

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

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

Bruno della Chiesa  
Harvard Graduate School of Education / OECD-CERI  
Bel Air Hotel, The Hague, The Netherlands, 9.5.2012

**"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)**





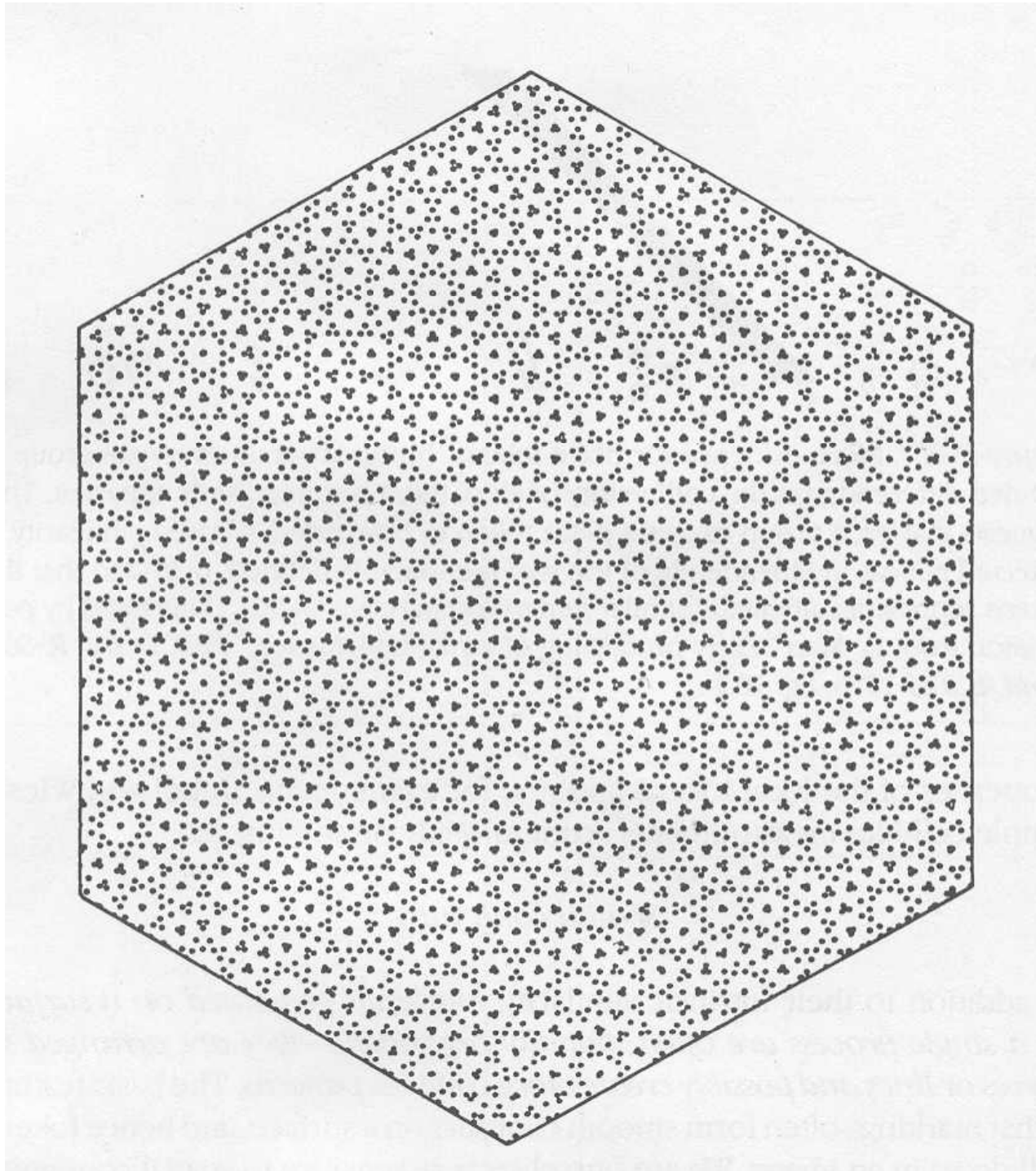
## Menu

- **Understanding is seeing patterns...**
- **Neurosciences to contribute to education?**
- **Ethics in the brain?**
- **Bonus (if we have time): in search of tesseract in the brain...**



## Menu

- **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



good

bad



bad

good





wise

old



old

wise

useful

useless

useless

useful

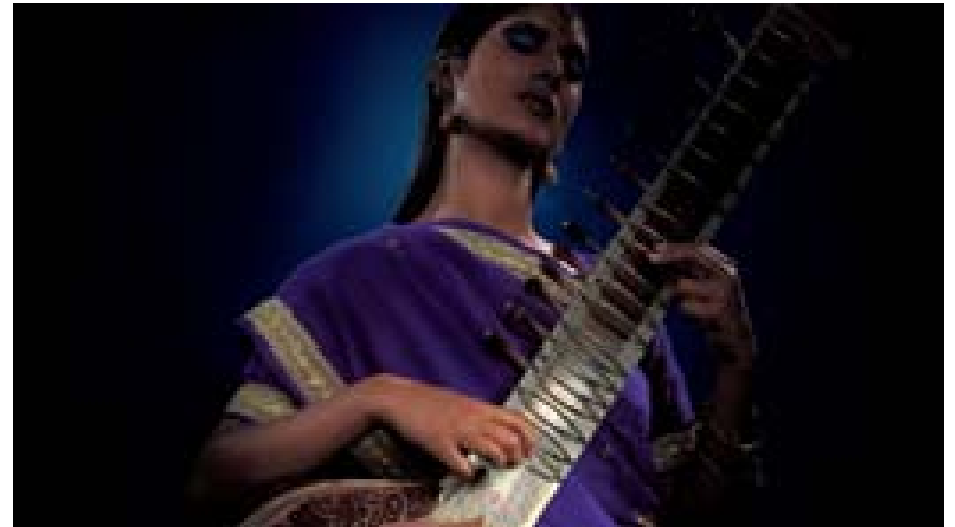




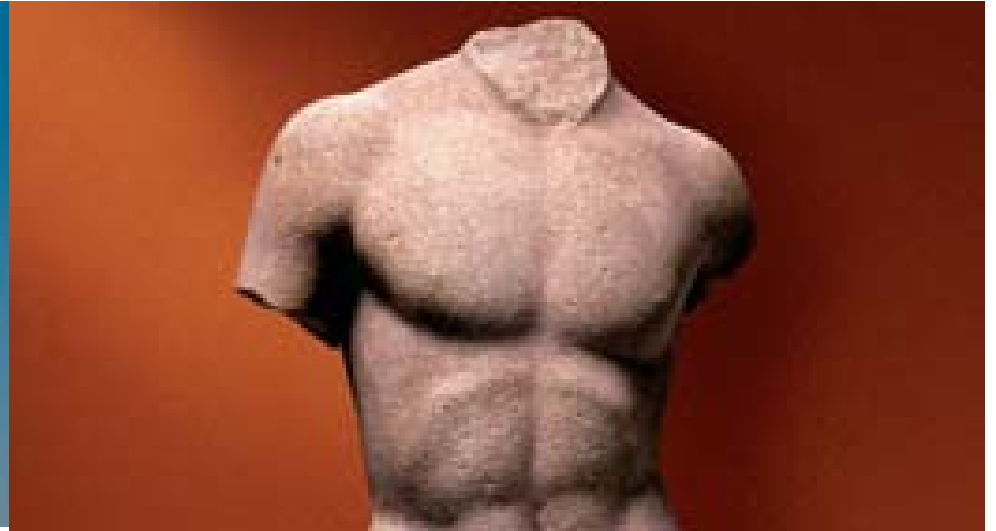
? enjoyable  
? unbearable



? unbearable  
? enjoyable







? ~~imperfect~~

? ~~imperfect~~

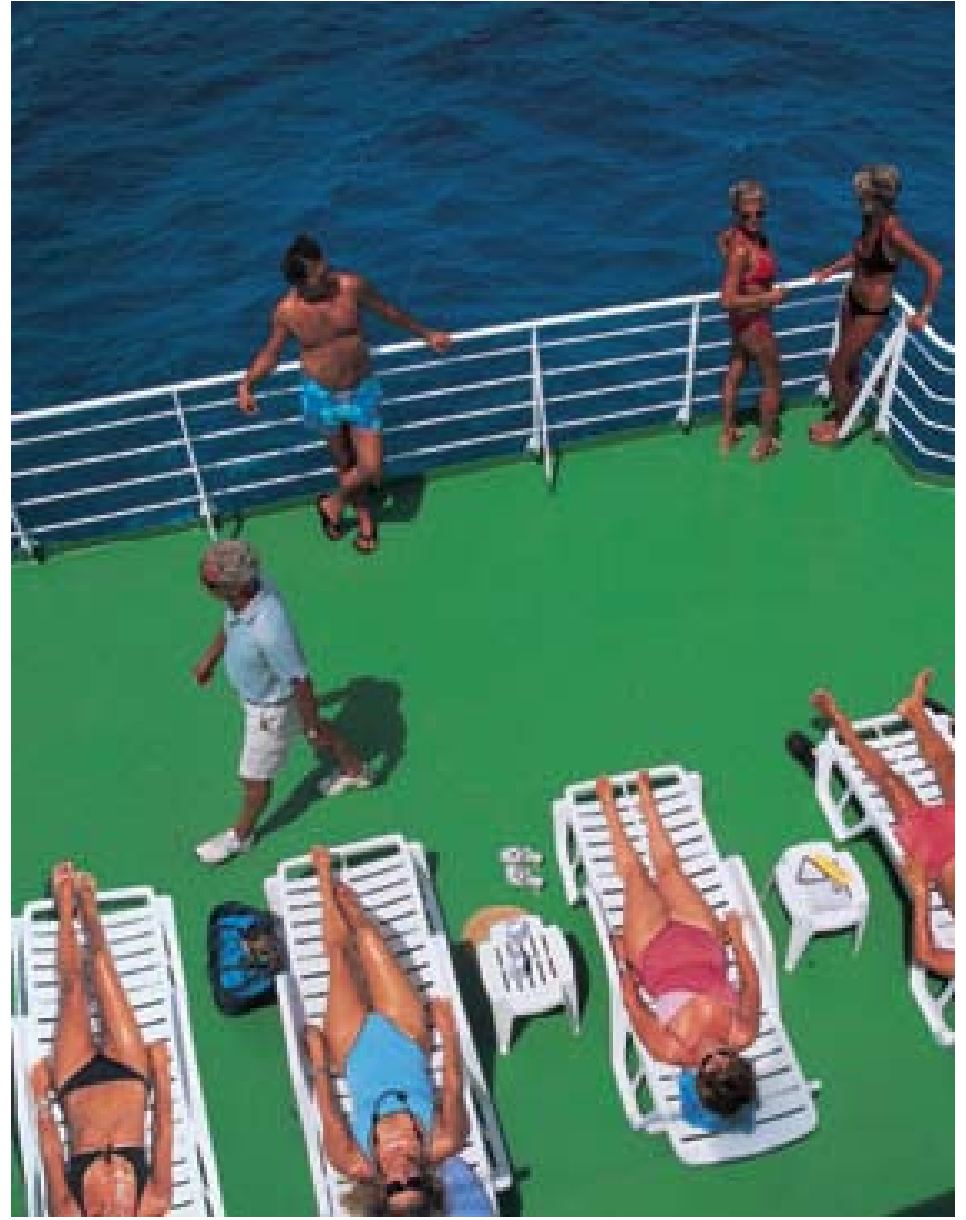
? ~~mark/park~~

? ~~leader/follower~~





holiday  
hell



holiday  
hell

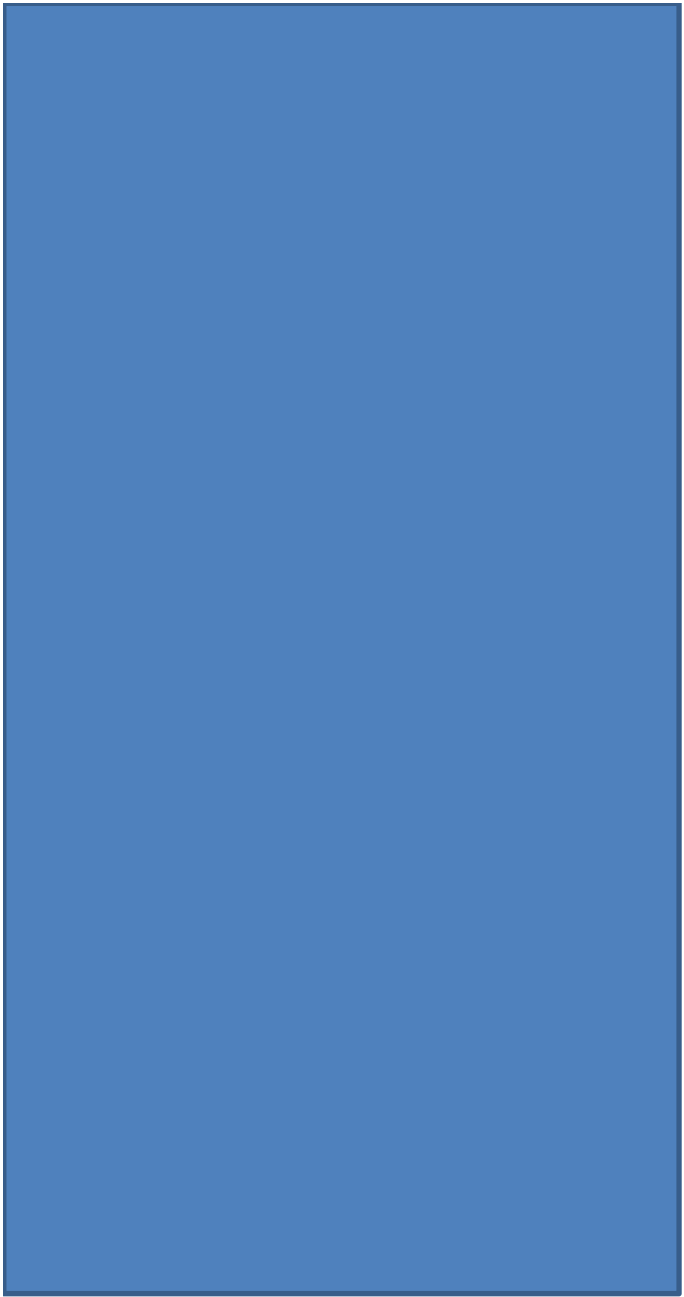


# Understanding is seeing patterns...

- The 'eureka!' experience: learning is extremely pleasurable...  
...even at school!
- Pattern recognition makes you feel secure...

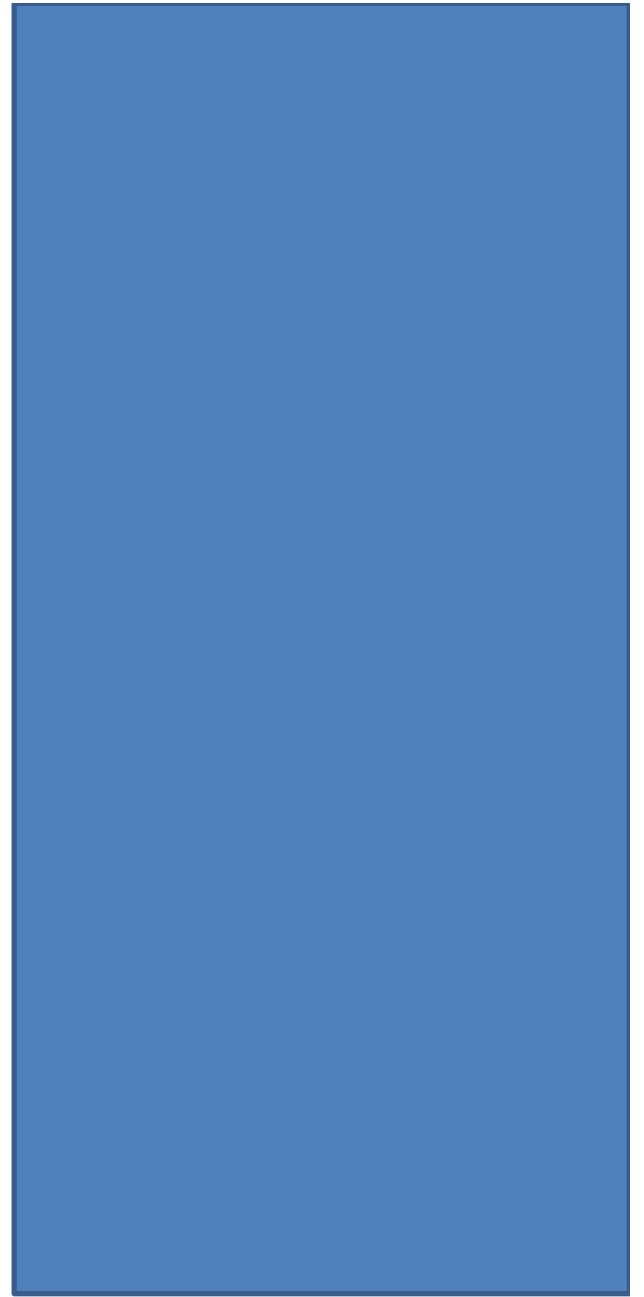
**...but 'seeing patterns' can be misleading**

- Matching with previously known patterns can lead to problems



B

B



Categorical perception (from Gärdenfors, 2007)

A

B

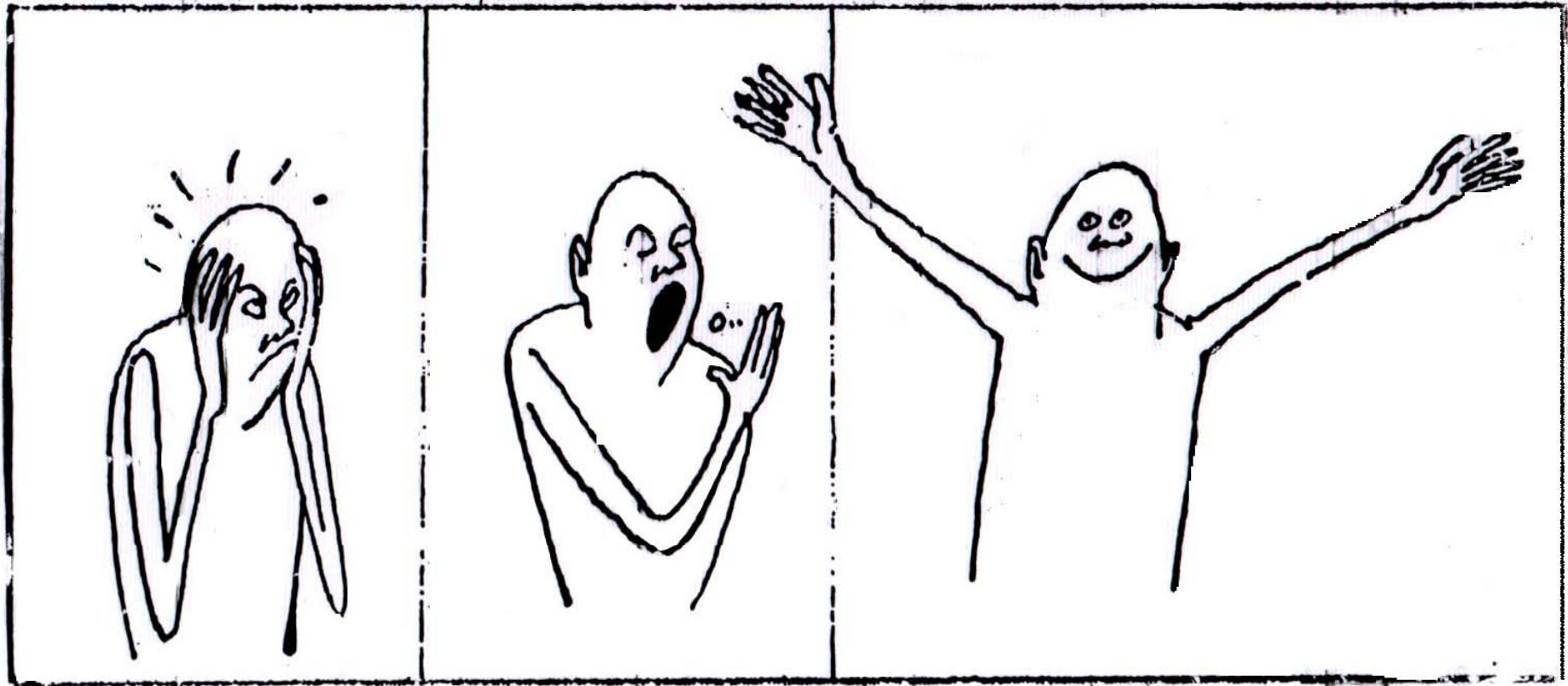
C

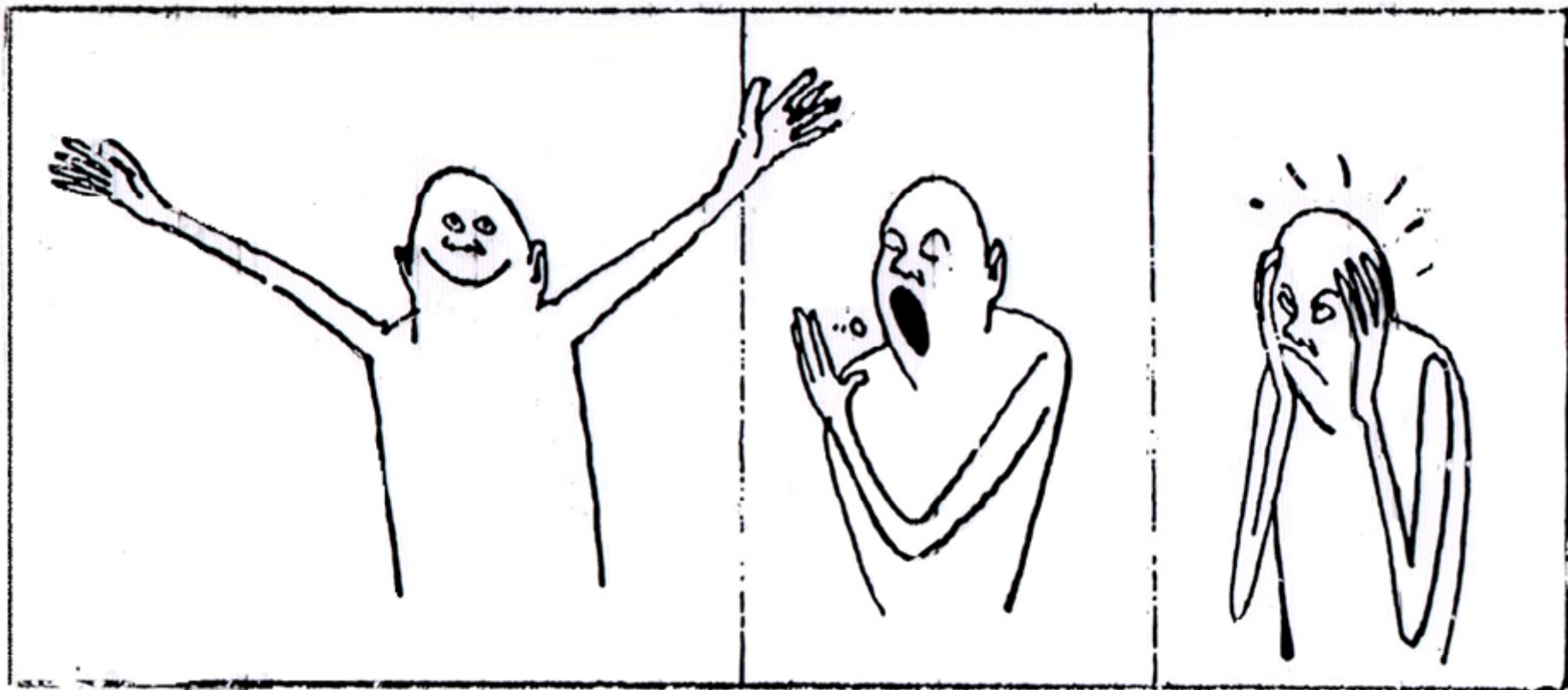
12

B

14

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)**





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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)...



