Human enhancement for the common good

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Using neurotechnologies to improve eyewitness memory

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Abstract

Neurotechnologies that are currently applied to treat a range of neurological and psychiatric diseases were found to have a number of positive side effects on cognitive functioning in healthy individuals. Consequently, these neurotechnologies could in theory be used for cognitive enhancement purposes, for instance the improvement of eyewitness memory. Improving the process of collecting eyewitness testimony would be of great value and is an example of cognitive enhancement for the common good. In the present paper, we discuss the epistemological and ethical issues such use raises. These issues are not only critical to using neurotechnologies to improve eyewitness memory, but have a wider scope. By discussing enhancement for a purpose that is not primarily self-regarding or self-serving but potentially benefits the society as a whole, we reflect on the consequences of accepting

enhancement for the common good for the acceptability of cognitive enhancement in general.

Keywords: neurocognitive enhancement, common good, transcranial magnetic stimulation, eyewitness evidence, epistemology

Shortened title: Human enhancement for the common good

1. Introduction

Consider the following hypothetical scenario. Anna and Ben who have been married for seven years go on a hiking trip. After a few hours of hiking, they decide to stop at a precipice for a break and to enjoy the view. It so happens that Chris, who does not know Anna and Ben, is also hiking and has been observing the other two hikers for a little while from a distance. When Chris gets a little closer, he sees that the two hikers are standing at the precipice. Chris observes the two for a little while and then suddenly he does not see the woman anymore. At first he thinks that she just disappeared from his field of vision, because trees between him and the other two hikers are blocking his sight. However, when he gets closer to the precipice he recognizes that the man is upset and hastens toward him in order to discover what has happened. When Chris gets to the precipice, he finds out that the woman has fallen to the base of the cliff and died. Since Anna has procured a life insurance shortly before this incident and some of her relatives report marital problems between Anna and Ben to the police, the suspicion arises that Anna's fall was not an accident. Ben denies having hustled Anna, however, and persists on Anna's fall being a tragic accident. Fortunately, the police have an eyewitness, Chris, who has seen Anna and Ben standing at the precipice. Although Chris witnessed the incident, he cannot exactly remember what had happened. What he does remember is that he saw the two standing at the precipice, that he suddenly did not see the woman anymore, that he then got closer and found out that the woman had fallen down the precipice. That he cannot provide the police with more detailed information is partially due to the circumstance that he was only asked about this incident several weeks later when the police came to suspect Ben. Obviously, it is of paramount interest to the police whether Anna had been pushed by Ben. The police decide to do everything they can in order to obtain an accurate and reliable account of what exactly had happened at the precipice. Ultimately, they call on a neurologist. The neurologist's task is to implement a transcranial magnetic stimulation (TMS) procedure, a non-invasive method to stimulate certain brain regions while the witness is interviewed about the incident. After arriving at the neurology department of the hospital, Chris is seated and receives an explanation about the TMS procedure and its

purpose. A trained police officer interviews Chris about the incident while the neurologist holds an electromagnetic coil against Chris' scalp during the interrogation in order to enhance his memory. The coil produces a magnetic field that easily passes through the skull and induces electrical currents that affect neuronal activity. The procedure is painless and seems relatively safe as it involves little risk for adverse reactions. During the interview conducted under TMS, Chris remembers that he has seen Anna trip over a rock and fall down the precipice while Ben tried to hold her. In contrast to the police' presumption, it was a tragic accident after all and Ben, who might have been charged with murder without Chris' statement, was subsequently acquitted and released.

It is important to note that while the enhancement of memory described in this hypothetical scenario might seem unrealistic and speculative now, it might not in the future. As experts within the field of eyewitness evidence have recently suggested, "it is possible to imagine a future science of eyewitness evidence that is radically different from the methods used today" (Wells et al. 2006, 69). Without a doubt, neuroscience is a future science and neurotechnologies such as TMS are radically different from methods used today. Whether it is acceptable or even desirable to enhance eyewitness memory by means of neurotechnologies and what kind of epistemological and ethical issues would surface from such practice are discussed in this paper. Obviously, using neurotechnologies in order to improve eyewitness memory is a very controversial issue. Our intention is to put forward a new idea, depict the potential of neurotechnologies in criminal justice and to encourage further research. Another aspiration is to approach the cognitive enhancement debate from a different perspective, as the debate so far has almost exclusively focused on enhancement for self-regarding or self-serving purposes. Discussing cognitive enhancement from the common good perspective might challenge some of the arguments that are often used against cognitive enhancement. Of course, especially with regard to enhancing eyewitness memory, specific legal questions arise as well. These include for instance the following questions: Who (the police, prosecutors, lawyers, and/or judges) should be able to use the technology? Should the enhancement be voluntary? And: does evidence obtained by enhancing an

eyewitness' memory by means of TMS comply with rules regarding scientific evidence (e.g. the Daubert standard and the Federal Rules of Evidence)? To the degree that the legal issues do not overlap with the epistemological and ethical issues discussed here, we addressed these questions elsewhere (Klaming and Vedder 2009). After briefly describing the potential of TMS for the improvement of eyewitness memory, we focus on the epistemological and ethical questions raised by such practice. By discussing these issues, we show that they provide insufficient basis for obviating the enhancement of eyewitness memory by means of TMS.

2. Cognitive Enhancement

The use of genetic, medical or pharmacological knowledge for the purpose of improving normal functioning in general is known as human enhancement. The use of this knowledge for the specific purpose of improving normal human cognitive functioning is referred to as cognitive enhancement (Bostrom 2008, Bostrom and Sandberg 2006). Cognitive functions comprise all processes involved in the organization of information, including perception, understanding, memory and executive functions. These faculties can be improved by various means, including education and training, drinking coffee or other energy drinks, meditation and yoga, or mental strategies (Kosslyn 1988). Although the effectiveness of these methods may vary, they all aim at an improvement of cognitive performance. In addition, cognitive functions can be enhanced by means of neurotechnologies including psychopharmaceuticals, Deep Brain Stimulation (DBS) and Transcranial Magnetic Stimulation (TMS). Improving cognitive functions by means of neurotechnologies is referred to as neurocognitive enhancement (Bush 2006, Farah et al. 2004, Wolpe 2002). Neurotechnologies can enhance cognitive functions probably not only more effectively but are moreover more specific, i.e. they are targeted at a specific function. In addition, neurotechnologies have fewer side effects and are therefore more selective.

An individual might have various reasons for wanting to improve his cognitive functions. These may be self-regarding – meaning that they are directly and mainly relating to the individual himself, including the sheer pleasure of excellence or the desire to improve performance in order to become a better

person. Enhancing cognitive functions may also result in improved performance at school, college or work, which may in turn lead to better grades, better career perspectives or a higher salary. If the primary objective is some kind of economic gain, the enhancement may not only be referred to as self-regarding but also as self-serving. If enhancement is neither primarily self-regarding nor self-serving but potentially benefits society as a whole it may be referred to as enhancement for the common good. The improvement of eyewitness memory falls into this latter category as its primary objective is the delivery of accurate evidence and it therefore potentially benefits the society as a whole. Enhancement for a non self-regarding or self-serving purpose has not yet received much attention in the cognitive enhancement debate. Instead, cognitive enhancement has been discussed from a more general perspective. This debate mainly focused on: (1) the definition of enhancement and the distinction between enhancement and therapy, (2) the risks and benefits of enhancement for the individual, (3) privacy and autonomy issues, (4) possible transformations of personality, (5) the transcendence of given limitations, and (6) selfishness and issues of distributive justice, i.e. the fair or equal accessibility of enhancement technologies in society (e.g. Chatterjee 2006, Farah 2002, Farah et al. 2004, Rose 2002, Wolpe 2002).

