntyre, 1990; Nussbaum, 2001). This matter is seen as imperative to understanding the results obtained in the empirical study.

6. Method

The study took place as initial data collection for a project focusing on cognitive enhancement technologies and their impact on collaboration in education and work place settings. The premise was to gain insight into the state-of-the-art, views and discussions attached to the emerging technologies, and in particular to observe ethics, and the impact of ethical discussion on people's attitudes towards various types of CETs. The empirical data collection took place via an online questionnaire. The questionnaire was in turn distributed via social media (Facebook) and university mailing lists. Questionnaire development began by specifying and limiting the CETs that were to be included as stimuli in the study. Technologies excluded from the study were performance enhancing drugs and e.g., collective wisdom (collective consciousness, crowd sourcing and collective intelligence). The questionnaire comprised three parts: 1) background information; 2) stimuli with a five point Likert-scale question "How likely is it that you will use the technology in question?", and an open field for qualitative comments regarding the technology; and 3) a question regarding whether or not the participant has used any of the technologies included on the questionnaire, and if so, which ones.

As a starting point, we formulated three hypotheses. The first hypothesis was in regards to the relationship between the CETs and the body. We posed that participants would be more negatively disposed to CETs which are inserted into and utilized internal to the body, such as implants, as compared to those which are carried and consumed externally to the body. The assumption connects appraisal theory and concern for physical wellbeing in the evaluation of various phenomena with the potential to interfere with this (Cottrell and Neuberg, 2005; Scherer, 1999). Other reasons for this hypothesis are linked with both ethical concerns of tampering with already healthy functioning bodies (Hogle, 2005), creating super-humans out of the financial '*haves*' (Cerqui, 2001; Soh, 2014; Warwick, 2002), as well as the people's concerns for the implications of machine control over brain function (Warwick, 2003, 2014b). Thus, it was our prediction that the further removed the technologies are from the body - smart environments being the least obvious (conscious) due to their nature as the disappearing computer (Streitz and Nixon, 2005) embedded in everyday things and environments - the more easily they would be accepted[2].

The second hypothesis was formulated, based on our reflection of hype cycles [3](O'Leary, 2008), technophobia (Brosnan, 2002) and the overall future-present-past process in which technology begins as overly pronounced or represented - causing discussion, debate and controversial attitudes and emotions towards the form of technology. The 'new technology' stage is filled with both promises and trepidation, whereby technologies are seen as being able to offer easy solutions

[2] This is where it is interesting to observe, that digital technologies are more obvious, and consciously present at the 'middle point', in wearable, mobile and desktop technologies. The computer 'disappears' when it is either perceived as being further away from the body - embedded in the environment - or within the body.

[3] The term 'hype cycle' or 'hype curve' refers to a dynamic and multi-component cycle in which technologies are responded to and acted upon in stages. These stages or points on the hype curve include: technology trigger (idea), peak of inflated expectations, trough of disillusionment, slope of enlightenment and plateau of productivity (Fenn 1995, 2005). In other words, the hype curve describes how technology evolves from an idea (individual and social), to being materialized, scrutinized (technically and ideologically), then gaining momentum in the mainstream and subsequently plateaued when the artefact/concept/system loses its novelty effect.

(Meinhof, 1990), while at the same time its unknown nature often can be interpreted as a threat (Mason, Stevenson and Freedman, 2014). Once people "find a place" for these new technologies in their daily practices, it then becomes accepted[4], and the technologies become "normalized" and start to disappear into the background (Bax, 2000). Thus, perceptions of technology and its various forms constantly change with time (Bhattacherjee and Premkumar, 2004). It can be speculated that the concept of technology generations, whereby people's comfort zones rest in the technology that people learn and get used to earlier in life (their formative years) (Leikas, Ylikauppila, Jokinen, Rousi and Saariluoma, 2011), as this forms their understanding of what technology is like. Thus, the more technology progresses, the further away it becomes from people's initial ideas of technology - particularly, useful and *beneficial* technology. Our second hypothesis, hereby, pertained to the prediction that the age of participants would have an effect on their attitudes towards CETs. The younger a participant was the more open and positively disposed they would be towards the CETs - endo, exo and external.

Our third hypothesis related to work undertaken in the realm of gender and ICT, and particularly cyborgism. Here, we reflected on Donna Haraway (1999) who poses that our contemporary ontology exists as cyborgs - a combination of imagination and physical reality, instrumentally used throughout history for political and social power. Haraway argues that the cyborg is removed from gender, as it no longer strictly attributes organic reproduction to individuals. On the socio-political note, Grint and Gill (1995) discuss the relationship between gender and technology, citing arguments which posit that technology is gendered - both politically, in terms of the cultural associations between technological progress and masculinity (civilization as compared to primitivism), as well as in terms of use context and purpose (e.g. reproductive technology), and user stereotypes (femininity equals lower competence levels etc.). To test the effects of gender discourse,

[4] This is not to be confused with Davis' (1989) TAM-model, as it is talking about the overall collective and discursive acceptance of technology modes, once they have been consumed after a period of time, and are no longer considered a 'hot topic'. Clay Shirky (2008) refers directly to this in his observation that: "It's when a technology becomes normal, then ubiguitous, and finally so pervasive as to be invisible, that the really profound changes happen." (p. 248)

and as to whether or not, differences in attitudes towards CETs held by the genders were evident we suggested the third hypothesis, that the gender of participants affects their attitudes towards CETs. The questionnaire was constructed in SurveyGizmo due to its ease-of-use (for both researchers and respondents) and compatibility with SPSS. The five point Likert-scale questions were scaled from "not at all" (1) to "extremely likely" (5), in response to the question regarding how likely participants would use the CETs in question. In order to gain somewhat of an idea of familiarity towards using the technologies, participants were asked whether or not they had used the technologies in question.

