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Intelligence, empathy, and memory: Exploring moral enhancement through gene editing, training, and computer–brain interfaces

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In this research article, I seek to expand the conversation regarding moral enhancement by identifying traits or capacities that if enhanced would lead to an increase in moral behaviour. I decided to focus on the three capacities: intelligence, empathy and memory. These abilities do not necessarily lead to moral behaviour on their own; however, building on a study on the relationship of intelligence and morality, I argued that enhancing intelligence and empathy simultaneously allows for moral behaviour as an emergent property. Intelligence alone is not sufficient because even though greater intelligence leads to more prosocial behaviour, prosocial behaviour is not inherently moral. Empathy alone can lead to partiality, especially favouring those who are a part of one's in-group. The virtue of prudence, practical wisdom, relies on more than intellect or reason; it requires lived experience in order to effectively deliberate. Memory provides intelligence with that information. There are a variety of ways in which human enhancement can be pursued. I chose to focus on three methods in this study: gene editing, training and computer–brain interfaces. Turning to the existing scientific literature, I attempted to find examples or potential ways in which intelligence, empathy and memory could be enhanced through these methods. Genetic examples are difficult given the complexity of multi-gene traits, and that heritability is only a small percentage of overall variance. Training these capacities has had limited success, and there is no consensus in the literature on how effective is the training. Computer–brain interfaces appear to offer potential, but some experiments have only just begun on human subjects, whilst other approaches are still being tested on other animals.

Contribution: This article ends with an appeal to prioritise moral enhancements over other forms. Doing so allows for a great impact on society and a safer overall approach to enhancements.

Keywords: transhumanism; moral enhancement; gene editing; empathy and morality; memory and prudence; bioethics; virtue; empathy training.

Introduction

As humans learned that traits can be inherited, they have sought ways to bring about desired outcomes. In plants and other animals, it took the form of artificial selection to choose which organisms reproduced in order to increase crop yield, milk production, etc. People also desired to perform the same with humans, giving rise to the notion of eugenics, controlling reproductive access in order to improve humanity by selecting desirable traits. Proponents of eugenics can be seen as the first transhumanists. Transhumanism is a broad movement that seeks to take control of human evolution, to improve the human condition, enhance human abilities, add new capacities and create post-human species. With recent advancements in technology, including clustered regularly interspaced short palindromic repeats (CRISPR) gene editing and computer–brain interfaces (CBIs) such as Elon Musk's Neuralink, there are some who believe that significant enhancements may soon be available to at least a portion of the population who can afford them and are willing to be amongst the first to take the risk. The questions surrounding human enhancement engage a number of fields, and this interdisciplinary work can become complex and tangled. Enhancing current abilities that humans have, or even possibly introducing new abilities or traits raises scientific, theological and ethical questions. A fundamental question for theological

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enquiry is the question of the malleability of human nature; is human nature static or potentially dynamic? Related to this is a question about the end or *telos* of humans, and how much modification can be made before the end is altered so much that it is possible to think of one or more post-human species. Elsewhere I have examined these questions in the context of gene editing (Molhoek 2018). There is also a great deal of existing literature on these questions (Mercer & Trothen 2015). Therefore, this article focuses on addressing ethical issues regarding the question of moral enhancements.

Whilst the types of possible enhancements include better health, longer life and the introduction of new abilities or capacities, this study focuses on the category of moral enhancement. I begin by identifying three traits or abilities that together would lead to an increase of moral capacities. The three potential candidates that I choose include intelligence, empathy and memory. Turning to the existing scientific literature, I suggest three methods of moral enhancement: genetic, training and CBIs. Examples of how intelligence, empathy and memory could be affected by these methods will be explored. However, because of factors, such as biological complexity, disagreements in experimental results, and a lack of full knowledge or understanding, most of these examples are well beyond the current capabilities of science and technology. I conclude by arguing why moral enhancements should be prioritised over other kinds of enhancements, or at the very least, pursued simultaneously.

