Ethical issues in neuroscience

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Purpose of review

The study gives an overview of ethical questions raised by the progress of neuroscience in identifying and intervening in neural correlates of the mind.

Recent findings

Ethical problems resulting from brain research have induced the emergence of a new discipline termed neuroethics. Critical questions concern issues, such as prediction of disease, psychopharmacological enhancement of attention, memory or mood, and technologies such as psychosurgery, deep-brain stimulation or brain implants. Such techniques are capable of affecting the individual's sense of privacy, autonomy and identity. Moreover, reductionist interpretations of neuroscientific results challenge notions of free will, responsibility, personhood and the self which are essential for western culture and society. They may also gradually change psychiatric concepts of mental health and illness. These tendencies call for thorough, philosophically informed analyses of research findings and critical evaluation of their underlying conceptions of humans.

Summary

Advances in neuroscience raise ethical, social and legal issues in relation to the human person and the brain. Potential benefits of applying neuroimaging, psychopharmacology and neurotechnology to mentally ill and healthy persons have to be carefully weighed against their potential harm. Questions concerning underlying concepts of humans should be actively dealt with by interdisciplinary and public debate.

Keywords

brain enhancement, ethics, free will, mind–body problem, neuroscience, self

Curr Opin Psychiatry 19:600–607. © 2006 Lippincott Williams & Wilkins.

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Current Opinion in Psychiatry 2006, 19:600–607

Abbreviation

ADHD attention deficit hyperactivity disorder

0951-7367

Introduction

Progress in neuroscience is rapidly increasing our knowledge of neural correlates of the mind. Researchers are beginning to identify brain processes that are related to experiences and concepts such as free will, agency, moral judgment, self and personality. At the same time, those processes become increasingly accessible to specific modifying techniques. This development raises ethical problems whose importance is likely to surpass even the implications of modern genetics. What are the social and cultural consequences of technologies that enable humans to manipulate their own minds? What impact will neuroscience have on our self-understanding and our concept of humans in general? Are we facing an age of a 'technology of consciousness'?

In view of these questions, an intensive dialogue between neuroscience and the humanities becomes more than ever necessary. Growing awareness of this need has led to the emergence of a new discipline termed 'neuroethics' [1]. Psychiatry has started to join these activities as shown by a recent conference on philosophy and neuroscience in Leiden [2]. The ethical issues raised by neuroscience have proven to be twofold: On the one hand, new methods and techniques, by laying bare neural correlates of personal identity, cause problems of individual rights on privacy, noninterference and inviolability. On the other hand, the results of neuroscience tend to support reductionist concepts of free will, autonomy and the self. This interferes with the fundamental intuitions that we have of ourselves and questions notions such as responsibility and culpability on which central institutions of our society are based. Accordingly, the present review explores these issues on the levels of (a) practical and (b) conceptual ethics.

Ethical problems of neuroscience-based diagnosis and interventions

This section concerns problems resulting from neuroimaging, pharmacological brain enhancement and new technical interventions in the brain.

Neuroimaging: methods and techniques

In accordance with the growing sophistication of neuroimaging techniques, they may be used to infer not only people's actual mental states but also their unconscious attitudes and predispositions to a particular kind of behaviour. Recent examples include brain structures involved in racial biases, trustworthiness, moral reasoning, economic cooperation, social rejection and even

consumer brand attachment [3–5]. This inference opens up a wide array of options beyond genuine medical use for diagnosis and treatment. Thus, the brain's reaction to certain stimuli could be used to not only detect predispositions to mental illness ('neuro-screening'), but also to recognize violent offenders ('brain fingerprinting'), examine participants' responses to advertising ('neuromarketing') or optimize children's school carriers by measuring specific cortical functions.

