Chapter 1

Why Use the Term 'Cyberneuroethics'?

In order to examine why the term 'cyberneuroethics' was developed in this book, it may be useful to present a brief overview of the manner in which each component of the cyberneuroethics triad is used in order to provide clarity before exploring how they interact together. For example, it is easy to talk about connecting a computer to a nervous system without emphasising whether the point of contact will be the brain, the spinal cord or the peripheral nerves. Indeed, each would have quite different implications.

In this regard, the prefix 'cyber' and 'neuro' will first be studied before examining the manner in which 'neuroethics' is presently defined in bioethics and why the term 'cyberneuroethics' was finally chosen.

The 'Cyber' Prefix

It was the French physicist and mathematician André-Marie Ampère (1775–1836) who first mentioned the word 'cybernétique' in his 1834 *Essai sur la philosophie des sciences* to describe the science of civil government.[1] However, the original term of cybernetics came from Ancient Greek, where it reflected the notion of a 'steersman, governor, pilot or rudder', while including notions of information, control and communication.

The term 'cybernetic' was also borrowed by the American mathematician and philosopher Norbert Wiener (1894–1964) and colleagues, who examined how communication and control could be examined in animals,

including humans, and machines.[2] Wiener published a book in 1948 foretelling a new future entitled *Cybernetics: Or Control and Communication in the Animal and the Machine*, which gave an intellectual and practical foundation to the idea of highly capable interconnected calculating machines.

In his introduction to this volume, Wiener describes a situation in which it is difficult to make progress without a pooling and mixing of knowledge and skills between the various established disciplinary fields. This is because:

> Since Leibniz there has perhaps been no man who has had a full command of all the intellectual activity of his day. Since that time, science has been increasingly the task of specialists, in fields which show a tendency to grow progressively narrower . . . Today there are few scholars who can call themselves mathematicians or physicists or biologists without restriction . . . more frequently than not he will regard the next subject as something belonging to his colleague three doors down the corridor, and will consider any interest in it on his own part as an unwarrantable breach of privacy.[3]

For Wiener, the loss incurred by this restriction of knowledge was tragic, since the most fruitful areas of enquiry lay at the boundaries of different disciplines, which could only be explored by enabling two or more different sets of expertise to come together.

Eventually, the Second World War created an impetus and funding stream that enabled Wiener to draw together specialists who normally would not have interacted, enabling them to share their skills. But it was not long before the team realised that it was creating a new world that needed a new name. In this Wiener indicated that he had already become aware of 'the essential unity of the set of problems centering about communication, control, and statistical mechanics, whether in the machine or in living tissue . . . We have decided to call the entire field of control and communication theory, whether in the machine or in the animal, by the same "Cybernetics"'.[4] The interdisciplinary technology of cybernetics was thus born, which included the study of information feedback loops and derived concepts.

Wiener was actually convinced that these feedback loops were necessary for the successful functioning of both living biological organisms and machines. This was because they enabled self-regulating and self-organising activities through a continuous updating of information given to the machine or organism with respect to variables such as their environment. In addition, he suggested that since both machines and living organisms equally relied on such feedback processes, they could actually be combined to create a new entity or creature.[5]

Cybernetics also focused on the manner in which anything (digital, mechanical or biological) processed information and reacted to this information, as well as the changes that were necessary to improve these tasks.[6]

The power of this control and communication theory was immense and, over the years, the term 'cyber' began to extend to all things representing a combination or interchange between humans and technology. In this way, the term started to evolve in many different settings where interactions were possible with electronic applications. This included everything from cybercafés to cyberdogs and from cyberwarfare to cybersex. How far Wiener could see into the future is difficult to say, but it would have been an adventurous mind that could envision the present concept of cyberspace.

Cyborg

With the concept of cybernetics being defined, as already noted, by Wiener and his colleagues, the term 'cyborg' was originally coined, as its close cousin, by the Austrian research scientist Manfred Clynes and the American research physician Nathan Kline (1916–1983) in 1960 as a combination of 'cybernetic and organism'. This included an enhanced individual with both human and technological characteristics.[7] Thus, any living being which was merged with neuronal interfaces was considered to be a cyborg.

