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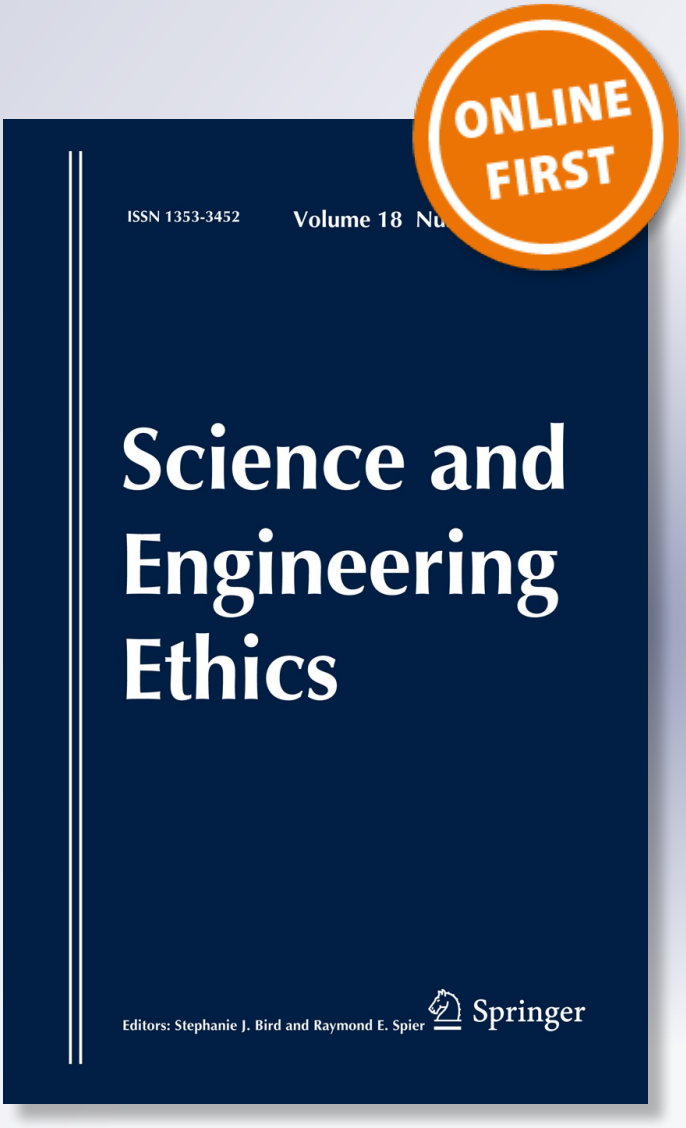

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ORIGINAL PAPER

European Public Deliberation on Brain Machine Interface Technology: Five Convergence Seminars

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Abstract We present a novel procedure to engage the public in ethical deliberations on the potential impacts of brain machine interface technology. We call this procedure a convergence seminar, a form of scenario-based group discussion that is founded on the idea of hypothetical retrospection. The theoretical background of this procedure and the results of five seminars are presented.

Keywords Brain machine interface · Ethics · Public deliberation · Hypothetical retrospection · Decision making under risk

Introduction

The last decade has seen an astounding development of a range of technologies collectively known as brain machine interfaces (BMI) (Lebedev and Nicolelis 2006). These technologies involve an implant that connects the human nervous system via electrodes to a machine, thereby making communication between the two possible (Vidal 1973). BMIs are already used in treatments for profound deafness, Parkinson's disease, and depression. BMI developments currently at the experimental stage include retina implants, which could provide some blind people with rudimentary visual orientation, and advanced prostheses, maneuverable by neural control, for patients with some types of paralysis.

The potential effects of BMI technology in our society may be substantial. Issues under discussion include human enhancement, military applications, privacy, safety and risk, as well as challenges to the body and especially the brain (Clausen 2010;

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Bell et al. 2009; Glannon 2009; Haselager et al. 2009). A need clearly exists for public participation in discussions regarding how and to what ends this technology should be used and on the risks and the ethical issues associated with it. The experience from public engagements of this kind is still relatively scant and somewhat mixed. In some countries, constructive dialogues have begun, whereas in France, some public meetings have been interrupted by activists in 2009 and 2010 (Phillips 2012). Sabine Roeser has argued that experts and policy makers have been reluctant to engage the public in a dialogue on the risks associated with new technology. This lack of communication tends to result in either technocratic policies without democratic legitimacy or populist policies contrary to scientific advice (Roeser 2011).

