Neurosurgeons’ perspectives on psychosurgery and neuroenhancement: a qualitative study at one center

Clinical article

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Object. Advances in the neurosciences are stirring debate regarding the ethical issues surrounding novel neurosurgical interventions. The application of deep brain stimulation (DBS) for treating refractory psychiatric disease, for instance, has introduced the prospect of altering disorders of mind and behavior and the potential for neuroenhancement. The attitudes of current and future providers of this technology and their position regarding its possible future applications are unknown. The authors sought to gauge the opinions of neurosurgical staff and trainees toward various uses of neuromodulation technology including psychosurgery and neuroenhancement.

Methods. The authors conducted a qualitative study involving in-depth interviews with 47 neurosurgery staff, trainees, and other neurosurgeons at a quaternary care center.

Results. Several general themes emerged from the interviews. These included universal support for psychosurgery given adequate informed consent and rigorous scientific methodology, as well as a relative consensus regarding the priority given to patient autonomy and the preservation of personal identity. Participants’ attitudes toward the future use of DBS and other means of neuromodulation for cognitive enhancement and personality alteration revealed less agreement, although most participants felt that alteration of nonpathological traits is objectionable.

Conclusions. There is support in the neurosurgical community for the surgical management of refractory psychiatric disease. The use of neuromodulation for the alteration of nonpathological traits is morally and ethically dubious when it is out of sync with the values of society at large. Both DBS and neuromodulation will have far-reaching and profound public health implications. (DOI: 10.3171/2010.5.JNS091896)

Key Words • enhancement • neuroethics • personal identity • psychosurgery

TECHNICAL advances in neurosurgery are transforming the field. Minimally invasive options, such as DBS and GKS, are available to treat diseases of both structure (such as tumors) and function (such as movement disorders).3,7 The application of DBS to psychiatric diseases such as depression represents a paradigm shift in therapy and raises important ethical issues.

Advances in neurosurgical technology and neuroimaging are stirring intense debates regarding potential applications of neuromodulation. The use of DBS to treat obesity, the development of a brain-machine interface to facilitate independence for paralyzed patients, and the potential use of functional imaging for “lie detection” underscores both the concerns and promise regarding technical advances.2,12,28 Neuroethics is the dedicated field that explores the ethical implications of these advances.1,4,13,22

The misadventures of psychosurgery in the mid-20th century resulted in a stigma on the surgical management of mental illness. Prefrontal leucotomy, or lobotomy, harmed many patients and serves as a reminder of patient safety being trumped by technological advances.15,26 The development of stereotactic neurosurgery, which allowed more precise anatomical targeting, led to safer and more effective means of operating on diseases of brain function. Success in the realm of movement disorders with ablation of deep brain targets stimulated the development of similar ablative procedures for treating mental illness. Cingulotomy, capsulotomy, and subcaudate tractotomy are surgical options for refractory disorders of mood and anxiety.3 Despite early successes, it is unclear to what extent the public and the neurological community support neuromodulation for treating psychiatric diseases.

The ability of clinicians to alter pathological thinking and behavior has led ethicists to predict substantial public health and societal consequences for functional neurosurgery.5–10 Due to the intimate relationship between the mind and personal identity, altering individual personality traits can be considered changing personal identity, and some have postulated that the era of surgically assisted neuroenhancement, defined as improvement in the absence of medical need,5 is close behind. Such research may also cause the establishment of artifi-

Abbreviations used in this paper: DBS = deep brain stimulation; GKS = Gamma Knife surgery; OCD = obsessive-compulsive disorder; PTSD = posttraumatic stress disorder.
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social inequalities, based not on merit, but on access to surgical technology.

In recent years, commentators have called for increased public engagement in the neuroethics discussion. Leshner has argued that the brain’s significance in defining personality and individuality necessitates the inclusion of the public in the neuroethical debate. The opinions of clinicians and patients toward neuroethical issues and the implications of novel neuroscience tools have undergone limited study.

Neurosurgeons will be the future providers of neuromodulation technology. Therefore, it is essential to assess their attitudes toward ethical issues involving the use of neurosurgical interventions.

In this study, we interviewed neurosurgery staff, fellows, and residents at the University of Toronto about their views of hypothetical ethical issues in psychosurgery and neuromodulation. Our objectives were to explore neurosurgeons’ attitudes toward psychosurgery and to examine the public health and larger cultural implications of neuromodulation.