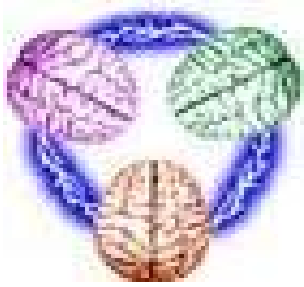
## To begin with, plasticity and periodicity...



- ...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**

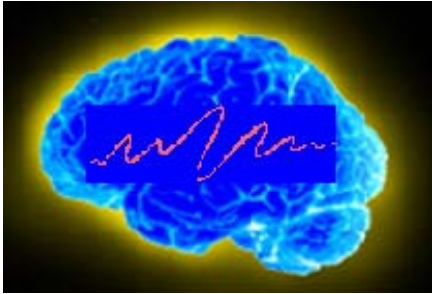
**- the education community**

**(policy-makers, teachers, researchers, students, parents...)**

**...on international level...**

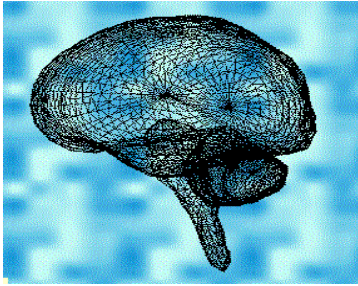
**...in order to reply to questions ...**

- of technical and scientific nature**
- of social and economic nature**
- of ethical and political nature**

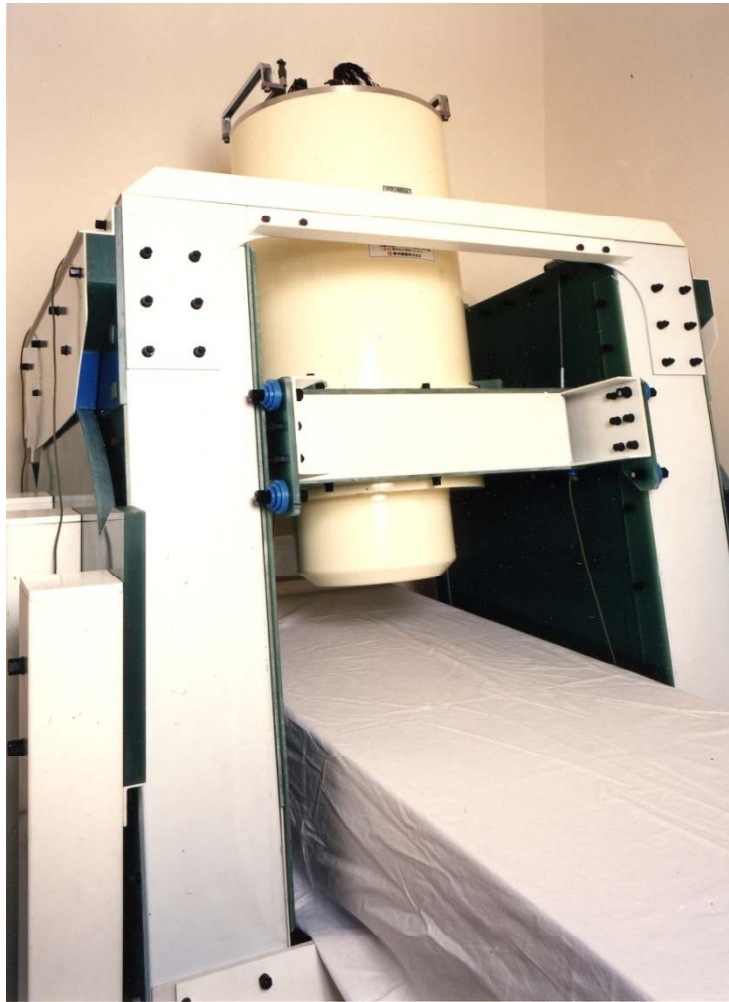


# WHY THEN ?

- Impact of brain imaging technologies:  
new discoveries with educational implications
- Crucial notions of
  - brain plasticity and
  - brain “periodicity” (sensitive periods)



# Magneto-encephalography: MEG

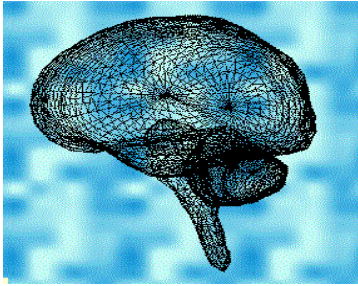


Using SQUID

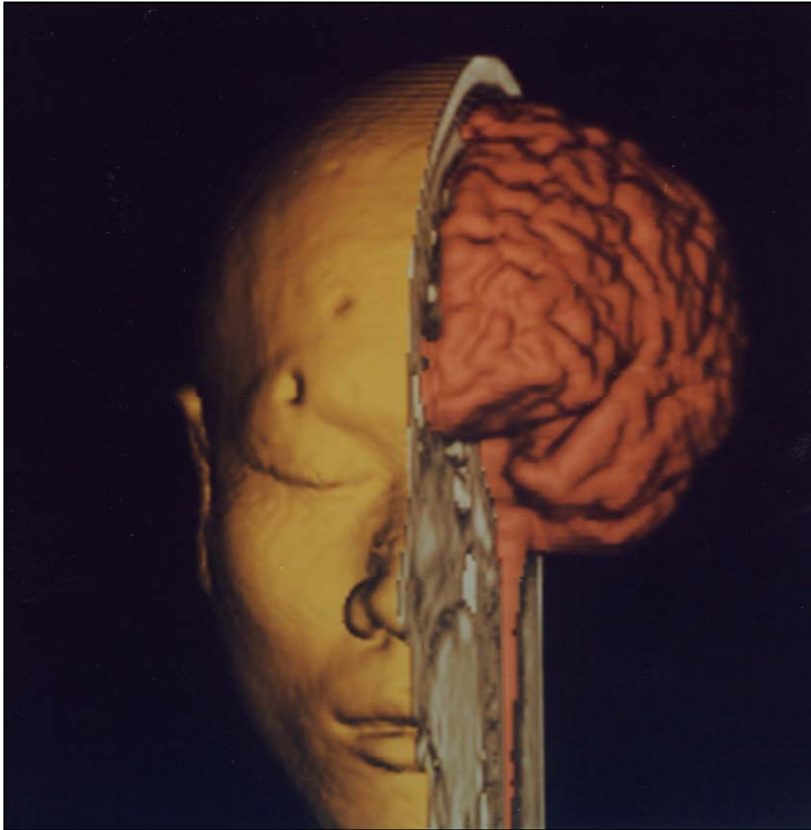
Super-conducting QUantum Interference Device

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

Prototype MEG, Hitachi CRL (1990) - courtesy of Hitachi Advanced Research Laboratory

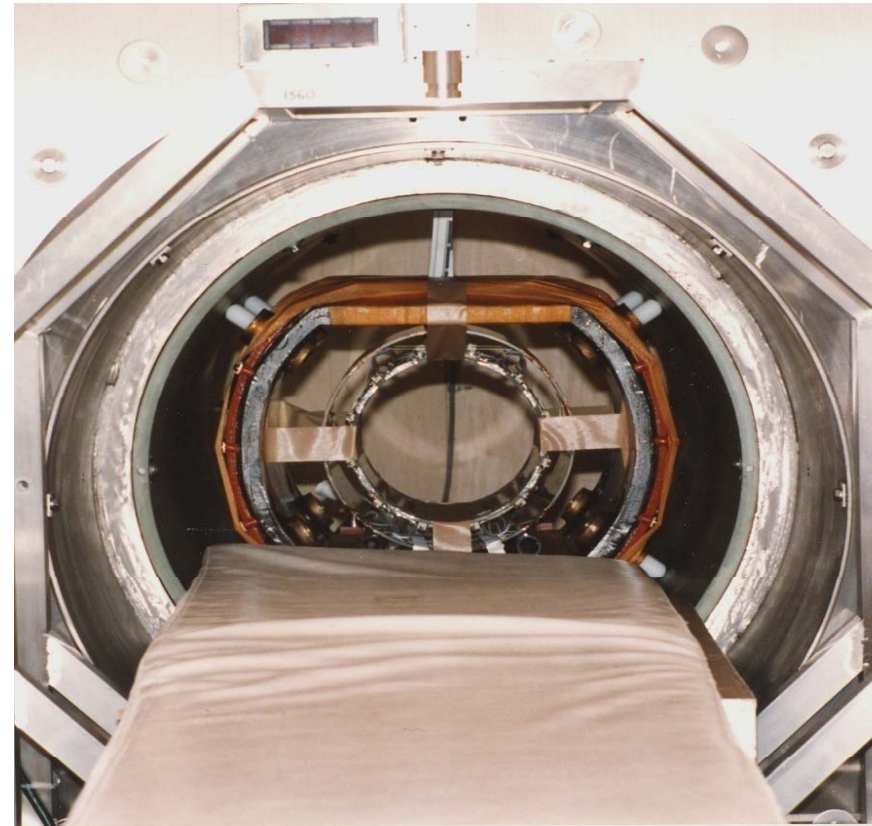


# Functional Magnetic Resonance Imaging: fMRI



3D anatomical image

Hitachi SDL (1990)

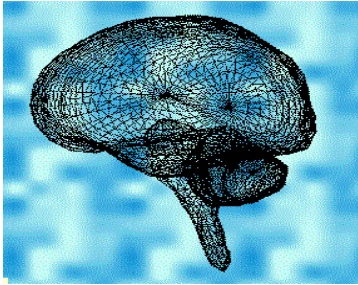


EPI-fMRI (magnetic field : 2T)

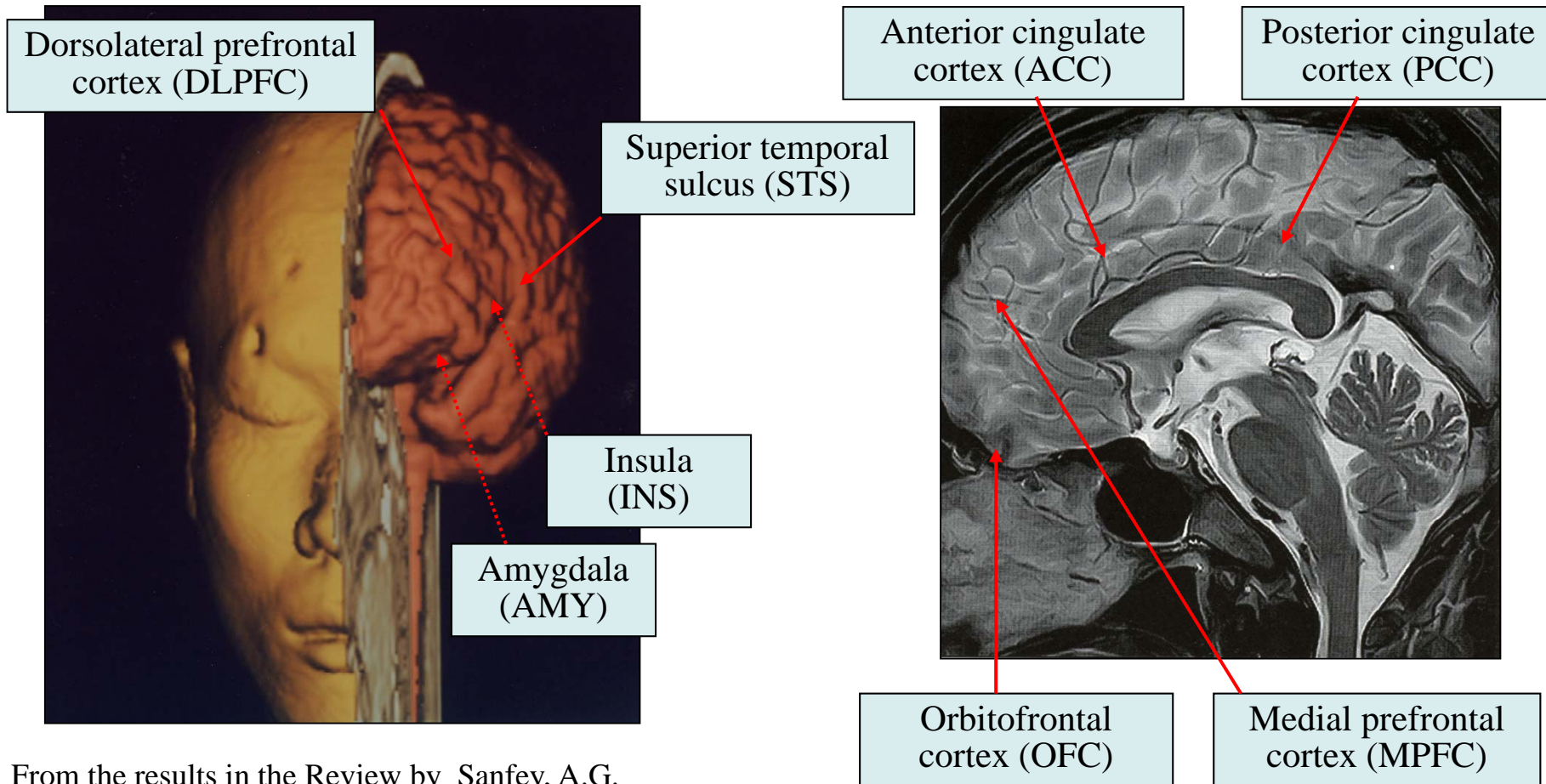
Hitachi CRL (1992)

Courtesy of Hitachi Advanced Research Laboratory

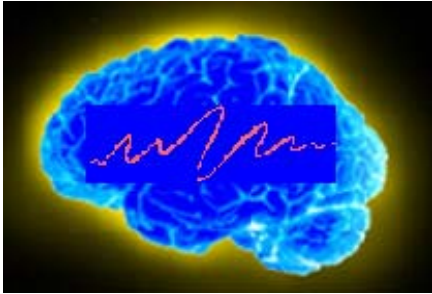




## Brain areas activated in social decision-making



From the results in the Review by Sanfey, A.G.  
“Social Decision -Making: Insights from Game  
Theory and Neuroscience, Science (2007)

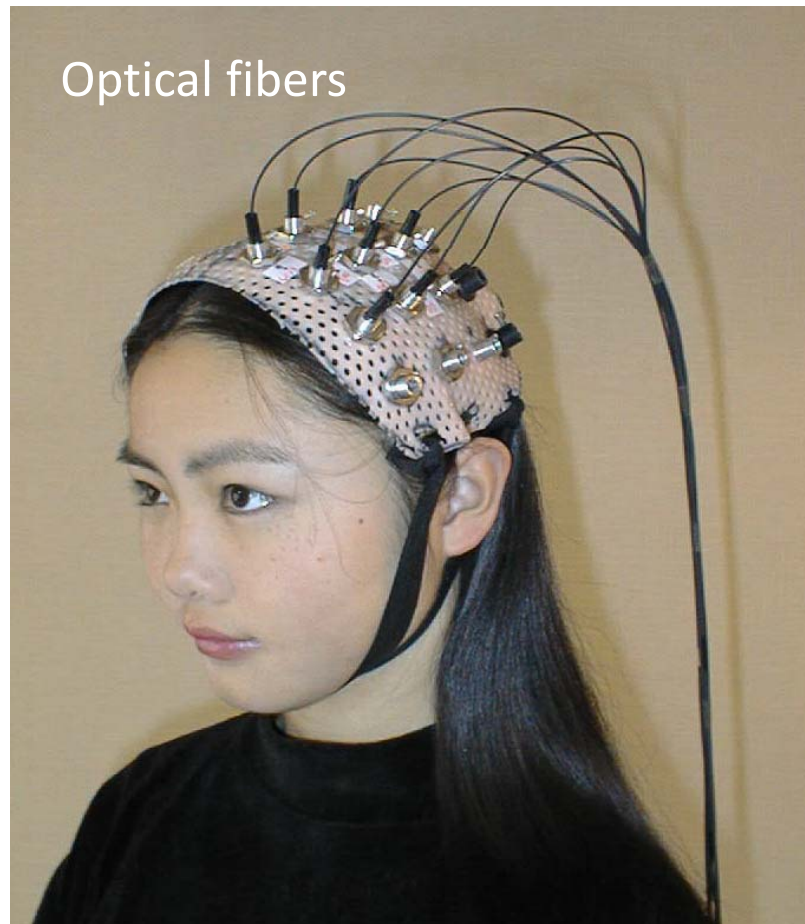


# WHY NOW ?

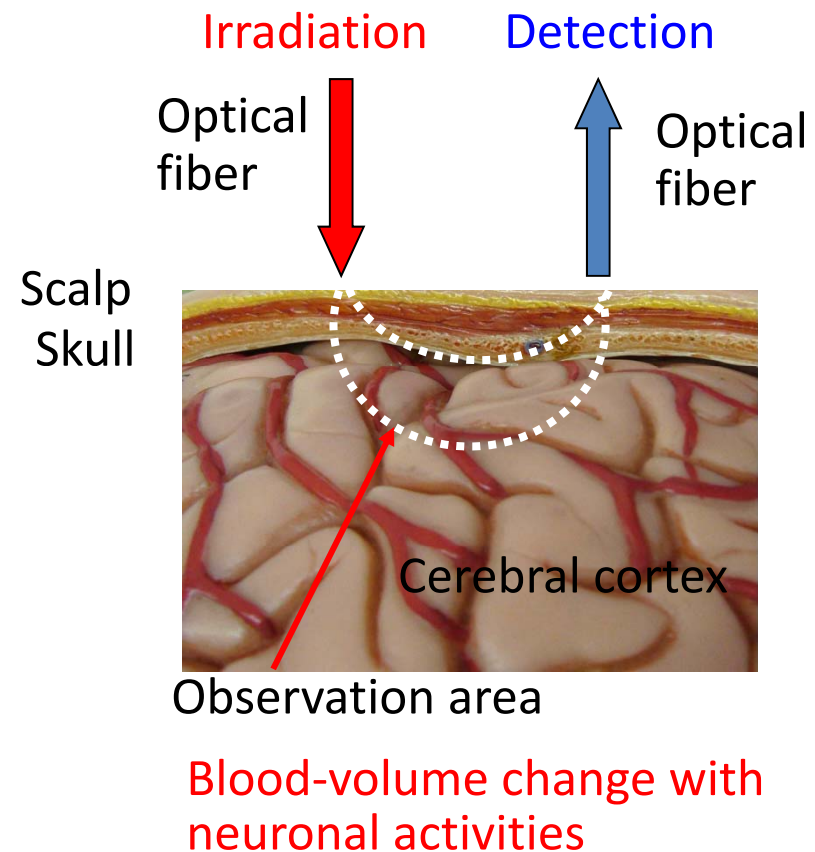
- More impact of brain imaging technologies:  
yet other discoveries with educational implications
- Better understanding of
  - emotions in the brain
  - higher-order functions



# Near infrared optical topography: NIR-OT



Anyone, Anytime, Anywhere



Maki, A. et al. (Koizumi, H.) *Med. Phys.* (1995)

Yamashita, Y. et al. (Koizumi, H.) *Rev. Sci. Instrum.* (1996)