In this regard, the notion of humanity being enhanced by technology has stimulated the imagination of the public since the 1920s. The British Broadcasting Corporation (BBC) television science-fiction drama series *Doctor Who*, which is one of the oldest in the world, was quick to pick up on the theme when, in 1963, the 'Daleks' were conceived. These were genetically modified humanoids from another planet, who had been integrated into a robotic shell while being modified to no longer experience pity, compassion or remorse.

From the 1970s onwards, cyborgs became popular in many other films, where they figured as invincible humanoid machines demonstrating no emotion. Some were visibly indistinguishable from humans, though others were more mechanical than human, such as with 'Darth Vader' from the 1977 film *Star Wars* created by George Lucas. Other examples are the 'Cybermen' introduced in the 1966 *Doctor Who* series. This brand of super-villains was created by degenerating humanoid beings, whose body parts were replaced with plastic and steel as a means of self-preservation. But because their humanoid brains were retained, 'emotional inhibitors' had to be inserted so that the new Cybermen could cope with the trauma and distress of their transformation. Yet at the same time, this meant that they could no longer understand the concepts of love, hate and fear.

Interestingly, cyborgs are often portrayed in popular culture as representing hybrid figures who overlap boundaries where existing familiar, traditional categories no longer exist. As such, they are often used to create narratives of apprehension about possible future technological developments, while

raising questions about what human nature, identity and dignity actually mean. On this account, the cyborg expresses both the unease resulting from the perceived negative consequences of technology, and the sense of bewilderment and wonder before the extent and dominance of human technological achievement. [8]

One example of some of these anxieties may be considered when cyborgs are portrayed as being controlled by their technology to the detriment of their humanity and dignity. They are then presented as a kind of solitary monster, bringing disorder between the clear existing boundaries of what is human and what is machine. In fact, the Latin root of the word 'monster' is made up of *monstrare* (to show) or *monere* (to warn or give advice). As the American theologian Brian Edgar explains: 'Cyborgs – human-machines – are thus seen, perhaps more intuitively than anything, as both dehumanising and a threat to the order of the world. The idea produces existential feelings of insecurity and disorder as though the structure and fabric of society was under threat.'[9]

As such, cyborgs may play a similar role to the human-nonhuman mythological monsters of antiquity, such as the Chimera and the Minotaur, which were also considered as bringing disorder between the human and nonhuman boundaries. Because of this, these monsters were even considered dangerous and malign, necessitating destruction.[10]

But this kind of thinking did not stop in ancient history, since even during the Enlightenment, a number of scholars believed that the concept of monstrosity served as a moral boundary-marker. As the British social scientist and theologian Elaine Graham indicates: 'Monsters stand at the entrance of the unknown, acting as gatekeepers to the acceptable . . . the horror of monsters may be sufficient to deter their audience from encroaching upon their repellent territory.'[11] More generally, she argues that monsters serve a special function, which is neither totally beyond the bounds of the human nor conforming completely to the norms of humanity. In this way, they characterise but also subvert the boundary limits of humanity. She notes:

> Their otherness to the norm of the human, the natural and the moral, is as that which must be repressed in order to secure the boundaries of the same. Yet at the same time, by showing forth the fault-line of binary opposition – between human/non-human, natural/unnatural, virtue/vice – monsters bear the trace of difference that destabilizes the distinction.[12]

The American science and technology scholar Donna Haraway wrote an essay entitled *A Cyborg Manifesto* in 1983. This was prepared to encourage women to move the boundaries that appeared to be limiting their autonomy and as a response to the American politics of the day that explored and criticised traditional ideas about feminism. In this respect, Haraway explains

that the breakdown in boundaries since the twentieth century enabling the concept of a cyborg to be explored included a disruption of the borders between: (1) human and animal; (2) machine and human; and (3) physical and nonphysical. In this, she uses the concept of the cyborg to illustrate the possibility that no real distinction exists between human beings and human-made machines.[13]