In this paper, we present the results from a novel form of public engagement that aims to discuss these issues in focus groups in an informed and deliberative manner. We refer to this form of public engagement activity as convergence seminars. This method was developed and used by Sven-Ove Hansson and Marion Godman for the first time as part of the EC FP6 NanoBio-Raise interdisciplinary project on nanobiotechnology and ethics, which was the predecessor of ETHENTECH. The results were discussed in the article "European public advice on nanobiotechnology—four convergence seminars" (Godman and Hansson 2009). Convergence seminars seek to combine public participation with a systematic use of scenarios in order to ensure that several possible future developments are seriously considered. It should be stressed that the opinions of the participants that are not necessarily supposed to converge, but rather the participants themselves converge, as they test their views and arguments in different sub-groups.

The theoretical basis of the convergence seminars is a model of decision-making called hypothetical retrospection (Hansson 2007). The aim of these seminars is both to gather opinions on BMI, and to inform and engage the public with respect to these issues. We believe that public participation and deliberation on morally relevant issues is intrinsically valuable and that it also contributes to bridge the gap between the public and academia.

We endeavored to recruit participants with a limited background within technology or natural sciences and in particular with little to no prior experience or knowledge of BMI. This was partly in order to avoid stakeholder interest and partly to hinder the discussion being dominated by concern for technical rather than ethical issues. Our idea when choosing participants was to include a set of distinct groups with reasonable cohesion. The idea here was also to focus the discussion on the ethical challenges rather than the plausibility of the scenarios. This is because this methodology is intended to record a variety of (reasonably considered) opinions rather than to determine the representative public opinion. We chose participants who were expected to approach the issue from widely different angles, as they were from different regions, different demographics and with different expected attitudes to BMI. We chose four distinct cultural regions of Europe to conduct our seminars: two seminars in Stockholm (Sweden), and one each in London (UK), Warsaw (Poland), and Seville (Spain). In Sweden, we consulted with members of the Parkinson's association and with philosophy students; in the UK, with students at a theological and philosophical college; in Poland, with medical students and

practitioners; and in Spain, with schoolteachers in a small village. However, our choice of participants was constrained by logistical concerns and our limited resources, which means that we were not able to have the kind of diversity that we aimed for.

Theoretical Background of the Methodology

Participative methods for technology assessment (TA) and decision advice have been developed within the broad tradition of decision-oriented technology studies that began with the introduction of TA in the 1960s and early 1970s. The initial hopes of developing efficient means of predicting the consequences of emerging technologies were not fulfilled. The discipline was therefore reoriented towards tasks that were more realistic. In the 1980s, participatory technology assessment (pTA) emerged as an alternative to traditional, more expert-driven procedures, foremost in Denmark and the Netherlands. The purpose was to improve public influence and participation in decision-making on future technologies. Various participatory methods such as dialogue forums, focus groups, future panels, and consensus conferences were developed for this purpose (Belucci et al. 2000; Palm and Hansson 2006).

In our view, one of the weaknesses of most of these approaches is their insufficient attention to uncertainties and in particular to the several alternative future developments that need to be taken into account in most assessments of future technology. Critics have also pointed out that TA is resource intensive and that the quality of the outcome seems to be proportionate to the financial means available (Palm and Hansson 2006). In a parallel development, methods based on the systematic use of several scenarios have been developed for expert-driven decision support. Scenario planning has its roots in post World War II defense planning in the US, with major contributions made since by Royal Dutch/Shell in the 1970s. Scenario planning is now used in corporations and increasingly by governments and international organizations (such as the International Panel on Climate Change, IPCC). The standard method is to develop a handful of external scenarios that cover factors and developments beyond the decision-maker's control, and then to combine them with various possible responses and actions by the decision-maker. Scenario development often takes place in workshops that involve experts and stakeholders. The finished scenarios are then used by decision-makers in exercises aimed at developing insights about future uncertainties and possibilities that can be used to improve decision-making.

In the last decade, nanotechnology and brain-machine interfaces have become the focus of an increasing number of public participation activities in several different countries (Gavelin et al. 2007). The methods used in these attempts include many classic educative methods such as lectures, seminars, and question-hours with experts. They also include some of the participative methods developed in technology assessment, such as focus groups. However, just as in previous work in technology assessment, the combination of participative methodology with the systematic use of different scenarios to deal with uncertainties and divergent

possibilities seems to be absent (or at least very uncommon). Our desire to improve previous work in this respect led to our decision to develop the method of convergence seminars.

