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Are We Ready for Direct Brain Links to Machines and Each Other? A Real-World Application of Posthuman Bioethics

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Background: A real chance of becoming posthuman?

Neuralink, a company founded by Elon Musk three years ago, is the most notable of several companies developing a new type of Brain-Computer Interface (BCI): a direct, two-way, digital system that is robust, compact, and wireless. BCI is already being used therapeutically to reduce seizures in severe epileptics, resolve tremors in Parkinson's patients, and to stabilize mood disorders in psychiatric patients. But the devices used to do this are bulky and hardwired, causing difficulty of use for patients and requiring invasive surgeries and large incisions to implant them. So, researchers have been trying to make these devices more compact, easier to implant, and wireless.

About four years ago, a team at Harvard led by Charles Lieber devised a prototype for this new type of BCI that seemed to offer answers to these problems. They had developed a plastic-coated micromesh of tiny wires that could be inserted more easily into the brain via syringe to form an embedded wireless antenna. They implanted it in mice and found that the mesh bonded harmlessly with the brain's cells within a few weeks and that they could subsequently use it to send and receive signals to external digital devices. One big difference between this mesh and other substances is that it is much more pliable: "a hundred times more flexible than other implantable electronics," according to Lieber (Powell, 2015). It was this extreme pliability that allowed it to be rolled up, inserted into a syringe, and injected directly into the brain. Lieber envisions the possibility that this tiny micromesh could eventually be injected via the carotid artery, by which it could travel to the brain and bond with its cells—promising to solve the problem of invasive surgery (Liu et al., 2015).

Elon Musk heard about this development and was so enthralled with this mesh—which he calls "neural lace"—that two years later, in 2017, he started a new company called Neuralink, funding it with 100 million dollars of his own money. There are a number of other companies working on improving BCI, such as Kernel and Synchron, but Musk's company is receiving the lion's share of publicity. A big reason for this, besides Musk's own notoriety, is Musk's radical goals. He has stated that his long-term aim for such devices goes beyond current therapeutic uses of BCI; he wants to use it to enhance the human brain in order to make it competitive with AI, especially in the workplace, and perhaps eventually to allow the merging of humans with AI (Knapp, 2019). This is because he sees AI as an existential threat to

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humanity, particularly in the realm of jobs, and sees neural lace as something that could make humans able to compete with ever more powerful AI. As he says, using neural lace in a bi-directional manner "could make us smarter, improve our memory, help with decision-making and eventually provide an extension of the human mind" (Marsh, 2018). It could also allow us to communicate at lightning speed with each other via a form of wireless communication similar to telepathy. He wanted to start working with human subjects in clinical trials by the second quarter of 2020 (Knapp, 2019).

Ethical considerations

Let me quickly outline the ethical concerns projects such as Musk's raise, and then delve more deeply into the details. The chief questions that projects such as his raise are those of safety, distributive justice, privacy, and human autonomy and agency—many of which questions arise with any effort at human use of advanced technology to provide a posthuman transcendence of our species. More specifically, the questions here are: how closely is safety being monitored, given the speed of these developments? Will the benefits of any enhancements be evenly distributed through society? How will that be done, and who will pay for distribution of benefits to people other than the wealthy? What about the issue of coercion? As others, such as Briggle in his book *A Rich Bioethics* (2010, 66), have pointed out regarding human self-enhancement, if some people choose to use implantable BCI to make themselves more competitive with machines, they also become better competitors with other humans for jobs, as well as for other pursuits. Consequently, others will feel compelled to get the implants too, whether or not they really want them. Also, and not least in importance: if our thoughts become easily transmittable digitally (as Musk envisions), what does that mean for the privacy of those thoughts? Furthermore, a crazy sounding question scratches at the door of possibility: if our brain is connected with the Internet or other networks, wouldn't it be theoretically possible in the future to hack people's digitally-connected brains? After all, the basis of neural lace, as conceived and tested by Lieber's team at Harvard, was that the Wi-Fi antenna implanted in a subject's brain would have technology connected to it to allow two-way translation—from brain waves to code and from computer code to brain waves. This would eventually crack the digital-brain barrier as part of the process of providing the sort of telepathy that Musk hopes for.

Such technology as he envisions entails making a subject's brain data directly accessible for collection by outside entities, such as corporations and governments, threatening individual privacy and autonomy. This is already happening in China, which is monitoring data from some employees' brains by forcing them to wear caps outfitted with sensors while they work; these sensor arrays can scan their brainwaves for emotional disturbances and send that data to their bosses (Stephen, 2018). This procedure is taking place for three types of Chinese workers: telecommunications factory workers, high-speed train drivers, and military workers. Hangzhou Zhongheng Electric is one company that uses this arrangement. According to information provided by Hangzhou, workers on their production lines all wear caps with sensors that "monitor their brainwaves," and then management feeds that data into algorithms that allow AI to recommend changes, such as adjusting "the pace of production and redesign[ing] workflows" (Chen, 2018). The company claims that, among other things, they can use this process to "increase the overall efficiency of the workers by manipulating the frequency and length of break times to reduce mental stress" (Chen, 2018).

The Chinese government is the major funder of the research into this area, but managers and scientists also tout this technology, asserting that it can improve safety. As one "professor of brain science and cognitive psychology at Ningbo University's business school" said, "a highly emotional employee in a key post could affect an entire production line, jeopardising his or her own safety as well as that of others… Some jobs require high concentration. There is no room for a mistake" (Chen, 2018).

The Chinese also use this kind of rationale to justify the monitoring of high-speed train drivers: "Deayea, a technology company in Shanghai, said its brain monitoring devices were worn regularly by train drivers working on the Beijing-Shanghai high-speed rail line" (Chen, 2018). The devices are worn under the driver's cap and can monitor an array of things, including fatigue and attention loss. If the system detects these things, it sounds an alarm in the cabin to wake the engineer up.