In this paper, we will argue that enhancement for the common good challenges the meaningfulness of the traditional distinction between enhancement and therapy. Furthermore, without denying the importance of some of the arguments that have been raised against cognitive enhancement, we will show that none of these build up to conclusive arguments against cognitive enhancement *per se*. Moreover, some of these objections lose their significance when the enhancement contributes to the common good of society. In the second half of this paper, we will adress several of the objections raised by other researchers in more detail and describe how discussing enhancement for a common good purpose might put them into perspective. Exploring cognitive enhancement for a common good purpose sheds new light on the cognitive enhancement debate and shifts the focus from whether it is acceptable to enhance normal cognitive functions in general to the question under what circumstances it is acceptable and maybe even

desirable to apply neurotechnologies for purposes that might benefit society as a whole.

2. 1 The Problem with Eyewitness Memory

Eyewitness testimony plays an important role in the apprehension, prosecution and adjudication of criminals. Eyewitnesses to crimes are typically asked to give an account of what happened and to identify the offender during the criminal investigation or judicial procedure. In their decision-making processes, law enforcement officials rely heavily on eyewitness reports and cases may sometimes be decided exclusively on the basis of eyewitness testimony. Unfortunately, the significance generally assigned to eyewitness testimony by the police, prosecutors, lawyers and judges does not exactly match the actual accuracy and reliability of eyewitness memory.

Memories for past events typically change over time with new information being an important factor that influences the accuracy and reliability of the original memory.[1] Numerous studies have consistently demonstrated that new information that is experienced after a specific event, e.g. information received as the result of suggestive questioning, can alter an individual's original memory (e.g. Braun et al. 2002, Haber and Haber 2000; Heaps and Nash 2001, Hyman et al.1995; Loftus and Pickrell 1995, Porter et al. 1999; Wagenaar and Crombag 2005). The powerful effect of suggestive questioning on eyewitness memory was first experimentally demonstrated by Loftus and Palmer (1974). People who witnessed a car accident and were later asked to estimate the cars' speed testified that the speed was significantly higher when they were asked at what speed the cars had "smashed into each other" than when they were asked at what speed the cars had "hit each other". Apparently, subtle changes in the way questions are phrased can have a remarkable impact on eyewitness memory.

Given the malleability of memory as demonstrated in numerous studies and the significance that law enforcement officials generally assign to eyewitness testimony, it can be concluded that decisions made by law enforcement

[1] For more information about memory in general see e.g. Baddeley (2002), Tulving (1995) and Wagenaar (2008).

officials are sometimes based on eyewitness reports that are not (completely) accurate. Erroneous or incomplete eyewitness reports can have serious consequences as they can impede or even prevent the apprehension of the offender, lead to a wrongful acquittal, and in the worst case even to a wrongful conviction. Although the actual number of wrongful convictions based on mistaken eyewitness identification is unknown, it is generally agreed that eyewitness misidentifications are a serious problem accounting for more erroneous convictions than all other factors combined (Levine and Loftus 2004, Wagenaar 2008, Wells et al. 2006). The fact that eyewitness testimony plays such a crucial role in the criminal justice system despite the fact that it is often incomplete or inaccurate demonstrates the need for methods to improve eyewitness memory in order to eventually obtain accurate and reliable evidence.

2.2 The Enhancement of Eyewitness Memory

Various methods for the improvement of eyewitness memory have been explored throughout the past decades (e.g. Fisher et al. 1987, Geiselman et al. 1985, Kebbell and Wagstaff 1998, Malpass and Devine, 1981, Yuille and McEwan 1985). Administering drugs during interrogation, hypnosis and guided imagination were found to carry a substantial risk of creating false memories and are therefore useless for the purpose of eyewitness memory enhancement (Dinges et al., 1992, Kebbell and Wagstaff 1998). Only the cognitive interview, which aims at increasing the number of retrieval cues, was found to have a small but significant effect on correct recall (Geiselman et al., 1984, Köhnken et al.1999). Nonetheless, the cognitive interview seems to have several significant limitations that confine its usefulness for obtaining more accurate and reliable evidence (Kebbell et al. 1999, Memon et al.1997, Memon and Higham, 1999). It is therefore crucial to explore new, unconventional and potentially initially controversial possibilities of improving eyewitness memory. Neurotechnologies may provide a powerful means for enhancement of eyewitness memory at the retrieval phase, e.g. by stimulating certain brain regions that are involved in memory retrieval processes. By directly affecting brain structures and processes, using neurotechnologies to

enhance eyewitness memory may exceed methods used today thereby potentially leading to more accurate and reliable eyewitness evidence.

2.3 The Potential Role of Neurotechnologies

Recently, deep brain stimulation (DBS), which involves the implantation of several electrodes into the brain, was found to have a memory enhancing effect (Hamani et al. 2008). DBS is a well-accepted treatment for Parkinson's disease and is being explored for various disorders. However, since there is potential for serious complications and unexpected side effects (Burkhard et al. 2004, Houeto et al. 2002, Mandat et al.2006, Soulas et al. 2008, Voon et al. 2008, Weaver et al. 2009), DBS at least currently seems an unacceptable intervention for enhancement purposes.

Besides DBS, another less invasive brain-based procedure called transcranial magnetic stimulation (TMS) was found to have an effect on memory (Boggio et al. 2009, Fregni et al. 2001, Gallate et al.2009). This procedure was used in order to improve Chris' memory in the hypothetical case described above. TMS does not require surgery. Instead, a coil that is placed on the scalp produces a magnetic field that induces electrical currents in the brain (Hallett 2000, Schutter 2009). TMS is used for diagnosis of neurological deficits and to treat patients suffering from various disorders including depression, obsessive-compulsive disorder, Parkinson's disease, and auditory hallucinations in schizophrenia (George 2003, Greenberg et al. 1997, Hoffman et al. 2000, Pascual-Leone et al. 1996, Schutter 2009). In contrast to DBS, TMS was not found to produce any serious adverse reactions that cannot be controlled for (Jahanshahi et al., 1997, Pascual-Leone et al. 1993).[2] Interestingly, researchers have found several unexpected positive effects of TMS, such as extraordinary and newfound mental skills including improved drawing and proofreading abilities (Snyder et al. 2003). Additionally, TMS was found to improve various cognitive functions, which lead to the suggestion that TMS might be useful in order to improve certain aspects of learning (Boroojerdi et al. 2001, Fregni et al. 2001, Moser et al. 2002). Recently and more importantly with regard to the possibility of using TMS for the purpose of

[2] We address safety issues in more detail in section 3.2.1 on page 14.

improving eyewitness memory, research has demonstrated that TMS can be used to reduce false memories without affecting veridical memories by temporarily disrupting anterior temporal lobe activity (Boggio et al. 2009, Gallate et al. 2009). In these studies, TMS was applied for a few minutes after encoding and before retrieval (Gallate et al. 2009) and before encoding and during retrieval (Boggio et al. 2009). Disrupting activity in areas that are involved in conceptual labeling, like the anterior temporal lobes, causes literal recall of information, which reduces the occurrence of false memories. Semantic processing in contrast contributes to a tendency to reconstruct facts to fit preconceptions, which in turn increases susceptibility to false memories (Boggio et al. 2009, Gallate et al. 2009). The finding that TMS can be used to decrease false memories has led to an increased interest in the potential of TMS. Research that further explores the possibility of reducing false memories by means of TMS is already underway (Gallate et al. 2009). Although research concerning the effect of TMS on memory is yet limited, it seems to be possible to apply TMS to eyewitnesses before retrieval in order to reduce false memories. To what extent TMS can be used to increase correct recall remains to be explored. In this regard it is important to mention that in order to improve memory retrieval it might be necessary to affect deeper and more central brain structures like the hippocampal formation. TMS devices that currently exist can excite only the surface areas of the brain and cannot stimulate more central brain structures, which may at present restrict the use of TMS for memory enhancement purposes to a certain extent. However, extensive development is proceeding on the design of new coils that can stimulate deeper and more central brain regions (George 2003).