Courtesy of Hitachi Advanced Research Laboratory



# Wearable Optical Topography – WOT (prototype)

Head-mount unit



Calculation task



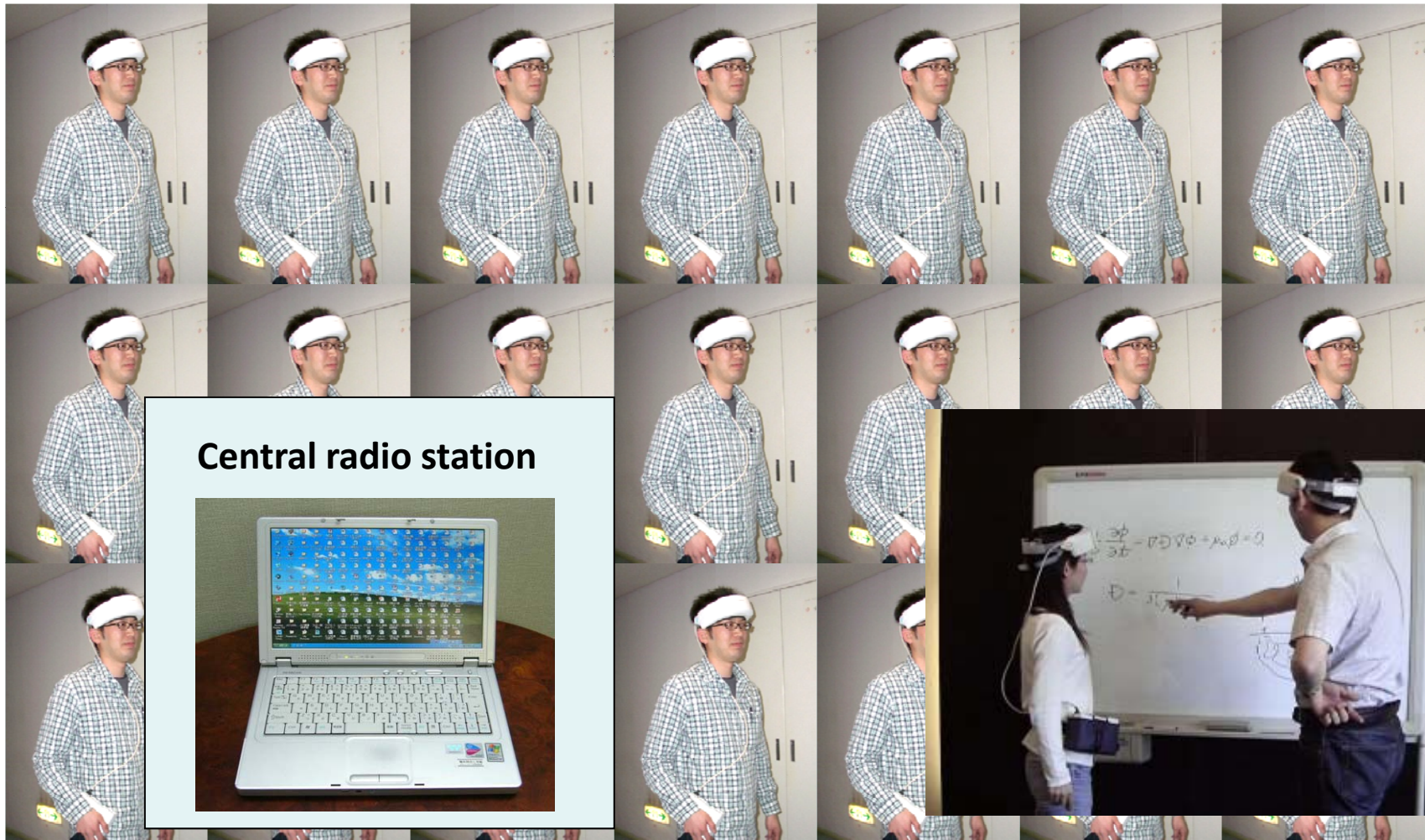
**Total weight: 1 kg (including a battery for 4 hours operation)**

Processing & control unit

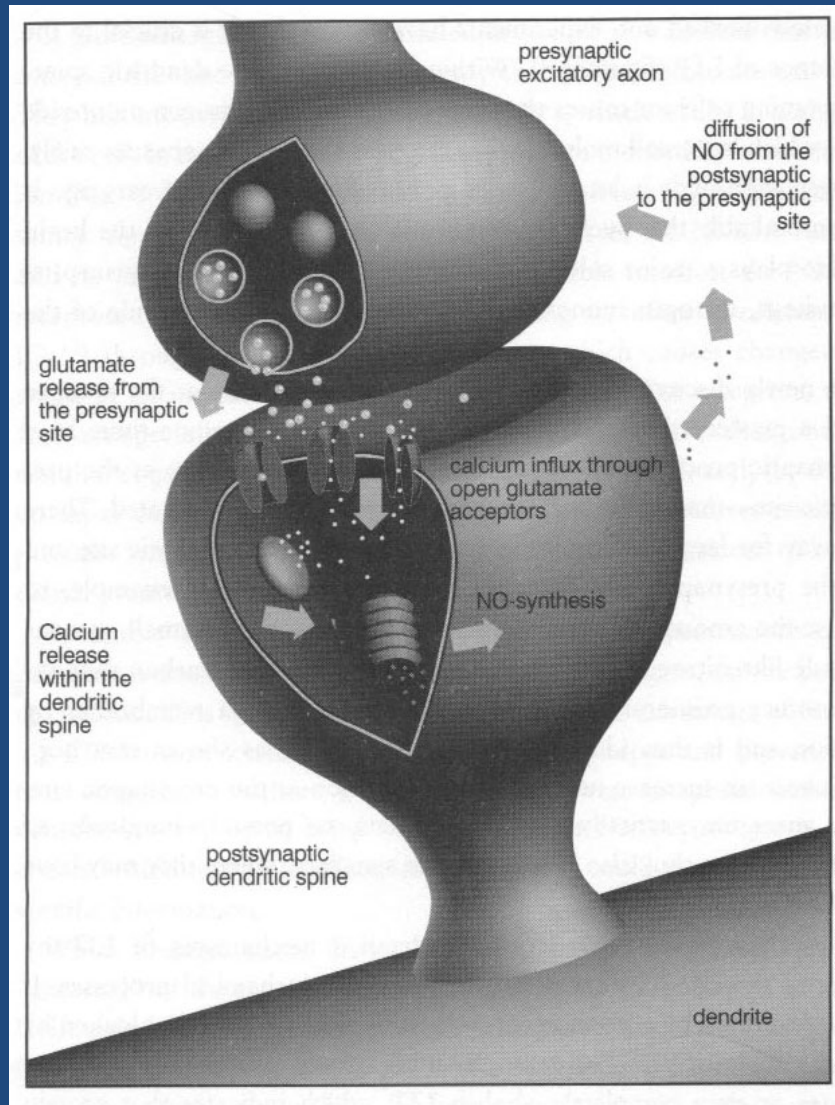
Courtesy of Hitachi Advanced Research Laboratory



# Exploring brain activity in daily life



Courtesy of Hitachi Advanced Research Laboratory



Kandel's hypothesis:

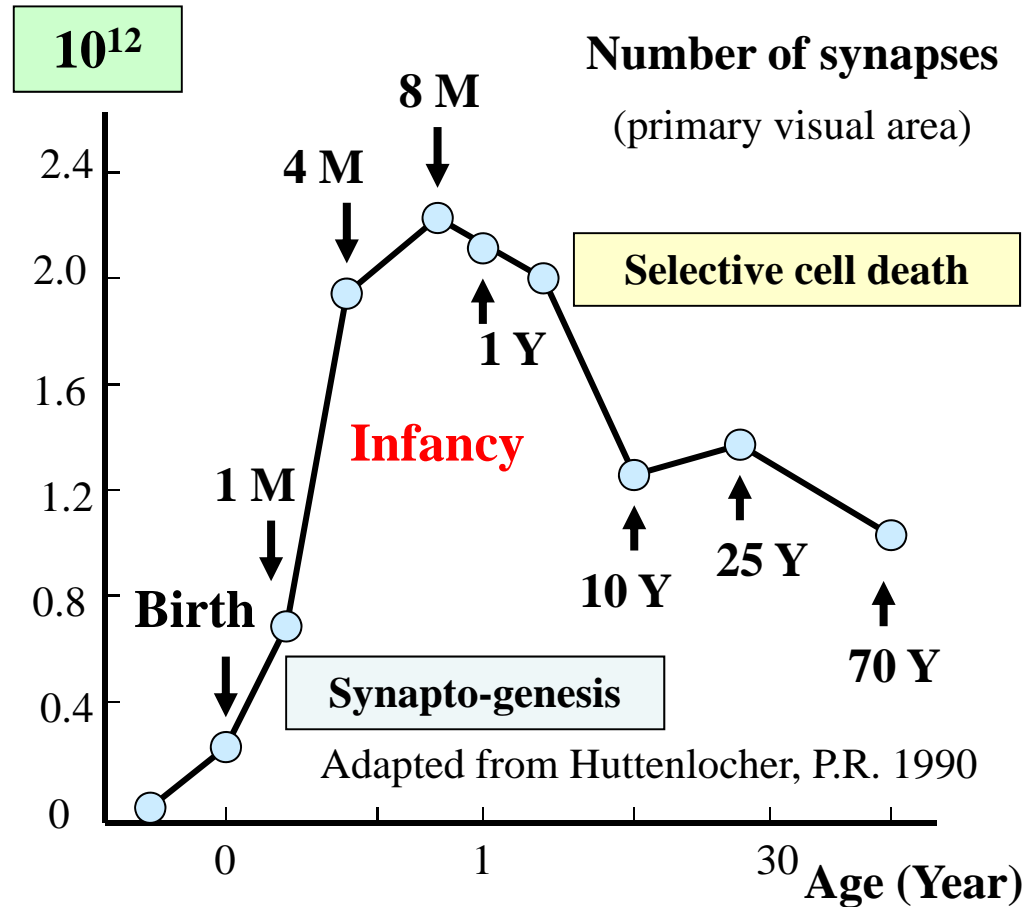
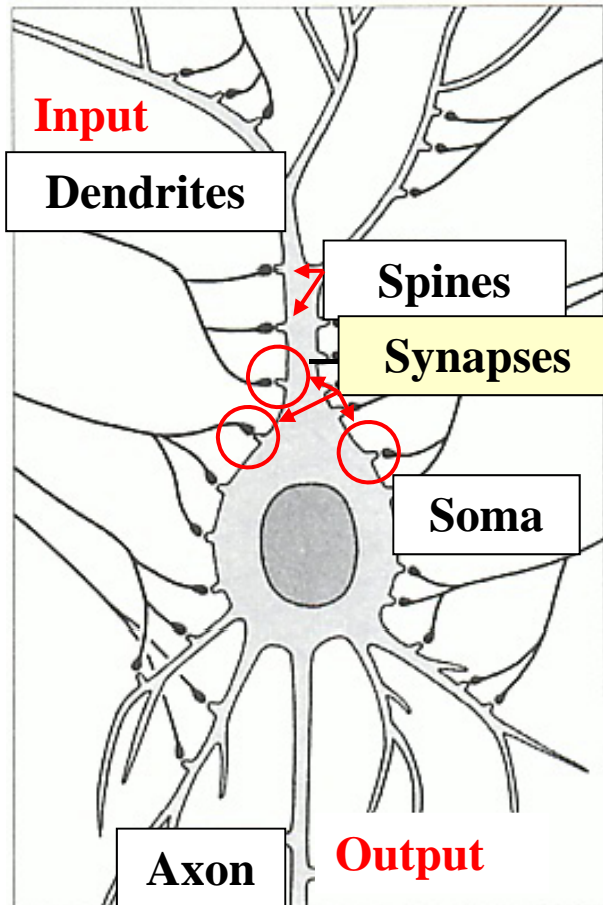
*“synaptic changes parallel behavioral changes”*

Source: Manfred Spitzer: The Mind Within The Net, 1999 MIT Press, p. 48



# Formation and elimination of synapses

Presence of input signals makes neuronal connection



Mikoshiba K, Kubata K, *Brain Book 21*  
 (Koizumi H, ed.), Kosakusha (2001)  
 Courtesy of H. Koizumi



Source: Mike Posner & Marcus Raichle: Images of Mind, Scientific American Library, 1997, p. 152



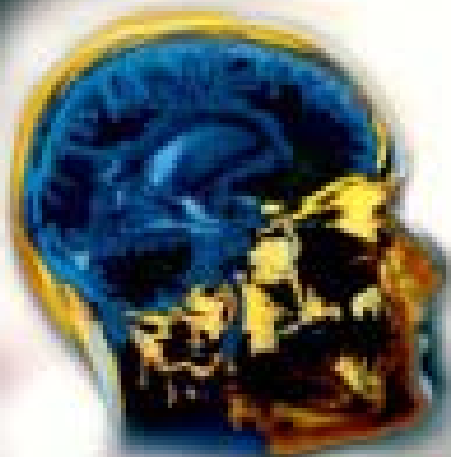


# Neuromyths to be dispelled...

- **“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...**

**Understanding  
the Brain: The Birth  
of a Learning Science**



**CERI**

**Published 2007**

**Available in:**

- Arabic**
- Chinese**
- English**
- French**
- Japanese**
- Serbian**
- Spanish**

...and a follow-up...

# Languages in a Global World

LEARNING FOR BETTER CULTURAL UNDERSTANDING



Published 24 April 2012

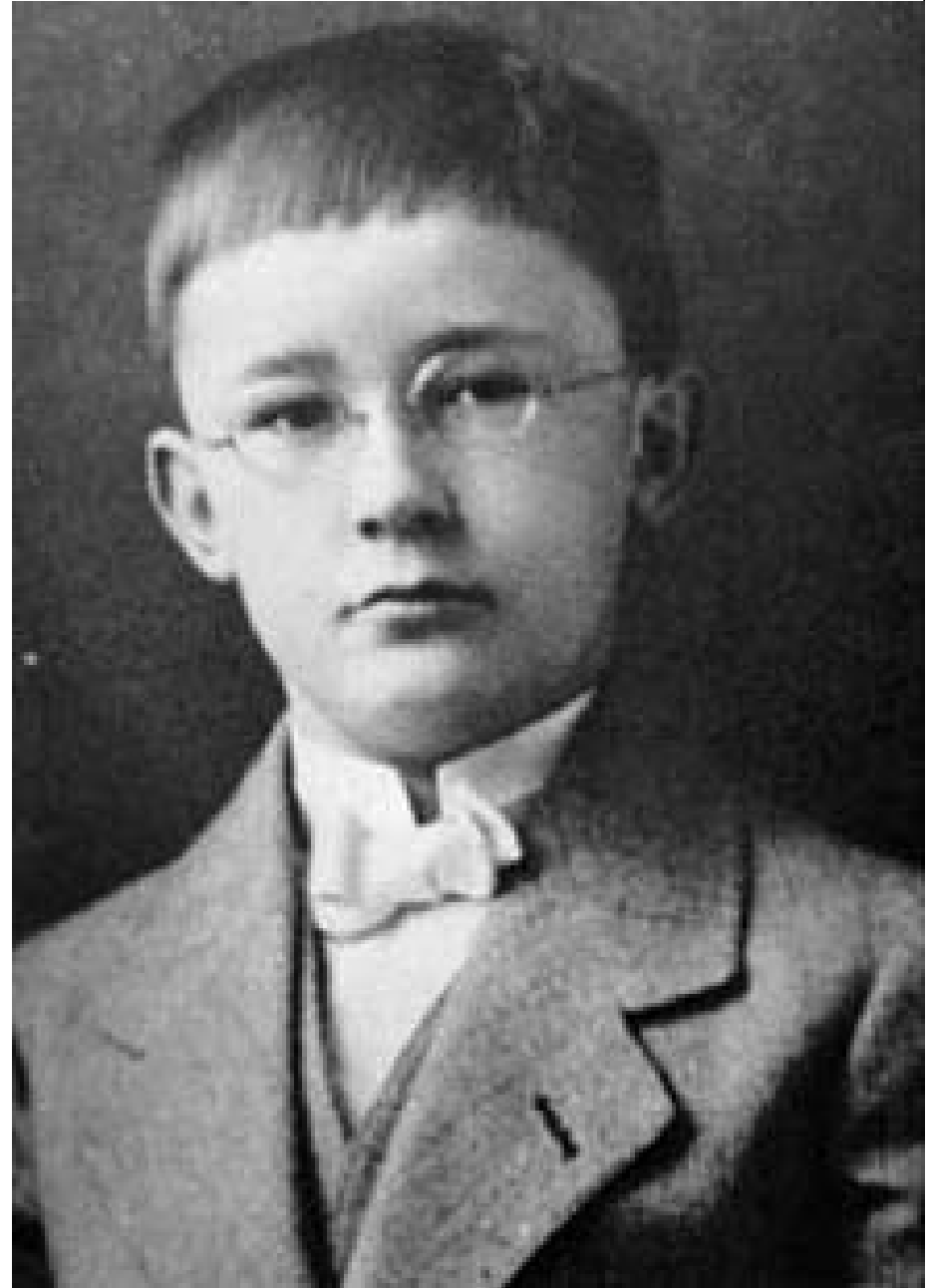
B. della Chiesa, J. Scott and C. Hinton (eds.) (2012)  
*Languages in a Global World: Learning for Better Cultural Understanding*, 460 pages.  
OECD Publishing. <http://dx.doi.org/10.1787/9789264123557-en>



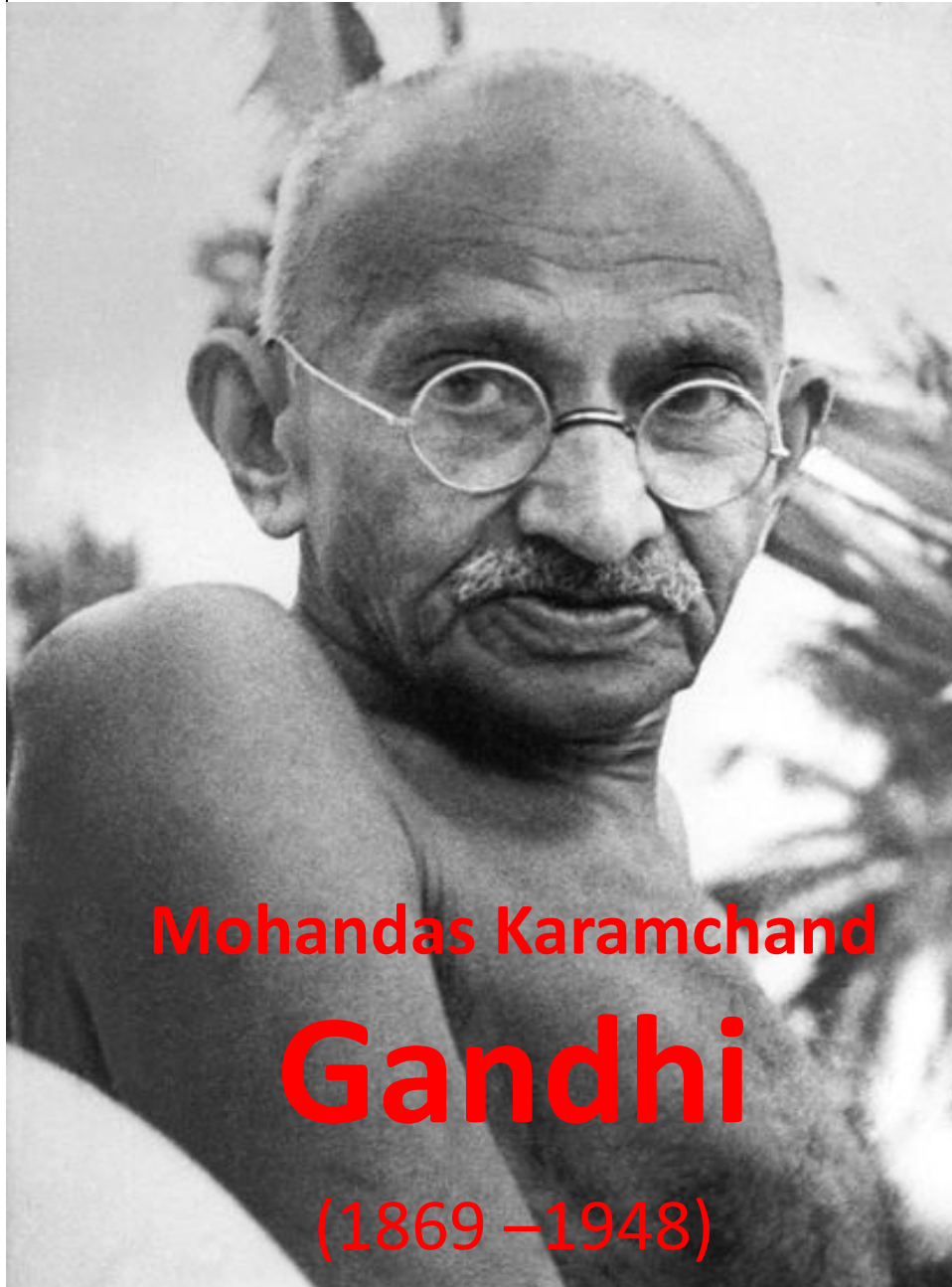
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## TWO KIDS: ETHICS IN THE BRAIN, NATURE, NURTURE, OR BOTH?



## TWO INDIVIDUALS AT THE EXTREMES OF AN ETHICAL SCALE





# Questions...

- Are human beings *born unequal* when it comes to ethics?
- Or are ethical standards *acquired*?
- Or both: nature *and* nurture?  
(genetics vs. socialization?)



