# What is digital world doing to our brains?


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Digital World and human brains.

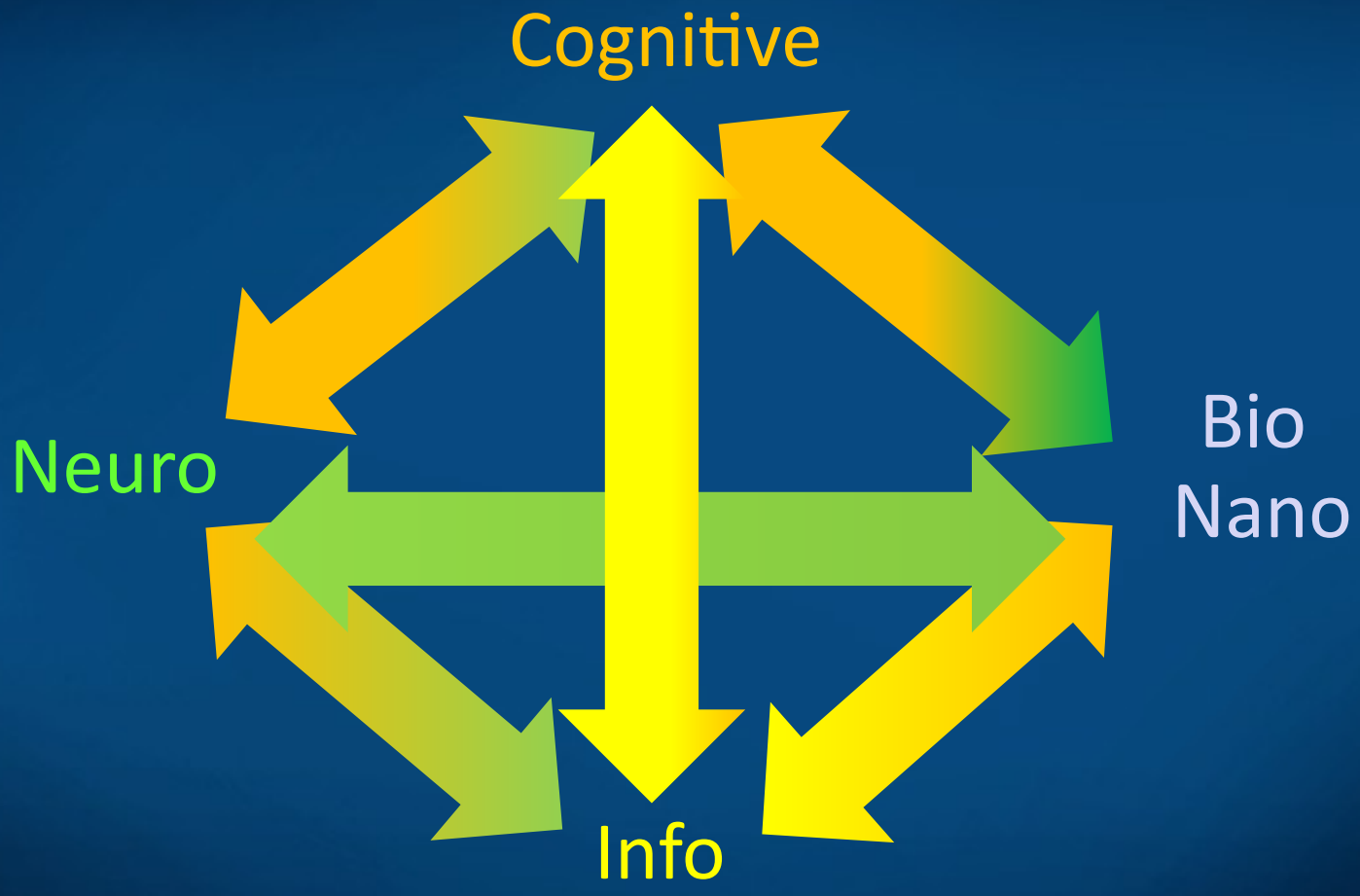
- Why am I interested in this? Our neurocognitive research.
- Digital world - Destroying?  Improving? Changing our brains?
- Are we ready for personalized brain-centered education?
- Radical changes in (not so) distant future ...

# MOOC and e-learning

- First step – Internet and distance education.


- Second and third step: VR and digital immersion.

# Most important 21 century technologies



# Brain: my favorite organ!

# Center for Modern Interdisciplinary Technologies, NCU

What are we trying to do?

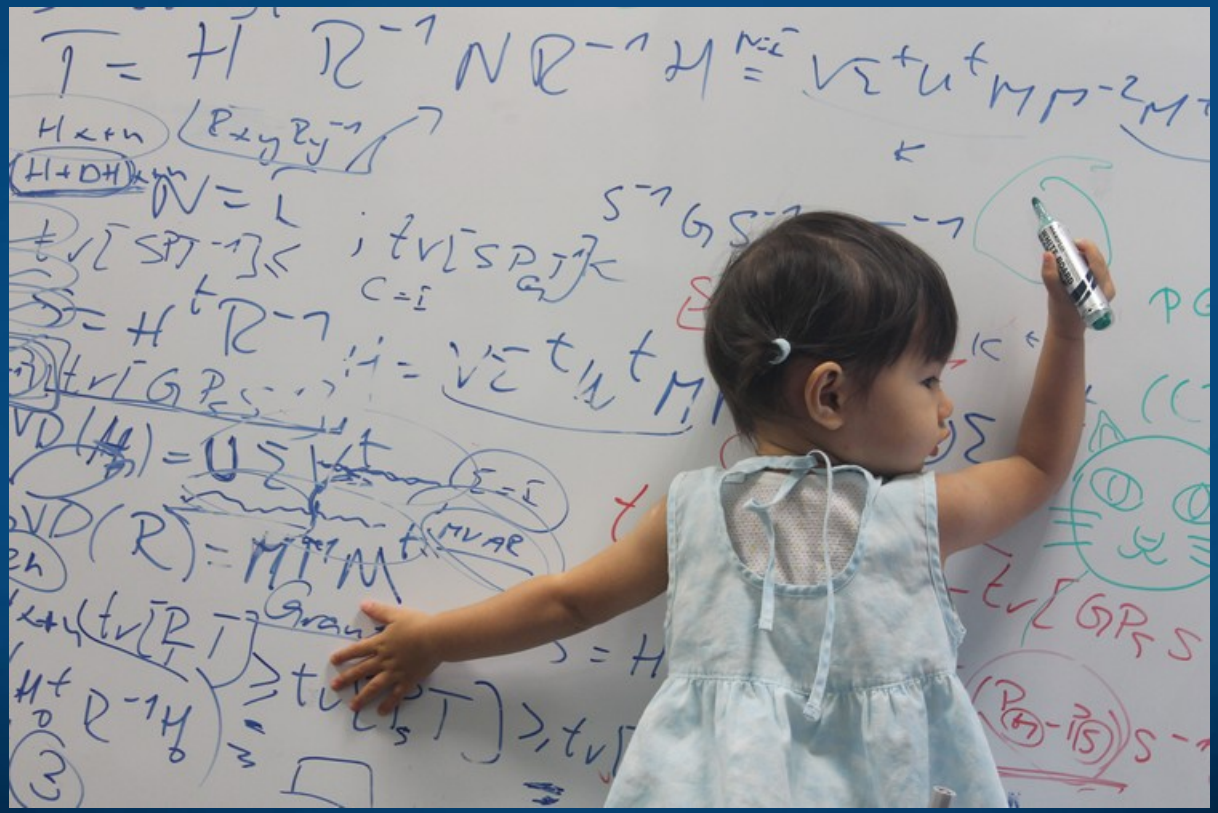
Bio + Neuro +
Cog Sci + Physics
=>
Neurocognitive lab!

~5 units with many projects requiring experimental work.

Main theme: how to maximize human potential, from birth to the old age.
Pushing the limits of brain plasticity and understanding brain-mind relations, with a lot of help from computational intelligence/machine learning!
Funding: national/EU grants.

# BabyLab in Neurocognitive Laboratory

## CMIT NCU



# Our toys


Treatment Coil
Prefrontal Cortex
Stimulated Area
Magnetic Field
NEUROSTAR

# A group of neurofanatics

# ERP and speech

D.L. Molfese used auditory event-related potentials recorded at birth to speech and nonspeech syllables.

Predictions based on ERPs: dyslexic, poor, or normal readers 8 years later ($2^{nd}$ grade), with 82% accuracy.

=> reading problems can be identified and possible interventions undertaken up to 9 years earlier than is currently possible.

Can this be changed?

ERP for high school students learning names for different countries as indicated after a 15 minute period how successful these students will be in learning to associate names with the outlines of different countries.
ERPs allow for prediction when the material was mastered versus when students were only familiar with the material but had not yet mastered it.

# ERP and speech

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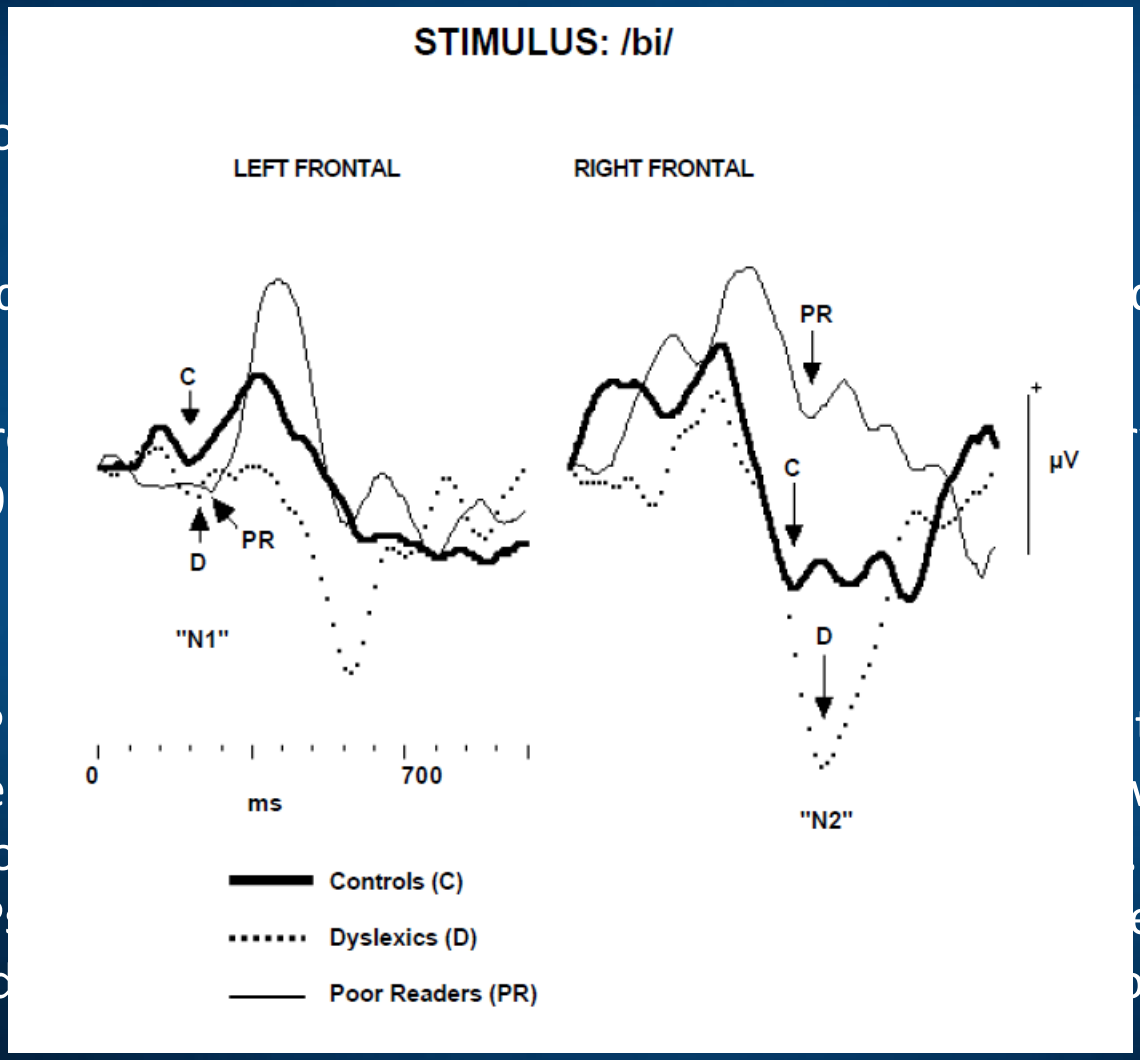
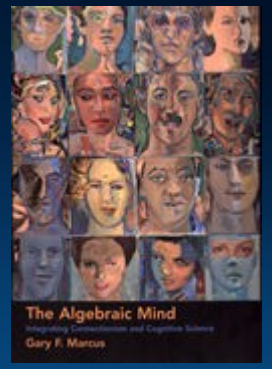


# IQ corelates



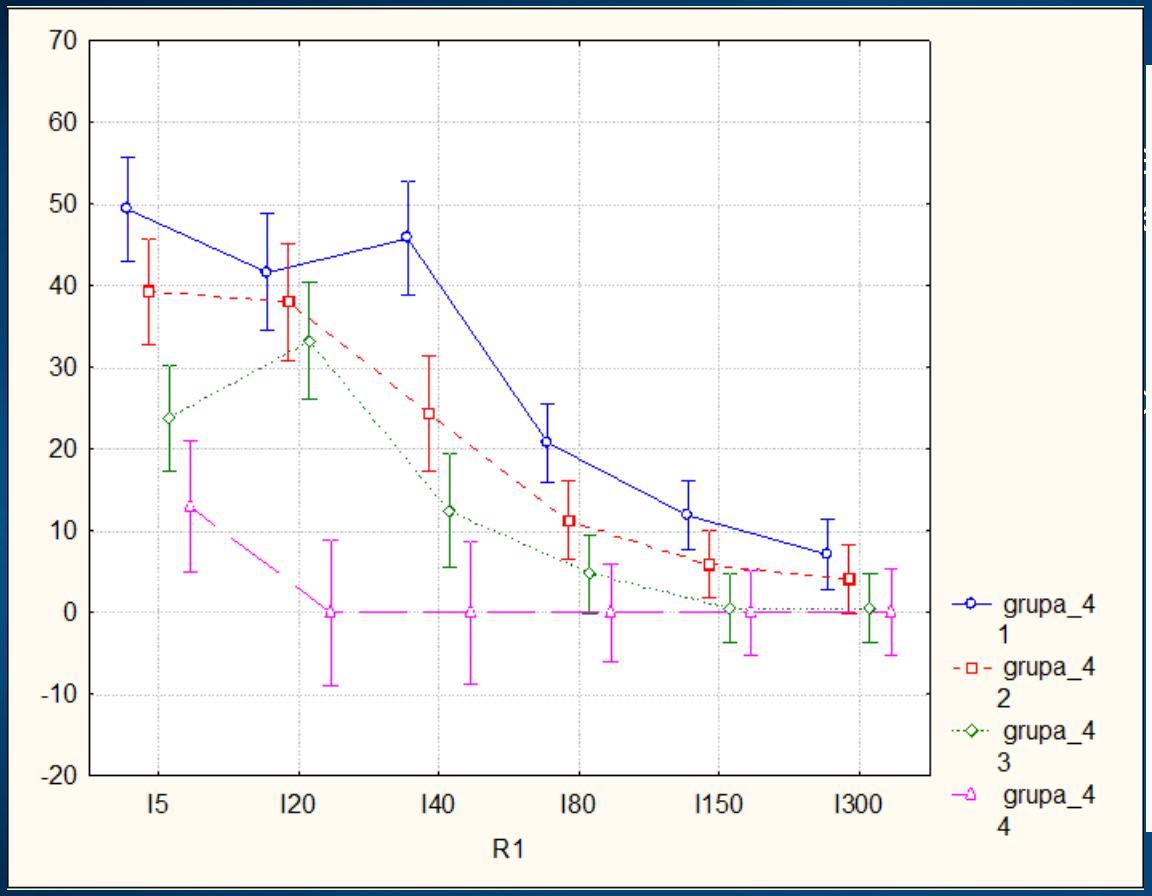

Where does intelligence comes from?
Speed of thinking + synaptic density + working memory.
This is reflected in behavioral tests and seen in Event-Related Potential structure, also connectome structure.

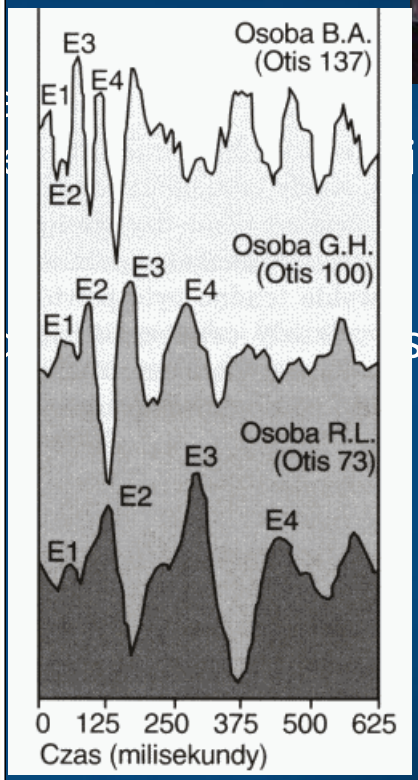
Strong correlation of IQ between the ability to order two very short sounds, one with higher pitch (ex. J. Drescher, Torun).

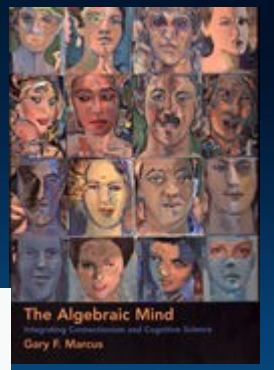
Lynn-Flynn effect: IQ grows everywhere in the world, 24 points in USA since 1918, 27 points in UK.
Toys and nutrition help to develop better brains?

Other NCL projects that should lead to social innovations: creativity, anhedonia, imagery agnosia, neurofeedback for cleaning brain processes …

# IQ corelates




Other NCL projects that should lead to social innovations: creativity, anhedonia, imagery agnosia, neurofeedback for cleaning brain processes …

# Dyscalculia screening/therapy

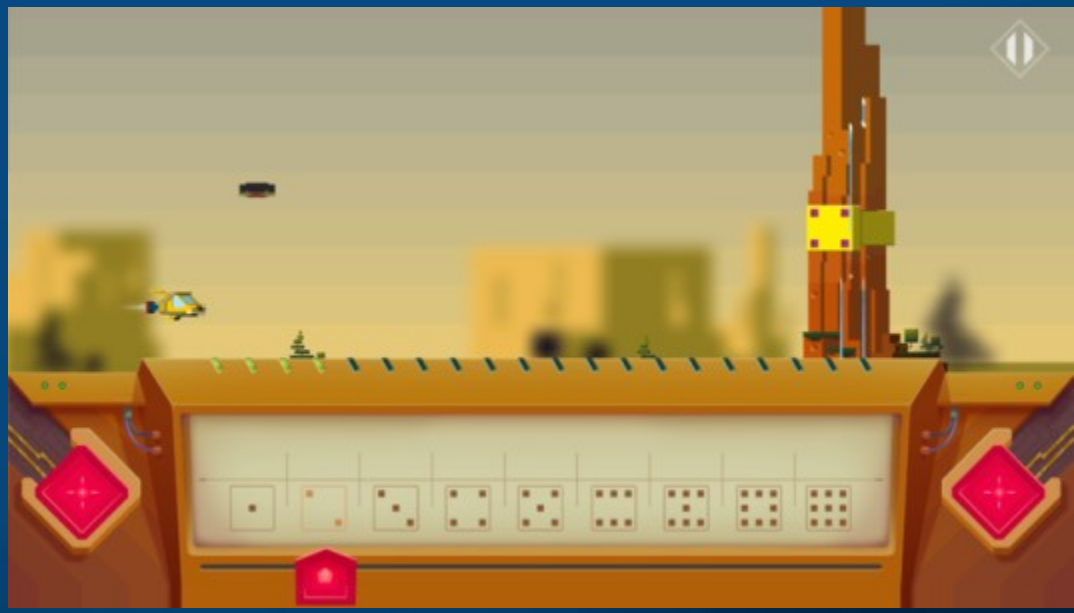
Understanding numerosity, a new complex brain function, involves HIPS structure. **6-10%** of children in primary education suffer from dyscalculia, specific difficulties with learning mathematical concepts. Rarely diagnosed, most countries have no screening tests.

**Goals:**

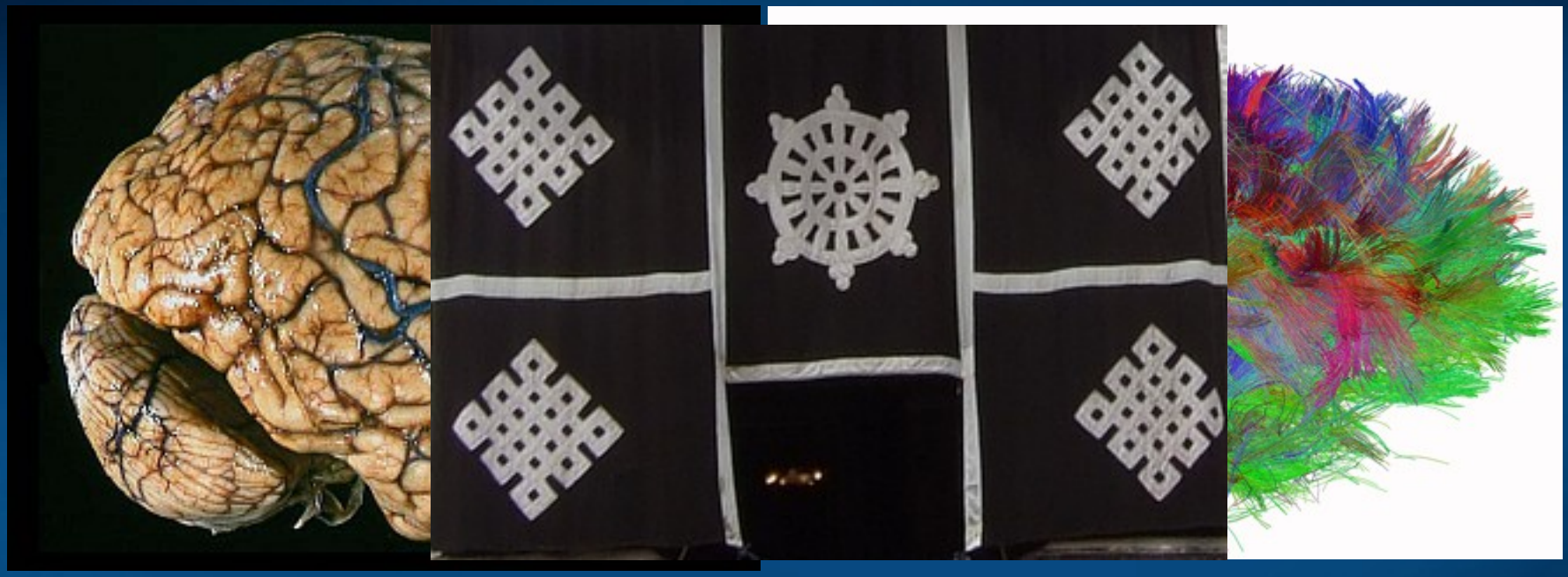
**1.** Introduce screening test for the preschool/first class to identify children with the risk of dyscalculia.

2. Short intensive training using computer game to associate mental number line with spatial dimensions.

Further therapy is done by experts.



# Neural determinism



**Our possibilities are limited by genetic and neural determinism.**

„Comes to my mind" = neural activity arising in a given context.

**Neural determinism** is the effect of genetic predisposition and individual experiences, family, social interactions, education.

