Education and the Human Brain

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Plan

- In an ideal world …
- Problems with the babies.
- Neurocognitive phenomics, or what do we know about
- Perception, will, motivation, consciousness.
- Memes and conspiracy theories in the brain.
- Implications and dreams.

You may say that I'm a dreamer …

But I hope not the only one.

In an ideal world ...

Society would support full development of human potential, from conception to senior years. Does it?

Human potential is wasted in so many ways:
in developing countries due to poor conditions,
in rich countries due to the greed of big companies that encourage unhealthy lifestyles.

Education imparts knowledge, but can we successfully teach wisdom, understanding what is really good for children, what will make them happy in the long run?

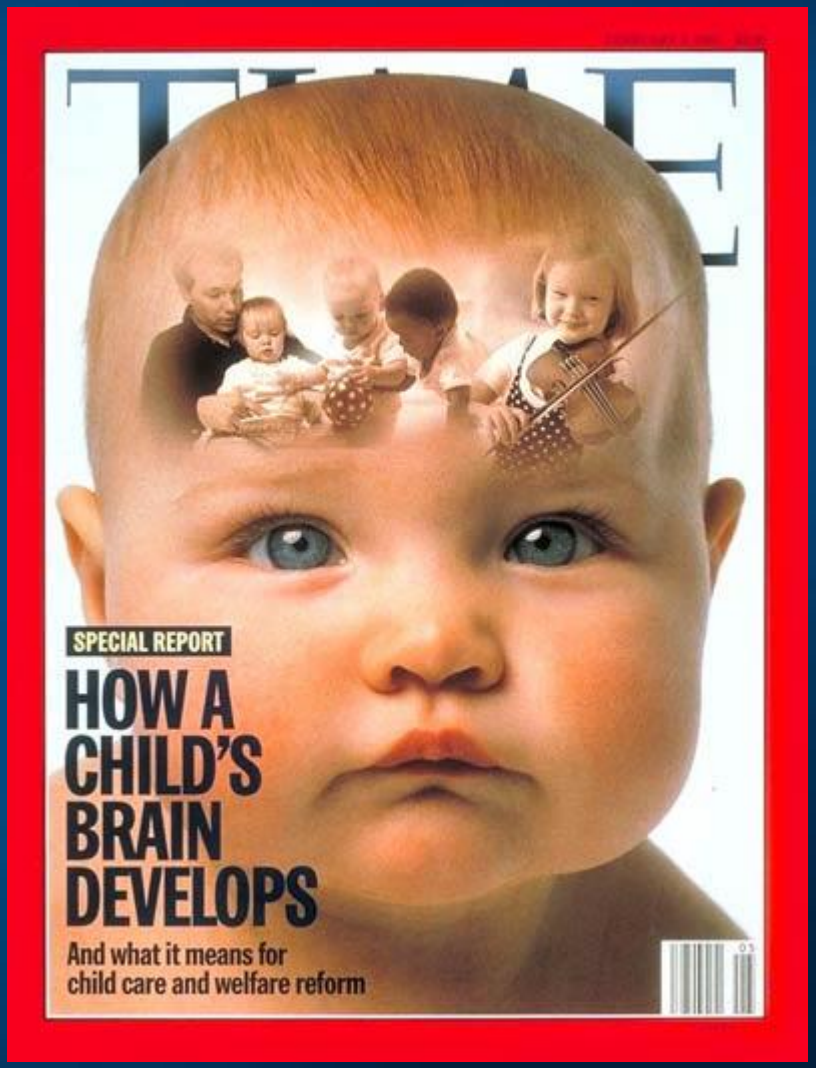
Can technology help?

Innovative education

Standard: introduce new tool and see how it does influence learning.

Target: understand how the brain learns, what are the conditions for optimal development, how to increase creativity, encourage exploration, will power, motivation to learn.

Implementation: monitor how brains react, create environments and tools that have desired impact.



In an ideal world …

- Children will be born in perfect condition.

In the first 9 month of our lives even small errors have disastrous consequences.

Problems arise due to genetic errors, viruses, disease, poisoning (including alcohol and nicotine), vitamin imbalance (A, B, E), but also lack of education of pregnant woman.

Understanding of various factors that can influence baby development, software for monitoring and giving informed advices is still in infancy, although some useful applications for smart phones exist.

Computers may help us to learn about ourselves in many ways.

Genes and brains

Genetics is at the top now, but think about it:

C-elegans worm

19.000 genes
302 neurons
7800 synapses

Human

23.000 genes
100 billion neurons (10^{11})
~ 10^{14} – 10^{15} synapses

Conclusion: the number of genes is not directly connected to the complexity of brain. The way DNA is decoded depends on many epigenetic factors, and it may be easier to control them.

In an ideal world …

Child obesity would not exist.

Diseases of affluence affect large percentage of young children, type 2 diabetes, asthma, coronary heart disease, cerebrovascular disease, peripheral vascular disease, obesity, hypertension, addictions, allergies, developmental problems …
Relations between environmental factors, food and health should be studied and technology used for training, monitoring and explaining the consequences of our choices and actions.

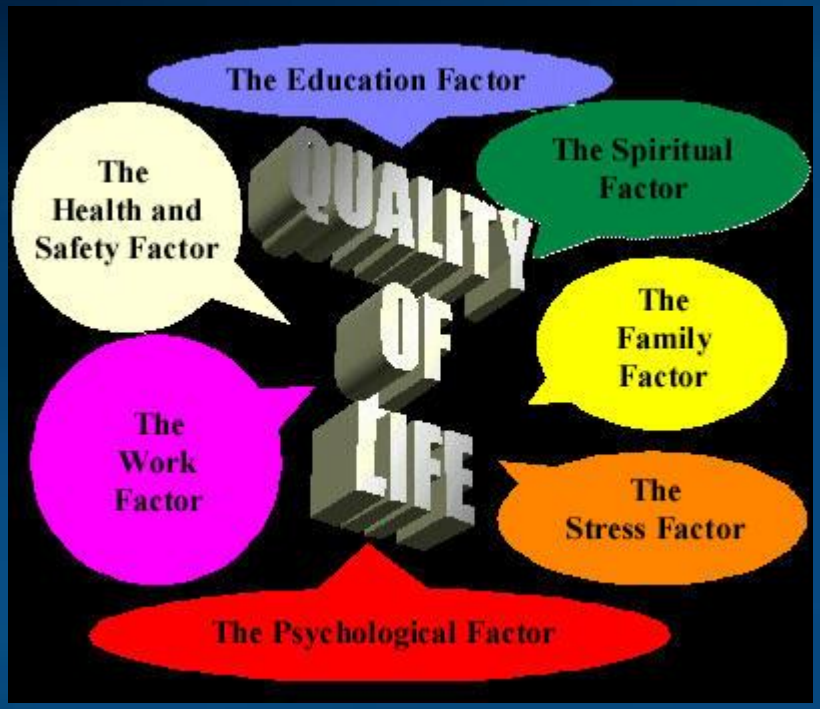
The first World Conference on Early Childhood Care and Education took place in Moscow in September 2010, jointly organized by UNESCO and the city of Moscow.

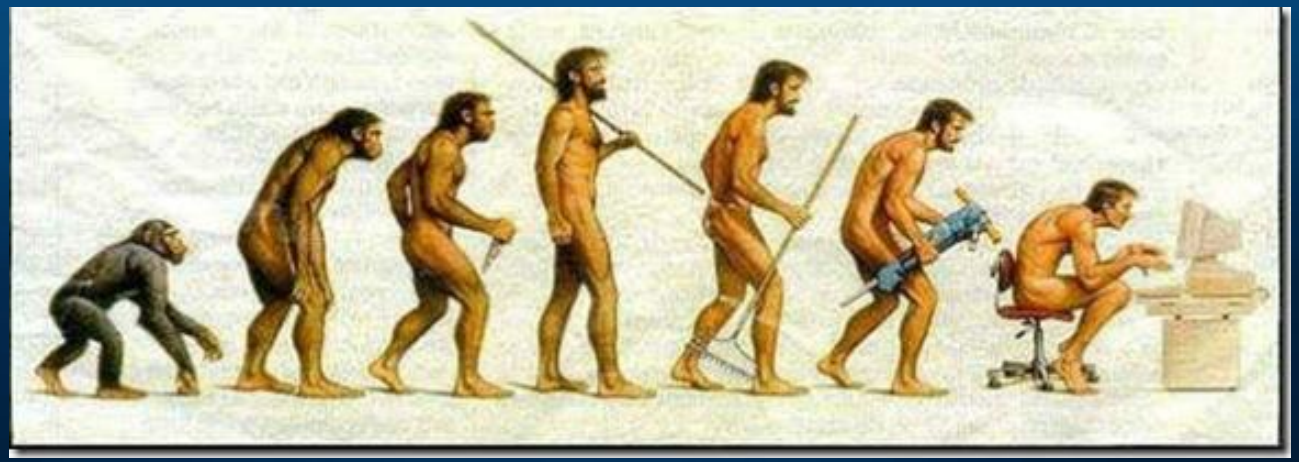
In an ideal world …

- Babies would develop in an stimulating environment that will monitor their development, interact with them and encourage positive habits.
- Motivation, curiosity, willingness to explore the world would develop in infancy.
- Schools would help to form personality, develop emotional intelligence, empathy …

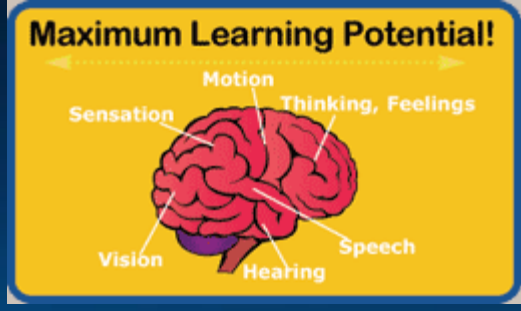
- People would learn to set wise goals worth the required effort, increasing their happiness, not only self-promotion.
- At each stage of life technology would support high quality of life, advice young people in decision making, help older people to keep their memories, social contacts, encourage activity.

All we really want is a better quality of life





Brain problem



Brain is the ultimate engineering problem!
How to nurture it? How to prepare brains for education?

Although genes set limits for potential individual development these limit are almost never reached, and genetic manipulation is not a solution.

“The early childhood years lay a foundation that influences the effectiveness of all subsequent education efforts.” US National Research Council, Committee on Integrating the Science of Early Childhood Development: “From Neurons to Neighborhoods: The Science of Early Childhood Development” (2000 report).

Challenge: prevent developmental abnormalities,
boost optimal brain development.

Global problem

Genetics sets the limits but random interactions of babies with their environment leaves no chance to achieve full development of inborn human potential.

The special issue of *The Lancet* (January 2007):
Early childhood development: the global challenge.
Article: Developmental potential in the first 5 years for children in developing countries.

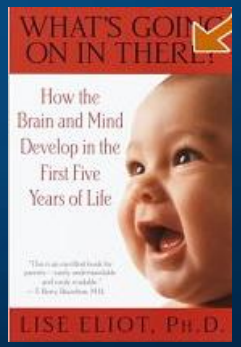
At least 200 million children aged under 5 years fail to reach their potential in cognitive and socioemotional development, because of four causes: malnutrition that leads to stunting, iodine and iron deficiency, and inadequate stimulation in their first 5 years of life.

Developmental problems

5-10% of all children have developmental disabilities that cause problems with speech and language and later difficulties in learning.
Without proper stimulation full in-born potential is not reached.

Genes specify only roughly where neurons should go (ex: eye to visual cortex, across the whole brain) too many neurons are created, and those unused die (apoptosis).
Maximum number of neurons: 1-2 month before birth, although infant's brain is only ¼ of the final size.

Max synaptic density in the 3 year of age.



General principle:

growing up is specializing = narrowing potential possibilities.

How to keep more possibilities open?

Neuroeducation

As educators you are sculpting brains!

Pedagogy has developed through trial and error, 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.

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!

Erosion

Questions of the King Milinda (Milinda Panha, ca. 400).
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.

Synaptogenesis

Synaptogenesis creates, experience sculpts, leaving only useful pathways. After birth neurogenesis is limited to a brain few areas.

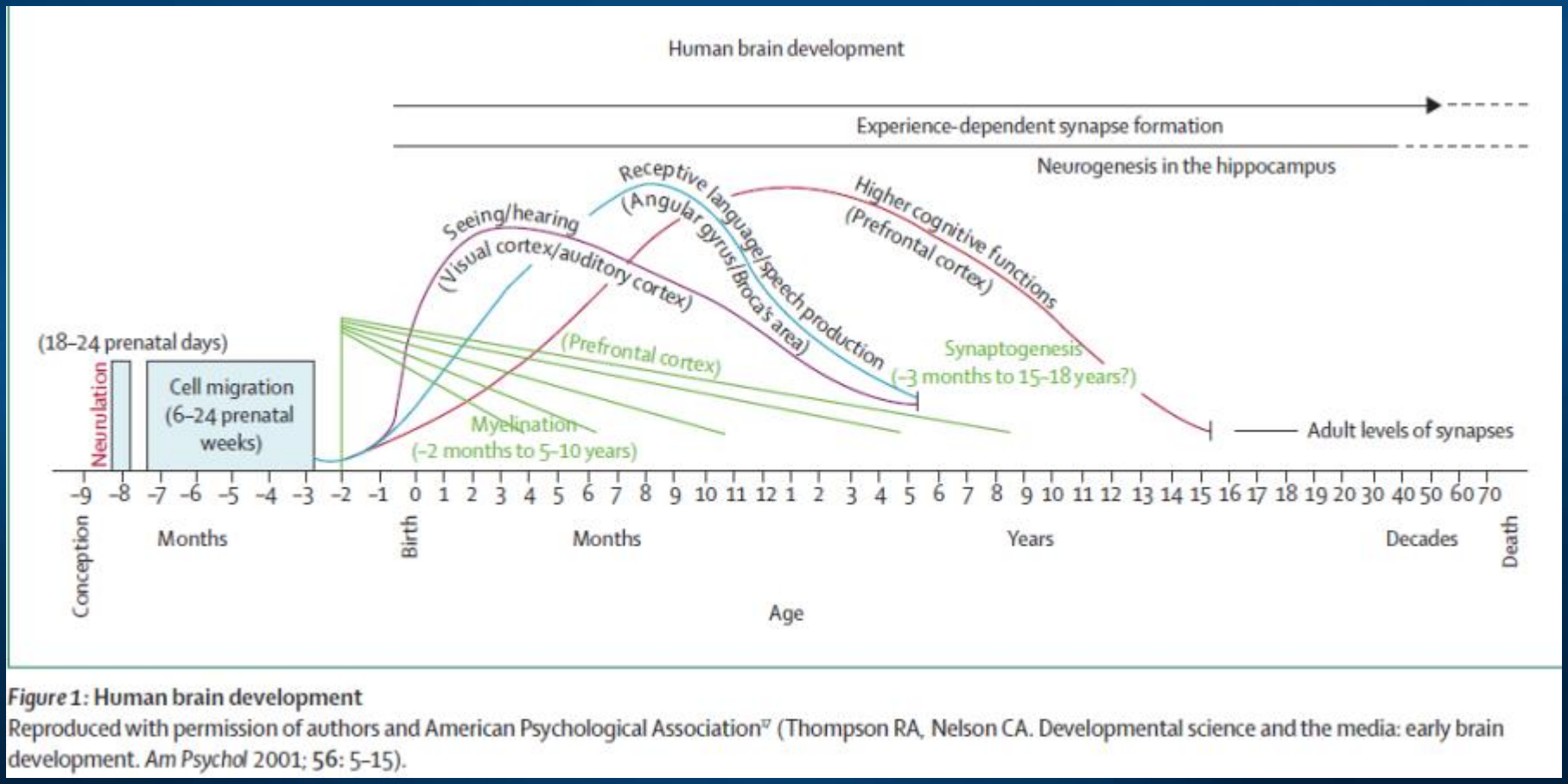
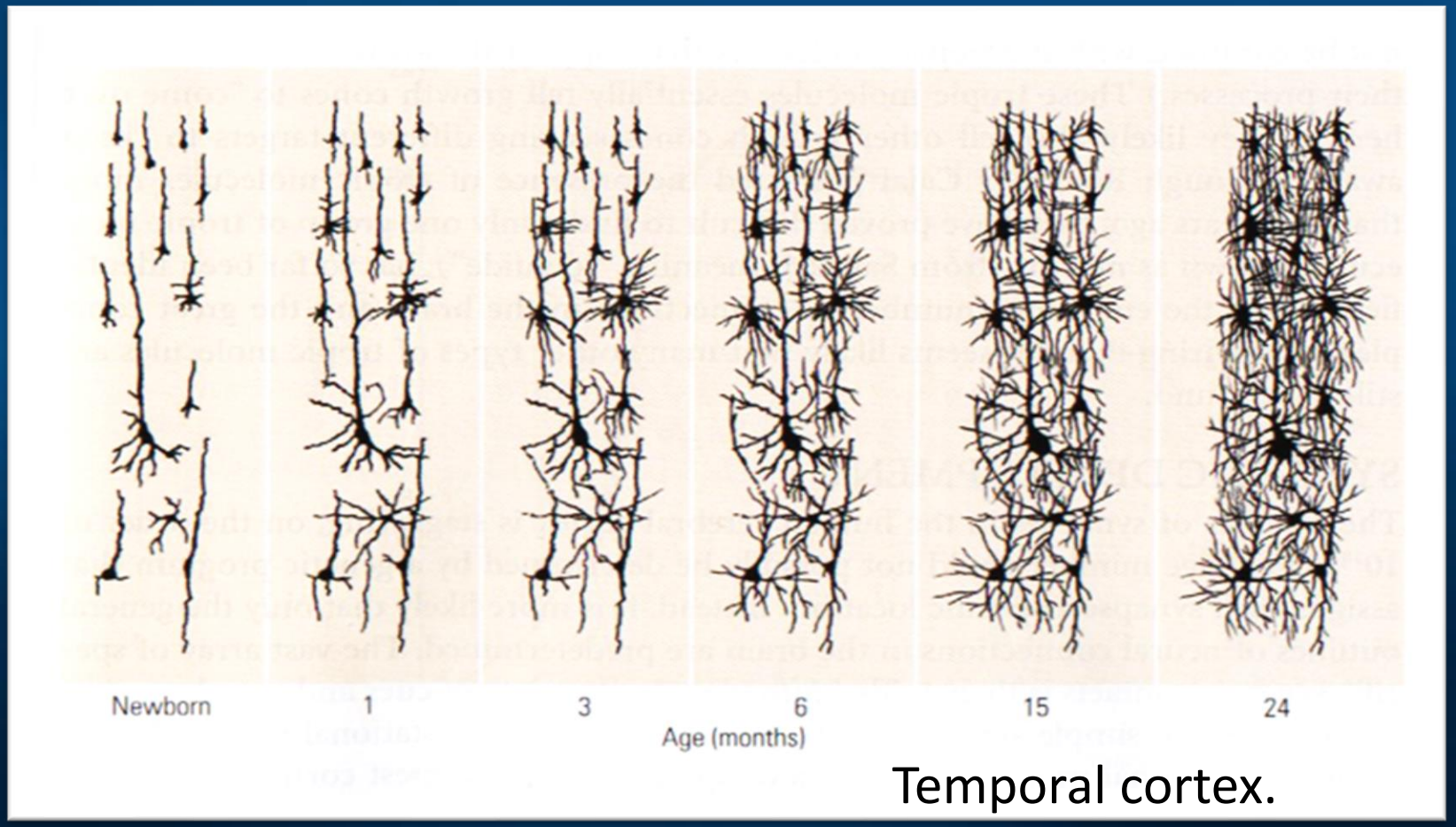


***Figure 1*: Human brain development**
Reproduced with permission of authors and American Psychological Association[17] (Thompson RA, Nelson CA. Developmental science and the media: early brain development. *Am Psychol* 2001; **56**: 5–15).