Unconscious attitudes

Imaging studies [6,7] found that white participants had greater activity in the amygdalae when viewing pictures of black people as opposed to white people's faces, pointing to unconscious racial attitudes. Similarly, sexual preferences or aggressiveness have neuroimaging correlates which could be used to detect further potential violence in sexual offenders [8]. Furthermore, positron emission tomography (PET) studies [9] with committed murderers show poor functioning in their prefrontal cortex to a significant degree. Specific functions related to this area are the ability to control one's impulses, to weigh uncertain risks, to act with regard to potential negative consequences, to take another viewpoint and to empathize. These areas can be damaged in subtle ways, even through childhood abuse or severe neglect, making it difficult to draw a line between culpable offenders with normal brain findings and persons to be exculpated because of obvious brain injury [10••]. Thus, it seems likely that both healthy and certifiably insane delinquents could in future be submitted to certain tests and brain scans in order to assess their potential dangerousness.

Detection of deception

More sophisticated imaging techniques may enable researchers to distinguish between true and false memory and to improve the methods of lie detection. Recent studies [11] found activation in the dorsolateral prefrontal cortex associated with the active suppression of memory. Other studies [12,13] indicate that intentional deception may be correlated to rather specific neural substrates such as the anterior cingulate cortex. Finally, 'brain fingerprinting' attempts to demonstrate the knowledge of facts about a crime or other information by measuring the electroencephalogram (EEG) responses (p300 wave) to relevant words or pictures presented to the participant ('guilty knowledge test' [14]). This technique was already used in a court case in Iowa, where a murder conviction was reversed because of the missing response of the convict's brain to relevant details about the crime [15••].

Neuroimaging: ethical problems

Though opening up most interesting prospects for research and diagnosis, the possibility of a 'transparent brain' raises a number of critical issues.

Reliability and validity

A general problem posed by these techniques is the apparent objectivity of visualizing the 'brain in action'. The complex assumptions required for jumping over the gap between subjective experience and electromagnetic signals are hardly known to the public. Imaging studies are based on probabilistic covariances and not on causal connections. Their interpretation depends on the design and theory behind the study and is highly influenced by cultural and anthropological frameworks [15••]. Moreover, it is unclear in how far complex phenomena such as social attitudes and behaviour may be grasped by the rather simplified scenarios of neuroscience, applying video games or faces on a screen instead of real social interactions [3]. Therefore, it seems questionable to rely on neuroimaging techniques in complex social issues such as solving a crime, assessing a person's dangerousness, or choosing young people's training options.

Neuroimaging is bound to momentary states, and inferences on personality, propensities and actual dangerousness are hardly warranted. For example, latent aggressiveness need not be harmful as long as it is under control, whereas it is well known that the most dangerous offenders act without any or with low emotional involvement [16]. Therefore, the information gained by neuroimaging might become a helpful tool, but will at most supplement, not replace existing criteria of responsibility in the criminal justice system [17••]. The wide-spread misunderstanding of brain scans as direct measures of psychological states or even traits, however, carries the risk that courts, parole boards, immigration services, insurance companies and others will use these techniques prematurely [5].

Predictive neuroimaging

Another ethical issue concerns the increasing use of neuroimaging to predict later onset psychiatric disorders. Thus, functional magnetic resonance imaging (fMRI) scans of adolescents considered at high risk of schizophrenia showed structural and functional abnormalities in certain areas [18,19]. Early pharmacological intervention might prevent or delay the onset of psychosis. The complexity and plasticity of the brain, however, definitely restrict the reliability of such prognoses [17••]. What degree of probability would count as sufficient? Which long-term side effects would be acceptable? The possible benefit of predictive imaging would have to be carefully weighed not only against possible harm but also against the burden of knowledge and the possible discriminations caused by being an at-risk patient.

Privacy

Brain processes are intimately bound to our selves and personal identity. Our sense of privacy may be threatened by technologies that can reveal the neural correlates of

our innermost thoughts and unconscious attitudes. Still the reliability of imaging studies is limited and their applicability to the individual subject questionable. In future, however, it might be possible to more reliably 'read' personality features, psychiatric history, truthfulness and hidden deviations from a brain scan. This could be exploited for such purposes as screening job applicants, assessing insurance risks, detecting a vulnerability to mental illness, determining who qualifies for disability benefits, and so on. For this reason, 'cognitive liberty' has already been postulated as every person's fundamental right on autonomy over his or her own brain states [20].