Since TMS does not require surgery, does not modify any brain functions or structures permanently but only has a short term effect, and is furthermore thought to be relatively safe, it may be a neurotechnology that could be used in manifold contexts including cognitive enhancement.

3. Epistemological and Ethical Issues

While memory enhancement by means of neurotechnologies sounds appealing – especially when considering the importance of eyewitness testimony in criminal justice despite the fallibility of memory – such use raises

an array of epistemological and ethical questions that need to be addressed. Epistemological questions refer to issues of (assessing) quality and reliability of knowledge, information and expertise. Ethical questions are concerned with the relevance as well as the positive and negative significance of the technologies involved for the well-being of people and societies.

3.1 Epistemological Issues

In the introductory section we outlined an exemplary story about Chris who had seen Anna and her husband, standing at a precipice, shortly before the former's unfortunate disappearance. When the police came to doubt the husband's version of his wife's death, they interviewed Chris while he received TMS. Chris had problems with exactly recalling what had happened; but after receiving TMS, he suddenly remembered that he had seen Anna stumble over a rock and fall down the precipice, while her husband had tried to hold her. We happily concluded the story observing that the husband had been exculpated from being responsible for his wife's fall.

Of course, the claim that Chris' final rendering of the facts is the correct one calls for careful critical scrutiny. There are four important epistemological questions that need further discussion. None of these is unique for enhancement by means of TMS. The first issue relates to a general problem involved in describing human behavior that affects the quality of memory in a fundamental way. The second and third issues are closely linked to the first issue and concern the perception of an event and the storage and retrieval of a memory. The fourth issue more specifically applies to the use of innovative technologies for the enhancement of eyewitness memory and therefore refers to the quality of expertise. The reason for discussing this set of disparate epistemological questions is to determine whether from an epistemological point of view there are reasons to reject the possibility of using TMS for the purpose of enhancing eyewitness memory.

The first and deeply philosophical factor that is relevant to the claim that Chris' final rendering of the facts under TMS is the correct one is a complicating factor regarding descriptions of behaviour (Anscombe, 1957, Armstrong, 1973, Davidson 2001, Searle, 1983). Let us once again return to the exemplary story. Chris remembers seeing Anna trip over a rock and fall down

the precipice “while Ben tried to hold her”. What exactly has happened, deserving the description “Ben tried to hold her”? Is “trying to hold” something that can be perceived and remembered? It certainly is not easy – and perhaps even not always possible – to show convincingly that the phenomena described as holding someone are different from the phenomena that could be described as trying to push someone away. The difficulties arise from the explicit and implicit reference to intentionality in such statements. In “Ben tried to hold her”, there are two notions expressing intentionality, i.e., “tried” and “hold”. Ben’s intention is explicitly clarified by the use of the finite verb “tried”. “Hold”, however, like many verbs relating to behaviour, implicitly also refers to intentionality. The meanings of notions, such as “holding” and “pushing” include important connotations of the intentions of the actors involved – be it almost latently. For that reason, the relevant facts underpinning those meanings cannot merely consist of descriptions of bodily movements, such as contractions and extensions of arms and hands, and the directions of these movements. They will also have to include descriptions of the context that provide us with clues about the actor’s preferences and desires. In the case of Ben trying to hold his wife, these would include descriptions of the body of Ben’s wife moving downward, Ben’s face looking very concerned and affectionate, et cetera. It is such aspects of the context that Chris will put forward when asked to explain why he is sure that Ben was trying to hold her and not to push her. And of course, in addition to the description of bodily movements and aspects of the context, there will always remain the subjective element of Chris’ classification of Ben’s act as an attempt to save her – a subjective element that may in turn be influenced by the variable qualities of perceptions of bodily movements and circumstances in the context as well as personal factors of the perceiver, i.e. his interpretation of the event. In the end, issues like these can perhaps only be resolved by taking steps to (1) identify the circumstances in the problematic situations that are relevant for the interpretation, (2) reduce complex notions and propositions containing references to intentions to elementary, neutrally describable facts and (3) make people remember such neutral elementary facts. The sheer possibility of such an approach may be subject to philosophical controversies. These controversies, however, could help focus further empirical research by

clarifying exactly this need to reduce complex notions referring to intentionality to elementary describable facts.

The second issue refers to the general limitations of the human predicament, in particular the intrinsically imperfect human capacities for perception. These can be influenced by circumstances both internal and external to the individual. Although a person may remember correctly what he perceived at a specific moment, his perception may have been suboptimal or flawed due to the normal limitations of human perception. In the above described hypothetical scenario, the distance between Chris and the couple might have been too long for Chris to actually observe what occurred. Consequently, even if an individual claims to remember having seen what happened, it is important to keep in mind that a memory can sometimes be incomplete or inaccurate due to our limited capacities for perception. In addition, a memory is never an accurate reproduction of what happened, but instead a reconstruction that is strongly influenced by an individual's interpretation. Since the enhancement of eyewitness memory always takes place after the perception of an event, the limitations in perception and the influence of subjective interpretation will always interfere with the quality of a memory. Consequently, no method or technology for memory enhancement can ever undo the effect of imperfect perception and subjective interpretation on memory.

The third issue refers to the retrieval of a memory. As previously described, post-event information and the way in which an eyewitness is questioned can lead to memory alterations. This is a complicating factor, since every time an eyewitness is interviewed about an event, his memory might change slightly. Ideally, the use of TMS would help an individual to retrieve the original memory, which however seems unrealistic. Nevertheless, TMS might reduce the effect of post-event information and repeated or suggestive questioning. Obviously, empirical research is necessary – not only to explore the memory enhancing effect of TMS – but also in order to be able to answer the question whether or not TMS helps to reduce the effect of post-event information and repeated or suggestive questioning on memory. In addition to the effect of post-event information and repeated or suggestive questioning, long durations betwen perception of an event and retrieval of the memory are likely to

compromise the quality of the memory. Consequently, if empirical research finds a memory-enhancing effect of TMS, it will be important to explore whether there is a maximum time interval for this effect. Without empirical research it is impossible to predict whether TMS can only be used to enhance memory if it is applied shortly after the event or whether the time interval is irrelevant to the effectiveness of the technology.

The fourth and final issue refers to the reliability of relevant experts. If TMS was used to enhance the memory of eyewitnesses, law enforcement officials must be able to rely on the expertise and interpretation of findings of experts who use TMS in order to enhance eyewitness memory. Just as in any other field of specialized science, in order to rely on an expert, the non-experts must be confident that the expert's interpretation is in conformity with principles and assumptions that reflect the general opinion in the relevant community of scientists and experts. This is critical when innovative technologies are involved and the common ground between relevant experts and scientists is in the process of being developed.

