Global Warming on Neuroscience and Education: Navigating between Scylla and Charybdis

EIPPEE Conference 2012: Advancing the use of research in education across Europe

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“In all affairs it’s a healthy thing now and then to hang a question mark on the things you have long taken for granted.”

Bertrand Russell
(1872-1970)
• Understanding is seeing patterns...

• Neurosciences to contribute to education?

• Ethics in the brain?

• Bonus (if we have time): in search of tesseracts in the brain...
• Understanding is seeing patterns...

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From:
Marroquin, J.L.
(1976)
*Human Visual Perception of Structure*,
Masters degree thesis,
MIT Dept. of Electrical Engineering & Computer Science
imperfect
play/work leader/follower
holiday
hell

holiday
hell
• The ‘eureka!’ experience: learning is extremely pleasurable... ...even at school!

• Pattern recognition makes you feel secure...

• Matching with previously known patterns can lead to problems
Categorical perception (from Gärdenfors, 2007)
Categorical perception (from Gärdenfors, 2006)
“Do not fear to be eccentric in opinion, for every opinion now accepted was once eccentric.”

Bertrand Russell  (1872-1970)
• Understanding is seeing patterns...

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• Bonus (if we have time): in search of tesseracts in the brain...
Brain research is not likely to solve EVERY educational problem
Brain research is not likely to solve ANY educational problem

BUT...

... this does not mean it is useless, because findings from brain research & cognitive neuroscience can (at least):

1/ shed new light on old issues,

2/ raise new questions, and

3/ inform ideology-dominated debates (of pre-scientific nature)
To begin with, plasticity and periodicity...

- Particular "sensitive periods" exist for different types of learning
- Functional brain maturation proceeds up into the third decade of life
- Emotions play a crucial role in the learning processes
- The remarkable plasticity of the brain not only makes it a lifelong learning device, but makes remediation for learning disorders possible even if they have not been diagnosed at a very early age

In other words...

You can teach an old dog new tricks!
The “Brain Challenge”, back in 1999

Dialogue necessary between:

- the neuroscientific community
  and
- the education community
  (policy-makers, teachers, researchers, students, parents...)

...on international level...
...in order to reply to questions ...

- of technical and scientific nature
- of social and economic nature
- of ethical and political nature
WHY THEN?

- Impact of brain imaging technologies: new discoveries with educational implications

- Crucial notions of
  - brain plasticity and
  - brain “periodicity” (sensitive periods)
Magneto-encephalography: MEG

Using SQUID
Super-conducting QUantum Interference Device

Detecting a magnetic field of $10^{-15}$ T

Prototype MEG, Hitachi CRL (1990) - courtesy of Hitachi Advanced Research Laboratory
Functional Magnetic Resonance Imaging: fMRI

3D anatomical image
Hitachi SDL (1990)

EPI-fMRI (magnetic field: 2T)
Hitachi CRL (1992)

Courtesy of Hitachi Advanced Research Laboratory
Brain areas activated in social decision-making

Dorsolateral prefrontal cortex (DLPFC)
Anterior cingulate cortex (ACC)
Posterior cingulate cortex (PCC)
Superior temporal sulcus (STS)
Insula (INS)
Amygdala (AMY)
Orbitofrontal cortex (OFC)
Medial prefrontal cortex (MPFC)


MR Images courtesy of Hitachi Ltd. and Hitachi Medical Co.
WHY NOW?

- More impact of brain imaging technologies:
  - yet other discoveries with educational implications

- Better understanding of:
  - emotions in the brain
  - higher-order functions
Near infrared optical topography: NIR-OT

Optical fibers

Irradiation

Detection

Optical fiber

Scalp
Skull

Cerebral cortex

Observation area

Blood-volume change with neuronal activities

Anyone, Anytime, Anywhere


Courtesy of Hitachi Advanced Research Laboratory
Wearable Optical Topography – WOT
(prototype)

Total weight: 1 kg (including a battery for 4 hours operation)

Courtesy of Hitachi Advanced Research Laboratory
Exploring brain activity in daily life

Central radio station

Courtesy of Hitachi Advanced Research Laboratory
Kandel’s hypothesis:

“synaptic changes parallel behavioral changes”

Formation and elimination of synapses

Presence of input signals makes neuronal connection

Number of synapses (primary visual area)

Synapto-genesis

Selective cell death

Infancy

Birth

Adapted from Huttenlocher, P.R. 1990

Mikoshiba K, Kubata K, Brain Book 21
(Koizumi H, ed.), Kosakusha (2001)
Courtesy of H. Koizumi
Neuromyths to be dispelled...