There is no linear causality here, everything in time/space interacts.

# Erosion: neural determinism

Questions of the King Milinda (Milinda Panha, ca. +400).
Nagasena: Water erodes the soil and flows in the same riverbeds, just like neural activation flows in our brains, creating habits and memes.

New things are learned on the canvas of what we already know, the order in which we learn is important (ex. creationist ideas).

# Neuroeducation

As educators we are sculpting student brains!

Pedagogy has developed through trial and error, but now technology that shows how experience and teaching creates pathways in the brain already exists.

Neuroeducation: interdisciplinary field that connects many branches of science, including pedagogy, psychology, neuroscience and informatics to understand information flow in the brain and create effective ways of teaching.

Brain-based education: 19th century dream!

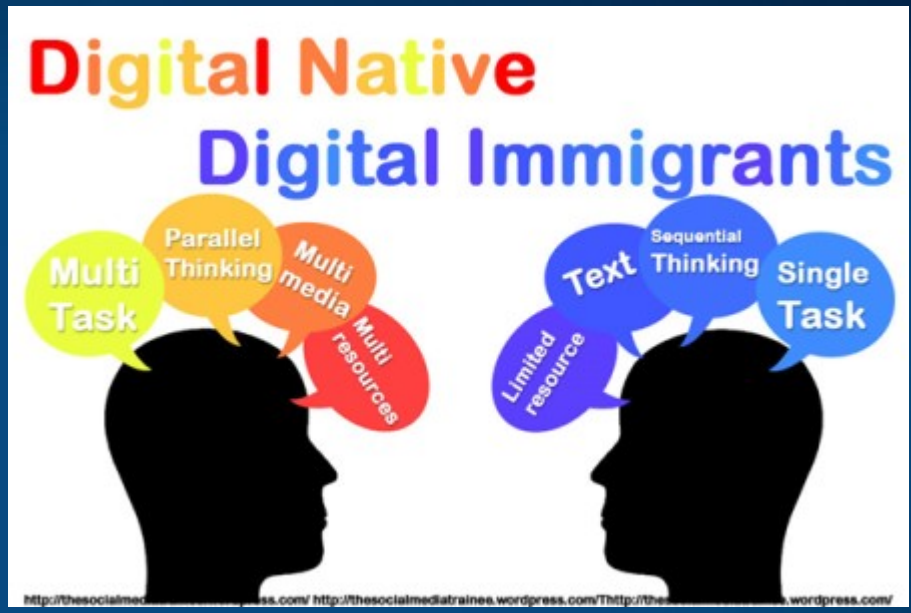
H.H. Donaldson wrote „The Growth of the Brain: A Study of the Nervous System in Relation to Education", in 1895.

R.P. Halleck, The Education of the Central Nervous System: A Study of Foundations, Sensory and Motor Training, 1896.

# Digital Natives and Immigrants

**M. Prensky, Digital Natives, Digital Immigrants**. 2001.

Children raised in a digital, media-saturated world, require a media-rich learning environment to hold their attention.




Should we focus on technology and change the whole education system, adjusting it t o digital natives?

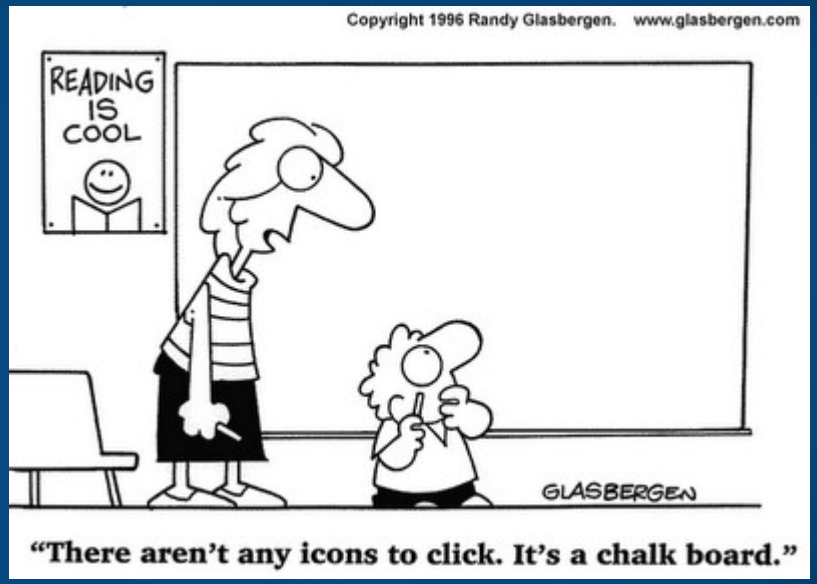
Episodic memories are formed quickly, help to find shallow associations, but they should be converted into a semantic knowledge structures to be useful for deeper understanding and reasoning.

Forming semantic memory is a slow process requiring repetition.

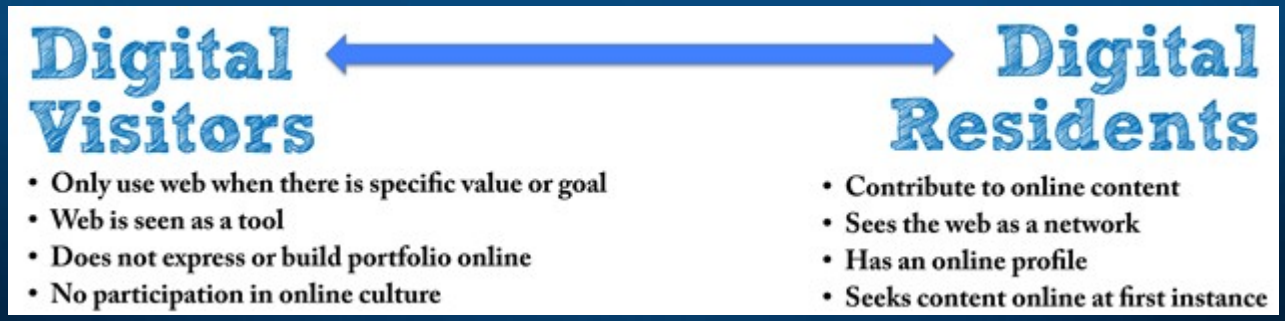
# Digital Visitors and Residents

Should we focus on technology and change the whole education system, adjusting it to digital natives?

Can we find a common language?



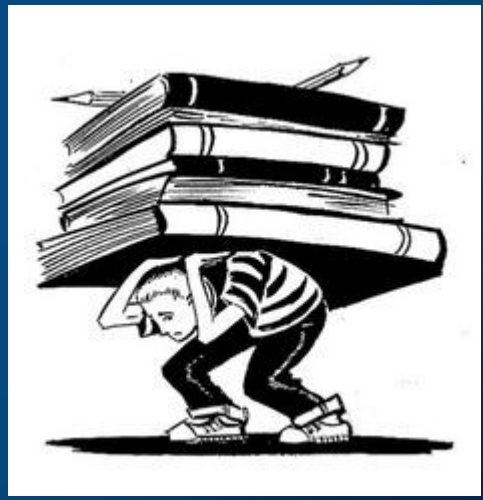

Digital Visitor and Resident (V&R) – a more relevant model.



# Digital Natives – worse?


Internet might have detrimental effects on cognition that diminish the capacity for concentration and contemplation.

N.G. Carr, *The Shallows: What the Internet Is Doing to Our Brains* (2010).



Socrates complains that writing will destroy memory and wisdom (Plato, *The Phaedrus*).
Same objections were brought against the printing press.

But now the information overload is critical.
Multitasking, lifelogging, gadgets to quantize our life ...
Multitasking has a lot of negative effects: switching between subjects requires a lot of mental energy.

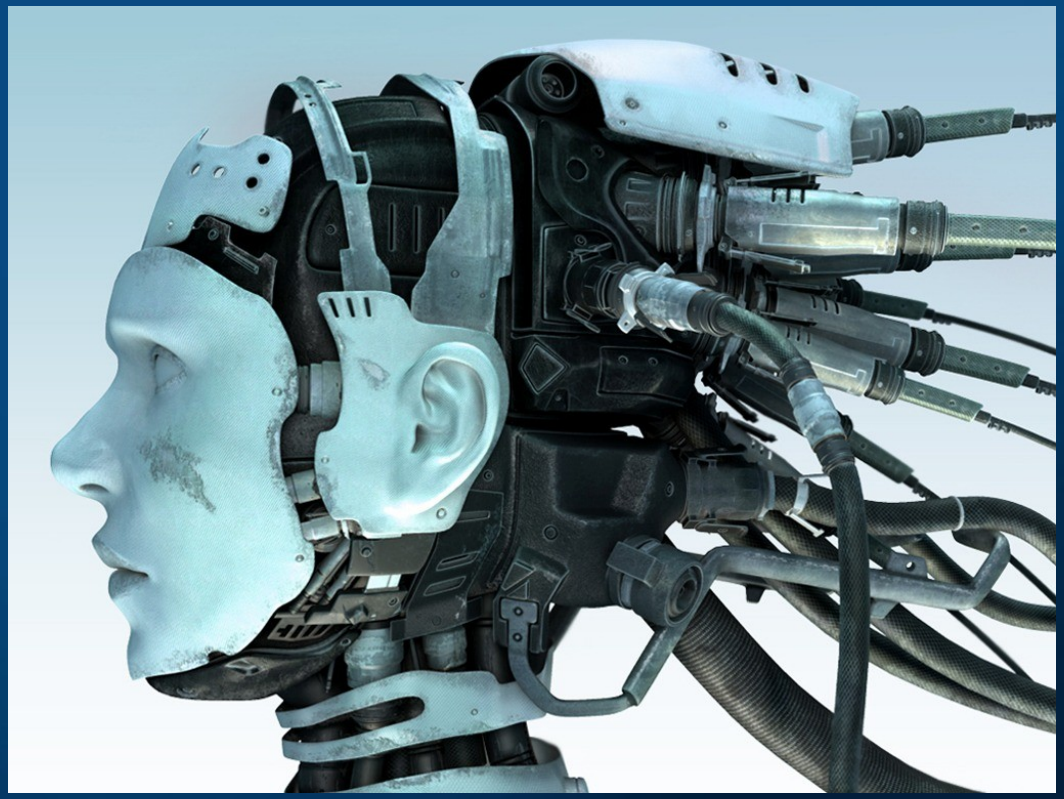
Wherever we are we are somewhere else … existing in many places.

# Homo Sapiens Digital – transhuman?

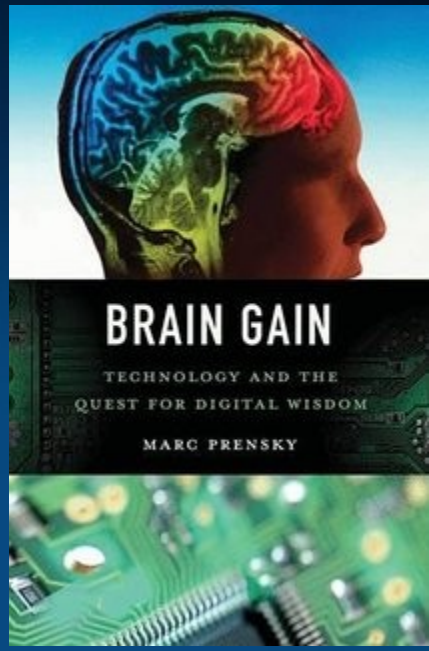
Emergence of Homo Sapiens Digital (HSD), or digital transhuman?

HSD accepts **digital enhancement** as an integral fact of human environment, is **digitally wise** (not just clever), using digital enhancements to complement innate abilities and facilitate wiser decision making.

**Minds are not just brains**, but brains extended by strong coupling to the environment: smartphones, hearing/vision aids, tactile and olfactory aids, brain-computer interfaces, and soon memory implants and direct brain stimulations.



# Digital Natives – smarter?




Perhaps digital technology is making us smarter?
More cognitive demands => increase of cognitive capabilities.

**All enhancement comes with a trade-off**: memory moved from minds to books, papers and computers, speeding up the retrieval process – **to search you need to know!**

Multitasking, attention deficits, cognitive overload …
Learning semantics from episodes becomes increasingly difficult, requires time and repetition, attractive multimedia show will not replace it.

Soon we shall have e-Learning in VR, and even **training in lucid dreams**!

Educational personalized techniques coming ... DCS? TMS? Neurofeedback?

Start from teaching how to learn? Learning sciences instead of pedagogics?

Learning sciences, "an interdisciplinary field that works to further scientific understanding of learning as well as to engage in the design and implementation of learning innovations, and the improvement of instructional methodologies." (Wikipedia definition)

# Digital wisdom


USA, National Academies Keck Future Initiative:
2012 Conference explored common rewards and dangers to humans among various fields that are being greatly impacted by the Internet and the rapid evolution of digital technology.

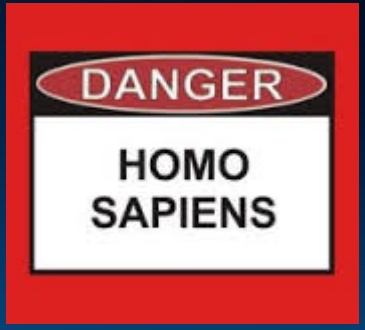
Brain Steering Committee. *The Informed Brain in a Digital World: Interdisciplinary Team Summaries*. National Academies Press (2013).
... it remains to be known whether access to seemingly unlimited information is actually helping us learn and solve complex problems, or ultimately creating more difficulty and confusion for individuals and societies by offering content overload that is not always meaningful.

The Oxford English Dictionary **definition of wisdom**: "Capacity of judging rightly in matters relating to life and conduct, soundness of judgment in the choice of means and ends". Wisdom lies in knowing what is important, includes “practical wisdom” (Aristotle), and moral judgment wisdom.

**Digital wisdom can and must be learned and taught.**

Courses in digital literacy are not sufficient!

# Need for enhancement

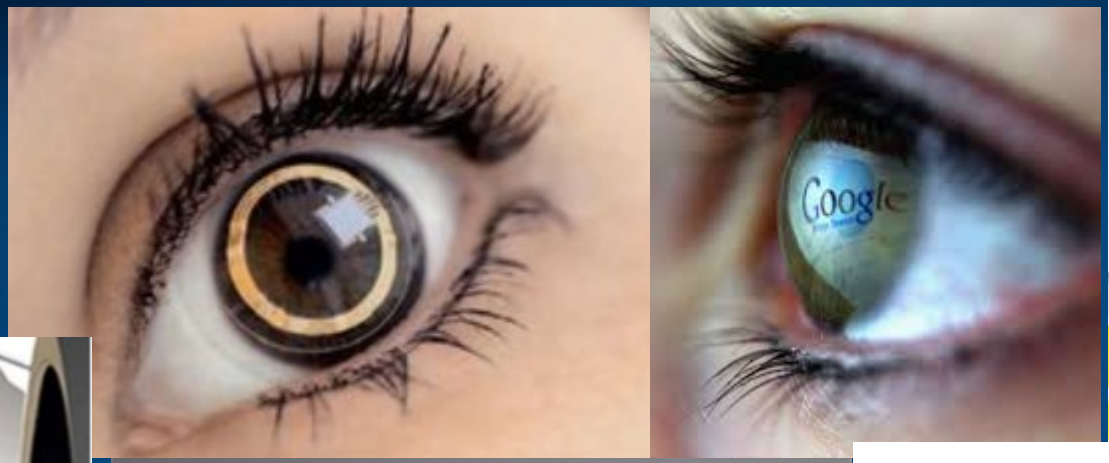



Humans have problems with emotional and cognitive functions:

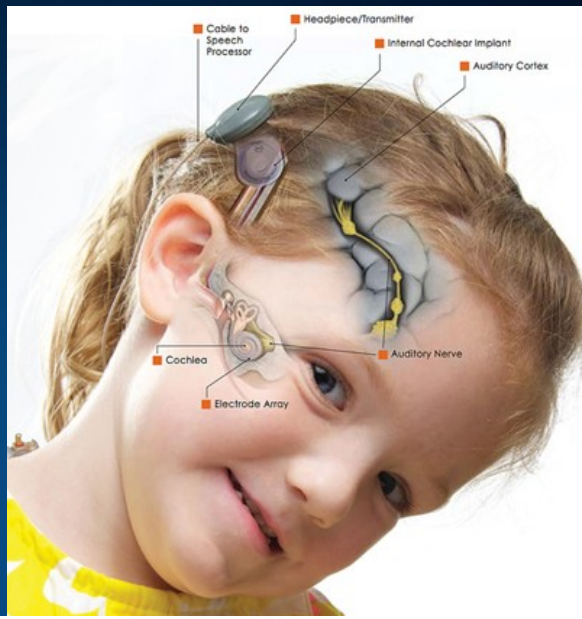
- Understanding their real needs, leading to happiness in a longer time.
- Separating emotional responses from rational conclusions.
- Wrong assumptions about the thoughts or intentions of others.
- Resisting addictions, immediate rewards.
- Forgetting and other memory problems.
- Handling complex problems/situations.
- Limitation of our senses.
- Making decisions based on limited available data.
- Holding multiple perspectives simultaneously.
- Use of educated guessing and verification to find new answers.
- Limited ability to predict future and construct what-if scenarios.

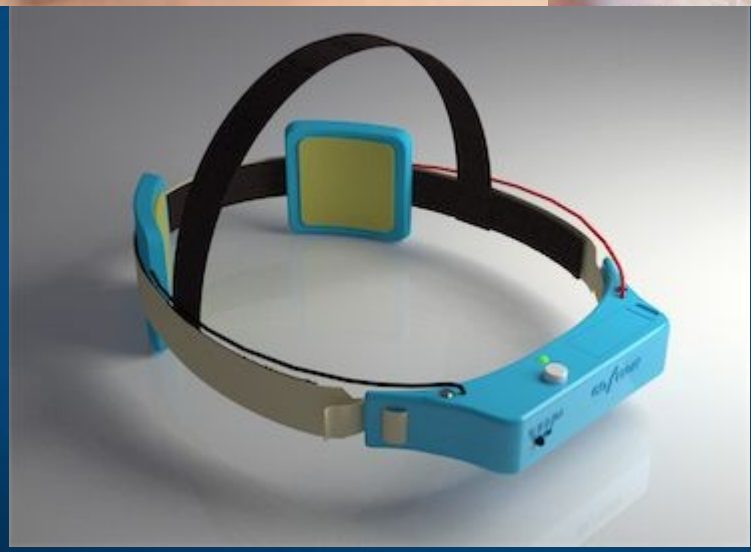
In short, **we need to shape minds/brains of our students empowering them to learn and be successful in their activities**.

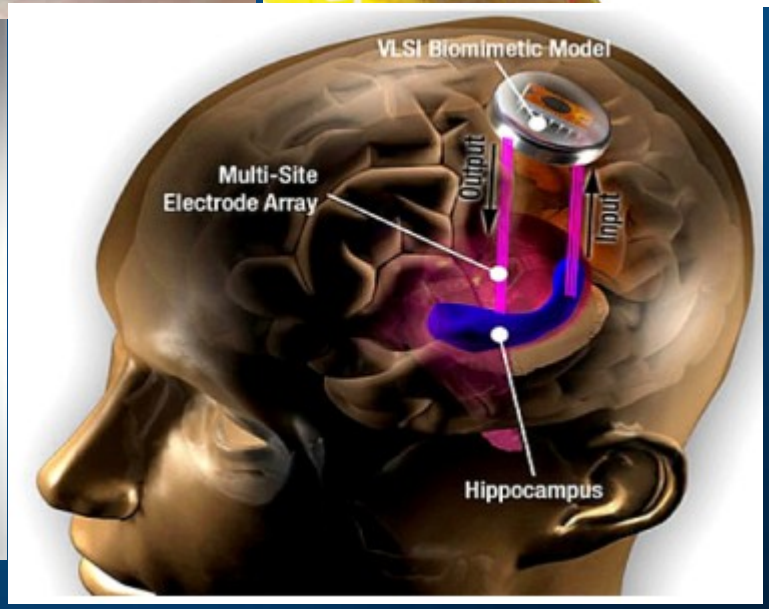
# Enhancements





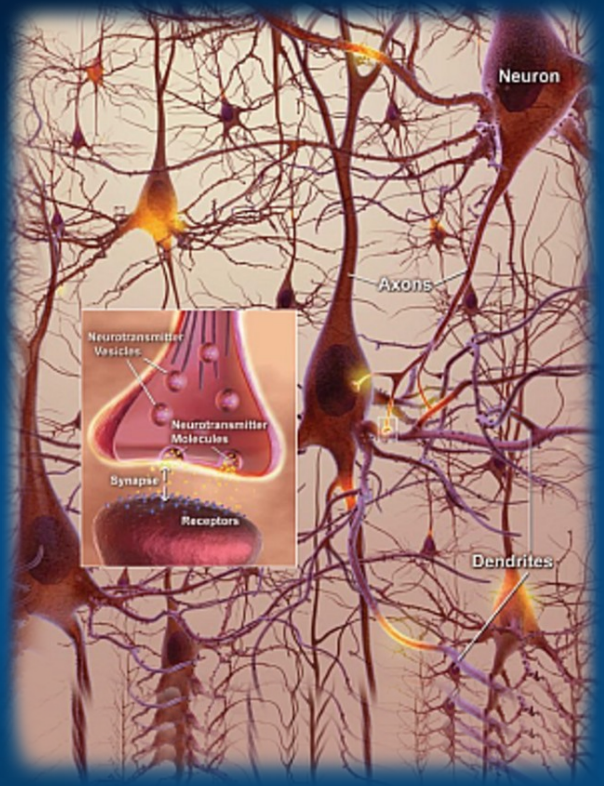



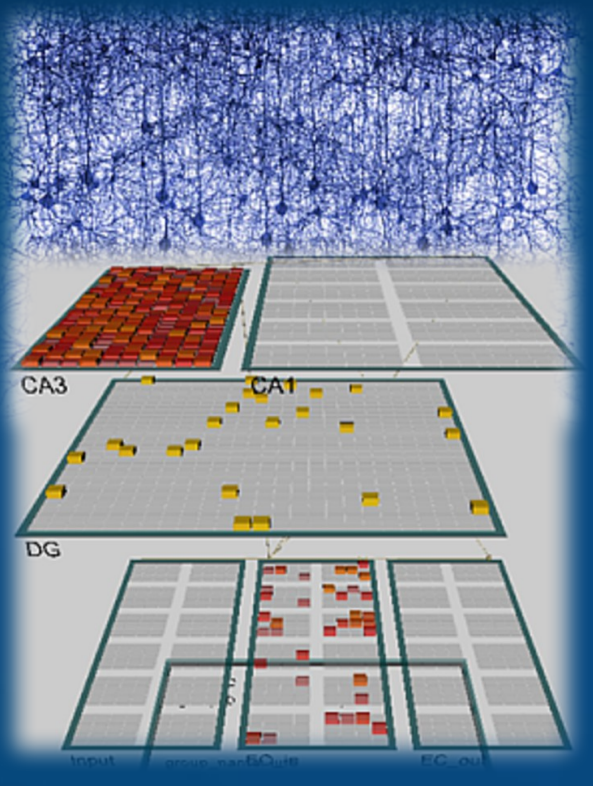






Augumented vision, hearing, other senses+memory & direct brain stimulation
How can we use them wisely?