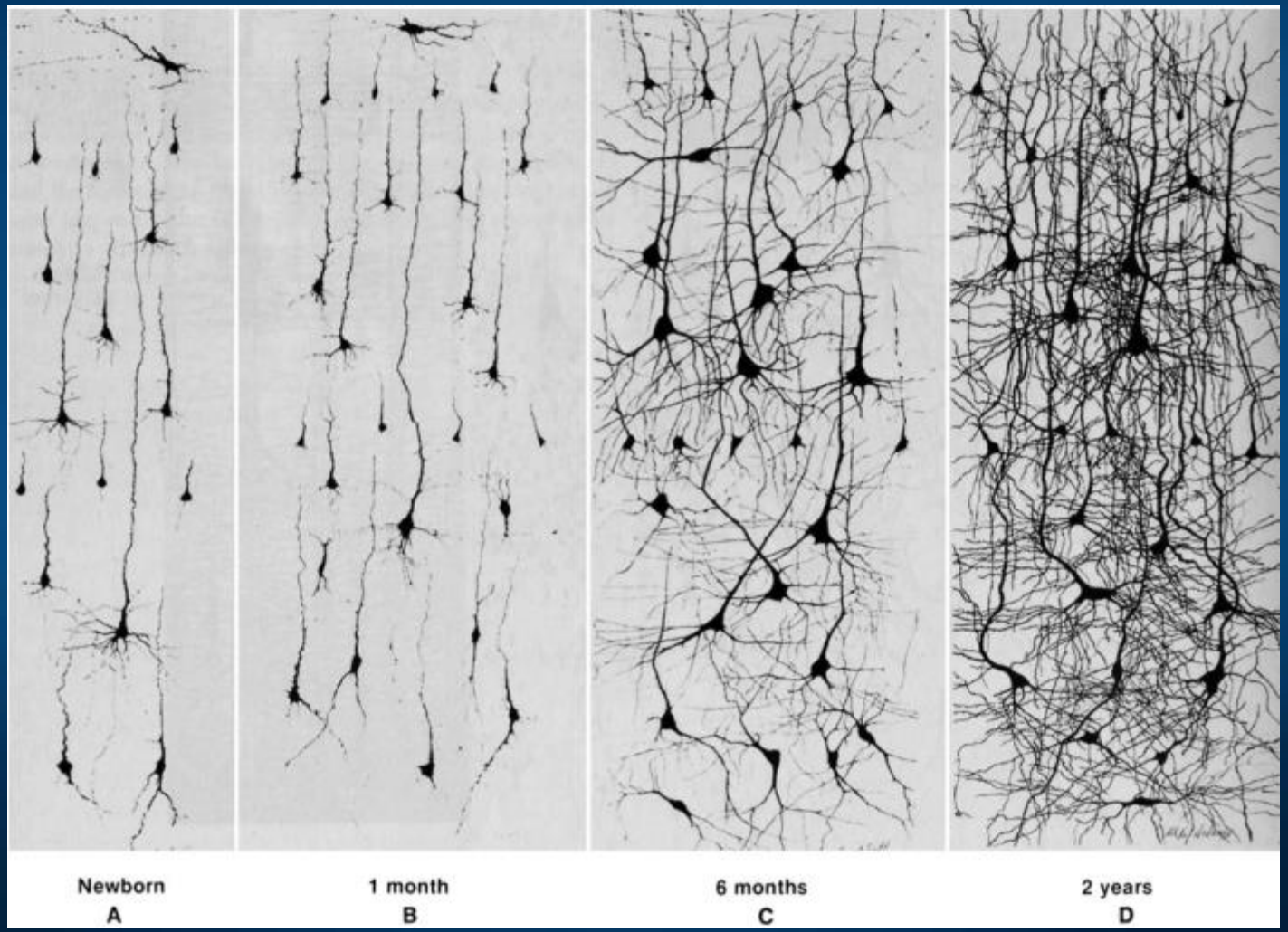
From 0 to 24 month

Brain at birth has only ¼ of its final mass, and creates a few million new connections per second!

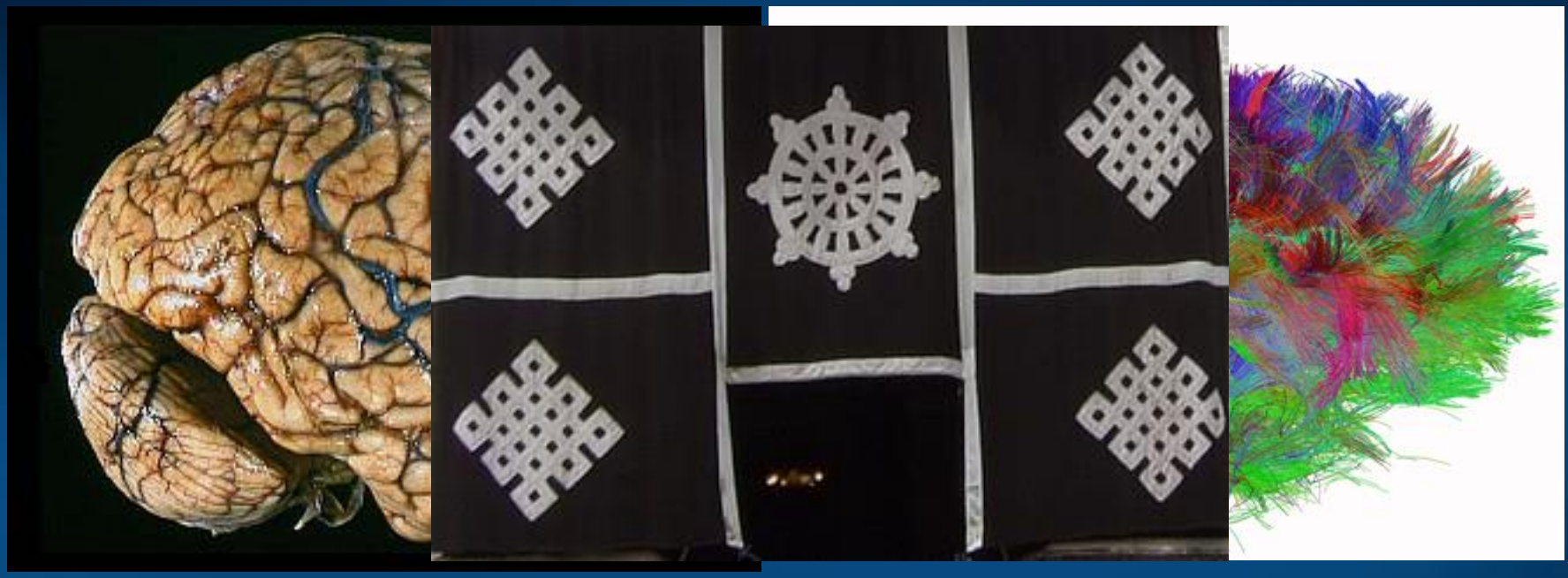


Temporal cortex.

Medium Frontal Gyrus (MFG)



Neural determinism



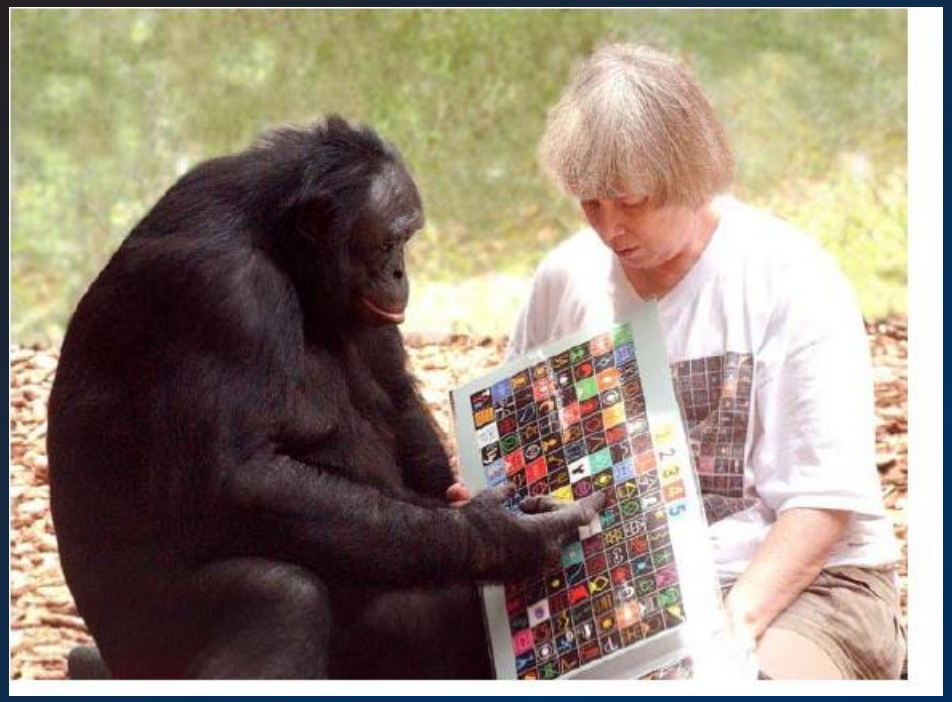
Our possibilities are limited by genetic and neural determinism.

„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 is one.

Simple brains



Chimps have better working memory than people, but they are less creative: 1/10 of our association cortex = less noise and better focus without background thoughts.

Chimps have rich social life, show altruistic and emphatic behavior, have sense of justice, may combine a few symbols and express simple intentions but stay at the level of 2-years old.


WHO? WHAT?
WHERE? WHEN? HOW?
WHY? WHICH? HOW MUCH?
HOW MANY? HOW LONG? HOW FAR?
WHAT FOR? WHAT NEXT? THEN
WHAT? WHY ME?

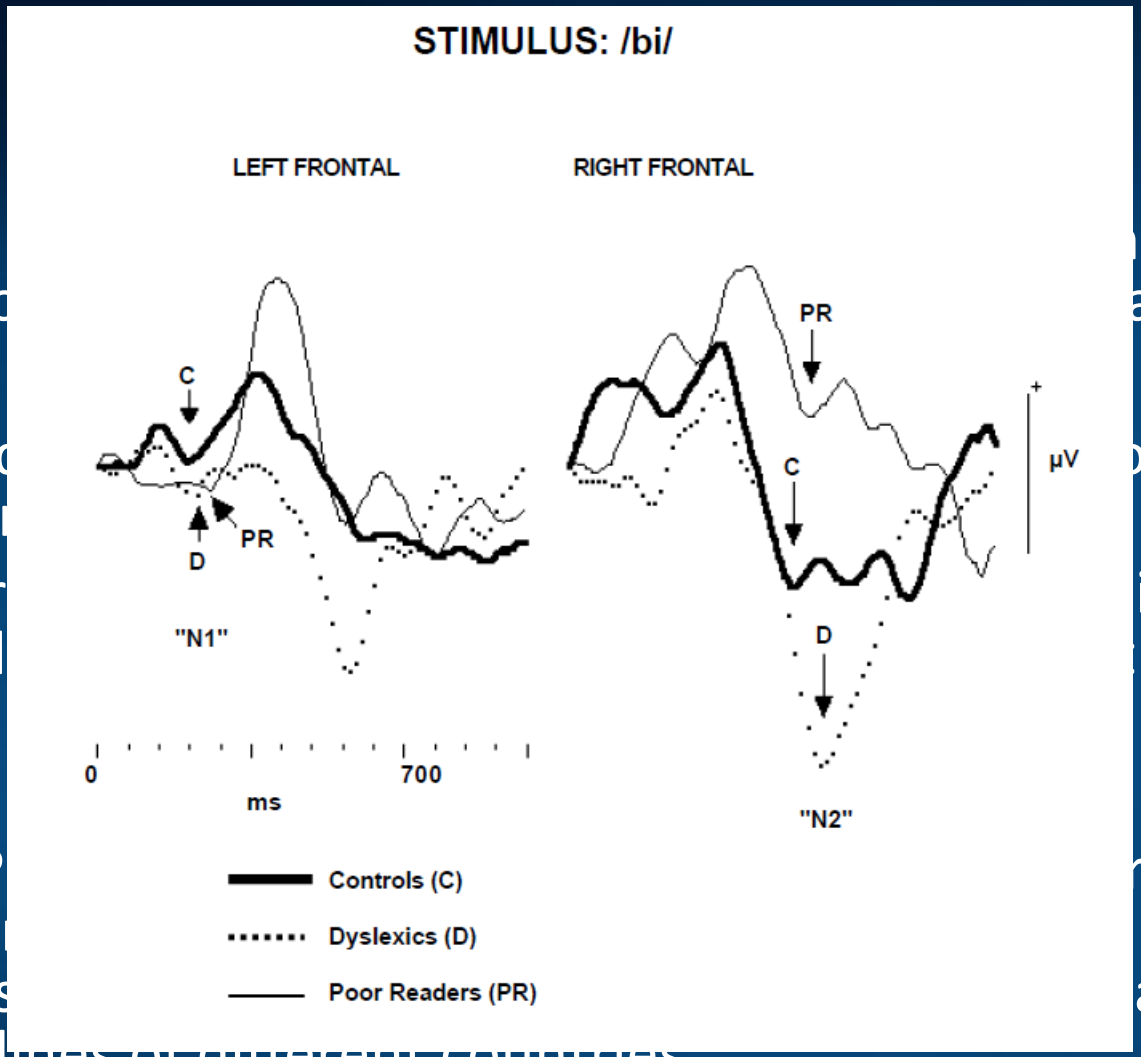
Educational questions

How strong is neural determinism?
How strong are influences from learned behavioral patterns? Khmer Rouge children were given "leadership in torture and executions", practicing torture on animals before killing people.

Should free choice be enforced on small babies?

From Greece to China positive and negative behavioral patterns have been provided through legends, dramas, religious stories, helping to learn virtues and values through personifications (arete, persona, bodhisatwa), self-regulation of behavior.

What is the source of values for young generation? Where are their role models? Harry Potter?



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ERP… …r different
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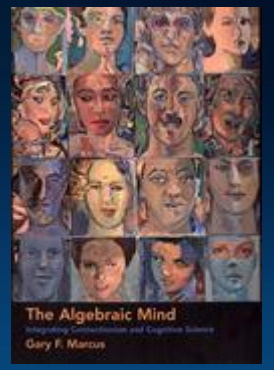
ERPs allow for prediction when the material was mastered versus when students were only familiar with the material but had not yet mastered it.

Abstract thinking



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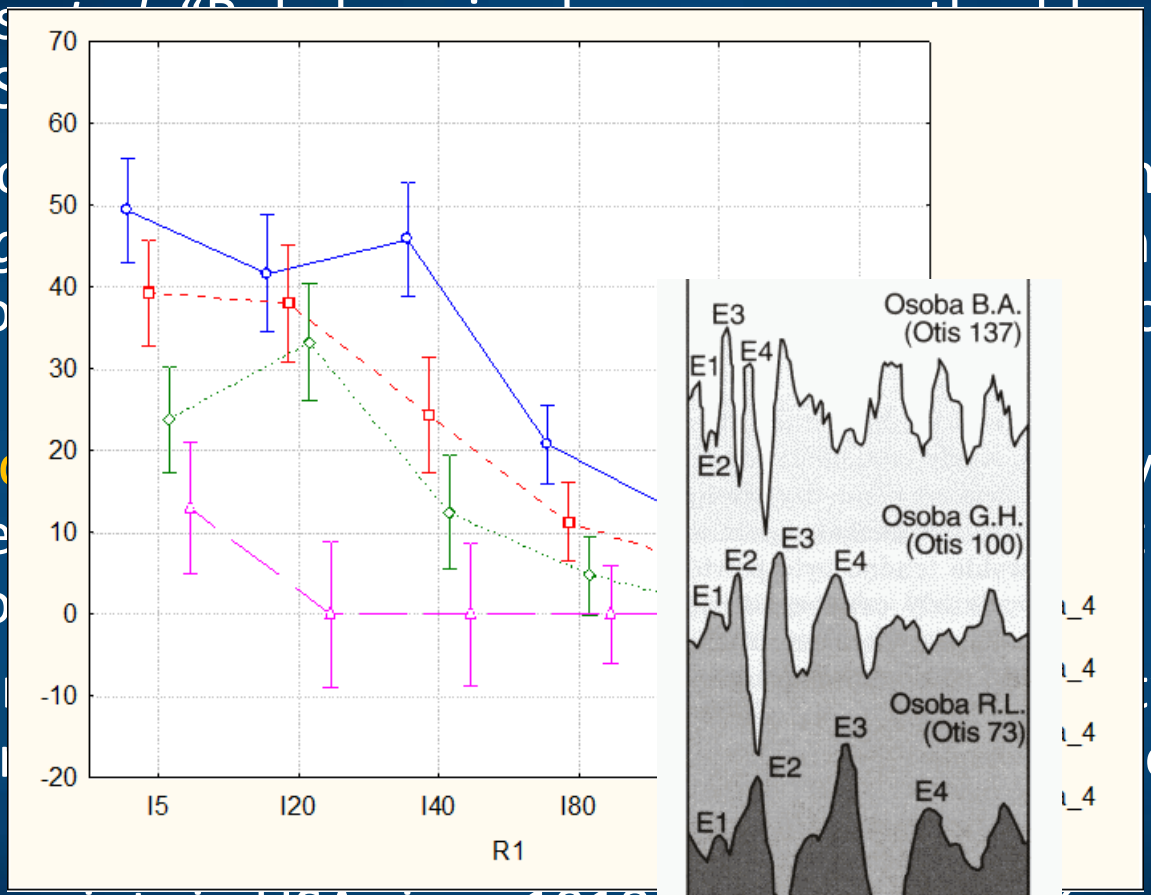
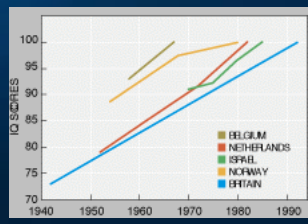
Toys and nutrition help to develop





Solution

Understand how environment may influence development of nervous system, provide advice (apps).

Teach infants perception and cognition!

Supervise perceptual and cognitive development of infants.

- Use interactive devices that stimulate infants, observe their reactions and provide precise feedback to improve their categorical perception.
- Prevent developmental problems discovering them at early stages, call experts if necessary.
- Encourage the infant brain to use working memory, stimulate discovery of abstract patterns in visual and auditory stimulations, increase speed of reactions ...

Phenomics

Phenomics is the branch of science concerned with identification and description of measurable physical, biochemical and psychological traits of organisms.
G*enom*, *proteom*, *phenom, interactom, exposome, virusom …*
omics.org has a list of over 400 various …*omics*.

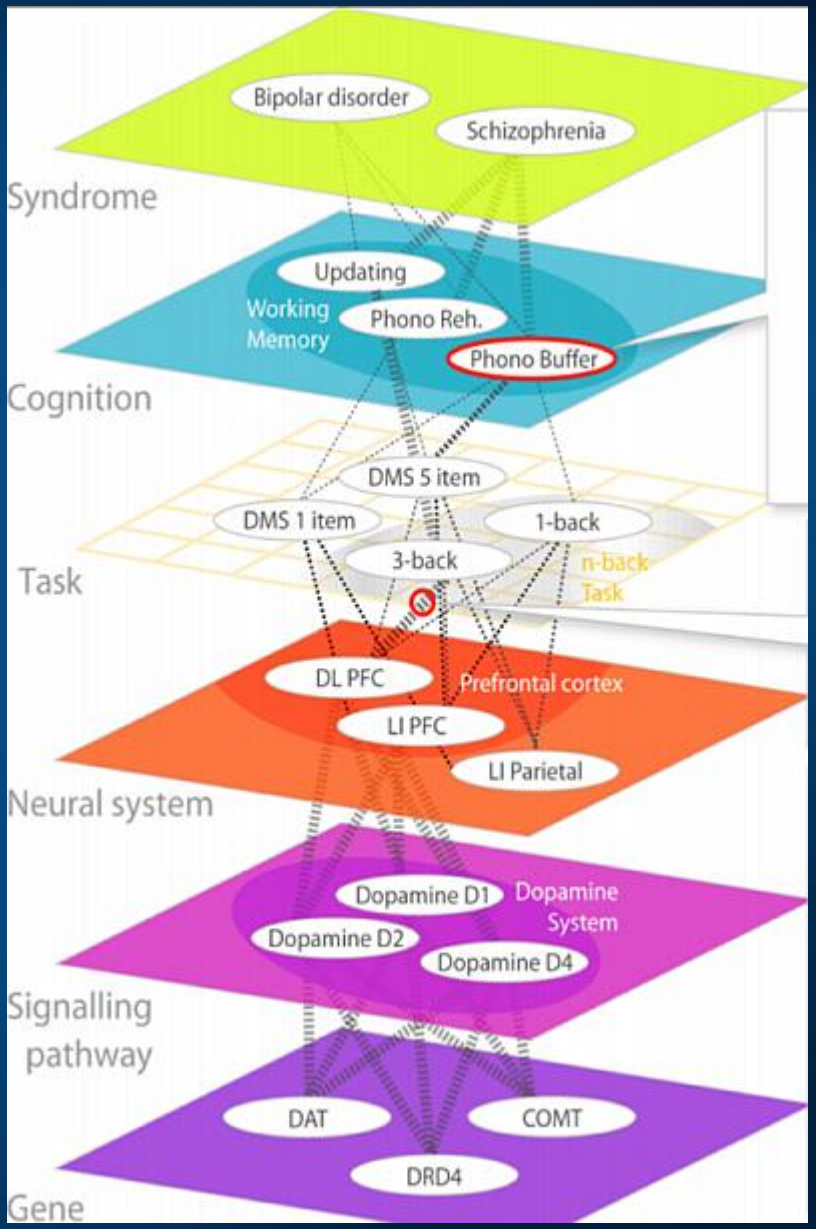
Human Phenome Project, since 2003.
Human Epigenome Project, since 2003.
Human Connectome Project, since 2009.
Developing Human Connectome Project, UK 2013
Consortium for Neuropsychiatric Phenomics, since 2008 investigates phenotypes of people suffering from serious mental disorders at all possible levels.

Neuropsychiatric Phenomics in 6 Levels

According to
The Consortium for
Neuropsychiatric Phenomics (CNP)
http://www.phenomics.ucla.edu

From genes to molecules to neurons and their systems to tasks, cognitive subsystems and syndromes.

Neurons and networks are right in the middle of this hierarchy.