Of course, these epistemological issues do not as such diminish the potential of TMS for the purpose of eyewitness memory enhancement. The fact that fundamental difficulties in describing human behavior, limitations in human perception and subjective interpretation as well as post-event information, repeated or suggestive questioning and time compromise the quality of a memory is independent of the method used to improvement eyewitness memory. The fourth issue, i.e. the quality of expertise, also equally applies to other methods for improvement of memory. However, in the case of emerging technologies, criteria and guidelines are still in the process of being developed. The discussion of the epistemological issues shows that even if TMS can be used to improve eyewitness memory in the future, it should be kept in mind, that its application will not make careful interviewing techniques, further research and ample reflection on some deep epistemological issues completely redundant.

3.2 Ethical Issues

The application of TMS for the improvement of eyewitness memory should not only be accompanied by certain epistemological scruples; ethical aspects

should be considered as well. In this section, we discuss a broad range of different ethical concerns that might be brought against using a neurotechnology such as TMS for a common good purpose such as eyewitness memory improvement. All of these are well-known arguments in the general debate on human enhancement. We address five types of concerns that have been raised against the use of cognitive enhancement in general. We have clustered these under the headings of (1) safety, (2) privacy and autonomy, (3) personality, (4) given limitations, and (5) selfishness.

Before discussing these five types of arguments, we want to emphasize that many of the ethical concerns put forward in the general debate on cognitive enhancement appear to be multilayered. In their clustered compound state they can easily obfuscate possibilities of refutation and thereby impede resolution. When they are meticulously analyzed and reduced to underlying constituents, these arguments become manageable and can sometimes be refuted. Some arguments against cognitive enhancement however, e.g. some of the privacy and autonomy objections, seem irrefutable. Nevertheless, instead of thwarting cognitive enhancement, these arguments motivate discussing additional measures to prevent infringements of privacy and autonomy.

3.2.1 Safety

Safety concerns focus on the possible side effects and unintended consequences of neurotechnologies (Bostrom and Sandberg 2006, Farah 2005, Farah et al. 2004). Since neurotechnologies affect brain structures and functions, people seem to believe that the risks involved in these procedures are higher than for other types of enhancement strategies. Most certainly, some brain-based interventions, such as DBS, are invasive and involve a risk for adverse reactions and should therefore only be applied for therapy-related purposes, if no better alternative seems to exist. TMS in contrast seems to be a relatively safe procedure as it does not require surgery, is painless, does not modify any brain functions or structures permanently but only has a short term effect, and does not have any serious side effects that cannot be controlled for (George, 2003, Illes et al. 2006). Several studies have explored the safety of TMS finding very few side effects. More specifically, adverse reactions such

as headaches, visual impairments, vertigo, weakness or paresthesias were not reported. In addition, no permanent neurological or neuropsychological changes, no changes in EEG and no effects on hormone levels were found (Jahanshai et al 1997, Pascual-Leone et al 1993). Very few subjects had temporary auditory threshold shifts due to the noise associated with the discharge of the coil. This can however easily be avoided by wearing earplugs during the TMS procedure. Probably the most serious possible side effect of TMS is a seizure. The induction of seizures however seems to be very rare, even in patients with epilepsy (Pascual-Leone et al. 1993, Tassinari et al. 1990). On the basis of the existing studies, safety guidelines for TMS were developed by Pascual-Leone and his colleagues (1993). As longs as these guidelines are adhered to, the risk of adverse reactions seems very small. TMS may therefore be an adequate procedure for enhancement purposes like the improvement of eyewitness memory. There are however two important issues with regard to safety concerns involved in applying TMS to this specific purpose. First, not all short- and long-term effects of TMS are yet known (Illes et al. 2006). It is therefore difficult to determine the safety of TMS with certainty without further extensive research. Second, as previously mentioned, stronger TMS devices that stimulate more central brain regions probably have more potential for eyewitness memory enhancement than devices that currently exist. As these stronger TMS devices are not yet available, little can be said about their safety besides that they might involve higher risks for adverse reactions and unanticipated problems since they are more powerful. However, it may be assumed that safety concerns play an important role in the development of stronger and more advanced TMS devices. With regard to safety concerns of neurotechnologies, it should also be mentioned that not only neurotechnologies but virtually all interventions can have unpleasant side effects.

If more advanced future TMS devices are at least as safe as current TMS devices, TMS may from a safety perspective be an adequate procedure for the enhancement of eyewitness memory and probably for other common good enhancement purposes in the future. Moreover, if from a safety perspective, TMS is an adequate procedure for common good purposes, it

seems difficult to think of relevant arguments against the use of TMS for primarily self-regarding or self-serving purposes.

3.2.2 Privacy and Autonomy

The information revealed by some neurotechnologies pertains to psychological traits and states of the individuals involved. It is therefore, by its very nature, private. Certain characteristics can be identified on the basis of brain activity (Canli and Amin 2002, Childress et al. 1999). This kind of information can only be revealed by certain neuroimaging techniques and not by neurotechnologies that stimulate brain activity such as TMS. Nevertheless, TMS may prompt the witness to provide information, which directly or indirectly relates to his privacy or which affects an individual's capacities to choose and act autonomously. It is for example possible that when certain brain regions are activated by TMS, this causes unpredictable responses such as unwanted or even traumatic memories (Illes et al. 2006). In addition, if TMS is found to be effective in enhancing memory, it will be important to determine whether witnesses should be free in their choice to undergo TMS. This discussion is not straightforward, since voluntary TMS safeguards autonomy, but can lead to an imbalance between testimonies obtained from witnesses who undergo memory enhancement and those who do not agree to memory enhancement. Mandatory TMS undermines autonomy, but prevents such imbalances. Various issues need to be considered in this discussion (Klaming and Vedder 2009).

Although it may not be possible to avoid all privacy and autonomy risks for individuals who undergo a TMS procedure in order to enhance their memory, several measures may be taken to reduce some of these risks. First, the information acquired could be reduced to the minimum that is required for achieving the original purpose. Second, the information can be secured and only selectively revealed to people who are involved in achieving this original purpose. Third, the information can be acquired under conditions of informed consent.

It seems that privacy and autonomy concerns need to be considered carefully in any discussion on cognitive enhancement regardless of its primary purpose. However, instead of concluding that cognitive enhancement should

be disapproved of because it may interfere with an individual's privacy or autonomy, these concerns should lead to discussion of measures that safeguard an individual's privacy and autonomy. These may include informed consent procedures and making enhancement voluntary. Especially in cases in which the enhancement benefits society rather than the individual, the protection of privacy and autonomy of individuals seems important.

3.2.3 Personality

Another important reason for wariness with regard to neurocognitive enhancement is a fear that enhancement of cognitive faculties may change aspects of personality (Elliott 1998, Farah 2005, Farah et al. 2004, Wolpe 2002). One of the objections expressing this fear builds on the assumption that human beings are defined by their shortcomings as much as by their abilities and that we should therefore value human life in all its imperfection (Farah et al. 2004). Unfortunately, imperfection can reach dramatic depths. In the case of mistaken eyewitness testimony, imperfect memory can have widespread judicial consequences and it seems that there is little to value about this shortcoming. Additionally, one may wonder whether valuing human imperfection in general does not go against the main currents of most moral systems. Typically, morality or some set of rules expressing minimal decency, are deemed indispensable exactly to remedy at least to some extent the limitations of human capabilities by which people are vulnerable and prone to harm themselves and others. These include cognitive fallibility and limited capacities for sympathy with others (Warnock 1971, Gert 2004).