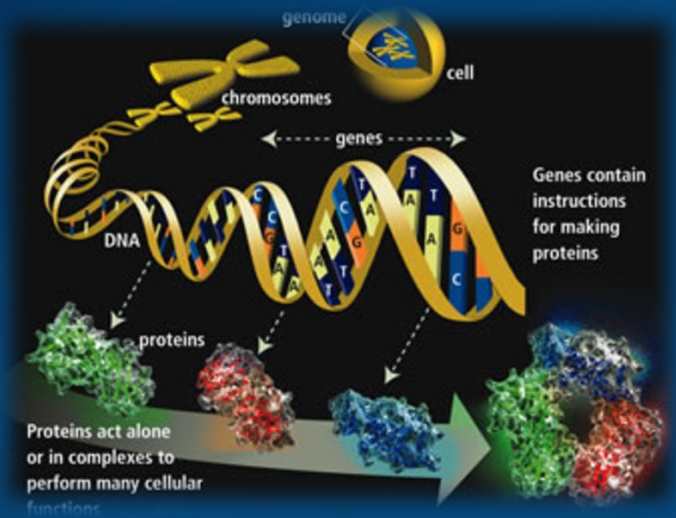
# From Behavior to Neurons

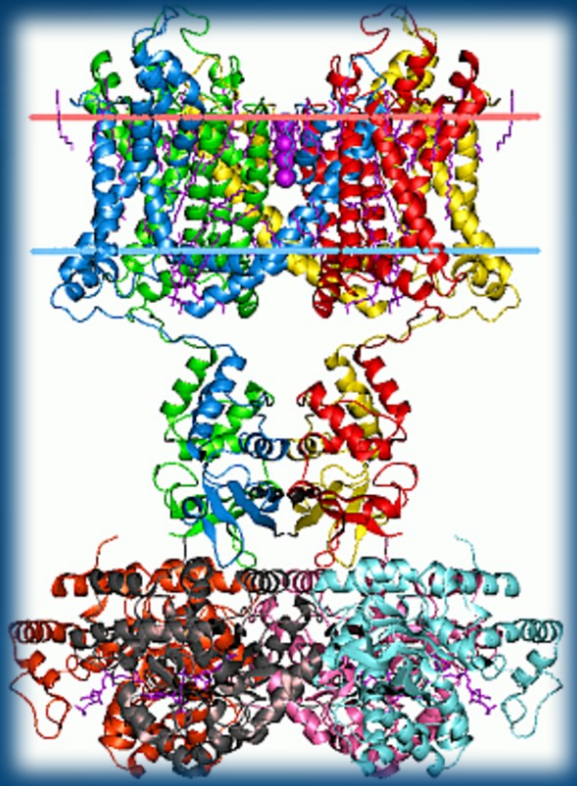


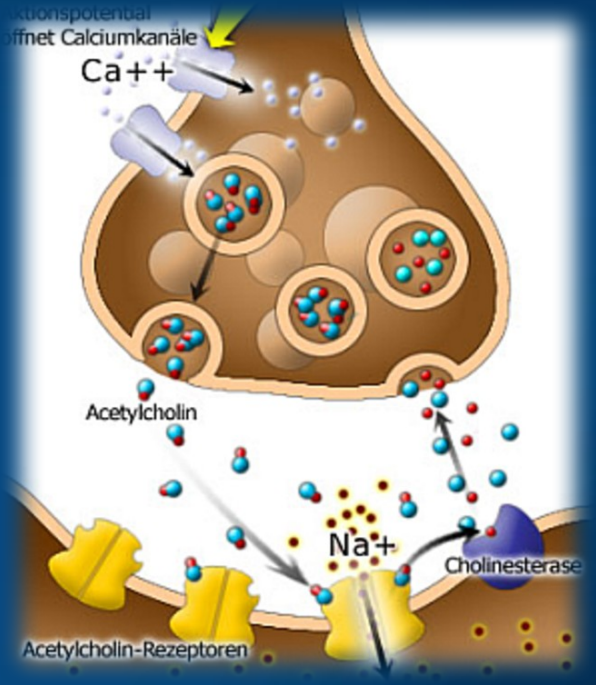




behavior ⊂ cognitive phenotypes ⊂ **neurodynamics** ⊂
⊂ networks ⊂ connectomes ⊂ properties of neurons ⊂
⊂ receptors, ion channels, synapses ⊂ proteins ⊂ genes

# From Neurons to Genes






Behavior ⊂ cognitive phenotypes ⊂ neurodynamics ⊂
⊂ networks ⊂ connectomes ⊂ **properties of neurons** ⊂
⊂ receptors, ion channels, synapses ⊂ proteins ⊂ genes

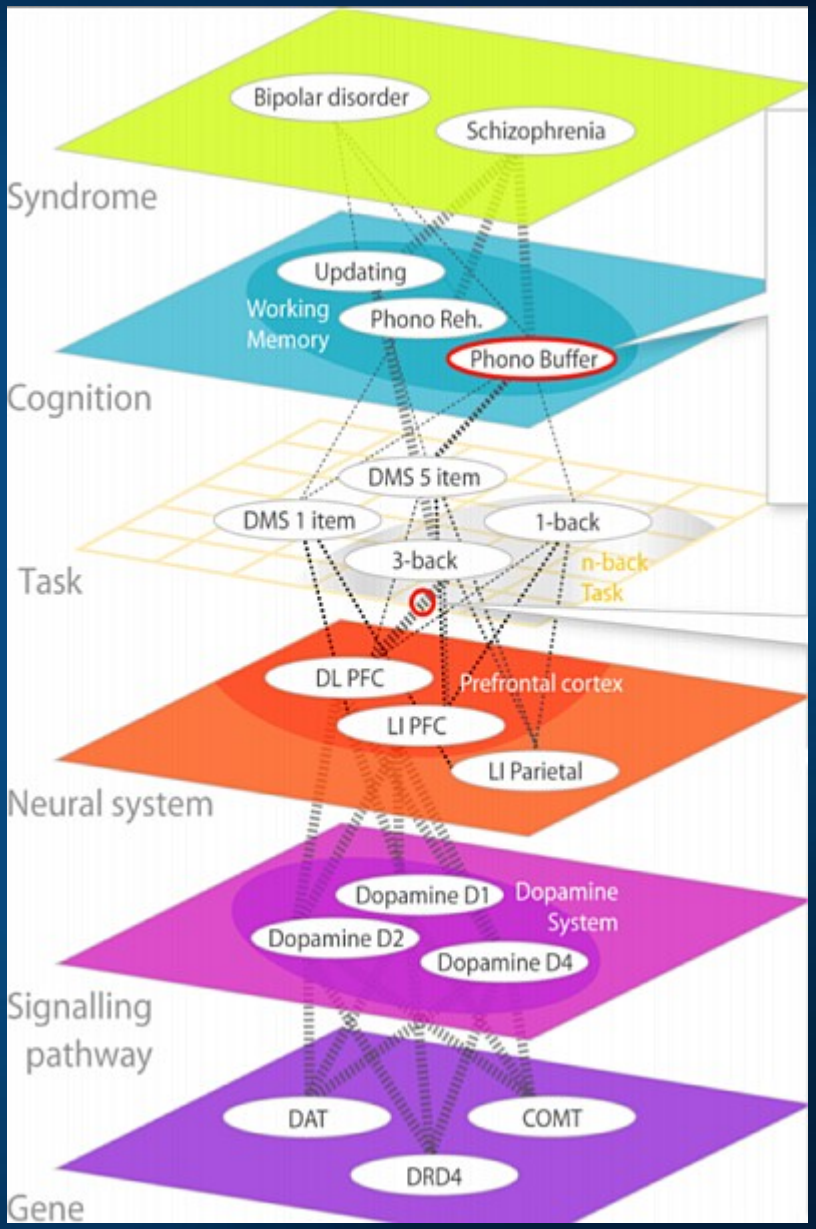
# Neuropsychiatric Phenomics in 6 Levels

6 levels, according to
The Consortium for Neuropsychiatric Phenomics (CNP)
http://www.phenomics.ucla.edu

From genes ⇒ molecules ⇒ neurons ⇒ networks ⇒ large systems ⇒ tasks, cognitive subsystems ⇒ syndromes.

Neurons and networks ⇒ neurodynamics is right in the middle of this hierarchy.

Model-based thinking is very useful.



# Neurocognitive Phenomics

Phenotypes may be described at many levels. Ex. from top down:
**learning styles** - education, psychiatry & psychology;

**neurodynamics**, connectomes, microcircuits, neural networks;

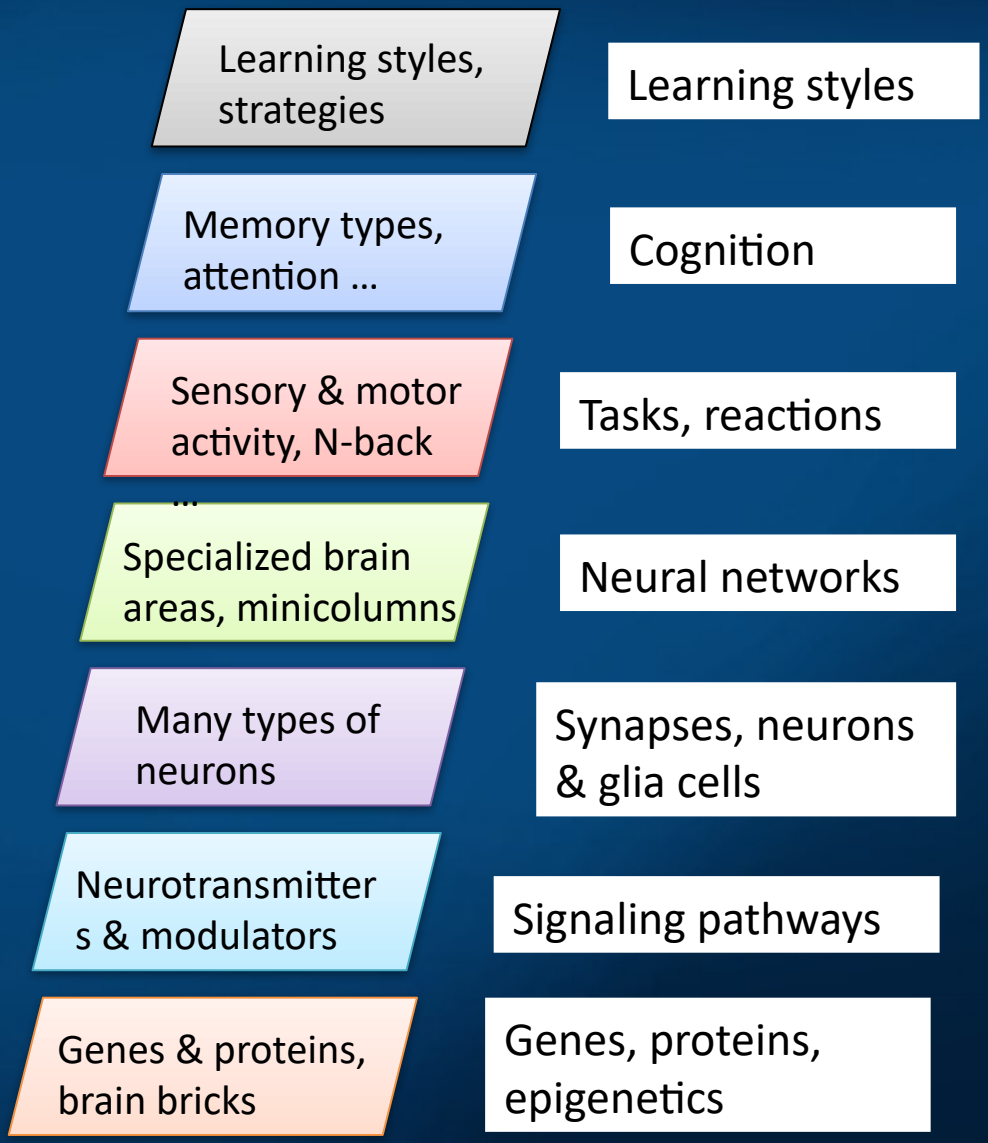
**neurobiology** - cells, tissues, organs;

**molecular/genetic**: biophysics, biochemistry & bioinformatics.

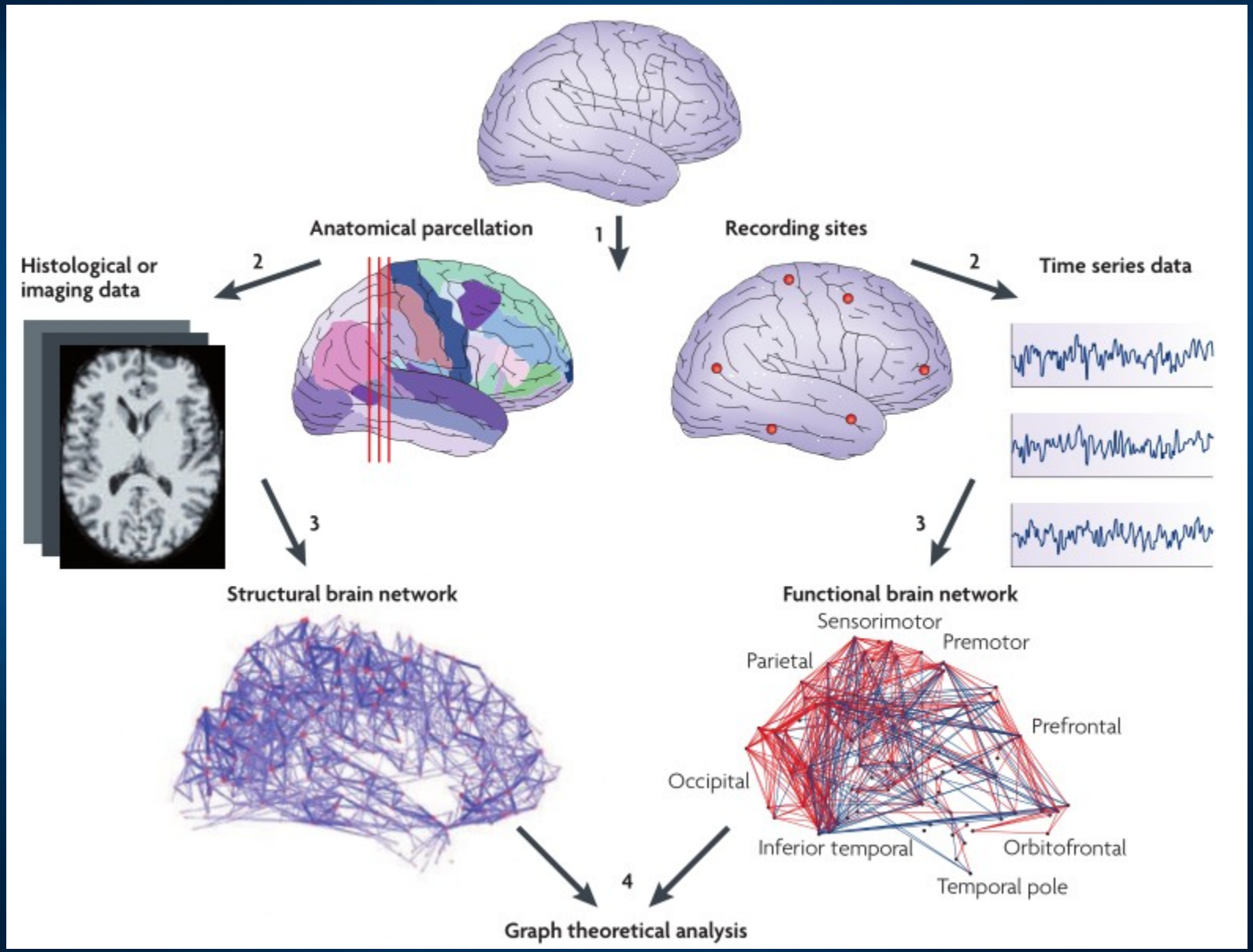
**Neurocognitive phenomics** is even a greater challenge than neuropsychiatric phenomics.

Effects are more subtle, but this is the only way to understand fully human/animal behavior.

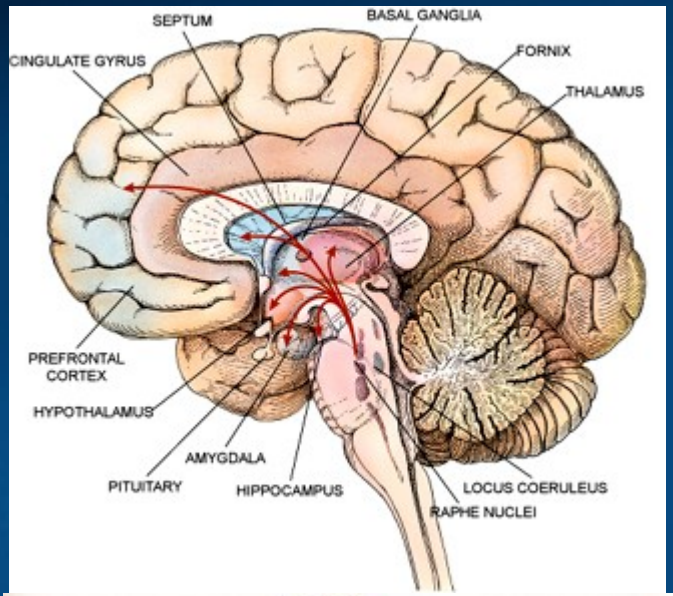
Data driven science!

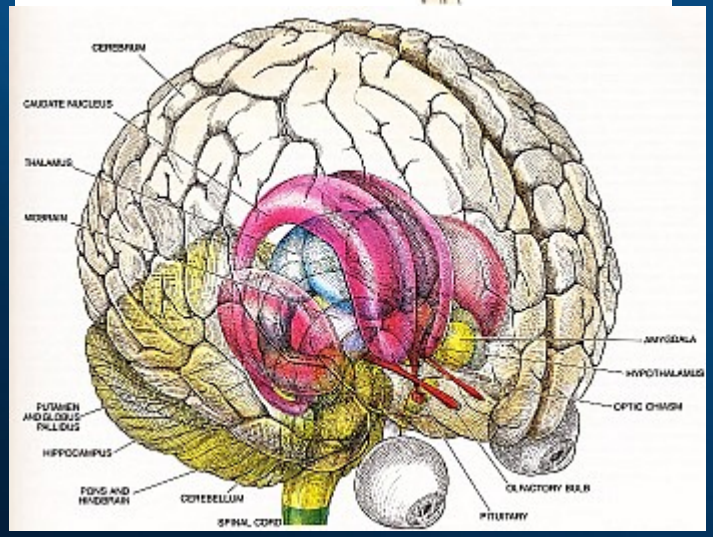


# Structure & function

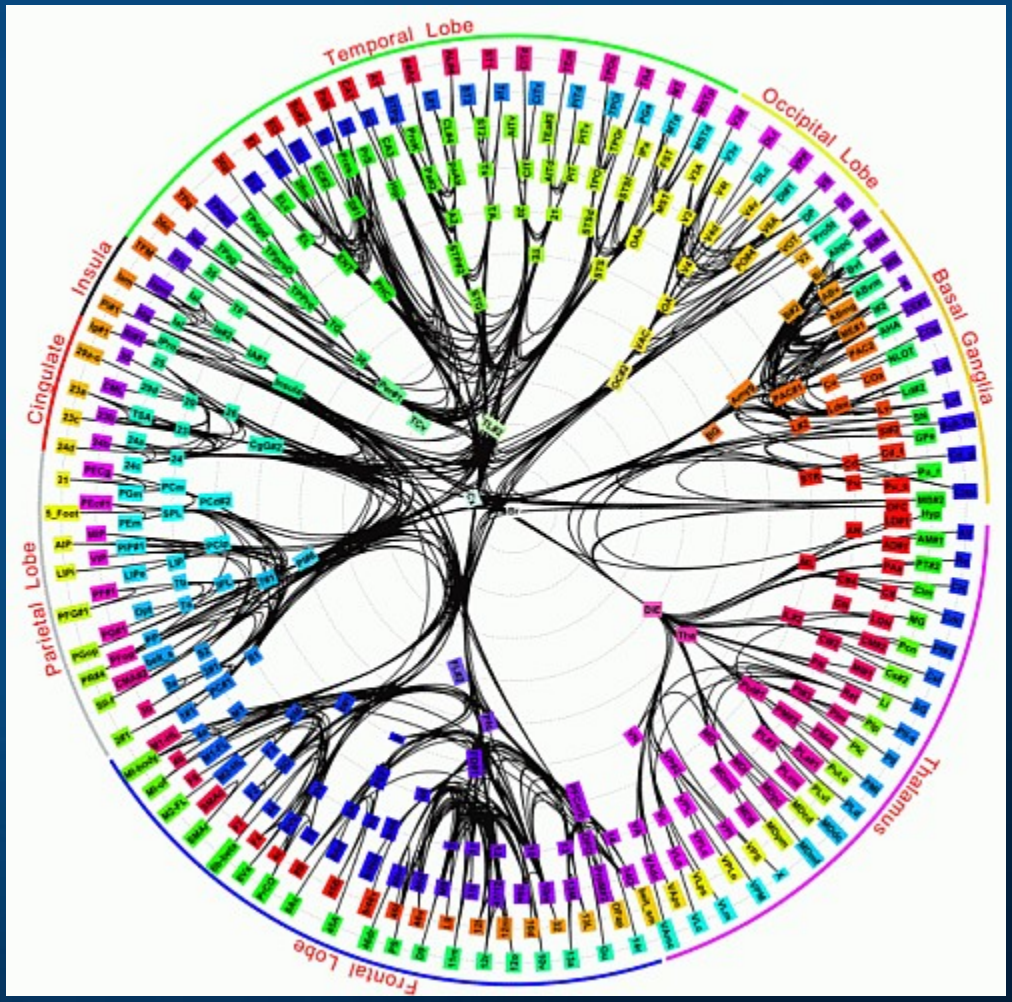


# Modules: core brain

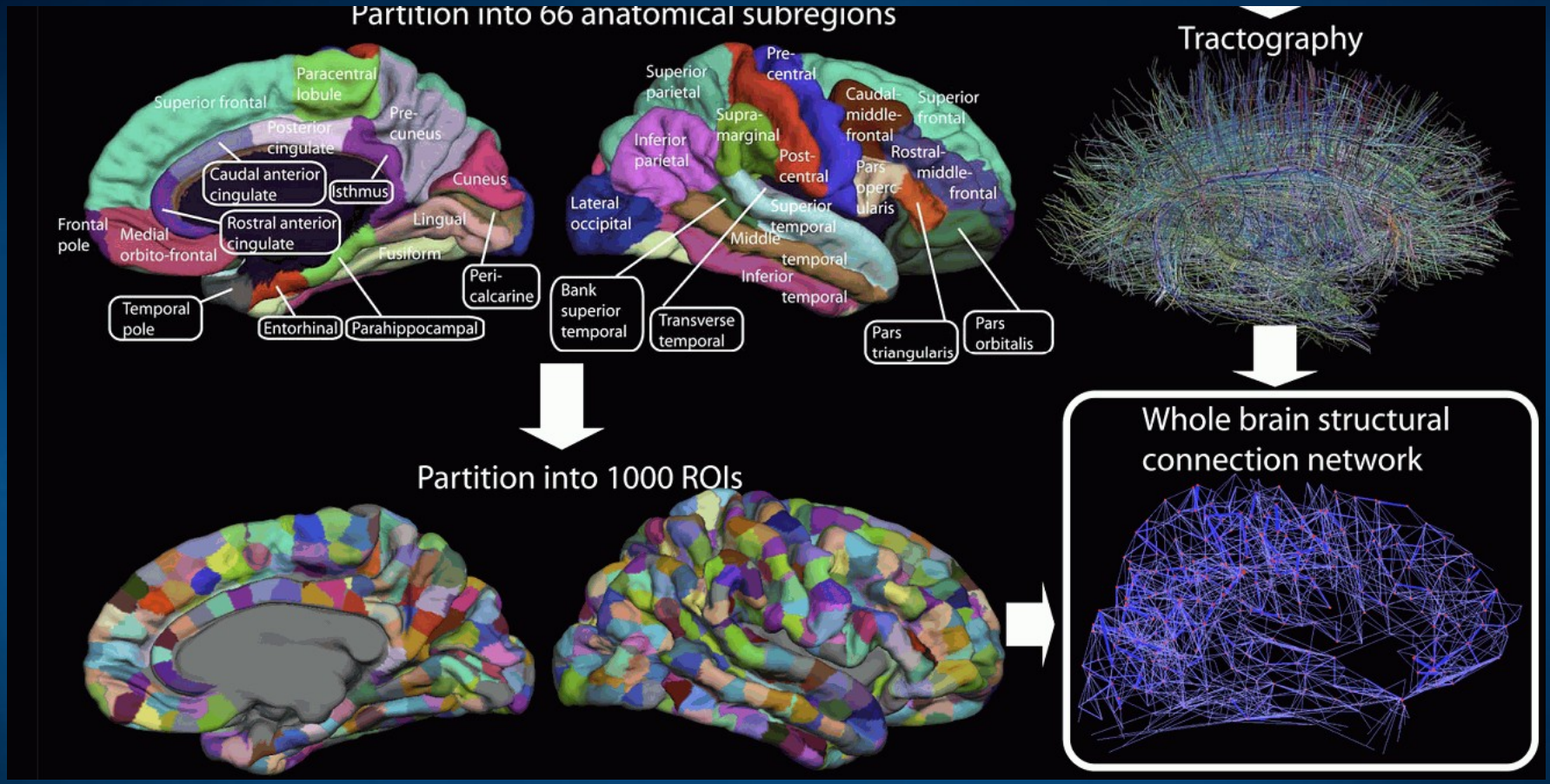



Connectivity of 383 regions in macaque brain; Modha & Singh, PNAS 2010.