Strategy for Phenomics Research

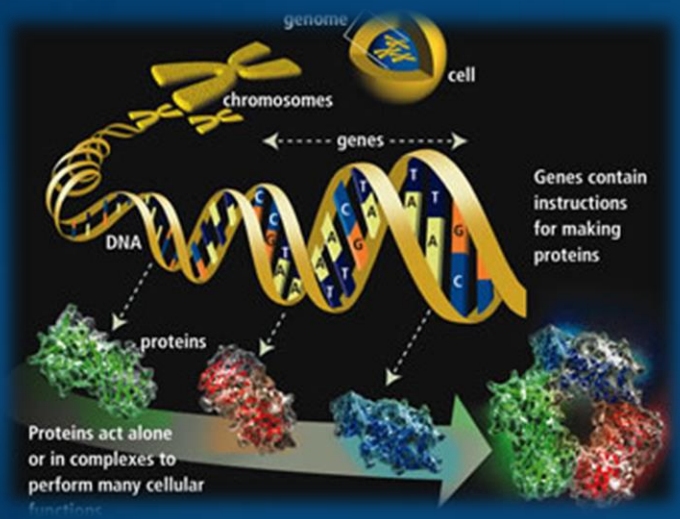
The Consortium for Neuropsychiatric Phenomics: research should provide bridges between all levels, one at a time, from environment to syndromes.

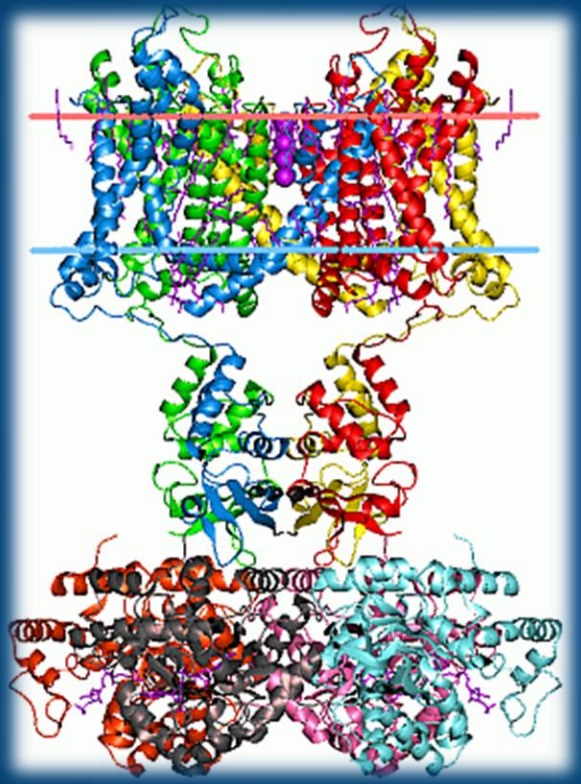
Strategy: identify biophysical parameters of neurons required for normal neural network functions and leading to abnormal cognitive phenotypes, symptoms and syndromes.

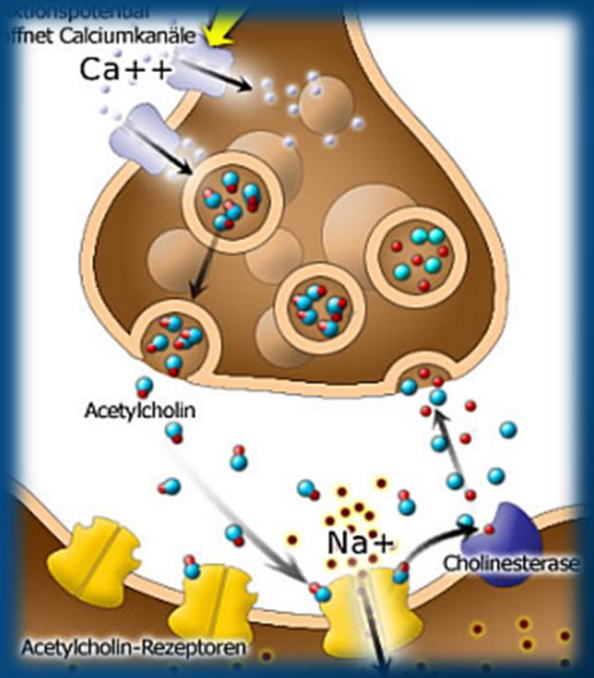
Create models of cognitive function that may reflect some of the symptoms of the disease, ex. problems with attention, relating them to model biophysical properties of neurons.

Result: mental events at the network level are linked to neurodynamics and to low-level neural properties.
Ex: why drugs that stimulate the brain help in ADHD case?
Relation of ASD/ADHD symptoms to neural accommodation.

From Genes to Neurons

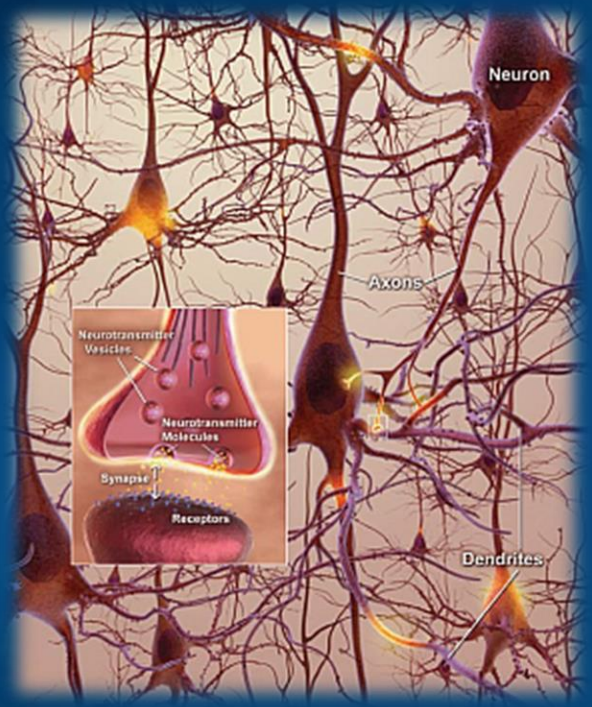


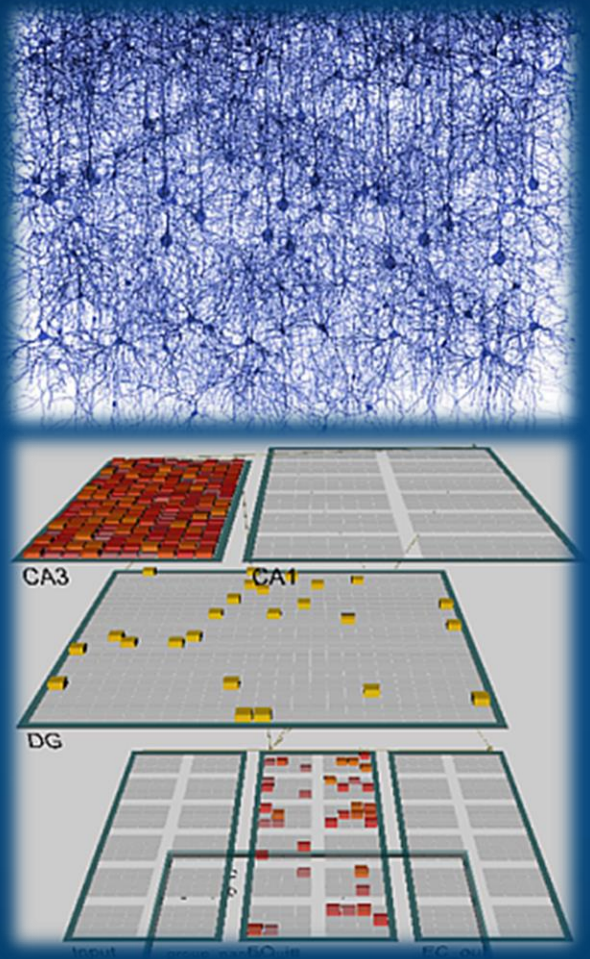


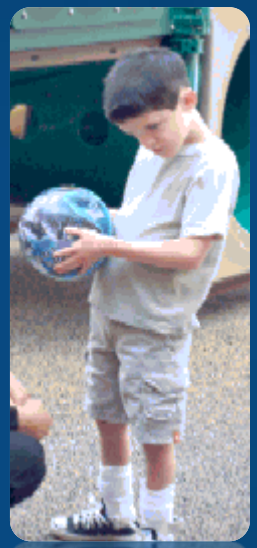


Genes => Proteins => receptors, ion channels, synapses
=> neuron properties, networks, neurodynamics
=> cognitive phenotypes, abnormal behavior, syndromes.

From Neurons to Behavior







Genes => Proteins => receptors, ion channels, synapses
=> neuron properties, networks
=> neurodynamics => cognitive phenotypes, abnormal behavior!

Neurocognitive Phenomics

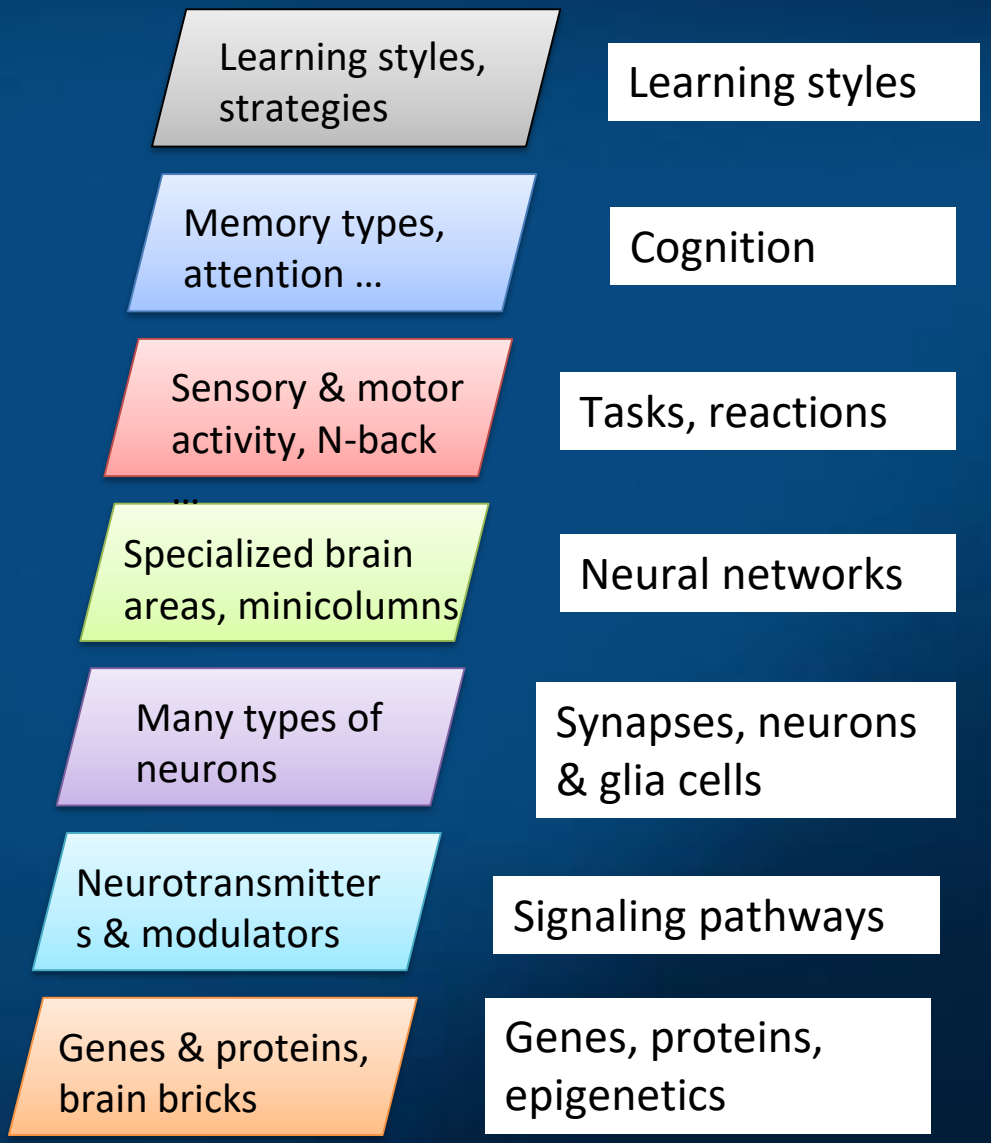
Phenotypes may be described on many levels, here from top down it is pedagogics, psychiatry, psychology,

neurophysiology, neural networks,

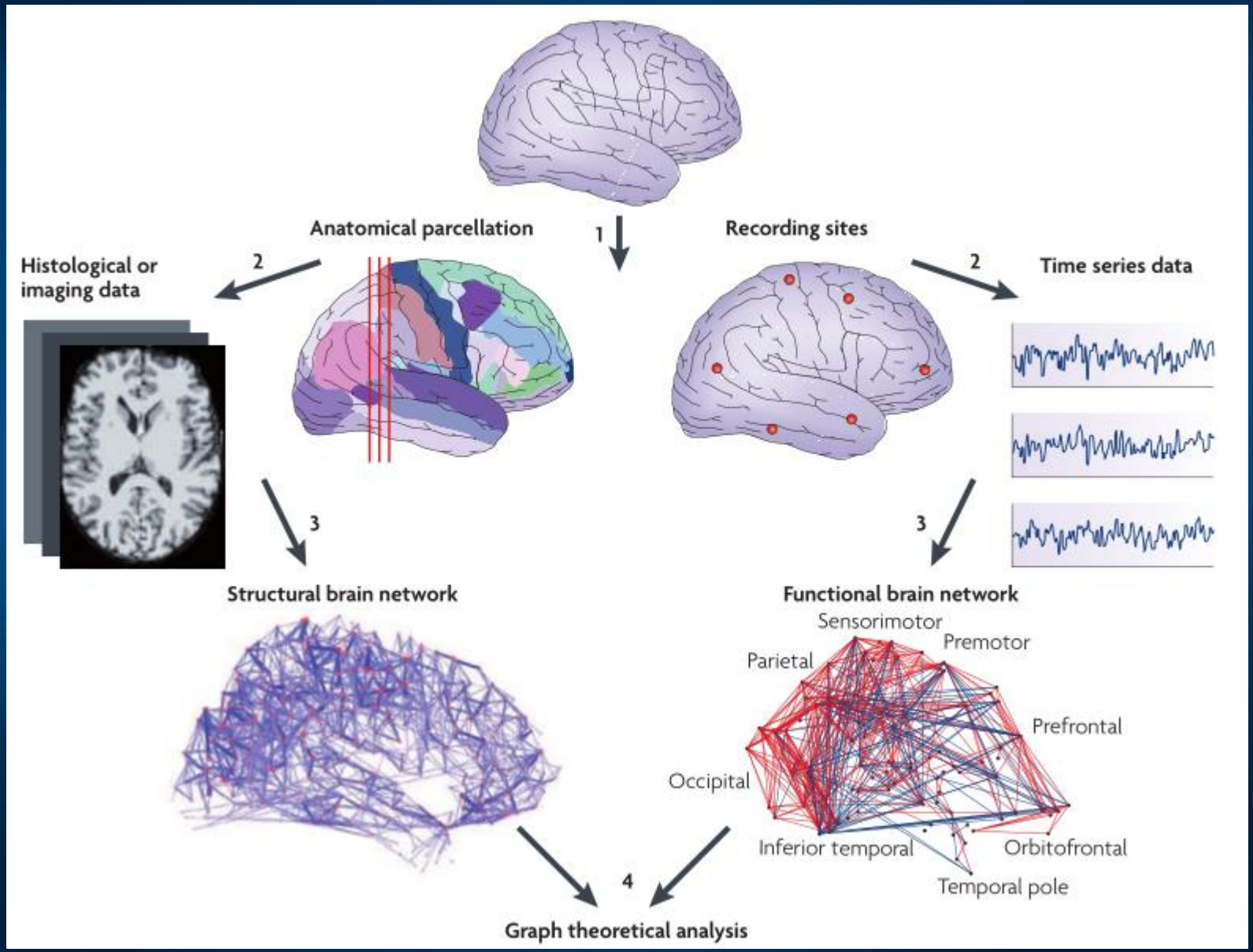
biology, neurobiology,

biophysics, biochemistry, bioinformatics.

Neurocognitive phenomics is even greater challenge than neuropsychiatric phenomics, effects are more subtle.



Structure and function



Our toys

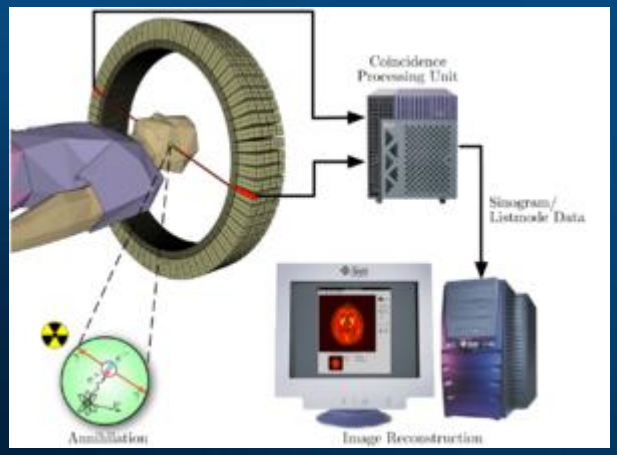

Coincidence
Processing Unit
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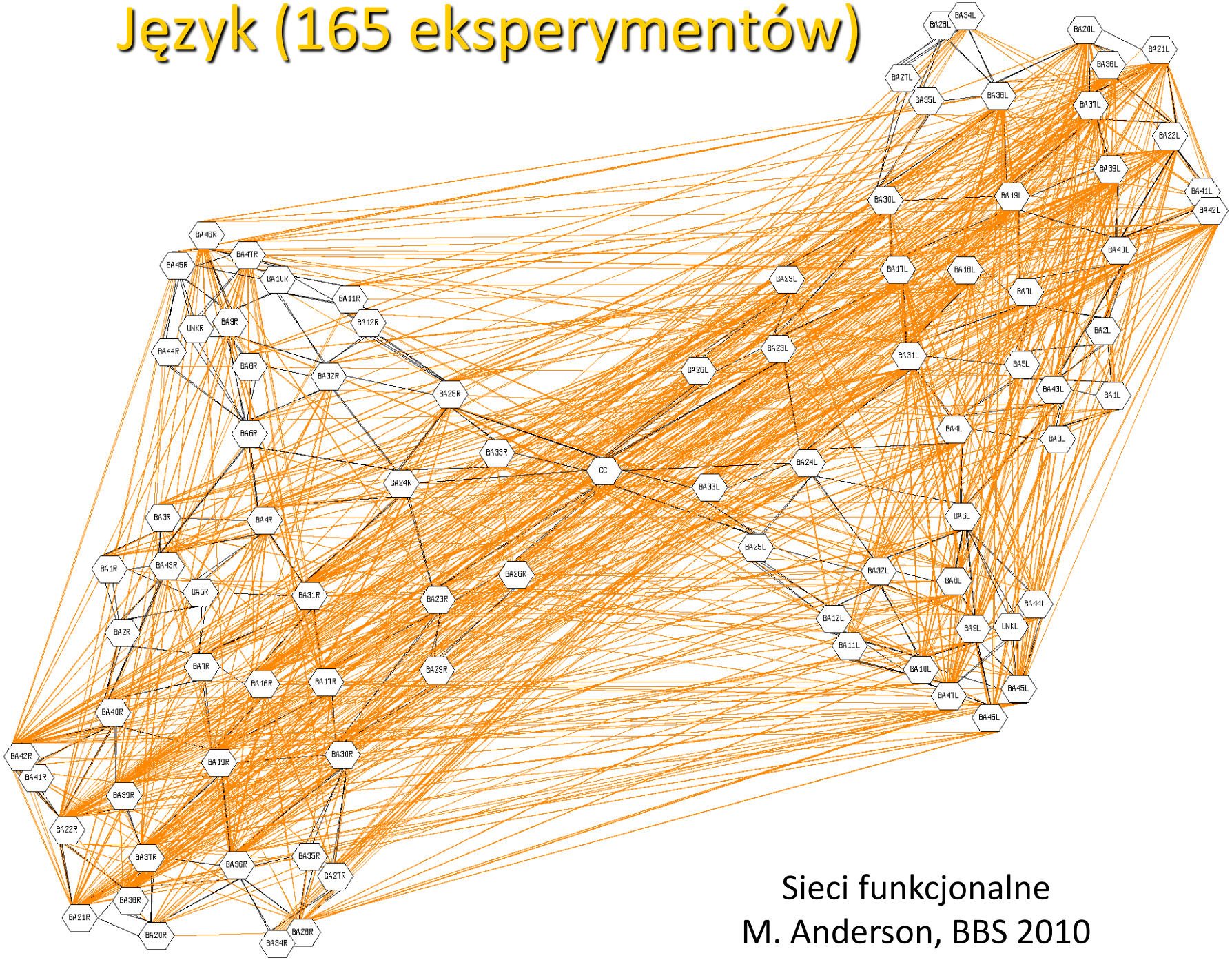
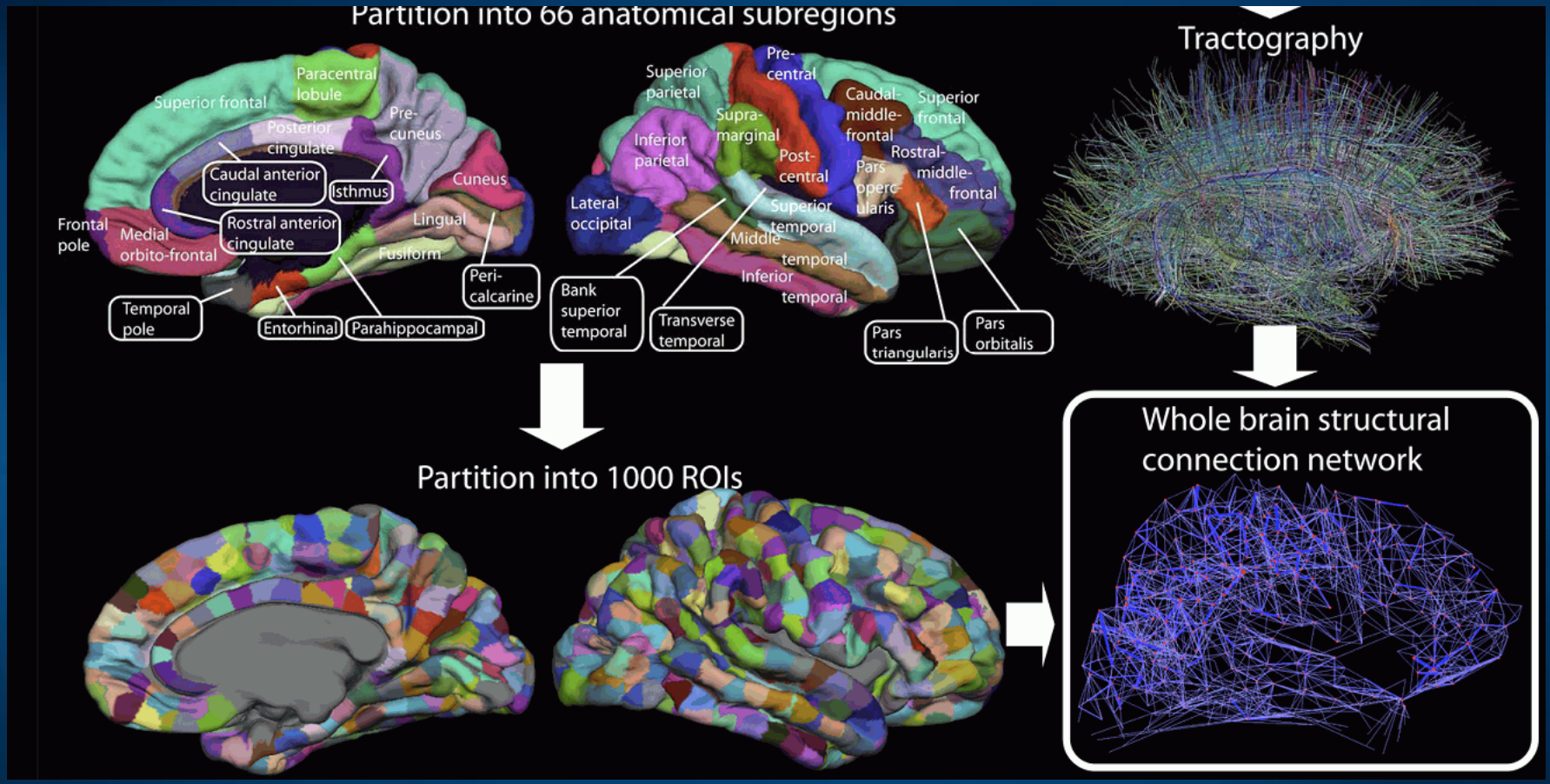
Image Reconstruction