Methods

Study Design

This was a qualitative study using semistructured one-on-one interviews. Participation was voluntary, and anonymous and informed consent was obtained from each participant. The study was approved by the University Health Network Research Ethics Board.

Participants

All neurosurgery staff, fellows, and residents training at the University of Toronto were offered participation in the study by email. Neurologists, neuroradiation oncologists, and medical students interested in neurosurgery were also invited to participate. We recruited 47 participants including neurosurgery staff (18), fellows (8), residents (11), neurologists (3), neuroradiation oncologists (3), and medical students interested in neurosurgery (4). The number was to ensure saturation, at which point additional interviews do not provide any new concepts.

Only 2 of the participants were active stereotactic and functional neurosurgeons. Participants underwent open-ended, face-to-face, semistructured audio-recorded interviews. Demographic information and participants’ educational exposure to ethical theory was collected (Table 1). The interviews assessed attitudes and opinions toward ethical issues presented as case scenarios (Appendix).

Analysis

The interview transcripts were analyzed by the authors using thematic analysis involving open and axial coding. Reading fragments were grouped according to main ideas (open coding). Dominant ideas that emerged were organized into overarching themes (axial coding).

Results

Four distinct themes are described below and illustrated with verbatim quotes.

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<thead>
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<th>No. of Participants*</th>
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<tr>
<td>after medical school</td>
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* Unless otherwise noted.
† Four of the 47 participants were current medical students; thus only 43 participants could have had formal education in ethics after medical school.

Personal Instinct and Traditional Ethical Principles Govern Responses

Several of the scenarios discussed evoked strong emotional responses from the participants. It became clear that many initial responses were emotion laden, which then gave way to more rational and logical reasoning. The scenarios, some of which dealt with elective personality alteration and cognitive enhancement, were met with an initial “gut instinct” and subsequently approached with reasoning and traditional ethical principles.

“I don’t think personally I would do it to be honest, it just doesn’t feel right.”

“[Psychosurgery] would have to be in the context of failed medication, failed things that are less risky because brain surgery is dangerous. But as long as the benefits of the treatment are outweighing the consequences of the disease, I think it’s something that should be done.”

In scenarios involving the balance between individual rights and the greater good of society, such as the hypothetical use of neuromodulation during a military
interrogation, participants cited classic ethical principles to support their opinions.

“It guess you are weighing autonomy against the perceived benefit to a very large number of people.”

Surgery for Refractory Psychiatric Disease is Ethically Justified

All participants (47 of 47) agreed that surgery for mental illness is warranted if it is sufficiently safe and efficacious, other treatments have failed, direct or indirect informed consent is obtained, and the condition significantly impacts a patient’s quality of life. Widespread agreement persisted even for some treatments that may result in alterations in personal identity.

“I would have no objection to [surgery for psychiatric disease] because these are pathologic states and if functional neurosurgery is one way of treating it then I have no objection to that.”

“…those conditions are very disabling and if you can help improve the quality of life of those individuals then I’d be supportive, like anyone would.”

A clear relationship emerged between surgical interventions that alter mind functioning and the perceived risks and benefits. The decision to proceed with surgery varied inversely with physical invasiveness and directly with perceived benefit. This trend persisted for hypothetical interventions, such as the surgical treatment of antisocial personality disorder.

“Potentially yes because I know that that anti-social personality disorder can be very severe, you can end up in prison… it can destroy people’s lives …and can cause harm to others. So if you have a therapeutic intervention that can help them then yes.”

“Mental invasiveness” was an aspect incorporated into several approaches to scenarios. An intervention for treating a psychiatric condition, such as selective memory ablation for treating severe refractory PTSD, was rationalized if risks were low enough that the therapeutic benefit would justify the intervention’s mental invasiveness. Improving functionality and restoring a patient’s quality of life became a justifiable rationale for the mental invasiveness of altering personal identity through a personal identity change as a side effect or by erasing a patient’s life-altering experiences.

“It does seem like something the patient would benefit from in this particular case because he has a pathologic diagnosis related to memory. Yeah I think in this case I would.”

However, given the role memory has in shaping personality and identity, a global memory alteration was generally too mentally invasive to permit even for treating severe refractory PTSD.

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“Someone’s life experiences is what makes them what they are… altering somebody’s memory and experiences I think is, you know, dangerous territory.”

Surgery to Enhance Nonpathological Traits is Unethical

A large majority of participants (39 of 47) felt that surgery to alter personality traits that are nonpathological is not ethically justified. A common argument against enhancing any form of natural physiological variation was that surgical and medical interventions are generally only indicated for pathological diagnoses.