The objections with regard to personality may also be directed in a more straightforward way against interference in the personality as such. *Prima facie,* it may seem likely that interventions that affect the neurochemical and structural components of the brain influence an individual's personality. This assumption is supported by research demonstrating that patients who received DBS experienced personality changes (Gisquet 2008, Goethals et al. 2008, Leentjens et al. 2004, Mandatet al. 2006). Proponents of neurocognitive enhancement argue that changes in identity are not problematic as long as autonomous choices are made (DeGrazia, 2005a), whereas critics fear that cognitive enhancement could lead to "losing, confounding, or abandoning our

identity" (President's Council on Bioethics 2003, 294). Moreover, it has been argued that what has been termed "cosmetic psychopharmacology" (Kramer 1994 in Elliott 1998) leads to inauthenticity, i.e. to a personality that is not one's own even if the new personality is better than the original personality.

Whether or not changes in personality are problematic depends on the extent to which alterations occur and on how critical they are to the overall personality of the individual. Consequently, the questions should rather be to what degree and under what circumstances personality alterations are acceptable. It is also important to note that cognitive enhancement does not necessarily lead to personality alterations. While significantly enhancing overall cognitive functioning may change aspects of an individual's personality, temporarily improving eyewitness memory in order to obtain an accurate report is unlikely to affect an individual's personality. Nevertheless, in order to be able to determine whether TMS would be a desirable method for the purpose of enhancing eyewitness memory, more research exploring the effects of TMS on an individual's personality is necessary. If TMS turns out to have such an effect, the discussion should, subsequently be redirected by separating two different issues. First, it should focus on the question why changes in someone's personality are typically considered bad. It seems that who the primary beneficiary of the enhancement is plays an important role in this discussion. Second, the discussion should focus on how changes to personality and identity relate to an individual's autonomy (DeGrazia 2005a). This latter issue could be dealt with in the ways proposed with regard to the privacy and autonomy objections discussed previously, e.g. by arranging an informed consent procedure.

3.2.4 Given limitations

A cluster of concerns in the general enhancement debate refers to what could be called "given limitations of nature and culture". All of these arguments are somehow connected to the idea that certain given limits of the human predicament should be respected. As we already noted before, many of these given limitations concerns are intricately intertwined with one another. In the previous section, we already discussed the argument of valuing imperfection and objections to personality and identity changes, which are hard to separate

from the idea that nature and culture come with certain limitations and that humankind should not try to amend these. A similar claim seems to be woven into often heard objections about a trend of medicalization that is by some assumed to occur in the wake of widespread introduction of human enhancement applications (Conrad 2007). Medicalization is a tendency to try to solve problems with medical devices rather than in traditional natural, psychological, social or organizational ways. The medicalization concern is strongly linked to distributive justice concerns, as it pertains to worries about the fair and equal access to basic health care facilities for all. In addition, the medicalization concern consists of the claim that traditional ways of solving problems should not be changed.

Another argument in this cluster is the moral objection to “gain without pain” (Farah 2002, 1125). Certain skills are admirable because it is difficult to achieve them. Hence, it is not only the fact that someone possesses a certain skill, that makes this skill special but also, and maybe more importantly, the fact that he put an enormous amount of time and effort into achieving that ability. Improving performance by means of neurotechnologies is often perceived as cheating. For instance, using Ritalin before taking an exam in order to improve concentration and ultimately obtain a higher score is typically perceived as taking the easy way. Against this objection, it could be argued that other means to improve performance and short-cuts to excellence are often approved. Private lessons, drinking coffee or taking herbal extracts that are claimed to improve concentration are usually tolerated.

The arguments discussed in this section, seem to be consistent with what Bostrom and Sandberg (2008) have described as the “wisdom of nature” heuristic. Apparently, people accept what they may be inclined to call “natural” types of enhancement and disapprove of “unnatural” or “artificial” interventions such as neurotechnologies. The objection against artificial interventions are often based on a religious belief, e.g. that God created the world and that people should not play God, or on a quasi religious belief that likewise forecloses interference in the natural order of things. We will not go deeply into all the theological or philosophical assumptions that may underlie these concerns. Suffice it to say that under all the objections in the “given limitations” cluster, the classic failure to distinguish between facts and norms

(is and ought) seems to lure. The *status quo* is considered as the norm: The way things are is how they ought to be.

This failure has ever since Hume been referred to as a fallacy. The possible psychological background of the tendency to attribute normative status to the actually existing limitations of nature and culture is interesting (compare Bostrom and Ord 2006). It seems that intuitively, people believe that it is better to stick with the given than start trying something new. This is probably due to the uncertainties that often accompany the introduction of new technologies and applications. With regard to the enhancement of eyewitness memory this bias would lead to continuing use of the CI to enhance eyewitness memory instead of exploring the potential of neurotechnologies such as TMS for this purpose. As pointed out by Turner and Sahakian (2008), many of the concerns that people had in the past when certain technologies such as heart transplantations and in vitro fertilization were new, now no longer worry most people. Of course all arguments that build on the assumption that the given sets the rule can be easily rebutted by the observation that humans have already used technologies and thereby changed the natural order in the past, very often for the better (Bostrom and Sandberg 2008). This reply seems to make the objections in the given limitation cluster a weak argument not only against using neurotechnologies for common good enhancement purposes but against neurocognitive enhancement in general.

3.2.5 Selfishness

The arguments in the "given limitations" cluster are hard to separate from each other and sometimes difficult to pin down exactly. Something similar applies to an objection that can be rarely met with in its pure form: the objection of "selfishness". Although it is rarely explicitly stated, reproaches of egoism are often important objections against human enhancement. Often the accusation of selfishness is merely hinted at in other arguments such as the "gain without pain" objection, which we discussed in the previous section.

The objection of selfishness deserves ample attention, as it is itself again a compound of different arguments. Selfishness refers to putting one's own interests and needs ahead of those of others. Objections or accusations of

selfishness always presuppose some additional element of either harm or unfairness: one's interests are put ahead of those of others at their cost or under conditions that contribute for instance to unacceptable inequalities or exclude fair competition. Many forms of enhancement may be applied for self-regarding purposes, however, without any harmful consequences for others and under perfectly fair and equal circumstances. Enhancement for self-regarding purposes is not necessarily selfish, but may be motivated by prudence or the aspiration of excellence or sheer delight. Even if enhancement solely serves a self-serving purpose, it depends on the circumstances whether the enhancement is harmful or unfair.

Interestingly, the enhancement of eyewitness memory is an exemplary form of enhancement that is neither self-regarding nor self-serving, as it potentially benefits the society as a whole. Eyewitness memory enhancement aims at overcoming normal human fallibility and seeks to enhance someone's memory for a specific event without any long-lasting effects. The primary beneficiary of the procedure is not the individual – although he will be freed from doubts concerning the accuracy of his testimony – but society at large as accurate and complete eyewitness testimonies allow law enforcement officials to do a better job. Investigations can be improved, the likelihood of apprehending the offender can be increased and wrongful apprehensions and convictions can be avoided. As such, the enhancement of eyewitness memory by means of neurotechnologies benefits several agents including law enforcement officials, innocent suspects and eyewitnesses and is therefore not selfish.

