Cognitive Enhancement

Developments, Findings, Questions and Emerging Policy Issues
as observed in the SESTI Project




Human Enhancement Technologies

Physical

- Strength
- Health
- Ageing

Cognitive

- Rational
- Creative
- Psychological/Emotional

	Improving Existing Capabilities		"Outsourcing" Mental Tasks		Adding New Capabilities	
	Exo	Endo	Exo	Endo	Exo	Endo
Social	learning, training, communication	N.A.	writing, information storage	N.A.	N.A.	N.A.
Bio-neuronal	TMS, meditation	coffee, nicotine, ritalin, mood enhancing drugs DBS, implants for neurostimulation, neuro growth etc.	external BCI for controlling computers	Future: BCI implant for ICT access	TMS?, external BCI?	Future: advanced nootropics, genetic technologies, nanotech, BCI, DBS? neurochips
Hardware/ Software	training technologies, gaming	Future: neuroprosthesis	augmented reality, decision support systems, translation technologies	Future: bi-directional BCIs for feeding information from computers into the brain	External BCIs, new senses	Future: neurochips, ICT implants, new senses, "uploading"

Based on Leis/Sandberg, 2010

Cognitive Enhancement (CE) = Improvement of mental/cognitive capabilities

Ia) through educational means (e.g. learning and memorizing techniques etc.)
Ib) through natural practices (e.g. meditation, yoga, martial arts)
Ic) through natural substances (food, coffee, tea, nicotine (?), marihuana (?) etc.)

IIa) through technical assistance (e.g. computers, AR, decision-support systems etc.)
IIb) through artificially designed/modified substances (e.g. Ritalin, Modafinil etc.)
IIc) through neurotechnology (e.g. BCI, DBS, implants etc.)
IId) through biotechnology (genetic technologies)

III) through future technologies (e.g. brain implant, cyborg technologies, “uploading”)

→**Methods of category II increasingly got into the focus related to:**

- New scientific discoveries and technological developments
- Real-life applications (e.g. off-label use of Ritalin)
- Socio-economic pressures (e.g. in schools, workplaces, knowledge society)
- Concerns over risks and ethical considerations (as a result)

Multi-Dimensionality of Cognitive Dimensions and Enhancement

NeuroSciTech
Exotechnologies
AR, Mobile Technologies etc.
Endotechnologies
ICT-Implants, DBS etc.
Drugs etc.

Education

Training

Chemistry
Natural substances
Synthetic substances

Genetics
IVF + PID
"Smart Dating
"Smart genes"

CE

Learning
Techniques

Human Factors Research

Intelligence
Language
Emotional
Rationality
Numerical
etc.…

Life Style

Wisdom

Experience

Signals → Convergence of Driving Factors → Issue

Sci-Tech

- New Research Results
- New Technologies
- Possibilities for faster R&D
- Acceleration of knowledge
- Networking of Scientists
- NBIC Convergence

Society

- Ageing Society & Fear of dementia
- Knowledge Society
- Competition
- Education system
- Work environment
- Social/Peer Pressure
- Interest groups

Economy

- Investments in dementia research and NeuroSciTech
- Investments in ICT
- European Competitiveness
- Pharmaceuticals over the internet

"Signals"/Observables — "Signals"/Observables — "Signals"/Observables

(Sub)Issue Cognitive Enhancement

What are the Signals?

NeuroSciTech

Gene switch rejuvenates failing mouse brains

MAY 7, 2010 BY ADMIN LEAVE A COMMENT

06.05.2010

"Step aside, Sudoku. A genetic switch that causes memory impairment in ageing mice when it goes into "off" mode has been flicked on, restoring failing brains to a more youthful state.

If a similar switch can be found in people, it might provide a new way to keep ageing human brains young.

Cognitive decline, particularly memory impairment, is a normal part of ageing in humans and animals. [...]"

Source/article: New Scientist

Allon drug boosts memory in pre-Alzheimer patients

Reconstructing the brain piece by piece and building a virtual brain in a supercomputer—these are some of the goals of the Blue Brain Project. The virtual brain will be an **exceptional tool** giving neuroscientists a new understanding of the brain and a better understanding of neurological diseases.