Język (165 eksperymentów)



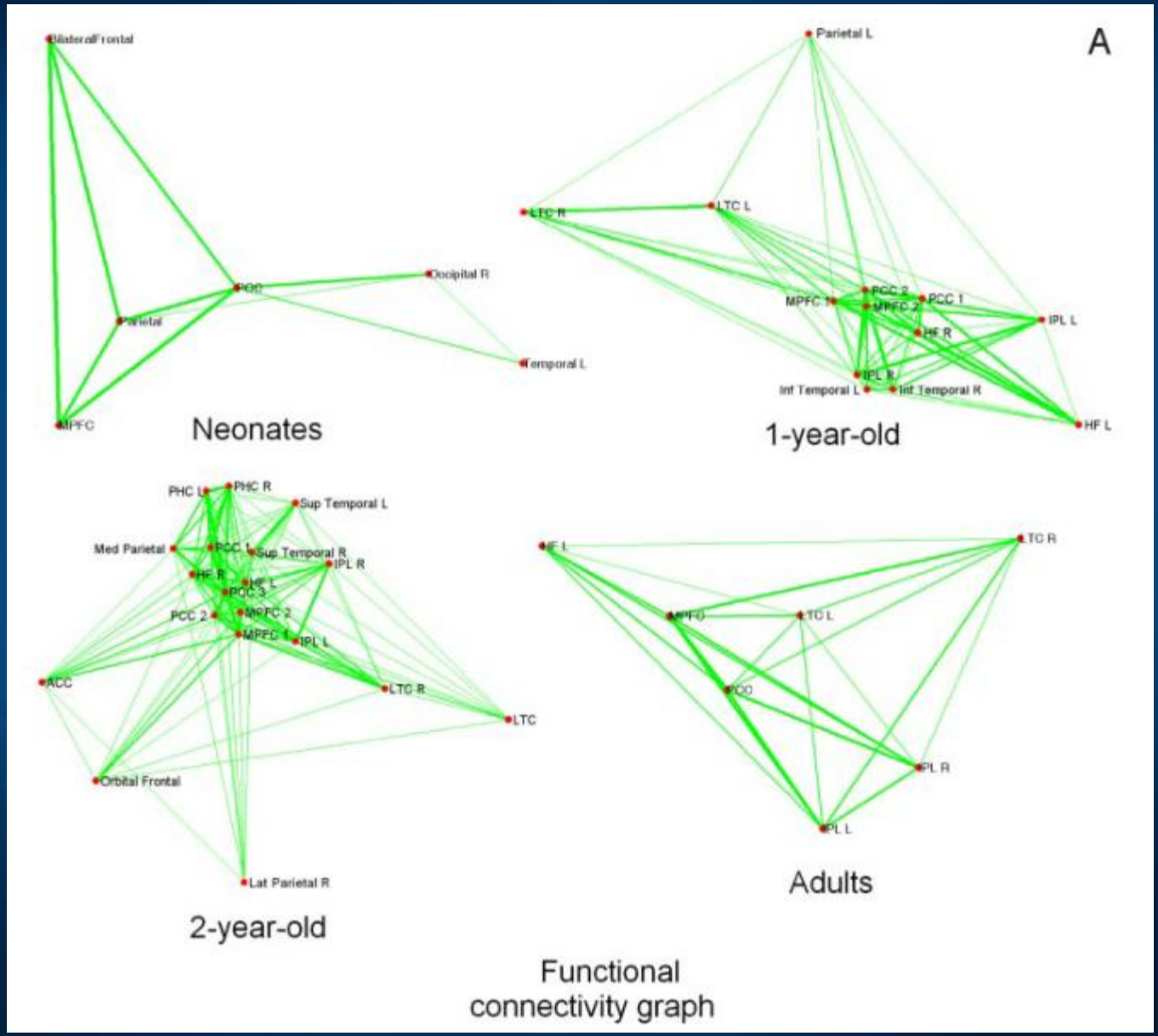
Sieci funkcjonalne
M. Anderson, BBS 2010

Connectome

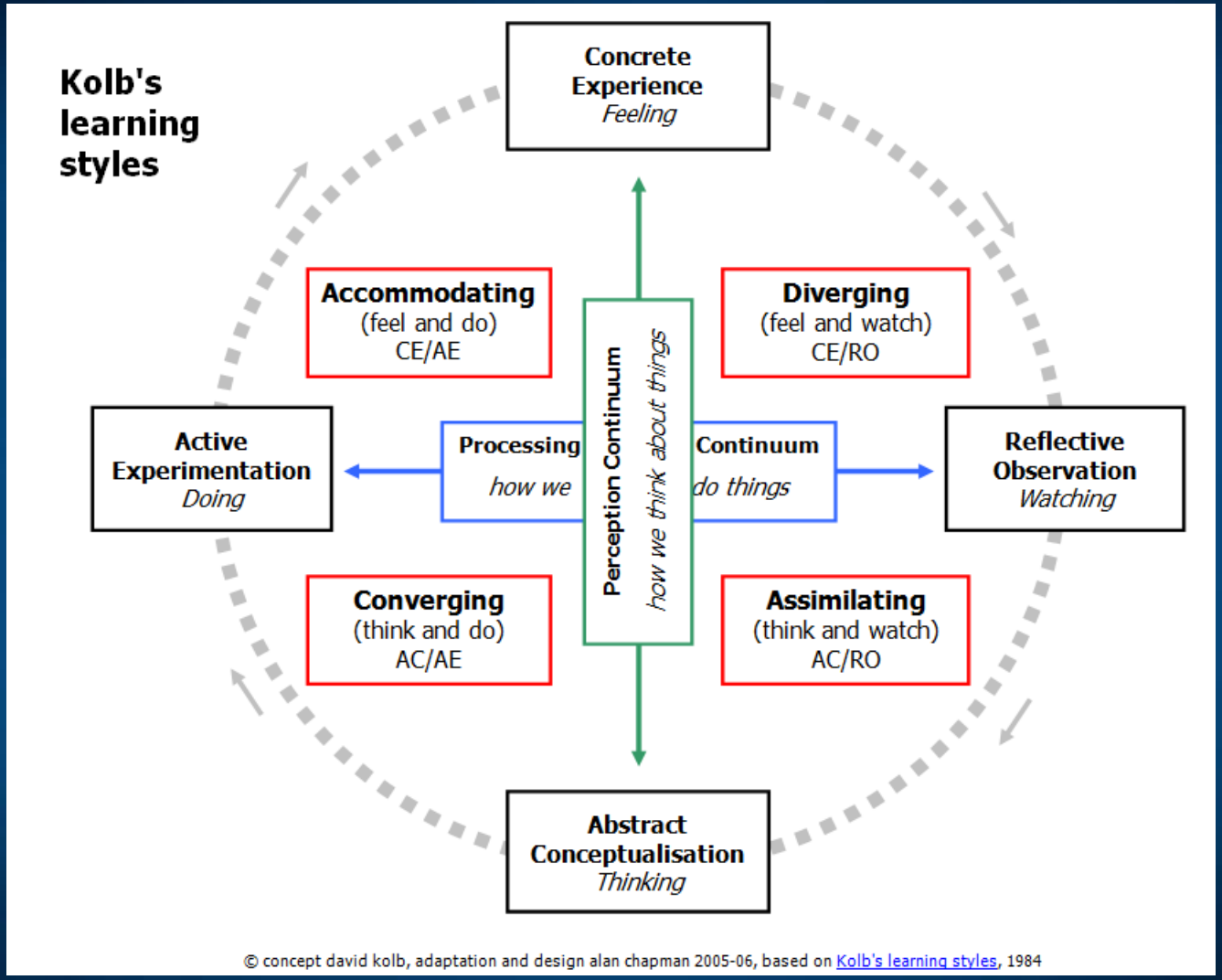


Brodmann areas are not sufficient, more detailed picture will distinguish 1000 regions of interest (ROI) and their activations. Concept = sustained prototype activity of ROIs.

Default Mode Network (DMN)



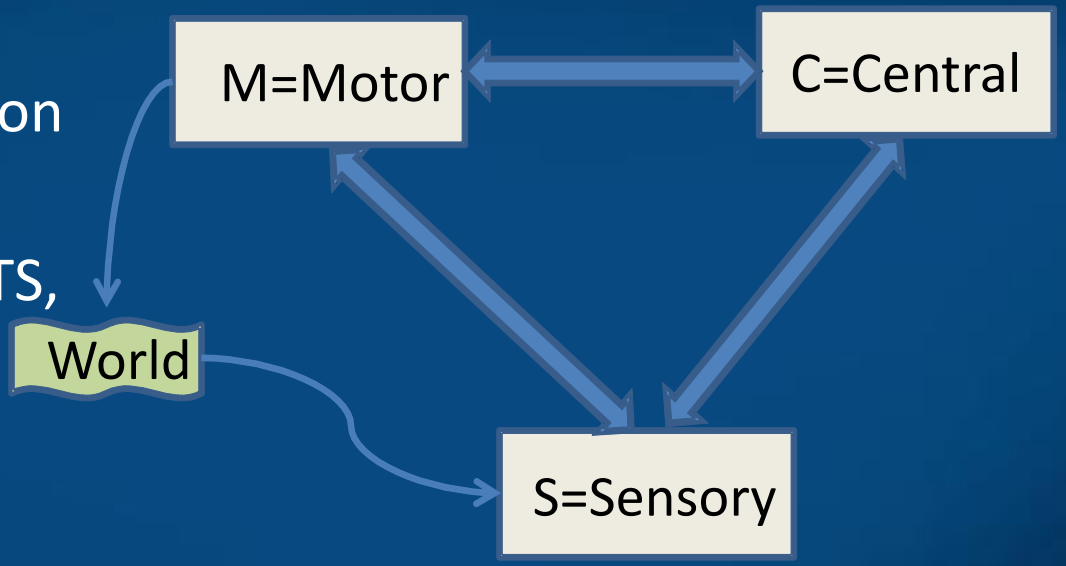
Learning styles



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

Learning connectome styles

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



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

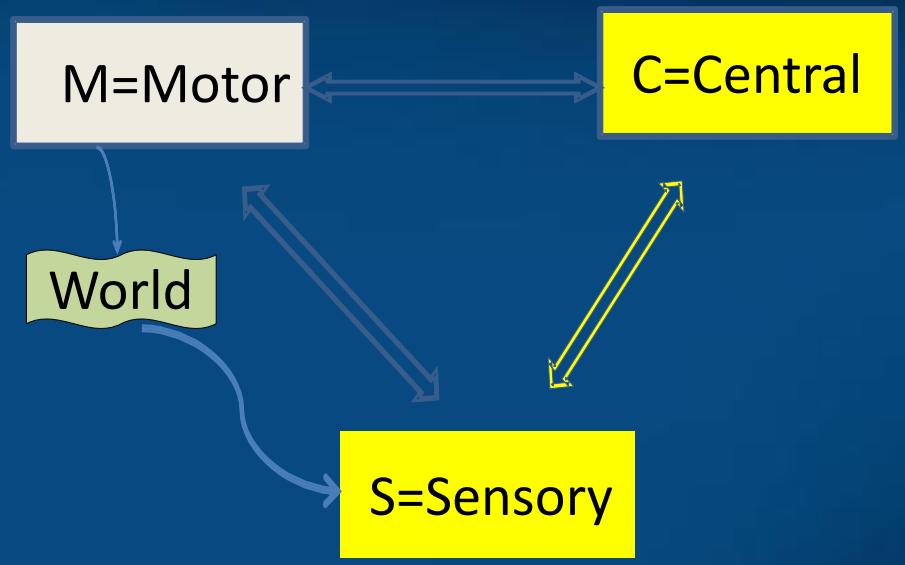
C, central associative level, abstract concepts that have no sensory components, mostly parietal, temporal and prefrontal lobes;

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 1st D

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.

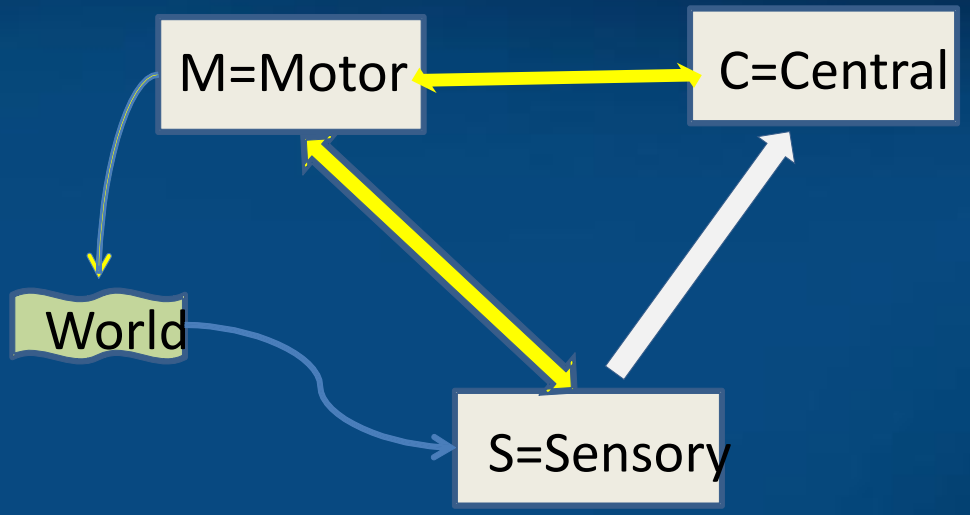


Attention = synchronization of neurons, limited to S, perception S⇔S strongly binds attention, no chance for normal development.
Asperger syndrome strong C=>S activates sensory cortices preventing understanding of metaphoric language.

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

Learning styles 2nd D

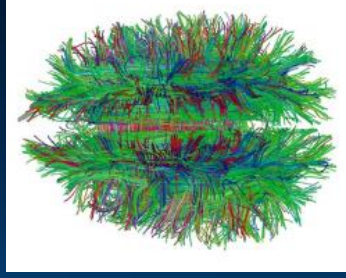
Kolb passive-active dimension, observation – experimentation: motor-central processes M⇔C, sensory-motor processes M⇔S. Autistic people: processes at the motor level M⇔M, leads to repetitive movements, echolalia.



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

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

4 styles and more



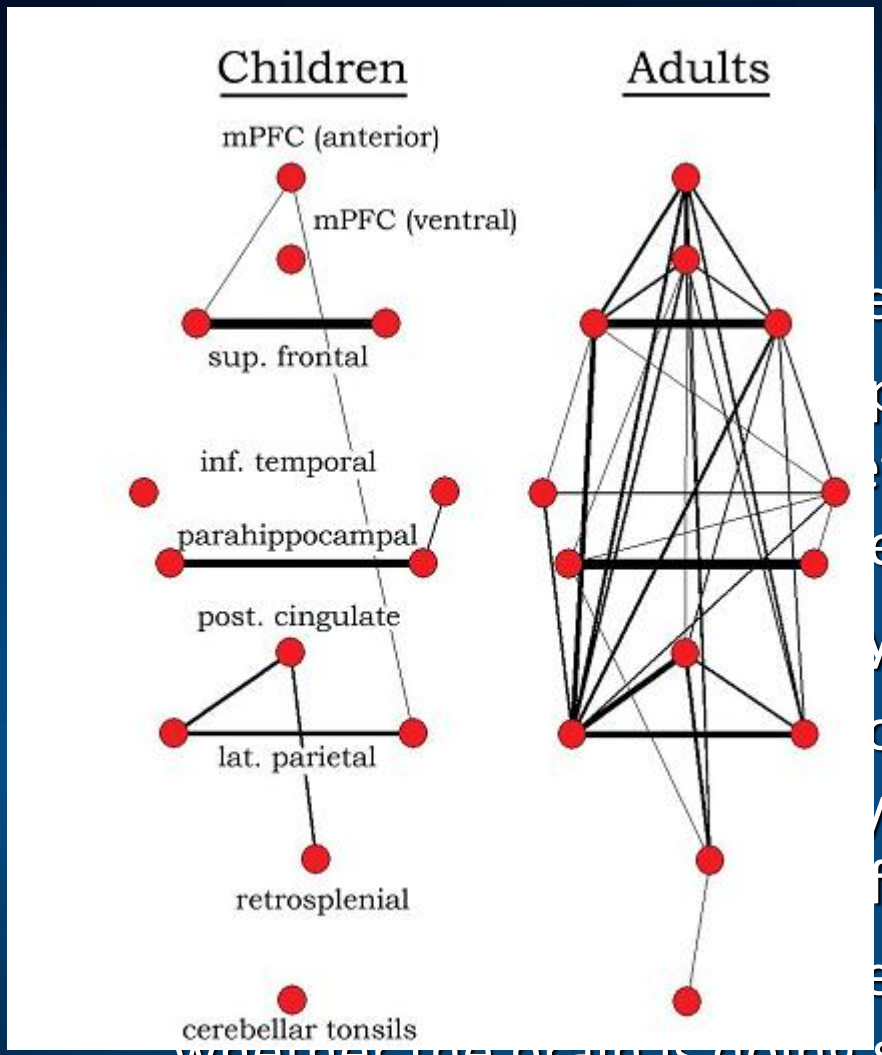
Assimilators think and watch: prone to abstract thinking, reflective observation, inductive reasoning due to strong connections S=>C and within C⇔C, weak connections from S=>M and C=>M.

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.

Objective tests of the learning style may be based on brain activity.



earning styles

e birth and in the first years of life.

pment is very difficult and depends
tic, signaling pathways) processes,
erience and learning.

y) processes S⇔S.