4. Discussion and Conclusion: The Common Good Perspective

Neurotechnologies seem to become plausible interventions for purposes, other than therapy, such as the enhancement of eyewitness memory. Rapid advancements in neuroscience in the past years make it clear that a lot more will be feasible in the coming years. If empirical research demonstrates that TMS can be used to enhance eyewitness memory, it can become an acceptable and potentially even desirable method if (1) the research demonstrates that TMS is more effective in improving eyewitness memory than conventional methods, (2) the use of TMS for the purpose of eyewitness

memory enhancement involves little risk for the individual in terms of side effects, and (3) remaining drawbacks concerning for instance privacy and autonomy can be resolved in a satisfactory manner by additional arrangements such as informed consent procedures.

Instead of asking whether cognitive enhancement is acceptable, we should ask under what conditions is it acceptable or even desirable. Maybe discussions of cognitive enhancement for the common good should focus on exactly these conditions: drawbacks need to be discussed in a more differentiated way. For instance, whether cognitive enhancement is acceptable from a safety perspective strongly depends on the technology involved. As described previously, using DBS for the purpose of enhancing eyewitness memory seems inacceptable mainly due to the invasiveness and risks involved in this procedure. Other technologies, such as TMS, however, may serve a similar purpose, but are less invasive and seem to be relatively safe in terms of side effects. Consequently, instead of objecting to enhancement by means of neurotechnologies in general, the debate would benefit from differentiating between technologies and of focusing on the ways in which remaining drawbacks can be resolved or compensated.

But can accepting cognitive enhancement for a common good purpose have consequences for how we think about cognitive enhancement in general? Some objections that have been raised against cognitive enhancement seem to lose their significance when discussing enhancement from the common good perspective. This is most poignantly clear with regard to the objections from the “given limitations” cluster. Since inaccurate or incomplete eyewitness memory can have widespread judicial consequences, there seems to be little to value about this given limitation. Hence, valuing life in all its imperfection and accepting normal human shortcomings at least in this case seems to be a very unconvincing argument against enhancement. As we have shown there are more reasons why in other cases shortcomings are equally unacceptable. If this kind of argument can be discarded with regard to enhancement for the common good, there is no reason to consider it valid with regard to enhancement for self-regarding or self-serving purposes.

Accepting enhancement for the common good might have additional consequences for the acceptability of enhancement for other purposes. First,

considering enhancement from a common good perspective might make the traditional distinction between therapy and enhancement redundant. This distinction as such has often been criticized because of the blurred lines between therapy and enhancement as it builds on a presupposed vague notion of normal health conditions. We believe that in general, the distinction between therapy and enhancement is only useful as a practical analytical tool to define by and large two distinct types of actions on a very general level. The distinction is simply convenient, but one should be careful not to overlook its lack of precision. However, the distinction is often not meant to merely serve the theoretical purpose of creating definitional clarity; it is also often implicitly used to depict a class of actions as morally unproblematic (therapy) and a class of actions as morally problematic (enhancement). The implicit normative connotation should be avoided. When considering enhancement from the common good perspective, the therapy-enhancement distinction is irrelevant, because inherent in the distinction is the assumption that the individual is the primary beneficiary .The eyewitness who receives TMS in order to provide a more accurate testimony however is not the primary beneficiary of the enhancement.

Second, the acceptability of enhancement for the common good might indirectly lead to increased acceptance of enhancement for self-regarding and self-serving purposes. Once people get used to types of enhancement for the common good, they may loose their hesitation with regard to other types of enhancement. While opponents of enhancement may believe that this gradual transition is distressing, in our view this empirical slippery slope is something that should in principle not be feared. We believe that it is important to approach cognitive enhancement as something that may benefit society as a whole in most if not all cases. Common good perspectives on human enhancement are still rare. Some authors tend to espouse the opinion that enhancement can be indirectly in the best interest of society or even the human species as a whole. Bostrom and Sandberg (2006) for example emphasize that many cognitive abilities have an instrumental value and society could benefit from individual enhancement. According to them, “society faces many pressing problems which would be more readily solved if its members were smarter, wiser, or more creative” (Bostrom and Sandberg

2006, 36). Harris (2009) argues along the same lines and concludes that we even have a moral obligation to enhance ourselves. Neurocognitive enhancement of eyewitness memory is a *direct* contribution to the common good of society. The articulation of this contribution by a specific technology appears to provide a new angle to the debate on enhancement in general.

References

Anscombe, G.E.M. 1957. *Intention*. Oxford: Blackwell.

Armstrong, D.M. 1973. *Belief, truth and knowledge.* London: Cambridge University Press.

Baddeley, A.D. 2002. The psychology of memory. *In Handbook of memory disorders*, ed. A. D. Baddeley, B. A. Wilson and M. Kopelman , (3-15). Hove: Psychology Press.

Boggio, P. S., F. Fregni, C. Valasek, S. Ellwood, R. Chi, J. Gallate, A. Pascual-Leone, and A. Snyder. 2009. Temporal lobe cortical electrical stimulation during the encoding and retrieval phase reduces false memories. *PLoS One, 4 (3)*: e4959.

Boroojerdi, B. M. Phipps, L. Kopylev, C.M. Wharton, L.G. Cohen, J. Grafman. 2001. Enhancing analogic reasoning with rTMS over the left prefrontal cortex. *Neurology*, *56*: 526-528.

Bostrom, N. 2008. Smart policy: cognitive enhancement in the public interest. *In Reshaping the human condition: exploring human enhancement*, ed. L. Zonneveld, 29-36. The Hague: Rathenau Institute.

Bostrom, N. and T. Ord. 2006. The reversal test: Eliminating status quo bias in applied ethics. *Ethics,* 106: 656-679.

Bostrom, N., and A. Sandberg. 2006. Cognitive enhancement: methods, ethics, regulatory challenges. Retrieved June 10th, 2009 from http://www.nickbostrom.com/cognitive.pdf

Bostrom, N. and A.Sandberg. 2008. The wisdom of nature: an evolutionary heuristics for human enhancement. *In Human enhancement,* ed. J. Savulescu and N. Bostrom, 375-416. Oxford: Oxford University Press.

Braun, K. A., R.E. Ellis and E. F. Loftus. 2002. Make my memory: how advertising can change our memories of the past. *Psychology & Marketing,* 19 (1): 1-23.

Burkhard, P. R., F.J.G. Vingerhoets, A. Berney, J.Bogousslavsky, J.-G. Villemure and J. Ghika. 2004. Suicide after successful deep brain stimulation for movement disorders. *Neurology* 63 (21) *)*: 2170-2172.

Canli, T.and Z. Amin. 2002. Neuroimaging of emotion and personality: scientific evidence and ethical considerations. *Brain and Cognition,* 50: 414–431.

Chatterjee, A. 2006. The promise and predicament of cosmetic neurology. *Journal of Medical Ethics*, 32 (2): 110-113.

Childress, A. R., D. Mozley, W. McElgin, J. Fitzgerald, M. Reivich, C.P. O'Brien. 1999. Limbic activation during cue-Induced cocaine craving. *The American Journal of Psychiatry,* 156 (1):11-18.

Conrad, P. 2007. *The medicalization of society: On the transformation of human conditions into treatable disorders.* Baltimore: Johns Hopkins University Press.

Davidson, D. 2001. Agency. *In Agent, action, and reason* ed. R. Binkley, R. Bronaugh, A. Marras Toronto: University of Toronto Press, 1971, reprinted in Davidson, D., *Essays on Actions and Events.* Oxford: Clarendon Press.