What traits to consider enhancing

Intelligence

As many scholars once believed that reason and rationality were what separated or elevated humans above other species, proponents of human modification always have supported the amplification of intelligence. Even before the structure of DNA was known, there were supporters of eugenics who believed that it was not only best for the flourishing of the societies in which these supporters lived but also best for the survival of humanity as a whole to artificially select for traits that society deemed as positive and to select against undesirable traits. Like humans did with agricultural crops and domesticated animals, the idea is to promote mating between those with desired traits and to eliminate unwanted traits from the population, either from a lack of access to mating or by forced sterilisation. Intelligence is a trait that is usually seen in a positive light, particularly because it was human cognitive abilities that seemed to elevate them as a species above even the most closely related species. Increasing the overall intelligence of the species, then, would be beneficial for both individuals and the species as a whole.

The support for increasing intelligence is strengthened by a number of studies that claim an increase in intelligence is connected to an increase in prosocial behaviour (PSB). Prosocial behaviour:

> [*I*]s a voluntary behavior that is intended to benefit others (Eisenberg, Spinrad & Knafo-Noam 2015), or at least promotes harmonious relations with others (Hay 1994). A range of positive social behaviors, including donating, sharing, formal and informal helping, and cooperating, can be labeled as prosocial (Eisenberg et al. 2015; Hay 1994). (Guo et al. 2019:1)

Whilst many studies argue that cognitive ability leads to greater cooperation or giving, there are also studies that argue that this connection only exists for complex tasks, not simple ones, or that great attention has been paid to kin only (Guo et al. 2019:1). Guo et al. attempt to make sense of these conflicting studies.

The results of Guo et al.'s study revealed that there was 'a positive association between intelligence and self-reported PSB. This is consistent with previous findings that highly intelligent individuals are more likely to engage in prosocial and civic activities' (Guo et al. 2019:5). The study also concluded, however, that there were also mediating factors, namely, empathy and perspective taking. Guo et al. (2019) argued that:

> Higher levels of cognitive abilities (e.g. executive function, language and mentalizing abilities) are contributive to more empathic responses (e.g. experiencing or sharing others' thoughts and feelings, generating a real concern for others), which in turn enhance the willingness to help others. (p. 6)

A third conclusion was that highly intelligent people identify themselves as moral. This, they argue, is because of choosing to adopt or internalise the values that accompany prosocial behaviour and choosing to make morality an important part of their identity (Guo et al. 2019:6).

Overall, then, it appears that greater intelligence leads to more prosocial behaviour. Some of these behaviours, such as generosity, are generally considered moral actions themselves; however, I would argue that not all prosocial behaviour is inherently moral. Even Darwin believed that prosocial behaviour was something that multiple species developed through natural selection (Simpson & Beckes 2010:35). Humans may be more prosocial than other species; however, even actions such as an individual sacrificing for the good of the group are not something that biologists believe is exclusive to humans (Simpson & Beckes 2010:36). Altruism for evolutionary biologists is not something that is incompatible with biology; kin selection and inclusive fitness are concepts used to understand how an individual's sacrifice can still serve their own biological drives to have their genes passed on to future generations.

Whilst cooperation in evolution is often used as a counter example to the idea that competition in biology must be violent, some prosocial behaviours, such as civic engagement and cooperation, are morally ambiguous. People can get involved with various civic organisations because they care about their community; however, they can also do so in order to gain power or maintain an advantage they currently possess. Likewise, cooperation can be a good thing; however, there are a multitude of examples in history of humans doing terrible things when they cooperate. It takes cooperation to wage war, to commit genocide or to oppress a population. Even the example I provided earlier of generosity has moral ambiguity. Although Aristotle named generosity a virtue, it is clear that people can give for a variety of reasons. The most moral of these reasons would be to help those in need; however, giving can also be done to gain influence or to increase one's legacy.