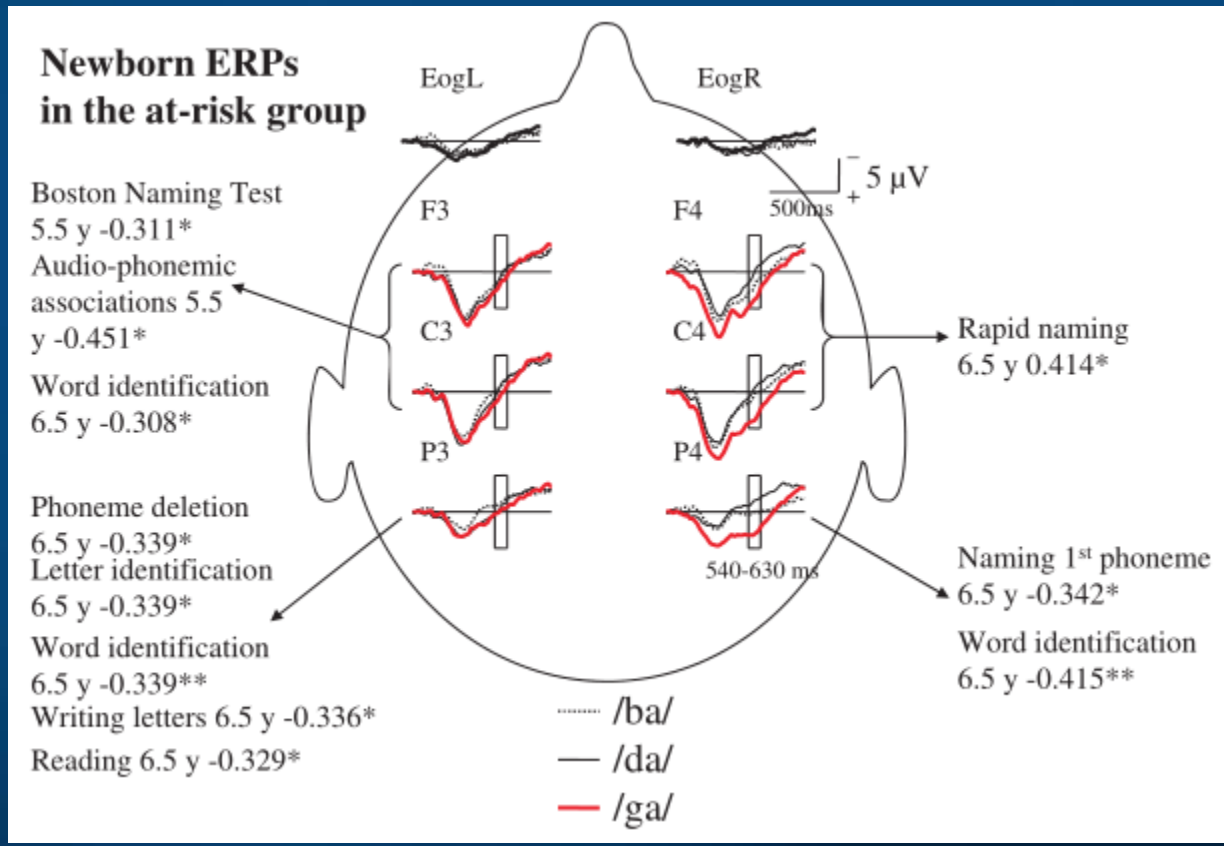
ons and synchronization,
y for abstract thinking, weak
frontal lobe ⇔ other areas.

e 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.

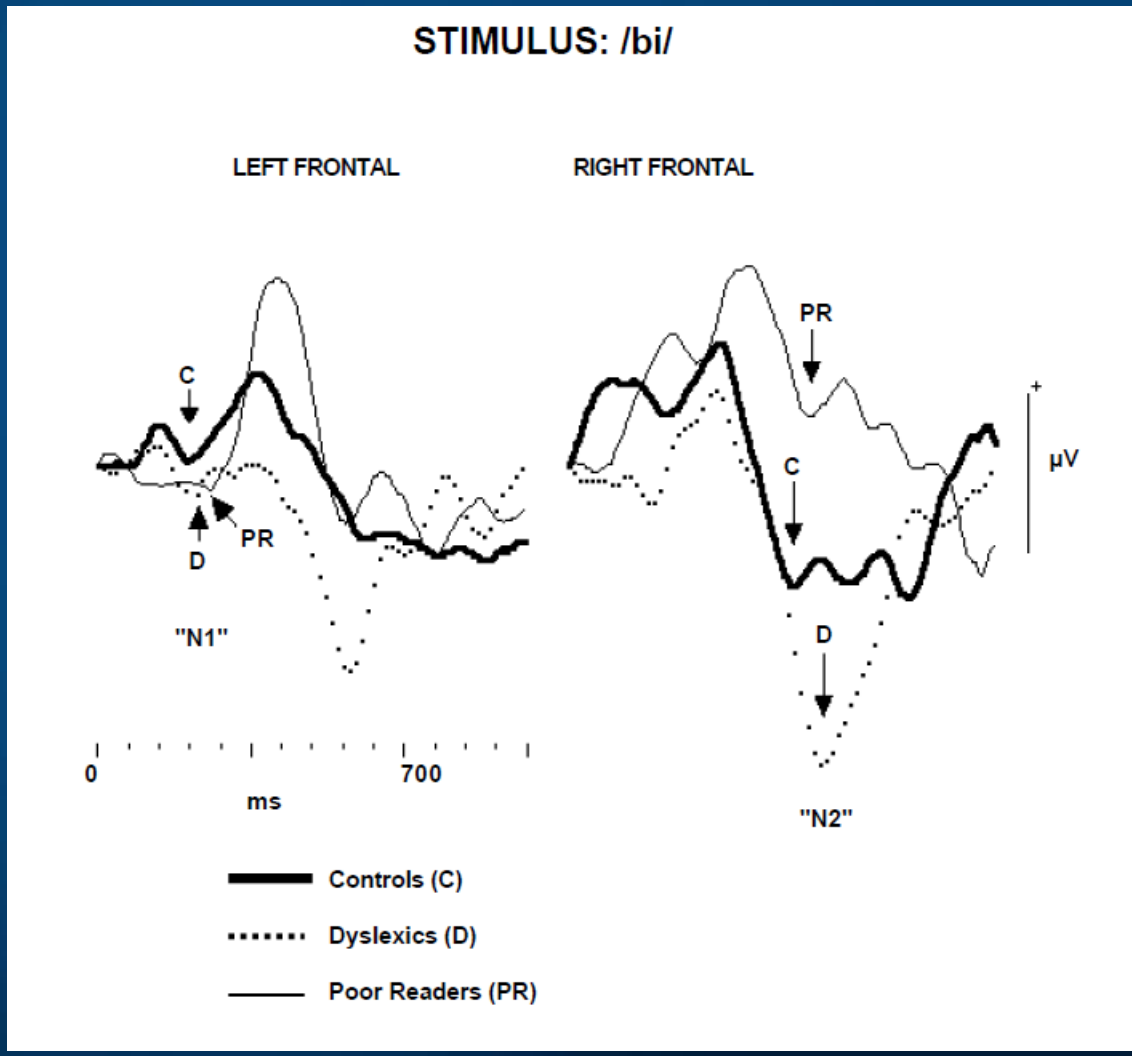
Infants, syllables

Brains of newborns react to ba/ga/da syllables in the 3–5 day of life in a way that allows for prediction of problems with learning to read years later.

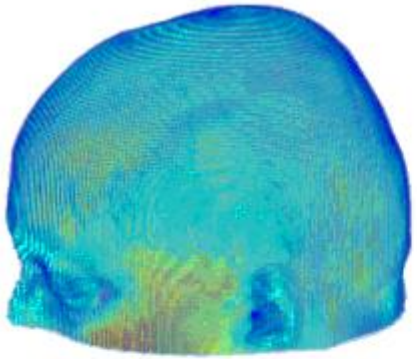


Infants, syllables

Brains of newborns react to ba/ga/da syllables in the 3–5 day of life in a way that allows for prediction of problems with learning to read years later.



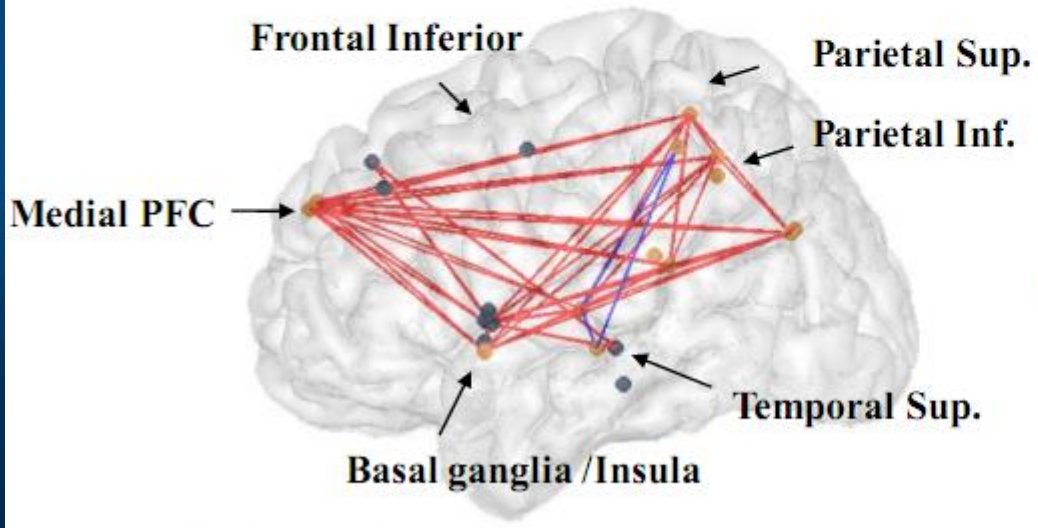
Head position



Connectivity : 63 ROI analysis

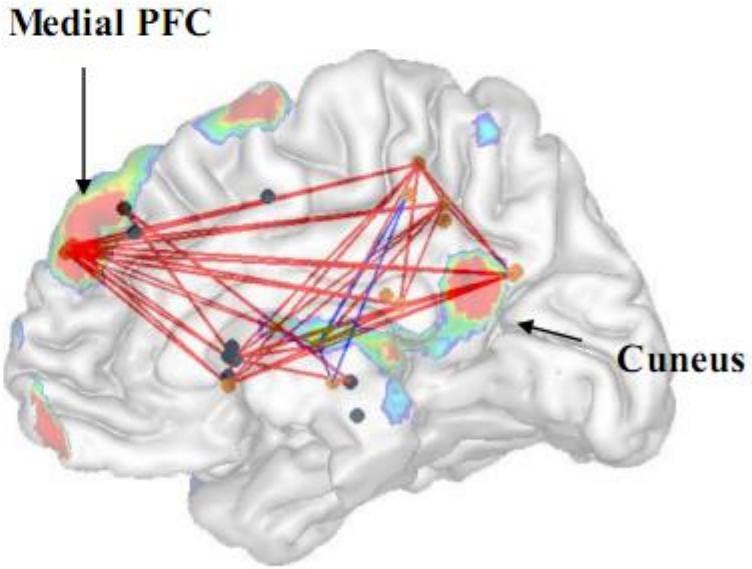
Significant in ASD not in Controls

Significant in Controls, not in ASD



Region of the default mode network

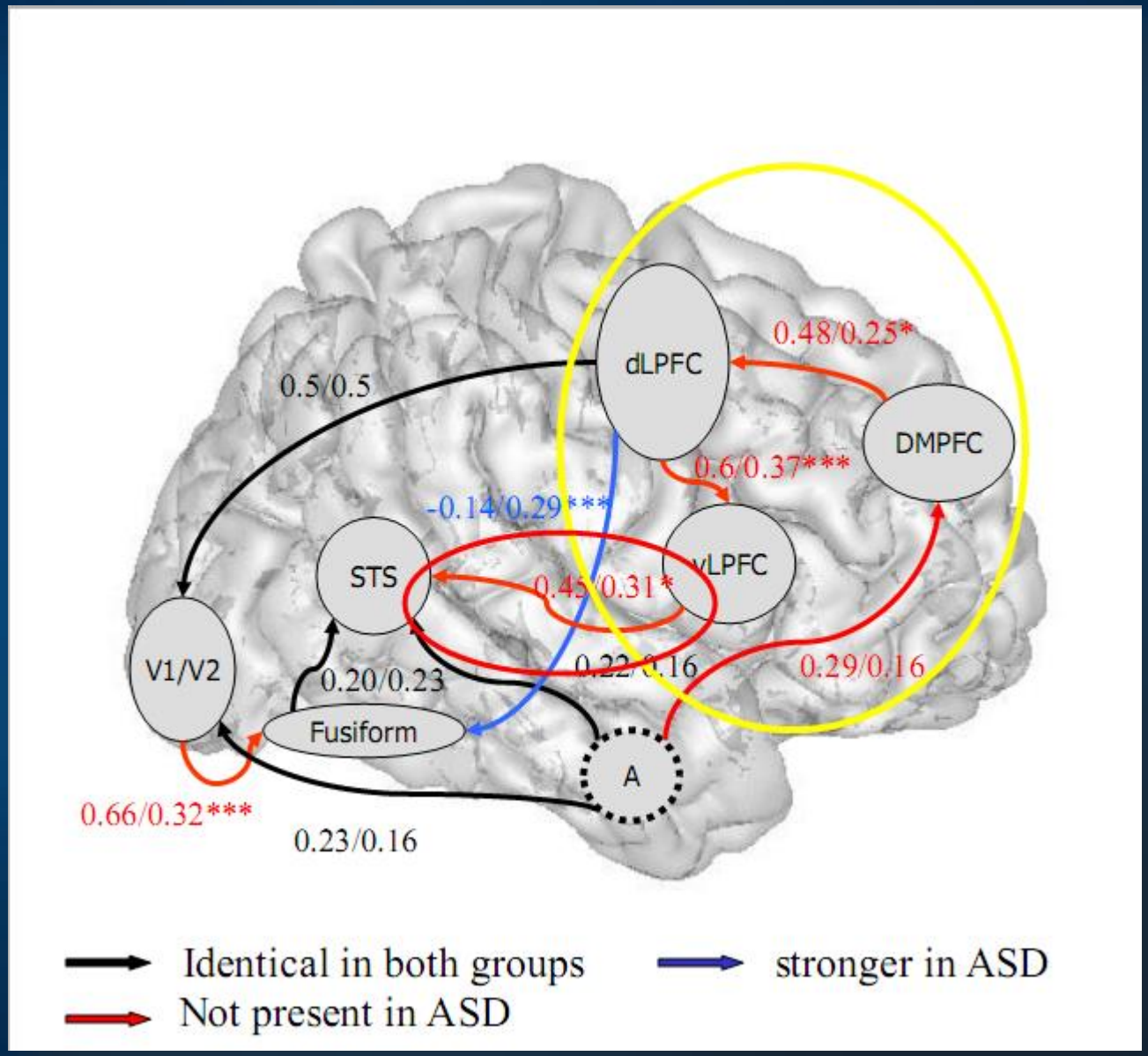
Region of the active network



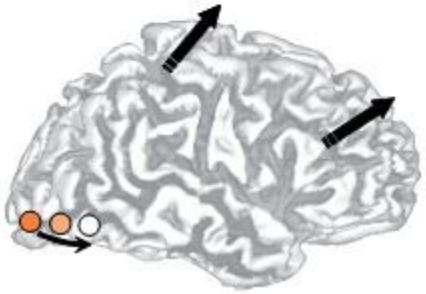
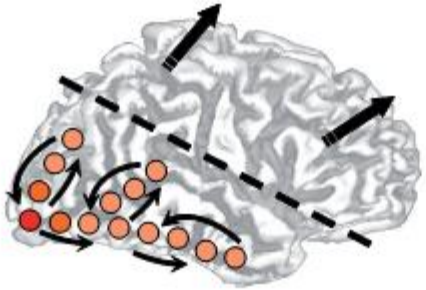
Brain activations in the FMRI experiment on emotion perception

Effective brain connections

B. Wicker et al.
SCAN 2008

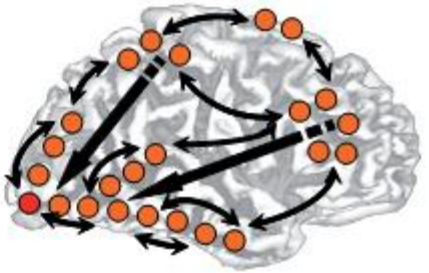


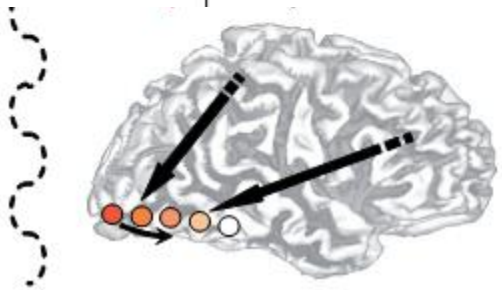
Cor

Bottom-up stimulus strength	Top-d absent	sufficiently strong
	Subliminal (unattended)	Preconscious
↓	• Very little activation • Activation is already weak in early extrastriate areas • Little or no priming • No reportability	• Intense activation, yet confined to sensorimotor processors • Occipito-temporal loops and local synchrony • Priming at multiple levels • No reportability while attention is occupied elsewhere
weak or interrupted		

Conscious

- Orientation of top-down attention
- Amplification of sensori-motor activity
- Intense activation spreading to parietofrontal network
- Long distance loops and global synchrony
- Durable activation, maintained at will
- Conscious reportablity





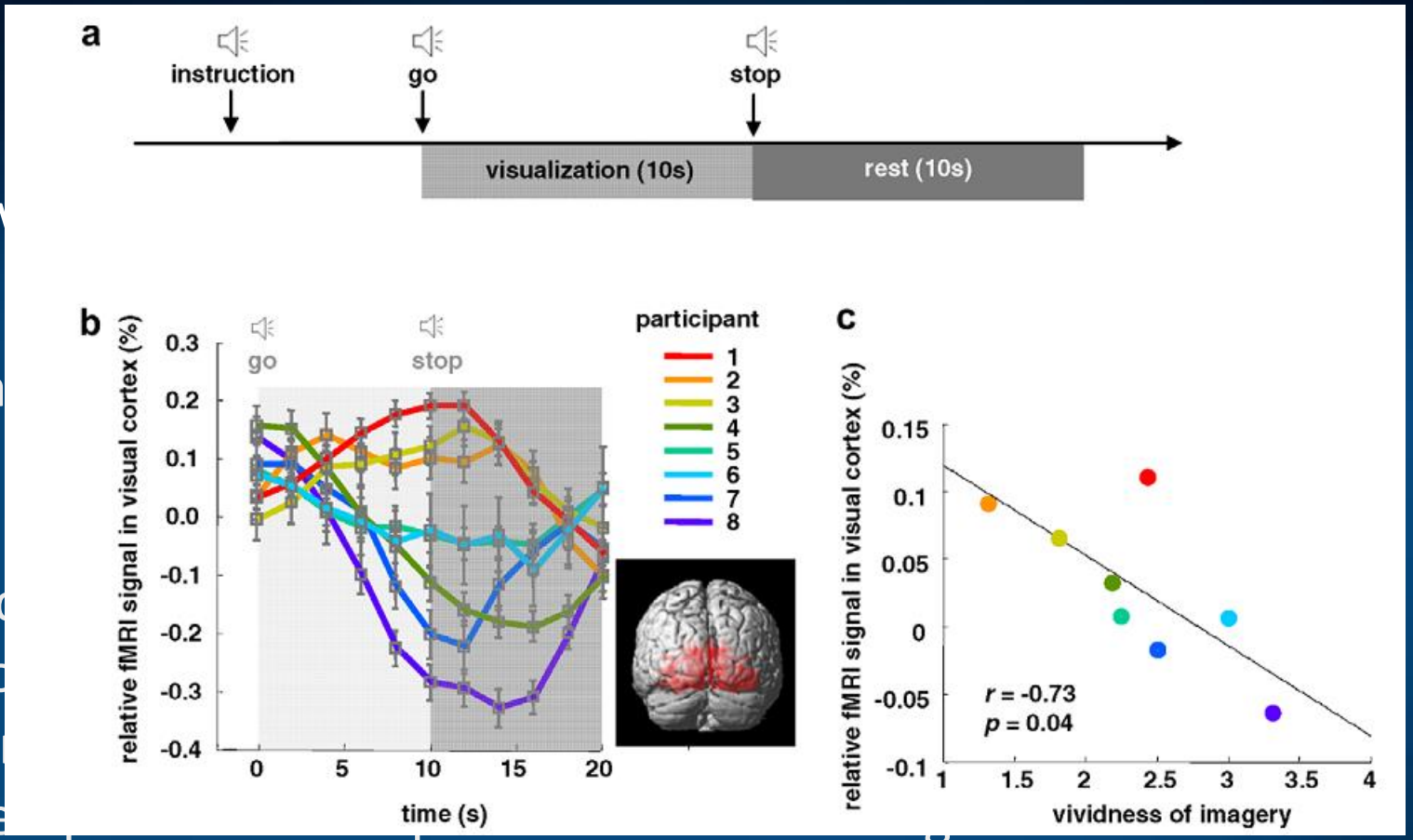
d subliminal processing,

ombined leads to 4 brain states with both stimulus and attention required for conscious reportability.

How and

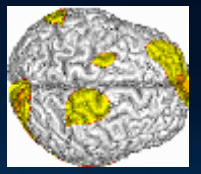
"... image
that visua

Reported
al. 2007)
relative to
performa
Findings e
subject variability.



Poor perceptual imagery: why? Weak top-down influences? Unable to draw from memory, describe details, faces, notice changes, etc.