DeGrazia, D. 2005a. Enhancement technologies and human identity. *Journal of Medicine and Philosophy*, 30: 261-283.

DeGrazia, D. 2005b. *Human identity and bioethics*. Cambridge: Cambridge University Press.

Dinges, D. F., W.G. Whitehouse, E.C. Orne, E.W.Powell, M.T. Orne, and M.H. Erdely. 1992. Evaluating hypnotic memory enhancement (hypermnesia and reminiscence) using multitrial forced recall. *Journal of Experimental Psychology: Learning, Memory and Cognition,* 18: 1139-1147.

Elliott, C. 1998. The tyranny of happiness: ethics and cosmetic psychopharmacology. *In Enhancing Human Traits: Ethical and Social Implications* ed. E. Parens, 177-188. Washington, D.C: Georgetown University Press.

Farah, M. J. 2002. Emerging ethical issues in neuroscience. *Nature Neuroscience,* 5 (11): 1123-1129.

Farah, M. J. 2005. Neuroethics: the practical and the philosophical. *Trends in Cognitive Sciences,* 9 (1): 34-40.

Farah, M. J., J. Illes, R. Cook-Deegan, H. Gardner, E. Kandel, P. King, E. Parens, B. Sahakian, B. andP.R. Wolpe.2004. Neurocognitive enhancement: What can we do and what should we do? *Nature Reviews Neuroscience,* 5 (5): 421-425.

Fisher, R. P., R.E. Geiselman, D.S. Raymond, L.M. Jurkevich, and M.L. Warhaftig. 1987. Enhancing enhanced eyewitness memory: Refining the cognitive interview. *Journal of Police Science and Administration,* 15 (4): 285-290.

Fregni, F., P.S. Boggio, M. Nitsche, F. Bermpohl, A. Antal, E. Feredoes, M.A. Marcolin, S.P. Rigonatti, M.T.A. Silva, W. Paulus, W. and A. Pascual-Leone. 2001. Anodal transcranial direct current stimulation of prefrontal cortex enhances working memory. *Experimental Brain Research,* 166 (1): 23-30.

Gallate, J., R. Chi, S.Ellwood, and A. Snyder.2009. Reducing false memories by magnetic pulse stimulation. *Neuroscience Letters,* 449: 151-154.

Geiselman, R. E., R.P. Fisher, I.Firstenberg, L.A. Hutton, S.J.Sullivan, I.V. Avetissian, and A.L. Prosk. 1984. Enhancement of eyewitness memory: an empirical evaluation of the cognitive interview. *Journal of Police Science and Administration,* 12: 74-79.

Geiselman, R. E., R.P. Fisher, D.P. MacKinnon, and H.L. Holland. 1985. Eyewitness memory enhancement in the police interview: cognitive retrieval mnemonics versus hypnosis. *Journal of Applied Psychology,* 70 (2): 401-412.

George, M. S. 2003. Stimulating the brain. *Scientific American*. Retrieved from http://www.musc.edu/fnrd/tmssciam.pdf

Gert, B. 2004. *Common morality: Deciding what to do*. Oxford: Oxford University Press.

Gisquet, E. 2008. Cerebral implants and Parkinson's disease: A unique form of biographical disruption? *Social Science & Medicine,* 67 (11): 1847-1851.

Gleitman, H., A.J. Fridlund, and D. Reisberg. 1999. *Psychology*. New York: W. W. Norton & Company Inc.

Goethals, I., F. Jacobs, C. Van der Linden, J. Caemaert, and K Audenaert. 2008. Brain activation associated with deep brain stimulation causing dissociation in a patient with Tourette's Syndrome. *Journal of Trauma Dissociation,* 9 (4): 543-549.

Greenberg, B. D., M.S.George, J.D. Martin, J. Benjamin, T.E. Schlaepfer, M. Altemus, E.M. Wassermann, R. M. Post and D.L. Murphy. 1997. Effect of prefrontal repetitive Transcranial Magnetic Stimulation in obsesive-compulsive disorder: a preliminary study. *American Journal of Psychiatry*, 154 (6): 867-869.

Haber, R. N. and L. Haber. 2000. Experiencing, remembering and reporting events. *Psychology, Public Policy, and Law,* 6 (4): 1057-1097.

Hallett, M. 2000. Transcranial magnetic stimulation and the human brain. *Nature,* 406: 147-150.

Hamani, C., M.P. McAndrews, M. Cohn, M. Oh, D. Zumsteg, C.M. Shapiro, C. M., R.A. Wennberg and A.M. Lozano. 2008. Memory enhancement induced by hypothalamic/fornix deep brain stimulation. *Annals of Neurology,* 63 (1): 119-123.

Harris, J. 2009. Enhancements are a moral obligation. *In Human Enhancement* ed. J. Savulescu and N. Bostrom, 131-154. Oxford: Oxford University Press.

Heaps, C. M. and M. Nash. 2001. Comparing recollective experiences in true and false autobiographical memories. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 27: 920-930.

Hoffman, R. E., N.N. Boutros, S. Hu, R.M. Berman, J.H. Krystal and D.S. Charney. 2000. Transcranial Magnetic Stimulation and auditory hallucinations in schizophrenia. *Lancet,* 355 (9209): 1073-1075.

Houeto, J. L., V. Mesnage, L. Mallet, B. Pillon, M. Gargiulo, S. Tezenas du Moncel, A.M. Bonnet, B. Pidoux, D. Dormont, P. Cornu, and Y. Agid. 2002. Behavioural disorders, Parkinson's disease and subthalamic stimulation. *Journal of Neurology, Neurosurgery, and Psychiatry,* 72: 701-707.

Hyman, I. E., T.H. Husband and F.J. Billings. (1995). False memories of childhood experiences. *Applied Cognitive Psychology,* 9: 181-197.

Illes, J., M. Gallo, and M.P. Kirschen. 2006. An ethics perspective on transcranial magnetic stimulation (TMS) and human neuromodulation. *Behavioural Neurology,* 17: 149-157.

Jahanshahi, M., M.C. Ridding, P. Limousin, P.Profice, W., Fogel, D., Dressler, R., Fuller, R., Brown, P., Brown and J.C. Rothwell. 1997. Rapid rate transcranial magnetic stimulation – a safety study. *Electroencephalography and Clinical Neurophysiology/Electromyography and Motor Control,* 105 (6): 422-429.

Kebbell, M. R. and G.F. Wagstaff. 1998. Hypnotic interviewing: the best way to interview eyewitnesses? *Behavioral Sciences and the Law,* 16: 115-129.

Kebbell, M. R., R. Milne, R. and G.F. Wagstaff. 1999. The cognitive interview: a survey of its effectiveness. *Psychology, Crime & Law,* 5: 101-115.

Klaming, L. and A. Vedder. 2009. Brushing up our memories: Can we use neurotechnologies to improve eyewitness memory? *Law, Innovation and Technology,* 1 (2*):--*

Köhnken, G., R. Milne, A., Memon, A. and R. Bull. 1999. A meta-analysis on the effects of the cognitive interview. *Psychology, Crime, and Law,* 5: 3-27.

Kosslyn, S. M. 1988. Imagery in learning. *In Perspectives in Memory Research* ed. M. S. Gazzaniga, 245-274. Cambridge, Mass.: MIT Press.