To compliment and explain the quantitative responses, qualitative open fields were available for participants to elaborate. Furthermore, space was also available at the end of the questionnaire for participants to offer more comments regarding CETs. To facilitate the statistical analysis, the background information section featured four questions: age, gender, educational background, and earlier experience using CETs. Pilot tests were conducted to ensure the usability and understandability of the questionnaire, and improvements were made based on pilot-participants' comments.

6.1 Participants

Calls for participation were made through social media (Facebook), as well as through the university student and staff mailing lists. All in all, 128 people responded to the call but 24 of these were excluded from the data set due to incomplete surveys, and one was excluded due to their age (15 years old). This left a total of 103 responses. Out of the participants 43.8% were female and 56.2% were male. The age distribution did not adhere to what is considered a normal age distribution. The mode of age distribution was 26, of which the frequency was 11 and 60.9% of the participants represented were 35 and under (the oldest being 75). Thus, participants who were 36 years of age and over were underrepresented. For this reason, the second hypothesis was unable to be verified. Many of the participants notably possessed a higher education, 34.4% of which had received a higher (masters) degree, 21.9% had achieved bachelor's level studies, 16.4% had obtained a vocational diploma or certificate, and those without tertiary education remained underrepresented in the sample.

6.2 Stimuli

The CET stimuli included in the questionnaire were divided into four types: in-body, on-body, social and environmental. The in-body (endo) CETs were represented in the forms of brain memory chip implants and eye, or ocular, implants. The on-body (exo) CETs were seen in smart clothing (textiles) and smart glasses (Google Glass). Stimuli representing social CETs were in the form of two games. One game was intended to enhance cognitive capacity through exercises targeting specific parts of the brain, and the other game focused on language learning. Environmental (external) CET examples used in the questionnaire were the smart driver control area (dashboard) of a car, and a smart shopping cart/trolley, labeled a smart shop. All of these stimuli were accompanied by a short piece of text (one to two sentences long) explaining what the example was and how it should be used.

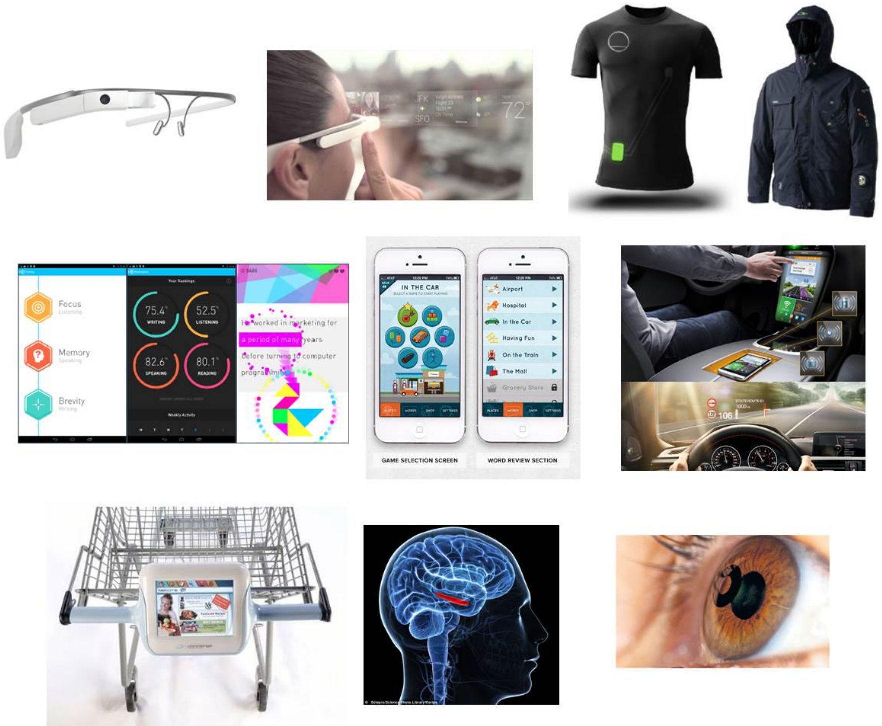

Fig. 2. Questionnaire stimuli from upper-left to right – Google Glass, Google Glass display, smart clothing; from center-left to right – cognitive enhancement game, language learning game; smart dashboard; lower-left to right – smart shopping cart, brain implant, eye implant.

6.3 Procedure

Before commencing the questionnaire, participants were informed about the study and for what purposes the data would be used. The steps of the study were then explained. The participant was informed that they would be

Participants were informed that they could discontinue questionnaire participation at any time, and were then asked to give informed consent before continuing to answer the questionnaire. The questionnaire took approximately 15 minutes to complete. It was open for responses for five and a half weeks, and people were given two reminders - two subsequent calls for participation - through social media and the university mailing lists in accordance with recommendations by Hirsjärvi and associates (2005). Questionnaire data was then processed in IBM SPSS.

6.4 Analysis

IBM SPSS was utilized to statistically analyze the quantitative data. Thus, qualitative data was used to support the quantitative findings, in order to measure opinions via triangulation with more reliability and in terms of participants' semantic stance towards the stimuli (Boone and Boone, 2012; Greene, Caracelli and Graham, 1989; Reinchardt and Rallis, 1994). Qualitative data was used as an explanatory vehicle to decipher why participants' responses were either positive or negative (Neal, Neal, Van Dyke and Kornbluh, 2014). Furthermore, frequency analysis (Auer-Srnka and Koeszegi, 2007) was also performed on the qualitative data, to ascertain the dominance of positive and negative valence in relation to each stimulus. All the Likert-scale data was based on the question: "How likely is it that you would use this technology" (1= not likely at all; 5= extremely likely). The question "how likely is it that you would use this technology" was designed to elicit responses in which the participants would envisage themselves in relation to the technologies. The intention in the study was to encourage participants to imagine their potential embodied relationship to the technologies and gauge their attitudes and associated emotions with potential use in mind. Thus, firstly the averages were used to descriptively represent how participants were disposed to the stimuli overall. Then, the standard deviation was used to describe uniformity or variation between the responses. It was not possible to utilize Pearson correlation (r) to examine the correlations between background variables and opinions, because the data did not obey normal distribution. Instead, Spearman's rank-order correlation was utilized due to its suitability for calculating correlations in ranking. Further, the significance of gender on opinion was examined through performing an independent variable sample two-tailed non-directional t-test.