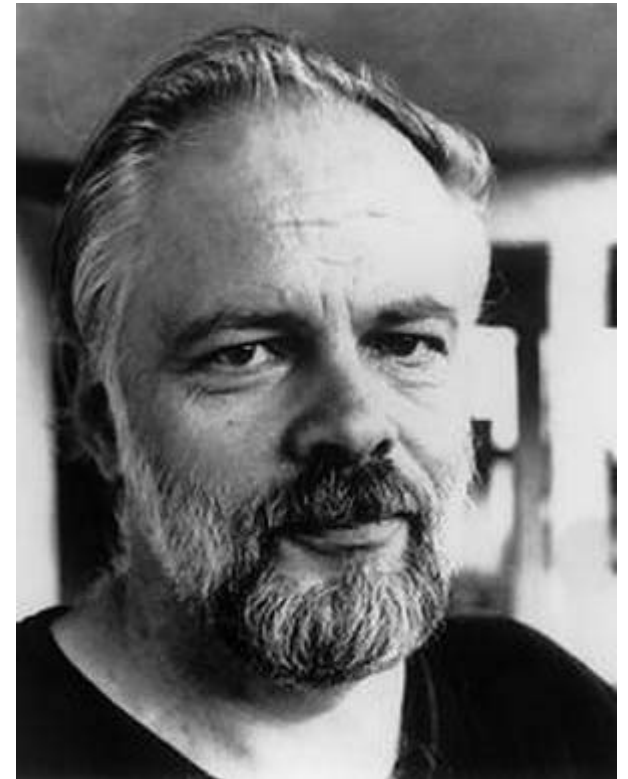
# **Biological mechanisms of ethics soon discovered in the brain?!**

- **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:**

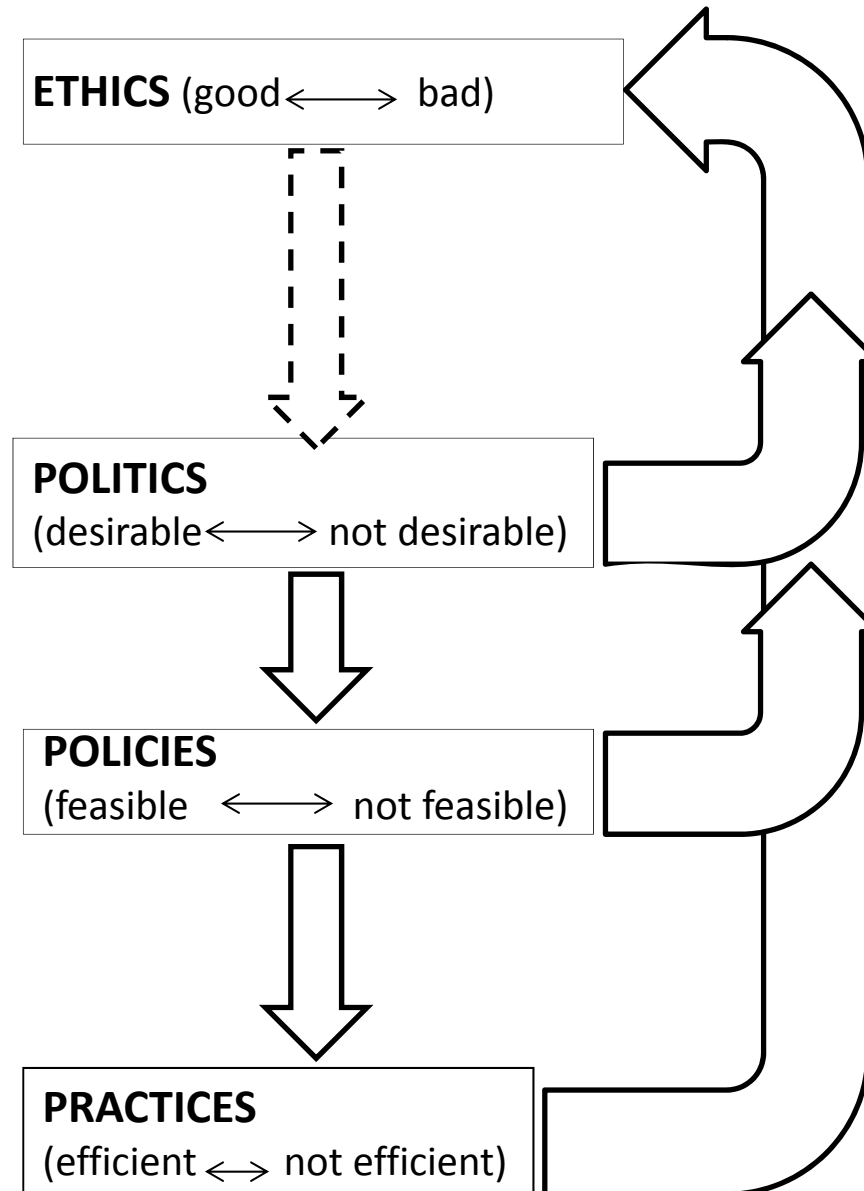
- 1. It is “nature” (genetics: we are pre-programmed by our genes);**
- 2. It is “nurture” (acquired: through environment, particularly education); or**
- 3. It is a combination of both** (probable majority for this on experts' side; cf. Dynamic Skill Theory's bio-psycho-social model of human development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

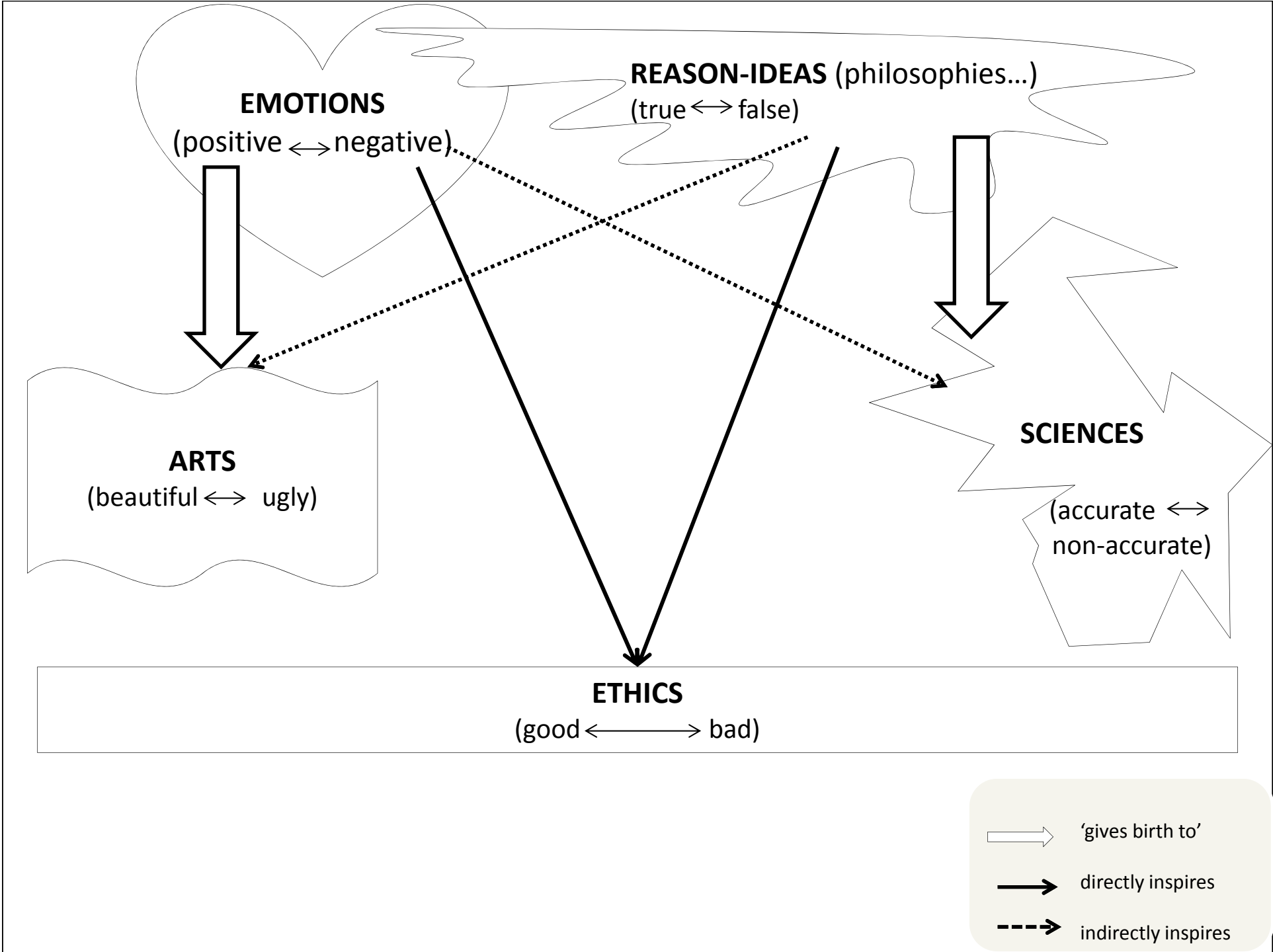
- **3<sup>rd</sup> explanation probably not to please the media: too complex/complicated  
(Scylla or Charybdis...)**
- **2 first ones simple (univocal), easy to understand and to convey**
- **Mass media not equipped to deal with complexity (scientific or not)...**  
(cf. Bourdieu, 1996; Chomsky, 1989; della Chiesa, 1989, 1993, 2008)

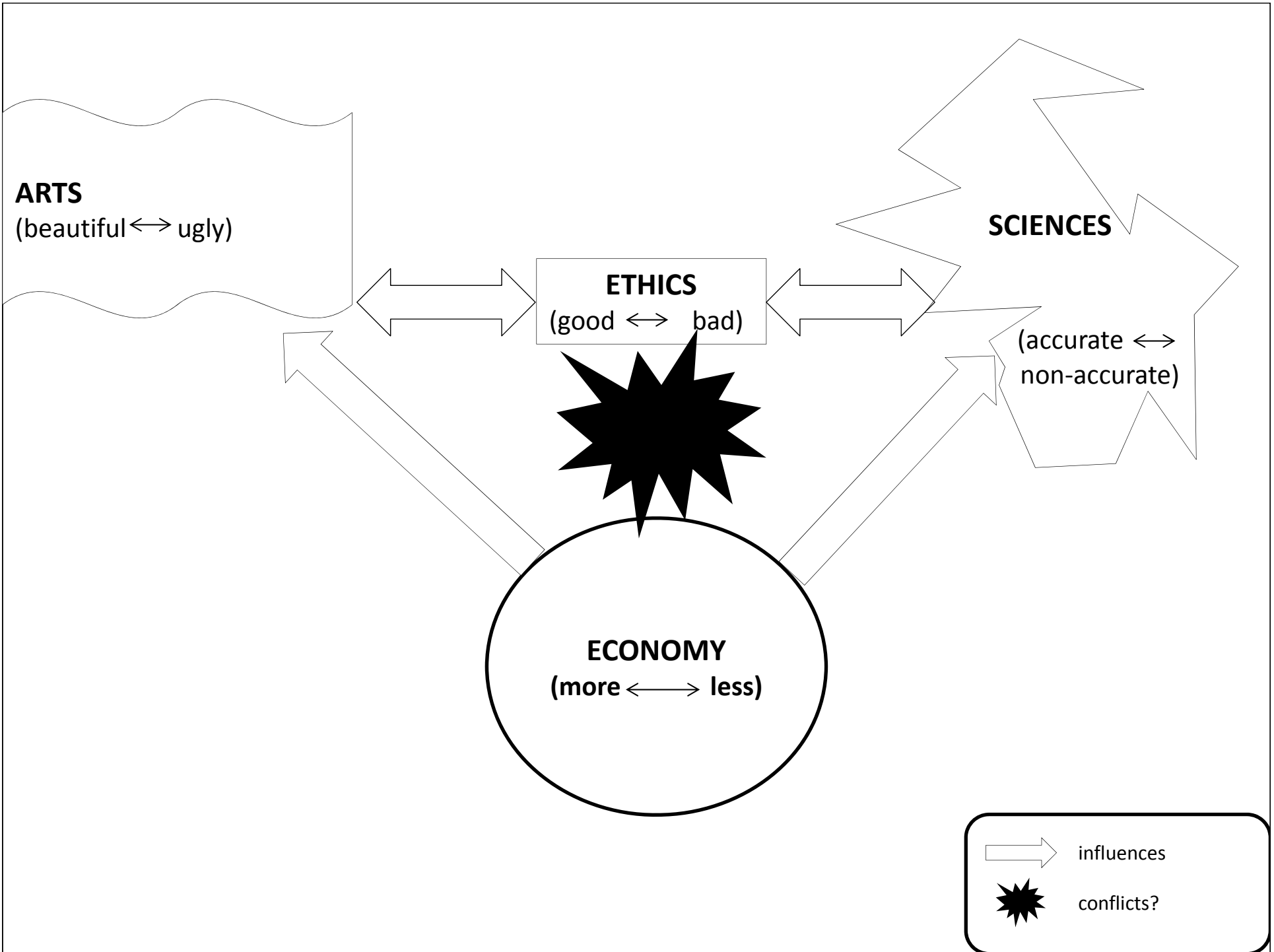
*The hardest challenge for our (democratic) societies in the 21<sup>st</sup> century?*

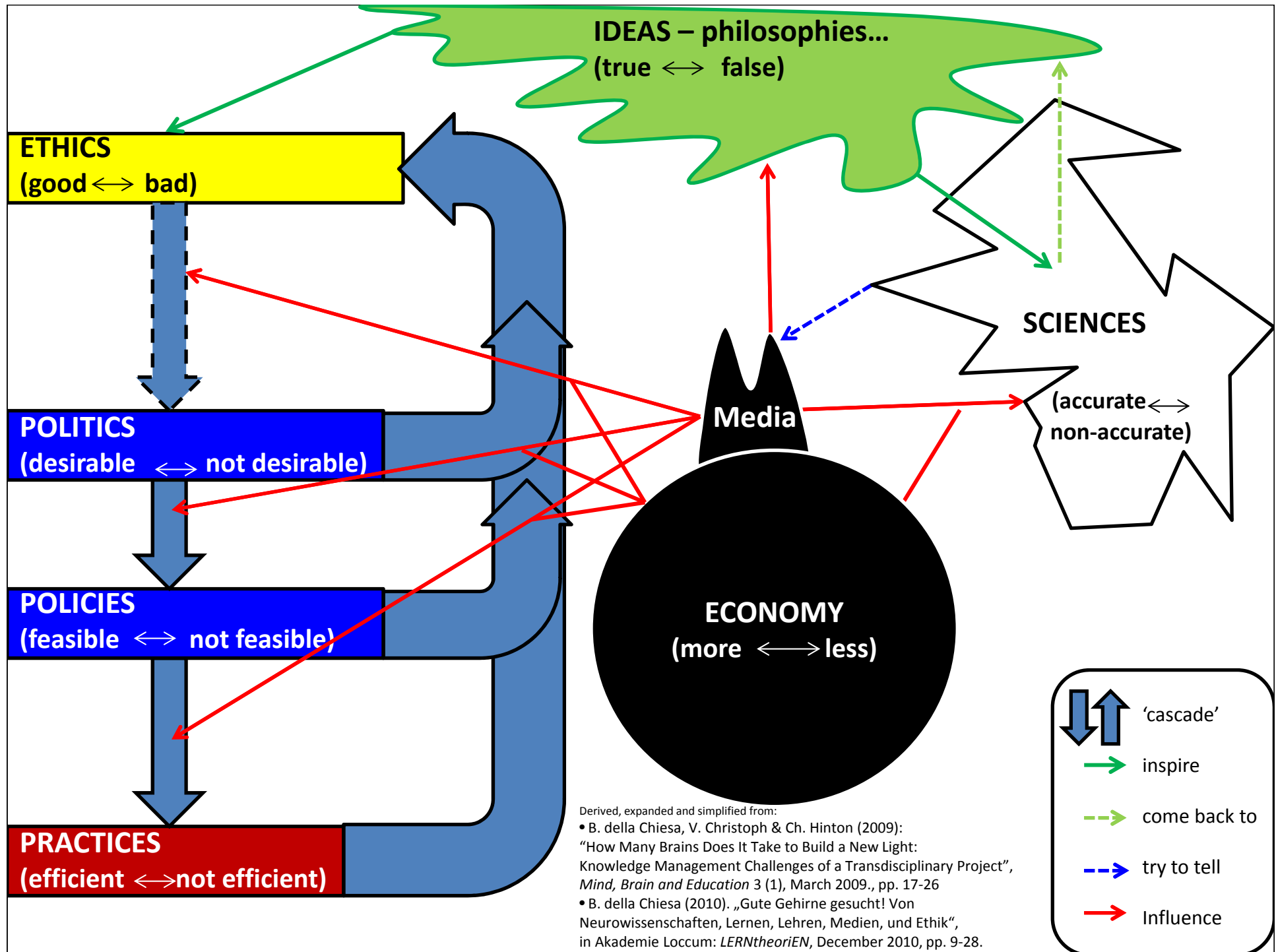


# Of ethics, politics, policies, practices, sciences, and more...









After one  
look  
at this planet  
any visitor  
from  
outer space  
would say:  
"I want to  
see  
the  
manager!"

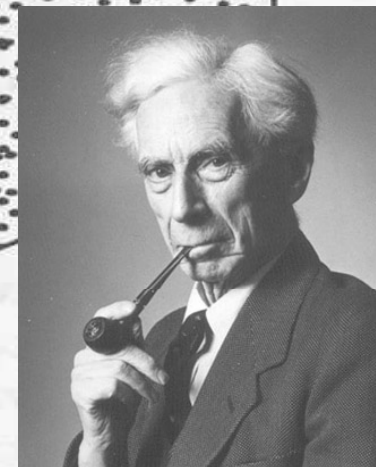


**William S.  
Burroughs  
(1914-1997)**



**I shouldn't wish people  
dogmatically to believe  
any philosophy,  
not even mine.**

Bertrand Russell  
(1872-1970)







**Bedankt!**

[bruno\\_della\\_chiesa@gse.harvard.edu](mailto:bruno_della_chiesa@gse.harvard.edu)

[bruno.della-chiesa@oecd.org](mailto:bruno.della-chiesa@oecd.org)

The image features a central, glowing brain with a pinkish-purple hue, set against a dark blue background with a subtle grid pattern. The brain is surrounded by a bright, circular glow. Overlaid on this scene is the text "LET'S BRAIN-STORM!" in a bold, red, sans-serif font, slanted diagonally from the bottom left towards the top right.

**LET'S BRAIN-STORM!**

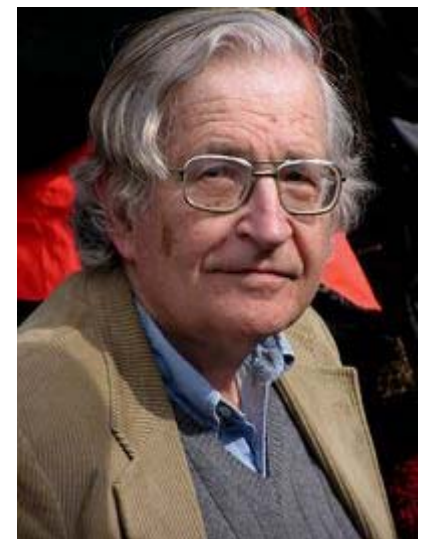


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**“For us, we are all very different; our languages are very different, and our societies are very different. But if we could extract ourselves from our point of view and sort of look down at human life the way a biologist looks at other organisms, 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)**

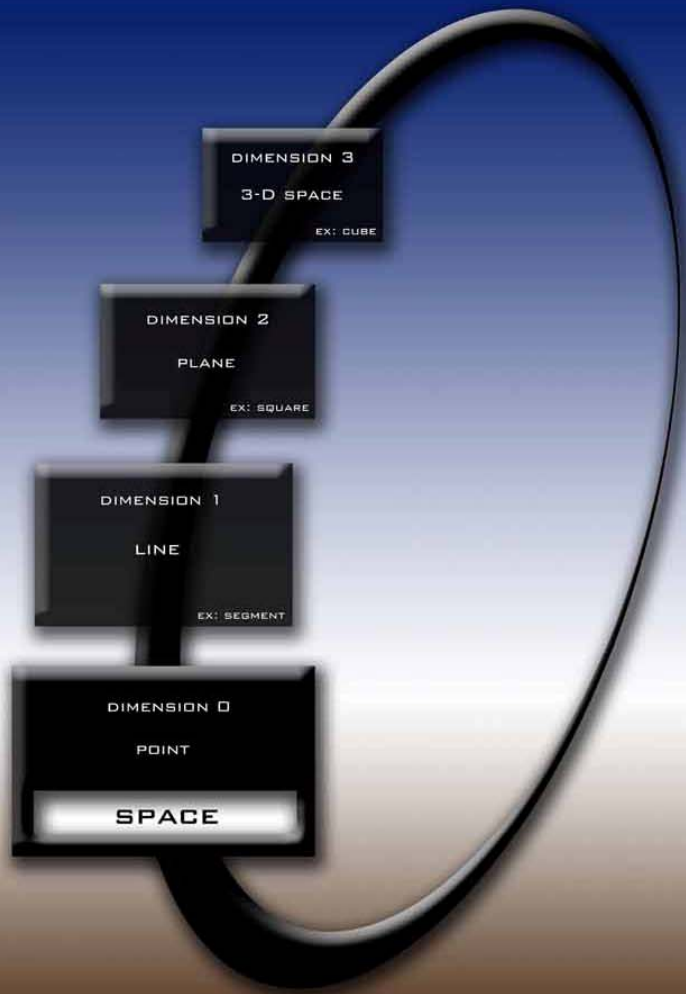


# IN SEARCH OF TESSERACTS IN THE BRAIN

„WER FREMDE SPRACHEN NICHT KENNT,  
WEISS NICHTS VON SEINER EIGENEN.“  
„THOSE WHO DO NOT KNOW OTHER LANGUAGES  
KNOW NOTHING OF THEIR OWN.“  
J.W. V. GOETHE  
MAXIMEN UND REFLEXIONEN II, 1833

„DIE GRENZEN MEINER SPRACHE  
BEDEUTEN DIE GRENZEN MEINER WELT.“  
„THE LIMITS OF MY LANGUAGE  
MEAN THE LIMITS OF MY WORLD.“  
L. WITTGENSTEIN  
TRACTATUS LOGICO-PHILOSOPHICUS, 1921