Therefore, the prospect is for humanity to increasingly question what it means to be human when the traditional boundaries are challenged. As the British philosopher Andy Clark explains, in the future 'we shall be cyborgs not in the merely superficial sense of combining flesh and wires but in the more profound sense of being human-technology symbionts: Thinking and reasoning systems whose minds and selves are spread across biological brain and nonbiological circuitry'.[14]

This would then require a significant reappraisal of the way in which human beings consider themselves and relate to others. In this regard, Clark indicates that human beings may already be natural-born cyborgs in that they have a capacity to fully incorporate tools even as simple as a pen and notebook as well as cultural practices which are external to their biological bodies. He also suggests that human minds are already conditioned to integrate non-biological resources enabling them to think through technologies.[15]

Cyberspace

First used in science fiction in the 1980s, the term 'cyberspace' now refers to the virtual space created as communication technology extends into settings such as offices, schools, homes, factories, trains and refrigerators. More specifically, the concept of cyberspace became popular in the 1990s when the Internet, which is an interconnected network between several billion computers around the world, and digital networking were growing exponentially. The term was able to reflect the many new ideas and developments that were emerging at the time.[16]

Cyberspace was also popularised through the work of American-Canadian science-fiction author William Gibson and became identifiable to anything related to online computer networks.[17] But he has now criticised the manner in which the term is understood, indicating, with respect to the origins of the word in 2000: 'All I knew about the word "cyberspace" when I coined it, was that it seemed like an effective buzzword. It seemed evocative and essentially meaningless. It was suggestive of something, but had no real semantic meaning, even for me, as I saw it emerge on the page.'[18]

The concept of cyberspace has therefore developed on its own and now denotes a global network of social experiences where persons can interact

through, among other things, exchanging ideas, sharing information, providing social support, conducting business, directing actions, creating artistic media, playing games and engaging in political discussion. But while cyberspace should not be confused with the Internet, the term has slowly been transformed to reflect anything associated with online communication. A website, for example, may be said to exist in cyberspace, which is a space that cannot actually be characterised. Cyberspace thus represents the flow of digital data through the network of interconnected computers and is not 'real' in any three-dimensional sense, since it is impossible to spatially locate it as a tangible object. In this way, the term never really reflected a spatial concept as such, but rather described a network. Moreover, since cyberspace is the site of computer-mediated communication, in which online relationships and alternative forms of online identity are enacted, it is not just the place where communication takes place, but is also a social destination.[19] In other words, the concept of cyberspace does not simply refer to the content being presented, but also to the possibility for a person to use different sites, with feedback loops between the user and the rest of the system, enabling new developments for the user.

The American science fiction author Bruce Sterling explains:

> Cyberspace is the 'place' where a telephone conversation appears to occur. Not inside your actual phone, the plastic device on your desk. Not inside the other person's phone, in some other city. The place between the phones . . . this electrical 'space' . . . has flung itself open like a gigantic jack-in-the-box . . . This dark electric netherworld has become a vast flowering electronic landscape. Since the 1960s, the world of the telephone has cross-bred itself with computers and television, and though there is still no substance to cyberspace, nothing you can handle, it has a strange kind of physicality now. It makes good sense today to talk of cyberspace as a place all its own.[20]

Popular examples of persons being able to enter into cyberspace include the 1982 American science fiction film *Tron*, written and directed by the U.S. film director Steven Lisberger and based on a story by Lisberger and U.S. author Bonnie MacBird. In this film a computer programmer is transported inside the software world of a mainframe computer, where he interacts with various programs in his attempt to escape and get back out.

Another example is the 1999 film entitled *The Matrix*, directed by the American Wachowski siblings, which depicts a dystopian future where reality, as perceived by most humans, is actually a simulated reality called the Matrix created by sentient machines to subdue the human population. This is done in order to use their bodies' heat and electrical activity as a source of energy.