7. Results

To summarize the overall results according to each hypothesis, it can be seen that the first hypothesis, which pertained to the relationship between the technology and the body (endo as compared to exo and external) is supported, in that, participants were more negatively dispositioned towards in-body CETs than they are towards CETs that are used externally to the body (see Figure 3). Here, it can be seen that the most favored CET was the smart dashboard (3,89), while the least favored CET was the brain implant (2,47). These results may be explained by the direct safety benefit seen in the smart dashboard, as opposed to the intrusive and risk fraught procedure and usage of the brain implant. Additionally, the second hypothesis pertaining to the relationship between the age of the participants and their attitudes towards the stimuli could not be confirmed, as the data did not comprise a normal distribution of age. However, the third hypothesis relating to gender and its effect on attitudes was supported via a significant difference in regards to two stimuli - the eye implant and smart glasses.

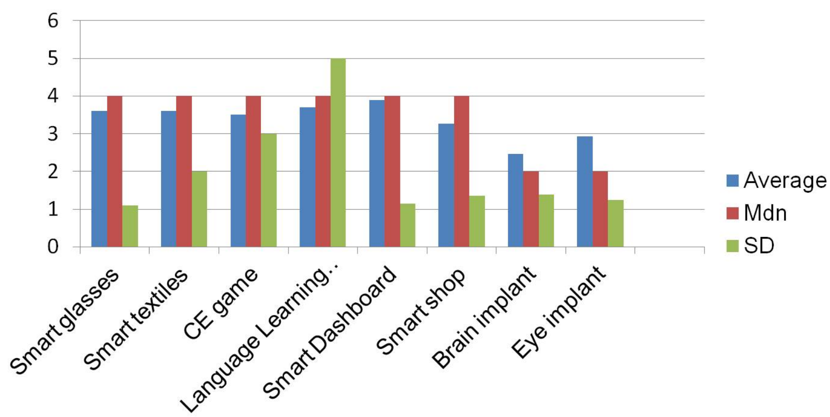

Fig. 3. Average results to the question – How likely are you to use this technology?

The qualitative results are also interesting to observe in terms of the quantity of comments voluntarily provided by the participants in light of the valence distribution (positive, neutral and negative) against the quantitative results. In light of the first hypothesis, Figure 4 illustrates how the brain implant can be considered not only the most negatively perceived, but also the most controversial, as it attracted 42 comments in total. Here, more comments were negative (28), three were neutral and 11 were positive. Interestingly, the CET which attracted the second highest rate of comments was an environmental CET, the smart shopping cart (37). In the case of the smart shopping cart, more comments were negative (17) than positive (14), which appears as a form of interaction effect on the graph between the exo-external CETs and the endo CETs. The negative reaction to the smart shopping cart may be explained by the significance of money in daily lives, and concern (suspicion) regarding personal information use for potential commercial exploitation, which in turn is perceived as a detriment to personal well-being. The CETs which attracted the least amount of qualitative comments were the smart textiles and the cognitive enhancement game (both 29 comments). Additionally, both had more positive comments than negative. Subsequently, both of these CETs had a quantitative average score of approx. 3,6. The smart dashboard, while receiving the most favorable quantitative rating attracted 35 comments, 20 positive, 10 neutral, and five negative. The smart glasses received 36 comments of which 20 were positive, 10 were negative and two were neutral.

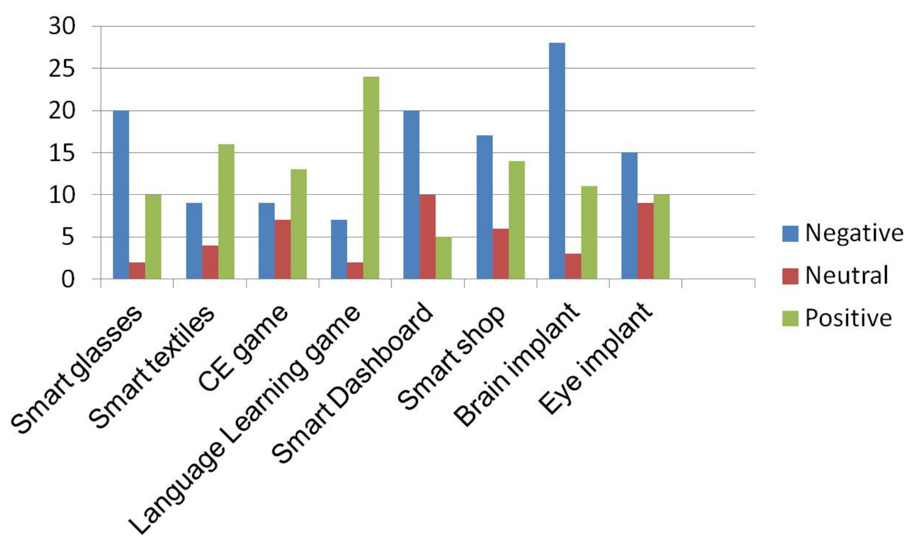

Fig. 4. Amount of comments attracted by each CET – positive, neutral, negative and total.

