Introduction

The seventeenth-century French architect, physician, anatomist and inventor Claude Perrault (1613–1688) is best known for designing the front of the Louvre Museum in Paris. But he left another legacy. Eleven years after his death, a small book was published entitled *Recueil de plusieurs machines, de nouvelle invention* (*Collected Notes of a Number of Machines, of New Invention*). The book contained a description for creating an advanced form of abacus, an ingenious calculating machine. This piece of equipment would, Perrault believed, be of great use to a 'computer' – a physical person who performs mathematical computations. In coining the term 'computer', therefore, he had in mind a physical person rather than an object.

But history has a curious way of reassigning the use of language. For Perrault, the person was still the principal calculator, while his machine was a tool to help the user perform calculations. Though he believed the machine would have its uses, the person was clearly more capable.

Time, however, has moved on! A half-decent office computer now performs more than a billion calculations every second, selecting data from many billions of items stored locally on computer disks or chips. As a result, for some kinds of tasks, the machine can outstrip its master. No longer is it appropriate to think of the physical person as the computer; instead, the term is more appropriately assigned to the machine. Moreover, until now, the two have been discrete entities. On the desk sits a machine – an object. At the desk sits a person – an agent.

However, the boundary is again beginning to change and become less distinct. With direct interfaces slowly being developed between the human brain and computers, a partial return of the term 'computer' to the human person may, at present, be seen as a plausible prospect.

Given this, what possible ethical and anthropological dilemmas and challenges would exist for such a machine-person? What would it then mean to be human? Many studies have examined the brain and nervous systems, which are often characterised by the prefix 'neuro'. Many others have considered computers as well as the information and network technologies characterised by the prefix 'cyber', and many more have discussed ethics. However, this introductory work is the first to draw on all three together in order to address the ethical and anthropological questions, challenges and implications that have arisen with respect to the new neuronal interface systems in both medical and nonmedical contexts. These describe devices that enable an interface between any neuronal network (including the brain) and an electronic system (including a computer), which may facilitate an interface between the mind (which makes persons aware of themselves, others, their thoughts and their consciousness) and cyberspace.

In this context, direct interfaces will be defined as those that enable an interaction between a neuronal network and an electronic system that does not require any traditional form of communication, such as the use of voice, vision or sign language.

At the very heart of this revolution in neuronal interface systems lies the computer. This is because computing power has increased exponentially over the last few decades and is certain to continue into the future. As a result, computing technology will invade the lives of nearly all *Homo sapiens* on the planet.

This means that new interfaces may provide fresh possibilities for human beings, enabling them to access new functions, information and experiences. As the Australian bioethicist Julian Savulescu indicates:

> [N]euroscience, together with computing technology, offers radical opportunities for enhancing cognitive performance. Already, chips have been introduced into human beings for purposes of tracking and computer-assisted control of biological functions. Minds are connected through the internet and there may be no barrier in principle to direct mind-reading and thought-sharing across human minds. Uploading of human minds to artificially intelligent systems represents one of the most radical possibilities for human developments.[1]

But questions may then be asked about the consequences on the lives of human beings of such a close association between humankind and machine-computers, as well as any resulting interface between the human mind and cyberspace. Would they, for example, enable individuals to really become

'hardwired' and 'programmed' to make certain decisions? In this regard, American neuroscientist James Giordano explains that these questions will quickly become more challenging and compelling when more integrated neuronal interfaces become possible, adding: 'But the time from first steps to leaps and bounds is becoming ever shorter, and the possibilities raised by the pace and breadth of this stride are exciting, and, I'd pose, equally laden with a host of concerns. It will be interesting to be part of this evolution.'[2]

Because of this, and although the consequences of neuronal interface technologies on society remain uncertain, a number of questions can already be presented on ethical, legal, political, economic, philosophical, moral and religious grounds. For instance, it will be possible to ask the following questions:

- Do neuronal interface systems belong to reality or fiction?
- Will a permanent link to vast amounts of information be beneficial or detrimental?
- Where does rehabilitation stop and performance enhancement begin?
- What are the risks relating to neuronal interfaces?
- When do invasive implants become justifiable?
- Can all the legal consequences from the use of such interfaces be anticipated and addressed?
- Can interfaces significantly change the very identity and personality of an individual?
- Could they be used to take away suffering?
- Will neuronal interfaces eventually lead to a redefinition of humanity?[3]

This book necessarily operates in a difficult territory since ethical considerations are intrinsically associated with what it means to be human and how society understands this concept of humanity – a task that has eluded most thinkers over the millennia.

Moreover, it is necessary to seek to better understand the concept of human identity in the context of the human person. This is because adding new capabilities to a person's mind by installing technology may well change his or her sense of self.

A person's perception of the benefit of a technology may, in addition, be affected by whether he or she remains in control or whether control is given over to something or someone else. In this regard, having a powerful system interfacing directly into a human brain may be too limited to be of concern, but may also enable possible external powers to have direct and abusive access to the inner being of a person.

It is indeed recognised that any form of new technology can affect the current dynamics of power. As the British technology commentator Guy

Brandon indicates: 'Technology always brings some value to the user and power over those who do not possess it.'[4]

Further questions can then be asked about what a human body or mind represents. As already mentioned, in the past a computer was generally something that was quite distinct from the human body that was relatively easy to define in both philosophy and law. With the development of direct interfaces between human bodies and computers, including devices that can be implanted inside the human brain, this will change. But what would this then mean for the person? Would the manner in which technology is applied to the body of an individual influence the way in which society considers this human being?

