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Neurotechnologies and ethics

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Abstract

Bioethics studies all ethical problems determined by the rapid progress in biological and medical research. It is a new multidisciplinary current subject involving other subjects such as biology, medicine, psychology, philosophy and law. The scientists working in the field of neurosciences, whose importance has constantly increased in recent years, feel it necessary to consider the subjects of their studies as persons. Non-invasive but nevertheless stressful exams are largely used in psychophysiology to investigate human brain. The ethical validity of experimental protocols has thus become a pressing need, in order to assure the respect of the individual and of his health in the investigation of the most mysterious organ: the brain.

Neuroethical considerations

In the last few decades many important steps have been taken towards the comprehension of brain activity and functions. Many moral and ethical questions have been raised due to the development of such new techniques, from those concerning the acquisition of new information on people's personality, on the decision-making process and on emotions.

In fact, any microchip implanted in the brain for medical purposes emits a pulse that allows the identification of the person who carries it, as happens with animals. In the United States, microchips are expressly used to identify patients. There are different types of microchips (European Group on Ethics in Science and New Technologies to the European Commission, 2004). Read-only: this is the simplest form of devices that have a read-only character. This most basic form would have numerous applications, for example, to identify Alzheimer's patients. A broader use would be as a sort of national identification card, based upon the identifying number carried on the microchip. Read-write. This type of microchip would be capable of carrying a set of information that could be expanded as necessary. It allows the storage of data and is programmable at distance. For example, when the microchip carries a person's medical history and the history evolves, the subsequent information could also be added to the microchip without the necessity removing the implanted chip. The third important set of information that a read-write microchip could carry would be criminal records. In addition, a device could also emit a radio signal that could be tracked. With a microchip implant constant monitoring would be possible. If each chip emitted a signal of a unique identifying frequency, implanted individuals could be tracked by simply dialling up the correct signal. Because the receiver is mobile, the tagged individual can be tracked anywhere. It was this rapid development particularly in non-medical applications that persuaded the European Group on Ethics to initiate an ethical analysis. The Group took into consideration both implants for medical and non-medical purposes. As to the former, the Group emphasised the importance of a clear understanding of the benefits and risks of implants and of the need for full and informed consent. The most important point is that "entails the moral duty of continuous risk assessment with regard to the not fully foreseeable impact of new technologies, as in the case of microchip implants in the human body". However there is also a need to exercise precaution, as the procedure involves significant risks and many patients do not benefit from the implants. On the other hand many people are concerned by the consequences the use of new procedures may have on social life: in fact, the information obtained thanks to research on the patients' brain could reduce people's social acceptability.

Indeed, neurotechnologies, such as functional magnetic resonance, contribute to the improvement in the quality of life; at the same time, however, they could also emphasise existing differences between individuals, thus putting patients' social life at risk. The problems linked to the consent, to potential risks and benefits and to data interpretation are amplified when neuroimaging techniques are applied to children. Due to the on-going psychical

development of individuals in paediatric age, the identification of ethical standards valid for every age group is virtually impossible. A child is not able to take important decisions and a teen-ager may evaluate the consequences of his/her own decisions incorrectly. At the same time, neuroimaging procedures may have different effects on children of different age. Nonetheless, some ethical guidelines have to be formulated. Clinicians or researchers who do not separate their own interests from those of the subjects of the study, thus exposing them to risks, violate the most elementary ethical rules. The use of children in studies on brain imaging should always require the explicit consent of the children's parents or tutors. Moreover, the particular environmental conditions in which experiments take place and the use of a technical jargon to describe the different procedure may cause children great anxiety. The participation of children to brain imaging studies is, therefore, unwise.

Evoked-related potential studies (ERP) consist in the measurement of neuron electrical signals in some parts of the brain by means of electrodes applied on the scalp of the patient and, in order to make the conduction of the signal easier, electrodes with subcutaneous needles are used. The researchers performing the test are the only responsible for the correctedness of the procedure and, failing precise ethical guidelines, the subjects of the studies are at the mercy of the researchers' good sense.

For a long time, death has been defined as the lack of heart activity and the interruption of the respiratory function. Thanks to resuscitation techniques, however, doctors are now able to keep the boy alive even in absence of brain activity or when the brain is no longer able to coordinate human essential functions; this is the so-called brain death, which occurs when the line on the electroencephalogram is straight. Brain death corresponds to the loss of one self's identity. In such a situation is the patient still able to perceive stimuli from the surrounding environment? The intensive treatment of terminally ill patients raises new ethical problems. When patients are conscious, they can declare they absolutely want to be kept alive and some people may say they do not want to be informed of the seriousness of their illness; when patients are unconscious, instead, they cannot consent to intensive treatment. It rests with the closest relative to take the decision; but who is the closest relative: the father/mother? The girlfriend/boyfriend?