Maya



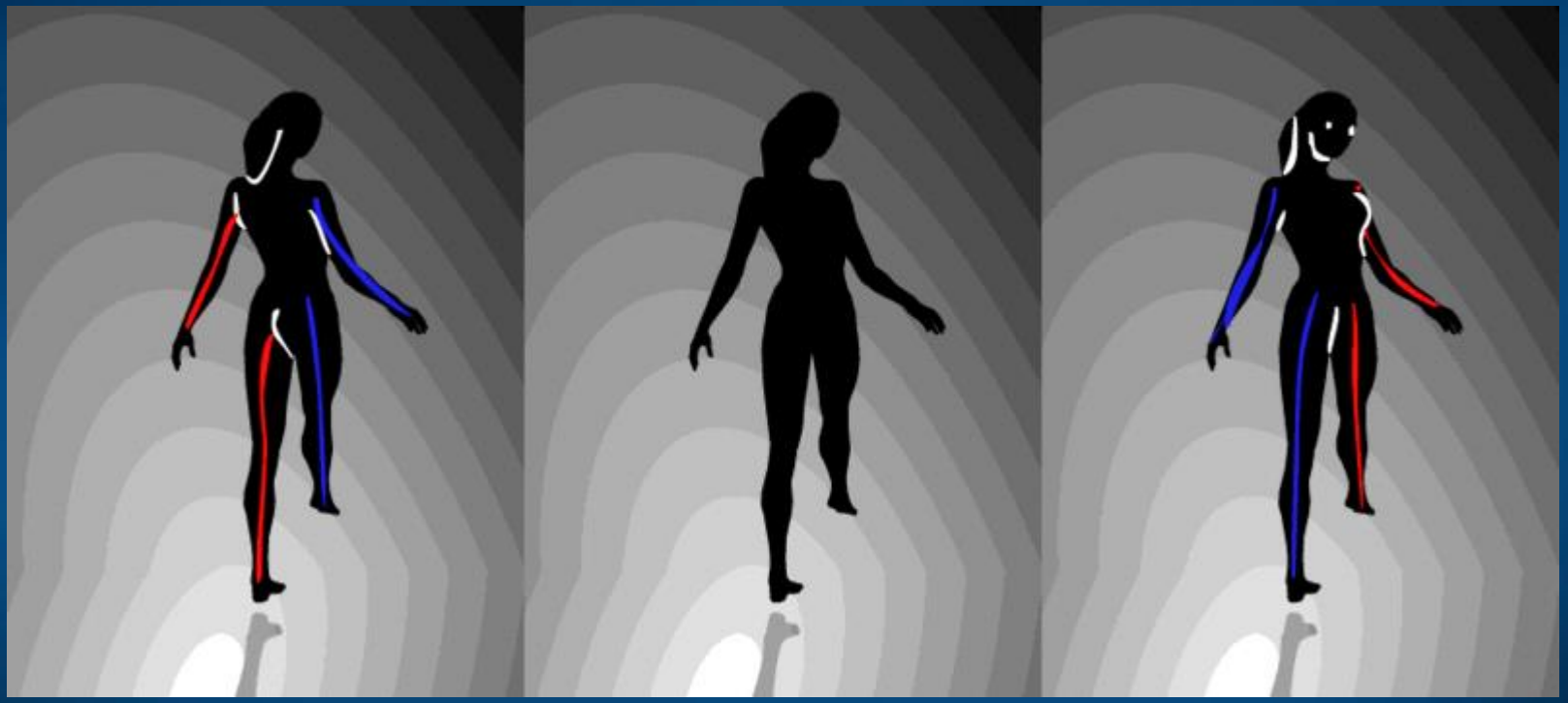
Maya: the world that we see is in fact our imagination!

The temple flag was flapped by the wind. Two monks argued about nature of reality: the flag is moving, said one. No, the wind is moving, said the second.
The Sixth Chan Patriarch hearing that said:
- It is not the wind that is moving, neither the flag.
It is your mind that is moving.

Mumonkan, China, 13 century, comments:

If you have a close grasp of the meaning you will see how the two monks, intending to buy iron, got gold.
We know that we open our mouth,
But we don’t know we go all wrong.

The world is just our imagination …



Who can be sure, in his sensible perception of a chair, how much comes from the eye and how much is supplied out of the previous knowledge of the mind?

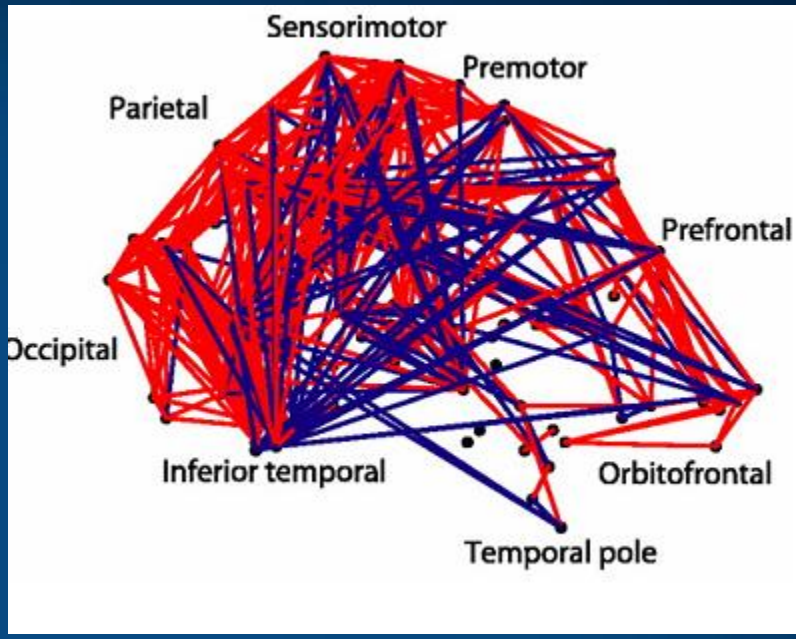
William James, The Principles of Psychology, 1890

Talent and imagery

Normal perception requires top-down influences to form expectations.

What if PC/FC feedback connections to visual/auditory areas are weak?

A kind of imagery agnosia.



Poor visual imagination, memory for visual features, inability to draw from memory, recall and describe faces and objects, notice changes, slow in making puzzles, difficulty to see 3D magic eye pictures, perhaps more introvert?

More conceptual than perceptual thinking.

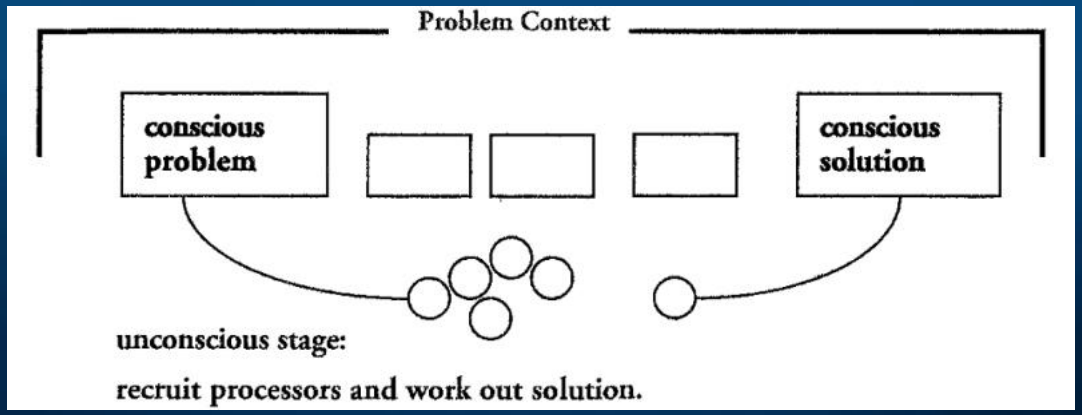
At PC/FC level less interferences from sensory areas, so imagination, creativity, reasoning are better than average.

Problem solving in 3 steps

Many cognitive processes may be decomposed into 3 steps:

1. Understanding of the problem (conscious);
2. Performing some transformation 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.

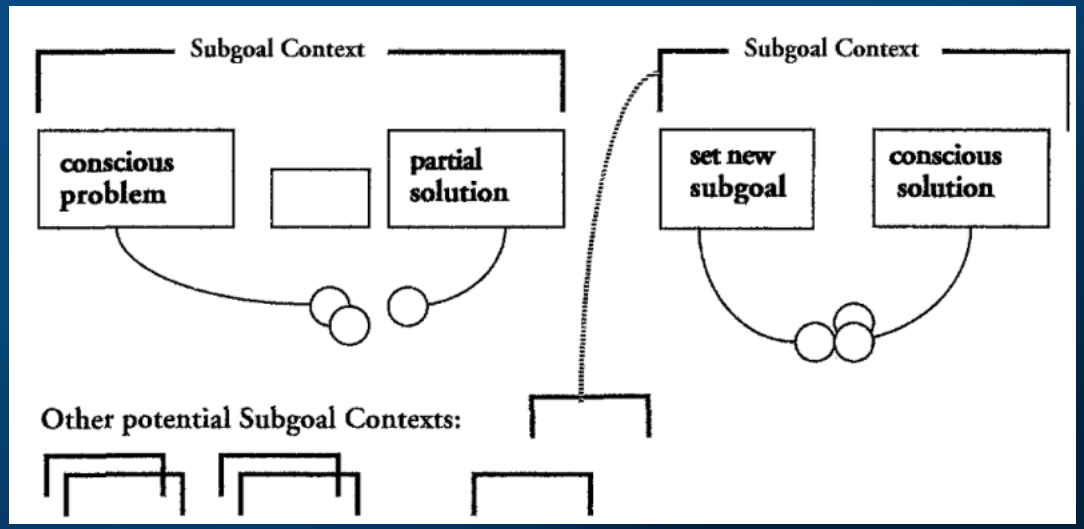


3 steps

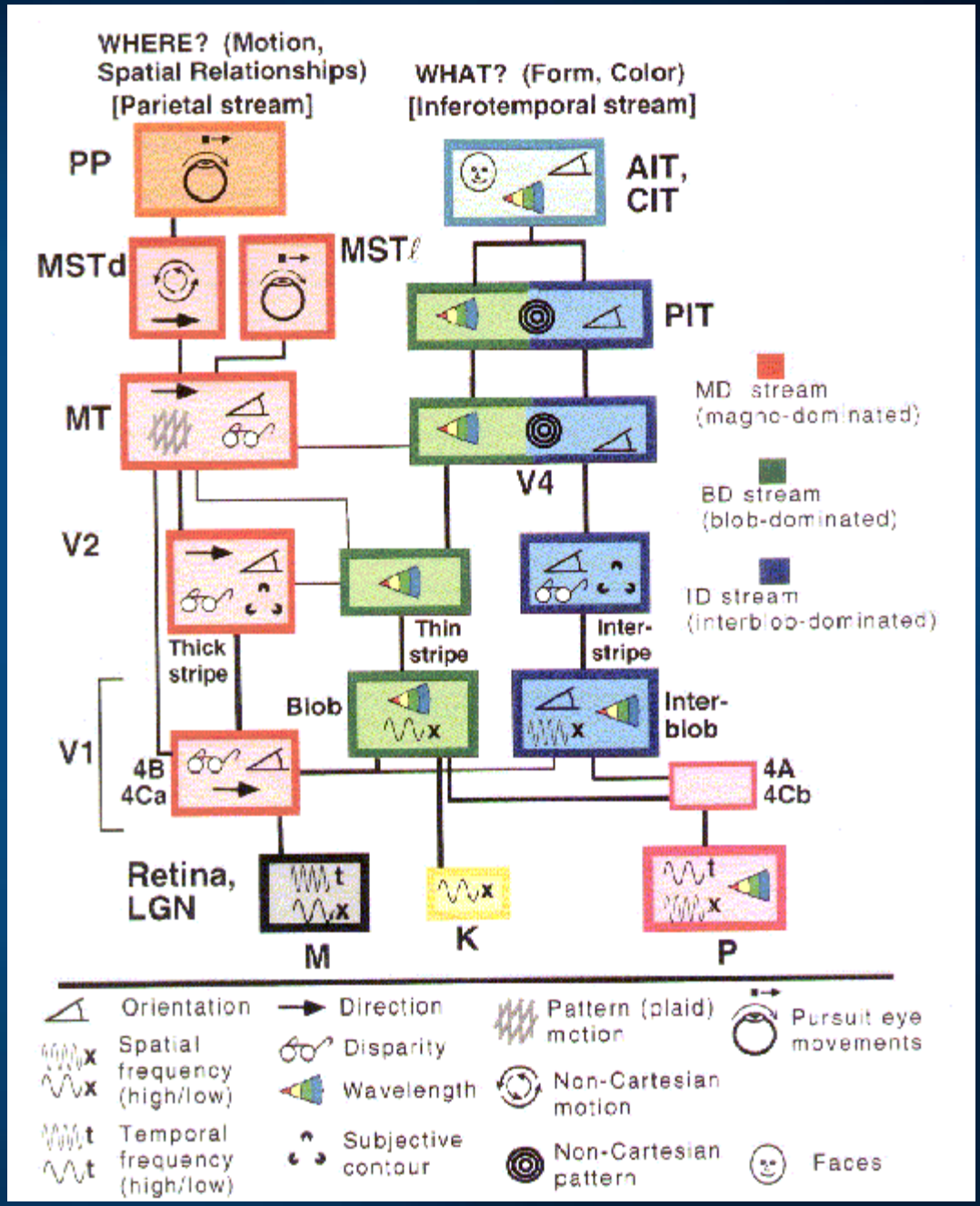
The same 3 steps may be distinguished in:

- 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.
- Planning.
- Problem solving

Sequential reasoning repeats the 3 steps many times.

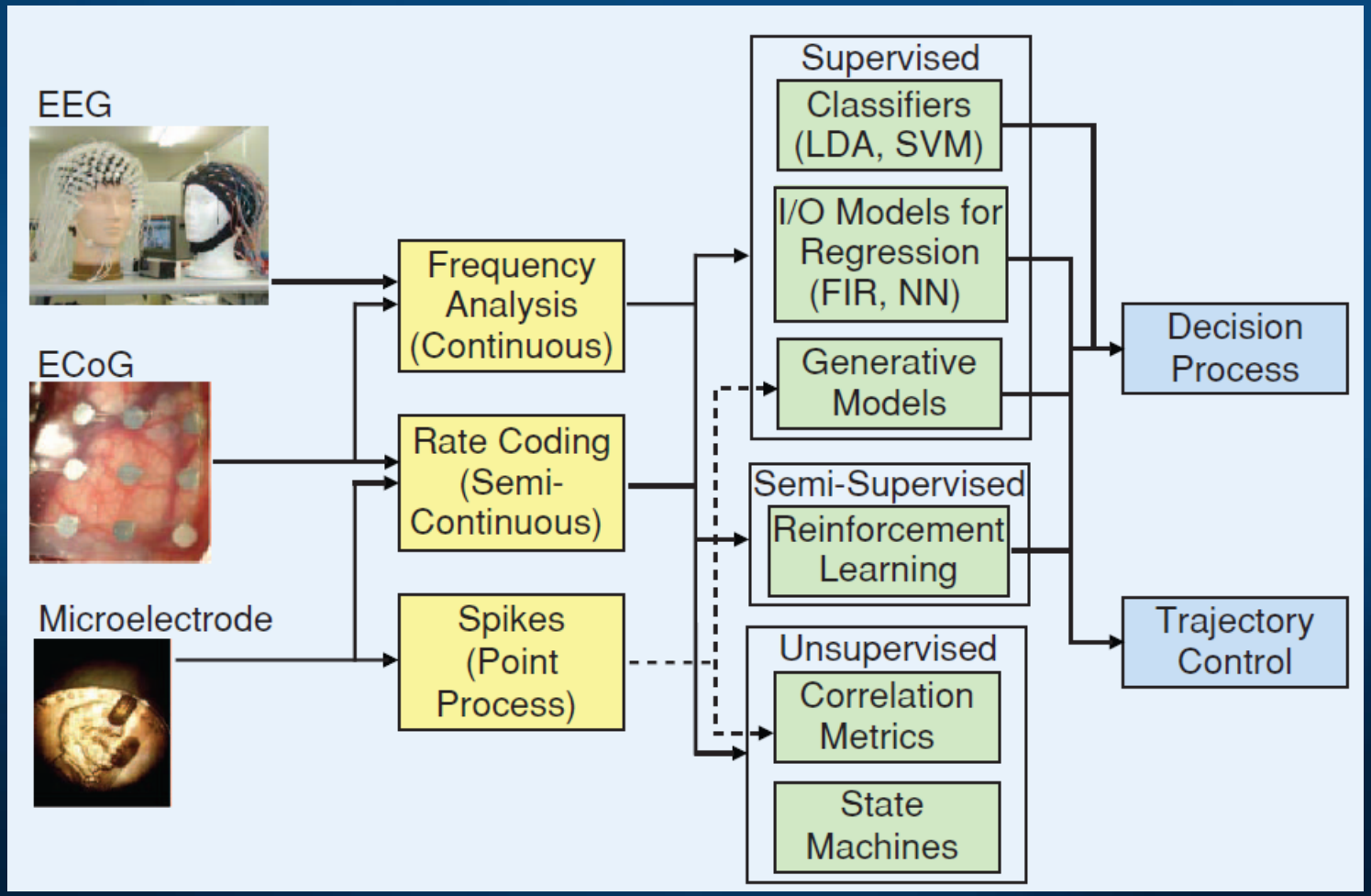


Seeing requires activation of areas in the visual pathway. There are important individual differences, due to the developmental processes as well as experience.
How can these differences help to understand the history of art?

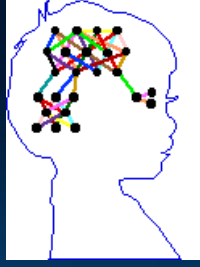


BCI: wire your brain ….

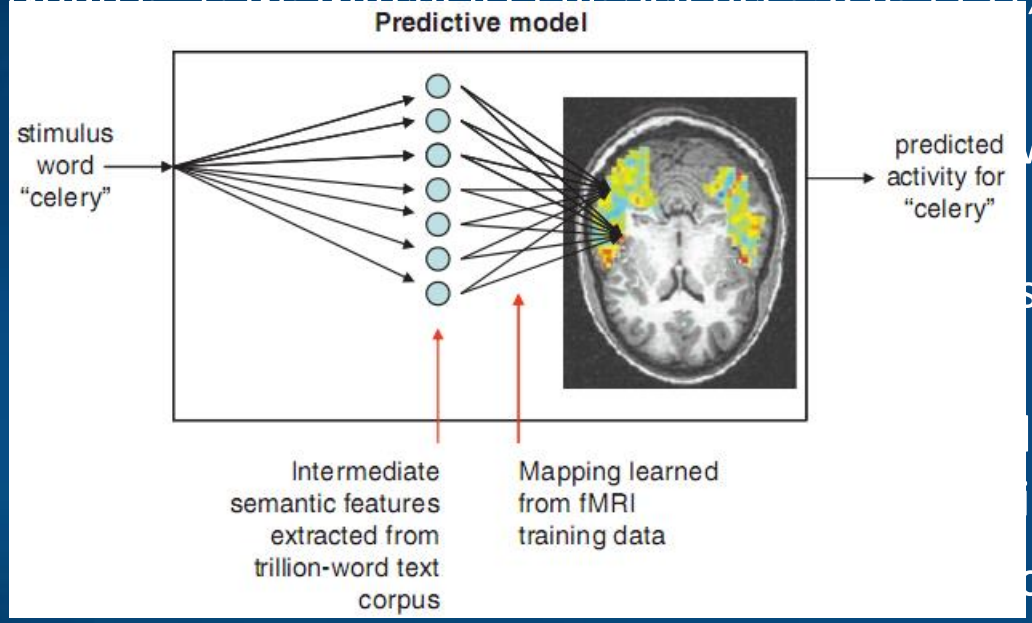
You must know what to do before you know what you are doing.
With access to your brain areas that do the planning I may know it first!

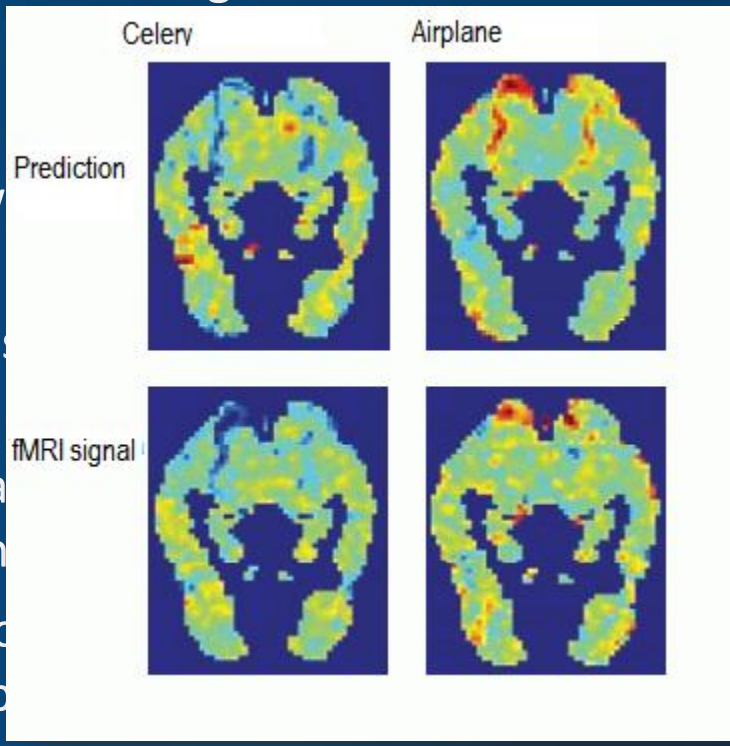


Private thoughts?