# Connectome Project




Brain-based representations of concepts based on distribution of activity over 1000 ROIs should be possible.

# Geometric model of mind

Objective ⇔ Subjective.

Brain ⇔ Mind.

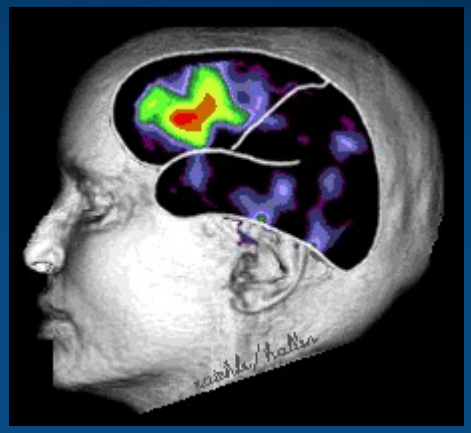
Neurodynamics describes state of the brain activation measured using EEG, MEG, NIRS-OT, PET, fMRI or other techniques.

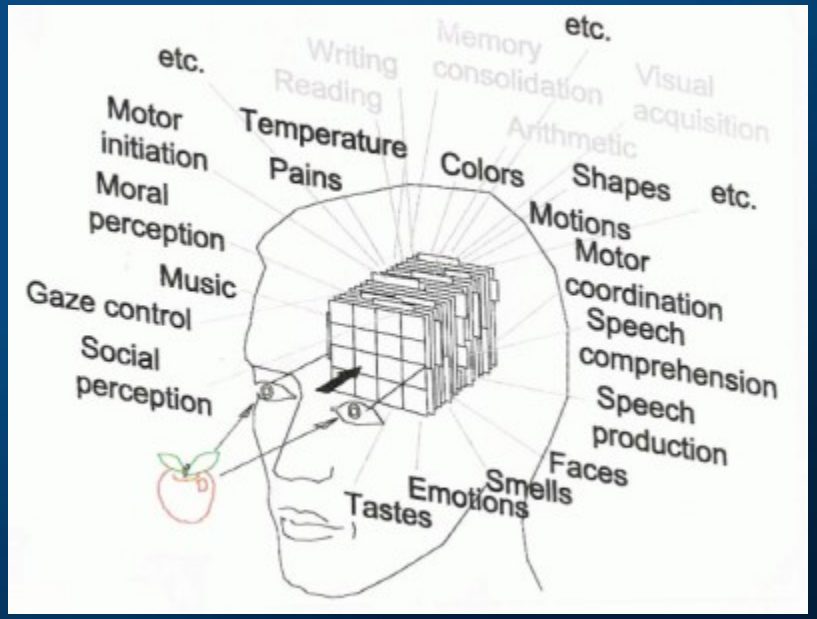
I am a function of my brain, but I can control

the brain to some degree.
How to represent mind states?

In the "psychological space" based on dimensions with subjective interpretation: intentions, emotions, qualia.

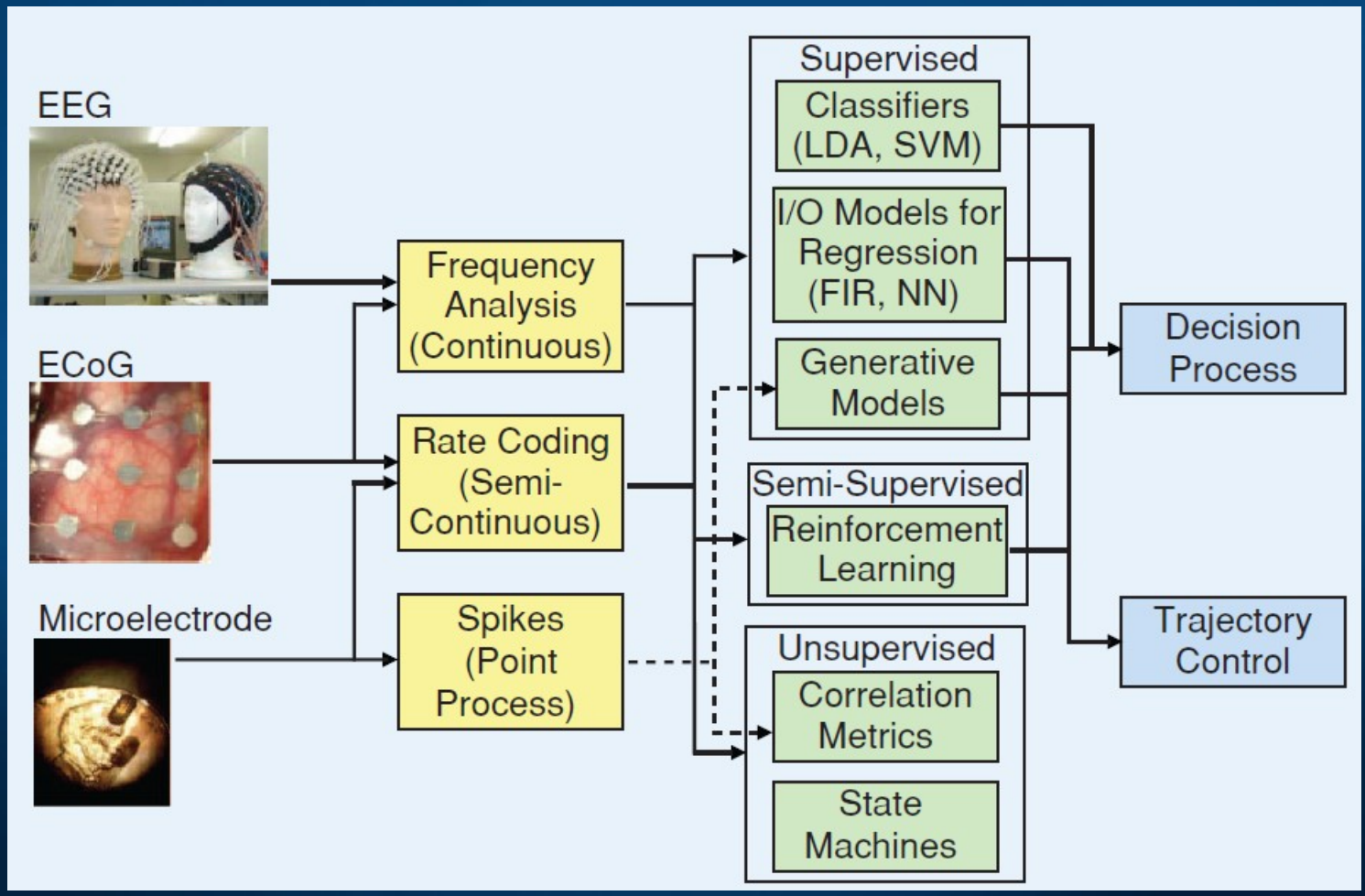
Mind state and brain state trajectory should then be linked together by mathematical transformations (BCI).





# BCI – practical applications

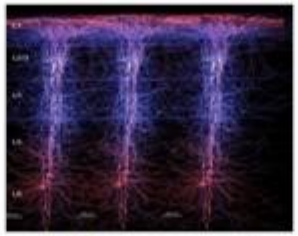
I know what you will do but my confidence will be greater if I have an access to electrodes or sensors in your brain => BCI, Brain Computer Interfaces.



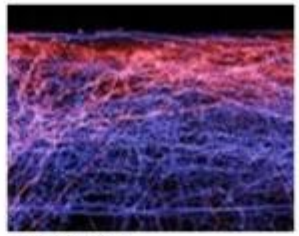
# From brains to machines

~$10^{10}$ synapses/cm$^2$

~$10^{6}$ neurons/cm$^2$



~$10^{4}$ neurons/ cortical column

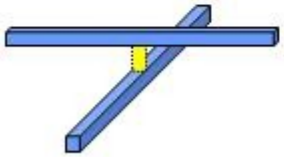


~5X$10^{8}$ long range axons @ 1 Hz

Biological Brain

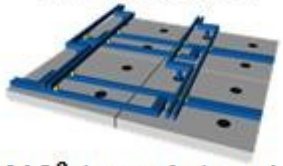
Synapse | Neurons | Microcircuit | Long-range interconnects | Brain

CROSSBAR JUNCTION



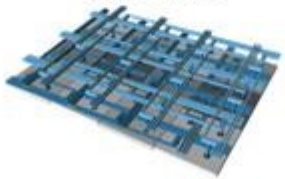
~$10^{10}$ intersections/ cm$^2$ @ 100 nm pitch

CMOS SUBSTRATE



5X$10^{8}$ transistors/ cm$^2$ @ 500 transistors/ neuron

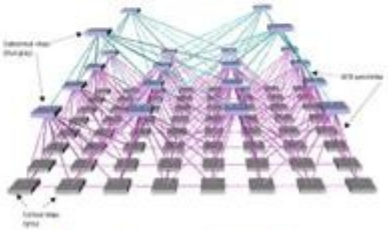
LAMINAR CIRCUIT



Layered cortical circuits with ~$10^{6}$ neurons/cm$^2$

HIGH SPEED BUS

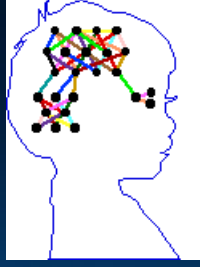
Multi-Gbit/sec digital comms



Electronic Brain

Source: DARPA Synapse project

# Private thoughts?



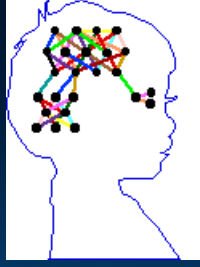
Predicting Human Brain Activity Associated with the Meanings of Nouns," T. M. Mitchell et al, Science, 320, 1191, May 30, 2008

- Clear differences between fMRI brain activity when people read and think about different nouns.
- Reading words and seeing the drawing invokes similar brain activations, presumably reflecting semantics of concepts.
- Although individual variance is significant similar activations are found in brains of different people, a classifier may still be trained on pooled data.
- Model trained on ~10 fMRI scans + very large corpus ($10^{12}$) predicts brain activity for over 100 nouns for which fMRI has been done.

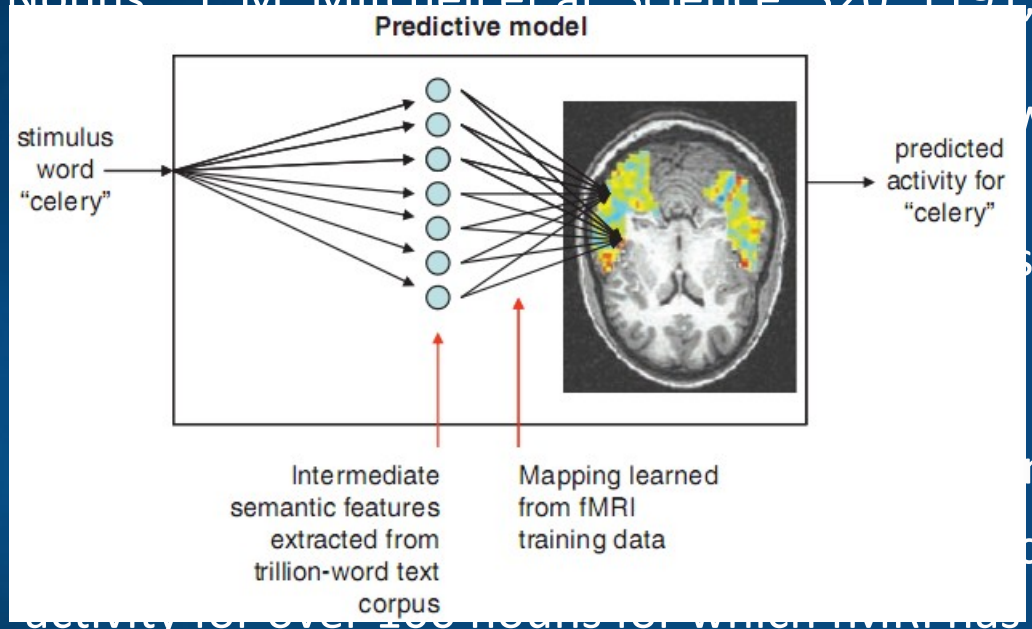
Overlaps between activation of the brain for different words may serve as expansion coefficients for word-activation basis set.

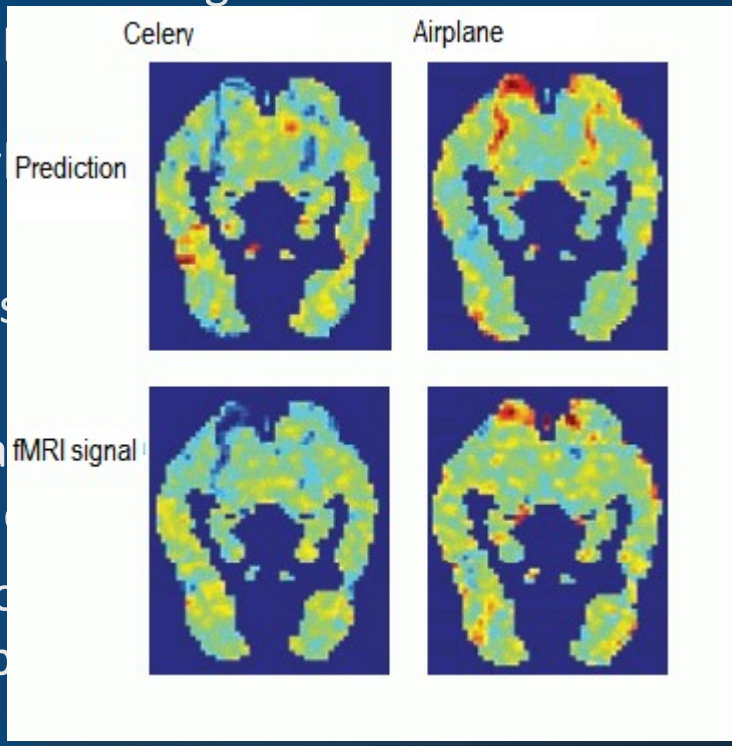
In future: I may know  what you'll think before you will know it yourself! Intentions may be known seconds before they become conscious!

# Private thoughts?



Predicting Human Brain Activity Associated with the Meanings of Nouns," T. M. Mitchell et al. Science 320, 1191 (2008)

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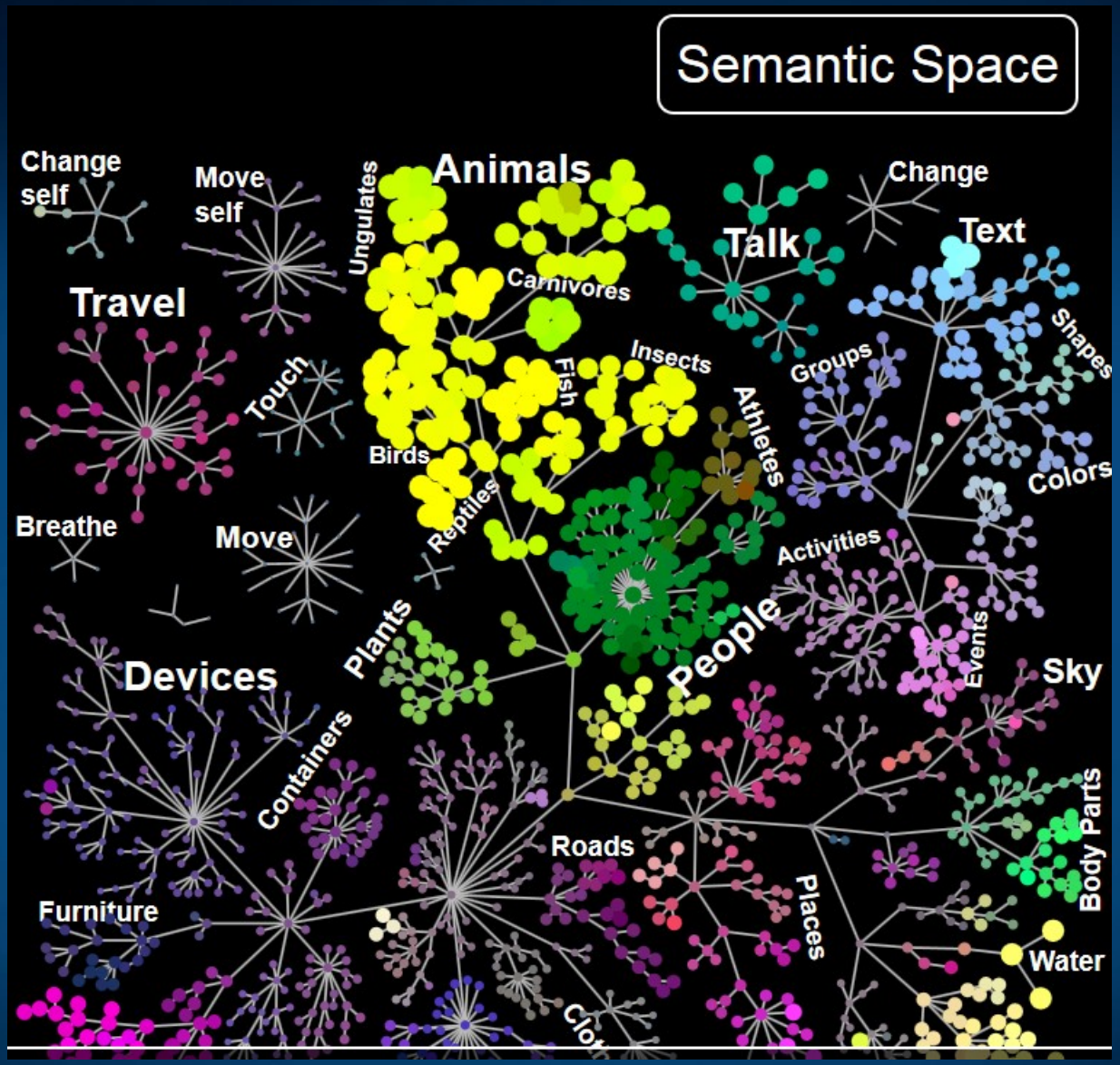
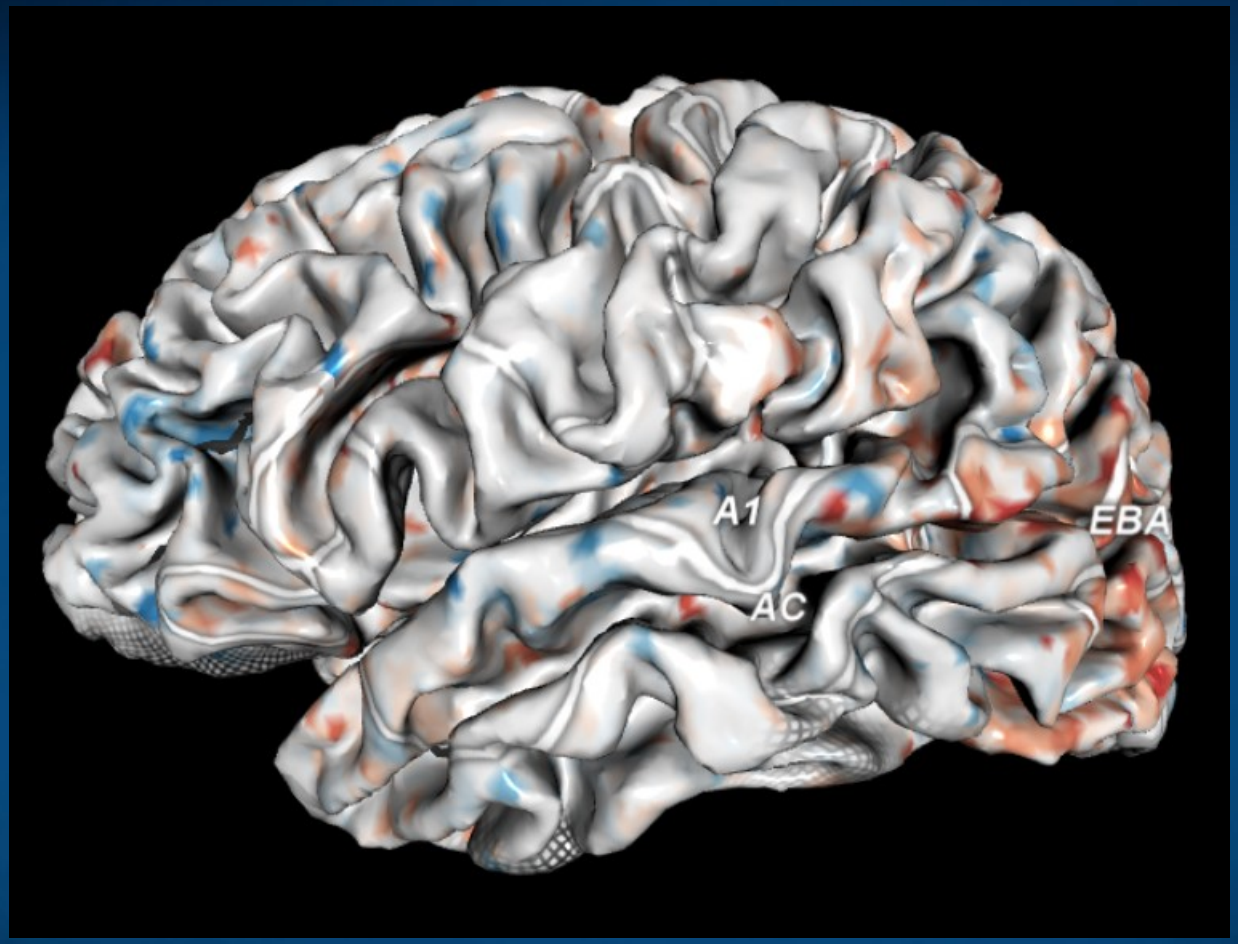
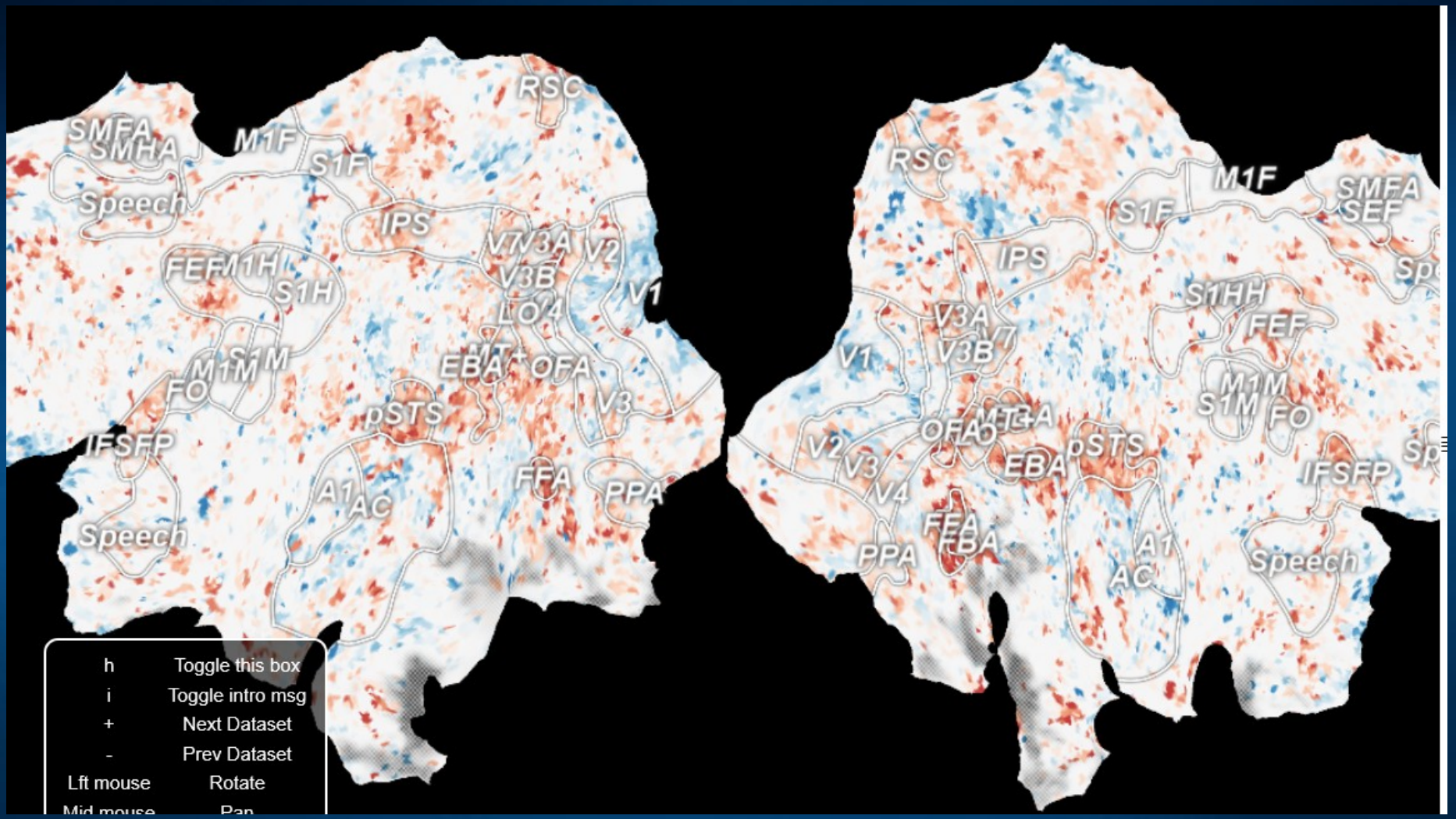



Activation of concepts in our minds leads to specific brain structure activity; each structure is involved in interpretation of many concepts.