The involvement of human beings in scientific experiments raises many ethical questions concerning the scientific value of the experiments, their risks and their benefits. Many ethical committees are already at work trying to find valid answers to these questions; the real problem, however, is that medical experiments are often in conflict with human rights.

Ethical questions have been raised as brain imaging techniques, such as Deep Brain Stimulation (DBS), Transcranic Magnetic Stimulation (TMS), Evoked-Related Potential (ERPs), functional Magnetic Resonance Imaging (fMRI) and Positron Emission Tomography (PET), were developed, concerning risks and benefits associated with their use in clinical experimentation or basic research. Deep brain stimulation consists in the stimulation of the centres of the nervous system related to a particular disease: electrodes implanted in the brain emit pulses of energy to block the abnormal activity of a part of the brain that causes the symptoms. At present, DBS is used to treat Parkinson's patients; in the future it could be used to treat severe long-term pathologies that barely respond to medications, such as obsessional-compulsive and sexual disorders or paedophilia. DBS, however, is still an experimental technique and it is not risk free: there is a 0.5-2% chance of heavy brain haemorrhage; other minor, yet unpleasant, complications are infections due to the implanted electrodes or to the impulse generator (European Group on Ethics and New Technologies to the European Commission, 2004). The most common doubts concern the safety level of the new neurological and neurosurgical procedures.

Other ethical questions relate to accidental discoveries made during an experiment: the neurologist may accidentally discover that one of the participants to the study has a brain tumour. Scientists do not know how to deal with all ethical and legal questions linked to accidental discoveries having serious repercussions on the health of the subjects of their studies. Such discoveries frequently occur in biological studies; and their implications are enormous. Neurological procedures, such as magnetic resonance, are widely used and accidental discoveries are very common. In such cases, is the neurologist morally (and legally) obliged to inform the person of the discovery? Normally precocious diagnosis allows prompt medical treatment; sometimes, however, the accidental discovery of a disease can have negative consequences as far as working conditions and insurance policies are concerned. In the United States there is the so-called "informed consent". In the United States lawyers, physicians and bioethicists maintain that researchers involved in the investigation of brain imaging procedures should be ready to deal with accidental discoveries. Some people claim that if it was considered a moral obligation to inform the participants to a study of any medical anomaly, then all of them should undergo clinical brain scans in addition to research scans; at the same time researchers should report any discoveries, even if they are not directly linked to the purpose of the study. However, new laws are to be written and ethical guidelines are to be formulated to discipline this subject.

Neuroethical doubts for forensic purposes

The polygraph, commonly known as lie detector, monitors those physiological signals (e.g. increase in heart rate, respiration, blood pressure and perspiration) that indicate that a person under interrogation, who fears to be arrested, is lying. The opponents to this method maintain that many people are able to control their physiological signals so as to easily deceive the polygraph. Thanks to the development of new brain imaging techniques, however, lie-detection is now coming to the fore again. The near-

infrared brain-imaging test allows monitoring blood flow in the brain. Optical probes and detectors are placed in direct contact with the patient's scalp and the imaging system uses near-infrared light to provide a view blood flow in the prefrontal cortex, that is, the part of the brain responsible for making decision. The LEDs detect the changes in blood flow due to the decision to lie, before the lie is uttered. Dr. Langleben, University of Pennsylvania, has carried out a study on 18 volunteers. After having been dealt some cards, each volunteer was shown the images of specific cards and asked whether they corresponded to the ones in his/her hands. His/her brain activity was monitored with a magnetic resonance. In case of lie, an increase in the activity of the anterior cingulate cortex (which is situated in the limbic system and is linked to the prefrontal cortex) and the superior frontal gyrus was observed, compared with the level obtained in case of truthful answers. The anterior cingulate cortex, in fact, is involved in the processes concerning emotions, decisions and the solution of conflicts and frequently activates itself when a person is going to lie. In the last few years in the USA the "Brain Fingerprints Testing" has gained more and more credence. This test allows discovering whether a suspect is familiar with details concerning the scene of the crime or the crime itself and that supposedly only the perpetrator of the crime knows. It consists in the measuring of the subject's electric potential through an electroencephalogram. The suspect is presented words, sentences and images that only the culprit should know; at the same time, the EEG measures his/her brain activity. If the suspect knows the information presented but he/she lies, a specific brain wave, called P300, swings into action, thus revealing that the brain has recognized the information. The test aims at determining whether a person is familiar with specific details even though he/she denies knowing them. A careful consideration is needed on the possible use of these new techniques. Is the use of such techniques for forensic surveys acceptable from an ethical point of view? This is the question.

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