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





- w
- s
- a
- i
- c

activity for over 100 nouns for which fMRI has b

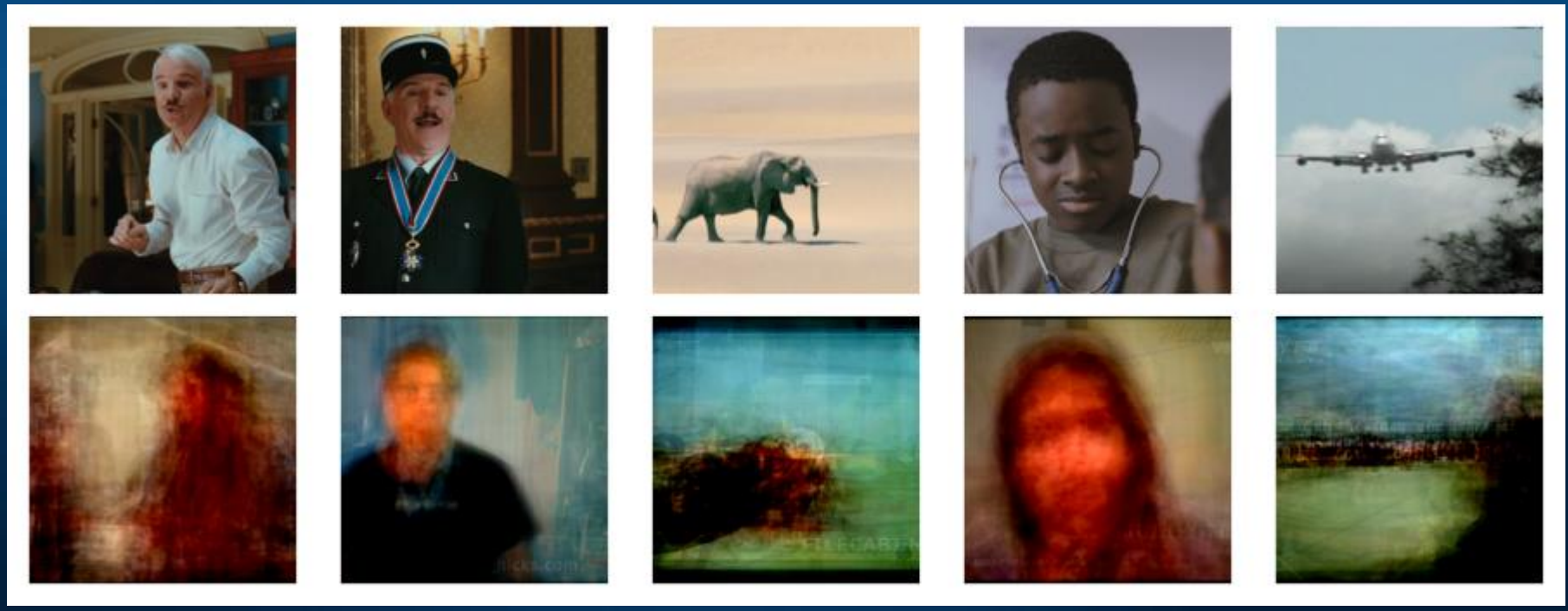
Overlaps between activation of the brain for different words may serve as expansion coefficients for word-activation basis set.

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

Looking inside

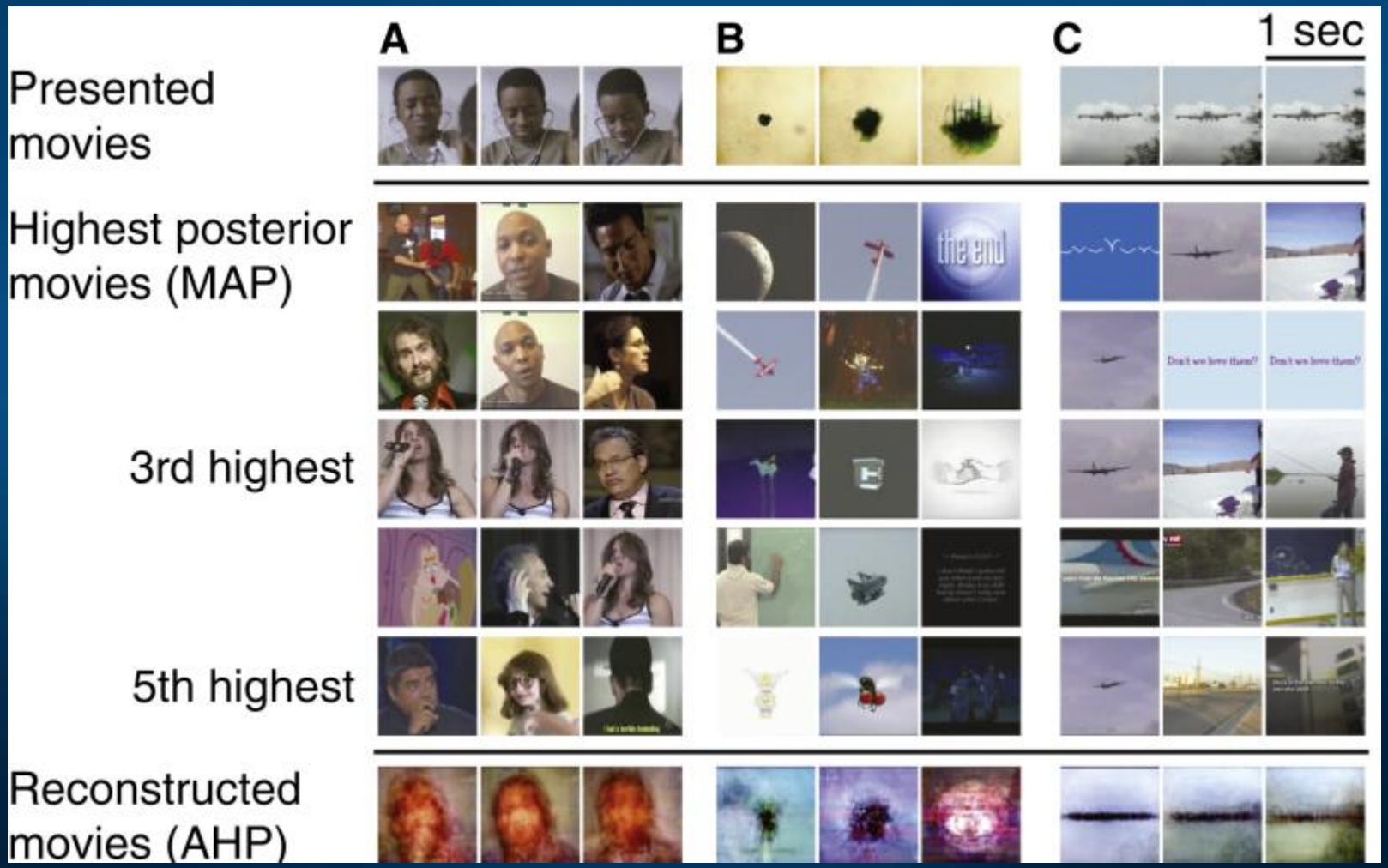
Scanner fMRI 4 Tesla

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



Reconstructing experiences

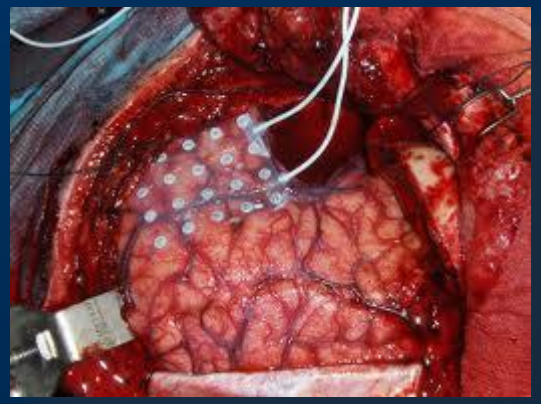
S. Nishimoto et al. Reconstructing Visual Experiences from Brain Activity Evoked by Natural Movies. Current Biology 2011



Blurred image?

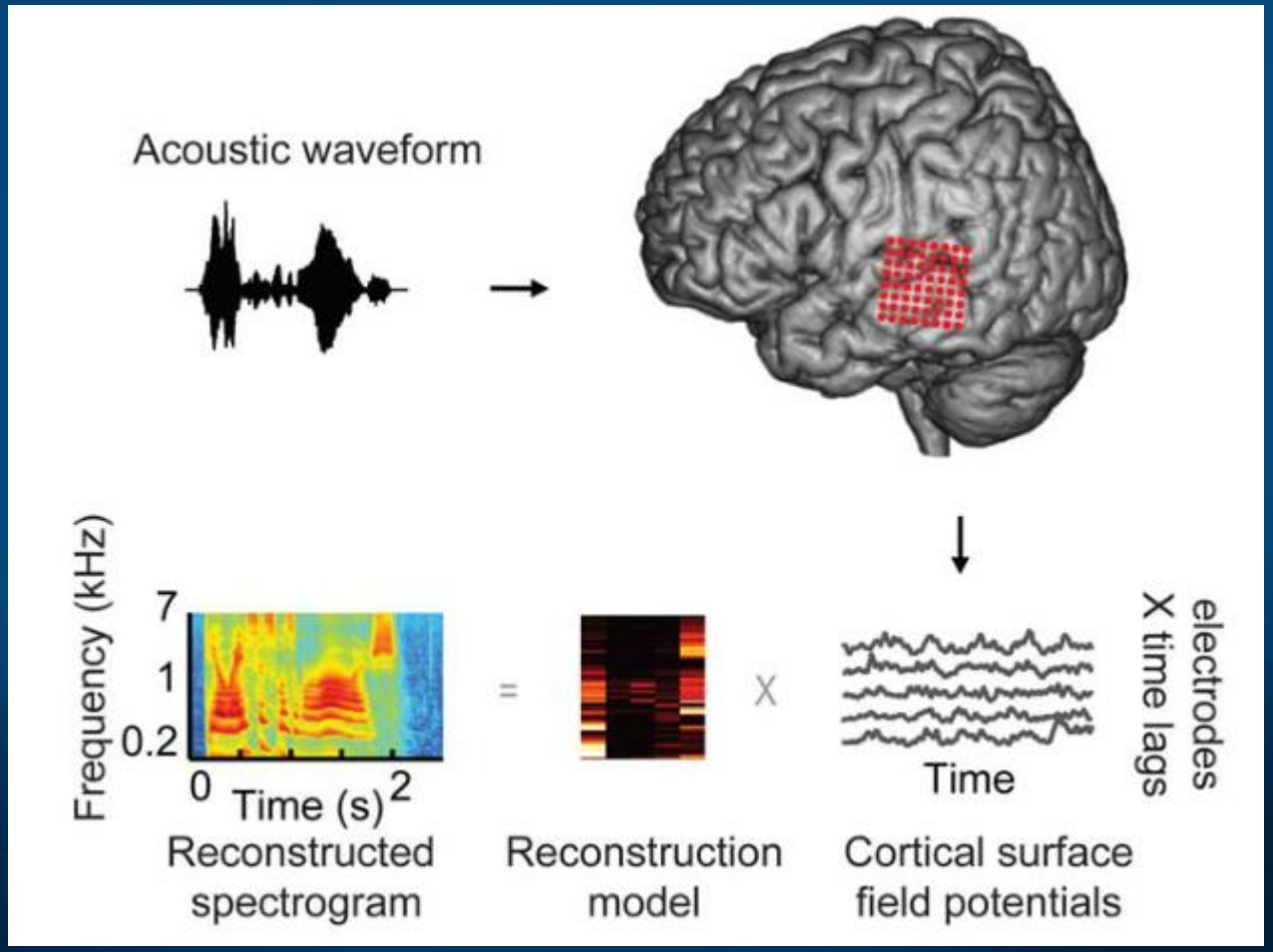
Just give us access to your cortex, open your skulls, please.

And if you do …

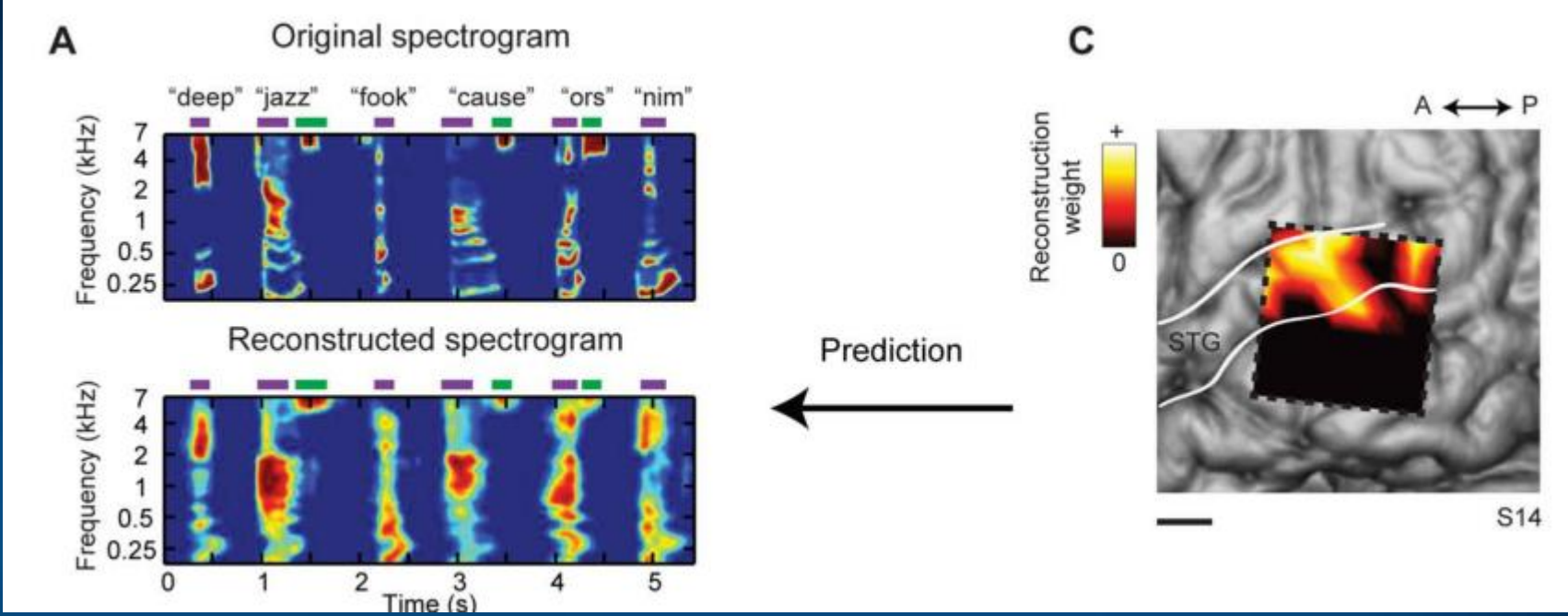


Hearing your thoughts

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



Thought: time, frequency, place, energy



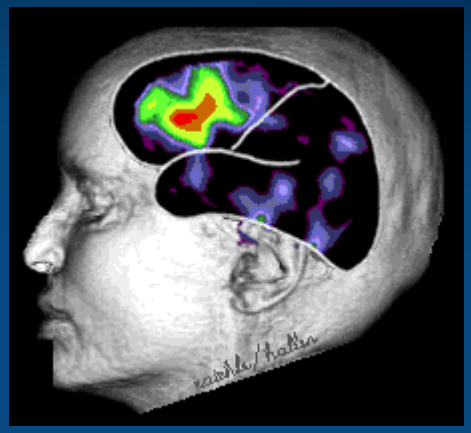
Pasley et al. Reconstructing Speech from Human Auditory Cortex PLOS Biology 2012

Geometric model of mind

Objective ⇔ Subjective.

Brain ⇔ Mind.

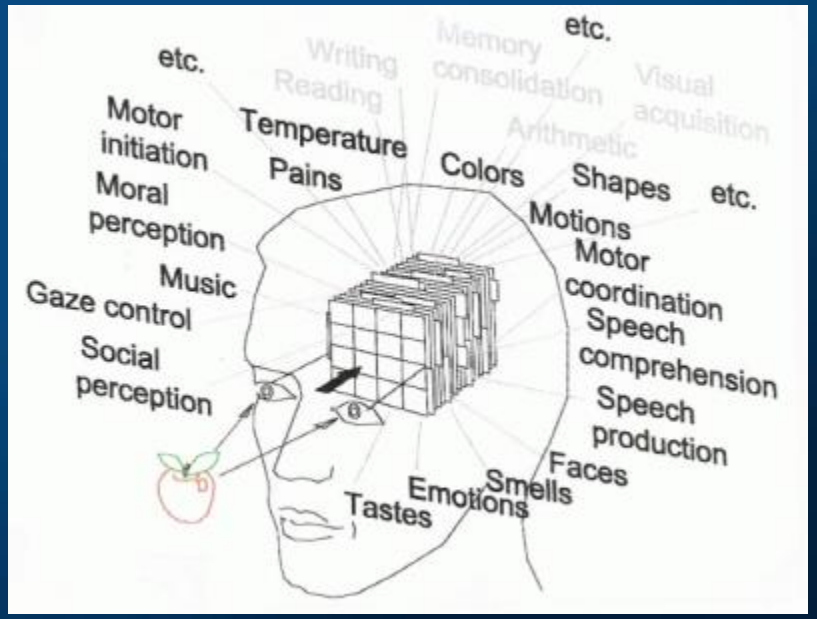
Neurodynamics describes state of the brain activation measured using EEG, MEG, NIRS-OT, PET, fMRI or other techniques.



How to represent mind state?

In the space based on dimensions that have subjective interpretation: intentions, emotions, qualia.

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



Nicole Speer et al.

Reading Stories Activates Neural Representations of Visual and Motor Experiences.

Psychological Science (2010).

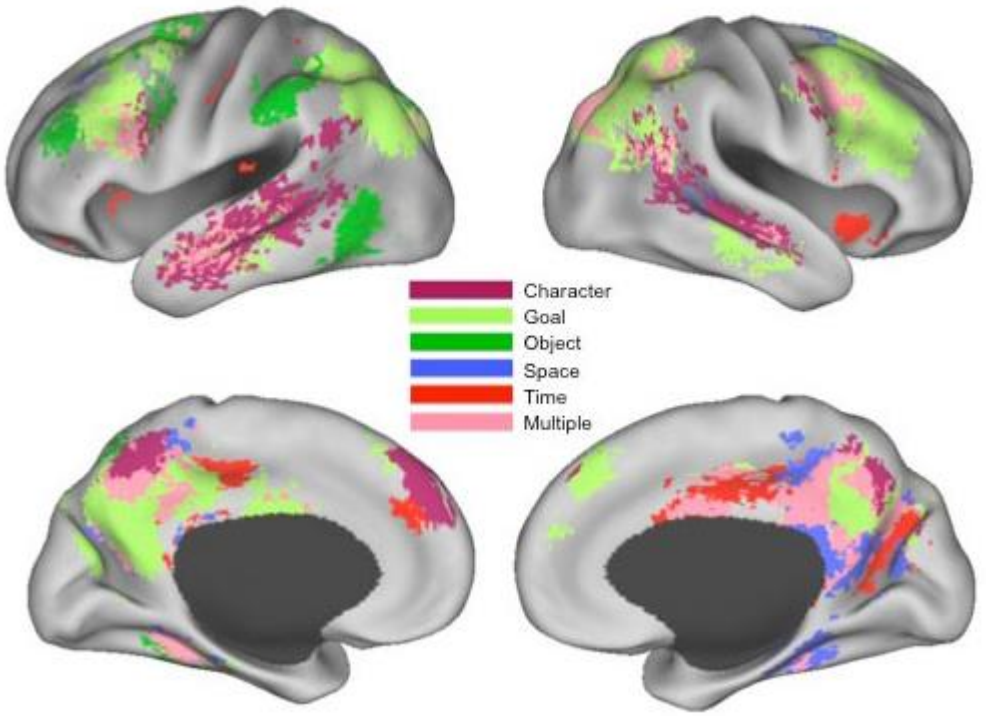
Meaning: always slightly different, depending on the context, but still may be clusterized into relatively small number of distinct meanings.