“If there is no deficit, you are interfering with human nature, which is beyond the scope of medical practice.”

“I don’t believe in altering personality that’s not considered to be in the disease state.”

The arguments against enhancement extended even to technology that was deemed essentially risk free, such as transcranial magnetic stimulation. For the vast majority, a clear line exists between pathology and nonpathology, and the application of neuromodulation for nonpathological normal variation was ethically dubious. For example, over 90% of the participants felt that enhancement to increase appreciation of a hobby was unacceptable.

When participants following this no-pathology–no-intervention approach were asked to contrast the ethics of enhancing the body with cosmetic surgery or enhancing the mind with functional neurosurgery, responses predominately fell into 2 categories. Participants either disagreed equally with cosmetic surgery and cosmetic neurosurgery or they stated that neurosurgical enhancement of normal traits was an unacceptable alteration of an individual’s essence with a potential to harm mind functioning.

“I think it’s uncomfortable for all of us… because the brain will define the person to a greater extent than other aspects of the body.”

Most participants placed a strong emphasis on personal identity. Any enhancement of a nonpathological state that threatens an individual’s sense of identity, be it a substantial alteration in personality or even sexual orientation, would not be ethically permissible.

“…those are specific personality traits that are unique to each individual and although we might not like them, it is not our role to change them.”

“I think that would again be changing the core person.”

Participants subscribed to a unique definition of personal identity, one that appeared to not be threatened by psychosurgery, but potentially altered by enhancement. The idea of changing someone’s personality was deemed to be a threat to personal identity when that change was to a characteristic outside the definition of pathology.

A small number of participants did not oppose en-
hancement. Those who supported it often cited patient autonomy and an individual’s right to access novel technologies that can offer improvement beyond their normal abilities.

“...if it’s safe, it’s a benefit to mankind, it will make us all better, make us all enhanced, yeah no problem.”

“I think if somebody had true informed consent and they understood the risks and the benefits and all that, yeah, it’s their brain.”

*Cultural Attitudes Govern the Acceptability of Surgical Innovation*

A commonly held reservation for surgical neuromodulation, in both pathological and nonpathological states, was that society is not ready for such interventions.

“I think it’s more of a societal definition of what is acceptable and I think society will move in what it sees acceptable.”

“If as a society we’re willing to start to talk about...um...manipulating the brain as a tissue as we would for cosmetic surgery of any area of the body and cosmosis, then they are both warranted.”

“...the world is not ready for it.”

Participants understood that the definitions of health and disease are dynamic and largely culturally driven. The majority of participants commented that acceptable criteria for surgical intervention, cosmetic or not, fluctuate with time, and with the evolving proclivities of society at large.

**Discussion**

Neurosurgery has made significant progress in the treatment of not only structural pathology but also functional pathology such as chronic pain and movement disorders. Recent studies have demonstrated a growing potential for treating diseases of the mind and perhaps eventually enhancing nonpathological states. Because there are potential financial incentives for surgeons and likely a substantial demand by patients, assessing whether an ethical marketplace for psychosurgery and neuroenhancement exists among providers of the interventions is important for both practical reasons and policy-making considerations. To the best of our knowledge, this is the first study to examine neurosurgeons’ opinions on the ethics of surgically treating psychiatric illness and enhancing nonpathological states.

Psychosurgery implies the capacity to alter an individual’s cognitive and emotional faculties, with “mentally invasive” surgeries becoming therapeutic options for refractory mental illness. The participants in our study widely supported a role for surgical management of a broad range of mental illnesses; all neurosurgeons stated that a sufficiently safe and effective surgery could be justifiable for treating psychosis (schizophrenia) and neurological depression, OCD. In several hypothetical scenarios, however, mental invasiveness became a factor affecting the justification of surgery. Many participants felt that a psychiatric illness could be sufficiently severe to justify the mental invasiveness of the intervention. However, the benefit would have to outweigh the disadvantages, and some neurosurgeons felt that psychiatrists are better equipped to decide if psychosurgery should be indicated for a particular mental illness. The participants’ views on the mentally invasive scenarios contrasted perspectives from the neuroethics literature. For instance, ethicists have debated the use of propranolol for the prevention of PTSD; administration of the drug hours after exposure to trauma can prophylactically prevent the debilitating anxiety disorder. Some argue that such an intervention would diminish the deterrent to harm others or mitigate the value of a traumatic life experience in shaping one’s identity and altering the natural course of personal growth. Interestingly, none of the neurosurgeons mentioned these concerns. Perhaps the clinician’s drive to relieve patient suffering, even with mentally invasive interventions when necessary, justified the proposed mentally invasive treatments.