7.1 Attitudes towards external CETs

The general response of participants towards external CETs was relatively positive, whereby each external CET, or *exo* (exo-self), technology received an average of at least 3 out of 5. The weakest average being 3,27 for the smart store and the strongest being 3,89 for the smart car dashboard. Other external technologies received between 3,6 to 3,71. Digital games stood out when comparing frequencies, particularly in light of game play for the purpose of learn languages. Here, opinions and reasoning was conclusively positive. Only one respondent had mentioned that they would not, under any circumstances use learning games.

The examination into the relationship between opinions and gender showed a *statistically significant correlation* only in regards to the use of smart glasses. From the perspective of other external technologies, it could be seen that men and women responded fairly similarly. Thus, hypothesis H3 – "*The gender of participants affects their attitudes towards using CETs*" was supported in the case of smart glasses. Moreover, through examining the attitudes in connection with age via the Spearman correlation test, it was observed that there was no statistically significant correlation. This means that H2 was not supported. Furthermore, the results showed no significant difference in response to whether or not participants had previous experience with the technologies.

7.2.1 Smart glasses

The average ranking for smart glasses was 3,6. The median was 4, mode 4 and standard deviation 1,132. The average ranking from female participants was 3,38 while for male participants this was 3,78. The t-test used to compare the results revealed a significance of $p=,045$ ($\alpha=0.05$), based on which we may conclude that the results are statistically significant. Four respondents answered that they would not, under any circumstances, like to use smart glasses, and 27 mentioned that the likelihood of them using smart glasses in the future was extremely high.

Altogether, 36 respondents wrote open form answers to the smart glasses stimulus. Through reading the responses, it became apparent that there was interest in using the smart glasses however many of the participants were dubious in regards to the economic and social aspects of purchasing them. Several participants were skeptical in regards to the price of the glasses, and others were also doubtful in regards to the social impact the outlooks of the products would have. Additionally, participants wondered whether the smart glasses would have any real added value in comparison to already used technologies. For example, a female participant, 26 years of age stated that she would be more likely to use smart glasses when they are more commonly used.

> *"I would most likely use smart glasses when they are more commonly used, in the meantime I feel a little too self-conscious with them. I have thought about how smart glasses use goes with normal eye glasses. I don't know whether you use contact lenses due to this. I would like more information about what smart glasses can do and how I could benefit."*

Thus, she also explained how she had thought about how the use of normal glasses would work when trying to use smart glasses, and wondered whether for this reason contact lenses would be better to wear. Furthermore, this particular participant questioned the benefit of using the glasses. In relation to concern for appearance of the glasses, a male participant (28 years of age) stated that they looked disgusting. On this note, another male participant (26 years of age) stated:

> *"They need to be light and unnoticeable. Programmes should really be beneficial, and they should not obstruct the normal field of vision."*

Concern for vision obstruction was repeated in several comments, as was the need for people to see that the smart glasses are useful and beneficial, not just another gadget. Another female participant (40 years of age), mentioned that information is already visible and available everywhere anyway. Thus, information retrieval from the environment was not seen by this participant as an existing problem. Yet, what she did mention is the problem of being able to process and integrate the information.

Some of the participants invented ways in which the smart glasses would be useful, and through these suggestions arose unifying themes. One such application was suggested by a female participant (20 years of age), who mentioned that the glasses would be extremely useful in her future work as a pharmacist. In this example, pharmacists could efficiently search for customer related information without having to go to the computer.

7.2.2 Smart textiles

Smart textiles received an average ranking of 3,6, which is comparable to the smart glasses. The median was 4, the mode 4 and standard deviation 1,096. As opposed to the smart glasses, the smart textiles did not reveal any statistically significant results between the genders. One main difference between the smart glasses and smart textiles can be seen in the fact that none of the participants ranked that they would not use the textiles under any circumstances. Instead, 29 participants mentioned that they would very likely use smart textiles in the future. Additionally, 29 participants also provided free form comments. The comments indicated that many of the participants who were interested in smart textiles were interested in using them for sports and healthy lifestyle purposes. One female participant (26 years of age) and two male participants (22 years and 24 years of age) stated that they could see the benefits in using smart textiles for sports, which the 22 year old male participant went on to mention:

> *"I would definitely use this in connection to sport or just out of interest to see what was going on in my body."*

Another male participant (24 years of age) commented that these would be attractive in terms of tracking health and fitness. However, there were several participants who articulated that people do not need the assistance of any tool to follow what is happening in the body. Instead, they felt that people automatically know when something goes wrong. In fact, these participants placed concern in technology dependence, and the potential for disconnection or inducing a non-ability to read one's own body.

A female participant (38 years of age) stated:

> *"Too much self-monitoring isn't of any benefit, if you have a heart attack people surely will notice. People do not need to constantly be aware of themselves. This kind of clothing on a so-called healthy person could in my opinion lead to obsessive compulsive disorder in relation to own's own health conditions, and even neuroticism."*

This quote articulates concern for excessive self-monitoring that may link to self-obsession and/or even privacy issues regarding big data about the population's health. She also mentioned that people should not always be conscious of what is happening within their bodies. She felt that usage of these types of technologies amongst healthy people might even lead to obsessive compulsive disorder and neurotic behavior – which very much ties in with the previous participant's comment. The issue of over trusting the technology to accurately monitor health was further mentioned as a concern amongst several other participants.

Many problems were articulated relating to the use of smart textiles. Some of these problems related to price, functionality and durability. In comparison to smart glasses, smart textiles were considered more socially acceptable, because the textiles are easier to conceal than the glasses.

7.2.3 Cognitive enhancement games

The first of the cognitive enhancement games presented was the brain function game, which focuses on enhancing different areas of the brain. This game received an average of 3,55. The median was 4 and the mode 4. The standard deviation was 1,085. This stimulus did not reveal any statistically significant difference between the genders. Extremities were not emphasized in the data. Rather, 23 participants gave top ranking (five out of five) for the game and three ranked the game as something that would not, under any circumstances, engage with.