Smart Rat 'Hobbie-J' Produced By Over-expressing A Gene That Helps Brain Cells Communicate

OCTOBER 20, 2009 BY ADMIN LEAVE A COMMENT

20.10.2009

"Over-expressing a gene that lets brain cells communicate just a fraction of a second longer makes a smarter rat, report researchers from the Medical College of Georgia and East China Normal University. [...]"

Source/article: Science Daily

Optogenetics: Controlling live neurons with light

PESCOVITZ: Biomedical engineer Theodore Berger at the University of Southern California in Los Angeles has developed an artificial hippocampus: a silicon substitute for the part of the brain that scientists believe encodes experiences as long-term memories. To do this, Berger built mathematical models of neuronal activity in a rat's hippocampus and then designed circuits that mimic those activities.

What are the Signals?

NeuroSciTech

Center for Neuroscience & Society
University of Pennsylvania

HOME ABOUT US PEOPLE EVENTS EDUCATION RESOURCES

Brain-Machine Interfaces and Non-pharmacological Enhancement

The man on the street is more likely to use pharmaceutical enhancement at some point in his life than any of the methods discussed in this section. Nevertheless, nonpharmaceutical methods for altering brain function have evolved rapidly over the past decade. It seems likely that they will become more widely used for the treatment of neurological and psychiatric disorders and, eventually, for the enhancement of normal healthy brains. Three lines of research are paving the way for nonpharmacologic brain enhancement. The first is brain stimulation, either by implanted devices or transcranial magnetic stimulators.

LONDON, England (Reuters) -- Scientists have developed the first artificial region of the brain -- a silicon chip that mimics an area that controls memory, mood and awareness.

Devised by researchers at the University of Southern California in Los Angeles, the chip is designed to carry on the functions of the region known as the hippocampus and could one day be used to help people with brain damage.

Neural-Silicon Hybrids Point to New Era in Technology

by James Cavuoto, editor and Warren Grill, senior technical editor

Direct interfaces between small networks of nerve cells and synthetic devices promise to advance our understanding of neuronal function and may yield a new generation of hybrid devices that exploit the computational capacities of biological neural networks. There are several research teams in the U.S. and Europe that are currently working on so-called neural-silicon hybrid chips.

Curr Med Chem. 2007;14(2):123-31.

Towards better brain management: nootropics.

Malik R, Sangwan A, Saihgal R, Jindal DP, Piplani P.

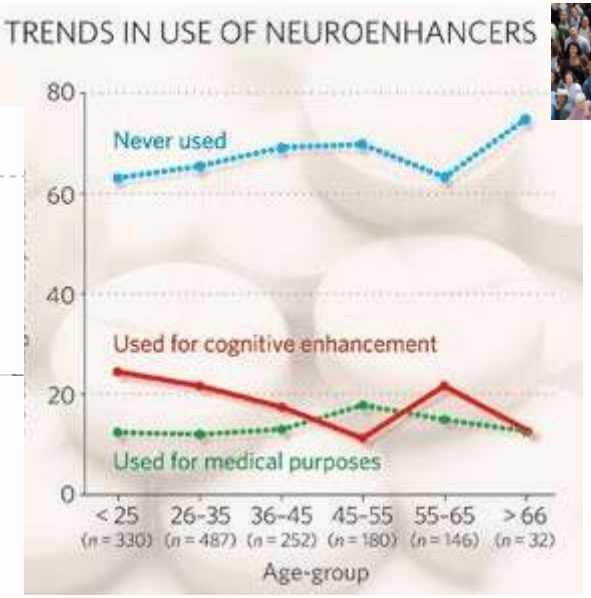
University Institute of Pharmaceutical Sciences, Panjab University, Chandigarh-160014, India.

What are the Signals?

Society

Poll results: look who's doping

In January, *Nature* launched an informal survey into readers' use of cognition-enhancing drugs. Brendan Maher has waded through the results and found large-scale use and a mix of attitudes towards the drugs.