Because of the moral ambiguity of prosocial behaviour, I think the conclusions that Guo et al. reached are extremely important. Intelligence alone is insufficient to ensure greater moral behaviour. Whilst greater intelligence may lead to more prosocial behaviour, it is the internalisation of this behaviour into one's character that generates greater self-reporting and self-identifying of being moral. On top of this, Guo et al. made it clear that even intelligence is mediated by perspective taking and empathy. Therefore, if enhancing intelligence is something that people want to pursue, then the enhancement of empathy must be discussed at the same time.

Empathy

Empathy has received a great deal of attention in the academic literature. In fact, using search data from PubMed, there has been an increase of 300% 'in the number of scientific publications using the term "empathy" during the past 10 years' (Decety & Cowell 2014:337). Similarly to intelligence, there is a general understanding that empathy promotes prosocial behaviour; however, there are also fundamental questions about the role of empathy for morality. Although the Guo et al. study cited above argues that perspective taking and empathy play a mediating role between intelligence and morality, there are some scholars who question whether empathy is necessary for morality at all. Whilst the role of empathy in morality may be disputed, its role in how humans relate to one another socially is not. The simplest definition of empathy is 'the ability to share the feelings of others' (Bernhardt & Singer 2012:1). Some scholars divide empathy into two types, lower level or basic empathy and higher level empathy. Lower level or basic empathy is when people experience empathy though 'emotional contagion', where one on a nonconscious level adopts the same emotional state as someone nearby, typically through mirror neurons (Masto 2015:75). Higher level empathy is not automatic; it requires a person to think 'what it is like to be the other in the other's situation, and imagining what it is like to be oneself in the other's situation' (Masto 2015:75). Infants are a prime example of emotional contagion, because they take on the feelings of distress that those who interact with them have; however, as they cannot distinguish between self and other, it is unclear whether this is even lower level empathy. Some scholars refer to this as egocentric empathy or an archaic form of it, but will eventually allow for the development of actual empathy (Chen, Martinez & Cheng 2018:2).

Like intelligence, empathy on its own does not necessarily lead to moral behaviour. The virtue of justice, for example, is about providing people what they are due. Because empathy can create emotional connections between people, empathy can interfere with the pursuit of justice by leading people to be less impartial and favouring some people too much (Decety & Cowell 2014:14). It is easier to feel empathy for people who are similar to or a part of their in-group; however, it is possible that empathy could be used to expand one's moral circle, to learn how others experience the world and to have a better sense of their feelings; however, there is no consensus in the literature that empathy is required for morality.

Whilst intelligence and empathy on their own are ambiguous from a morality perspective, I would argue that when combined, they can provide valuable insights into particular aspects of morality. To put it another way, moral concern is an emergent property that arises from the use of both intelligence and empathy. This is what Guo et al.'s study concludes that it is the combination of both intelligence and empathy that allows for the internalisation of moral value from prosocial behaviour. The arguments against intelligence and empathy as contributing to moral judgement mainly focus on partiality, a perspective in which individuals tend to favour those who are most like them. I believe the best way to combat this is with both intelligence and empathy. If people tend to view those who are like them more favourably, then what is lacking is the ability or desire to take seriously the perspective of people who are different. Empathy can help address this; however, of course, empathy itself can fall short and lead to partiality in a variety of ways. Intelligence, then, helps inform empathy beyond the emotional response, to determine whether the partiality that is being felt is appropriate or whether it needs to be adjusted in light of a broader perspective. I would argue that whilst empathy and intelligence are not virtues themselves, they contribute to the moral virtues, especially justice and prudence. The full examination of whether empathy is necessary for morality is beyond the scope of this essay; however, I believe that the coordination of intelligence and empathy can contribute to moral enhancement.