Out of the responses, 29 provided comments in the open field. Most of these came from participants who wanted to justify why they gave either positive or negative evaluations for the technologies. Through observing the responses, it became apparent that people who were especially busy, placed the game low on their priority list. This was due to what they explained as being lack of time to engage with these types of games. Another theme that arose in the qualitative data related to the significance of game experience. Several participants mentioned that they had experience in play similar games to the one in question, however, they stopped playing these games due to them being boring. One male participant (26 years of age) also mentioned concern for whether or not the effects of playing the game would be lasting, and for how long he would engage in playing such games before they grow boring. Moreover, interesting connections could be seen amongst the responses in line known theories. For example, one female participant (34 years of age) stated:

> *"Abilities which are enhanced through gameplay often have a limited transfer effect when applying those skills to real life situations."*

This statement comes complements Jak, Seelye and Jurick's (2013) critical view towards cognitive enhancement gaming. They mention that while positive effects may be observed regarding social connectivity and self-efficacy, methodological inadequacies in experimental research mean that there is no reliable knowledge regarding the long-term benefits of developing cognitive skills in digital games. What is more, is that Jak et al. (2013) do not deny that there are benefits, as there is much evidence to suggest that engaging people in mentally stimulating activities does produce long lasting positive effects on cognitive function, rather, they stress that due to the abundance of cognitive enhancement games available, it is difficult to track and ascertain exactly what the “transfer effects” – the effect that strengthening one learning area has on other learning areas – are of the technologies.

7.2.4 Language learning enhancement games

The second digital game stimulus was a cognitive enhancement game intended for language learning. The average ranking for this stimulus was 3,71. In other words, this was a slightly more attractive option than the brain function development game. The median and the mode were the same as with the previous technologies (4,00/ 4), however, the standard deviation was the smallest (1,028). Out of all the participants, only one indicated that they would, under no circumstances use this type of game. Twenty-seven participants on the other hand indicated that they would be extremely likely to use this type of game. However, this case did not reveal any statistically significant differences between the genders.

Altogether, 33 respondents wrote comments in the open field. The data emphasizes that people’s current needs for learning games are strongly reflected in their responses. For example:

> *“I have tried language learning games earlier on and have found that they help. In particular, with languages that use symbols such as pictures (i.e., Japanese and Chinese) and when language learning is not more simpler than learning by rote, these types of games are extremely useful in symbol learning and remembering.”* (Female, 26 years)

> *“Most likely I would use this as support is this type of application was on offer and IF I had the need to learn a language or practice. Now, I don’t have one.”* (Female, 53 years old)

Several participants explained that they did not need this type of game at the moment, however they might experience them as beneficial in other circumstances. Thus, the female participant (26 years of age) mentioned that she had tried language games and found them particularly useful for learning written languages containing symbols (e.g., Chinese and Japanese).

7.2.5 Smart dashboard

The smart (car) dashboard was the highest ranking technology of this study. Here, it had scored an average of 3,89, with a median of 4,00, mode 5 and standard deviation of 1,152. Out of all the participants, five were of the opinion that they would not, under any circumstances want to engage with a smart dashboard, whereby 50 participants indicated that they would very likely want to engage with one. Gender did not have a statistically significant effect on the opinions. The smart dashboard inspired many to describe their own hopes and potential use scenarios. Participants mentioned:

> *"In principle, nice to try. Therefore, this is a refreshing and attractive thought. Problems arise if there is too many elements in the screen, so that the text becomes too small. Already the amount of different things in the current screen makes it difficult for me to read when the letters and numbers are too small."* (Male, 70 years old)

Here, usability issues that often arise in age-related studies such as the size and amount of text in user interfaces (Chadwick-Dias, McNulty & Tullis, 2003) are mentioned by this 70 year old participant. Yet, these are more technical and traditional usability design concerns that do not seem to incite strong emotions, at least from the perspective of this static attitude study. Along the same lines, a female participant (40 years old) mentioned:

> *"This is interesting and could be useful. However: what kinds of long-term effects will there be? Will the speed limits be increased, and will there be an increase in traffic (and*

traffic exhaust fumes), will the driver experience become calmer or more restless etc.? This may, no doubt be quite an absolute no for professional drivers."

This participant was considering a more holistic perspective of the greater effects this technology would create, especially in terms of the mental and emotional states of the drivers. Moreover, another participant (female, 34 years old) considered the effects the technology would have on the techniques of the car itself:

> *"It's quite scary to think of the increasing in parts that can potential get broken within the vehicle. People cannot reverse anymore if there isn't a radar indicating whether or not the car is going to collide with something or not. And then, when the technology breaks down, expensive bills are incurred through the services."*

Thus, despite the fact that the dashboard received the highest attitude score, negative aspects were also raised. The above quote emphasizes the economic impact of faulty technology, and technology breaking down. Moreover, there is indication of the cognitive reliance people have on these technologies, meaning that they are destined to pay large sums of money to ensure that the technology is not only present, but working. Furthermore, other comments indicated concern for the realization of the user interface, especially in terms of usability and safety while driving.

7.2.6 Smart store

The smart store received the lowest ranking of all the stimuli with an average of 3,27. However, the standard deviation was noticeably higher (1,349 as compared to 1,028-1,152) than with the other stimuli. The median and mode were in line with the other technologies (4,00 / 4). Also, from the frequencies it can be observed that the smart store divided participants' opinions to differing extremes. Here, 14 participants gave the worst ranking possible (1), while 28 participants gave the best ranking possible (5). Statistical differences were not present between the genders.

Out of the participants, 37 wrote comments in the open field. Positive as well as negative opinions are evident in the comments. Positive comments towards the smart store were mainly of the opinion that the technology would enable better than ever targeted marketing to the consumer, which was considered a good thing. On the contrary however, were comments which characterized the possible advertising channels as irritating, worrying, and even frightening.