• “I read somewhere that we only use 10% of our brain anyway”
• “I’m a left-brain, she’s a right-brain person”
• “Let’s face it – men and boys just have different brains from women and girls”
• “Improve your memory!”
• “Learn while you sleep!”
• “There is no time to lose as everything important about the brain is decided by the age of 3”
• “There are critical periods when certain matters must be taught and learnt”
A basic book, not completely prehistoric yet...

Published 2007

Available in:
- Arabic
- Chinese
- English
- French
- Japanese
- Serbian
- Spanish
Languages in a Global World
LEARNING FOR BETTER CULTURAL UNDERSTANDING


Published 24 April 2012
• Understanding is seeing patterns...

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TWO KIDS: ETHICS IN THE BRAIN, NATURE, NURTURE, OR BOTH?
TWO INDIVIDUALS AT THE EXTREMES OF AN ETHICAL SCALE

Mohandas Karamchand Gandhi (1869 –1948)

Heinrich Luitpold Himmler (1900 –1945)
Questions...

• Are human beings *born unequal* when it comes to ethics?

• Or are ethical standards *acquired*?

• Or both: nature *and* nurture? (genetics vs. socialization?)
Biological mechanisms of ethics soon discovered in the brain?!

• if yes, it might (will?) dramatically modify:
  ✓ our philosophical and political views
  ✓ our conceptions of education
  ✓ ...and even the ways we perceive ourselves as a species

• there is no such thing as a “neutral” science (or technology)
  → perceptions, representations, values, prejudices, ideologies...
  (remember Trofim Lysenko; cf. della Chiesa, 1989).
“Being human is to feel empathy.”

Philip K. Dick
(1928-1982)
Where do differences come from?

3 options:

1. It is “nature” (genetics: we are pre-programmed by our genes);
2. It is “nurture” (acquired: through environment, particularly education); or
3. It is a combination of both (probable majority for this on experts’ side; cf. Dynamic Skill Theory’s bio-psycho-social model of human development - Fischer & Bidell, 2006)

• 3rd explanation probably not to please the media: too complex/complicated
  (Scylla or Charybdis…)

• 2 first ones simple (univocal), easy to understand and to convey

• Mass media not equipped to deal with complexity (scientific or not)…

The hardest challenge for our (democratic) societies in the 21st century?
Of ethics, politics, policies, practices, sciences, and more...

- **ETHICS** (good → bad)
- **POLITICS** (desirable → not desirable)
- **POLICIES** (feasible → not feasible)
- **PRACTICES** (efficient → not efficient)
Fig. 2 - The generation of arts, sciences, and ethics.
Fig. 3 – relationships between economy and arts, sciences, ethics

- **ARTS** (beautiful ↔ ugly)
- **SCIENCES** (accurate ↔ non-accurate)
- **ETHICS** (good ↔ bad)
- **ECONOMY** (more ↔ less)

- influences
- conflicts?
IDEAS – philosophies...
(true ↔ false)

ETHICS
(good ↔ bad)

POLITICS
(desirable ↔ not desirable)

POLICIES
(feasible ↔ not feasible)

PRACTICES
(efficient ↔ not efficient)

SCIENCES
(accurate ↔ non-accurate)

ECONOMY
(more ↔ less)

Media

‘cascade’
→ inspire
→ come back to
→ try to tell
→ Influence

Derived, expanded and simplified from:
After one look at this planet any visitor from outer space would say: “I want to see the manager!”

William S. Burroughs (1914-1997)
I shouldn't wish people dogmatically to believe any philosophy, not even mine.

Bertrand Russell (1872-1970)
Bedankt!

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LET'S BRAIN-STORM!
• Understanding is seeing patterns...

• Neurosciences to contribute to education?

• Ethics in the brain?

• Bonus (we have time!): in search of tesseracts in the brain...
“For us, we are all very different; our languages are very different, and our societies are very different. But if we could extract ourselves from our point of view and sort of look down at human life the way a biologist looks at other organisms, I think we could see it a different way. Imagine an extra-human observer looking at us. Such an extra-human observer would be struck precisely by the uniformity of human languages, by the very slight variation from one language to another, and by the remarkable respects in which all languages are the same.”

