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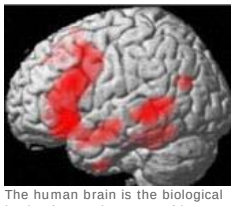
Where does man stop and machine begin?

Thinking, feeling and remembering take place in the brain. It is here that our consciousness lies, here that we keep secret longings, fears and misdemeanours hidden. Only the efficiency of our brain makes it possible for us to speak, hear, see, smell or move. Today, neurosurgeons and neurobiologists with modern surgical and investigation methods are intervening directly in the brain. Karin Bundschuh from BioRegio Freiburg spoke with Dr. Jens Clausen of Freiburg's Interdisciplinary Ethics Centre about the ethical questions and problems raised by modern brain research.

Curing disease is something that is fundamentally positive. But how does an ethicist judge when direct brain intervention should be part of the therapy?

Healing is not only an ethically justifiable objective, it is an ethically imperative one. However, this should not be at any cost. The question must be asked as to which methods are appropriate. Brain interventions have a particularly shattering effect since the brain forms the biological basis of all the central aspects of our self-understanding. Characteristics such as self-confidence, cognitive abilities, the emotions and memory are all located in the brain. If these functions are impaired by the intervention, then that is a shattering effect.



The human brain is the biological basis of central aspects of human self-understanding. This also includes our ability to speak. Speech areas are highlighted in red (Photo: Neurocentre Freiburg)

How do you rate a brain pacemaker operation, where electrodes are implanted in the brain in order to free Parkinson's patients from trembling and stiffness? In this case, the electrodes certainly have an effect on the brain.

On the one hand, it is precisely the goal of these electrodes to influence the brain and provoke the desired effect: To reduce or completely eliminate tremors. On the other hand, an electrode in the brain always creates a certain amount of anxiety. It is active inside the brain and triggers stimuli, but the different effects it may have are unpredictable. With deep-brain stimulations, serious side effects have arisen time and again, making psychiatric treatment necessary. This must always be taken into consideration, even if the goal of the intervention is a high priority. After all, the patient is very seriously ill. If there is no other way to help, it is difficult to justify a fundamental refusal of this therapy. One must look very carefully, however, at who is suitable for the operation and how any risks can be avoided.

What patients are suitable for this operation in your judgement?

Ethics would exceed its scope if it sought to define admissible cases. Its task is to indicate the questions raised by the new method. Medical criteria must be used primarily in the selection of patients and that is the responsibility of the treating physician.

What is your reaction to the statement: It is not ethically justifiable for a patient to be operated on only when medicines are no longer helping and the condition has worsened accordingly?

It is in the patients' own interests that such a serious intervention should be performed only when medicine is no longer having any effect – or at least not sufficient effect. Deep-brain stimulation is a relatively new form of therapy, which is high risk and about which a lot is still unknown. This method should not be used rashly if different, lower risk alternatives still exist.

What do you think about epilepsy patients who are not helped by medication? Physician and patient are time and again faced with the dilemma that the operation, which frees the patient from attacks, destroys other brain functions.

Neurosurgeons are faced with an extremely difficult situation with regards to epilepsy surgery or tumour operations. On the one hand, brain surgery is aimed at keeping a patient as healthy as possible and increase life expectancy and quality of life. On the other, cognitive achievements and regions of higher brain functions, such as language and memory or emotions, can be damaged. In this case, any benefits from this operation must be weighed against the risks. Moreover, the decision cannot be made by the physician alone. The issues that need to be taken into consideration can vary enormously from patient to patient. There are patients who are ready to accept restrictions on their ability to retain and remember if it means the attacks will finally stop and a social life can once again be possible.

Dr. Jens Clausen – works on the mechanisation of the brain and the ethical aspects related to cutting-edge neurotechnologies. (Photo: Clausen)

Are there any generally accepted recommendations that can make the physicians' and perhaps the patients' decision easier?

Each individual case has its own difficult questions, which cannot be answered in a general way. An agreed method of prioritising higher brain functions might assist decision-making. For example, is it more important to maintain language function or to protect the memory? Or are there functions that must not be impaired under any circumstances? The biases and considerations here are based on images of humanity that are backed by implicit anthropological convictions. The consequences of not intervening must also always be part of any decision about surgery. A growing tumour can eventually lead to function failure.

As an ethicist, are you ever called in by physicians for advice on such difficult decisions?

