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# What if others could read your mind?

*Brain-computer interface technology has been advancing rapidly and will continue to do so as our knowledge of how the brain works increases. Could this transform our understanding of life as we know it?*

A brain-computer interface (BCI)[1] is a direct communication pathway between the brain and an external device. This technology can be used to restore motor and sensory capacities which may have been lost through trauma, disease or congenital conditions. For example, combined with limb-replacement technology, BCI may allow patients not only to move prosthetic limbs, but also to feel the sensation of touch.

The technology can either be implanted (invasive) or used externally (non-invasive). Invasive BCIs, including neuroprosthetics and brain implants, are devices which connect directly to the brain and are placed on its surface or attached to the cortex. A key application area for contemporary brain implant research is the development of biomedical prostheses to circumvent areas of the brain that have become dysfunctional after a stroke or other trauma. With deep brain stimulation, a 'brain pacemaker' sends electrical impulses to specific parts of the brain for the treatment of disorders such as Parkinson's disease, dystonia and major depression. Non-invasive BCIs consist of a range of technological devices which provide a similar interface between the brain and other machines without the need for surgery. There are several technologies capable of measuring and recording brain activity, although the signal quality may be weaker than is possible with implanted devices. Nonetheless, non-invasive BCIs have been used effectively, for example to control prosthetic hands.

## Potential Impacts and Developments

First, steady growth in the use of BCIs is expected in various domains. For example, while many deaf and hearing impaired people already use cochlear implants, it is estimated that by 2020 the majority of all children worldwide with hearing loss will have access to these implants before the age of five. Over 100 000 patients already use 'brain pacemakers' to treat Parkinson's and other movement disorders, and these devices may be used in the future to treat a wider range of disorders, such as schizophrenia or Alzheimer's disease.

Second, several improvements and new developments in BCIs are expected, enabling greater uptake. BCI technologies may gradually become smaller, more effective and more intuitive. The need for wires has presented a barrier for some applications, but wireless interface devices have been developed which could enable more widespread use. There is already a commercially available, portable and affordable device that records activity in the brain and transmits it to computers or smart phones via USB, and recent experiments have created a connection between two people at a distance, with BCIs transmitting and receiving signals directly, effectively allowing the users to communicate 'telepathically'.

These developments will lead to debates about the impact of BCIs on society. We must consider questions of privacy (who has access to what, under which circumstances?), informed consent (how do we determine whether the patient has consented to a procedure?) and responsibility (who is responsible if something goes wrong?). However, debates about BCIs have some other interesting dimensions, including what it means to be a 'normal' human. Defining normality and disability/disease is not straightforward, as history has shown such definitions to be flexible, overlapping and context sensitive. Implants considered by some as medical may be seen as cosmetic by others. Without a fixed definition of normality, it is difficult to say whether an

[1] Also known as mind-machine interfaces (MMI), direct neural interfaces (DNI), synthetic telepathy interfaces (STI) or brain–machine interfaces (BMI).


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implant to improve cognitive or motor skills is a medical procedure to recover normal function, or an artificial enhancement of their natural state. While the costs of treatments to aid recovery from medical problems are often supplemented by the State, this is not usually the case for treatments for enhancements. As such, BCIs may force us to consider more carefully how we define the boundary between recovery from medical problems and human enhancement. Furthermore, human enhancement may not always be as desirable as it seems: while few would deny an Alzheimer's patient the opportunity to remember more of his or her life, an enhanced memory might prevent us from overcoming personal traumas. Indeed, the act of forgetting has many important functions in our lives and societies. Similarly, technologies to enable hearing among deaf people are controversial because, if cochlear implants were to eradicate deafness, they might also eradicate the deaf community, along with its unique language and culture. This is one reason why the deaf community does not always support technologies to enable hearing. Even though BCIs are applied to individuals, they may have wider social impacts. Could new communities of enhanced humans emerge, splitting away from the rest of society and further developing their privileged position?

Debate about BCIs can easily lead to speculation about a sinister future, with the concept of surveillance exaggerated to include 'thought police' and even mind control. Imagine a functional implant used to prove your identity. This could enable greater surveillance of your movements by the state. Then, as BCIs develop and become commonplace, perhaps the state could use the technology to detect subversive or criminal intentions and, eventually, to intervene directly before they are carried out. Of course, while functional implants are increasingly common, mind reading (and, indeed, mind control) remains firmly in the realm of science fiction. However, if we allow fears about potential problems in the future to overly restrict the development of BCI technology, we might also hinder the development of medical treatments for diseases such as Parkinson's and Alzheimer's.

## Anticipatory law-making

The possible commercialisation of BCI technologies raises a number of challenging legal issues that touch upon privacy, data protection, ownership, autonomy, personhood, safety, human dignity and mental integrity. If BCI devices were to become widespread, we might see private information about personal preferences, memories, prejudices and beliefs being extracted from individuals without their permission. For this reason, the introduction of privacy-by-design legal safeguards will need to be discussed at the earliest stages of research and development of this technological trajectory.

The connection of the human brain with an internet-enabled computer raises serious concerns about the adequacy of the current legal framework to respond fully to the potential threats to personal autonomy, integrity and privacy. A legal approach is also needed to respond to the challenges of controlling potential misuse/dual use of BCIs to assess or control mood, emotion, fatigue or cognitive functions. The introduction of horizontal legal safeguards may set a limit on the type and nature of information obtained or monitored, or the mental vulnerabilities manipulated. With regard to the latter, allowing the use of BCI devices opens up the discussion as to whether the standard informed consent procedures provide sufficient legal protection to respond to the heightened long-term safety and effectiveness risks that BCIs may represent.

Moreover, the risk/benefit analysis for such a technological application, which aims to prevent and mitigate potential negative side-effects, needs to be addressed in a legally harmonised way at the EU level. Particular attention should also be given to the notion of legal responsibility in case of erroneous actions that may affect bodily integrity and cognitive liberty, ownership and safety.

Lawmakers must ensure that methods of data transmission are robust and secure. The potential of this human-integrated technology to cause irreversible damage to our privacy, intimacy and autonomy will certainly raise questions about the extent to which the law is able to provide satisfactory responses, especially at a trans-national level. The potential of BCIs to enhance or stimulate human capacities brings with it the same challenges as are already associated with human enhancement techniques, in that a medical application of a given technology must be separated from a non-therapeutic enhancement application and legally guiding criteria devised to help define their legitimate and ethically permissible use.

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