Convergence seminars are based on a theoretical approach to rational decision-making under risk and uncertainty, which has been described more in detail by Hansson (2007). Like many other philosophical ideas, it consists in the refinement and systematic application of a pattern of argumentation that is prevalent in non-philosophical discussions. One of the most common types of arguments about future possibilities consists of referring to how, in the future, one might come to evaluate the actions one takes now. These arguments are often stated in terms of predicted regret: "Do not do that. You may come to regret it." This is basically a sound type of argument; from the viewpoint of classical instrumental rationality; it is irrational to perform an action whose effects will be unsatisfactory. Decision-stability, in the sense that we continue to consider a decision correct after we have made it, is clearly a desideratum. Just as we can improve our decisions by considering them from the perspectives of other concerned individuals, we can also improve them by considering them from alternative future perspectives, i.e., hypothetically seeing them as we will see them retrospectively in the future. However, although the idea of regret-avoidance is a reasonable starting-point, such hypothetical retrospection cannot just be accounted for in terms of avoiding decisions that one may come to regret. Regret is often unavoidable for the simple reason that it may arise in response to information that was not available at the time of decision. Hence, in a systematized application of hypothetical retrospection, regret-avoidance has to be replaced by more carefully carved-out criteria. We consider this methodology to be particularly useful in areas where considerable uncertainty exists and where standard quantitative methods for risk assessment are not applicable. Brain machine interface technologies are clearly such an area. This makes BMI technology an excellent testing-ground for the development of a methodology that employs hypothetical retrospection.

Method

The Structure of Convergence Seminars

Convergence seminars have been constructed as a practical decision-aiding method that employs hypothetical retrospection. For that purpose, it is necessary to achieve the following two main criteria:

(i) Several different scenarios should be discussed individually, where each scenario explores possible future consequences of decisions that we might take now or in the near future.
(ii) A comparative discussion should take place whereby each of these scenarios is taken into account and evaluated against the others.

Many of the available methods for TA are so resource-consuming that specific funding is needed for each procedure. Consequently, these methods are very seldom

used in practice. Our desire was to develop a method that is practically useful and has a chance to be used in practice, for instance, at evening meetings of voluntary organizations. This amounts to a third criterion:

(iii) The procedure should be easy to apply, and performable in a few hours.

In order to satisfy criterion (i), a set of concrete scenarios has to be developed for the discussions. These scenarios should be constructed in accordance with the requirements for hypothetical retrospection summarized above. Hence, they should all lead to some future point in time, but each scenario should lead to a different branch of future development. Each scenario should outline the respective branch in its full length, not only the "final state" at the point in time when the hypothetical retrospection is enacted. The focus should be on some decision in the present or near-present time that the participants are asked to evaluate from the viewpoint of their scenario. The different scenarios should also be selected so that they represent branches in which different alternative decisions give rise to problems that make them difficult to defend in hypothetical retrospection. Ideally, a large number of scenarios should be included in the procedure. However, in order to satisfy criterion (iii), the standard procedure proposed and used here employs only three scenarios. We felt that the participants were able to grasp the complex issues over the relatively short procedure and that they were able to express their views comprehensively. Our ambition was primarily to bring out spontaneous moral intuitions and reactions to the scenarios. We thought that, all things considered, this relatively minimalistic format was ideal, both in terms of cost, of the desired outcomes and of the selection effects of participants.

For the same reason, participants are divided into groups and each scenario is discussed in detail by only one group. In order to satisfy criterion (ii), i.e. the comparative analysis, this first phase of discussions is followed by procedures whereby participants from the different groups in the first phase exchange experiences. The seminars were therefore conducted in three distinct phases. In phase one, the participants were briefly introduced to modern brain implants and were then divided into three groups: A, B and C. Each participant was handed a scenario that corresponded to the assigned group. After carefully reading their scenario, they discussed within their own group the ethical aspects of that scenario. In phase two, participants were divided into new groups, whereby each group contained at least one person from each of the scenario groups of the previous phase. The discussion now focused on comparing and assessing the relative value and risks of each scenario. The third and final phase consisted of a discussion among all of the participants, where the topics could be synthesized into a more general discussion about what advice they would like to give decision-makers who decide on the development of BMI.

The Scenarios

The scenarios were written with the aim of provoking controversy and debate. Thus we introduced some speculative possibilities in order to bring out a full range of moral intuitions and emotional reactions. The value statements expressed in the