Memory

Increasing intelligence improves overall cognitive functioning; however, this does not necessarily lead to an increase in the capacity of the moral virtues. Clearly enhanced intelligence would impact human predispositions for the intellectual virtues, but cognitive ability alone does not suffice for the moral virtues. Reason allows humans to understand first principles; however, moral deliberation is not the exercise of pure reason. Aristotle refers to practical reason as the moral virtue of prudence. This virtue helps people to determine what ends fit into the overall goal of the Good, *eudemonia*; however, it also provides the means to a particular end in terms of moral deliberation. In order to accomplish the latter task, prudence requires experience to draw upon one's memory of previous events and specific circumstances (Aristotle, Thomson & Tredennick 1983:156). Therefore, increasing the brain's capacity for storing or accessing memories would allow for improved moral deliberation. An enhancement that is not yet possible in humans is the implantation of memories. Incorporating the memories of others, especially those who have been identified as moral exemplars, would provide people with an even greater breadth of experience from which to draw.

Types or methods of human moral enhancement

Having identified three traits that could be useful for moral enhancement, this section highlights possible ways of enhancement. These examples are not meant to be an exhaustive list of possibilities, rather, they are meant to point to present and future ways of approaching enhancement. Three types or methods of enhancement are explored: genetic, training and CBI, which will only focus on intelligence, empathy and memory.

Genetic enhancements

Intelligence

Whilst there is a great deal of interest in studying intelligence, from determining how much is heritable, whether there are biases in tests that are cultural, to what brain regions or genes might be associated with greater intelligence, there is still a great deal that is unknown. Sauce and Matzel (2018:27) concluded 'that IQ has a high heritability and a high malleability' due to environment. Because intelligence exhibits both high heritability and malleability, they argue that neither heritability nor malleability can be the most important factor, rather the interplay of gene and environment is the dominant approach. This is an important insight for the enhancement of intelligence because any genetic enhancement will have less impact than enhancing a trait that only has high heritability.

Utilising 10 years of research on genetics, intelligence and brain imaging, Deary, Cox and Hill examine genetic correlations of intelligence and measurements of brain volume, including 'intracranial volume, total brain volume, grey matter volume, white matter volume, and volume of the left posterior cingulate cortex' (Deary, Cox & Hill 2021). Healthier white matter correlates with faster reaction times and greater intelligence. However, they argue that both genetic and brain imaging differences in intelligence 'account for a minority of intelligence variation' (Deary et al. 2021).

Trying to determine specific genes or areas of the genome that are connected to intelligence has been a complex task. Twin studies, comparing the DNA of family members, and analysis of the genome as a whole have led to the conclusion that there are:

> [C]ommon genetic factors that influence both brain size and intelligence (Thompson et al. 2001; Posthuma et al. 2002, 2003; Toga and Thompson 2005; Hulshoff pol et al. 2006), a major contributor to the heritability of academic achievement (Krapohl et al. 2014). (Ge et al. 2019:3472)

Ge et al. focused on fluid intelligence because whilst it is only one component of general intelligence, fluid intelligence correlates with general intelligence measured by both imaging and genetic studies. Fluid intelligence is what allows for 'novel problem-solving' (Ge et al. 2019:3476). There was also a correlation between cortical thickness and fluid intelligence. Both fluid intelligence and cortical thickness were found to be heritable, so the study attempted to determine whether the two had a shared genetic basis. The conclusion was that there were 'positive genetic correlations observed in the predominantly left inferior precentral gyrus (including Broca's speech area), superior temporal cortex (including auditory cortex), supramarginal gyrus (including Wernicke's language area), and proximal regions' (Ge et al. 2019:3476). However, there is not sufficient evidence to claim that this genetic correlation between fluid intelligence and cortical thickness is a causal relationship.

What these studies indicate is that the biological enhancement of intelligence, whether it is through gene editing or somehow affecting the health, size or volume of brain tissue, is a complicated matter, and even if specific genes were identified to have an influence on general or fluid intelligence, the actual variation attributed to biology is relatively small. For the discussion at hand, this means that as much as people might want to seek the enhancement of intelligence through gene editing, there are perhaps more efficient ways to consider the enhancement of intelligence. Other forms of enhancement will likely have a greater impact on moral enhancement as well.