Brain enhancement: methods and options

The development of new psychotropic agents with fewer side effects carries the option of improving general psychological and cognitive functioning of individuals who are not ill. Mood, memory, attention, alertness and other cognitive capacities are on the agenda for 'brain enhancement' or 'mind doping'. The product range of pharmaceutical companies increasingly aims at healthy persons willing to increase their well-being and performance by legal drug use.

Attention and alertness

The last two decades have seen a new wave of drugs that may heighten cognitive ability and alertness. Psychostimulants such as methylphenidate and dextroamphetamine used for treating attention deficit hyperactivity disorder (ADHD) can also enhance attention and other executive functions in healthy people. The excessive administration of methylphenidate for school boys has raised concerns particularly in the United States [21,22]. Moreover, up to 16% of American college students take stimulants as regular study aids [23]. This misuse is favoured by the fact that ADHD obviously represents the lower tail of a continuum shading into the normal range rather than a qualitatively separate state of cognitive dysfunctions. Similarly, Modafinil reduces daytime sleepiness among shift workers, but in 90% of prescriptions, it is being used to promote alertness in people with regular sleep–wake cycles [24].

Memory

The search for memory-enhancing drugs is pursued with increasing effort. Recent advantages in the molecular biology of memory have pointed out two possible ways of enhancement, namely by targeting (a) the initial acquisition of memories by long-term potentiation and (b) the later stages of memory consolidation. Although the research is aimed at finding treatments for dementia, the main target group of pharmaceutical companies are 40–60-year-old people with mild cognitive impairment caused by the natural process of ageing [25]. On the contrary, the pursuit of mastery over our own memories includes blocking or erasing undesirable memories. Drugs that are being sought to prevent the consolidation of traumatic memories typical for posttraumatic stress disorder (PTSD) [26] could later be accessible to anyone who wishes to avoid remembering an unpleasant event.

Mood and happiness

Since Kramer's [27] *Listening to Prozac*, the nonmedical use of psychotropic drugs for mood brightening and personality alteration has received growing attention. Only a few studies [28,29] have actually assessed the effects of selective serotonin reuptake inhibitors (SSRIs) on mood and personality in healthy participants. People who take these drugs in the absence of mental illness, however, commonly report that negative feelings such as anxiety, sadness, disappointment, guilt or shame are attenuated, whereas self-esteem and confidence rise. SSRIs may establish a background sense of well-being and also seem to have a subtle positive influence on the quality of people's social interactions [30].

Brain enhancement: ethical problems

The growing options for brain enhancement raise ethical issues that are partly comparable with other nonmedical drug applications; however, they have also far-reaching impact on how we conceive of ourselves and of our conduct of life.

Safety

Neurocognitive enhancement involves intervening in a complex system with unanticipated consequences and long-term side effects. Thus, psychostimulants such as methylphenidate may increase the short-term capacity of working memory at the expense of information adequately anchored in meaningful, higher order knowledge. Memory enhancement might finally impair memory retrieval, because the natural balance between remembering and forgetting could be disturbed by an overload of memories stored in the brain [17••].

Competition

Once enhancement becomes widespread, pressure will rise to enhance one's cognitive abilities in situations of social competition, for example, in order to be admitted to a school, to reach better grades or to keep one's job. The growing frequency of 'brain doping' could raise the need to establish regular controls of psychotropic drug use in competitive situations, as currently in sports events. Moreover, cost barriers to enhancement would increase the disadvantages that are already faced by people of low socio-economic status in education and employment [17••].

Changing the human condition

On a more fundamental level, brain enhancement raises the question of whether we want to change the human condition by manipulating our subjective experiences,

cognitive abilities and personality traits. The use of biotechnology for augmenting human capacities and happiness is likely to become a predominant ethical issue of this century. In his prophetic science fiction novel *The futurological congress*, Lem [31] already envisaged a future in which people can change their views, feelings, memories and personalities at their own will by psychochemical drugs. Today, biotechnology actually offers the prospect to overcome the limitations of the human condition and to reconstruct people's mental lives. The current trend towards constructionist views of reality in neuroscience [32] and postmodernism supports such options: if every brain creates its own world, then why should not we intervene in this construction to select a better version?