scenarios do not represent the judgments of the authors or the project. The scenarios were written with the aim of identifying trends and driving forces in the commercial and developmental aspects of BMI technology. Some outcomes were more unlikely than others, but they were chosen for their potentially high costs. The scenarios were constructed by the authors after a thorough analysis of the current and emerging development of BMI technology (Jebari 2013). This technology essentially consists in various ways to connect the nervous system via electrodes to a machine, thereby making the direct exchange of information between these two possible. BMI technology can extract information from the brain or spinal cord, and direct prostheses, computers and accessories, making this technology very promising for people with disabilities such as paralysis. Although steering prostheses requires at the moment advanced arrays of micro electrodes, cheaper and simpler BMIs suffice to direct characters in computer games. Simple EEG-based BMIs have also been used in analyzing reactions to marketing input. Thus this technology has already entered the commercial realm. The breakthrough of EEG is important because it is, in contrast with earlier invasive BMIs, non-invasive and relatively cheap. Thus it has a potential for commercial use that the intracranial electrocorticography (ECoG) interfaces lacked. Brain–machine interface devices can also be used to feed information to the brain. This allows implants to provide hearing for deaf people or rudimentary visual orientation for the blind. Deep brain stimulation (DBS) is routinely used to reduce motor symptoms for patients with Parkinson's disease and other neurodegenerative diseases as well as chronic pain and major depressive disorder. However, as long as this treatment relies on an invasive procedure, it is likely to be restricted to use in cases of serious diseases.

The future development of the BMI is of moral concern. While this technology provides help for disabled and sick people, its commercialization can potentially undermine both privacy and autonomy. Advertisement agencies, employers and the government are all interested in effective ways to know how we feel, think and respond to stimuli. If privacy is important to preserve, as is generally accepted, the kind of information that could theoretically be extracted through brain machine interface devices is of concern. Here there is work to be done, both for philosophers and lawmakers, to hammer out a plausible definition of privacy and formulate a comprehensive and transparent regulatory framework. Threats to autonomy may come in the future if less risky technology for DBS is developed (Kados et al. 2012). Since DBS can powerfully alter emotional states and change our desires and dispositions, such a technology has clearly an enormous potential for abuse.

The Three Scenarios

The scenarios were not chosen to create an exhaustive matrix of possibilities or to include the most likely outcomes, but rather to introduce some extreme "worst-case" scenarios. For example, scenario A describes a situation that imposes strict regulations on the application of BMI technologies, with consequences of relative economic and technological decline. Scenario B imposes regulations that are very permissive, with consequences that include medical failures and massive workplace

surveillance. Scenario C also has very permissive regulations, but the consequences are social in nature, where widespread use of BMI technology leads to intergenerational conflicts, social unrest, and the deterioration of social norms.

Scenario A

The year is 2032. Fifteen years ago, in 2017, European politicians introduced the world's strictest regulation on BMI. Only therapeutic brain implants, such as deep-brain stimulation (DBS) and cochlear implants, were allowed. All commercial applications of BMI were banned, and the use of brain implants to alleviate psychological diseases was heavily restricted. DBS became the leading therapy for Parkinson's disease, dystonia, and other severe neurodegenerative diseases, but contrary to other parts of the world, it was rarely used to treat psychiatric conditions such as major depression, obsessive–compulsive disorder, and anorexia nervosa. Complex regulations and limited prospects for commercial use hampered investment in Research and Development for BMI, and European research lagged behind that of American and Asian competitors. Asian manufacturers now lead the field in BMI devices. Technology originally developed for patients with paraplegia has been further developed by Chinese manufacturers, and is now sold to consumers who want to improve their computer use, not least in gaming. Private imports of such devices have now gone out of control. Many experts regret that Europe, with its strong tradition in emphasizing product safety and individual privacy, did not take part in the development of this new technology. On the battleground, Chinese and American Special Forces operating together in Somalia vastly outperformed their European counterparts due to their ability to interface with advanced technology. Military pundits fretted that Europe's army would not be able to hold ground in a modern cyborg war.

1. What do you think of this scenario? Which are the positive and negative aspects?
2. What can we learn from the scenario?
3. Should different decisions have been made in 2017? Why?

Scenario B

The year is 2032. Fifteen years ago, in 2017, European politicians introduced permissive regulation policies on BMI. Any kind of non-harmful brain implant was allowed. This led to the rapid proliferation of therapeutic and commercial BMI-devices that improved the individual's ability to interact intuitively with computers, for instance in gaming. When non-invasive BMI devices became available, industry began to use them to improve employees' interaction with machines. In some cases, this technology was also used as a new means of surveillance of employees. Whistle blowing became virtually impossible. Although increased surveillance improved productivity, many unions complained of increasing alienation. In some companies, only people willing to accept surveillance with BMI technology were hired. In the last few years, the widespread and poorly controlled use of BMI devices has led to

problems in the form of medical malpractice, leading to cases of serious brain damage. Although BMI has been beneficial to many patients, it turned out that the new therapies were introduced too rapidly, and long-term side effects turned out to be quite severe in many cases. While European soldiers could compete with the world elite, ethical concerns were raised about new methods to stunt empathy in front-line military personnel. Although returning soldiers are now less likely to suffer from post traumatic stress syndrome, many have difficulties in maintaining close relationships, and are often involved in acts of random violence and drug abuse.

