iHuman

Blurring lines between mind and machine

SUMMARY

Neural interface technologies will deliver wide-ranging benefits while raising profound ethical, political, social and commercial questions. Both the opportunities and risks should be addressed as soon as possible to create mechanisms to encourage, approve or regulate the technologies as appropriate, as well as managing the impact they have on society.

THE ROYAL SOCIETY

Summary

Neural interfaces are devices that interact with the nervous system of an individual. They are electronic devices placed on the outside or inside of the brain, nerves or other components of the central and peripheral nervous system to record or stimulate activity – or both. Interfaces placed inside the brain or body are known as internal, invasive or implanted technologies, as opposed to external, non-invasive or wearable devices.

Much of the technology world's attention remains focused on the digital revolution and the long term impact of artificial intelligence (AI). But, neural technology could bring about even more profound change – linking the cognitive power of the human brain to the processing power of AI and computing. Current technologies and applications include:

- Brain implants to treat Parkinson's disease and tremor;
- Electrical foot stimulators to aid stroke recovery;
- Cochlear implants to convey sounds to people with hearing loss;
- EEG (electroencephalography) headsets used by gamers to control digital objects; and
- Transcranial stimulation used to boost memory or concentration.

Potential future applications may include:

- 'Typing by brain' and use of a 'mental mouse' to control computers and devices;
- Direct brain-to-brain communication, whether simple impulses or complex thoughts;
- Wider medical applications, such as for Alzheimer's disease and mental health conditions;
- Monitoring of brain activity to support health, safety and security;
- Enabling immobile people with paralysis to walk again; and
- Augmentation of human memory, concentration and learning.

Neural interface technologies are in their infancy, comparable to computers in the 1970s – but they are now experiencing a wave of innovation and investment that will lead to smaller, more powerful and more widely used devices.

In medicine, neural technologies are set to mature and expand significantly in the coming decades, potentially overtaking pharmaceuticals in efficacy in some areas, such as drug-resistant epilepsy or depression. At the same time, challenges are evident, particularly when introducing external technologies into the brain, the body's most complex and least understood organ.

Beyond medicine, interfaces offer benefits that are as unimaginable today as the smartphone was a few decades ago: better health; better memory; better concentration; healthier ageing; a more collaborative world. But, they also pose new risks: the risk of thoughts or moods being accessed by companies, governments or others; risks to privacy and human rights; and the risk of widening social inequalities. Widespread use of neural interfaces may pose more fundamental ethical issues. For example, do they change what it means to be human? Or are they just another example of an ever-expanding toolkit of capabilities?

The opportunities are unprecedented and immense – as are the challenges. Policymakers, business leaders and citizens need to prepare for this new wave of neural technology by building structures and systems needed to realise the opportunities, manage the risks and address the fundamental questions.

Calls to action

The full report highlights two separate, but linked, challenges.

The first is to fulfil the potential of neural interfaces in medicine, by advancing innovation, lowering cost and ensuring that safe, effective treatments can be approved efficiently and disseminated to millions who could benefit.

The second is to manage the risks associated with wider societal use of neural interfaces in everyday life, as they emerge from specialised markets such as computer gaming and become available to consumers.

Given these challenges, the Royal Society makes one central proposal, that the UK should use neural interfaces as a test case for an ambitious, democratised and anticipatory approach to promoting emerging technologies. This joined-up approach would seek to stimulate innovation in the field, while constructing responsible regulation around the technology as it develops. To achieve this aim, we recommend:

- The UK develop a 'Neural Interface Ecosystem' to accelerate the development of the technologies in the UK and encourage multidisciplinary collaboration across industries.
- An 'early and often' approach to addressing the ethical considerations of the field.
- The UK trial new approaches to technology regulation on neural interface technologies. These could include the use of regulatory 'sandboxes' and new ways of gathering evidence about the efficacy of medical devices.
- The general public be given a clear voice in shaping the future of neural interface regulation. Furthermore, the processes of consultation, regulation and policy choices be designed so that the public's voice has an impact on them. This should include a key role for public consultation in developing regulatory frameworks and public representation on relevant advisory boards.

The UK has a unique set of strengths that mean it is well positioned to become a world leader in neural interfaces.

- Academic excellence in relevant disciplines, from neuroscience to electrical engineering
- Supportive regulation – with an internationally renowned regulatory system that is taking a new approach to accelerate responsible innovation in emerging technology
- The NHS – providing a unified national platform for research, innovation and commercialisation
- Competitive advantage provided by a dynamic life sciences sector and thriving creative industries, of which gaming is a big part.

Taken together, these factors provide a clear technological pathway for the development of neural interfaces in the UK that builds on existing strengths. Looking forward, investment in neural interfaces could be an important avenue for the UK to explore as it considers how to meet its commitment to devote 2.4% of GDP to research and development by 2027.

To read the full report, please visit **royalsociety.org/ihuman-perspective**

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- Promoting excellence in science
- Supporting international collaboration
- Demonstrating the importance of science to everyone

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