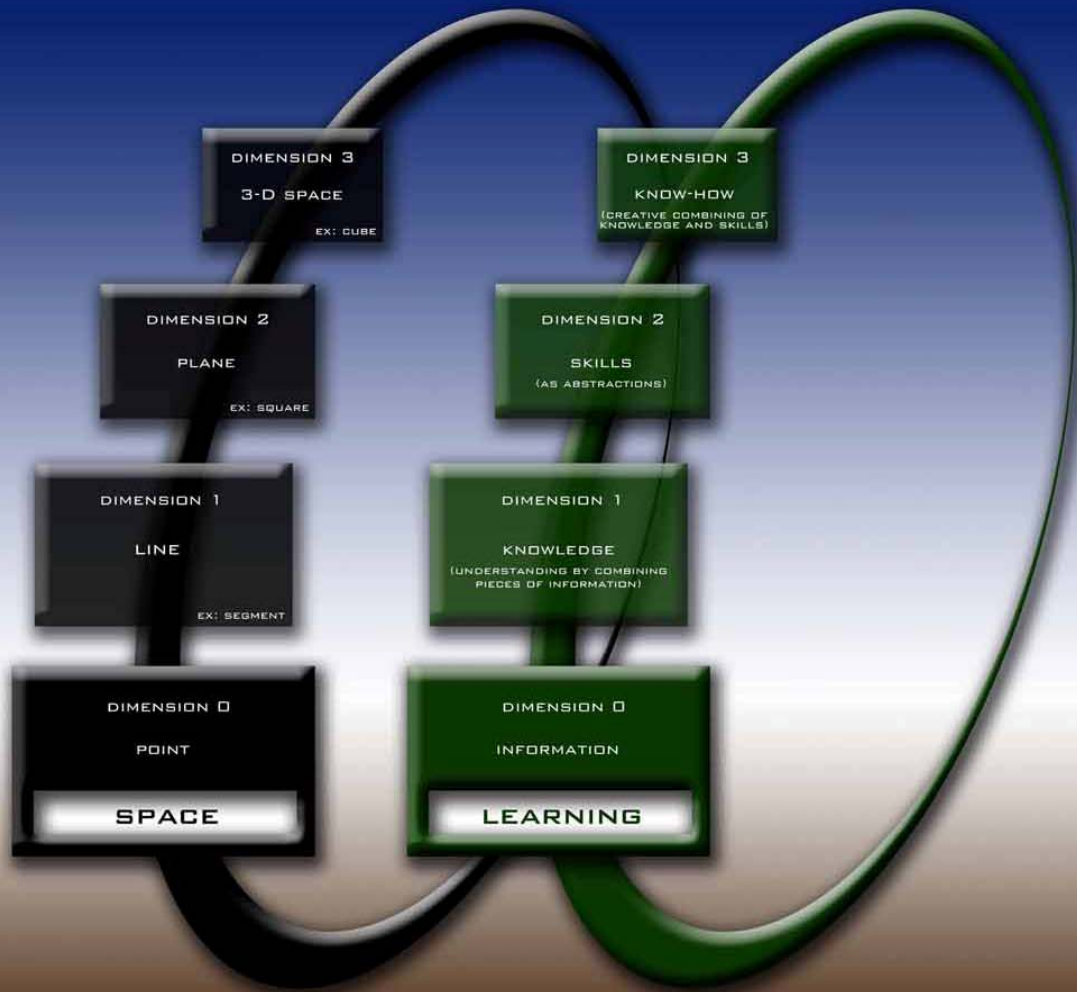
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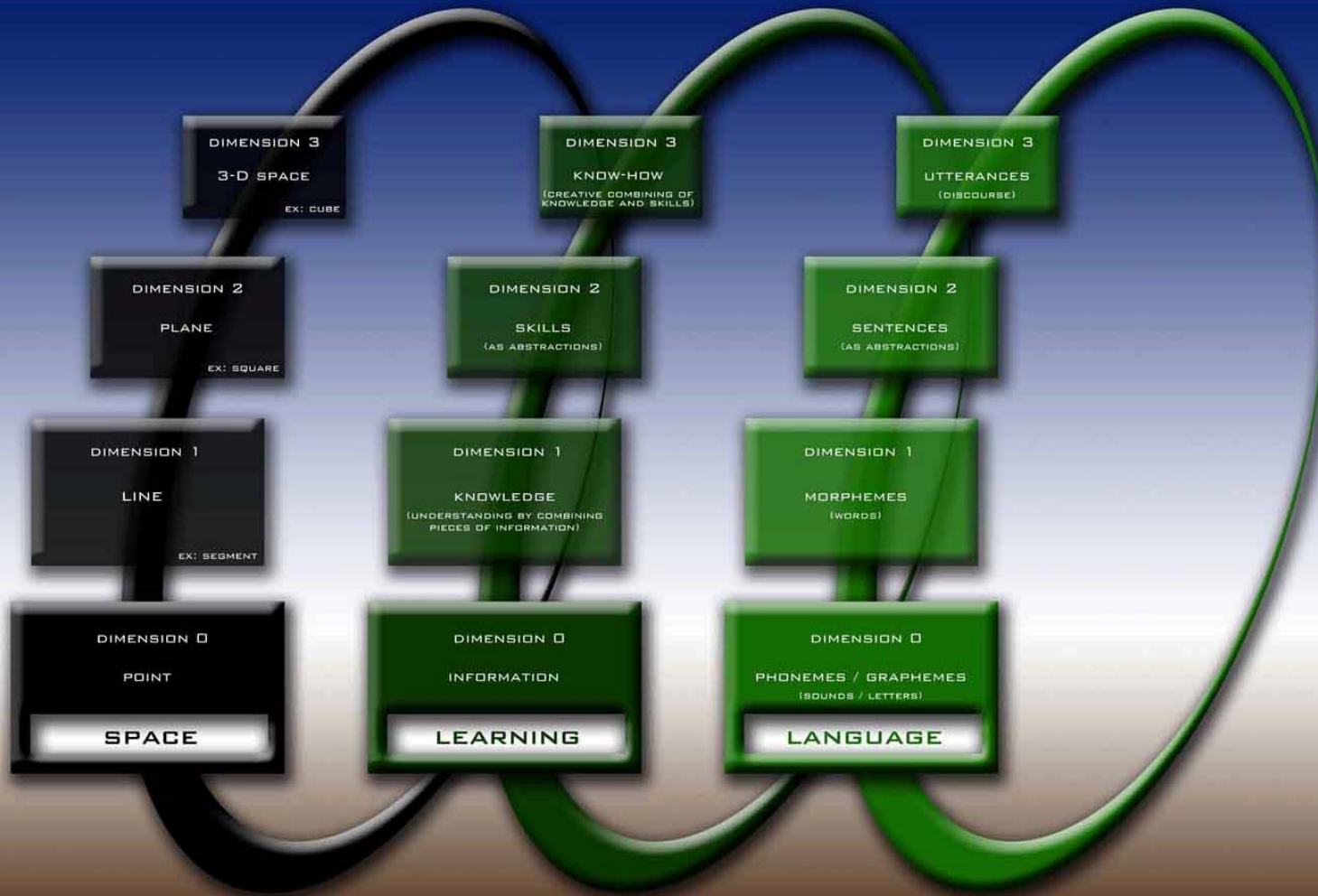
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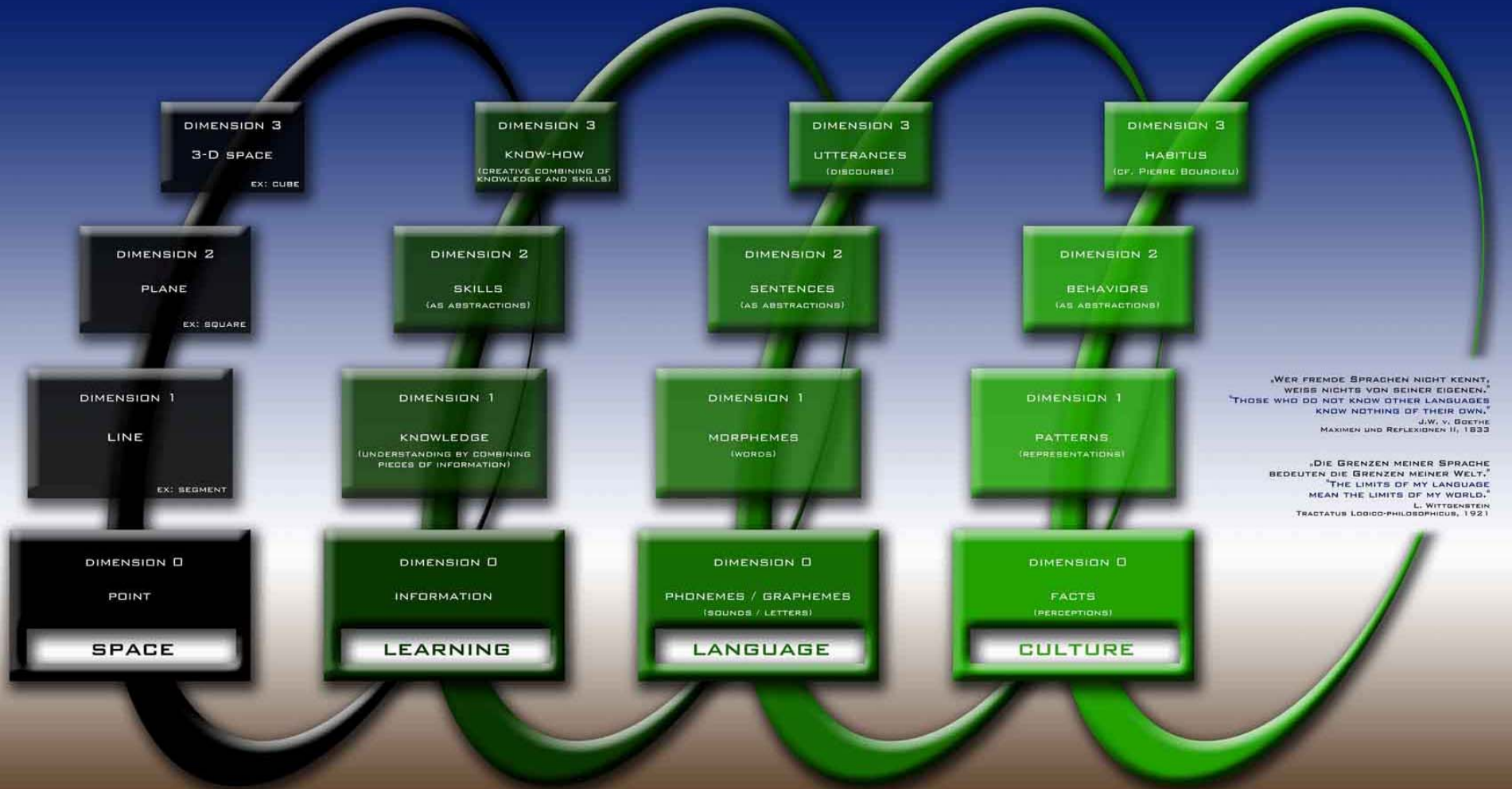