Royal Society says give neuroscience a greater role in education policy

24 February 2011

Brain Enhancement Is Wrong, Right?

Cognitive Enhancers are Not "Cheating"

Stumble! 3

LEISTUNGSGESELLSCHAFT

Eine Pille für die Eins

Mehr Konzentration, Erinnerungsvermögen, Wachsamkeit: Führende Hirnforscher haben die Debatte über Hirndoping neu entfacht. Sie fordern eine Freigabe der Mittel für alle

Matt Lamkin argues that universities shouldn't ban cognitive-enhancing drugs like Ritalin and Adderall. Lamkin is a lawyer and, like myself, a master's candidate in bioethics. He rightly believes that a ban would do little to promote fairness or safety among students. The rule followers would be at a

What are the Signals?

Society

STOA Workshop in the European Parliament:

A European Approach to Human Enhancement

Brussels, 24 February 2009

Rathenau Instituut
Research and debate on science and technology

Nieuwsberichten → Mensverbetering: conferentie over de kansen en de bedreigingen

Human Enhancement: conference on its possibilities and its threats

Nieuwsberichten

15-07-2010

Report on the conference 'Human Enhancement: facts, fables, and fictions.'

Policy Implications of Technologies for Cognitive Enhancement

May 3-5, 2006, Arizona State University

What are the Signals?

Economy

The partnership has now a dedicated website:
ec.europa.eu/active-healthy-ageing.

as adults? Should your employer have the right to require you to take a medication that would improve your performance on the job? I discuss some of the ethical and social challenges posed by the emerging trend toward cognitive enhancers in Chapter 11.

With the **Innovation Union** strategy, the European Commission aims to enhance European competitiveness while tackling societal challenges

(Savulescu 2009) . Widespread population level increases in cognitive ability could have profound social and economic benefits. Some studies estimate that a 3% population wide increase in IQ would reduce poverty rates by 25% (Weiss 1998), leading to an annual economic gain of US $165-195 billion and 1.2-1.5% GDP (Schwartz 1994; Salkever 1995).

TAKING EUROPEAN KNOWLEDGE SOCIETY SERIOUSLY

Report of the Expert Group on Science and Governance to the Science, Economy and Society Directorate, Directorate-General for Research, European Commission

Conclusions on research joint programming: initiative on combating neurodegenerative diseases (Alzheimer's)

2982nd COMPETITIVENESS
(Internal market, Industry and Research) Council meeting

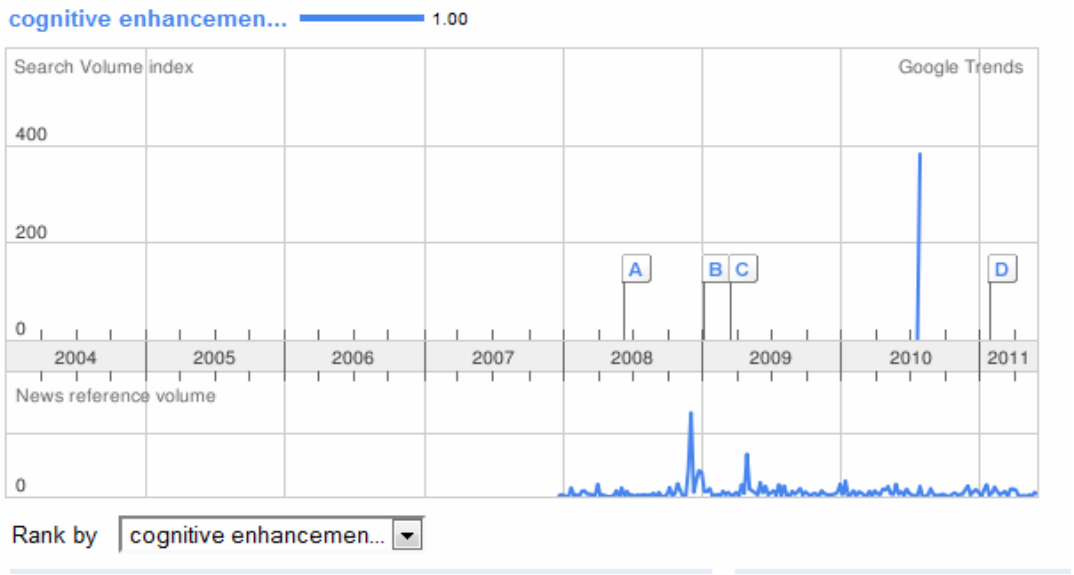
Brussels, 3 December 2009

Signals were gathered especially since the turn of the Century (2001 – 2011)