Activation of specific concept (mental state) leads to activation of specific brain structure. Each structure contributes to sematic interpretation of many concepts through global brain activity.



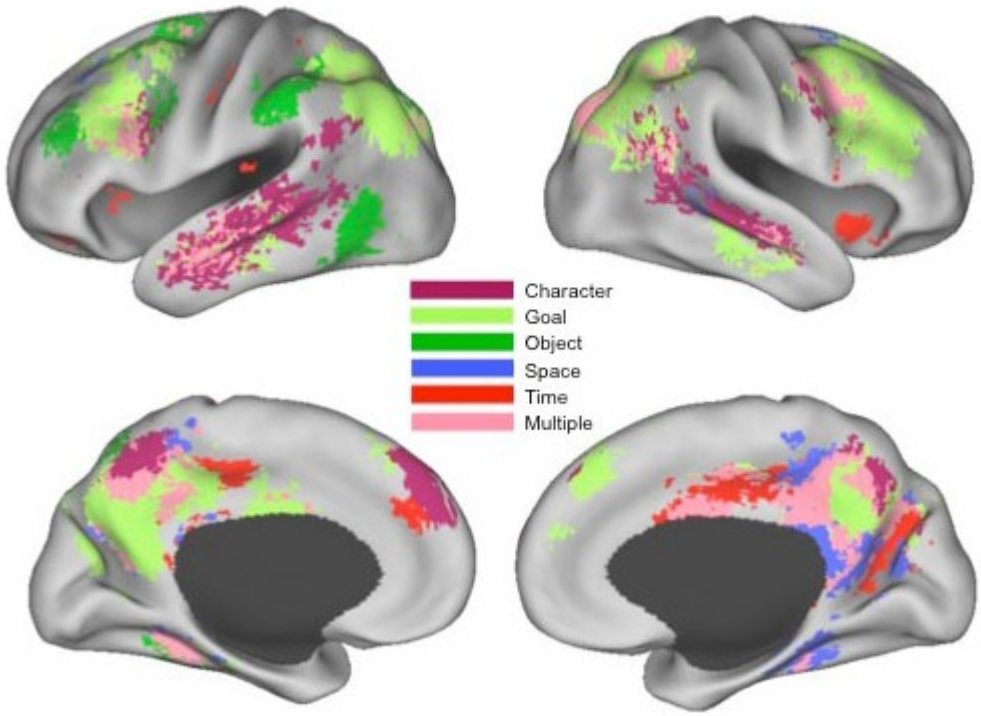

This activation is sparse and may be better observed by looking at the flattened cortex: http://gallantlab.org/brainviewer/huthetal2012/

Nicole Speer et al.
Reading Stories Activates Neural Representations of Visual and Motor Experiences.
*Psychological Science* 2009; 20(8): 989–999.
Meaning: always slightly different, depending on the context, but still may be clusterized into relatively samll number of distinct meanings.

A

| Clause | Cause | Character | Goal | Object | Space | Time |
|---|---|---|---|---|---|---|
| ...[Mrs. Birch] went through the front door into the kitchen. | ● | | | | ● | |
| Mr. Birch came in | ● | ● | | | ● | |
| and, after a friendly greeting, | ● | | | | | ● |
| chatted with her for a minute or so. | ● | | | | | ● |
| Mrs. Birch needed to awaken Raymond. | | ● | | | | |
| Mrs. Birch stepped into Raymond's bedroom, | | | ● | | ● | |
| pulled a light cord hanging from the center of the room, | | | | ● | | |
| and turned to the bed. | | | | | | |
| Mrs. Birch said with pleasant casualness, | | | | | | |
| "Raymond, wake up." | | | | | | |
| With a little more urgency in her voice she spoke again: | | | | | | |
| Son, are you going to school today? | | | | | | |
| Raymond didn't respond immediately. | | ● | | | | ● |
| He screwed up his face | | | ● | | | |
| And whimpered a little. | | | | | | |

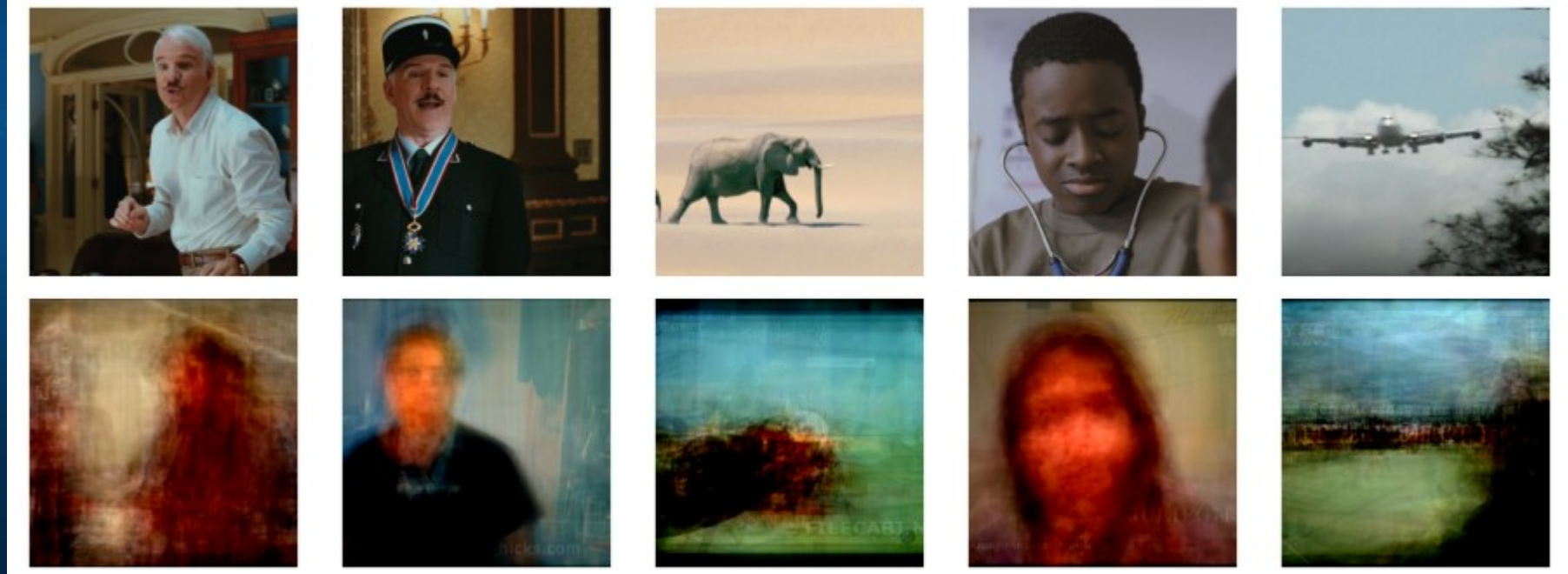
B



# Looking inside

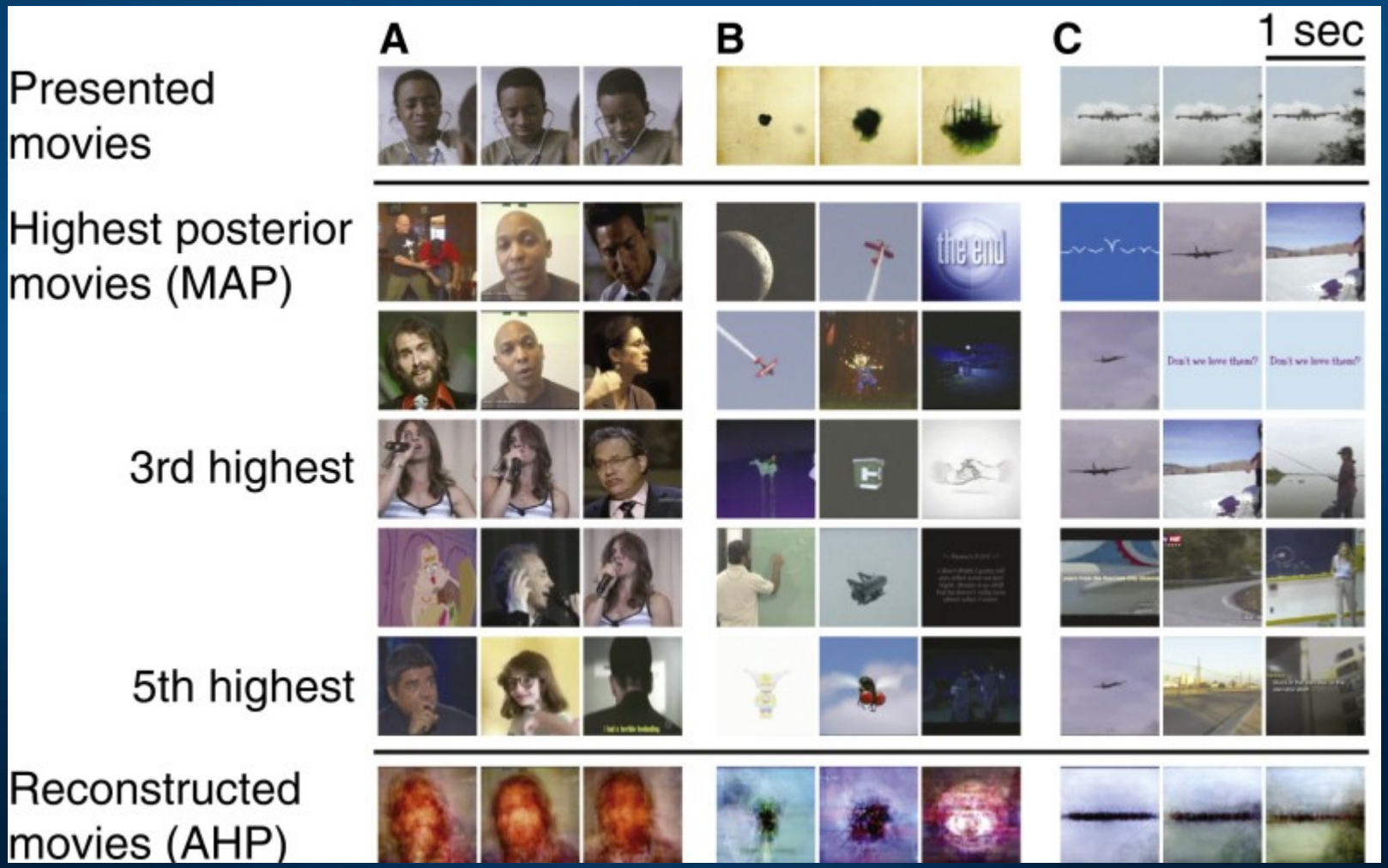
Scanner fMRI 4 Tesla

S. Nishimoto et al. Current Biology 21, 1641-1646, 2011



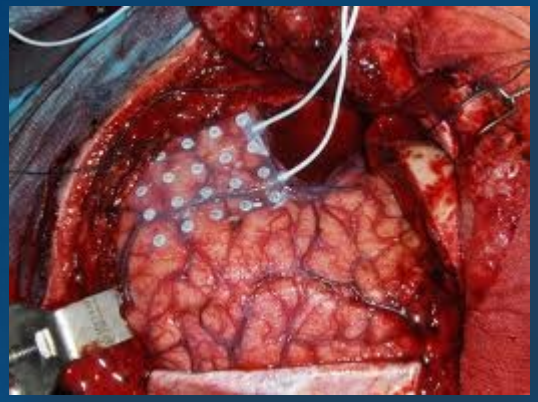
# Reconstructing Visual Experiences

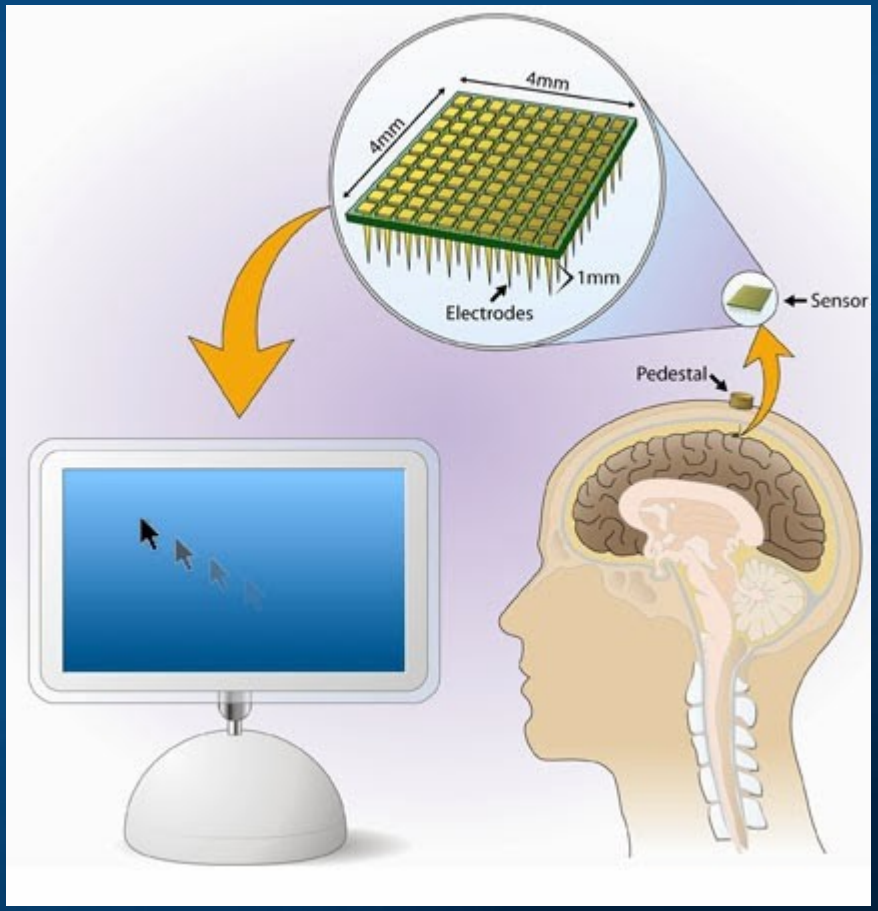
S. Nishimoto et al. Reconstructing Visual Experiences from Brain Activity Evoked by Natural Movies. Current Biology 21, 1641-1646, 2011



# Blurred image?

Just give us access to your cortex, open your skulls, please.
BrainGate Turning Thought into Action chip will help (4x4 mm, 100 sensors).

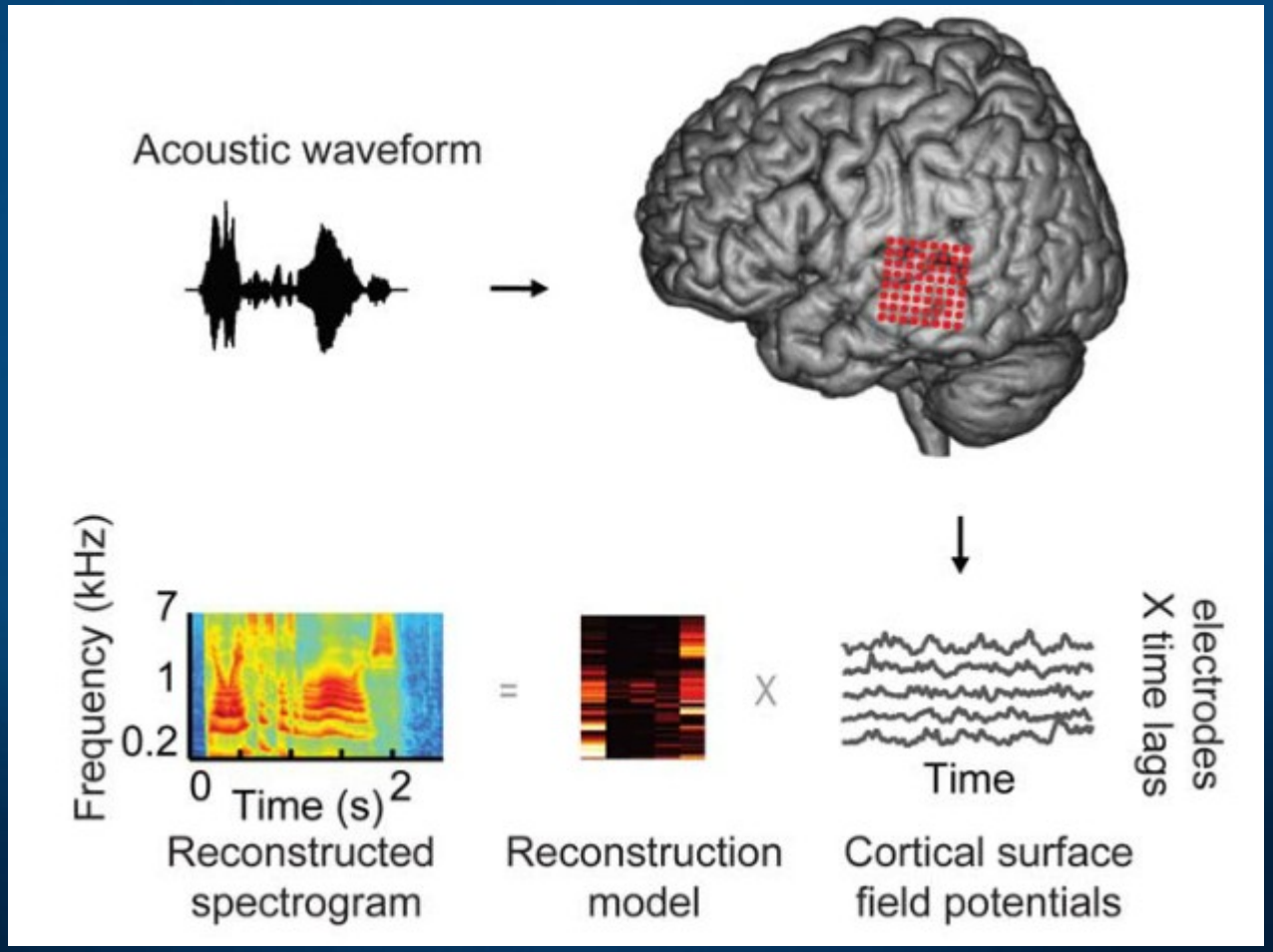




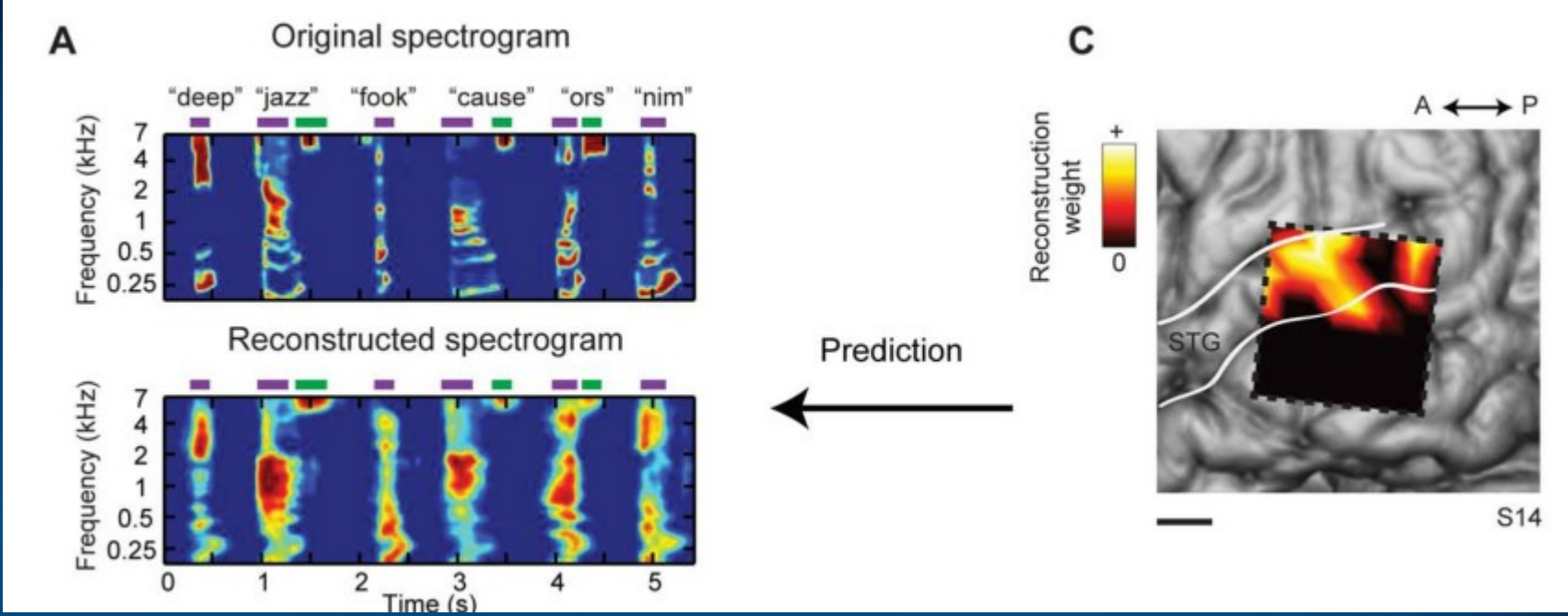

Then you may learn what your brain has already discovered but it has not yet become conscious, and you may control your own behavior using remote pilot …

# Hearing your thoughts

Spectrogram-based reconstruction of the same speech segment, linearly decoded from a set of electrodes.