We are in close contact with neuroscientists and physicians for clarification on this important question. Furthermore, we offer consultation in Freiburg in the form of the Ethics Council. In situations where there is ethical conflict, the treating physicians can call us here and request

BioRegio Freiburg BIOVALLEY

A new era is around the corner - and the neurosciences will be key

Some of the most thrilling scientific questions are certainly the following: How does the human brain work? How do neurones communicate and affect each other? What happens when we are thinking? Nowadays, many scientists and experts believe that the age of genes will now be followed by the era of the neurosciences.
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situations where there is ethical conflict, the treating physicians can call us here and request an ethics council. Two ethicists then go to the hospital and discuss the particular individual case with the treating physicians and healthcare personnel. An effort is then made to reach a result by consensus.

How frequently is this offer taken up by the clinicians?

It is regularly accepted, although the frequency varies. In one week there are no inquiries and in the next there are four.

Brain-machine interface (explanation see box below) is another neurobiological branch of research that scientists are working on all over the world. How would you evaluate this procedure?

Once again, the goal here is to heal and to help. Until now, brain waves have been measured mainly using the EEG, or the electroencephalogram, and used to control a computer cursor. However, these EEG recordings provide only limited information that is insufficient for controlling motor prostheses. Research therefore extends to invasive procedures such as those being worked on in Freiburg. So-called epicortical electrodes are used, which are applied on the brain surface and require the skull to be opened in order to implant them. The objective behind this, which is the control of motor prostheses, I find completely understandable. If paraplegics are able to regain a certain motor function with this method, then it is totally justifiable.

Ethics is however questioning this approach?

There are far-reaching ethical questions that need to be asked and answered. This approach is still very much at the basic research stage; therefore the question arises as to who is best suited to the research. What happens when the approach is allowed to be implemented? The results of animal experimentation have been very promising, relatively speaking, but there are even further-reaching questions that go beyond the surgical risk. Electrical signals recorded in the brain cannot be very easily converted in order to be able to control a prosthesis. The signals must be interpreted and decoded by a computer. In the meantime, it has become clear that it is best if the computer can learn autonomously. If, however, this self-teaching computer is connected to the brain, then there are dynamic systems interacting with one another on both sides. The question must therefore be asked as to how these self-regulating processes can be controlled. The patient sees whether the movement is happening as required and naturally has the opportunity to correct the impulses, but in the end, the prosthesis is being steered by a computer that is generating the signals.

What are the consequences of this?

If the prognosis of the algorithms does not correspond to what the patient actually wanted, then the question remains: who is actually responsible for such an action or movement? And if one looks even further into the future, one can naturally also ask how much mechanisation humans and their brains can stand. This does not mean that cyborgs are in danger of becoming immediate reality (Cyborg: mixing living organism and machine, editor's note), but we are certainly moving in that direction. On one side are humans, on the other machines. If, however, human beings are implanted with more and more technology, then the question arises: where do human beings stop and machines begin? It will surely not only revolve around the amount of technology. Whether someone now has one arm or two or his legs are fitted with prostheses will not be the deciding factor. There is still a lot of research to be conducted and that is what we are doing. In September, we are organising a week-long interdisciplinary conference on this precise topic with approximately 15 up-and-coming scientists in order to work on the ethical and anthropological questions involved in mechanising the brain.

When one can measure signals for motor volition, one learns a lot about signal processing in general. Is there not also the danger that this technology may be used to decipher feelings or thoughts?

I cannot judge whether that is technically possible. If it were, then it would naturally be an abuse, if the electrode used for controlling a motor prosthesis were also used to read thoughts or decipher feelings without the patient's consent. And abuse is not only ethically alarming but must be condemned. I however consider it wrong to reject a technology in principle due to a possible potential for abuse. Ultimately, brain-machine interfaces have very positive aspects, if they succeed in improving the quality of life of people with paralysis. The question then becomes: how could I prevent this abuse if it were possible? And in the case of physicians and neurobiologists I have met so far, I find it hard to believe that they would want to deceive patients.

I was thinking more that the technology behind brain-machine interfaces could be used to stimulate signals in other places in the brain, thus making it possible to read thoughts or emotions.

One of the ethicist's jobs in a field as innovative as brain-machine interfaces, while it is still in the basic research stage, is to consider the ethical questions that arise and reflect on possible development scenarios -- which consequences are possibly questionable, which are not; which developments are justifiable and which are unacceptable. And this can only happen through interdisciplinary exchange with the scientists involved.

kb - 23 February 2007

Brain-machine interface
A brain-machine interface is an external device aimed at helping paralysed people move. Scientists are using electrodes to measure the existing brain activity of the brain motor areas. The signals are transferred to a computer via an amplifier. Mathematical analysis methods are then use to determine the intended movements from the measured brain activity. Once the brain signals are translated, a computer then controls a prosthesis or robotic arm.

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