Enhancement raises a number of ethical issues. Improving a trait artificially without the effort and dedication of the person otherwise required to attain the improvement may diminish the value of the accomplishment and inhibit personal growth. Quick-fix enhancements create imbalances in the playing field and confer unfair benefits on those with access to enhancement interventions. Surgical enhancement may alter personal identity. Neurosurgical enhancement is an extreme scenario of invasively altering the core of a person and the capabilities with which they were naturally endowed.

The majority of the participants believed that neuroenhancement is ethically dubious for memory enhancement and for elective personality alterations or recreational enhancement. Altering natural variation was a common refuting argument and inequality and society’s unpreparedness were other stated reasons. Those who supported enhancement cited free will; indeed, many nonneurosurgical forms of enhancement are available in society today. The importance of reserving surgery for pathological states was commonly stressed. A similar study by the authors involving neurosurgery patients (as opposed to doctors) roughly paralleled the results of the current study. Patients felt surgery for mental illness was ethically acceptable and neuroenhancement ethically questionable. Some ethicists believe free will and autonomy supersede arguments against enhancement and that individuals should not be prohibited from accessing neuroenhancing technologies.

The capacity to alter personal identity is the novel and unique factor underlying debates about psychosurgery and neuroenhancement. Some ethicists have criticized neuroscientists’ reductionism of the mind to a biological substrate. This mind-brain reductionism enables support for “artificial” alteration of nonpathological cognitive and personality traits. The vast majority of participants believed that the mind is more than just a product of the brain. Perhaps this nonreductionist perspective formed a basis for opposition to alteration of nonpathological states. When a mind is pathologically ill, an intervention altering personal identity may be the only method for remediating a sick patient. However, in the absence of pathology, the
mind’s uniqueness transcends humanity’s capacity to alter it through physical manipulations of brain function. If and when some of the neurological interventions become practically available, their uses will depend to some extent on society’s perspectives. Just as some societies have grown to accept physical enhancement through cosmetic surgery, perhaps society’s views on neuroenhancement will reach a similar degree of acceptance.

Limitations

Reducing complex issues to narrative scenarios may diminish the moral density of these issues. Conducting relatively brief interviews, posing numerous scenarios and requesting an immediate response in some cases may not have allowed the participants adequate time to think thoroughly about the cases. In our attempts to simplify the ethical issues, we often included in our cases surgery with no risk or with 100% efficacy, possibly biasing participants toward positive responses. Some participants found the scenarios too hypothetical. Finally, the results are possibly biased by the fact that the study was performed in a center with a long and deep tradition of stereotactic functional neurosurgery; however, only 2 (4%) of the participants were stereotactic and functional neurosurgeons who perform DBS.

Conclusions

Technical advances in neurosurgery, and their success in diseases of brain function, have led to debates surrounding the ethical implications of mind-altering surgery. Numerous commentaries have debated these issues, but this study is the first to actually assess the attitudes of neurosurgeons and neuroclinicians toward the application of neurosurgical technology in both pathological and nonpathological states. Psychosurgery for a broad range of mental illness was unanimously accepted. In contrast, enhancement of normal traits in otherwise healthy individuals resulted in less consensus with decision-making approaches rooted in patient autonomy, the pathology/nonpathology distinction, and the preservation of personal identity. The prospect of altering brain function in both disease and nondisease states has broad public health and cultural implications that extend beyond the individual patient or clinician. Further exploration of the views of stereotactic and functional neurosurgeons around the planet is needed.

Appendix: Interview Guide

Interviewer starts: Before we begin, I will ask some general questions.

1) How old are you?
2) Are you a member of the staff, a fellow, or resident?
3) How many years of neurosurgery training have you completed?
4) Have you ever had formal education in ethics prior to medical school? Y / N. [If yes] How many ethics courses did you take?
5) Have you ever had formal education in ethics during medical school? Y / N. [If yes] How many ethics courses did you take?
6) Have you ever had formal education in ethics after medical school? Y / N. [If yes] How many ethics courses did you take?

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[Formal education = Master’s degree, training session, CME (continuing medical education), conference attendance]

Interviewer continues with preamble: This is a qualitative study on neuroethics. Today’s interview is intended to ask your opinions toward select ethical cases related to neurosurgery. You will have an unrestricted amount of time to offer your opinion regarding each case.