Serious objections may be raised against such a view. First, mind enhancement threatens to devalue human life in all its imperfection. It nurtures an illusionary outlook of constant happiness and productivity while pathologizing negative moods, a normal attention span or natural forgetfulness. Second, mind enhancement interferes with our understanding of personal development as resulting from our efforts to overcome resistance, to cope with failures and to integrate adversities. After all, results of enhancement are likely to be transitory. The changes achieved by drugs will cease once they are discontinued, whereas necessary coping abilities may atrophy or become extinct. Medicalizing human efforts may weaken our sense of responsibility for ourselves and undermine our readiness to solve the problems of life [30].

Neurotechnology: methods and options

The growing tendency to localize mental disorders in the brain has favoured a comeback of neurosurgery, with ablations or resections carried out mainly in treatment-refractory obsessive–compulsive and even anxiety disorders [33–35]. Still in its early stages, neurostimulation by deep-brain electrode implants ('brain pace-maker') not only has helped to restore coordinated movement in patients with Parkinson's disease, but could also be used for treating epilepsy, obsessive–compulsive disorder (OCD), depression or chronic pain [36]. Both kinds of interventions may result in alterations of personality, though in contrast to psychosurgery, deep-brain stimulation is a reversible measure.

The connection of the brain with electronic devices is one of the cutting edges of present neurobiological research. Possible clinical applications are neuroprostheses for substituting sensory or motor defects, the best known example being the cochlear implant for labyrinthine hearing loss. Moreover, systems that process features of the patient's EEG to convey simple commands have been used with patients with paralysis. Neuroengineering, however, could also make it possible to directly register, analyse and influence neuronal signals by microprocessors. This conjecture opens up ambiguous future prospects including the development of brain–computer interfaces for robotic control, implantable brain chips for amplifying senses and intelligence [37], and finally, direct brain-to-brain communication.

Neurotechnology: ethical problems

Apart from the ethical problems already discussed in the section on brain enhancement, technical interventions in the brain raise particular concerns regarding the identity, agency and inviolability of the person. There exists still little understanding of how various brain circuits interact and how manipulations in one area affect other nontargeted aspects of behaviour and personality. Alterations in behaviour and personality have been observed in patients with deep-brain stimulation [38,39]. Moreover, neuroprosthetics conveys a mechanistic view of the human body and mind as seemingly composed of single, exchangeable elements. It adds new urgency to the question of what distinguishes humans from machines. Finally, research on electronic brain enhancement conjures up sinister scenarios involving mind control, hybrid brains and cyborgs. The dominant role of the US military in funding research in this area may well increase these worries [40].

Ethical problems concerning the conception of humans

Neuroscience seems to show, once and for all, that mental states may be reduced to brain states. Reductionist concepts of the mind–body problem and the self, however, pose serious ethical questions:

(a) Can the attribution of personal responsibility be reconciled with a neurobiological account of correlated brain processes?
(b) Should we treat mental disorders merely as brain diseases?
(c) Can the traditional notions of the unity and autonomy of the person be maintained in the face of their being questioned by neuroscience? Is the self only an illusion produced by the brain?

Neurodeterminism, free will and autonomy

A basic notion of free will is essential for our concept of humans and for our juridical systems. Free actions are characterized by (a) being explainable by their reasons or motives, (b) experiencing oneself as the author of the action, and (c) one's capability to 'act differently' under equal external circumstances. Neuroscientific research seems to show that these assumptions are illusory: as physical processes, brain functions underlying our actions should be completely causally determined.

(a) Libet's [41] controversial experiments, replicated by Haggard and Eimer [42], demonstrated that the brain's potential readiness in the secondary motor cortex precedes conscious 'decisions' to perform spontaneous movements by 350 milliseconds on average, implying that unconscious neuronal processes actually cause apparently volitional acts. Hence, our reports of conscious instigation of our own acts would be an illusion of retrospection.
(b) Illusions of control and authorship have also been demonstrated by unnoticed external interference with cursor moving tasks [43] or by interference with alternating finger movements through transcranial magnetic stimulation [44]. The presence of other actors who could contribute to the action in question can also obscure the experience of authorship of one's own action. It is then concluded that the experience of willing to do something is only a retrospective attribution of causality to our thoughts, whereas the actual causes are to be found in subpersonal neural mechanisms [45].