Leentjens, A. F. G., V. Visser-Vandewalle, Y. Temel and F.R.J. Verhey. 2004. Manipuleerbare wilsbekwaamheid: een ethisch probleem bij elektrostimulatie van de nucleaus subthalamicus voor ernstige ziekte van Parkinson. *Nederlands Tijdschrift voor Geneeskunde,* 148: 1394-1397.

Levine, L. J. and E.F. Loftus. 2004. Eyewitness testimony. *Encyclopedia of Applied Psychology,* 1: 889-894.

Loftus, E. F. and J.C. Palmer. 1974. Reconstruction of automobile destruction: an example of the interaction between language and memory. *Journal of Verbal Learning and Verbal Behavior,* 13: 585-589.

Loftus, E. F. and J. Pickrell. 1995. The formation of false memories. *Psychiatric Annals,* 25: 720-725.

Malpass, R. S. and P.G. Devine. 1981. Guided memory in eyewitness identification. *Journal of Applied Psychology,* 66: 343-350.

Mandat, T. S., T. Hurwitz and C.R. Honey. 2006. Hypomania as an adverse effect of subthalamic nucleus stimulation: report of two cases. *Acta Neurochirurgica (Wien),* 148: 895–898.

McCabe, D. P. and Castel. 2007. Seeing is believing: the effect of brain images on judgments of scientific reasoning. *Cognition,* 107: 343-352.

Memon, A., A. Holley, R. Milne, G. Köhnken, R. Bull.1994. Towards understanding the effects of interviewer training in evaluating the cognitive interview. *Applied Cognitive Psychology,* 8 (7): 641-659.

Memon, A., L. Wark, A. Holley, R. Bull, G. Köhnken. 1997. Eyewitness performance in cognitive and structured interviews. *Memory,* 5: 639-655.

Memon, A., L. Wark, R.. Bull and G. Köhnken 1997. Isolating the effects of the Cognitive Interview techniques. *British Journal of Psychology,* 88 (2): 179-198.

Memon, A.and P.A. Higham 1999. A review of the cognitive interview. *Psychology, Crime and Law,* 5: 177-196.

Moser, D. J., R.E. Jorge, F. Manes, S. Paradiso, M.L. Benjamin and R.G. Robinson. 2002. Improved executive functioning following repetitive transcranial magnetic stimulation. *Neurology*, 58: 1288-1290.

Pascual-Leone, A., C.M. Houser, K. Reese, J. Valls-Sole, E. Wassermann, and M. Hallett. 1993. Safety of rapid-rate transcranial magnetic stimulation in normal volunteers. *Electroencephalography and Clinical Neurophysiology/Evoked Potentials Section,* 89 (2): 120–130.

Pascual-Leone, A., B. Rubio, F., Pallardó, and M.D. Catalá. 1996. Rapid-rate Transcranial Magnetic Stimulation of left dorsolateral prefrontal cortex in drug-resistant depression. *Lancet,* 348 (9022): 233-237.

Porter, S., Yuille, J. C. and D.R. Lehman. 1999. The nature of real, implanted, and fabricated memories for emotional childhood events. *Law and Human Behavior,* 23: 517-538.

President's Council on Bioethics.2003. *Beyond Therapy: Biotechnology and the Pursuit of Happiness.* Retrieved from http://www.bioethics.gov/reports/beyondtherapy/beyond_therapy_final_webcorrected.pdf

Rose, S. P. R. 2002. 'Smart drugs': do they work? Are they ethical? Will they be legal? *Nature Reviews Neuroscience,* 3: 975–979.

Schermer, M. 2009. Changes in the self: The Need for Conceptual Research Next to Empirical Research. *The American Journal of Bioethics,* 9 (5): 45-47.

Schutter, D. 2009. Transcraniale magnetische stimulatie en cerebrale fysiologische processen bij psychiatrische stoornissen. *Tijdschrift voor Psychiatrie,* 51 (2): 97-105.

Searle, J. 1983. *Intentionality: An Essay in the Philosophy of Mind*. Cambridge University Press.

Snyder, A., E. Mulcahy, J.L. Taylor, D.J. Mitchell, P. Sachdev and S.C. Gandevia. 2003. Savant-like skills exposed in normal people by suppressing the left fronto-temporal lobe. *Journal of Integrative Neuroscience,* 2 (2): 149-158.

Soulas, T., J.-M. Gurruchaga, S. Palfi, P. Cesaro, J.-P. Nguyen and G. Fenelon. 2008. Attempted and completed suicides after subthalamic nucleus stimulation for Parkinson's disease. *Journal of Neurology, Neurosurgery, and Psychiatry,* 79: 952-954.

Tassinari, C. A., R. Michelucci, A. Forti, R. Plasmati, W. Troni, F. Salvi, M. Blanco and G. Rubboli. 1990. Transcranial magnetic stimulation in epileptic patients Usefulness and safety. *Neurology*, 40:1132-1133.

Tulving E. 1995. Organization of memory: Quo vadis? *In The cognitive neurosciences,* ed. M.S. Gazzaniga, 839-847. Cambridge, MA: MIT Press.

Voon, V., P. Krack, A.E.. Lang, A. M. Lozano, K. Dujardin, M. Schupbach, J. D'Ambrosia, S. Thobois, F. Tamma, J. Herzog, J.D. Speelman, J. Samanta, C. Kubu, H. Rossignol, Y.-Y.. Poon, J.A. Saint-Cyr, C. Ardouin and E. Moro. 2008. A multicentre study on suicide outcomes following subthalamic stimulation for Parkinson's disease. *Brain,* 131: 2720-2728.

Wagenaar, W. A. 2008. Enhancing memory in the criminal trial process. *In Reshaping the human condition: exploring human enhancement* ed. L. Zonneveld, H. Dijstelbloem and D. Ringoir, 65-75. The Hague: Rathenau Institute.

Wagenaar, W. A., and H. Crombag. 2005. *The popular policeman and other cases*. Amsterdam: Amsterdam University Press.

Warnock, G.J. 1971. *The object of morality*. London: Methuen.

Weaver, F. W., K. Follett, M. Stern, K. Hur, C. Harris, W.J. Marks Jr.,J. Rothlind, O. Sagher, D. Reda, C.S. Moy, R. Pahwa, K. Burchiel, P. Hogarth, E.C.. Lai, J.E. Duda, K. Holloway, A. Samii, S. Horn, J. Bronstein, G. Stoner, J. Heemskerk, G.D. Huang. 2009. Bilateral deep brain stimulation vs best medical therapy for patients with advanced Parkinson disease: a randomized controlled trial. *The Journal of the American Medical Association,* 301 (1): 63-73.

Weisberg, D.S., F.C. Keil, J. Goodstein, E. Rawson, J.R. Gray. 2008. The seductive allure of neuroscience explanations. *Journal of Cognitive Neuroscience,* 20 (3): 470-477.

Wells, G. L., A. Memon and S.D.Penrod. 2006. Eyewitness evidence: improving its probative value. *Psychological Science in the Public Interest,* 7 (2): 45-75.

Wolpe, P. R. 2002. Treatment, enhancement, and the ethics of neurotherapeutics. *Brain and Cognition,* 50: 387-395.

Wolpe, P. R., K.R. Foster and D.D. Langleben. 2005. Emerging neurotechnologies for lie-detection: promises and perils. *The American Journal of Bioethics,* 5 (2): 39-49.

Yuille, J. C. and N.H. McEwan. 1985. Use of hypnosis as an aid to eyewitness memory. *Journal of Applied Psychology,* 70(2): 389-400.