The 'Neuro' Prefix

The prefix 'neuro' originates from the Greek for neuron or nerve, which is related to the Latin *nervus* and has become popular in the last few decades to reflect something related to the brain and the nervous system. For example, the neurosciences form a multidisciplinary umbrella group in which each part unpacks some aspect of the way in which the brain and nerves operate. These include physical and biological sciences, behavioural and social sciences, clinical research, engineering and computer science, as well as mathematics and statistics.[21] In other words, the neurosciences examine aspects such as neurology, neurosurgery and neuro-oncology, with all the disorders relating to areas of the nervous system fitting under the frame of neuropathology.

But the 'neuro' prefix can also be used to express the manner in which the brain is sometimes used to understand other disciplines or ideas. This is why modern neurosciences are beginning to study the manner in which humans:

– use language and imagination to influence perceptions of time and space;
– perceive themselves and others;
– relate to other nonhuman living beings and to the natural environment;
– create from different historical, cultural, political, legal, economic and technical perspectives;
– acquire knowledge about themselves and the world; and
– produce and exchange things.[22]

From this perspective, neuronal modifications can be used for at least three purposes:[23]

– To maintain or improve mental health and cognitive function within typical or statistical norms.
– To address and treat disorders in order to achieve or restore typical or statistically normal functioning.
– To enhance function above typical or statistically normal ranges.

However, the neurosciences cannot answer on their own the significant ethical and anthropological questions that are important to society, such as what it means to be a morally responsible or free human being. But they can provide evidence for further reflection while supporting a better understanding of the functioning human brain, which may steer society's consideration of these questions.[24]

More recently, the prefix 'neuro' has also been added somewhat loosely to other terms that are not always easy to define, such as neuro-management,[25] neuro-fuzzy[26] and neuro-web design.[27]

Ethics

Ethics is the study of the values of human conduct and of the rules and principles that govern them. It seeks to distinguish what is considered to be good as well as ways of implementing these rules. Ethical considerations also seek to investigate the proportionality between the advantages and risks of a certain procedure, while examining whether it is possible to find an acceptable balance between the two. Sometimes, of course, it is difficult to define exactly what is meant by 'ethics' and even experts disagree. Generally, however, it refers to the study of standards of behaviour governed by what is agreed to be acceptable or correct. In this way, ethics examines and investigates moral choices, since morality refers more specifically to actual decisions and actions.

Ethical discussions have always been difficult because of the multiple ethical frameworks that exist, many of which argue from very different precepts and worldviews. In addition, few people currently adopt just one worldview while ruling out all other ways of thinking. This means that when facing a moral dilemma, most people usually pick and mix from the available options. Because of this, when a committee discusses an ethical dilemma, the issue often grows bigger with every additional participant. Each person is liable to have his or her own idea about which ethical approaches should be used at a given time and reaching a consensus can be well-nigh impossible. But if one is able to understand the principles underlying each mode of thinking, it is feasible to look at the outcome and ask questions about what led each person to that conclusion. This then strengthens the level of intellectual debate and, in theory at least, supports the development of more robust decisions.

In this regard, much of the so-called ethical debate occurring in modern media seems to operate at a level of descriptive ethics where stories are presented about the way in which people live and the choices they make. Through this, it is possible to gain a sense of where people place personal moral boundaries. However, the danger with this form of ethical debate is that it may imply a level of moral authority without actually explaining or even discerning the basis on which individual judgements are made.

In order to develop a better understanding, it is useful to examine the way people live, the choices they believe should be made and the values or worldviews they hold dear. From this perspective, it is possible to derive a sense of what they believe should normally take place. As a result, such 'normative ethics' can have a powerful effect on establishing moral frameworks within a society.

Like many disciplines, ethical concepts and principles also become more complex the more they are examined, which then introduces the concept of 'meta-ethics'. This questions the foundational thinking that is brought to any

debate, making it feasible to even consider the meaning of the words being used, the nature of language and the way in which statements can be seen to be true or false. The following questions then become meaningful:

– What does it mean to say that something is right or wrong?
– Are there any objective criteria by which it is possible to assess moral statements?
– What is moral discourse? Is it a statement of facts or more than that?
– In what sense can a moral statement or position be said to be either true or false?