1. What do you think of the scenario? Which are the positive and negative aspects?
2. What can we learn from the scenario?
3. Should different decisions have been made in 2017? Why?

Scenario C

The year is 2032. Fifteen years ago, in 2017, European politicians introduced *very* permissive regulation policies on BMI. Any kind of brain implant and trial procedure was allowed, no matter how invasive. This led to the rapid proliferation of therapeutic and commercial BMI-devices that improved the individual's ability to interact directly with vehicles, home appliances, and computers. The most controversial success of commercial BMI came in the form of a new type of BMI gaming control. Social psychologists warned about the long-term consequences of a whole generation being immersed in an eerily realistic simulated world, detached from contemporary values and social conventions. One result of this was social fragmentation, as the generational divide grew wider. While older generations found it increasingly difficult to adapt to the torrent of innovations in the IT-sector, many young adults seemed to disdain conventional social mores and civic duties. A whole subculture of "neurohackers" emerged; bent on experimenting with neural implants in a similar way to how previous generations had experimented with "mind expanding" drugs. When non-invasive BMI devices became available, industry started to use brain implants to improve employees' interaction with machines. The prospect of "engineered personalities" has led to severe political conflicts between proponents of the technology and opponents, who rally on the streets almost daily. While European soldiers are able to compete with the world elite, concerns are being raised about new methods to stunt empathy and to remotely control front-line military personnel. Although returning soldiers are now less likely to suffer from post traumatic stress syndrome, many have difficulties in maintaining close relationships, and are often involved in acts of random violence and drug abuse.

1. What do you think of the scenario? Which are the positive and negative aspects?
2. What can we learn from the scenario?
3. Should different decisions have been made in 2017? Why?

Results

Seminar 1

This seminar took place in Stockholm in September of 2010, with a total of 9 participants (7 men and 2 women), who were all members of the Parkinson association, an organization for patients with Parkinson's disease.

The participants' reflections on the "virtual reality-game" proposed in scenario C were mainly negative. They argued that it crowds out real life human interaction. The participants argued that most technology is beneficial—even technologies that today may be useless or have dangerous applications. One participant mentioned military technology that subsequently has been used for commercial or civilian purposes. Some participants felt that the "big picture issues" were not sufficiently discussed in contemporary debates. They wanted a wider discussion on disabled and "abnormal" people, as well as the meanings of these terms. They questioned whether the attitude of wanting to "fix" things constituted a kind of hidden intolerance against anyone who does not conform to the norm, as asked by one participant. Coercion and intimidation can take many forms, as pointed out by another participant who asked, referring to government interventions potentially possible with BMIs, "It is fine to treat a disease, like Parkinson's, but what about dyslexia?" Another participant asked, "Should we really intervene in such an arbitrary diagnosis?"

The notion of quality of life was thoroughly discussed. Some participants agreed that the sense of belonging to a community and of feeling included in a social context was very important. Displaying symptoms of Parkinson's in public places made many participants feel disconnected to "normal people." They felt that this sense of alienation was due to a lack of shared experience. Therefore, the brain implants were viewed by many participants as a mixed blessing. In some situations, they made some participants feel more "normal." However, they felt that by being normal, they made other people with Parkinson's feel less normal. Other participants said that too much focus was placed on trying to be an overachiever. They argued that perhaps they should concentrate on their innate talents. Most participants thought the greatest benefits from BMI would come from making better and earlier diagnoses. They also agreed that if BMI procedures were to become safer and less invasive, then their wider use would be acceptable. Some participants pointed out their own experiences with psychological side effects from their own implants.

During the last part of the seminar, the discussion was centered on technology and risk. Some participants pointed out that values and norms vary, and that publicized accidents may sometimes cause previously accepted technology to be viewed with more suspicion. Some technological advances were also ambiguous. They might benefit some, but impose costs on others, as some participants argued. Assessing the impact of yet unrealized technologies, or their potential development, was difficult. Some participants said that technological development could be delayed by politicians and regulators, but never stopped. Living with and defeating disease was also argued to be part of the human condition, and that curing a disease

could have costs. Participants also agreed on the importance of equal access to the benefits of medical technology. However, they emphasized that compliance on the part of the patient could be required. Patients had rights, but also duties, such as to obey recommended lifestyle changes.

Seminar 2

This seminar took place in London in November of 2010, again with a total of 7 participants (2 men and 5 women) who were all students at the Heythrop Philosophy and Theology College of the University of London.