7) Are you familiar with the concept of neuroethics? Y / N
8) [If yes] In your opinion, what is neuroethics?

Neuroethics encompasses various fields and issues. For the purposes of this interview, we are concerned with mainly one division of neuroethics. The following are two definitions:

1) “Neuroethics considers the ethical implications of advances in neurosciences.”
2) “Neuroethics embodies the theoretical and practical issues in the neurological sciences that have moral and social consequences in the laboratory, in health care, and in the public domain.”

9) Do you have any questions before we begin?

Interview continues: The following are hypothetical cases involving potential future possibilities in neurosurgery.

Case 1. In collaboration with a team of neurosurgeons, a biotechnology company has developed a DBS protocol for treating the memory deficits accompanying Alzheimer disease. The technology is also capable of enhancing memory in healthy adults, adolescents, and children.

a) Should this technology be available to healthy adults, adolescents, and children who wish to electively enhance their memory abilities? Why or why not?
b) [If yes] If the elective memory enhancement was accompanied by a personality change that the patient was not aware of, would this change your opinion? Why or why not?
c) [If yes] If this elective procedure was available to patients, however the cost was so high that only few could afford it, would this change your opinion on whether the elective procedure should be offered or not?
d) If instead, healthy individuals could take a memory-enhancing drug that was very safe with no side effects, would you support offering this form of memory enhancement? Why or why not?

Case 2. Researchers at the Toronto Institute of Brain Research have developed a DBS technique that is extremely effective at treating a number of psychiatric disorders including schizophrenia, severe depression, and OCD.

a) Should this technology be used for treating these psychiatric conditions? Why or why not?
b) [If yes] If a surgical procedure existed that could change a patient’s personality, whereby if the patient was inherently a greedy, rude, or selfish individual, or if they had an undesirable personality, they could become less greedy, less rude, or less selfish, would you support offering this? Why or why not?
c) Suppose a neurological intervention exists that is widely recognized as unethical. Are neuroscientists obligated to withhold information from the public about the existence of this intervention? Why or why not?

In the first two cases, you were asked about your opinions toward memory enhancement and personality enhancement or alteration. Elective surgeries for enhancement such as cosmetic surgery are readily available. Is there an ethical difference between elective enhancement of the body and elective enhancement of the mind? [If yes] What is the distinction?
Case 3. A functional MR (fMR) imaging protocol allows for the accurate predictive diagnosis of Alzheimer disease. Up to 20 years before the onset of clinical signs and symptoms, a predictive diagnosis can be made,

a) Should this “screening” investigation for Alzheimer disease be made available to patients? Why or why not?
b) If there were medical or surgical treatments available that could prevent the cognitive decline associated with Alzheimer disease detected with this fMR imaging screening protocol:
   i. [If no] Would this change your opinion? Why or why not?
   ii. [If yes] Would that further support your opinion?
c) [If yes] Would you consider offering a safe and effective prophylactic surgical treatment for a patient with a positive scan? Why or why not?
d) If a patient has an fMR imaging scan for other reasons and it shows they are at increased risk of developing Alzheimer disease in the future, should they be informed of the result? Why or why not?

Case 4. During a large study on GKS for tremor, patients reported an enhanced appreciation for opera music and, as a result, an enhanced quality of life. These findings are reported in the peer-reviewed literature and the public finds out. Healthy individuals are requesting GKS to enhance their appreciation for opera, to improve their quality of life.

a) Should neurosurgeons provide this as an elective procedure for healthy individuals? Why or why not?
b) If a safe drug was available that could also enhance appreciation for opera music, should it be made available to patients? Why or why not?

Case 5. A war veteran has PTSD caused by extreme experiences that occurred during military action. Ten years after these experiences, all available medical and psychiatric therapies attempted have been unsuccessful. Using fMR imaging and DBS, a team of neurosurgeons can successfully suppress the recall of the specific experiences that are causing this patient distress.

a) Is it ethical to surgically eliminate memories in this situation? Why or why not?
b) Suppose a middle-aged woman who was sexually abused by her stepfather throughout her childhood requests memory removal of her entire childhood, would it be ethical to offer this procedure? Why or why not?
c) Suppose an individual has experienced distress from a relationship that ended poorly 10 years earlier and all available treatment options have been unsuccessful, would it be ethical to eliminate the memories that cause distress if the patient desired this procedure? Why or why not?