Some new interfaces, for instance, may enable human minds to escape the limitations of their human brains by combining with human computers to become cyborg-like fusions of machines and organisms.[5] The English biologist and science fiction writer Brian Stableford states:

> The potential is clearly there for a dramatic increase in the intimacy with which future generations of people can relate to machines. Machines in the future may well be able to become extensions of man in a much more literal sense than they ever have in the past. Working systems directed to particular tasks will one day be constructed that are part flesh and part machine, and the two will blend together where they interface.[6]

But would this then be good, bad, inevitable or to be avoided at all costs? How would such direct neuronal interfaces impact upon business, security, education, freedom and liberty of choice? Would, for example, new legislation need to be drafted and enacted?

It is because of all these questions as well as the possible ethical, philosophical and social challenges resulting from neuronal interfaces that this introductory book on human cyberneuroethics[7] was written in order to present some of the ethical challenges while providing a basis for reflection concerning a possible way forward. Indeed, an engagement with the profound implications of direct interfaces between the human neuronal system and the computer, as well as between the human mind and cyberspace, has become crucial. This is especially the case if society wants to engage with the future of humanity in a responsible, considered and effective manner.

Unfortunately, it is all but impossible to completely foresee the different developments of a technology and be in possession of all the relevant information. Moreover, one of the real difficulties of examining the ethical consequences arising from new biotechnologies is that they often develop very quickly. As a result, ethical considerations may lag far behind current technological procedures. This is the reason why any ethical discussion related to neuronal interfaces will be a dynamic and evolving endeavour making the

preparation and drafting of regulations (such as the ones proposed in the Appendix) a continuous process with numerous re-evaluations.

In this context, the book will begin by exploring the existing situation in terms of what is already possible while considering future prospects and whether they are likely to help or harm. For instance, at present, neuronal interface systems considered for therapeutic purposes are, generally, seen as acceptable from an ethical perspective. If it becomes possible to read the brain pattern of completely paralysed persons so that they can use a computer, this would enable them to address some of their limitations, and the advantages may well outweigh the risks.

But when these therapeutic applications are transformed into possible enhancements, beyond what is considered to be normal, more ethical considerations about the proportionality between possible advantages and risks become necessary.

In order to study such future contexts, it is sometimes helpful to investigate the manner in which the technologies are already considered in society by examining, for instance, how the general public may understand or respond to popular fiction presenting the new developments. As such, fiction may be seen as a prophetic voice in this arena, asking the 'what if' questions through dystopian or utopian alternatives. In fact, connecting a person to a computer has often been a natural starting point for many science-fiction films and books, which can be useful in examining some of the possible consequences. But with new developments in technologies, more realistic fiction may now be required, since new possibilities have emerged. As the British engineer and neuronal interface pioneer Kevin Warwick explains:

> For many years science fiction has looked to a future in which robots are intelligent and cyborgs – a human/machine merger – are commonplace . . . Until recently however any serious consideration of what this might actually mean in the future real world was not necessary because it was really all science fiction and not scientific reality. Now however science has not only done a catching-up exercise but, in bringing about some of the ideas initially thrown up by science fiction, has introduced practicalities that the original storylines did not extend to (and in some cases still have not extended to).[8]

Cases of science fiction will thus be considered throughout the present study to examine some of the possible future challenges and advantages, while seeking to understand a number of the concerns that may already exist amongst the general public.

But it is also necessary to be wary since such science fiction may become, at one and the same time, more interesting but less careful as to future prospects. While there is huge value in exploring the 'not yet', it is important to do so cautiously before imagining opportunities that technology is unlikely

to deliver, or at least not in the near future. This is emphasised by the French computer scientist Maureen Clerc and others, who explain that 'despite the enthusiasm and interest for these technologies, it would be wise to ponder if . . . [neuronal interfaces] are really promising and helpful, or if they are simply a passing fad, reinforced by their "science fiction" side'.[9]

This warning is very apposite since current neuronal interface devices are still unable to compete in terms of speed, stability and reliability with the standard interaction devices that already exist, such as a mouse or keyboard. But it is impossible to predict how things will develop and it would be irresponsible to just sit back and watch technology develop, believing that it is as inevitable as the tide and a natural force that cannot be restrained. This means that society should be prepared to anticipate new technologies with their associated advantages and risks. Ethical reflection should therefore be welcomed in its assessment of all the new possibilities direct neuronal interfaces can offer.[10]

In short, the challenge of cyberneuroethics is to develop some form of consistency of approach while preparing policies to regulate developments in an appropriate manner with the support of public opinion. As such, it is only the beginning of what is certain to be a very long and vast process lasting decades if not centuries.

Notes

1. Savulescu, 'The Human Prejudice and the Moral Status of Enhanced Beings', 214.
2. J. Giordano, interviewed by N. Cameron. Retrieved 23 February 2017 from http://www.c-pet.org/2017/02/interview-with-dr-james-giordano.html.
3. Bocquelet et al, 'Ethical Reflections on Brain-Computer Interfaces'.
4. Brandon, 'The Medium is the Message', 3.
5. Nuffield Council on Bioethics, *Novel Neurotechnologies*, 7.
6. Stableford, *Future Man*, 171.
7. The term 'cyberneuroethics' is a neologism that was briefly used, for the first time, by the American legal academic Adam Kolber on the *Neuroethics & Law Blog*. Retrieved 9 October 2018 from http://kolber.typepad.com/ethics_law_blog/2005/12/cyberneuroethic.html.
8. Warwick. 2014. 'A Tour of Some Brain/Neuronal-Computer Interfaces', 131.
9. Clerc, Bougrain and Lotte, 'Conclusion and Perspectives', 312.
10. Ibid.; Schneider, Fins and Wolpaw, 'Ethical Issues in BCI Research'.

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