Empathy

The scientific literature distinguishes between two types of empathy, which seems to be very similar to the distinction made previously between lower level and higher level empathy. The first type of empathy is emotional empathy, the ability to feel the emotions of others. Cognitive empathy is the second type, also referred to as 'affective Theory of Mind (TOM) or affective perspective taking (Davis, 1980; Uzefovsky and Knafo-Noam, 2016). This component refers to recognition, understanding, and mentalizing of others' emotions' (Abramson et al. 2020:114). There are studies that suggest each of these types of empathy have different genetic correlates; however, questions arise about the results of these studies, which are not consistent with one another. For the discussion at hand, it is worth at least examining what researchers believe are genes that affect empathy. One such study showed that emotional empathy was connected to the oxytocin receptor, OXTR, whereas cognitive empathy was connected to the arginine vasopressin receptor 1a. There was no interaction between the two genes and any change in empathy. Women had higher empathy scores than men, leading to the conclusion that the combination of gender and genes accounted for 13% of the variance in empathy (Uzefovsky et al. 2015:62). With questions about the validity of such studies, there is no guarantee that focusing on these genes would lead to the enhancement of morality; however, it does provide specific locations for future study that have the potential to increase human empathy.

Memory

A study conducted in 2019 attempted to identify genes or gene regions that affect human memory. Not conclusive itself, the study suggested specific places on which future researchers should focus. In trying to find the best candidates, the study combined exploring the genes that were most common in the gene sets the researchers were examining and comparing that with studies done on model animals. They chose to focus on 10 genes that had a positive correlation and 10 genes with a negative correlation with cortical memory (Tan, Ananyev & Hsieh 2019:5). For the positively correlated genes, nine of them had already been previously suggested in the literature. All of the negatively correlated genes focused on histone protein H4. In mice, there was memory impairment if the acetylation of the H4 protein was not regulated; however, this could be reversed if regulation was restored (Tan et al. 2019:9). They carried out the same with genes for subcortical memory, and this time all 10 positively correlated genes were already in the existing literature as candidates for genetic influences on memory. Out of the 10 negatively correlated genes, seven of them controlled subunits of ribosomes (Tan et al. 2019:10). The full list of the genes they believe are the best candidates for future work are as follows: PRKCD, RAC1, HLA-DRB5, HLA-DRB1, HLA-DRB4, HCK, HLA-DRB3, LIMK1, CDC42 and VAV1 (for positively correlated cortical memory genes); HIST1H4A, HIST1H4E, HIST1H4H, HIST1H4I, HIST4H4, HIST1H4J, HIST1H4B, HIST1H4K, HIST1H4F and HIST1H4D (for negatively correlated cortical memory genes); CDK5, NLGN1, UNC13B, RAB3A, STX1A, SYT12, STX1B, SNCA, SYT1 and UNC13A (for positively correlated subcortical memory genes) and RPL34, RPS12, RPS13, RPS15A, RPS29, RPL11, RPL37A, RPL10, RPS25 and RPS27 (for negatively correlated subcortical memory genes) (Tan et al. 2019:10). These genes code for a variety of things, including enzymes and signaling proteins. Again, research study at this time cannot confirm that these genes will lead to the enhancement of memory; however, they are promising candidates for future research study.