Noam Chomsky (born 1928)
IN SEARCH OF TESSERACTS IN THE BRAIN

\[ \text{\textit{Die Grenzen meiner Sprache bedeuten die Grenzen meiner Welt.}} \]
\[ \text{\textit{The limits of my language mean the limits of my world.}} \]

\[ \text{\textit{Those who do not know other languages know nothing of their own.}} \]

- L. Wittgenstein

- J. M. Barthes

Maximen und Reflexe, 1923
IN SEARCH OF TESSERACTS IN THE BRAIN

“Jedes Fremde Sprachwort kennt,
werde nicht von seiner eigenen.
Those who do not know other languages
know nothing of their own.”
— J. L. VON SCHEM
Maximen und Reflexionen II, 1823

„Die Grenzen meiner Sprache
bedeuten die Grenzen meiner Welt.“
“The limits of my language
mean the limits of my world.”
— L. ROSENBERG
Transparent Language (Wien), 1921
IN SEARCH OF TESSERACTS IN THE BRAIN

DIMENSION 3
3-D SPACE
EX: CUBE

DIMENSION 2
PLANE
EX: SQUARE

DIMENSION 1
LINE
EX: SEGMENT

DIMENSION 0
POINT
SPACE
LEARNING

DIMENSION 3
KNOW-HOW
(creative knowing of knowledge and skills)

DIMENSION 2
SKILLS
(GR ABSTRACTIONS)

DIMENSION 1
KNOWLEDGE
(understanding by knowing pieces of information)

DIMENSION 0
INFORMATION
PHONICS / GRAPHEMES
(SOUNDS / LETTERS)

DIMENSION 3
UTTERANCES
(DISCOURE)

DIMENSION 2
SENTENCES
(GR ABSTRACTIONS)

DIMENSION 1
MORPHEMES
(GRAMM)

DIMENSION 0
FACTS
(REPRESENTATIONS)

DIMENSION 3
HABITUS
(GR. PHERE RULES)

DIMENSION 2
BEHAVIORS
(GR. ABSTRACTIONS)

[QUOTATION]
"WE HAVE NOT HER HERESY,"
"THOSE WHO DO NOT KNOW OTHER LANGUAGES
KNOW NOTHING OF THEIR OWN."
-J.F.K. BOHN
MAXIMEN UND REFLEXIEN II, 1823

[QUOTATION]
"Die Grenzen meiner Sprache
bedeutet die Grenzen meiner Welt."
"The limits of my language
mean the limits of my world."
-L. WITHEMEN
TRANSLATION: LEBERDORF, 1983
IN SEARCH OF TESSERACTS IN THE BRAIN

[Diagram showing various dimensions and concepts related to learning, language, and culture.]

"Weare Brachialnicht wem; weber kòmt von thome enwem." — Those who do not know other languages know nothing of their own.

"Die Hصنع meiner Sprache bedeuten die Grenzen meiner Welt." — The limits of my language mean the limits of my world.

"La tinta de los libros." — The ink of the books.
IN SEARCH OF TESSERACTS IN THE BRAIN

DIMENSION N
N-D SPACE
EX: TESSERACT

DIMENSION 4
4-D SPACE
EX: TESSERACT

DIMENSION 3
3-D SPACE
EX: CUBE

DIMENSION 2
PLANE
EX: SQUARE

DIMENSION 1
LINE
EX: SEGMENT

DIMENSION 0
POINT

DIMENSION 0
SPACE

DIMENSION 0
INFORMATION
LEARNING

DIMENSION 0
PHONEMES / GRAPHEMES
SOUNDS / LETTERS
LANGUAGE

DIMENSION 0
FACTS
PERCEPTIONS
CULTURE

DIMENSION 1
MORPHEMES
WORDS

DIMENSION 1
PATTERNS
REPRESENTATIONS

DIMENSION 2
SKILLS
ABSTRACTIONS

DIMENSION 2
SENTECES
ABSTRACTIONS

DIMENSION 2
BEHAVIORS
ABSTRACTIONS

DIMENSION 3
KNOW-HOW
CREATIVE COMBINING OF KNOWLEDGE AND SKILLS

DIMENSION 3
UTTERANCES
DISCOURSE

DIMENSION 3
HABITUS
(CF. PIERRE BOURDIEU)

DIMENSION 4
GUPSA
LINGUISTIC GRAMMAR

DIMENSION 4
METACOGNITION

DIMENSION 4
METAPHYSICS

DIMENSION 4
PHILOSOPHY OF LANGUAGE

DIMENSION 4
COUPSA
CULTURAL HABITUS

WEB: "Eine Menschenrecht oder zum Beschluss," - WEISER WIESER
"One of the greatest human rights is to know your language."
- ADAM WINTER, REPLOSA, 1993

WEB: "Die Grenze meines Sprachk" - WEISER WIESER
"The limits of my language mean the limits of my world."
- L. WITTGENSTEIN, TRACTATUS LOGICO-PHILOSOPHICUS, 1921
IN SEARCH OF TESSERACTS IN THE BRAIN