From this perspective, it could well be that ethical discussions may eventually prove inappropriate in giving absolute answers, but they do help in developing ethical theories and principles that can be useful in supporting discussions and public policy.

Neuroethics

The American author and journalist William Safire (1929–2009) is widely credited with giving the term 'neuroethics' its present meaning when, in 2002, he defined it as 'the examination of what is right and wrong, good and bad about the treatment of, perfection of, or unwelcome invasion of and worrisome manipulation of the human brain'.[28]

In other words, the interdisciplinary field of neuroethics generally refers to the ethical, legal and social impact related to neuroscience, neurology and neurotechnology.[29] This includes the manner in which neurotechnology, and an understanding of brain function, can be used to predict or alter human behaviour or change identity, as well as the implications for society. For instance, basic research in neuroscience is continuing to expand society's understanding of the biological basis of the brain's functioning and what this means for the mental, psychological and behavioural characteristics of a person.

This then raises new ethical and philosophical challenges with respect to the implications of these results and how they should be interpreted and used.[30] For example, the manner in which human beings understand themselves and other persons as 'neurological subjects'[31] is certain to affect the way in which individuals understand themselves and their relationships with others.

Difficulties and urgent questions also arise relating to the way in which society should make use of the knowledge obtained in neurobiology and the new applications emerging in this area with regard to healthcare provisions, legislative requirements and even political or social regulations.[32]

In 2013, the UK's Nuffield Council on Bioethics published its report *Novel Neurotechnologies: Intervening in the Brain*, which addressed the possible benefits and unintended consequences of intervening in the brain. It proposed an ethical framework to guide the practices of those involved in the development, regulation, use and promotion of novel neurotechnologies.

Likewise, the U.S. *Presidential Commission for the Study of Bioethical Issues* devoted some of its resources between 2014 and 2015 to explore societal and ethical issues raised by the government's Brain Research through Advancing Innovative Neurotechnologies (BRAIN) initiative,[33] which was financially supported to the tune of approximately $100 million in 2014 alone, with the primary goal of mapping the brain.[34]

In this respect, the U.S. Presidential Commission acknowledged in 2015 that the ethical questions arising from new neurotechnologies did need to be examined, even though it accepted that: 'Altering the brain and nervous system is not inherently ethical or unethical.' However, it did recognise that: 'Ethical assessment of neural modification requires consideration of who is choosing the modifier, what is being chosen, what its purposes are, who stands to benefit, and who might be harmed.'[35]

Some neuroethical questions are not very different from those often encountered in bioethics in general such as the challenges involved in participating in neurological research or questions relating to risks when new technologies are being applied. But others are unique to neuroethics, since any change to the brain, as the organ supporting the mind, may have broader implications relating to free will, moral responsibility, the nature of consciousness and personal identity.[36]

Neuroethical challenges and social consequences arising from the new neurosciences, together with all their consequences, will also demand careful consideration with regard to policy-making and government in the manner in which society may respond to these changes to protect public interest.

Cyberneuroethics

From the above definitions, cyberneuroethics can be characterised as the study of neuroethical challenges arising from a direct neuronal interface with a computer network and the resulting association that may develop between the human mind and cyberspace. This means that it will include some of the neuroethical questions arising from brain–computer interfaces and cyborg minds.

At this stage, and because of the pace of technological development, the interdisciplinary study of cyberneuroethics may have to be initiated despite the reality that many neuroethical and neuroscientific questions remain to be

answered and developed. This is indeed one of the challenges of examining an ever-changing and expanding technology.

A significant number of cyberneuroethical issues will also reflect the manner in which a person's mind may integrate the information available in cyberspace and the way in which a person may be immersed in, and absorbed by, virtual reality. This is a reality that can be defined as immersive multimedia or computer-simulated sensory experiences, such as sight and hearing, and replicates an environment that simulates a physical presence in the real or imaginary world while letting the user interact in that world. Virtual reality can also characterise the 'place' where the cybernetic principle of a continuous organising and reconfiguration of information is present. In other words, it represents a fluid realm where boundaries and new possibilities may be changing all the time.[37]

With the development of cyberspace and a growing number of human beings deciding to spend an increasing amount of time in this virtual setting, many new opportunities and powerful experiences will be available to individuals. Being in virtual reality may then become more satisfying and rewarding for many individuals than genuine reality and could even become a preferable venue for them in which to construct and develop their identity.