Group A participants said that they would have chosen differently than the politicians in the scenario. The regulations made an unfair distinction when choosing to treat neurodegenerative diseases but not depression or other psychopathologies. The consequences for Europe's economy outlined in the scenarios were clearly disadvantageous, as group 1 argued. The participants also agreed that the intrusions on privacy should be limited. However, the greatest concern was not about government intrusions, but rather what use terrorists might find for these devices. "It introduces an element that carries with it a long term risk," one participant argued. The participants were also concerned with the relationship between employers and employees. This relationship currently is based largely on trust, but it would be undermined, as one participant argued. In conclusion, Group B argued that more research needs to be done on side effects, long-term effects, and possible social consequences. In particular, they argued that the introduction of this type of technology could have "slippery slope effects," by changing social norms in ways that lead to disastrous consequences in the long term.

Group C participants were mostly concerned with what they perceived as the risk of moral decay. They referred to the BMI-based virtual reality game described in scenario C. In this world, participants argued, the consequences of one's actions were not real. People living large fractions of their lives in this type of game would lose their moral compass, the participants argued. However, group C did not believe that future BMI technologies would undermine freedom; rather, they felt that the opposite was more likely. Too much freedom was much more dangerous, as one participant argued. Some disagreement existed regarding whether this game would be beneficial overall. The whole group was appalled at the notion that this technology could be used to remotely control people. This was "the worst possible offence," as one participant argued.

Most participants agreed that rather than imposing a monolithic regulation on BMI technology, the EU needs a regulatory authority with experts who could keep up with the changing technological landscape. Most participants also suggested that the preliminary regulatory framework should have a restrictive approach to commercial applications of BMI technology. Participants also agreed that further research should not be restricted by new regulations, but that it should be monitored, and ethical rules on human and animal experimentation should be carefully followed. Both research and the legislative process should be more transparent. Some participants noted that the European legislative process and the allocation of EU funds are difficult to follow.

The participants moved on to discuss the areas where regulations would be most important. Some participants argued that the protection of privacy was crucial. Most agreed that intrusions into individual privacy should be directly outlawed. Safety measures should be taken to prevent people's private information from being hijacked by hackers, as one participant argued. "What if people would voluntarily disclose information about themselves?" one participant asked. Another area where regulations should be strict was the potential use of BMIs in advertising. Participants argued that the advertising industry was already too powerful, and that this new technology would further increase their ability to manipulate people's desires. All participants agreed that subconscious manipulation ought to be forbidden. Opinions were more divided on whether BMIs and, in particular, some forms of brain or spinal cord stimulation should be allowed for recreational purposes. Some said that individual choice should be restricted. "Artificial pleasure is no different from real pleasure," one participant retorted. However, most participants were reluctant to allow this practice. "In the modern world, few choices are genuine," one participant stated, while the rest of the participants were concerned with potential brain injuries and long-term side-effects.

Many participants from seminar 2 handed in written commentaries about the seminar. Many believed that the scenarios were realistic. All wrote that they had learned a whole lot about this technology, and that they were likely to follow the debate on this issue more closely. However, some wrote that the seminar would have been better had more people attended. One participant would have liked a more detailed presentation of the technology.

Seminar 3

This seminar took place in Warsaw in January of 2011, and included a total of 10 participants (7 men and 3 women). About half of the participants were medical professionals or doctoral students, the others were their friends.

The general notion in this group was that technology was, in principle, impossible to stop, and that any political attempt to regulate it was doomed to fail. One participant also argued that society had no right to restrict access to any technology. It should be an individual choice, although this participant said he would not use BMI to enhance his own body. Participants also worried about the EU falling behind technologically, and the effects that this could have on economic growth. "We want to have money and develop as a nation," one member of the group said. Another member stressed that the long-term consequences of interfering with nature should not be underestimated.

Most Group B participants agreed that the scenario was realistic. One participant thought the increased control and surveillance over workplaces was undesirable, while another suggested that workplace accidents could be avoided with increased surveillance and that this would benefit everyone. However, most of Group B agreed that it was wrong to "play with people's brains" and that the legislation passed in scenario B was too liberal. Group C participants were initially worried about the fallibility of computers and the risks associated with making humans more dependent on them.

Despite these worries, other participants also appreciated some positive aspects of scenario C. The medical benefits and the treatment prospects were appealing and so was the possibility of this technology having a positive impact on the economy. The group consensus was that a strict prohibition was impossible, and that the best approach was to legalize and regulate the technology.

