



Scanning for Emerging Science and Technology Issues

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Identified Weak Signals and Emerging Issues in COGNITIVE ENHANCEMENT

Human Enhancement is a field of growing interest in different communities. It is an umbrella term used to describe the expansion of physical or cognitive abilities of individuals. It can be temporary (e.g. through the use of pharmaceuticals) or permanent (e.g. surgery, implants), and can be applied as a therapeutic measure (to correct a deficiency or impairment) or as an enhancement. The term is also sometimes used to refer to measures aimed at increasing the life-span of an individual.

Cognitive Enhancement is a related to Human Enhancement and may be defined as *the amplification or extension of core capacities of the mind through improvement or augmentation of internal or external information processing systems.*

About SESTI

The SESTI project (Scanning for Emerging Science and Technology Issues) is one of six foresight projects funded through a 2006 FP7 call under the Socio-economic Sciences and Humanities theme. During the project a number of techniques were developed to identify weak signals and emerging issues in a systematic, efficient and effective way. The project also included the organisation of a number of workshops designed to link the developed techniques in a meaningful way to existing policy processes.

The project was launched in October 2008 and has a duration of 30 months.

Cognitive Enhancement

Cognition is understood to include the following processes:

- **perception:** the acquisition of information;
- **attention:** selecting information;
- **understanding:** interpretation and representation of information;
- **memory:** retaining information; and
- **reasoning:** using information to reach conclusions or decisions.

There are various ways of classifying cognitive enhancement techniques and products, though none has achieved widespread acceptance. The following classification refers to the research fields where the enhancement techniques are expected:

1. **Electronic / cybernetic / ICT** including both non-invasive and invasive technologies. This category includes Augmented Reality, Virtual Reality, external BCIs (brain-computer interface), TMS (transcranial magnetic stimulation) neuroprosthetics and cyborgs that are expected in the future.
2. **Biological**, further subdivided into metabolic and genetic. The former refers to nutrition, non-prescription drugs as well as hard drugs and neuro/psychopharmaceuticals. The latter includes developmental biology, regenerative medicine, stem cell research and genetic selection and engineering.
3. **Psychological and behavioural** methods designed to enhance cognitive capacities. These include educational and learning techniques and related factors affecting them (at the social level) or methods such as hypnosis, mental training, or meditation affecting learning at the individual level.



The distinction must be drawn between technologies and knowledge which result in temporarily enhancement (which is achieved by application of the device or taking a metabolic active drug) and those which have an enduring effect where the focus is to develop enhanced individuals (by influencing or altering normal development, by genetic selection and modification, or by using developmental drugs).

Emerging Issues

The scanning process led to the identification of the following issues which might require special attention on the part of policymakers:

1. recent discoveries in invasive and non-invasive reading of brain activity (evoking many ethical and legal issues);
2. the use of neural implants as a possible means of unconsciously influencing thinking and emotions (also evoking many ethical and legal questions);
3. further deployment of cognitive performance-enhancing drugs (leading to unfair advantage during academic assessment, but also involving health risks);
4. genetic screening of an increasing number of 'cognitive' genes and In Vitro Fertilization (eugenics, new problem in use of animals, experiments with cognitive human-zoo hybrid);
5. possible development of developmental drugs influencing the neuro-cognitive embryological and later development (how impaired should people be to qualify for treatment?)
6. knowledge gained from healing and preventing developmental cognitive impairment could also be used for (costly) developmental treatments of normal individuals to induce higher performance levels;
7. commercial and military interest (neuromarketing - use of neuro-imaging to research subliminal influence);



8. cognitive enhancement of individuals with lower cognitive performance levels (creating problems on the insurance front, and further widening of the social and economic divide);
9. ICT-enhanced learning seems to be almost ripe for very promising tools for learning complex cognitive and cognitive motor tasks (augmented reality, virtual reality and gaming).