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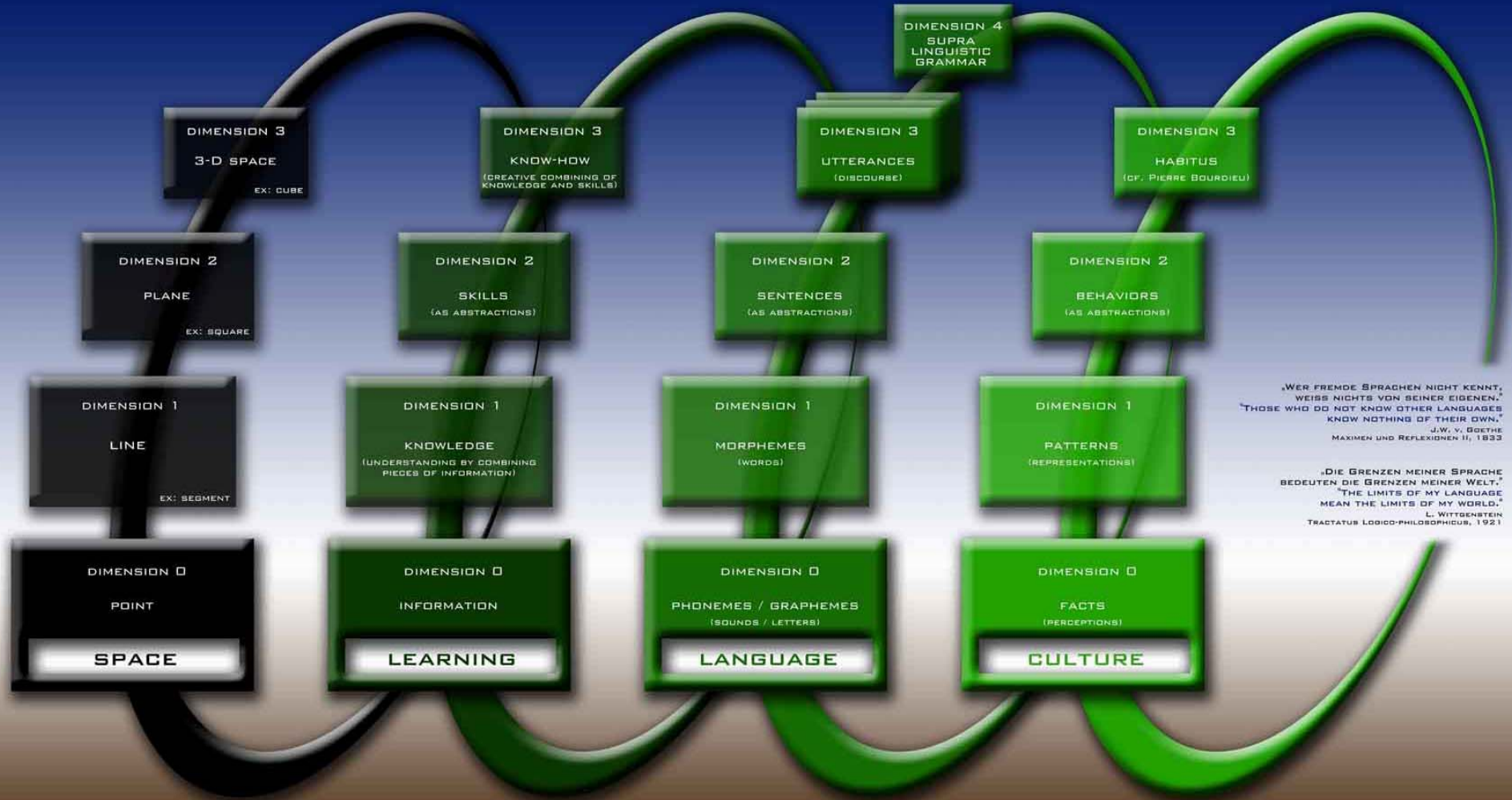
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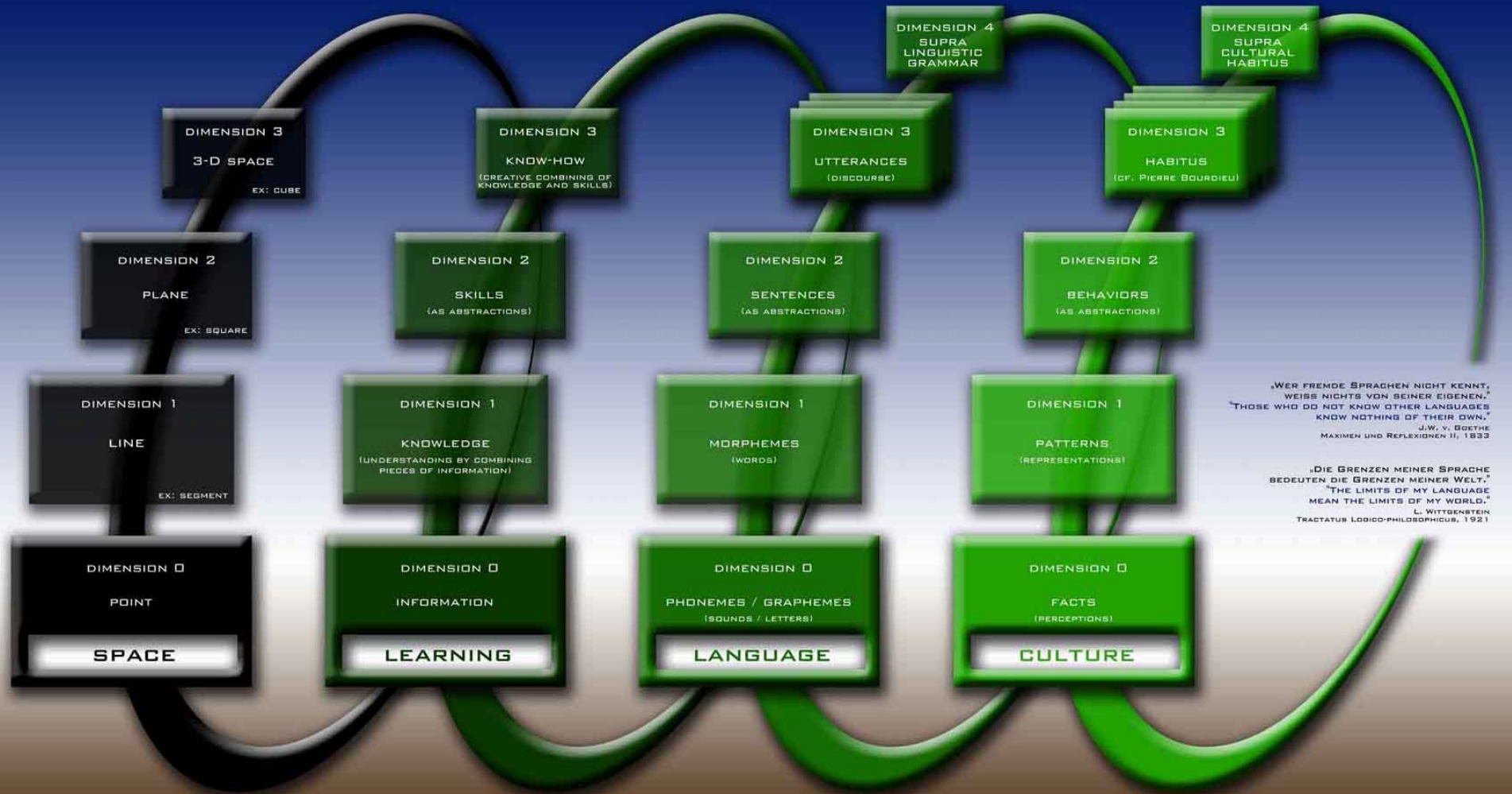
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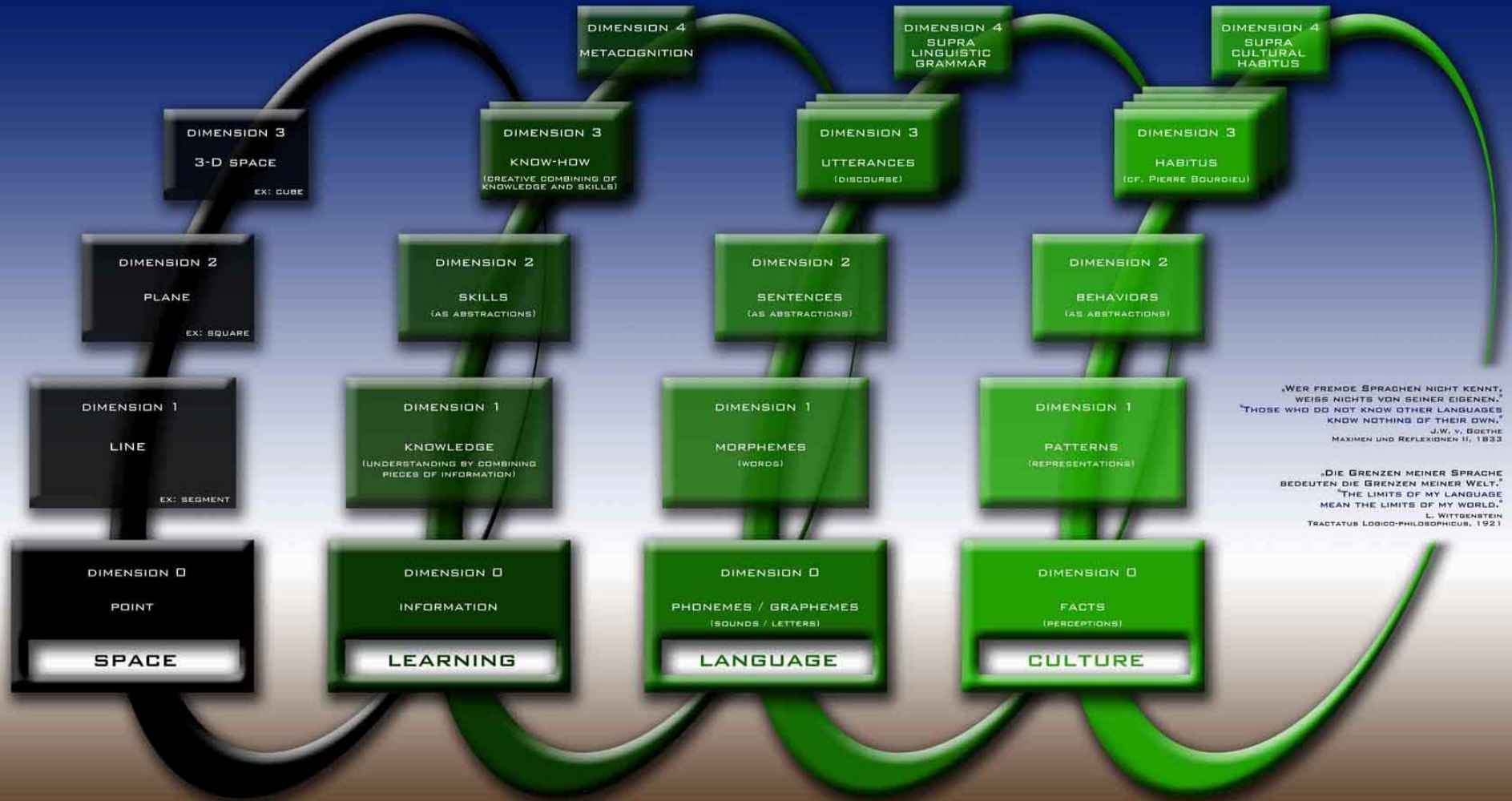
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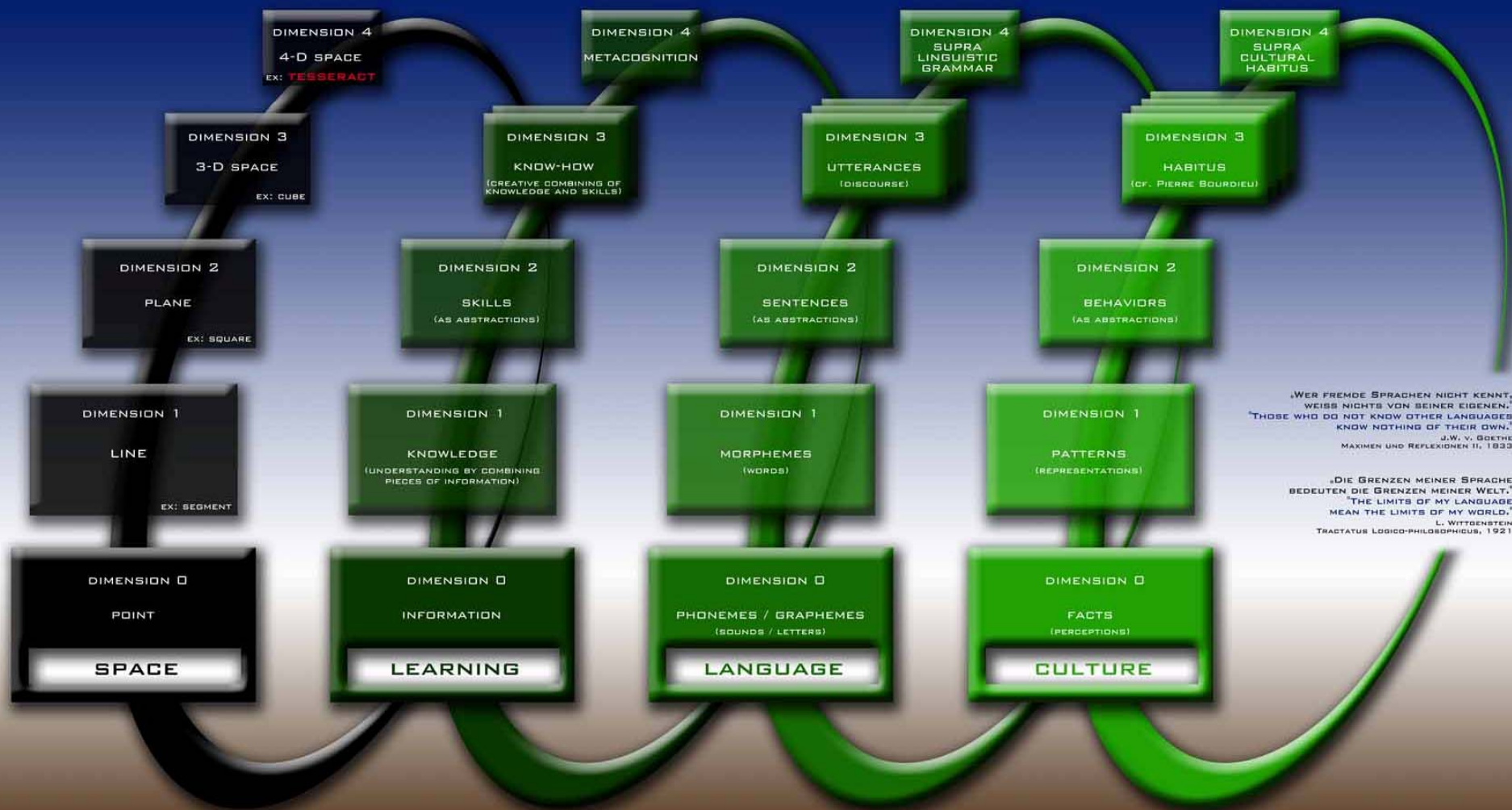
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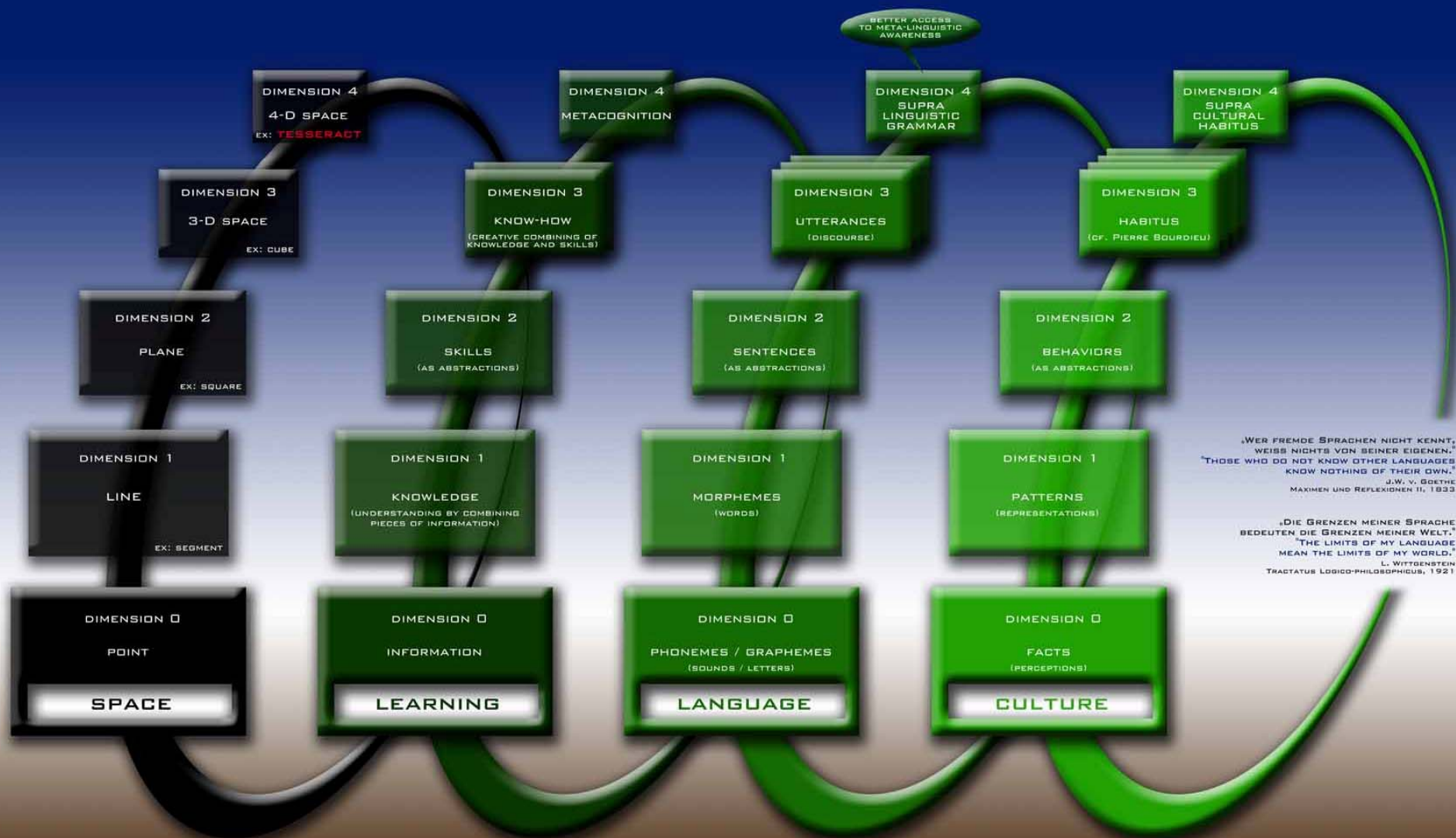
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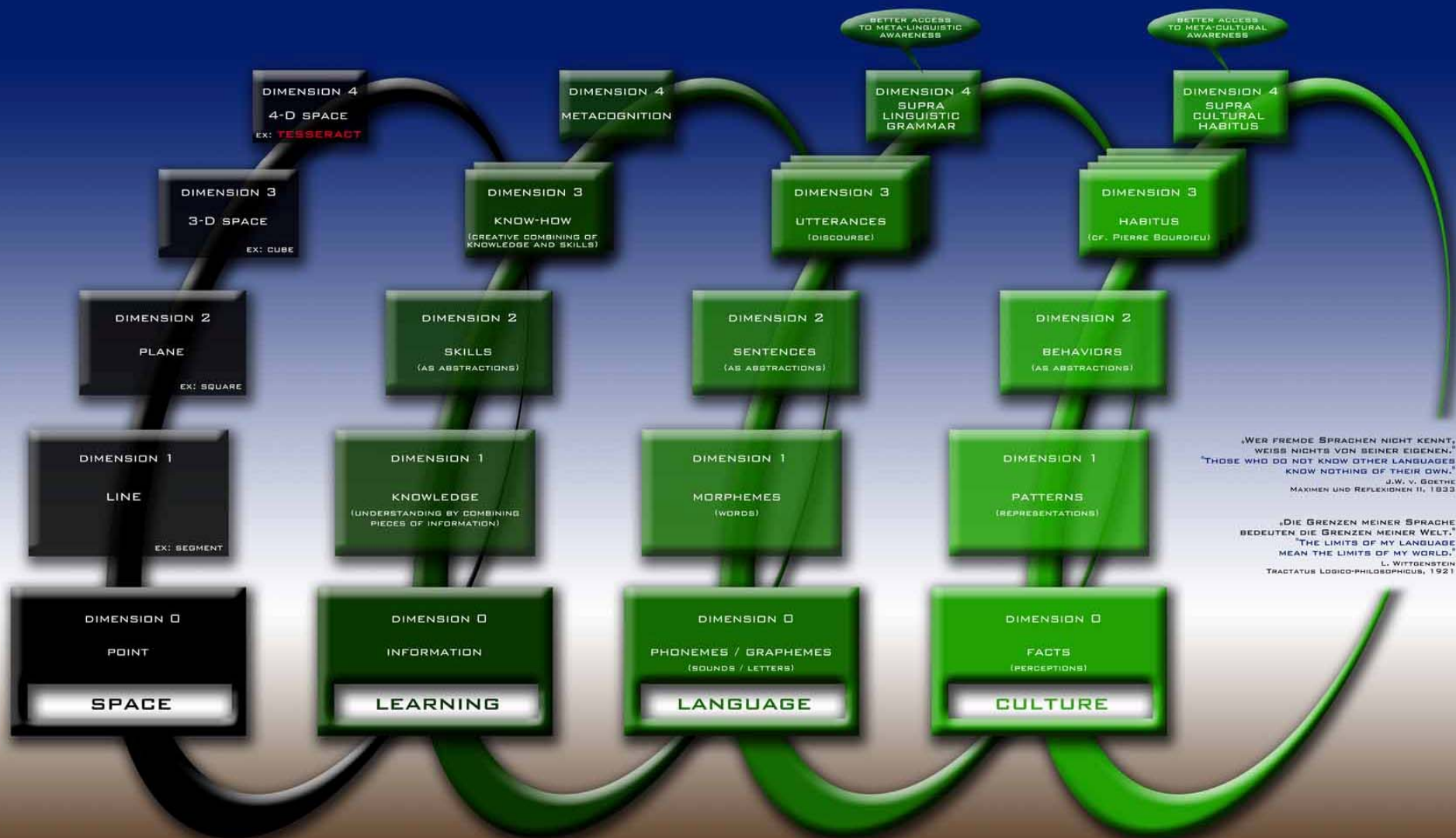
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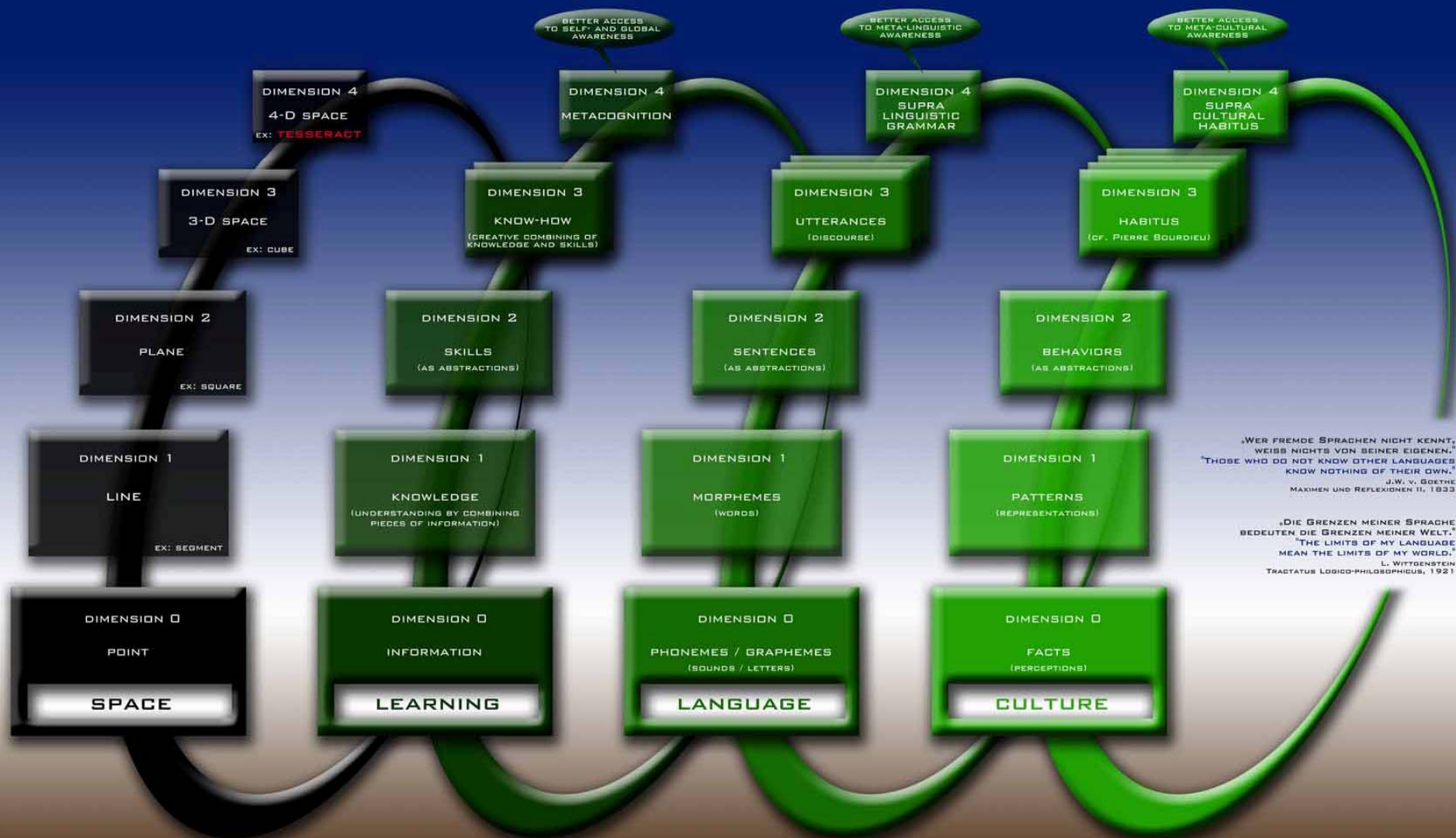
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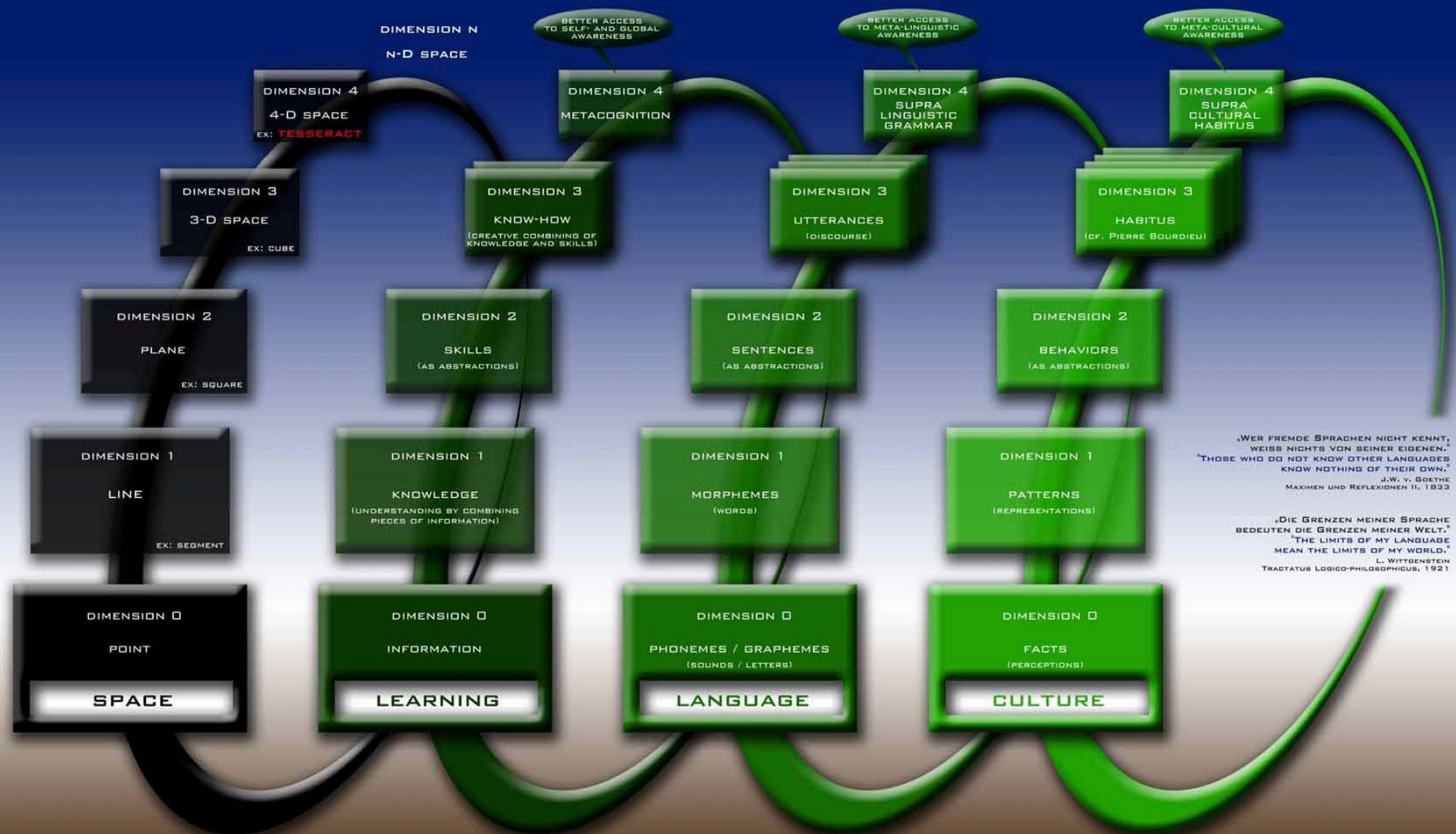


„WER FREMDE SPRACHEN NICHT KENNT,  
WEISS NICHTS VON SEINER EIGENEN.“  
"THOSE WHO DO NOT KNOW OTHER LANGUAGES  
KNOW NOTHING OF THEIR OWN."  
J.W. V. GOETHE  
MAXIMEN UND REFLEXIONEN II, 1833