Training enhancements

Intelligence

It is difficult to isolate attempts to try and increase intelligence through some kind of mental exercise or training from attempts to do the same with memory. Some studies link working memory and fluid intelligence. For the purposes of this study, I will need to mention memory in the intelligence section and intelligence in the memory section, but will try and minimise the overlap as much as possible. Studies show that training can make a difference in intelligence, roughly 5–20 IQ points; however, once the training is complete, the increase is lost over time compared with those who did not train (Garlick 2002:123). Another aspect of training the researchers are interested in is the concept of transfer, where skills learned in one area can be transferred, generalised or applied to another area. Whilst near transfer happens frequently, such as driving a car helps a person to drive a large number of styles or models of cars, far transfer, exchange between two areas loosely related, or not related at all, appears to be rare (Sala & Gobet 2017:515). Using 'two meta-analyses investigating the cognitive correlates of expert performance and three meta-analyses on the effectiveness of cognitive training in the domains of chess, music, and WM training', Sala and Gobet (2017:516) attempt to determine whether far transfer is occurring in these examples. The first meta-analysis showed that chess players displayed higher cognitive abilities compared with the general population, the difference being half of a standard deviation. The second meta-analysis showed that chess playing correlated significantly, statistically speaking, with fluid intelligence, processing speed, short term and working memory, and comprehension knowledge (Sala & Gobet 2017:516). In order to determine whether far transfer was possible, Sala and Gobet turned to the meta-analyses about chess, music and working memory training. It turns out that there is no evidence of far transfer in any of these met-analyses, and whilst those who played chess or music showed higher cognitive abilities, working memory and general intelligence usually predicted one's level of skill at chess or music (Sala & Gobet 2017:517). The conclusion to take away from this in the context of the enhancement of intelligence is that there is currently no reliable evidence that training of any cognitive abilities creates either a lasting advantage or the far transfer of skills to other areas of function.

Empathy

Given the positive view of technology, in general, from people who support enhancement, I believe that the use of video games and virtual reality (VR) stands out as potential candidates for the enhancement of empathy through training. In their study of adolescents who played a game designed to train empathy, Kral et al. (2018:6–7) found that there was no difference in empathetic behaviour; however, participants who spent more time on the part of the game that trained empathy, testing to recognise emotion and to determine how intense that emotion is being felt, had greater empathic accuracy when tested. Researchers believed that there was no change in behaviour because the game was viewed as easy by participants, so they speculate about how those who have trouble recognising emotion, such as those on the autism spectrum, might respond to games like this. A doctoral dissertation by Darin Hughes at the University of Central Florida examined how 10 children on the spectrum responded to a different empathy training game. There was no improvement regarding the recognition of emotions, there was improvement over time to trying to take care of the needs of the avatar in the game, and how participants responded to the avatar's needs (Hughes 2014:50). Even though this was a small sample size and there were issues with some players restarting instead of resuming their game, and improvements needed in some of the emotional prompts, particularly the mad and sad prompts, there appears to be some potential for video games to help train empathy, if in limited ways (Hughes 2014:50–51).

Virtual reality allows an individual to have an immersive experience in a 'different' body in a virtual setting. This takes the participant from a third-person perspective that might be found in video games or less immersive VR to a first-person perspective where the avatar is mirroring the participant's movements. In uncontrolled studies, there is some evidence that the embodiment that VR allows have a positive effect (Bertrand et al. 2018:10). This is perhaps the closest one can come to stepping into the shoes of another, and studies show that 'stepping into the shoes of outgroup members have shown significant plasticity of empathic abilities even after the experience by decreasing implicit racial biases' (Bertrand et al. 2018:10). The traits of the person being represented can also affect the participant. Those who represented superheroes had a greater increase to have altruistic tendencies than those who represented villains (Bertrand et al. 2018:10). Whilst this review article does point to specific ways in which VR can be used, there is little conclusive evidence of long-term success. However, even though it is a newer approach, there still appears to be reasons to be optimistic about the use of VR to enhance empathy.

Memory

In 2008, Jaeggi et al. published a study stating that fluid intelligence could be increased through training. The study concludes that transfer from working memory to fluid intelligence is possible (Jaeggi et al. 2008:6829). It became an important publication in the field, but subsequent studies argue the exact opposite, that training working memory does not influence intelligence (Chooi & Thompson 2012:538). Other research study has focused on how the brain responds to training focused on working memory. McNab et al. found changes in the D1 dopamine receptors after 14 hours of training over five weeks. Because working memory requires dopamine, an increase in the density of receptors seems to show plasticity that is affected by training memory (McNab et al. 2009:800).