In phase 2, the groups were reshuffled and three new groups formed. The first group seemed to agree that this kind of ethical debate was important. They also thought that scenario A was the worst one. It was impossible to stop this development, as one participant emphasized. Some argued that allowing BMI for commercial purposes did not exclude the possibility of its regulation, but regulation should be specific for different cases. This group also agreed on the military use of BMI technology, such as brain implants that could be used to improve the interaction between soldier and technology, or implants that could reduce stress from battle. However, one member argued that brain implants should never be required by firms or workplaces. In agreement with this, another member added, "People without BMI should not be subject to discrimination."

It was generally agreed that tampering with people's emotions was unacceptable. In particular, the participants were worried that advertisers could use BMI devices to manipulate desires and emotions. The general attitude was that scenario B was the worst one. One participant explained that even if outright coercion was banned, there would be informal coercion to use implants. On the other hand, one participant was worried about the risks of an unregulated black market. "If medical implants are allowed, there will be a black market for them," he argued.

The attitude of the third group to the scenarios was more cautious. The group generally agreed that only therapeutic uses of BMI technology should be allowed. However, they believed that the EU would not be able to enforce this type of regulation on its own. "This decision has to be made on a global level," one participant suggested. All participants in this group were skeptical of human enhancement. "It's OK to treat psychological diseases, but not to change people's characters," one participant suggested. When asked if not all therapies alter the personality, the participant answered, "Therapy only works if you agree to it. Implants may be imposed on you." A general concern was raised in this group that people with brain implants would not be "themselves."

When all of the groups came together, all 10 participants reflected on the seminar experience. They thought that it was stimulating, and generally enjoyable. One participant said, "I realized I had a lot of thoughts about these questions." Another stated, "We don't take time for these discussions." Yet another participant explained, "I didn't know anything about these things (brain implants)—that they were so advanced."

The group thought that the scenarios were "quite OK" and "not unrealistic." "A lot can happen in 20 years," one participant suggested. Another asked for more ethical questions, since the scenarios were "too simplistic."

Two participants voted for scenario A, seven were in favor of B, and only one was in favor of C. He explained that he thought that liberal regulations should be combined with education about the risks. This participant made a comparison with the war on drugs, which was "a failure." However, he thought it would be wrong to "switch off minds," as in the army case. Proponents of scenario A claimed that only

medical use could justify the risks, but medical technology also had to be regulated. One proponent of scenario A said, "I don't believe in this kind of total individualistic 'freedom'." They also agreed on the need to introduce strict controls to ensure that implants were safe.

Seminar 4

This seminar took place in Lepe, a small village close to Seville, in April of 2011, and included 9 participants (4 men and 5 women). About half of the participants were teachers in the local school; the others were their friends and visitors to a local pub.

Many participants in Group A were quite happy with strict regulations, but thought that they could gradually be liberalized if the technology proved to be safe. This, they argued, was "a golden mean." As with the other groups, they expressed concerns about military applications of BMI. Health seemed to be an uncontroversial purpose. The general opinion was that although the applications of this technology should remain restricted, research should be allowed to the full extent.

Group B participants were also quite skeptical of permissive legislation. They argued that the benefits were not sufficient to legitimize the medical risks. They argued that the uncertainty about the long-term effects of brain implants was great, as the brain is a complex and delicate system. Group C participants were very skeptical of the scenario. They saw nothing positive in C. They argued that interpersonal relationships are very important, and the development illustrated in the scenario seemed to undermine the norms and traditions that reinforce these relationships. In addition, they argued that these developments undermine privacy, further damaging friendships and relationships. A majority in this group agreed on strict regulations. BMIs were acceptable if used for medical purposes and perhaps also for trivial videogames, but not for surveillance. The group agreed that it would be unacceptable to use BMI technology for military purposes.

The first group discussed the potential risks of not developing military technology. One participant said that he was worried that if the EU did not invest in military technology, that the EU values and way of life might be threatened. Another participant replied that war was pointless and that European values were doomed regardless. The second group of participants was mostly concerned with the problem of exacerbated inequality that could be a potential side effect of human enhancement. Some argued that inequality would remain high, while others said it would become even worse. Another topic raised by this group was the comparison of electrical stimuli with the use of recreational drugs. Here, participants, who were mostly liberal with regard to drugs, thought that liberal thinking should be applied to this kind of recreational stimulation for the same reasons. The group also agreed that we are not empathetic enough, and that individualism is a problem.

Seminar 5

This seminar took place in Stockholm in June of 2011, and included 10 participants (7 men and 3 women). All of the participants were philosophy or anthropology students at Stockholm University.

The participants in Group A were very negative to scenario A. They all agreed that more regulations were necessary to avoid disastrous consequences. They suggested that rules should be simple, stringent, and transparent, rather than complex.