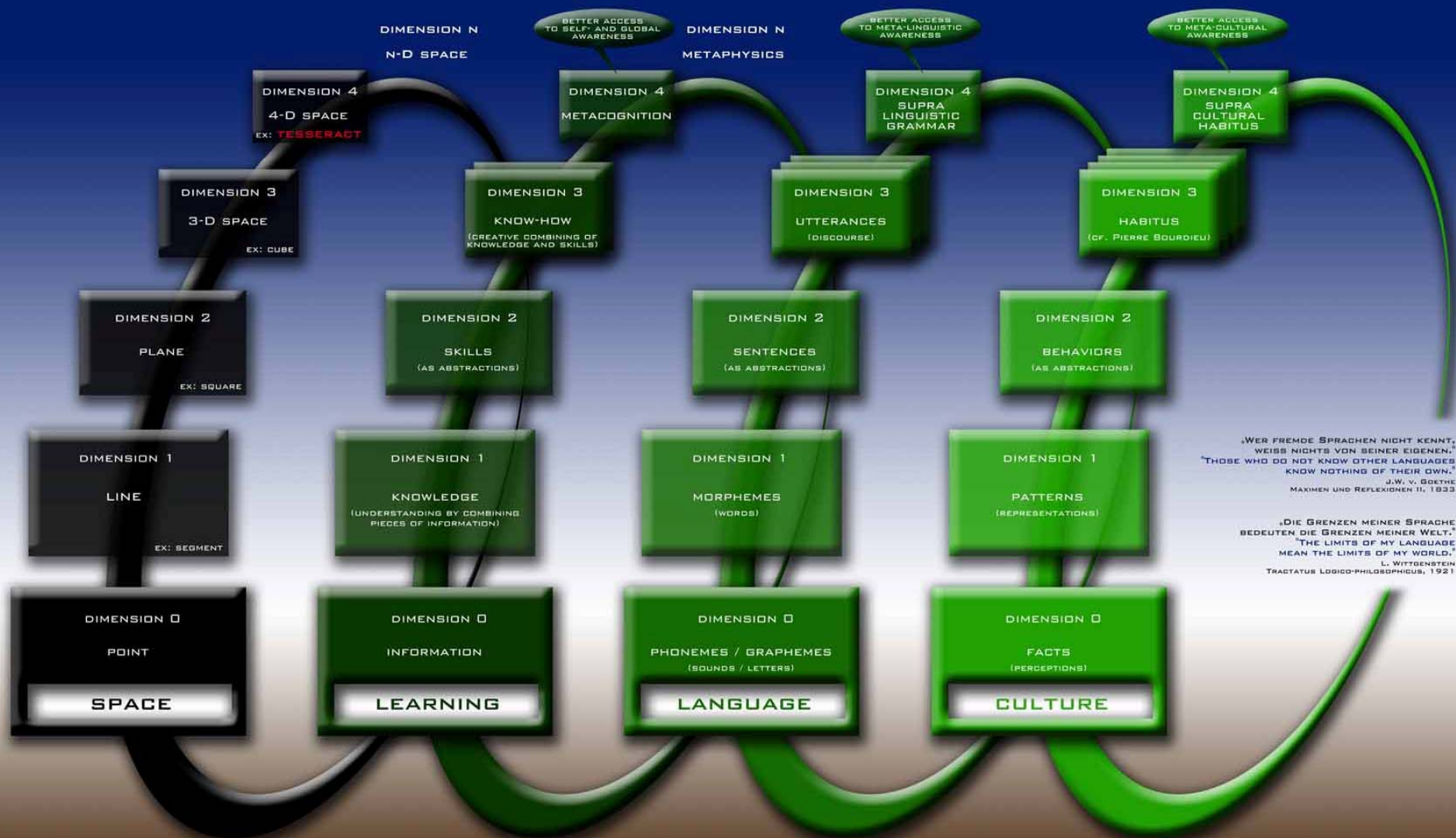
„DIE GRENZEN MEINER SPRACHE  
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"THE LIMITS OF MY LANGUAGE  
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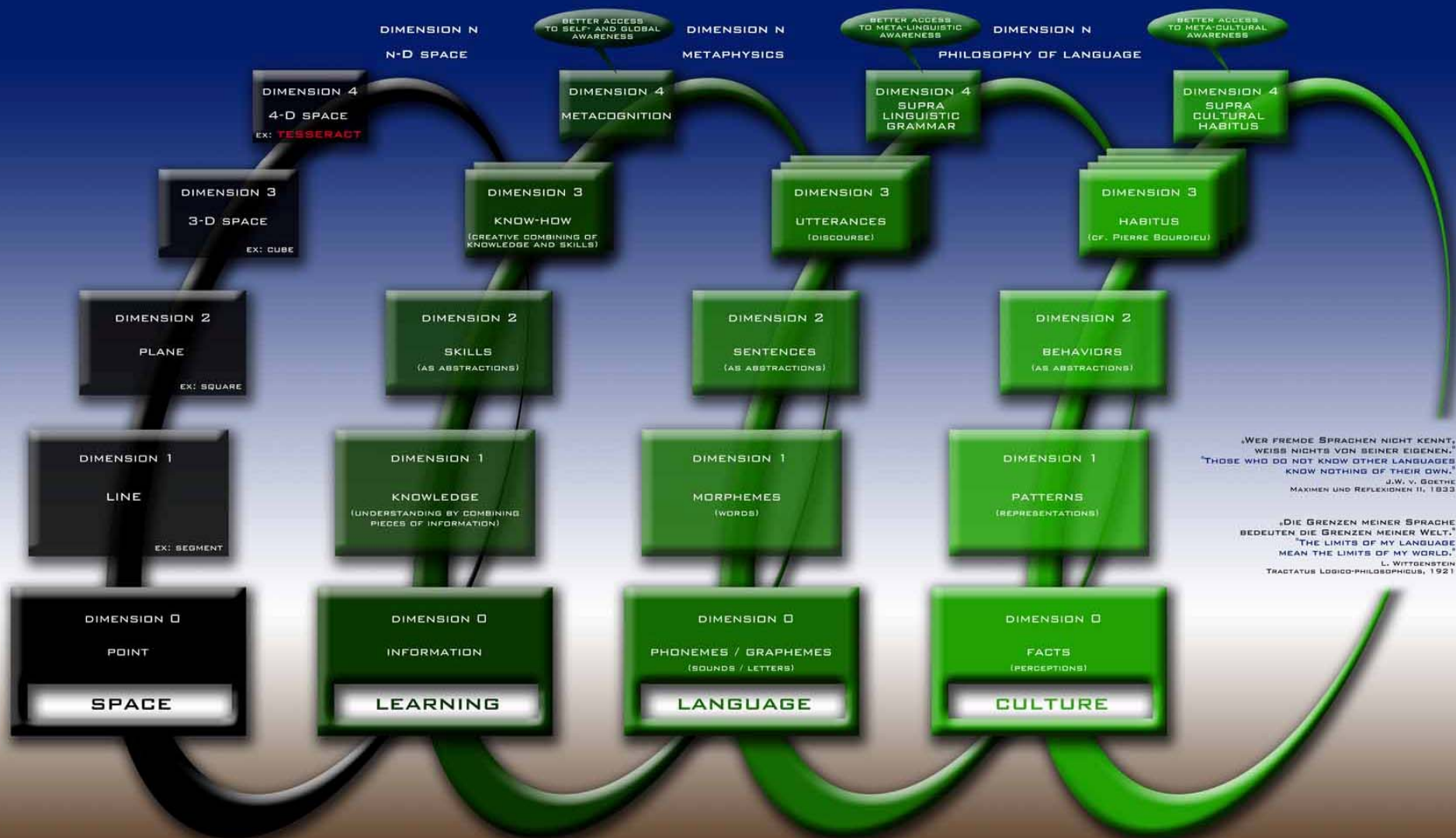
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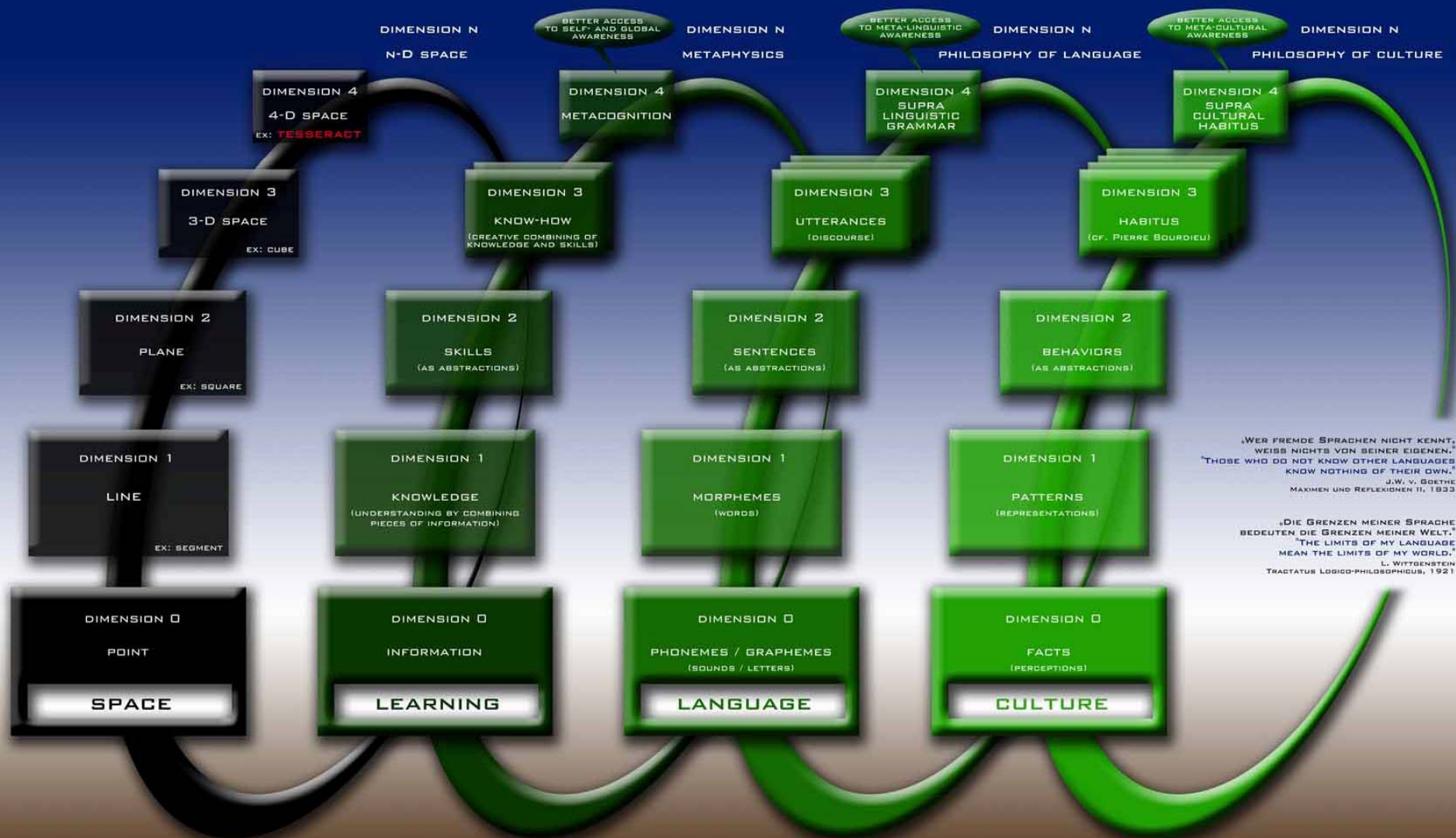
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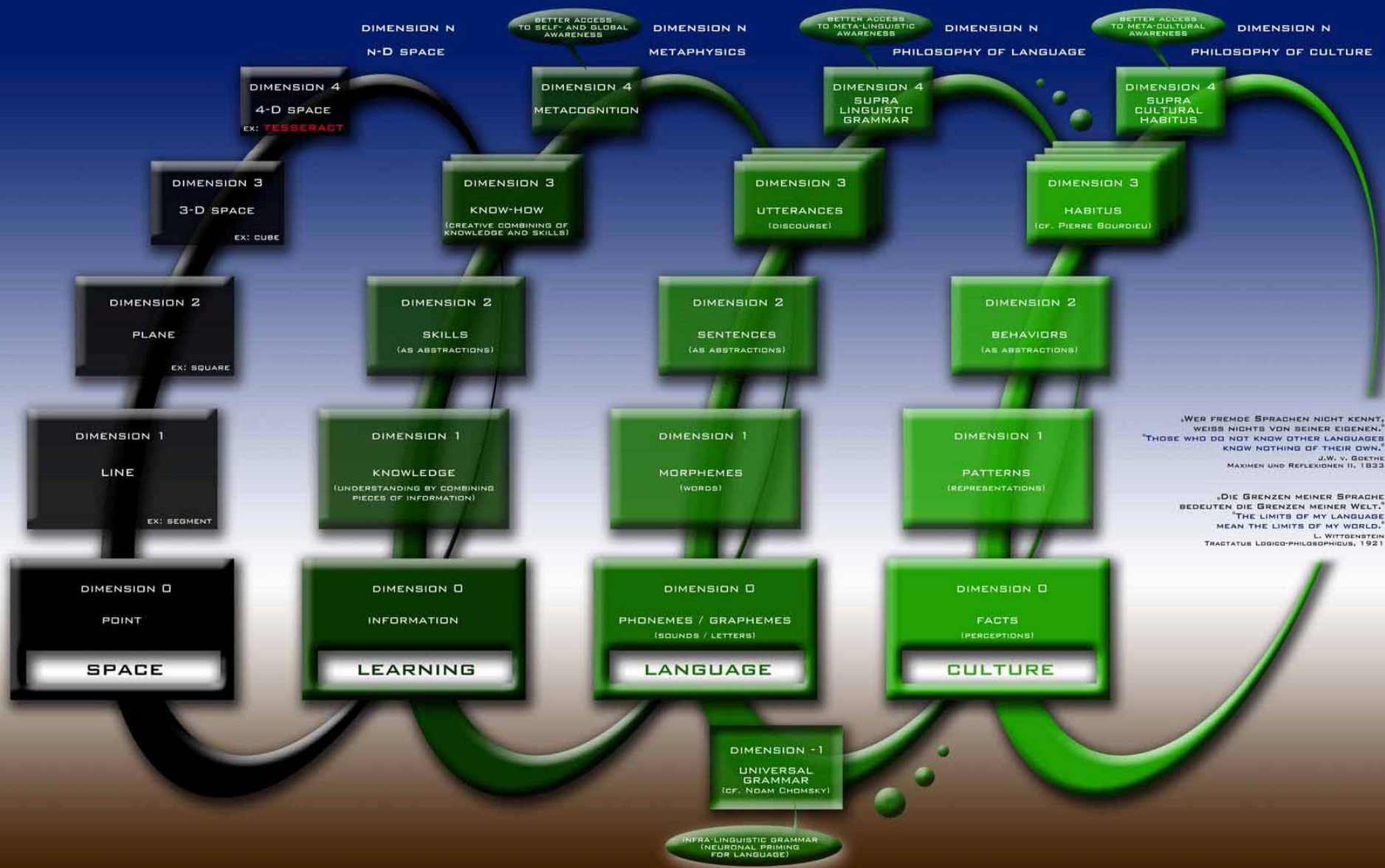
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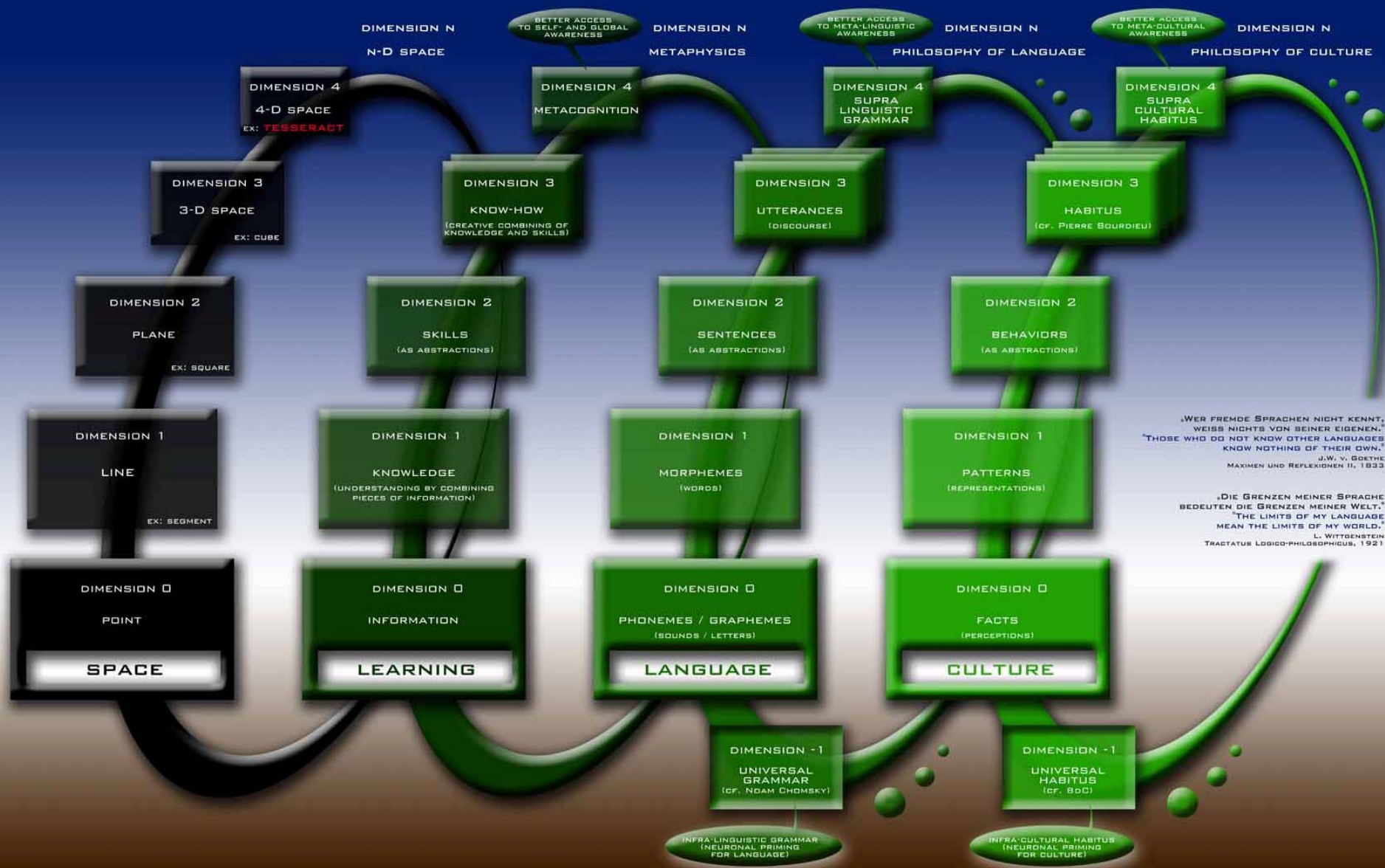
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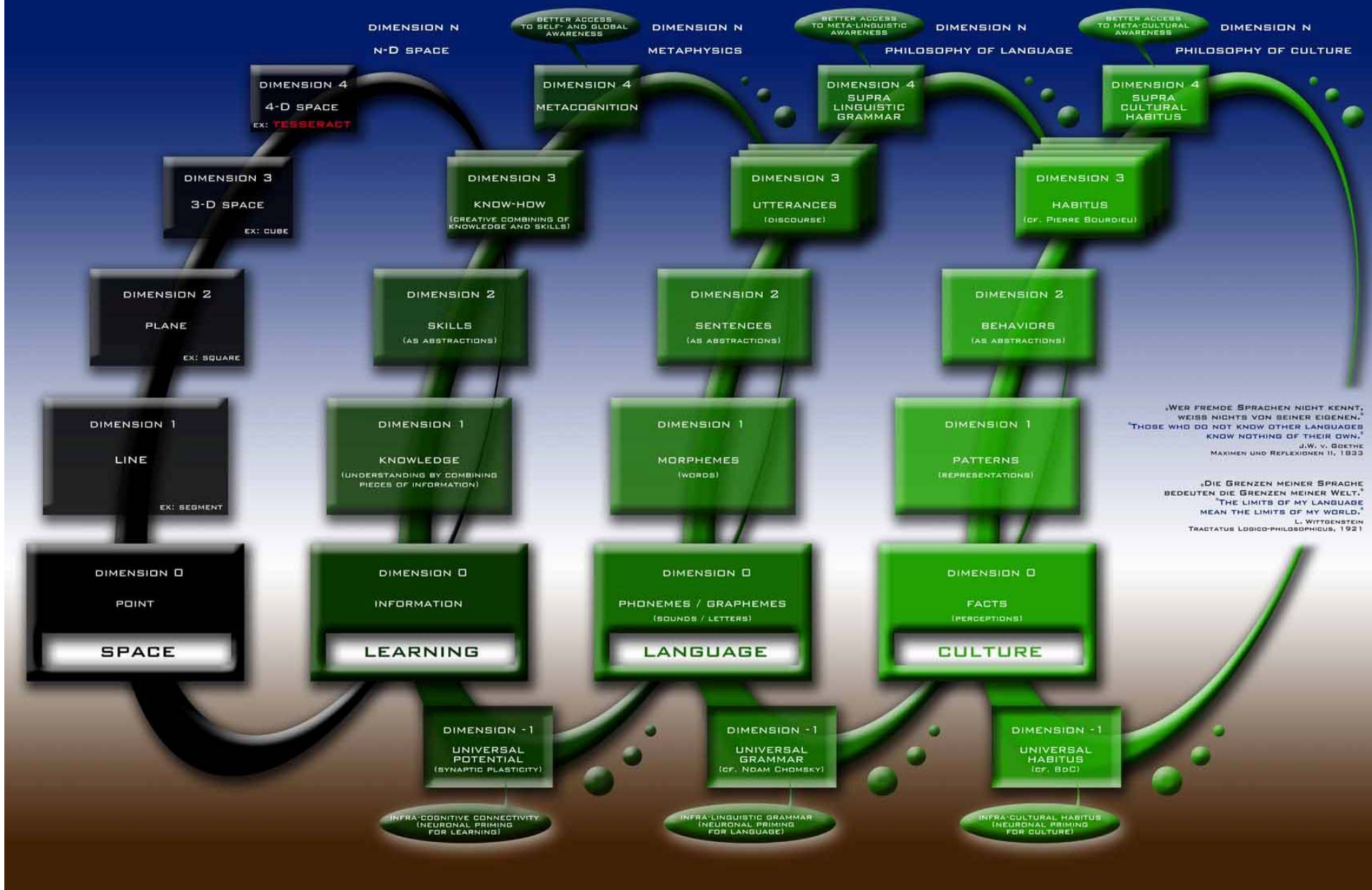
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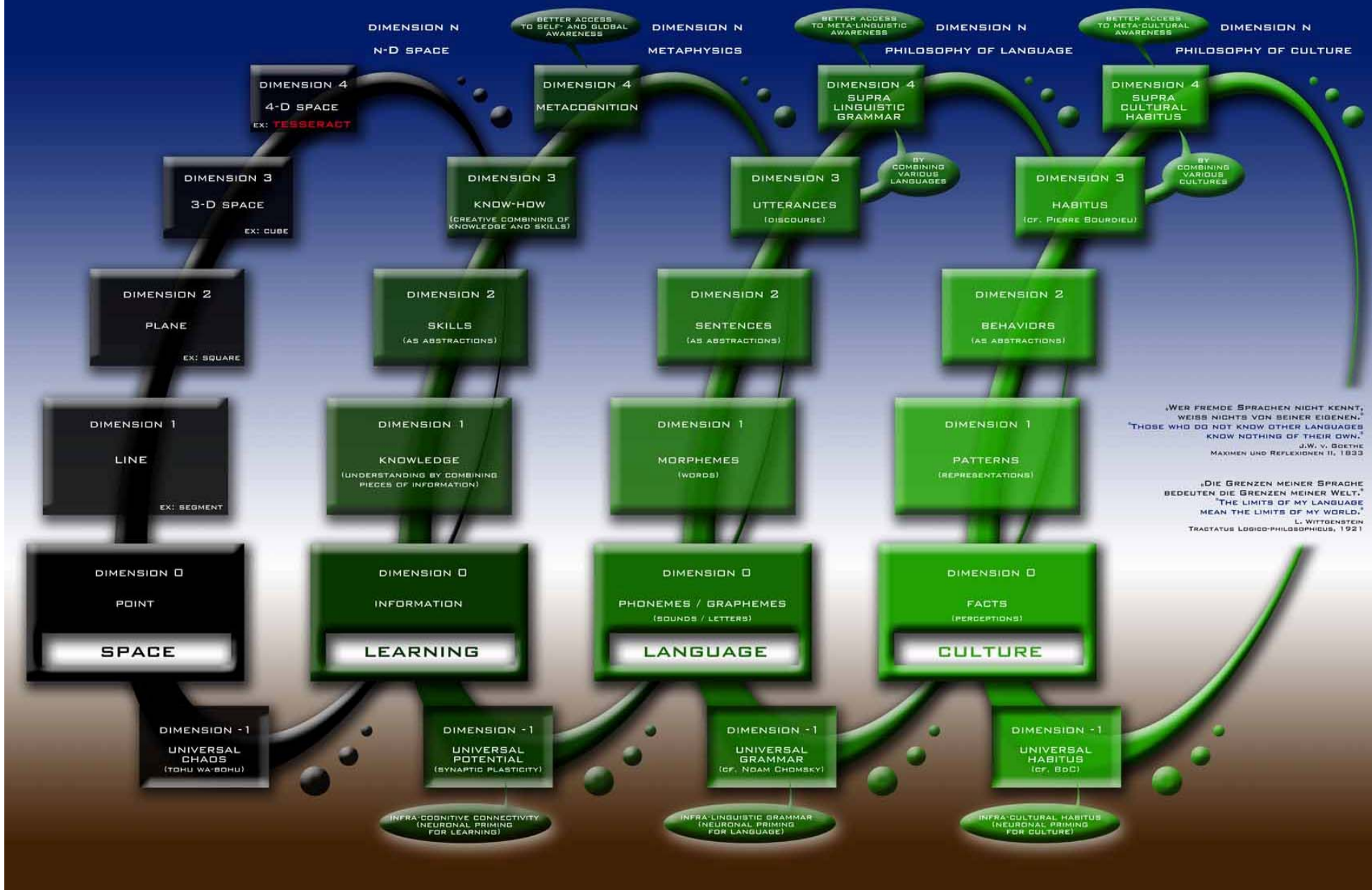
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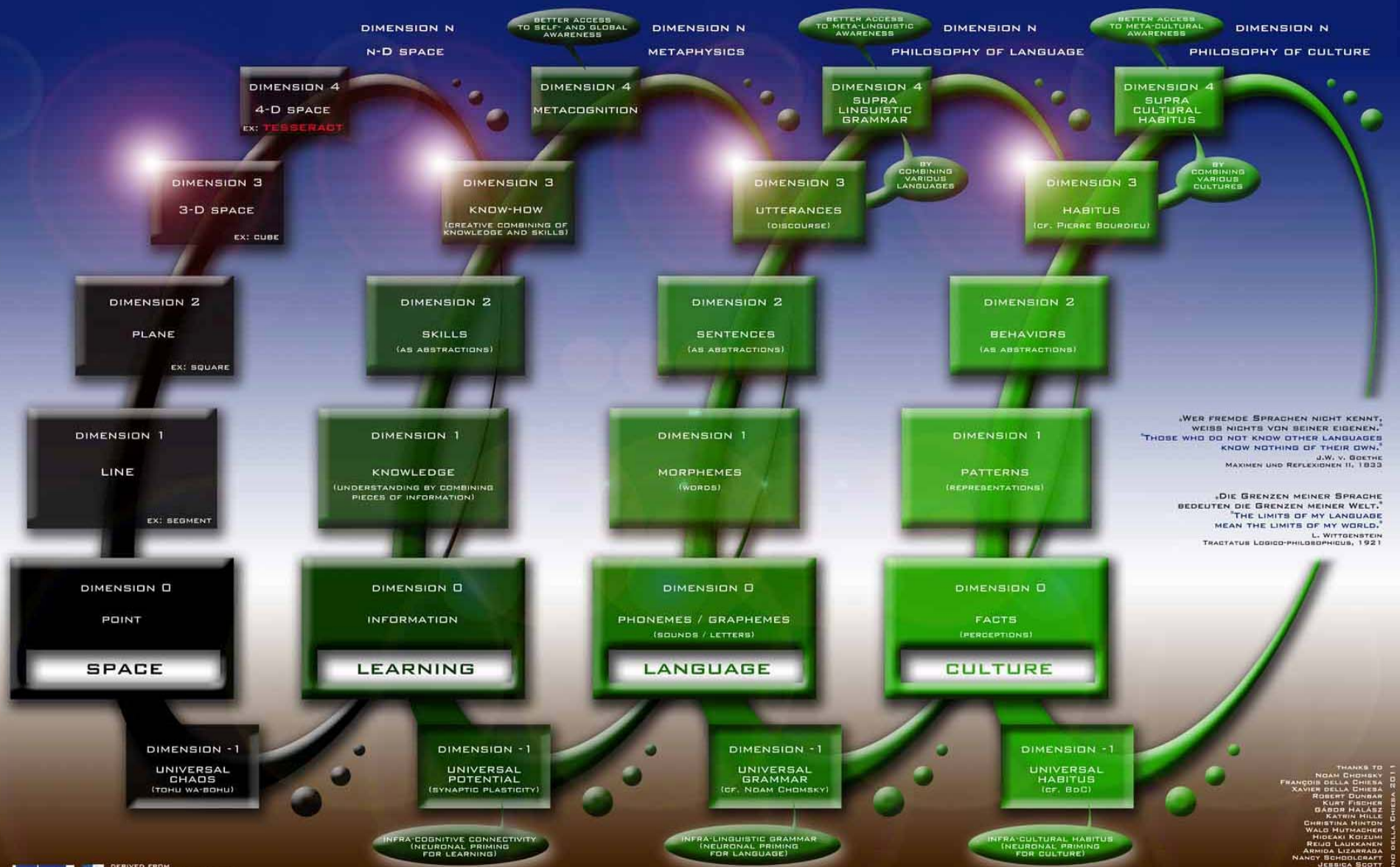