Case 6. A middle-aged man is involved in a motor vehicle accident and sustains significant frontal lobe injuries. Following the accident, the patient becomes disinhibited. Their poor judgment and decision making lead to several encounters with the law and eventually he is imprisoned. A team of researchers have discovered a method for surgically implanting stem cells into the frontal lobe, and, when combined with cognitive rehabilitation, these treatments can restore a patient’s capacity to make socially acceptable judgments and decisions involving legal risks.

a) Should this patient be offered this combined surgical and therapeutic intervention? Why or why not?
b) [If yes] If this surgical and therapeutic intervention was accompanied by a personality change from baseline, would this change your opinion? Why or why not?
c) Suppose the aforementioned surgical and therapeutic interventions are found to be successful at treating the antisocial tendencies in patients with antisocial personality disorder. Should patients with antisocial personality disorder be offered this combined surgical and therapeutic intervention? Why or why not?

Case 7. A terrorist suspect is captured by the US government. This terrorist suspect is strongly believed to have information regarding an impending terrorist attack that could kill thousands of Americans. The government calls on a group of Toronto neurosurgeons who have developed a method for using transcranial magnetic stimulation to disinhibit the frontal lobes sufficiently to prevent individuals from lying and to force them to tell the truth against their will.

a) Is it ethical for neurosurgeons to use this technology in this case? Why or why not?
b) [If yes] Would you feel comfortable doing the procedure yourself?

Case 8. An 18-year-old healthy woman is concerned that she will develop alcoholism and addiction because she has an extensive family history of substance use disorders. She does not have a substance use disorder. A team of neurosurgeons has discovered a method for significantly reducing propensity to develop addiction through DBS to the nucleus accumbens. This individual is requesting this neurosurgical procedure as a prophylactic measure to prevent alcoholism.

a) Should the neurosurgeons offer the operation to this patient? Why or why not?
b) If a neurosurgical intervention existed that could treat patients with severe alcoholism that is refractory to all other treatment options, would you support offering this procedure? Why or why not?

Case 9. A male adult has struggled with pedophilia for many years and has been imprisoned repeatedly due to sexual offenses.

a) If a neurosurgical procedure existed that could suppress this patient’s sexual impulses, would you support offering this procedure if the patient requested it? Why or why not?
b) If a neurosurgical intervention existed that could alter sexual orientation, effectively making a homosexual heterosexual, would you support offering this procedure if a patient requested it? Why or why not?

Case 10. A biotechnology company has developed a technology allowing quadriplegics to control wheelchair motion with their minds using scalp electroencephalography. The technology can also be used to allow military operatives to control combat robots over large distances, effectively reducing soldier casualties during military operations and improving combat efficiency.

a) Is it acceptable to use this medical technology for military purposes? Why or why not?
b) Is it acceptable to use this medical technology to enhance an individual’s ability to work at their job—such as enhancing an airline pilot’s ability to fly a plane? Why or why not?
c) Is it acceptable to use this medical technology to enhance a professional athlete’s ability to control their muscles, leading to improvements in athletic performance? Why or why not?
d) Is it acceptable to use this technology to allow quadriplegics to control wheelchair motion with their minds? Why or why not?
e) Who should regulate the uses of this technology? For instance, for military, commercial, or athletics purposes.

That is the end of the cases. Do you have anything to add to the cases?

The last question is: Do you consider the mind to be more than just a product of the brain?

There may be some thoughts and opinions we might not have touched on during this interview. Is there anything you would like to add?
Specific Follow-Up Questions:

Regarding risk:

a) Suppose the same outcome could be achieved with transcranial magnetic stimulation, would that change your opinion?

b) You mentioned the risk of the procedure as a factor affecting your opinion. If, hypothetically, the procedure carried zero risk of any complications, would you support offering this form of treatment?

Regarding personal identity:

a) You mentioned alteration of personal identity as a factor affecting your opinion. Is there an ethical difference between a neurosurgical procedure that alters personal identity and a physical operation (such as a face transplant) if both are used to treat clinically significant conditions and both lead to alterations in personal identity? [If yes] What is the distinction?

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References

1. Abi-Rached JM: The implications of the new brain sciences. The 'Decade of the Brain' is over but its effects are now becoming visible as neuropolitics and neuroethics, and in the emergence of neuroeconomies. EMBO Rep 9:1158–1162, 2008


17. Leshner AI: It’s time to go public with neuroethics. Am J Bioeth 5:1–2, 2005


30. Warnick JE: Propranolol and its potential inhibition of pos

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