Interestingly, when considering directly commercial applications such as technologies related to smart stores, there is increased concern for privacy and security, as an individual's economic livelihood is in question (Anderson & Moore, 2007; Cavelty, 2014; Frydman & Camerer, 2016). Similarly to some sentiments mentioned in relation to the smart dashboard, people are hesitant to transfer control of their finances over to technology and businesses. As with the concern for becoming cognitively and financially dependent on the reliability of dashboard functionality, here, concern is placed on the business's technology making financial decisions for the human consumers. As one 30 year old male participant stated:

> *"This kind of opportunity to collect information about purchases, in-store movement and the user's personal properties is only in favour of the business and capitalism. It wouldn't be a great step for the smart trolleys to receive targeted advertising, and in this way only the business owner is benefiting."*

Another male participant (24 years old) articulated:

> *"Here, there are good sides and bad sides. It's too easy to collect personal information about the users, but store chains already do this through bankcards and frequent customer rewards. I wouldn't use this myself, but from the perspectives of people with allergies and alternative diets this could be a good system."*

This thought was reinforced in some other comments such as:

> *I'm a vegetarian, thus welcome personalized suggestions in-store. In the store also usually I take the familiar routs and sometimes miss new items such as everyday food, which would be great to find new products quickly…"* (Female, 25 years old)

Thus, while the smart store attracted the lowest score in terms of the external CETs seemingly due to the intertwined relationship between the individual, their finances and corporate gain, positivity was expressed from the perspective of personalized advertising, suggestions and guidance that informed customers of opportunities outside their current knowledge.

7.3. Attitudes towards internal (in-body/ endo) CETs

The results gave clear indications of more unified attitudes towards these technologies. Both in-body (endo) technologies – the brain implant or memory chip, as well as the eye implant – received average rankings below the neutrality mark (3). Whereas, the lowest ranking of the external (exo) technologies was 3,27. Thus, hypothesis H1 is confirmed by these results. Furthermore, significance difference between the genders can be observed in response to these technologies, which also supports H3. However, no significant differences were noticed in relation to age and opinion. Additionally, in response to the question regarding previous use of the technologies there were no significant differences. And arguably, this sample was too small to gain insight into generalizable results on the relationship between familiarity through use and the technologies in question.

7.3.1 Brain implant - memory chip

The results gave clear indications of more unified attitudes towards these technologies. Both in-body (endo) technologies – the brain implant or memory chip, as well as the eye implant – received average rankings below the neutrality mark (3). Whereas, the lowest ranking of the external (exo) technologies was 3,27. Thus, hypothesis H1 is confirmed by these results. Furthermore, significant difference between the genders can be observed in response to these technologies, which also supports H3. However, no significant differences were noticed in relation to age and opinion.

The brain implant (memory chip) received the lowest ranking out of all the technologies, whereby the average was 2,47 (p=,050). The response median was 2,00 and mode 2, with a standard deviation of 1,386 (the greatest out of all the technology opinions). Women ranked the brain implant decidedly lower (2,20) than men (2,68) – who proved more neutral in their approach to the technology than women were. The brain implant also attracted the most negative comments. Thirty-seven participants stated that they would not, under any circumstances, use this technology. Forty-two participants provided comments in the open field.

In particular, the participants who gave the worst possible ranking were the ones who provided comments to rationalize their response. For example, a female participant (50 years old) said:

> *"I would not take this into use until it has been researched in regards to how it affects the brain."*

Thus, there was clear concern for how the technology could possibly negatively affect the health of the brain. Another female participant (38 years old) stated that no such technologies will be implanted in her, if it was not a question of life and death. This same sentiment of fear for brain interference and tampering can be seen in a male respondent's (46 years old) statement that anything touching the brain petrifies him, and that he remembers everything he needs to remember. He goes on to mention that perhaps it would be different for an ageing person whose brain function is below average.

On this note, one female participant (25 years old) stated that the acceptability of the technology depends on the situation. In particular she explained that there are examples in society, such as information intensive professions, which would benefit from these implants. She explained that she sees a lot of benefits from these technologies such as remembering important personal events, and their ability to e.g., alleviate pain. Thus, emphasis is placed on its ability to improve quality of life. Furthermore, she – similarly to a male participant (26 years old) who stated:

> *"I still don't trust this type of technology and nor do I want to be the first to try it."*

Here, the dimension of trust is clearly articulated, and further on is his comment he directly mentions that it seems strange to undertake an operation just in order to receive an implant. Thus, the unnecessary invasion of the body through surgery (similar to the female participant above) and the issue of trust, whether in terms of either privacy or technological reliability or both, are concerns for these types of internally consumed devices. Additionally, similarly to critique offered for the externally consumed technologies such as smart glasses, participants remarked that they would want to be sure of the benefits of use before considering. This was also stated by the 26 year old male participant:

> *"Then when all the advantages and disadvantages are mapped, I could begin to consider."*

Specific issues that arose, which relate to ethics literature include: trust, information security and autonomy (Bostrom and Roache, 2008; Gray, 1997; Warwick, 2003). Especially, autonomy or individuality and the ability to be surprised were something a female participant (38 years old) noted, and that sometimes the ability to forget is also a blessing and belongs to a healthy living. In a similar vein a female participant (53 years old) stressed:

> *"I want people to still be able to make mistakes and skewed choices that provide fun surprises, and of course to maintain the randomness of memory. I don't even want to*

remember everything in that sense problems don't come from forgetting. Remembering and forgetting are a part of life."

The above quote stresses humanity and its imperfections as an important part of life. Thus, in a semi-explicit way the participant is demonstrating concern for maintaining what it is to be human – the uniqueness, randomness and ability to forget. Without these small glitches one could even question the existence of subjectivity, and whether or not individual consciousness and intentionality even exist. Thus, modification to the brain may even be considered not simply a step towards trans or post-humanism, but indeed non-humanism.