Although this is not an effect of training, I want to include in this section a study that linked insulin with improvements in long-term memory. This example is included here because it is not a gene-based enhancement nor a CBI. The effects of insulin are more similar to the examples examining in this section of enhancements. The result of this study was that '[*i*]ntranasal intake of insulin enhanced long-term declarative memory in humans without causing systemic side effects like hypoglycaemia' (Benedict et al. 2004:1332). After eight weeks of treatment, there was improvement of recalling words, as well as improvement in mood. Researchers suggest that this could be a possible treatment for Alzheimer's disease (Benedict et al. 2004:1333). Because the study used healthy individuals, this could be an example of an enhancement for memory, but technically outside of the categories being explored in this essay.

Computer–brain interface enhancements

Intelligence

There are a myriad of suggested uses for CBIs, and whilst many of them involve restoring health or function, such as using the interface to move an artificial limb, there are also uses that allow people to have a greater sense of their own health, including their emotional or mental states. Whilst this is not necessarily enhancement of intelligence, it could help users to refocus or increase their attentiveness to a particular task, which would improve cognitive functioning if people were stressed or tired (Abdulkader, Atia & Mostafa 2015:217). Experiments using neurofeedback have shown improvement in sensory-motor tasks. Participants who received feedback realised they were becoming stressed and were able to reduce the state of arousal they were in, which researchers observed using heart rate and pupil dilation. They found that the observed 'pattern of pupil activity is consistent with a state of continued exploitation of previously learned models, high task engagement, high cognitive control, and high task performance' (Faller et al. 2019:6486). Using CBIs appear to be promising in improving cognitive abilities of people who are in non-optimal emotional or cognitive states and access to neurofeedback, including one's emotional state could improve moral deliberation by helping a person to recognise if they are choosing to act disproportionately out of emotion, or to use the neurofeedback to help calm themselves before choosing a course of action.

Empathy

As stated in the previous section, CBIs provide people access to their own emotional states, but they can also be used to induce people to feel emotions. There are several ways to elicit an emotional response, including using smells or images, or have the participant move the muscles of the face to form an expression like a smile (Molina, Tsoneva & Nijholt 2009:140). This of course raises ethical concerns on how emotional CBIs should be used, ensuring that people who use these interfaces are able to give informed consent as well as data privacy. However, if people used CBIs that displayed their emotional state to others, it could allow for more effective communication and for people to have a better sense of how the person they are interacting with is responding to their words, body language, etc. This could allow for greater empathy for a nervous presenter, or to provide concrete feedback if someone is uncomfortable and a change in behaviour is needed (Steinert & Friedrich 2019:358).

Memory

There are two main ways in which I imagine that CBIs could help enhance human memory. The first way is to improve the ability to store and access an individual's memories and the second would allow people to access the memories of others. The Defense Advanced Research Projects Agency has already provided funding for research into the first approach. A 2018 study showed 'for the first time, that multi-site spatiotemporal codes designed to mimic specific memory-related neural ensemble firing have been demonstrated to facilitate memory in humans' (Hampson et al. 2018:036015). The hippocampus plays a vital role in the encoding and retrieving of information. Researchers placed electrodes in specific parts of the hippocampus to record the firing pattern of neurons during encoding, which allowed them to build a model of how encoding occurs. They stimulated the same areas of the hippocampus artificially using this model

(Hampson et al. 2018:036014), resulting in a 35% increase 'in both short-term and long-term retention of visual information' (Hampson et al. 2018:036014). This work lays the foundation for what would be needed in order to implant a device to enhance human memory.

The second form of memory enhancement, the transfer or implantation of foreign memories, is not yet possible in humans; however, work is currently being done on mice. Because there is much known about the olfactory system of mice, researchers decided to use this system as the method of implanting a memory. In this case, scientists used photostimulation of glomerulus and reward or aversion pathways to either draw them towards or away from a particular smell, acetophenone. Even though the mice had not been previously exposed to acetophenone, after this stimulation, the 'memory' of a positive or negative association with the smell affected how much time they spent either in the presence of the smell or avoiding it (Vetere et al. 2019:935). This approach may not be the best to apply to humans; however, it represents the possibility of inducing memories. A prosthetic memory implant like the one suggested in the previous paragraph could also potentially be used to allow people to access the memories of others through the encoding or retrieval process it mimics.