# Thought: time, frequency, place, energy




Pasley et al. Reconstructing Speech from Human Auditory Cortex PLOS Biology 2012

# Logic and learning

Inferences of meaning and equivalent logical inferences engage different brain areas.

**Logical**: If both X and Z then not Y ⇔ If Y then either not X or not Z.

**Linguistic:** It was X that Y saw Z take ⇔ Z was seen by Y taking X.

Learning logic does not help in situated learning.

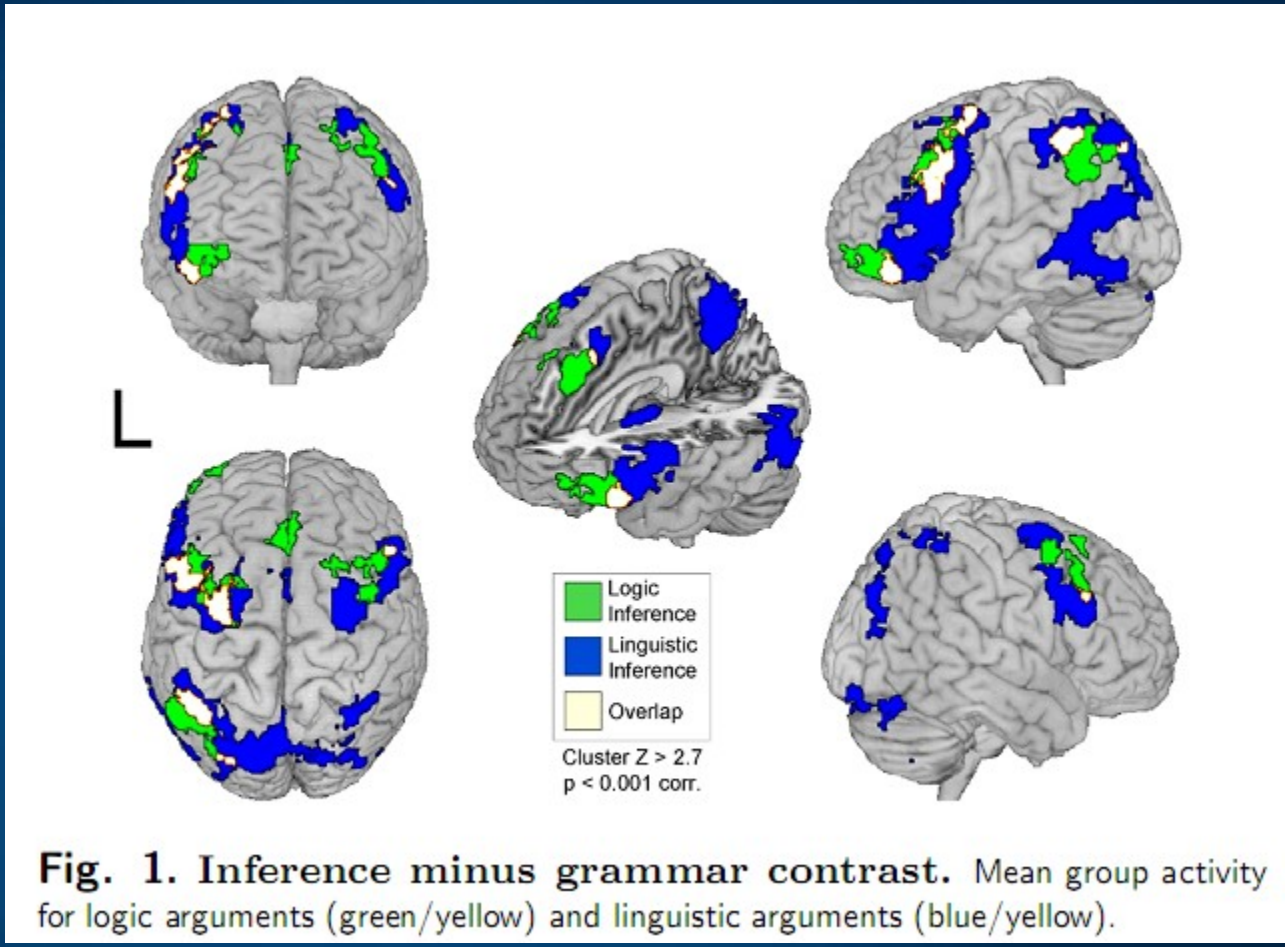



**Fig. 1. Inference minus grammar contrast.** Mean group activity for logic arguments (green/yellow) and linguistic arguments (blue/yellow).

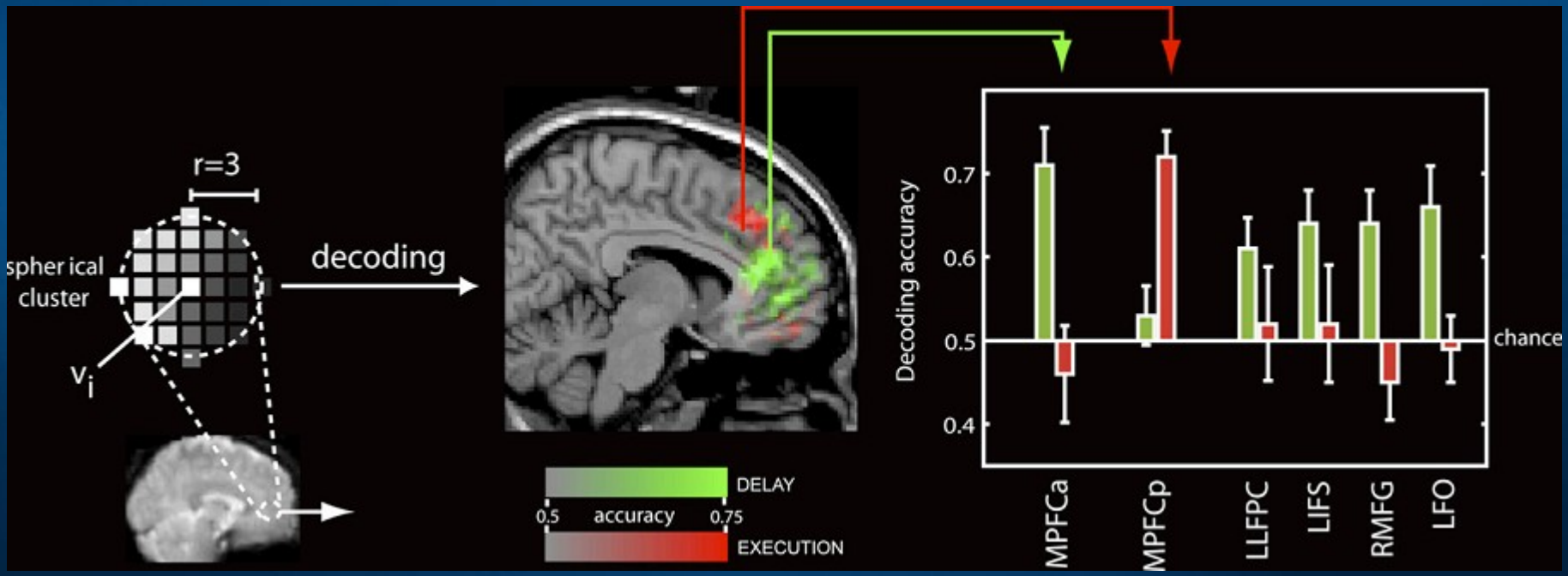
M.M. Monti, L.M. Parsons, D.N. Osherson, The boundaries of language and thought: neural basis of inference making. PNAS 2009

# Intentions in the brain

J-D. Hayens i inn, Reading Hidden Intentions in the Human Brain. Current Biology 17, 323-328, 2007.

Add or subtract two numbers as you wish.

Looking at the activity of medial prefrontal cortex (mPFC) I will tell you what you will do before you will make a decision ...



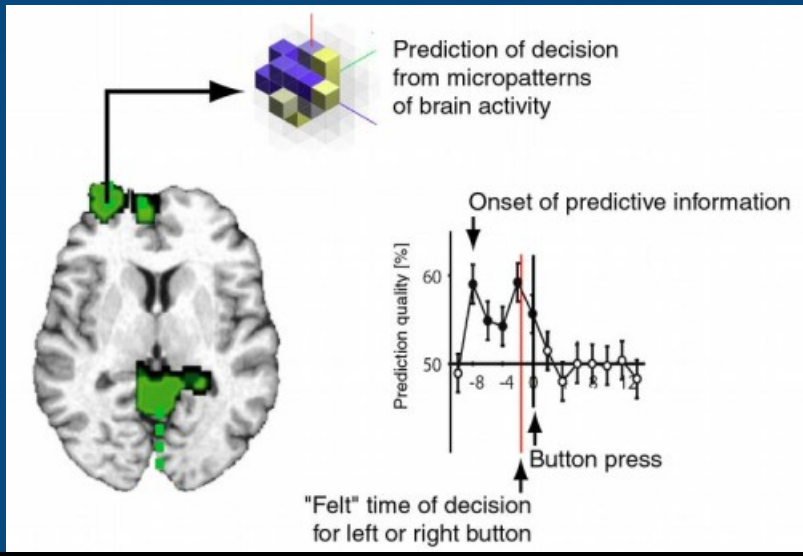
# 10 seconds clairvoyance

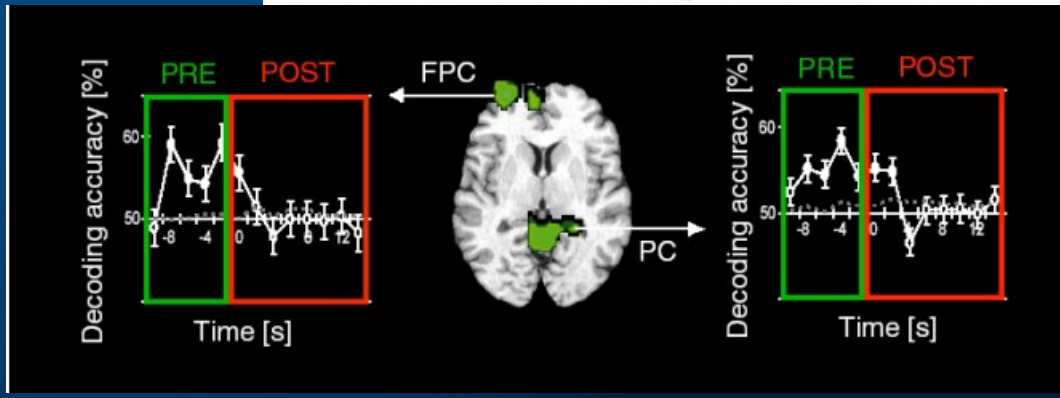
C.S. Soon, M. Brass, H-J. Heinze & J-D. Haynes,
Unconscious determinants of free decisions in the human brain.
Nature Neuroscience, April 2008.

Brain must plan action, and we are conscious of these plans only when activation of motor cortex is sufficiently strong to distinguish it from neural noise.

Looking at PFC using fMRI one may decode intentions even up to 10 seconds before conscious decision is made.

Brain creates my self,
but still I can control my brain!



# Brain control

Wegner DM, *The illusion of conscious will*. MIT Press(2002)

We may be acting but do not realize that we are: ex: ouija board to contact spirits, facilitated communication; water divination and hypnotism.

We are not acting, but think that we are: subjects may be induced to believe that they have performed some actions, or that their actions are achieving far more than they in fact are.

Conscious acts of will are never the direct causes of our actions, instead, both conscious willing and action are the effects of a common unconscious cause.

# Brain control


. MIT Press(2002)

we are: ex: ouija board to contact
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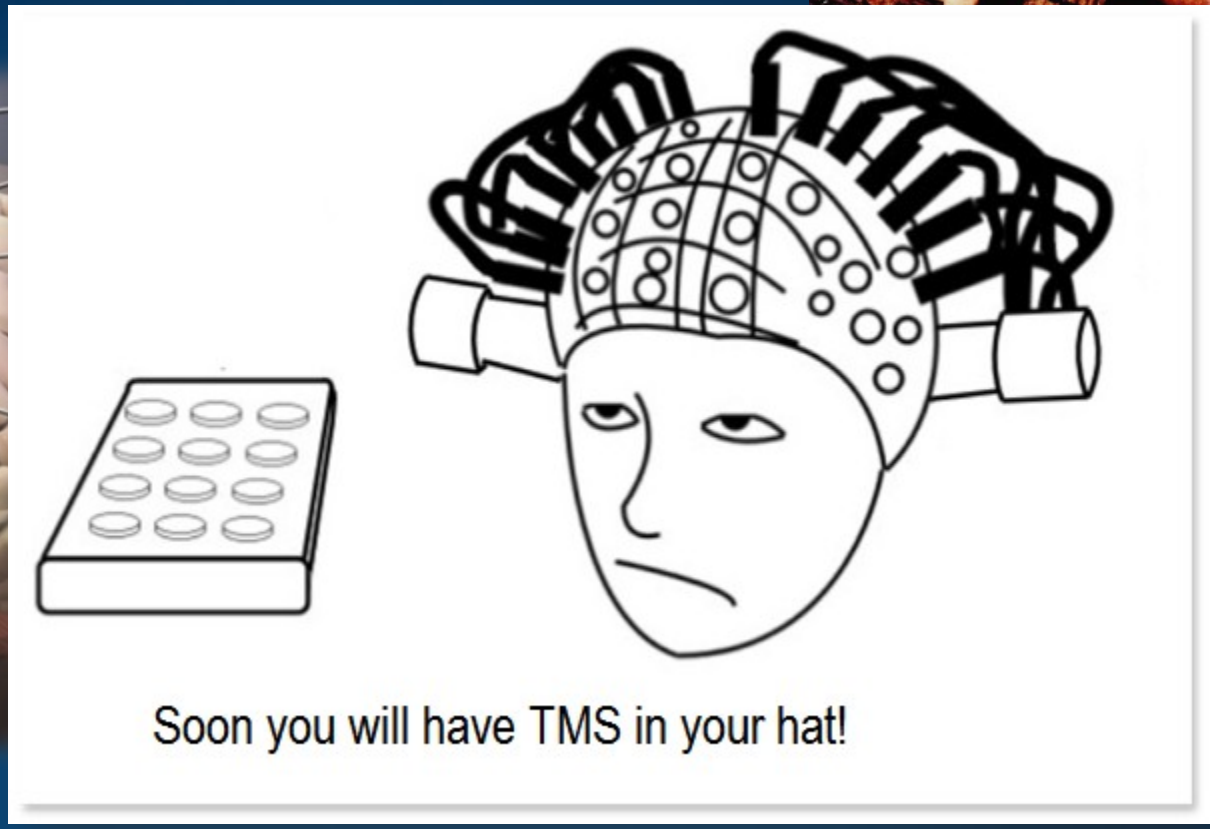
TMS stimulations: even if one side is selected 80% of times the choice is felt as free ... we could be radio controlled!

Will is just another feeling resulting from attention to the state of the pre-supplementary motor cortex (Pre-SMA).

# Brain control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Will is just another feeling resulting from attention to the state of the pre-supplementary motor cortex (Pre-SMA).

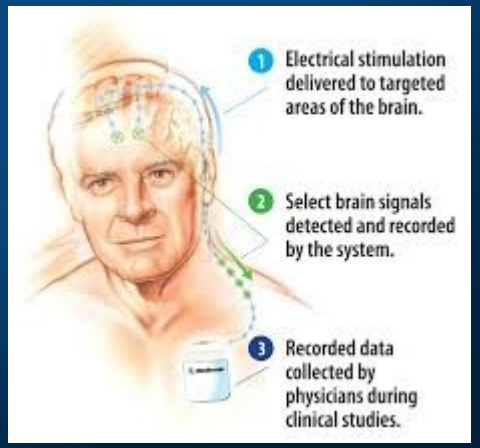
# Direct Brain Stimulation

Paying attention for a long time is difficult, requires sustained PFC activity to stimulate sensory/associative cortex. Direct stimulation using electric currents (tDCS) or magnetic fields (rTMS) is effortless.

This is used now by professional gamers, as well as in training of pilots and combat troops.

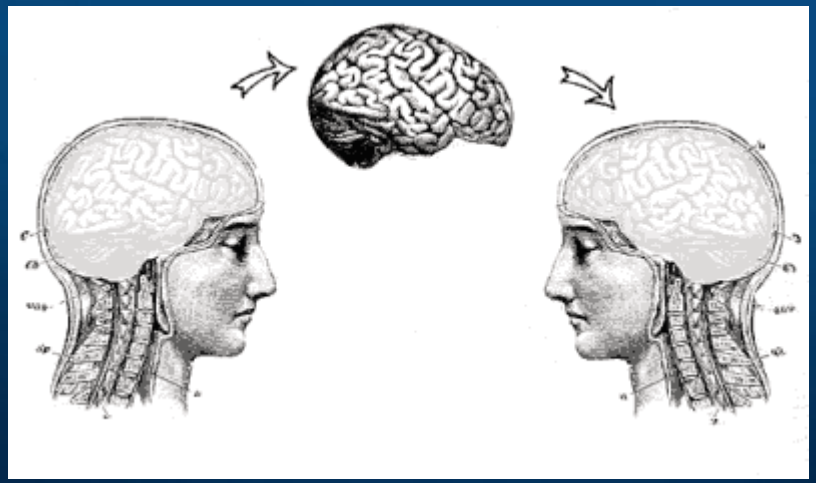
Engagement Skills Trainer (EST) procedures are used by the USA army; Intific Neuro-EST is a new technology using EEG to transfer skills between experienced operator and newcomers.

People who suffer from OCD or Parkinson disease and have deep brain stimulators feeling the onset of problems may increase or turn-on their stimulation, directly controlling their brains.

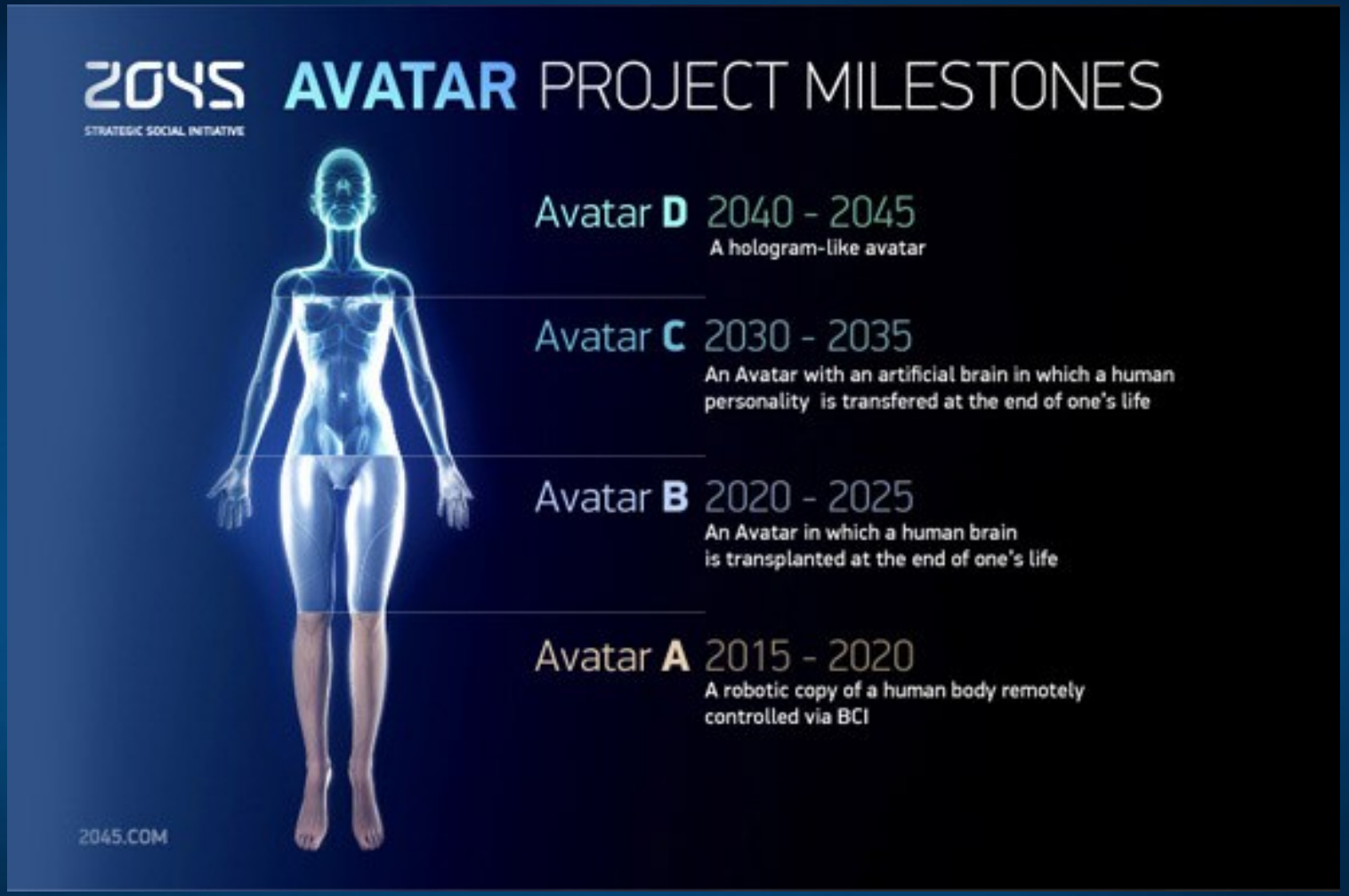



# Though transfer?

Read the thoughts from one brain (fMRI, NIRS, EEG) and stimulate another brain (DCS, TMS) in the same way? Mind transfer?

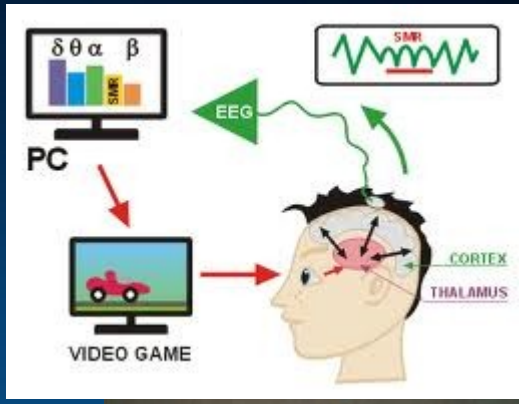


# Mind => Avatar




Some projects aim at mind transfer to artificial brains, creating our avatars by 2045 … see http://2045.com and The *Electronic Immortality Corporation*, a new social network.

# EEG and creativity




How to increase cooperation between distant brain areas important for creativity?

α–θ and heart rate variability (HRV) biofeedback produced "professionally significant performance improvements" in music and dance students. (J.H. Gruzelier, Soc. For Applied Neuroscience).

Musicality of violin music students was enhanced; novice singers from London music colleges after 10 sessions in 2 months learned significantly the EEG self-regulation of θ/α power ratio.

The pre/post assessment involves creativity measures in improvisation, a divergent production task, and the adaptation innovation inventory. Why there is improvement?