7.3.2 Eye implant

The eye implant received an average of 2,93 (p=,013), whereby females gave an average ranking of 2,63 and males gave an average of 3,17. Thus, men overall gave a slightly positive evaluation, while women were more skeptical towards the technology. The eye implant median was 2,00 with a mode 2, and standard deviation of 1,237. Thirty-four participants provided comments in the open response field. Thus, this technology attracted substantially less comments than the brain implant, and the comments given did not reflect the type of negative inclination as the former. Fifteen participants gave the eye implant the lowest ranking possible (1), and similarly to the brain implant, participants also displayed fear towards the eye implant, which was not clearly explained. In the positive comments there was a unified sentiment, indicating that they would be happy to use the technology, if first, all technological and other related problems are solved. Then its use would seem satisfactorily safe and desirable.

Among the comments the factor of fear was apparent. One female participant (26 years old) noted that on the one hand the idea is frightening while on the other, it seems to be a very good idea. But, she did not know whether or not she would personally go to get this implanted. Another female participant (25 years of age) mentioned that the idea of being operated on sounded dangerous. Furthermore, in her comment arose another of the core ethical issues in this domain and that is of the divide between the haves and the have nots (Gray, 1997; Warwick, 2003) – those who can afford this technology and those who cannot. Here, the matter of incremental or gradual adoption is also seen as a beneficial way of introducing the technology. On that note, another female participant (33 years old) stated that the technology seems too futuristic, which in itself is frightening. A male participant (34 years old), similarly to the brain implant stimulus, responded that he would not be the first to try this – or at least not in this generation of this specific technology.

The eye implant was the last of the stimuli to be presented. One part of the participants wrote in the field for 'other comments'. One comment in particular, written by a female participant (38 years old) was extremely interesting, as it related to the reviewed literature on cyborgism:

> *"It is ethically especially dubious to go and modify and "improve" people. A person is a person not a cyborg".*

Thus, concern was expressed along the lines of post-humanism. No doubt the technology of eye implants conjures images from science fiction movies, but also when considering folklore and traditional sayings such as, "The eyes are the gateway to the soul," implanting information intensive devices in the eyes may be interpreted as an intervention towards post-humanity. A female participant (33 years old) suggested:

> *"This also looks too futuristic and thus, slightly scary."*

Thus, the move towards a radical future technology that is inserted into the body draws concerns. The eye implant attracted 34 comments. Of those comments, 10 were positive, 15 were negative and 9 were neutral. The positive comments tended to lean towards the fact that contact lenses and laser surgery are both commonly used these days. Negative comments indicated that the same kinds of benefits can be derived from contact lenses and smart glasses, without the fear and interference of surgery. In particular, drastic nature of surgery was repeated as a concern several times in comments such as:

"I don't want to give up my glasses. Eye operations are scary." (Male, 28 years old)

"Eye surgery sounds perhaps a bit too dangerous just like the brain implant insertion into the head…" (Female, 25 years old)

However, there were comments that expressed concern for the surgery itself, yet pondered over the benefits of the technology and possibilities for using it in the future:

"On the one hand scary, on the other hand a good idea. I can't say whether I would dare to undergo this type of procedure myself." (Female, 26 years)

There were also participants who mentioned that they possibly would not mind using the technology once it had been tried, tested and running for a generation or two:

"When the implants have been experienced and there is enough information, maybe I would think about using these in the future." (Female, 38 years)

"The same as before, I wouldn't try these during the first generation, but then when the technology has been assured and the children's diseases smoothed over, absolutely. Eyes and brains are such sensitive areas that I don't want to risk them before there is a substantial success rate." (Male, 35 years old)

> *"Like before. If the risk, price and use comfort (possibly eye symptoms etc.)are OK, I would be interested in using these."* (Female, 50 years old)

Thus, the modification of the human body was considered unethical and dubious. The same 25 year old female participant as mentioned above stated:

> *"…but at the moment I don't know whether I would need the features that are in the example. From the perspective of the implants immediately to my mind comes the issue of social inequity, which inevitably arises from the fact that some people have the resources (can afford) to improve their own abilities via implants and some do not. Undoubtedly it feels like chaos will derive from this. Hopefully this type of technology will not become so common that this type of scenario will materialize."*

Out of the neutral comments, most stated that in comparison to other methods of sight enhancement, eye implants would be considerably more risky, and the use of these implants to enhance already normal visual abilities was considered doubtful. However, at the same time the neutral comments emphasized that if, for health reasons, this would be a good option then there should be no problems in using them. Cases in which use of eye implants would be acceptable were given regarding for example, the correction of sight amongst the ageing population, and with people who are visually impaired for diverse reasons.

8. Discussion

In line with hypothesis 1, the results revealed that participants were more favourable towards technologies consumed outside the body, rather than those designed to be implanted internally. Subsequently those which are to be inserted and consumer inside the body attracted the lowest attitude ratings and more negative comments. Certainly from social, psychological and none-the-least physical perspectives, the idea of placing something – particularly information technology or drug-related – inside the body raises many concerns ranging from the ideas of tampering with the nature of healthy bodies (Cabrera, 2015; Hogle, 2005), brain and body-hacking (technology taking over the body and mind, see, e.g., Edwards, 2019; Sandberg et al., 2019), to privacy and security (see e.g., Usieto & Minguez, 2018). Those who have viewed movies such as the *Matrix* and *Total Recall* will understand the images conjured through such technological invasions of the body, and in particular the idea of societal control through surveillance, tracking and experiential illusion. The matter of the significant difference in ratings between men and women in relation to the brain eye implants was interesting. This difference may be explained by gendered attitudes towards the body (Dillon, 2017). Research related to gender and emotional responses towards surgery have shown greater anxiety experienced by women, than that experienced by men (e.g., Mavridou et al., 2013). Yet, other gender comparison studies related surgery revealed a relationship between emotional response and the type of surgery undertaken (i.e., in light of the outcome), e.g., plastic surgery (Henderson-King & Henderson-King, 2005), whereby the perspective gain in terms of physical attractiveness outweighed concern for the pain and potential loss incurred by surgery. In the latter study's case, this gain over pain was more preferred by females than males, demonstrating a strong link between perceived social and psychological benefit and willingness to engage in invasive procedures. Perhaps this could indicate a social-cultural link to the results regarding internal CETs, whereby, either a) males perceive the social (economic, psychological) gain stronger than the female participants, appealing to areas of expectations connected to masculinity such as intellect, strategy, ability to focus and remember, as well as the potential to increase professional status and thus, livelihood. Or, b) the connection between the female body and the already abundance of surgery on offer to improve the female has now reached saturation, which may incur a backlash by females towards further tampering with the body.