A main objection to these refutations of free will is that they are based on the paradigm of 'mental causation', meaning that there should be a preceding mental state that somehow acts on the body and causes motor action. This dualistic paradigm, however, misses the point: Who or what acts is not a certain mental state but the embodied subject as a whole. Therefore, free will and choice are not concerned with neurons, muscles or bodily movements that we act upon but with meaningful actions that we plan and intend in the context of our goals ([46••], p. 237ff; [47], p. 224ff). This context, however, is cut off systematically in Libet's experiment by reducing its time frame to milliseconds. Meaning and intention can only come into play when there is time for conscious deliberation. From a phenomenological point of view, then, free will is not something attributable to a single mental state but rather to the person as a whole. This overarching level, however, is far beyond the reach of cognitive neuroscience. It is still an open question on how a decisive part of the brain's processes becomes informed by consciousness and meaning.

There exists another objection to neurodeterminism which is less motivated by phenomenology than by psychiatric ethics. Free will is a first-person experience that is more or less restricted in many mental disorders – being unable to resist one's impulses, being forced to think or act against one's will, and so on. The restitution of autonomy and agency is the aim of therapy, and it seems hardly plausible that this should only be the reestablishment of a 'healthy illusion'. For psychotherapy in particular, the attribution of responsibility and freedom is an essential factor of effectiveness. Thus, psychoanalysis seeks to increase the patients' self-determination by clarification of unconscious motives and conflicts. Cognitive–behavioural therapy uses concepts of self-efficacy or internal locus of control and techniques such as exposure exercises or changing cognitions that would be meaningless without any degrees of freedom. To regard freedom only as a useful illusion could undermine the patients' will to overcome their difficulties and result in a detrimental fatalism on both the patient's and the therapist's side.

Concepts of disease

The growing knowledge of mind–brain relations is likely to affect our concepts of mental illness in different ways that may be described in terms of medicalization, localization and reification.

(a) Medicalization: By being reduced to brain processes, abnormal behaviour of any kind will be increasingly regarded as a medical problem. Low cognitive performance becomes ADHD, shyness becomes social anxiety disorder, dissocial or criminal behaviour turns into mental illness, and so on. The arrival of efficacious psychotropic drugs with fewer side effects further invites enlargement of the domain of illness.
(b) Localization: The belief is widespread that brain images could show the cause of a mental disorder, or even the disorder itself, which then consists, for example, in an increased metabolic activity in certain areas of the cortex. Here the localizatory fallacy is lurking: Of course, increased activation may be only the concomitant of a disorder with quite different aetiologies. Moreover, focusing on the brain tends to separate the individual patients and their disorders from the interconnections with their environments.
(c) Reification: Imaging and other methods of neuroscience tend to turn lived experience and dynamic processes into thing-like objects. Functional and structural deviations from the 'normal brain' are regarded as defects and diseases, thus shifting the focus of attention to the field of biochemical or 'molecular' psychiatry. This development favours reductionist conceptions operating in simplified claims like 'depression really is a chemical imbalance'. Such explanations, however, are inadequate to the causal complexity of mental disorders. Moreover, simplified theories of aetiology are likely to result in patients being merely symptomatically treated.

Another ethical issue is the polarity of exoneration versus self-responsibility. The biological model emphasizes the physiological and deterministic nature of the patients' disorders and thereby claims to reduce their moral stigma. An argument exists that focusing on impersonal brain mechanisms may disburden the patient or his relatives from inadequate feelings of guilt and responsibility [48]. On the other hand, the biological model can induce him

to rely solely on expert knowledge and thus weaken his own efforts to overcome his illness. External interventions could increasingly replace coping abilities and personal development. The boldly renewed application of neurosurgery even for anxiety disorders [35] does little to alley these worries.