However, in this cyberspace, the nature of moral agency and conduct may need to be redefined since it is possible to enquire whether common principles, values and rules are different between real and virtual realities or even between different virtual realities. It is thus possible to ask, as does the American ethicist Brent Waters, whether 'moral principles, values and rules make much sense within a realm of temporary borders and fluid boundaries?'[38]

What may eventually be considered ethical by examining what can be considered as good or bad behaviour in this virtual world existing in cyberspace is one of the main aspects of cyberneuroethics. But this implies that a person is able to make a choice between right and wrong, which requires a level of self-awareness, meaning that he or she has a mind supported by a brain or some other physical support.

It follows that cyberneuroethics will have to take account of the external effects that may influence the mind and brain of a person and how both of these interact when a person is seeking an experience in cyberspace.

The Terminology Being Used

In the context of the ethical debate relating to neuronal interfaces, many discussions note the difficulty of establishing clear borders between paired terms such as 'healing' and 'enhancement' or 'ability' and 'disability'.[39] Some even

question whether it is actually meaningful to make a distinction between such terms.[40] Indeed, healthcare is often seen as being more than just treating disorders, which means that some procedures may occupy a grey area.[41]

It is also difficult to consider the concept of enhancement without understanding what is meant by the concept of 'normal'. As a result, it may be useful to try to characterise the different terms and the questions they raise in the context of cyberneuroethical discussion in order to inform the conversation in the twenty-first century and beyond. But because agreed definitions of the following terms seem impossible to obtain for the foreseeable future, only a regular redefining and updating of what these terms actually mean, based on common practice, may be feasible.

Enhancement (or Augmentation)

Enhancement can be defined as an activity (whether biological or not) through which an object or subject is transformed to exceed what is normal in order to improve its natural state or function.[42] For example, human enhancement has been defined by the U.S. President's Council on Bioethics in 2003 as 'the directed use of biotechnical power to alter . . . the "normal" workings of the human body and psyche, to augment or improve their native capacities and performances'.[43]

In other words, the concept of enhancement reflects the idea of using technology and science to increase the human functioning of a healthy individual beyond the norm for that person and in the absence of any identified dysfunction.[44] However, the concept does not generally include the creation of capacities in new beings that have never previously existed in humans (which may be considered under the concept of transhumanism). The aim is to improve upon the norm, but not to surpass a pre-existing, human, natural state or capacity. This means that enhancement procedures are not geared towards exceeding the achievement potential of human beings who are at the upper end of the statistical distribution. In this context, a cognitive enhancement was defined by the Swedish philosopher Nick Bostrom and the computational scientist Anders Sandberg as 'the amplification or extension of core capacities of the mind through improvement or augmentation of internal or external information processing systems'.[45]

Therapy versus Enhancement

As previously noted, distinguishing 'therapy' from 'enhancement' is difficult and would depend on the definitions of other terms as well as cultural norms and values.[46] Generally, however, therapy is associated with maintaining, treating or restoring body parts or functions that the patient previously

possessed or enjoyed. A medical intervention is considered to be therapeutic when it restores human functioning to species-typical norms or gives abilities integral to the body that are considered to be normal. A therapy thus counteracts a known or an anticipated health deficit.[47] For example, kidney dialysis is a therapy that enables dysfunctional kidneys to filter impurities from the blood in a manner that approximates the properly functioning kidneys of a human being. However, an alteration of the brain that adds forty IQ points would be considered an enhancement if performed on someone who already has a normal IQ.[48]

This also means that if a society willingly seeks to enhance its members, then what would be considered normal for this community would eventually change. Previously normal traits could even be considered as dysfunctional if they no longer attain the new 'norm'. In such an event, these new dysfunctions could begin to be considered for treatment.