In addition to factors such as pain versus gain in relation to the physiological body, there may also be explanations which rest within social, economic and cultural factors that link to long established discourse on gender and cyborgism. Due to both the cultural and futuristic nature of the research related to these factors, studies have often been undertaken in the fields of media and film studies. Yet, the main arguments pertaining to gender and invasive cyborgism are: 1) the ways that femininity is represented through cyborgs in media can be predictive of how females are being constructed for the future. This can be interpreted as the somewhat invisible yet present voice, e.g., seen in the movie *Her*, or the fact that the technology affords the agency of female actors (Dillon, 2017). Either way, once again in relation to current perceptions of the body and what it is to be human, the above quoted comment by a female participant stating that she does not want the intrusion of implants, due to the fact that she wants to maintain the idiosyncrasies and imperfections that make people human (cognitively and emotionally).

With the human history of technology and males tampering with and defining the female body, it is interesting to note Mark A. McCutcheon's (2018) observations of the historical cyborg/biotechnological monster, *Frankenstein* that, "technology… has become widely understood as a gendered discourse, a domain of boys and their toys. How ironic then that the epistemic foundations of this discourse were set down… by the prodigious and audacious imaginings of one well-read teenage girl" (p. 204). Already in 1818, the technological backfire of tampering with the body, man's aspirations to play God and conquer nature and the serious consequences that followed were expressed through the imagination of Mary Shelley (Raulerson, 2019). CETs existing and consumed outside the human body already bring with them concerns relating to privacy, safety and security, yet somehow once the body has been surgically and intrusively hacked by external information hardware, there are fewer chances of escape.

8.1. Limitations

This study has several limitations such as the relatively small sample size for a primarily quantitative questionnaire study. Moreover, the sample group was irregularly distributed and a more systematic sampling approach should have been implemented accounting for age groups, gender, educational background and profession to name some. Additionally, future studies would benefit from a more rigorous approach to examining participants' familiarity with the technologies, as well as experimental techniques designed to gauge physiological and subjective emotional responses such as biometrics, and self-reporting scales as have been adopted for similar types of studies including those related to robotics and human interaction (see e.g., Meisner, Isler & Trinkle, 2008; Schniter, Shields & Szyncer, 2018; Stark, Mota & Sharlin, 2017). This small-scale study however, revealed an interesting relationship between gender and internally consumed CETs (brain and eye implants), suggesting that the acceptance of such technologies along with associated emotional reactions is quite complex. This indicates that upon further, more rigorous and systematic examination between the sexes may reveal not only how they differ in regards to the internally consumed CETs, but why. One interesting notion to explain the differences may be connected to gendered relationships towards the body, that in turn may be affected by several factors such as biological and evolutionary psychological, or even social and cultural. Yet, these require further in-depth study, and would no doubt provide fruitful insight into both the relationship between the genders towards these types of technology, but also insight into the social and psychological effects of the location of gender within technological discourse.

9. Conclusions

The article presented a questionnaire study regarding the opinions people have towards CETs – exo and endo – in-body, on-body and environmental. Due to the nature of the topic of the empirical study, cognitive enhancement technology, several factors were considered which may influence people's opinions towards the technologies implicated: ethics, emotions and how the technology examples relate to the human body and society at large.

The study's results supported H1 that CETs intended for and utilized internally to the body would be rated more negatively than those intended for use outside the body. Moreover, H3 – the effect of gender on opinions of CETs can be seen to be supported in the example of the smart glasses, and to some extent both endo-CETs (brain and eye implants). H2 regarding the influence of age on opinion was not supported in any of the examples. Through observing the relationship between the quantitative results and the qualitative comments a reflection of commonly discussed ethical issues can be seen. These ethical issues include: concern for privacy and the divide between the haves and have nots. Other matters stood out such as concern for technology dependence, pricing (attached to the CET/cyborg divide), social acceptability (those game enough or not to be first movers), issues or safety and health (reluctance before adequate research and proof of safety), and the threat of the loss of autonomy.

Other important considerations derived from this study can be seen as general issues arising from informational technology development and consumption today, which include: concern for too much information; concern for the inability to forget (particularly in the age of social media); and our ability to read our own biological patterns and health circumstances. The study's findings have direct design implications in terms of understanding how people read the technology, and what concerns them physically, socially, and ethically. Furthermore, the specific finding of the significant statistical differences in gender relating to how participants scored particularly the eye implants and smart glasses calls for further empirical and theoretical investigation. Future studies should probe into the specificity of the eyes and whether or not throughout history and other research, gender differences have been discovered for differing social, cultural, psychological and biological reasons. While all technologies progress through many stages of social acceptance such as hype curves, it is important to keep in mind the values of potential users. Given the significance of hype curves, societal, cultural and consumption trends, there is a need to study people's opinions for a longer duration of time at regular intervals. Technologies which may seem daunting and even dubious to people at this point in time such as eye and brain implants, may in 10 years' time be the norm. Increasing popularity of the cyborg and body hacker movements may support this.

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