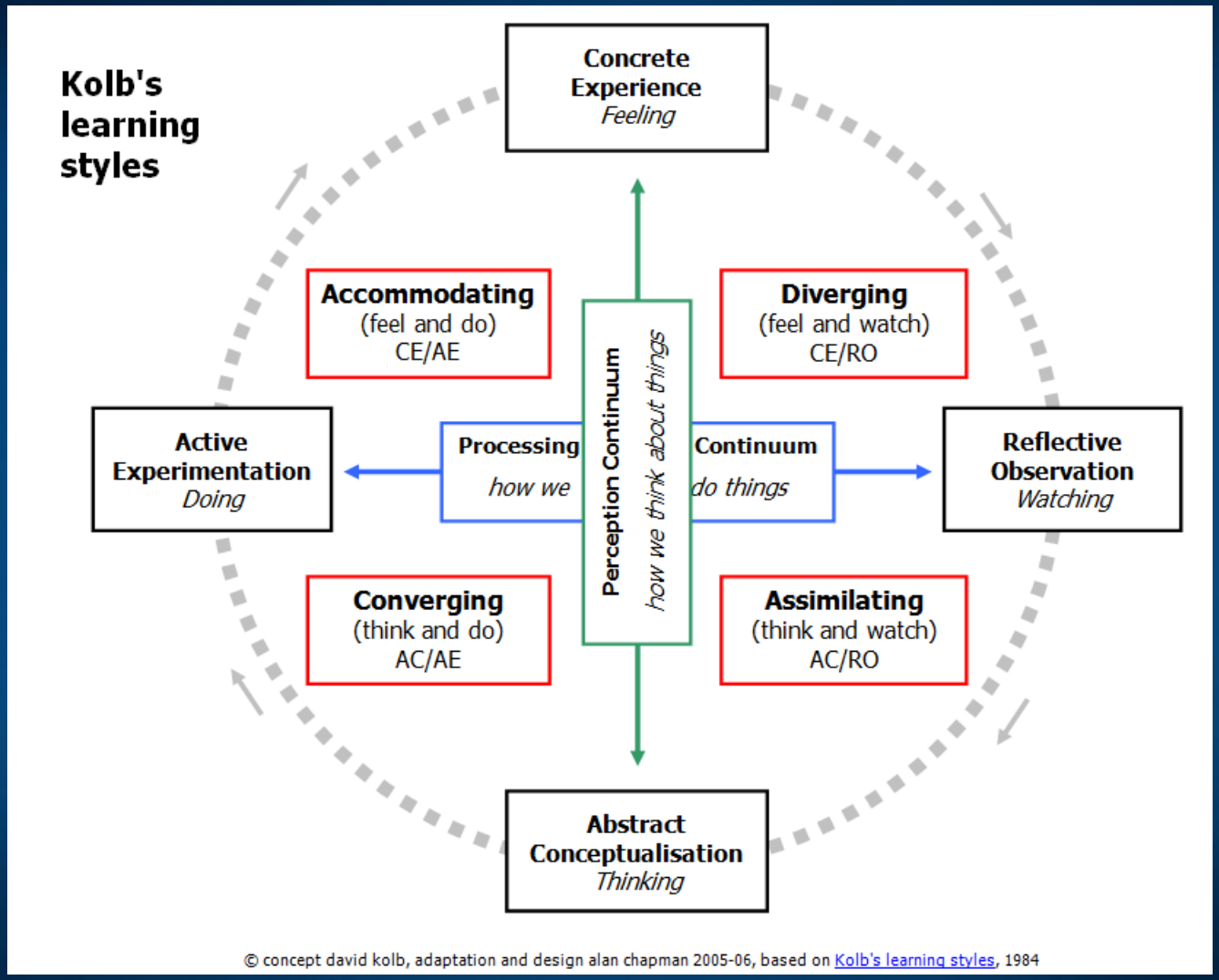
1. Low frequency waves = easier to synchronize distant areas.
2. Decrease of background processes and parasite oscillatory processes.

# rTMS and savant syndrome

Allan W. Snyder et al. (Centre for the Mind, The University of Sydney), Savant-like skills exposed in normal people by suppressing the left fronto-temporal lobe. Journal of Integrative Neuroscience, 2003
Chi, Snyder, Facilitate Insight by Non-Invasive Brain Stimulation, PLoS One 2011


Few percent of mentally retarded people show unusual memory, arithmetics, artistic or musical skills – savant syndrome.
Using rTMS 3 Tesla low frequency magnetic field) helped 4 out of 11 subjects to draw better pictures.
Direct Current Stimulation (DCS) opens short (~15 min) window of brain plasticity, facilitating rapid learning (and brain washing).

# Learning styles



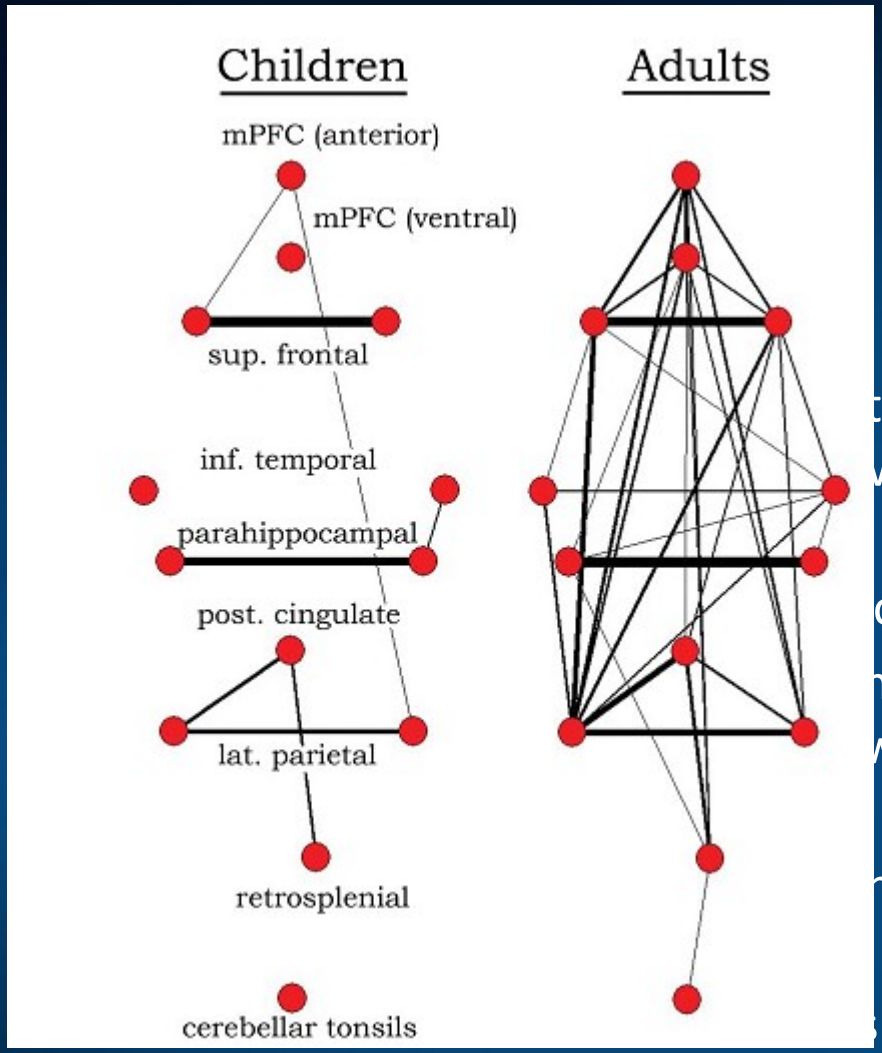

David Kolb, *Experiential learning: Experience as the source of learning and development* (1984), and *Learning Styles Inventory*.

# Origin of the learning styles

Connectomes develops before birth and in the first years of life.

Achieving harmonious development is very difficult and depends on low-level (genetic, epigenetic, signaling pathways) processes, but may be influenced by experience and learning.

- Excess of low-level (sensory) processes S⇔S.
- Poor C⇔C neural connections and synchronization, frontal⇔parietal necessary for abstract thinking, weak functional connections prefrontal lobe ⇔ other areas.
- Patterns of activation in the brain differ depending on whether the brain is doing social or nonsocial tasks.
- “Default brain network” involves a large-scale brain network (cingulate cortex, mPFC, lateral PC), shows low activity for goal-related actions; strong activity in social and emotional processing, mindwandering, daydreaming.




# earning styles

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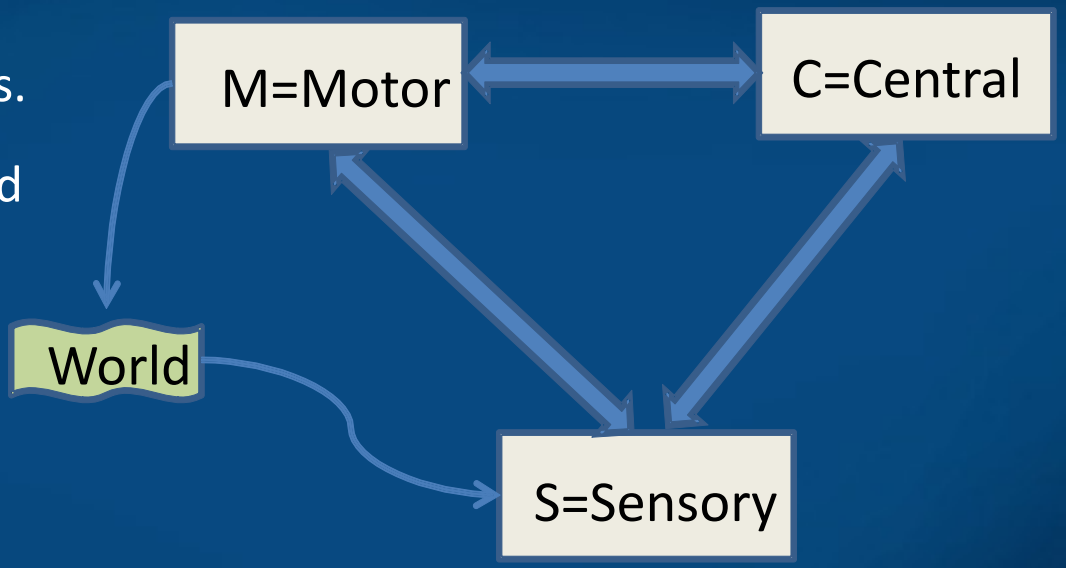
# Connectome and learning styles

Simple connectome models may help to connect and improve learning classification of the styles.

S, Sensory level, occipital, STS, and somatosensory cortex;

C, central associative level, abstract concepts that have no sensory components,

mostly parietal, temporal and prefrontal lobes.



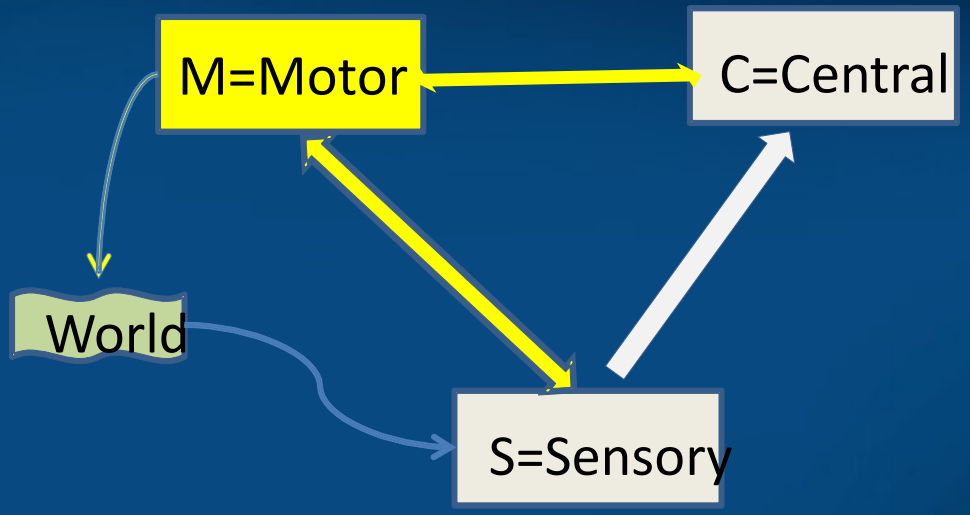

M, motor cortex, motor imagery & physical action.
Frontal cortex, basal ganglia.

Even without emotion and reward system predominance of activity within or between these areas explains many learning phenomena.

# Learning styles D1

Kolb passive-active dimension, observation – experimentation: motor-central processes M⇔C, sensory-motor processes M⇔S.

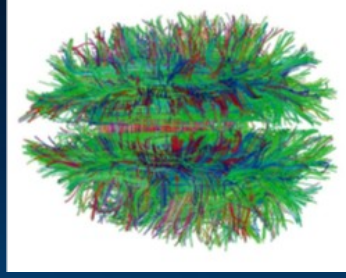
Autistic people: processes at the motor level M⇔M, leads to repetitive movements, echolalia.




The *Learning Styles Inventory* is a tool to determine learning style. The tool divides people into 4 types of learners:

- divergers (concrete, reflective),
- assimilators (abstract, reflective),
- convergers (abstract, active),
- accommodators (concrete, active).

# 4 styles and more



Assimilators think and watch: prone to abstract thinking, reflective observation, inductive reasoning due to strong connections S=>C and within C⇔C, weak connections from S=>M and C=>M.

Convergers combine abstract conceptualization, active experimentation, using deductive reasoning in problem solving.
Strong C⇔C and C=>M flow of activity.

Divergers focus on concrete experience S⇔S, strong C⇔S connections and C⇔C activity facilitating reflective observation, strong imagery, novel ideas but weak motor activity.

Accommodators have balanced sensory, motor and central processes and thus combine concrete experience with active experimentation supported by central processes S⇔C⇔M.

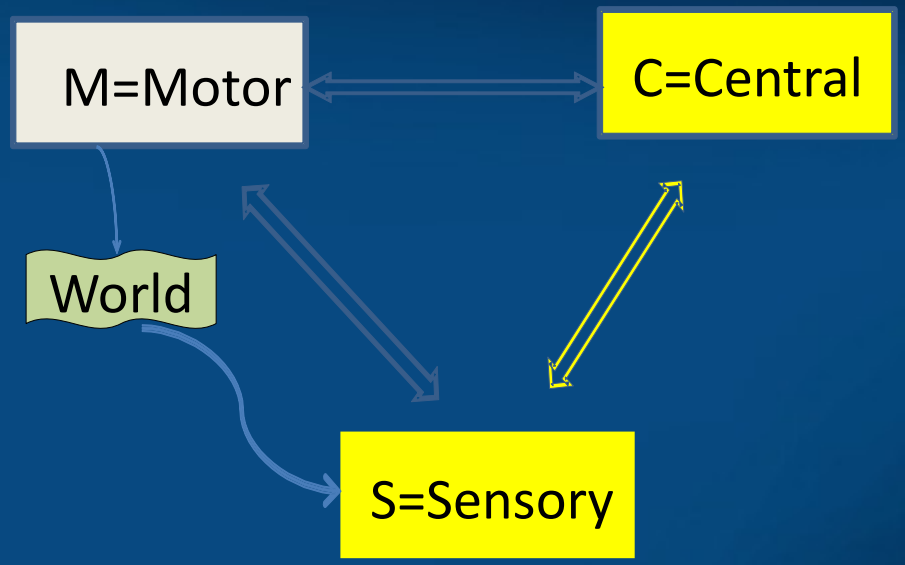
The idea of learning styles is criticized because there was no theoretical framework behind it, but objective tests of the learning styles may be based on brain activity.

# Learning styles D2

Kolb perception-abstraction:
coupling within sensory S⇔S areas, vs.
coupling within central C⇔C areas.

Strong C=>S leads to vivid imagery dominated by sensory experience.

Autism: vivid detailed imagery, no generalization.




Attention = synchronization of neurons, limited to S, perception S⇔S strongly binds attention => no chance for normal development.
**Asperger syndrome** strong C=>S activates sensory cortices preventing understanding of metaphoric language.

If central C⇔C processes dominate, no vivid imagery but efficient abstract thinking is expected - mathematicians, logicians, theoretical physicist, theologians and philosophers ideas.

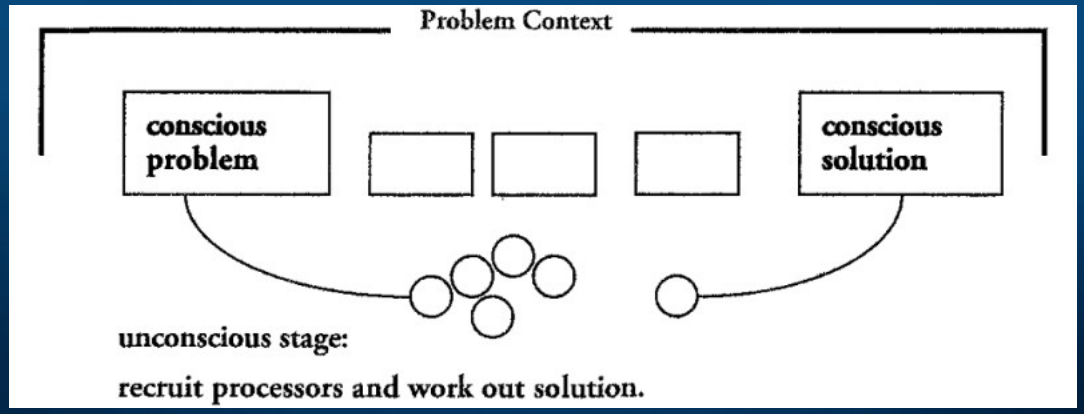
# Problem solving in 3 steps

Many cognitive processes may be decomposed into 3 steps:

1. Understanding the problem (conscious);
2. Performing transformations/associations towards solution (unconscious);
3. Recognition of situation after transformation (conscious).

The process should be effortless as long as one can focus, initiate brain activity focusing on the problem and its context, perform unconscious transformation and recognize the result.

So if you have done your homework: just focus and wait for the solution.

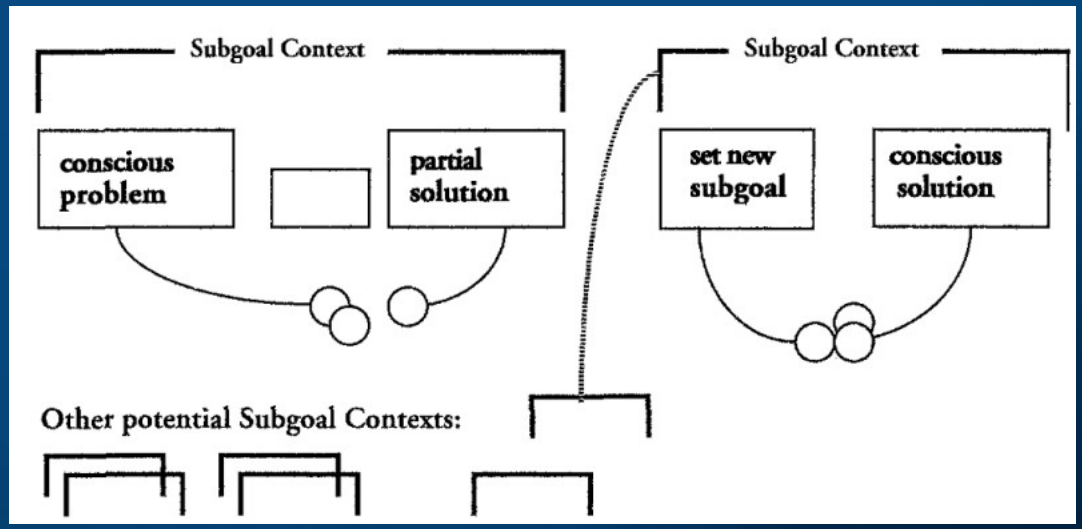


# 3 steps are found in many activities

The same 3 steps may be distinguished in:

- any action control: intention, unconscious activity (motor, associative), perception of results and comparison with intentions;
- recall from memory: intention, wait, recognize;
- object recognition, perception of ambiguous situations;
- spontaneous, creative actions;
- problem solving;
- planning.

Sequential reasoning repeats these 3 steps many times.

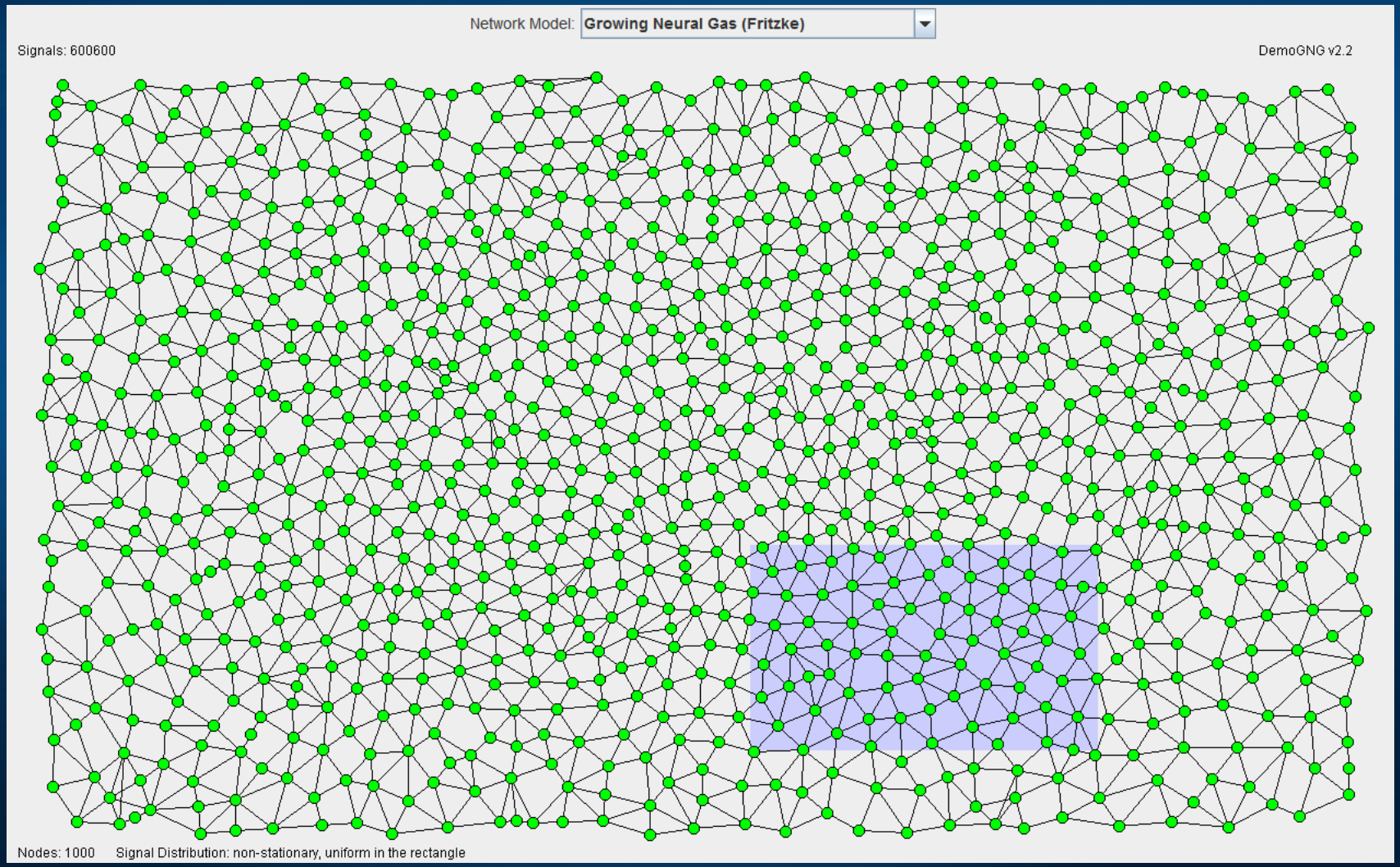


# Conspiracy in the brain


- Emotional situations => neurotransmitters => neuroplasticity => fast learning, must be important.
- Fast learning => high probability of wrong interpretation.
- Traumatic experiences, hopelessness, decrease brain plasticity and leave only strongest association.
- Conspiracy theories form around associations with frozen brain activities, that become strong attractors channeling thoughts.
- Simple associations save brain energy and rational arguments cannot change them.
- This explanation becomes so obviously obvious … it will appear even in your dreams.