DIMENSION 0
POINT
SPACE

DIMENSION 1
LINE
EX: SEGMENT

DIMENSION 2
PLANE
EX: SQUARE

DIMENSION 3
3-D SPACE
EX: CUBE

DIMENSION 4
4-D SPACE
EX: TESSERACT

DIMENSION 5
N-D SPACE

DIMENSION 1
KNOWLEDGE
UNDERSTANDING BY COMBINING PIECES OF INFORMATION

DIMENSION 2
SKILLS
AS ABSTRACTIONS

DIMENSION 3
KNOW-HOW
CREATIVE COMBINING OF KNOWLEDGE AND SKILLS

DIMENSION 4
METACOGNITION

DIMENSION 5
INTERACTION TO REALIZATION, GROWTH, ACHIEVEMENT

DIMENSION 1
MORPHEMES
(HOARIS)

DIMENSION 2
SENTENCES
(AS ABSTRACTIONS)

DIMENSION 3
UTTERANCES
(DISCOURSE)

DIMENSION 4
SUPERSOGLIC GRAMMAR

DIMENSION 5
INTERACTION TO REALIZATION, GROWTH, ACHIEVEMENT

DIMENSION 1
FACTS
(RECEPTIONS)

DIMENSION 2
BEHAVIORS
(AS ABSTRACTIONS)

DIMENSION 3
HABITUS
(CF. PIERRE BOURDIEU)

DIMENSION 4
SUPERSOGLIC CULTURAL HABITUS

DIMENSION 5
INTERACTION TO REALIZATION, GROWTH, ACHIEVEMENT

DIMENSION 1
PHONEMES / GRAPHEMES
(SOUNDS / LETTERS)

DIMENSION 2
LEARNING

DIMENSION 3
LANGUAGE

DIMENSION 4
SUPERSOGLIC LANGUAGE

DIMENSION 5
INTERACTION TO REALIZATION, GROWTH, ACHIEVEMENT

"DER SCHNELLER BRADBACH BEDEUTET DIE SCHNELLERN WELT?"  THE LIMITS OF MY LANGUAGE MEAN THE LIMITS OF MY WORLD.
L. Wittgenstein
Tractatus Logico-Philosophicus, 1922

"WEITER BRAUCHT NICH NOETZEN," WEHRES MOKT DER BESTE ZUNGEN.  "THOSE WHO DO NOT KNOW OTHER LANGUAGES KNOW NOTHING OF THEIR OWN."
SCHÖN, V. ZURLICH.
HESSEN UND KURHESSEN II, 1923
From Bourdieu’s kitchen, crucial notion of...

...‘DOXA’:

...or ‘culture’ considered ‘nature’...
Do we really want to...

• Promote empathy and tolerance?
• Promote high ethical standards?
• Promote equity (in education systems, to begin with)?
• Fight against ‘failure’ in our schools?

Do we really want this?
• Understanding is seeing patterns...

• Neurosciences to contribute to education?

• Ethics in the brain?

• Bonus: in search of tesseracts in the brain...

• Bonus #2: Emotions and learning, the example of language
Everyone on Earth had the same language, and the same words…

(Genesis, 11-1)

Tower of Babel by Pieter Brueghel (1563)
The

‘Army Method’: success...

and

consequences
“Motivational Spiral Hypothesis”

- formal education (schooling,...)
- immediate (family) environment
- (early) media exposure
- learning results
- (early) Representations
- (altered) Representations
- social and economic outcomes
“Motivational Vortex Hypothesis” (positive)

Acquired Knowledge
(surface on top of vortex)

Learning vector (time)

WIND
(stronger or weaker)

wind reinforcement/weakening

fast/slow speed of whirlwind

Real World
social/economic
benefits

Learning results

PERCEPTION
of outcomes/benefits

informal learning (…)

formal learning (school)

(early) media exposure

Immediate (family) environment
‘I speak Spanish to God, Italian to women, French to men, and German… to my dog’.

Emperor Charles V (1500-1558)
Le cerveau apprenant est le produit de l’interaction entre l’inné (génétique) et l’acquis (environnement)

- Importance cruciale des émotions et des stimuli motivationnels dans l’apprentissage.

- Fortes différences individuelles dans l’apprentissage (plus intra-genres qu’inter-genres).

- Solides éléments scientifiques pour
  - étayer (ou non) les théories existantes en matière d’enseignement/apprentissage
  - montrer pourquoi et comment certaines approches et méthodes appliquées depuis des décennies en matière d’enseignement “fonctionnent” (mieux que d’autres).