Prioritising moral enhancements?

Transhumanism, as a movement, covers a broad range of perspectives and beliefs; however, they all share a commitment to improving life of humans (Bostrom 2003). Whilst some may seek to enhance human capacities, others desire to take control of human evolution altogether and create a posthuman species that eliminates the suffering people currently undergo. Bostrom (2003), however, argues that transhumanists are not naïve; they acknowledge that technology offers great potential for helping humans, which could also be used in disastrous ways:

> [*R*]anging all the way to the extreme possibility of intelligent life becoming extinct. Other potential negative outcomes include widening social inequalities or a gradual erosion of the hard-to-quantify assets that we care deeply about but tend to neglect in our daily struggle for material gain. (n.p.)

The kinds of enhancements that transhumanists discuss also vary widely from gene editing to the abandonment of biological bodies through mind uploading. Radical life extension or even an effective immortality where people could choose if or when they want to die is also a goal for some (Bostrom 2003). This essay has shown how difficult it is to speak of enhancements that could be done right now, and even though transhumanists agree that it may take a long time to enact their vision, there does not appear to be much discussion of prioritising certain enhancements over others. Because there are so many voices and the potential of technological advancement appears to be limitless, the implicit argument seems to be that all forms of enhancement should be pursued. However, I agree with other scholars that moral enhancements should be prioritised, or at the very least pursued alongside whatever other enhancements are desired first.

If the goal of transhumanism is to improve the human condition, then it should stand that the most important enhancements are those that would make the greatest difference. Moral enhancements would have a greater impact on human society than radical life extension, particularly if life extension is not available to everyone. Some of the enhancements discussed earlier in this article may be easier and cheaper to achieve than others. Guo et al. (2019) when discussing the results of their study on prosocial behaviour argued that:

> [*I*]f moral identity is promoted and empathic skills are trained, prosocial engagement (especially of those who have relatively low levels of intelligence) could be enhanced. We further propose that when intelligence in a society is improved through healthier environments, better education and nutrition, more prosocial engagement is expected to emerge (Jones, 2008). (p. 6)

Having access to education and good nutrition may not be seen as enhancements to some; they could be considered basic human rights, but rather than spending a great deal of money researching genes that only contribute a few percentage points to the overall variance of intelligence, investing in improving education and nutrition would have a more immediate and arguably greater effect.

Oxford Philosopher Julian Savulescu argues that there is a moral imperative to prioritise the kinds of enhancements that increase human moral capacities. The quickest summary of his argument is that if there are more moral people in society than not, that society will be able to function better. He emphasises the importance of moral enhancements by saying that:

> [*E*]ven if almost all of us are moral to a high degree, there is good reason to think that a cognitive enhancement, and a consequent faster increase of knowledge, which extends to all of us may be worse for us on the whole than no cognitive enhancement at all, if there is a minority which is morally corrupt. (Persson & Savulescu 2008:163)

John Harris argues against Persson's and Savulescu's position and in their response Persson and Savulescu clarify that it is not just immoral people that are a threat, but that the increase of intelligence will accelerate scientific progress, and as humans are already able to do ultimate harm to all life on this planet, so their argument also holds for people who are careless or incompetent (Persson & Savulescu 2011:127). Prioritising cognitive enhancements, as it could be argued, will increase the rate at which other enhancements, including moral enhancements, are available. However, if moral enhancements are prioritised, then any resulting enhancements will have gone through a process where people with greater moral capacities were part of the planning, experimentation and implementation of enhancements. I would argue that the latter provides a safer framework for research and applications that have profound implications for human welfare, human nature and even the future evolution of species.

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Author's contributions

B.M. is the sole author of this article.

Ethical considerations

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