Neuroscience and the self

A growing body of research is investigating the neural correlates of functions related to the self, for example, bodily self-awareness [49], agency [50,51], self-reflection [52], changing from one's own to another's perspective [50,53], empathy [54] and personality features such as extraversion or self-consciousness [55]. In particular, cortical midline structures in the prefrontal and parietal cortex have been identified as neuronal equivalents for self-related cognitions [52,56]. On this basis, it has been suggested that the self is merely an epiphenomenon of brain states and corresponding representational structures. Concepts such as the 'synaptic self' [57] or the 'self-model' theory of subjectivity [58] conceive of the self as the construct of electrochemical and computational processes inside the brain. The current dominant 'theory of mind' concepts of social cognition [59,60] point out that the other is conceived by neuroscience as being a hypothetical 'model' or 'construct' as well.

In general, there is a tendency to believe that we are our brains, not only in lay public but also among neuroscientists who assume this 'astonishing hypothesis' [61] as self-evident doctrine. Arguments put forward by Bennett and Hacker [47] against the 'mereological fallacy', that is taking a part of the living being for the whole and ascribing attributes of the person to the brain, have shown only limited effect on this predominant paradigm. The basic naturalistic assumption that human behaviour, self-experience and understanding of meaning could be reconstructed on the basis of a physicalist ontology is still unbroken.

Nevertheless, it might be a fundamental misunderstanding to search for the self in states of the brain. From a phenomenological point of view, the principal quality of consciousness is intentionality or 'aboutness': As conscious beings, we are always related to the world, directed towards, or caring about something. Thus, the self is not an entity that can be found somewhere in isolation; it is rather the continuous transcending movement towards the world and the others. Mental states depend upon the patient's relations to numerous other entities and to the world as a meaningful whole. These relations are certainly not contained in neuroimaging data. Neither the mind nor the self is to be found inside the skull.

Moreover, the temporal dimension of the self is not captured by the concept of self-representations correlated to certain states of the brain. The self is a dynamic process of retrospection into the past and projection into the future. This dimension is tightly connected to narrativity [62,63]: In constructing our identity, our personal life narrative, we continuously arrange and order our experiences in communication and reciprocity with others who may accept, reject or confirm our stories. We register these responses and respond to them in turn. This hermeneutic process of continuous redefinition of the self in correspondence with others is far beyond the reach of the objectifying and reifying approaches of neuroscience.

Finally, a nonreductionist concept of the self seems indispensable for psychiatry. After all, the patient's self-experience is the starting point of psychiatric diagnosis and the target of therapy. Intersubjective understanding is the way to establish a relationship even to a psychotic or a suicidal patient. Would we welcome a reductionist concept of the self as an illusion created by the brain? Would we adopt the idea that we are reprogramming or rewiring the patient's brain instead of talking to him or her as a person? This would undermine essential presuppositions for our therapeutic efforts, namely understanding, empathy and responsibility. In the last analysis, the question of what is 'really real' – brains instead of selves, physical matter instead of animated bodies – is an ethical question.

Conclusion

Techniques for monitoring and manipulating brain functions are developing rapidly. Prudence and restraint in their application seem advisable. We still do not know precisely how the different systems of the brain interact, or what a particular brain abnormality can predict about future psychopathology. Nor do we know precisely how intervening in these systems can affect the beliefs, desires, intentions and emotions that constitute the human mind [17••]. Moreover, the tension between traditional, intuitive or religious views of persons and the neuroscience view of a 'physical mind' is likely to have far-reaching social and cultural consequences. Thus, neuroscientists will be increasingly challenged to explain the significance of their work not only in scientific but also in moral terms. Psychiatrists could play an important role in identifying the ethical issues raised by the neuroscientific progress; for the task of psychiatrists has always been to bridge the gap between the biological and the personal level, in their decisions as well as in the communication with their patients. Not the least important thing to do will be to develop and support an integrative, nonreductive view of the mind–brain relationship, remaining aware of the fact that we do not treat brains, but persons.

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