- Possibilities are growing
  - Drugs
  - Neurotechnologies
  - Genetic research
  - Evidence-based Life Style

- Applications are practiced
  - Wellness
  - Gaming (e.g. Dr. Kawashima)
  - Off-label medication/drugs
  - "Citizen Science"

- Interest groups
  - Elderly
  - Industries/Employers
  - Medical
  - Competitiveness
  - Futurists



- Interest is growing
  - Tests, quizzes etc.
  - Students, employees
  - Ageing society & Dementia
  - Knowledge capital
  - NeuroSciTech R&D for Ageing
  - Chine, Singapore???

A Cognitive enhancement: why mess with our minds?
Times Online - Jun 9 2008

B Popping Smart Pills: the Case for Cognitive Enhancement
TIME - Jan 6 2009

C Cognitive enhancement drug may also cause addiction
Nature.com (subscription) - Mar 17 2009

D Cognitive enhancement: A molecular memory booster
Nature.com - Jan 26 2011

More news results »

Issues mentioned in the CE Expert Workshop:

A number of implications for policy and regulation have been identified:

- Emerging ethical issues call for further dialogue and research in the area;
- There is a need for undertaking the necessary studies to identify benefits and associated risks;
- Introducing appropriate regulation which strikes a careful balance between the required safeguards and adequate research freedom;
- Proactive policy approaches to monitor the blurring boundaries between treatment and enhancement;
- Market penetration of new applications needs to be explored.

Implications for Policy Making – CE is already reality, but…:

Issues related to R&D and investment:

- Should CE technologies be regulated and if so, which ones and why?
- Should public money be invested into the development of potential CE technologies and how does it relate to dementia research?
- Which criteria should serve for regulation? Natural vs. Artificial? Risk? Accessibility?
- Legal issue: in which category would CE medication fall – can it be related to a disease and therapy? → Therapy-Enhancement debate
- What to do about off-label use of medication for CE?
- How should CE technologies be evaluated, certifies, assessed?

Implications for Policy Making – CE is already reality, but…:

Issues related to society and economy:

- Who would pay for CE technologies and what about equal access?
- How to deal with CE in schools, workplace etc.?
- Implications of the availability of CE on employment and the job market?
- Can Europe remain competitive without CE in view of the growing interest in Asia?
- CE technologies as therapy for the cognitive impaired?
- What would the implication of applied CE technology be for the future of humanity?
- Are there dangers of discrimination, eugenics, “brain washing” etc.?
- Implications for other drug (ab)uses?
- CE and liberty?
- What is the role of governments and markets?
- Should CE technology be allowed to be imported from abroad?
- Privacy/security/safety issues related to technology implanted in the brain

Conclusions in the Context of Signal Scanning for Strategic Policy & Foresight

- **Fact, not Fiction**: Cognitive Enhanecement is already reality, but early stage
- **Multi-Dimensionality**: It crosses through health, ageing, knowledge society, education, competitiveness, R&D, policy on medication and off-label use, risk assessment, equality/accessibility, healthcare financing etc...
- **Emerging**: CE has gained some interest within the policy context, but far less than other issues/topics like finacial crisis, costs of ageing etc. → but CE shows relations to these issues (e.g. European competitiveness, dementia problem)
- **Controversy**: CE is already causing social controversies, but still less than other topics/issues (e.g. climate change, oil, nuclear, employment, social security etc.)
- **Disruptive Potential:** CE has a disruptive potential for the future knowledge society, education, employment, regulation of medication, equality, disability, “normality”, social cohesion, global competitiveness, innovation capacity, the “future human” etc.

Thank You
For Your Attention