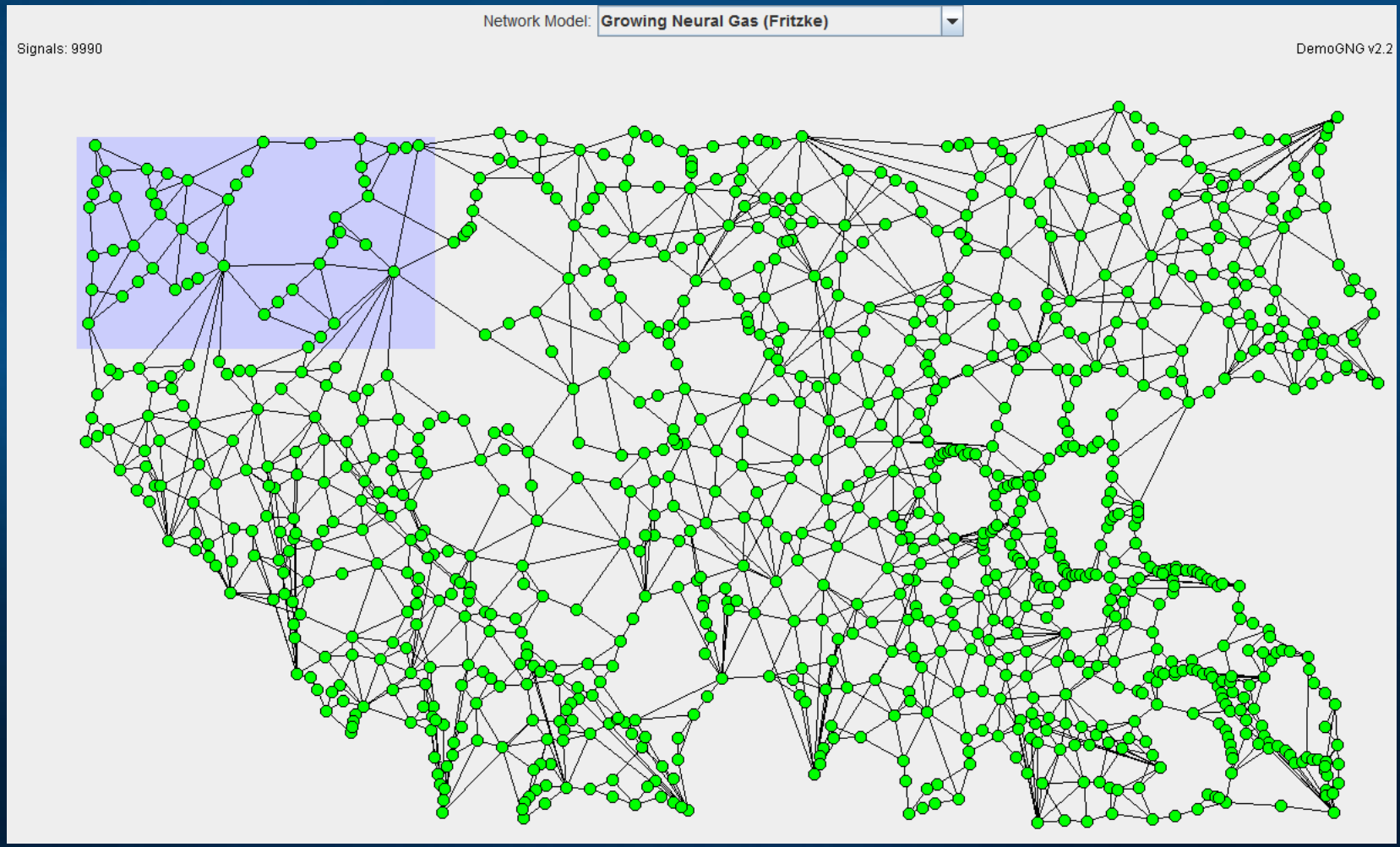
# Internalization of environment

Episodes are remembered and serve as reference points, if observations are unbiased they reflect reality.



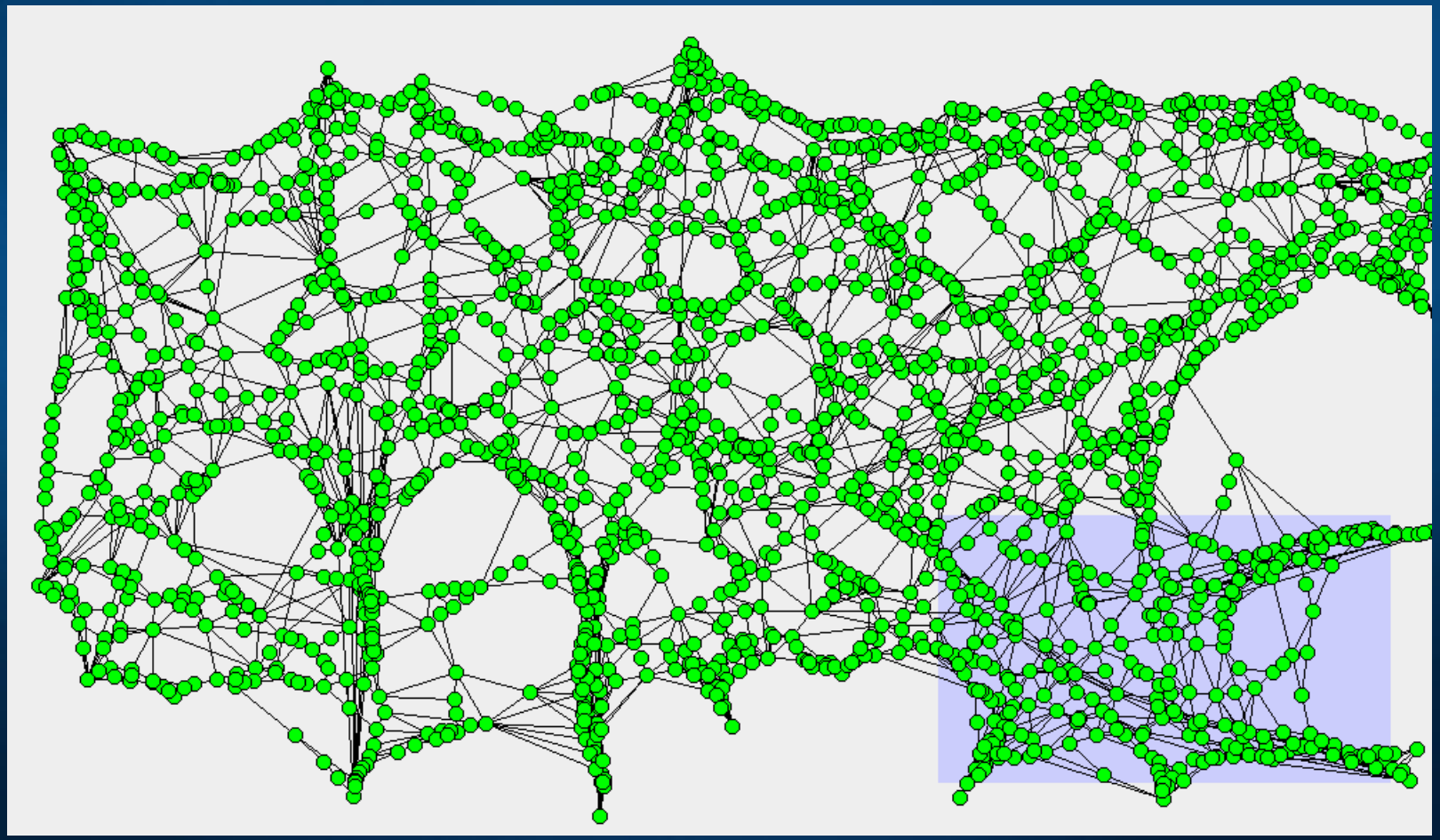
# Extreme plasticity

Brain plasticity (learning) is increased if long, Slow strong emotions are involved. Followed by depressive mood it leads to severe distortions, false associations, simplistic understanding.



# Conspiracy views

Illuminati, masons, Jews, UFOs, or twisted view of the world leaves big holes and admits simple explanations that save mental energy, creating „sinks” that attract many unrelated episodes.

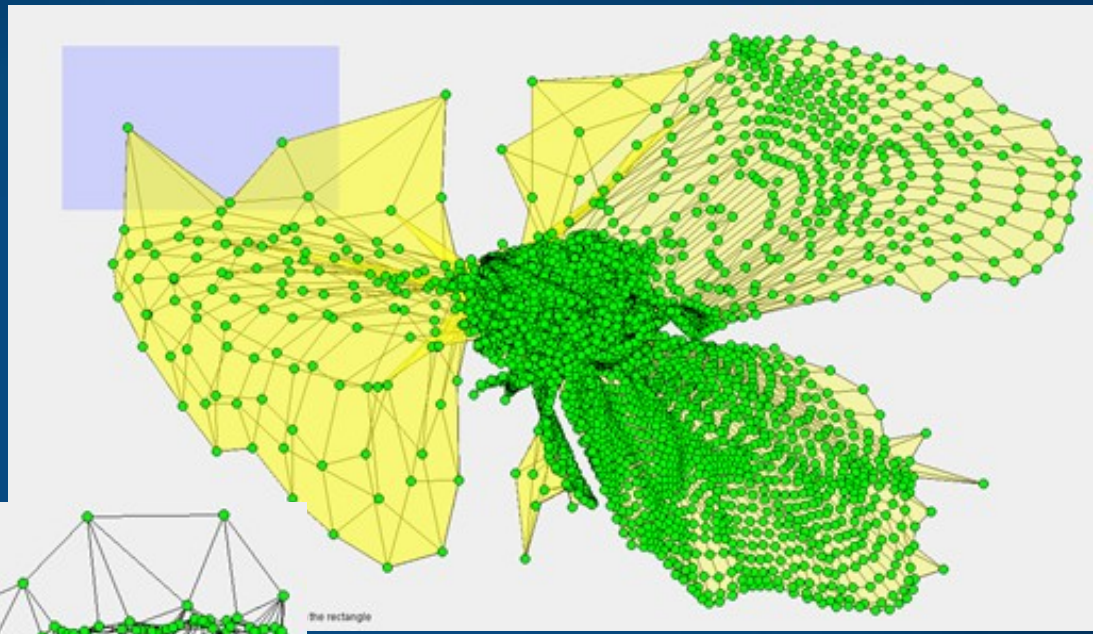


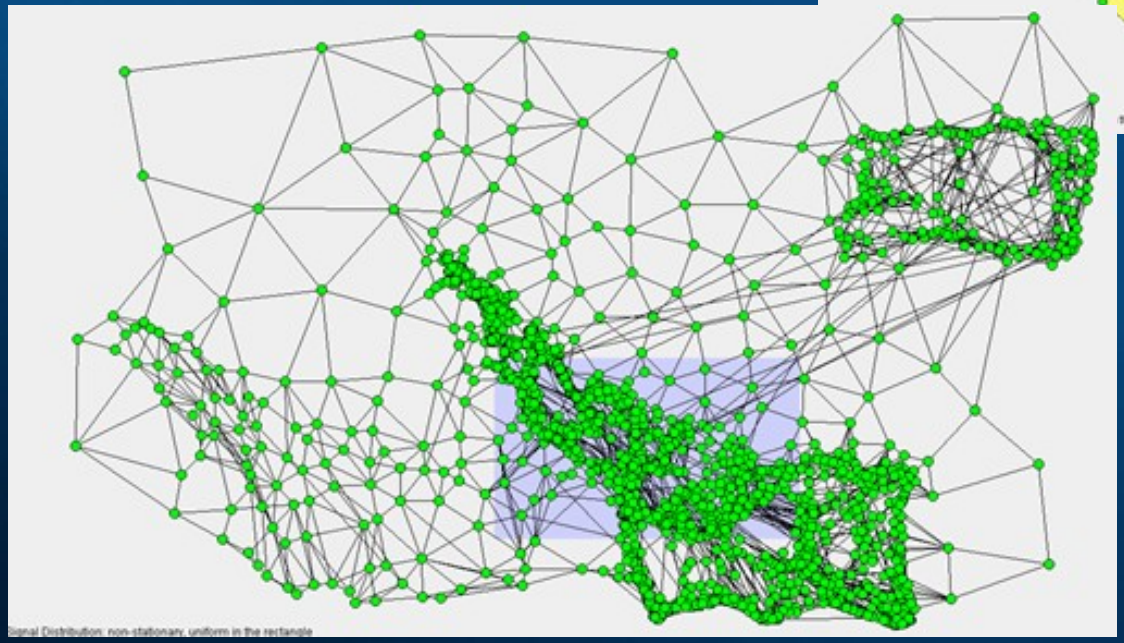
# Memoids …

Totally distorted world view, mind changed into a memplex

…

Ready for sacrifice.



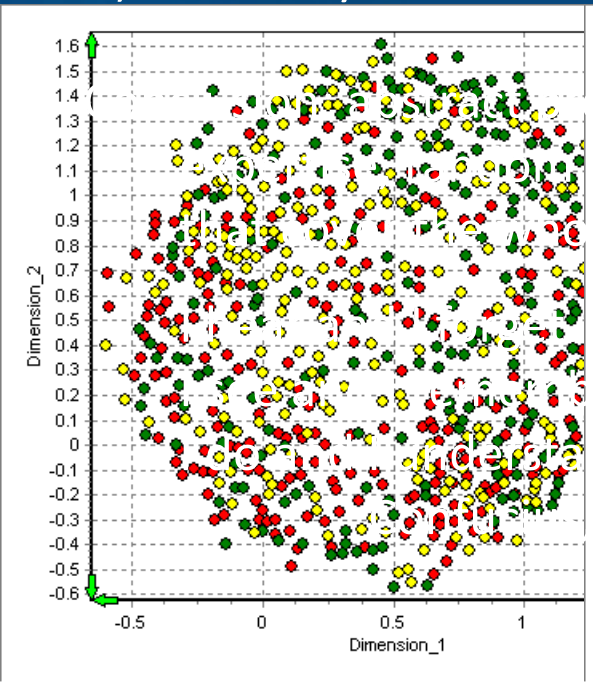
# How to become an expert?

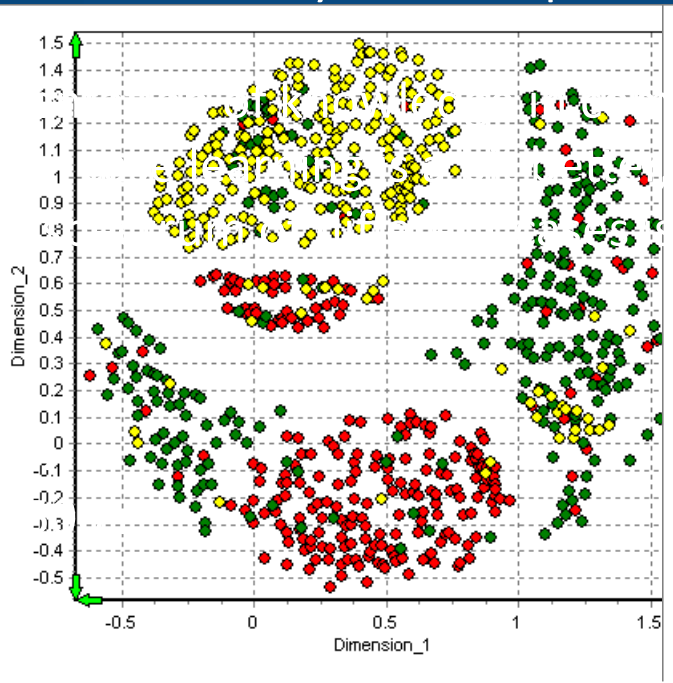
Textbook knowledge in medicine: detailed description of all possibilities.

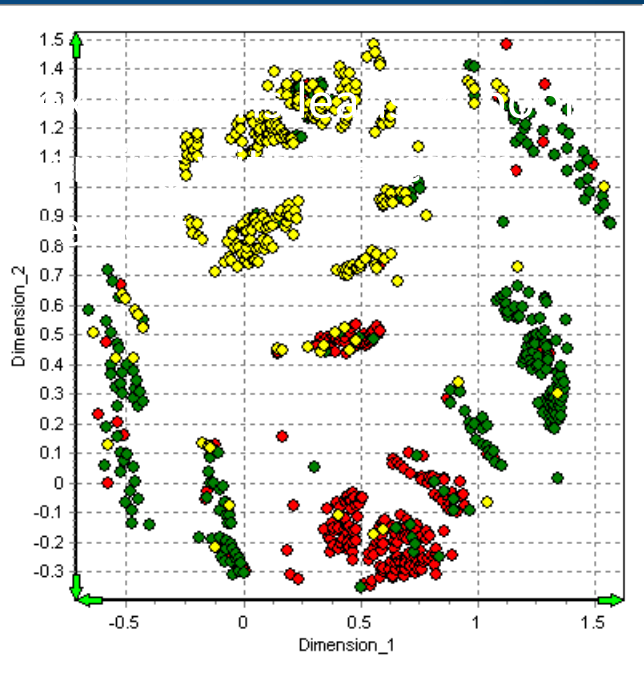
Effect: neural activation flows everywhere and correct diagnosis is impossible.
Correlations between observations forming prototypes are not firmly established.
Expert has only correct, “intuitive” associations.

Example: 3 diseases, vector NLP on clinical case description, MDS visualization.

1) System that has been trained on textbook knowledge.
2) Same system that has learned later on real cases.
3) Same system that has learned only on description of real cases.



# A tip of the iceberg …

Technology changes us, offers many enhancements.

We will face the emergence of homo sapiens digitalis,
a great challenge for Universities leading to many open questions.

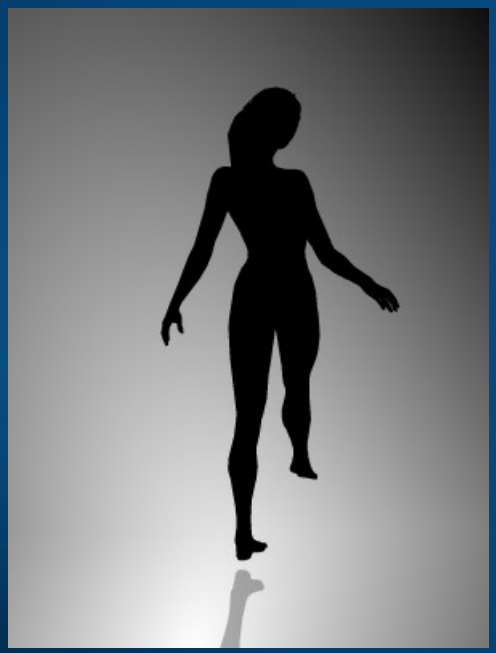
- How can we help to develop full intellectual potential of our students?
- Lifelong education should start from infancy, monitoring of development at each step is needed to personalize it.
- Which factors shape human nature? How is the culture, literature, music and art influencing brain development?
- How can we understand and regulate our own behavior to develop the skills that will help us to achieve worthy goals, make us happy and wise?
- How to protect brains from damage through information overflow, teach some kind of ecology of mind?
- Understanding brain development may lead to brainwashing techniques, media manipulation, breeding of fanatics, and even brain hacking – remote control of the enhanced brains.
- Can university education lead to the Greek **paideia ideal?**

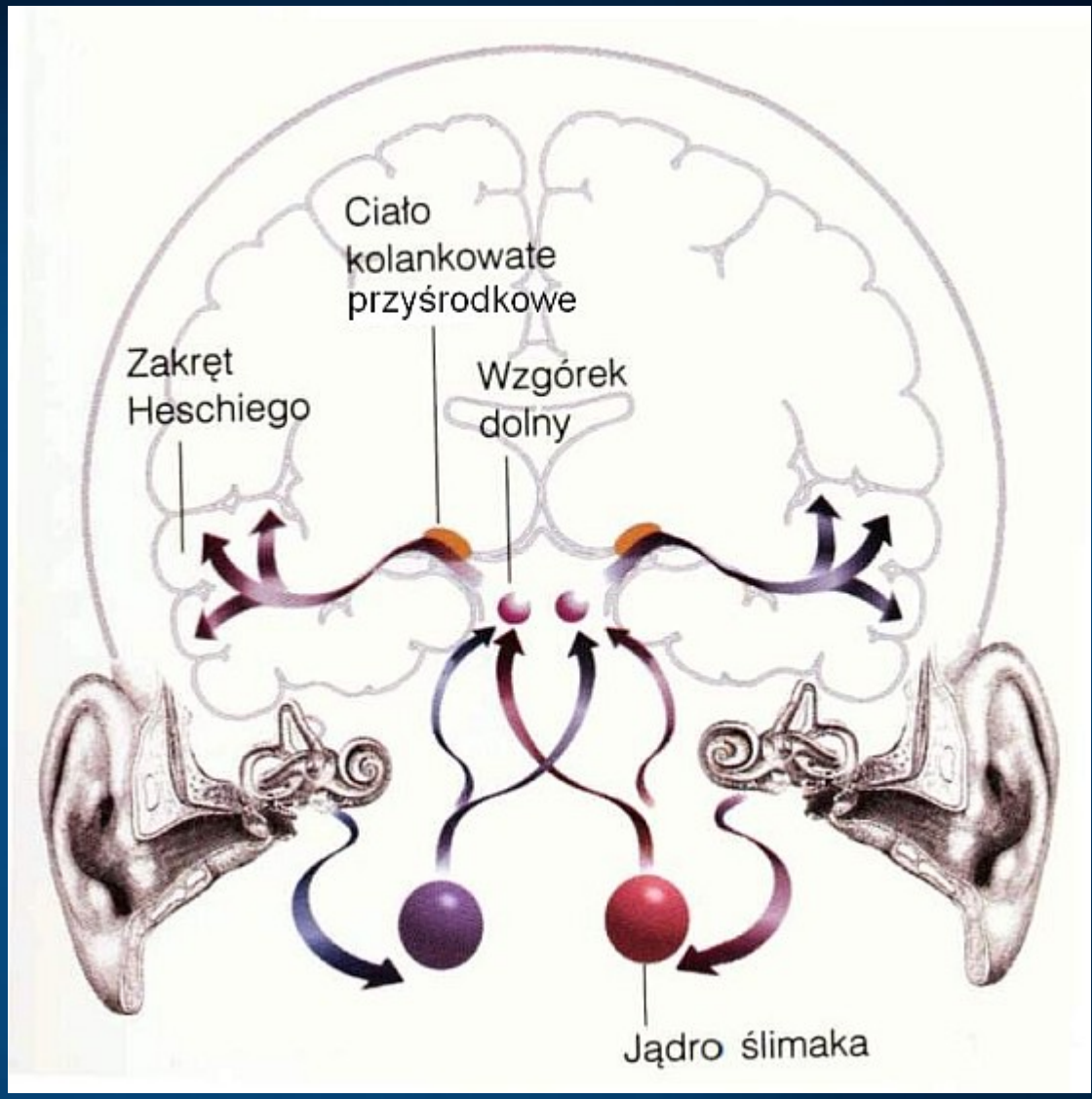
# Final advice

Old universities will have to deal with new students.

Homo sapiens digitalis will soon change even more through various technological enhancements.

- Universities should **empower their students** to be successful in their life, not just professional activities.
- Education should give students not only knowledge but be based on the ancient Greek **paideia ideal:** shape the way they learn and think, form their character.
- Courses in **digital wisdom** should be developed to help students protect their brains/minds from information overload, dangers of multitasking and lack of attention control.
- Universities need to develop **learning sciences**, not just pedagogics.



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