Despite proclamations of increased safety and efficiency, however, other proclamations show that a major reason for this technology is just increasing profit. Hangzhou Zhongheng Electric, for instance, bragged that "it has boosted company profits by about 2 billion yuan ($315 million) since it was rolled out in 2014" (Chen, 2018). So, this kind of monitoring seems, in reality, to be a violation of cognitive freedom for the sake of profits as much as safety or anything else. There are also clear problems here not only with user privacy and autonomy but also with informed consent. For instance, with respect to consent, it is unclear whether there is really effective communication to the users of the complex ways these devices work and proper framing of how users' information is used.

Perhaps most important to consider is the question of human autonomy and agency. An example of how technology such as Musk's is already used as therapy illustrates this. BCI is already being used as a form of next-generation Deep Brain Stimulation (or DBS) to treat mood and emotional disorders, such as obsessive-compulsive disorder and depression. The use of computer-to-brain BCI such as Neuralink's would be for the purpose of regulating the therapeutic stimulation to the brain to enhance its consistency: because diseases such as depression vary in intensity and frequency, it would be much more effective if an AI algorithm could monitor and adjust stimulation to the brain accordingly—as is done now with implantable defibrillators for the heart.

The problem is that directly modulating the brain raises questions of autonomy and agency, as well as privacy. In terms of privacy, one group of BCI researchers note, "A system that employs BCI-like technology to decode a patient' s emotional state comes much closer to 'mind reading' than existing motor BCIs. The internal data from such a system could be damaging if compromised" (Eran et al., 2016). Regarding autonomy and personal agency, if an AI is controlling the brain's moods and the reactions a person has toward her environment, then, patients and physicians worry, is it the person or the AI being expressed at any given moment? As some neuroscientists working on this type of BCI point out, "If [an AI] controller is added, one has effectively constructed a device that autonomously determines what the patient may or may not feel" (Klein et al., 2016, 141).

Patients in those researchers' study expressed the same concerns. Some patients who have been treated for depression started losing their sense of self. One said, "There are parts of this where you just wonder how much is YOU anymore, and you wonder kind of, 'How much of it is my thought pattern? How would I deal with this if I didn't have the stimulation system?' You kind of feel artificial" (144).

How all this relates to Musk and neural lace

As the two foregoing examples of BCI show, there are possible specific public benefits to brain implants and sensors, such as increased safety for public transit in China and therapeutic psychological benefits for those who suffer from depression or obsessive-compulsive disorder. But these are countered by some serious downsides. As opposed to these innovations, which have specific and relatively limited uses, Musk's idea of implantable, wireless antennae into the brain for the general purpose of raising our cognitive speed, memory capacity, and intelligence via direct connection to digital devices has much less specific situational benefits. Yet it has all of the dangers of the other examples of BCI I have mentioned—perhaps more. Consider: who would pay for everyone to get these implants so as to encourage distributive justice? Walter Veit has tried to answer this by suggesting that employers would have a natural desire to pay for enhancements for their employees and that this would resolve uneven availability to people and concentration of benefits to the rich (Veit, 2018). This is unlikely. After all, only certain large, wealthy companies have the deep pockets to provide novel bioenhancements. And they would likely be very selective to whom they provide them, given the expense. In their chapter of the book *Enhancing Human Capacities* Nick Bostrom and Rebecca Roache suggest using government subsidies to promote fair distribution (Bostrom & Roache, 2011). However, we already have huge public resistance to government subsidies—at least in America, and it's also growing in places like Switzerland and Finland; the latter country's experiment with Universal Basic Income (UBI) was cut short for this reason, and in Switzerland, public resistance ultimately prevented UBI's implementation.

Also, with regard to potential moral enhancement that might result, there is the question of efficacy for Musk's wireless BCI. Increased intelligence does not necessarily resolve bad behavior, unhappiness, and emotional problems. Instead, current research suggests that, by some measures, it is personality traits such as conscientiousness that make the difference for self-actualization and social success (Flam, 2016). Indeed, as one can discover by working with academics, a person can be very smart and still be a neurotic, unhappy mess. And the negative impact on privacy caused by the telepathic communication Musk envisions as a result of his neural lace is unlikely to improve a neurotic's paranoia.

International regulation is needed

At the very least, the more practical solution, given all of the foregoing examples, would be some sort of regulation for highly transformative, next-generation BCI devices such as Musk's neural lace. There are already regulatory models to consider. One might be a type of broad statement of ethical standards for BCI development that scientists and researchers would agree to in order to try to ensure everyone was operating along the same ethical lines. The recently published Montreal Declaration regarding the responsible development of AI does this for emerging technology. Originally drafted and promoted by Yoshua Bengio and others at a recent meeting of academics at the University of Montreal, it is now posted online for the signature of anyone who is concerned about the responsible development of emerging technology.[2] Perhaps it could be adapted specifically for biotechnology such as BCI.

Another model is provided by Allen Buchanan's "Global Institute for Justice in Innovation" (GIJI), discussed in his book *Beyond Humanity*. This type of institute would license companies to distribute bioenhancing innovations and make sure via various means that innovations are used and distributed fairly (Buchanan, 2011). However, even this is an uncertain measure because it is market-driven. Moreover, regulations are difficult to enforce. World politicians already lack the will to strictly enforce previous international treaties, such as those for nuclear weapons. So, I would like to end with a plea for all of us to work on this idea of effective regulation for increasingly transformative and powerful Brain-Computer Interfaces.

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[2] The Montreal Declaration can be found here: https://www.montrealdeclaration-responsibleai.com/the-declaration