Group B participants were mainly worried about the level of social control and surveillance. In particular, they were concerned with the possibility of implicit coercion and the implantation of devices that might be risky or very intrusive. Regulations were needed to avoid this. Although participants were negative to the use of BMIs for military purposes, they argued that similar things could be possible with drugs. If legislation could protect workers from intrusion, their use could be acceptable. Group C participants saw many risks. The group was also very concerned by the many accidents that probing into the brain could cause. Without any regulations, misuse and quacks performing sham surgery would be certainties.

In the first group, participants were very hostile to all scenarios, but most upset by scenario C. Even though the intentions were good, the participants argued that the consequences of scenario C were awful, and the consequences mattered more. This group concluded that scenarios B and C would impose unacceptable infringements on individual freedom since, in practice, getting the implants would be mandatory.

The second group was mostly concerned about the risks of "brain hacking" in scenarios B and C, although they also worried about what employers might do with this technology. They found the notion of removing a soldier's empathy appalling.

The third group discussed the problems of the superpower dynamics implicit in the scenarios. If China and the US race ahead with BMI technologies, the EU must follow, as one participant argued. Another suggested that the rivalry between the US and China may work to the EU's advantage, since it could profit from exporting to them if they were to engage in a trade war. Concerns were raised about the simulated world mentioned in scenario C. For example, would some people rape simulated children? Some acts were considered bad, even though they did not necessarily have bad consequences. Being able to live out any fantasy or preference would undermine virtue, as one participant stated. Scenario B was also found problematic for other reasons. The legislation would allow shady medical practitioners to install unsafe devices, perhaps analogous to some cases of failed breast implants.

All participants agreed that the scenarios were interesting, and it was fun to talk about these issues. B was the worst scenario, some opined. Others disagreed and thought that C was worse, since it was more permissive. One participant emphasized the influence of the superpowers in scenario A. According to this participant, war would be a likely outcome, with much worse consequences than for either B or C. The participants also argued that it was important to ask who has the power. The powerful will control technological developments to further their own ends. In that respect, a few participants thought that scenario C was the likely development. They viewed technological progress as something that cannot be stopped, and once the technology is available to improve computer games, this will be very popular. After some discussion, most participants agreed that violent simulated computer games might have a detrimental effect, if realistic enough. However, if these games were to promote appropriate social behavior, the effects could be positive.

Conclusions

The differences among the participants in terms of geographic, demographic, and professional characteristics did not prevent the expression of some similar views and support at all five of the convergence seminars. For example, a general consensus emerged that research priorities in BMI should be those which meet crucial societal needs. Many participants claimed that socially useful applications that would benefit human health should be prioritized over novel consumer products and military applications. Further public participation on social and ethical issues of BMI was unanimously encouraged. A broader public influence over the technological development was supported in its own right, but it was also advocated as a necessary step in avoiding (additional) public alienation or backlashes, and in enabling BMI to benefit citizens.

Views were more divided regarding the extent of regulation needed to curb unwanted developments. Some participants believed that a strong regulatory scheme was necessary, as it would deter unwanted applications. Others argued that regulation (and bureaucracy) was important since it would at least create some inertia in the development, thereby allowing for more insight into long-term impacts and side effects. In contrast, some participants said that over-regulation and excessive precaution were a problem because these implied a loss of potential benefits and would generate (economic) imbalances if certain countries went ahead with less regulation. Another finding was that many important ethical issues were not necessarily ones that arose in the mid- to long-term stages of the BMI development.

This study has collected qualitative data of attitudes and viewpoints in different sectors of the European population, in an attempt to cover some of its geographic and social divergence. The large degree of agreement on some topics that we found between the participants in the five different seminars indicates that these views may be widespread, but of course does not exclude the likelihood that other views may also be widespread. Additional studies are needed to obtain a more complete picture of opinions on BMI in the European population.

This was the first use of convergence seminars on this topic. The method functioned well, both logistically and more importantly, by giving rise to the type of discussions that we aimed for, namely discussions on how today's decisions might be influenced by different possible future developments. The methodology was well suited for discussions on the future of BMI, with its many uncertainties. We also believe that the fact that three different scenarios were used gave the participants a sense of the uncertainty of technological developments and that the speculative nature of the scenarios helped the participants to focus on the potential ethical controversies of this technology. Furthermore, we feel that the idea of hypothetical retrospection was well received by the participants in that they could easily make use of this counterfactual reasoning strategy. The responses provided by the participants in discussions and questionnaires indicated that their advice regarding what decisions should be made about the BMI development was influenced both by different possible future developments and by the points of view of their co-participants.

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