Notes

1. Tsien, *Engineering Cybernetics*, Preface, vii.
2. Hayles, *How We Became Posthuman*, 7.
3. Wiener, *Cybernetics*, 2
4. Ibid., 11.
5. Hook, 'Cybernetics and Nanotechnology', 53.
6. Kelly, *Out of Control*.
7. Clynes and Kline, 'Cyborgs and Space'.
8. Garner, 'The Hopeful Cyborg', 87–88.
9. Brian, *God, Persons and Machines*.
10. MacKellar and Jones (eds), *Chimera's Children*.
11. Graham, *Representations of the Post/human*, 53, quoted in Messer, *Respecting Life*, 135.
12. Graham, *Representations of the Post/human*, 54, quoted in Messer, *Respecting Life*, 135–36. See also Braidotti, 'Signs of Wonder and Traces of Doubt', 141.
13. Tirosh-Samuelson, 'Transhumanism as a Secularist Faith', 713–16.
14. Clark, *Natural-Born Cyborgs*, 3.
15. Clark, *Natural-Born Cyborgs*.
16. Strate, 'The Varieties of Cyberspace', 382–83.
17. Thil, 'March 17, 1948: William Gibson, Father of Cyberspace'.
18. Documentary Film made by Mark Neale: *No Maps for These Territories*, 2000; Thil, 'March 17, 1948: William Gibson, Father of Cyberspace'.
19. Graham, 'Geography/Internet'.
20. Sterling, *The Hacker Crackdown*, Introduction.
21. Presidential Commission of the Study of Bioethical Issues, *Gray Matters*.
22. Secretariat of the EGE, European Group on Ethics in Science and New Technologies to the European Commission, *Ethical Aspects of ICT Implants in the Human Body: Opinion No. 20*, 5.
23. Presidential Commission of the Study of Bioethical Issues, *Gray Matters*, vol. 2, 3.
24. Ibid., 104.

25. Braidot, *Neuromanagement*.
26. Jyh-Shing, *Neuro-fuzzy and Soft Computing*.
27. Weinschenk, *Neuro Web Design*.
28. Safire, 'Our New Promethean Gift'.
29. Illes and Raffin, 'Neuroethics'; Farah, 'Neuroethics'.
30. Chan and Harris, 'Neuroethics', 77–78.
31. Cunningham-Burley, 'Engaging with Neuroscience'.
32. Chan and Harris, 'Neuroethics', 77–78.
33. U.S. Presidential Commission for the Study of Bioethical Issues, 'President Announces $100 Million Investment into BRAIN Initiative'.
34. White House, 'BRAIN Initiative'.
35. Presidential Commission of the Study of Bioethical Issues, *Gray Matters*, vol. 2, 3.
36. Chan and Harris, 'Neuroethics', 77–78.
37. Waters, *From Human to Posthuman*, 52.
38. Ibid., 53.
39. Grunwald, 'Human Enhancement'.
40. Parens, 'Is Better Always Good?', s1; see, for example, Norman Daniels' position discussed in ibid., s2.
41. Nuffield Council on Bioethics,*Novel Neurotechnologies*, 165; Parens, 'Is Better Always Good?'; World Health Organization, *Definition of Health.*
42. Moore, *Enhancing Me*.
43. President's Council on Bioethics, *Beyond Therapy*, 13.
44. Harris, *Enhancing Evolution*. Cf. British Medical Association, *Boosting Your Brainpower*, 9.
45. Bostrom and Sandberg, 'Cognitive Enhancement', 311.
46. For some, an intervention may be a therapy, but for others the same intervention may be a clear enhancement, leaving a grey area in between. Moreover, it can be unclear whether therapies, whose primary purpose is curing diseases, but that have a secondary potential of improving performance, should be classed as enhancements or treatment.
47. British Medical Association, *Boosting Your Brainpower*, 5.
48. Mitchell, 'On Human Bioenhancements', 133.

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