# IN SEARCH OF TESSERACTS IN THE BRAIN





# IN SEARCH OF TESSERACTS IN THE BRAIN



DERIVED FROM  
BRUNO DELLA CHIESA (2010)  
"WANTED: TESSERACT - ONE HYPOTHESIS ON LANGUAGES, CULTURES, AND ETHICS FOR MIND, BRAIN AND EDUCATION"  
[ MIND, BRAIN AND EDUCATION, 4(3), SEPTEMBER 2010, NEW YORK: BLACKWELL PUBLISHING, 135-148 ]

THANKS TO  
NOAM CHOMSKY  
FRANCIS DELLA CHIESA  
XAVIER DELLA CHIESA  
ROBERT DUNNAR  
KURT FRIEDER  
GÁBOR HALÁSZ  
KATRIN HILLE  
CHRISTINA HINTON  
WALD MUTMÄCHER  
HIDEAKI KOBAYASHI  
REIJO LAUKKANEN  
ANANDA LICARRADA  
NANCY SCHOLZBERG  
JESSICA SCOTT  
TEVSTAN TODOROV  
TO PIERRE BOURDIEU, IN MEMORIAM

BRUNO DELLA CHIESA, 2011



**From Bourdieu's kitchen, crucial notion of...**

**... 'DOXA':**

**...or 'culture' considered 'nature'...**



## **Do we really want to...**

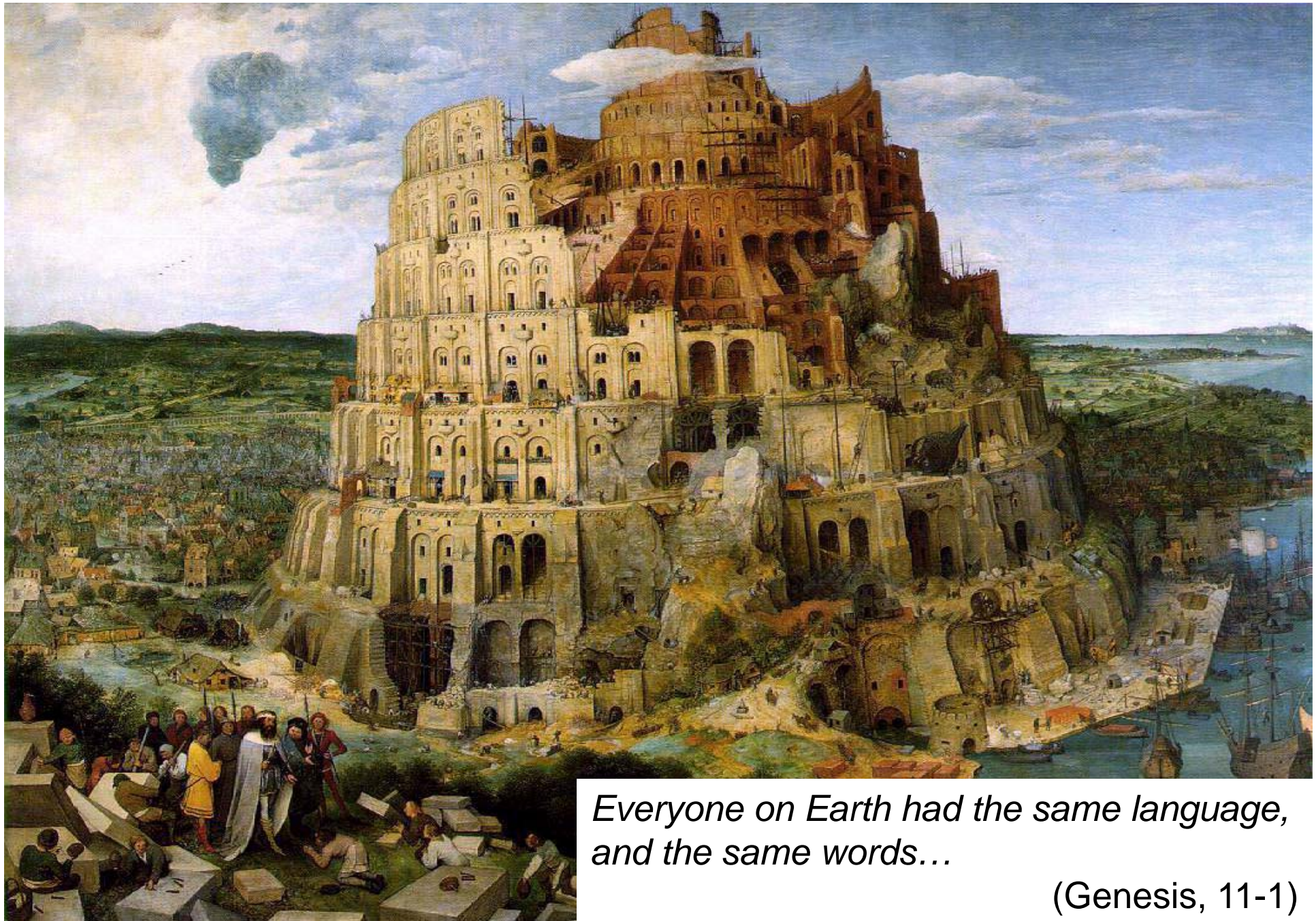
- **Promote empathy and tolerance?**
- **Promote high ethical standards?**
- **Promote equity (in education systems, to begin with)?**
- **Fight against 'failure' in our schools?**

**Do we *really* want this ?**



## Menu

- Understanding is seeing patterns...
- Neurosciences to contribute to education?
- Ethics in the brain?
- Bonus : in search of tesseract 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 Bruegel (1563)



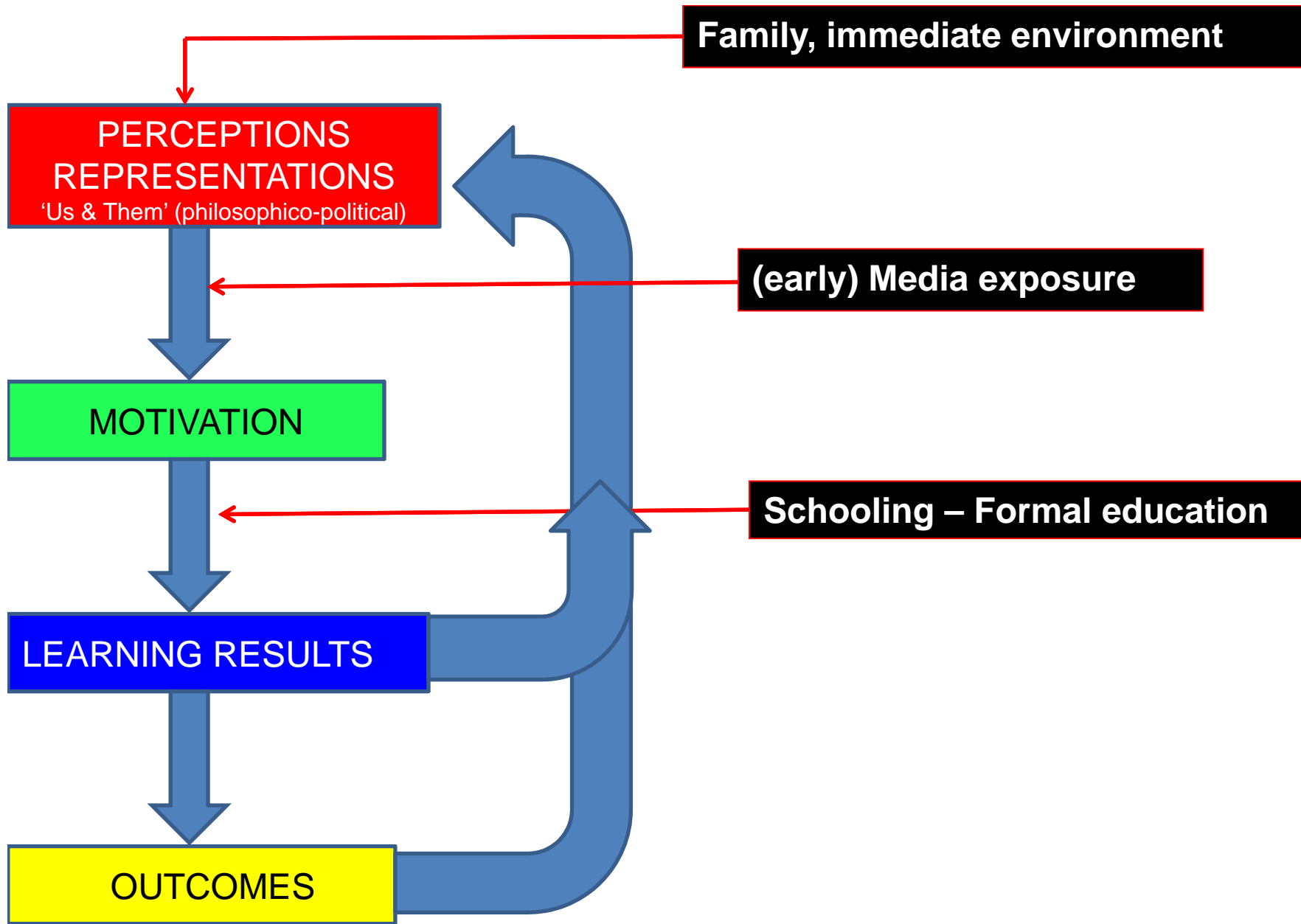
**The**

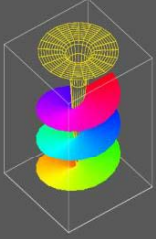
**'Army Method':**

**success...**

**and**

**consequences**





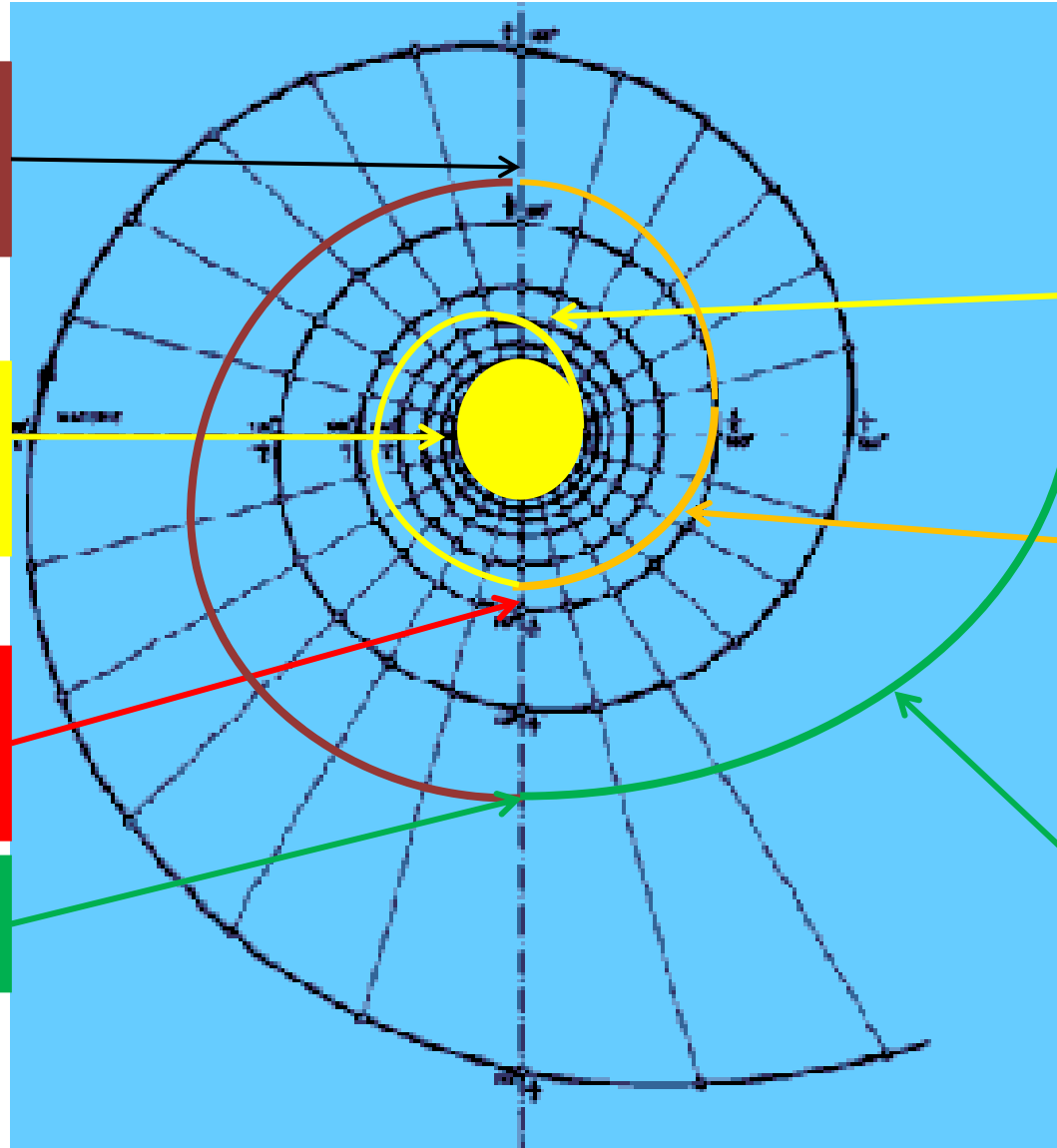
# “Motivational Spiral Hypothesis”

formal  
education  
(schooling,...)

immediate  
(family)  
environment

(early)  
media  
exposure

learning  
results

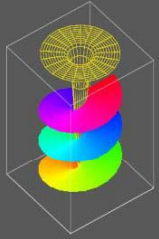


(early)  
Representations

(altered)  
Representations

social and  
economic  
outcomes

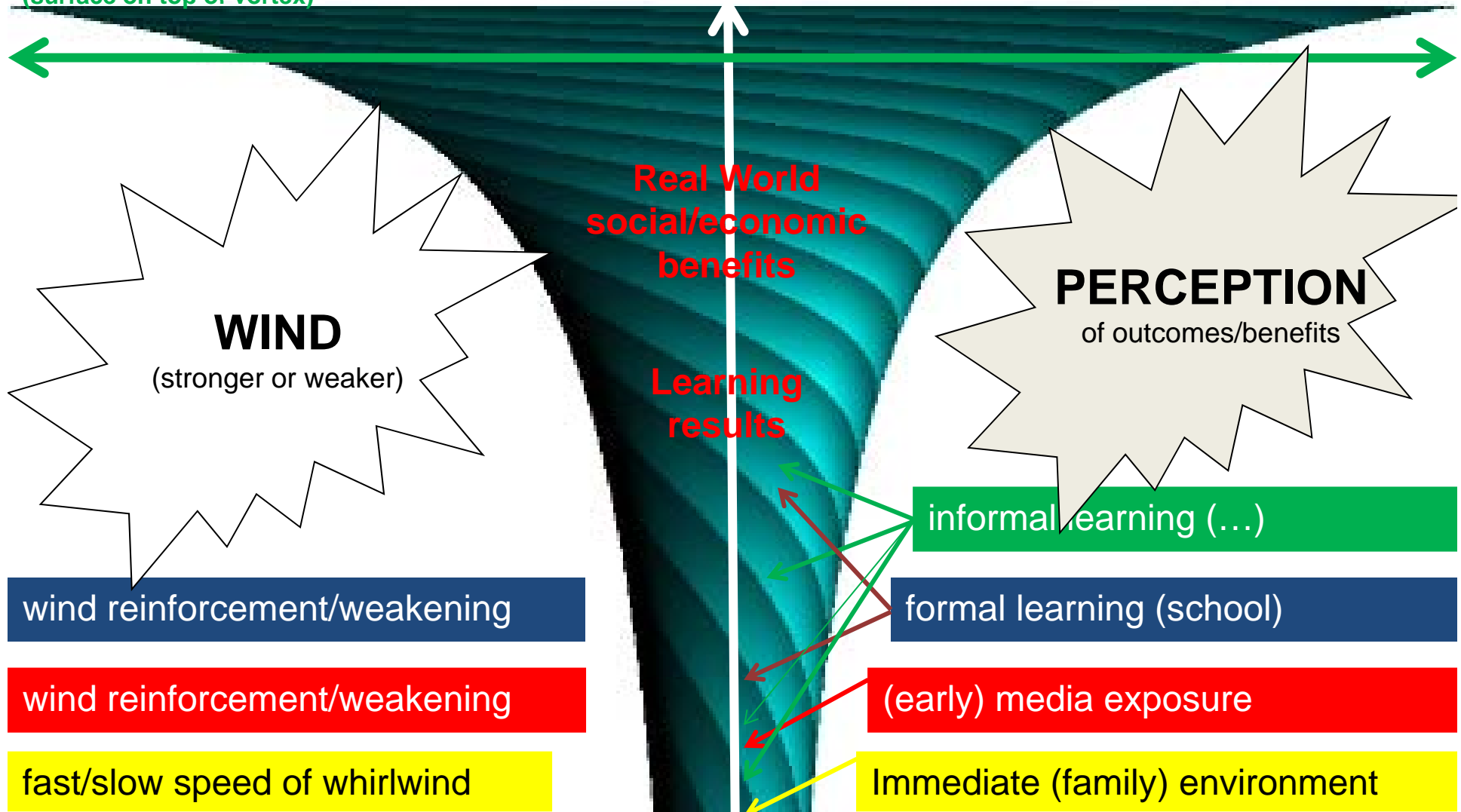




## “Motivational Vortex Hypothesis” (positive)

Acquired Knowledge  
(surface on top of vortex)

Learning vector (time)





*'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).**
- **Exemple: déficits précoces du sens des nombres (dyscalculie): 'peur des math' et conséquences à court, moyen et long terme.**