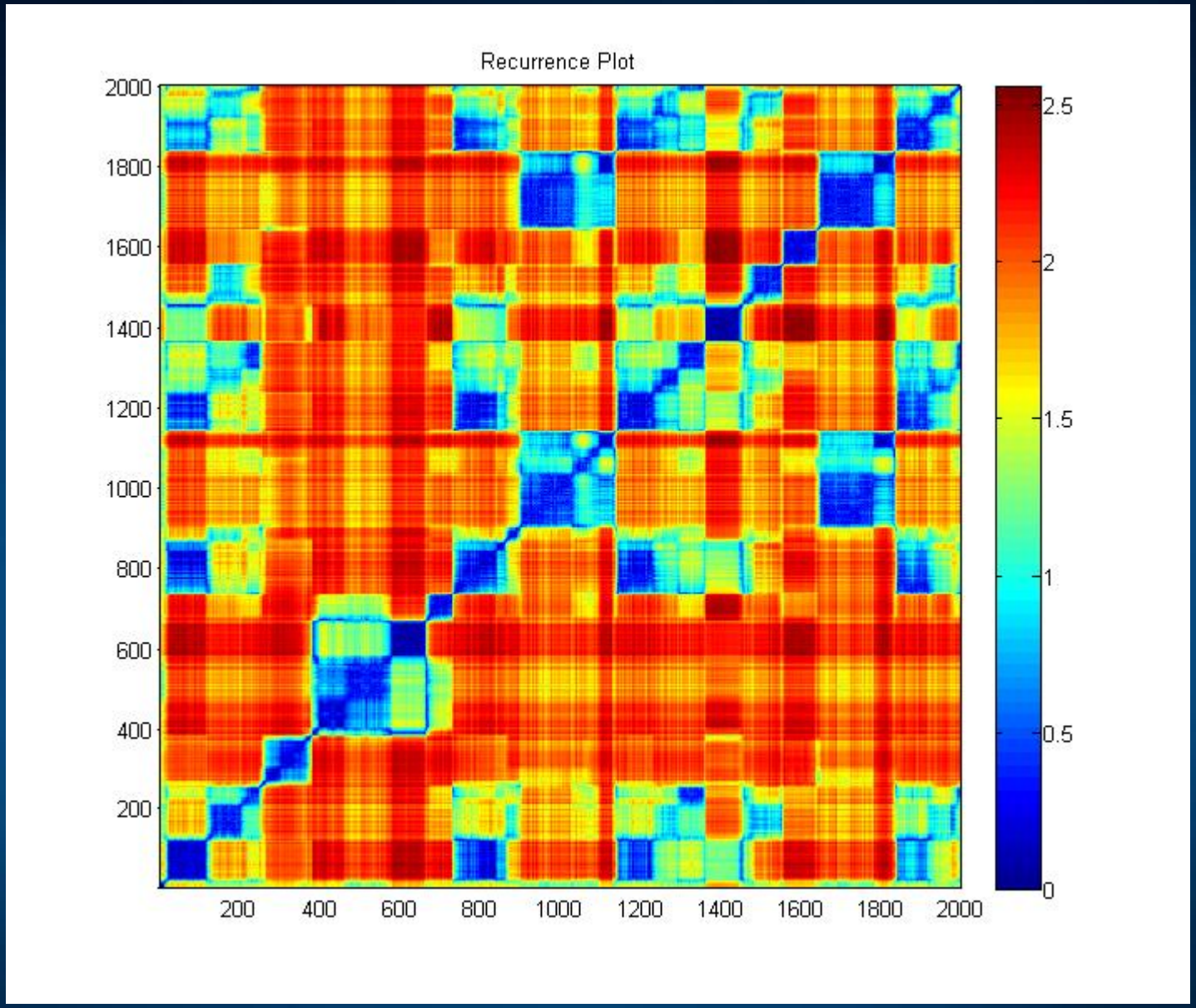
Experience is segmented (Zacks et al, 2010).

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.						

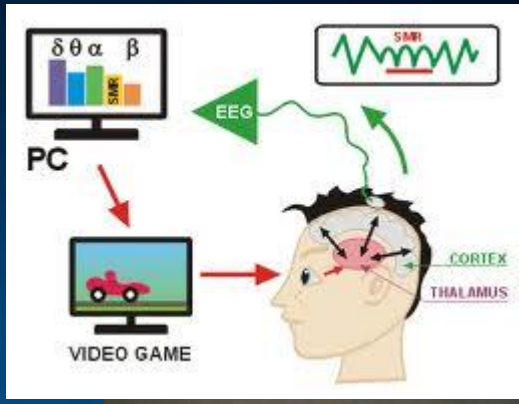
B





„Gain” – trajectory of semantic activations quickly changes to new prototype synchronized activity, periodically returns.

EEG and creativity



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

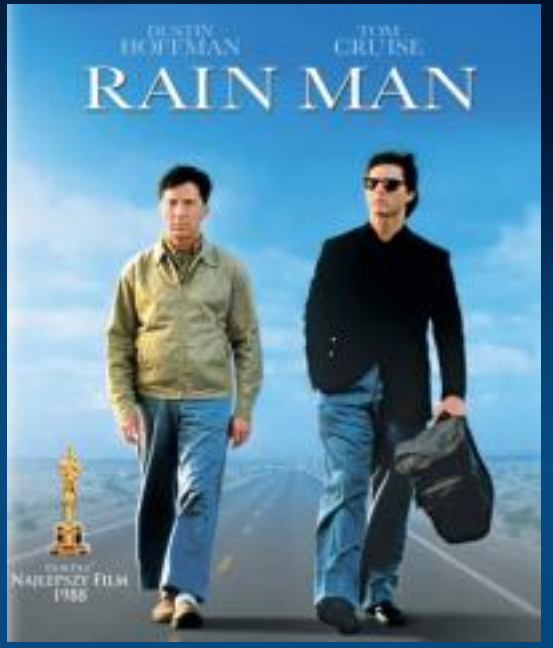
α–θ and heart rate variability (HRV) biofeedback produced "professionally significant performance improvements" in music and dance students. (J.H. Gruzelier, Soc. For Applied Neuroscience).

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 oscillations .

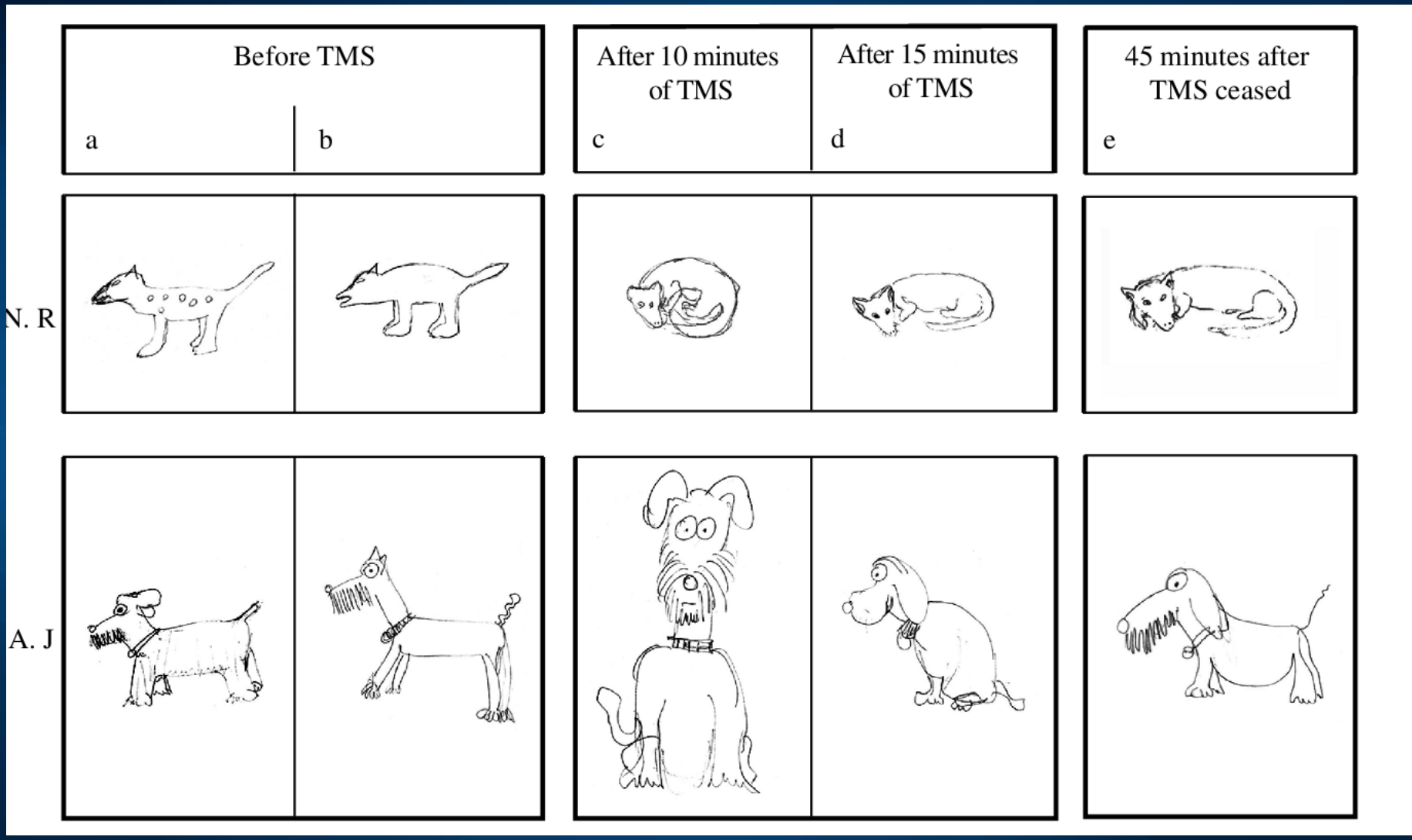
rTMS and savant syndrome



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

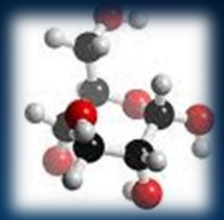
Few percent of mentally retarded people show unusual memory, arithmetics, artistic or musical skills – savant syndrome.
Using rTMS 3 Tesla low frequency magnetic field) helped 4 out of 11 subjects to draw better pictures.
Direct Current Stimulation (DCS) opens short (~15 min) window of brain plasticity.

rTMS and savant syndrome



After TMS drawings got better.

Energy for the brain



Can one train willpower, motivation, perseverance, curiosity and creativity using neurofeedback? Thinking and self-control requires mental energy derived from food.

Higher levels of blood glucose reduce reliance on intuitive, heuristic-based decision making, help controlling attention, regulating emotions, coping with stress, resisting impulsivity, refraining from aggressive behavior.
Alcohol reduces glucose levels impairing many forms of self-control. Self-control failure is most likely during times of the day when glucose is used least effectively.

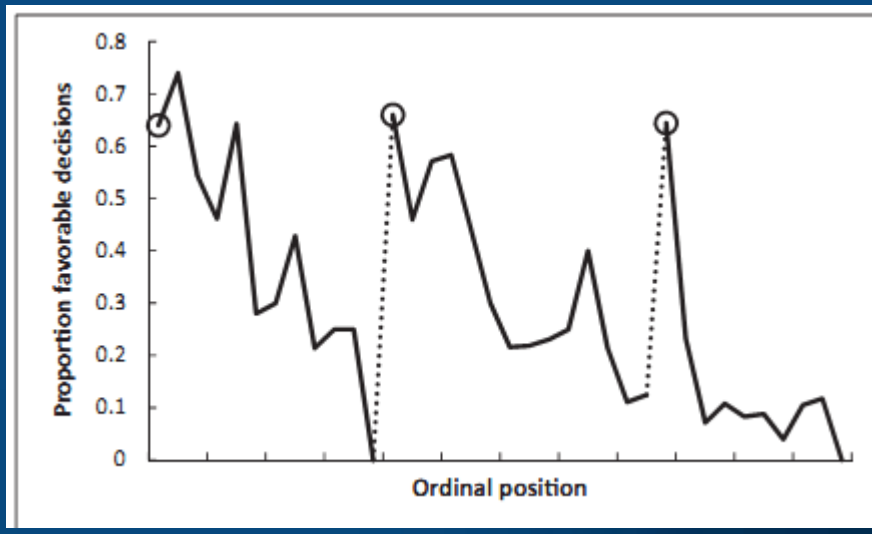
Willpower and glucose: Gailliot MT & Baumeister RF (2007) The physiology of willpower: Linking blood glucose to self-control. Personality and Social Psychology Review, 11, 303-327.

Sufficient energy for mental activity is a necessary condition.

Decisions of judges

Justice is “what the judge ate for breakfast”.
Sequential parole decisions for 1000 rulings, 8 Israeli judges each with 20-year of experience (S. Danziger 2011).

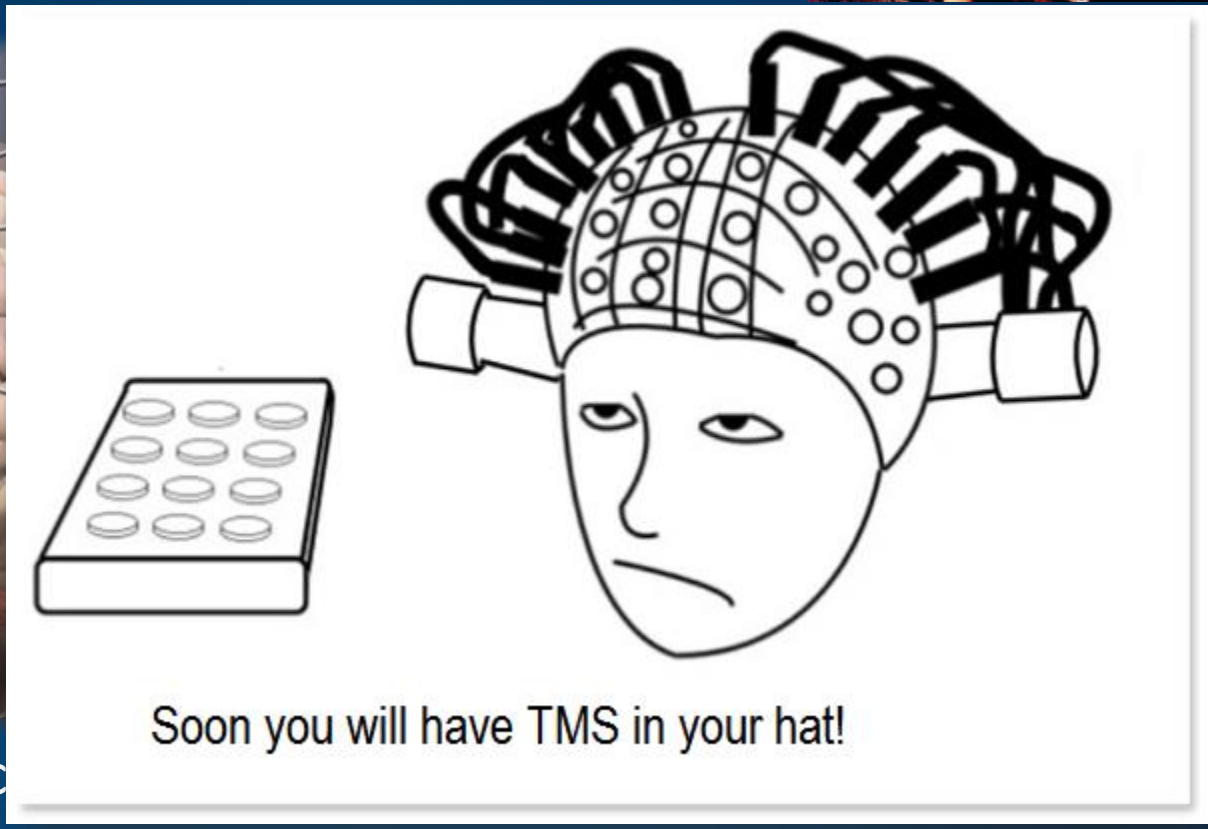
When professor is hungry avoid examinations !



Self-regulation, making decisions requiring thinking needs energy, glucose and oxygen. After hard decisions or problem solving instead of thinking people follow sterotypes.

R.F. Baumeister, Ego Depletion and Self-Regulation Failure (2003).

Will is just another feeling



common unconscious c

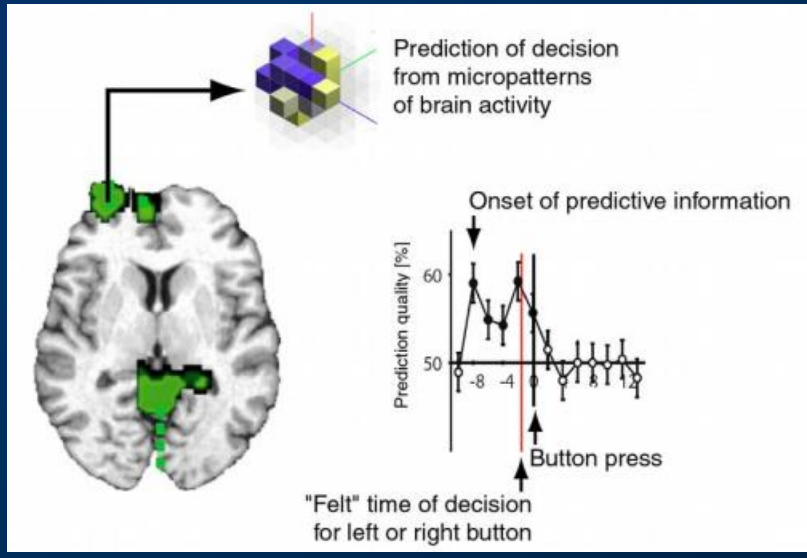
TMS stimulations: even if one side is selected 80% of times the choice is felt as free ... we could be radio controlled!

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

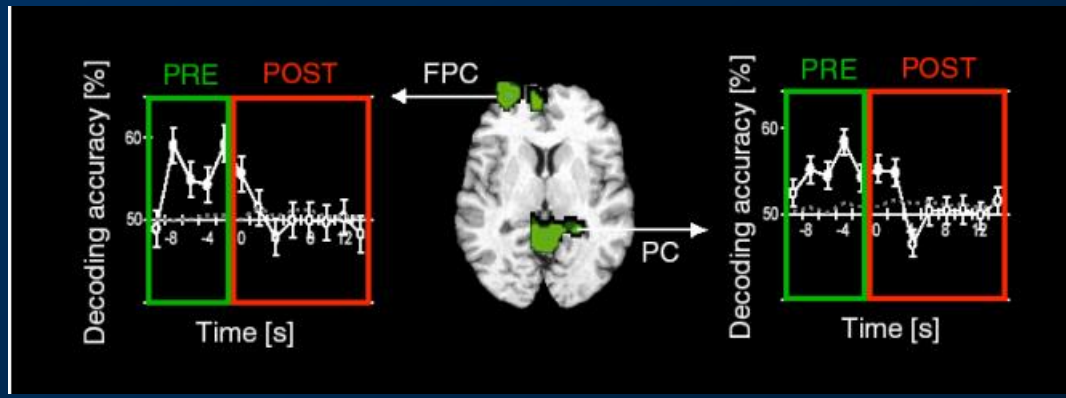
10 seconds delay!

C.S. Soon et al, Unconscious determinants of free decisions in the human brain. Nature Neuroscience, 2008.

We found that the outcome of a decision can be encoded in brain activity of prefrontal and parietal cortex up to 10 sec before it enters awareness.



This delay presumably reflects the operation of a network of high-level control areas that begin to prepare an upcoming decision long before it enters awareness.

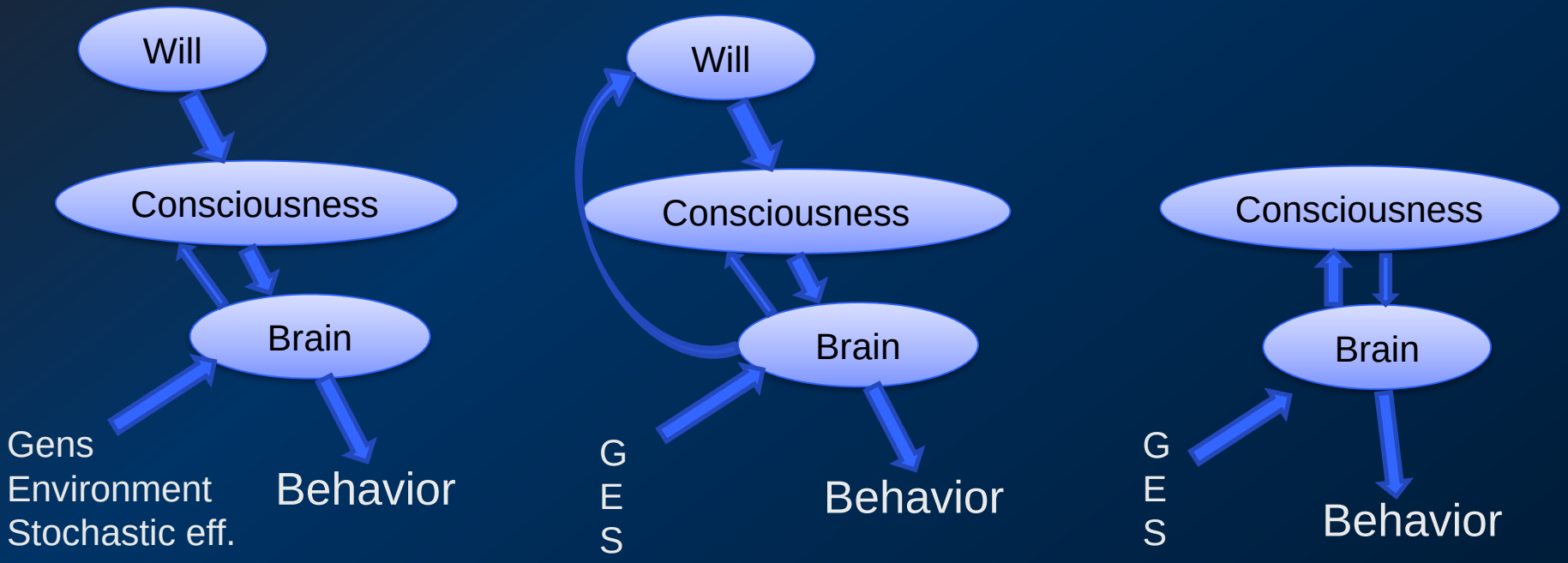


Brains and will

Brain exists solely for its own survival, not to understand ourselves. Only by looking from outside we can understand the brain and draw conclusions about its nature and functions.

Edward Osborne Wilson

What are the options? Naive, reflexive and mechanical.

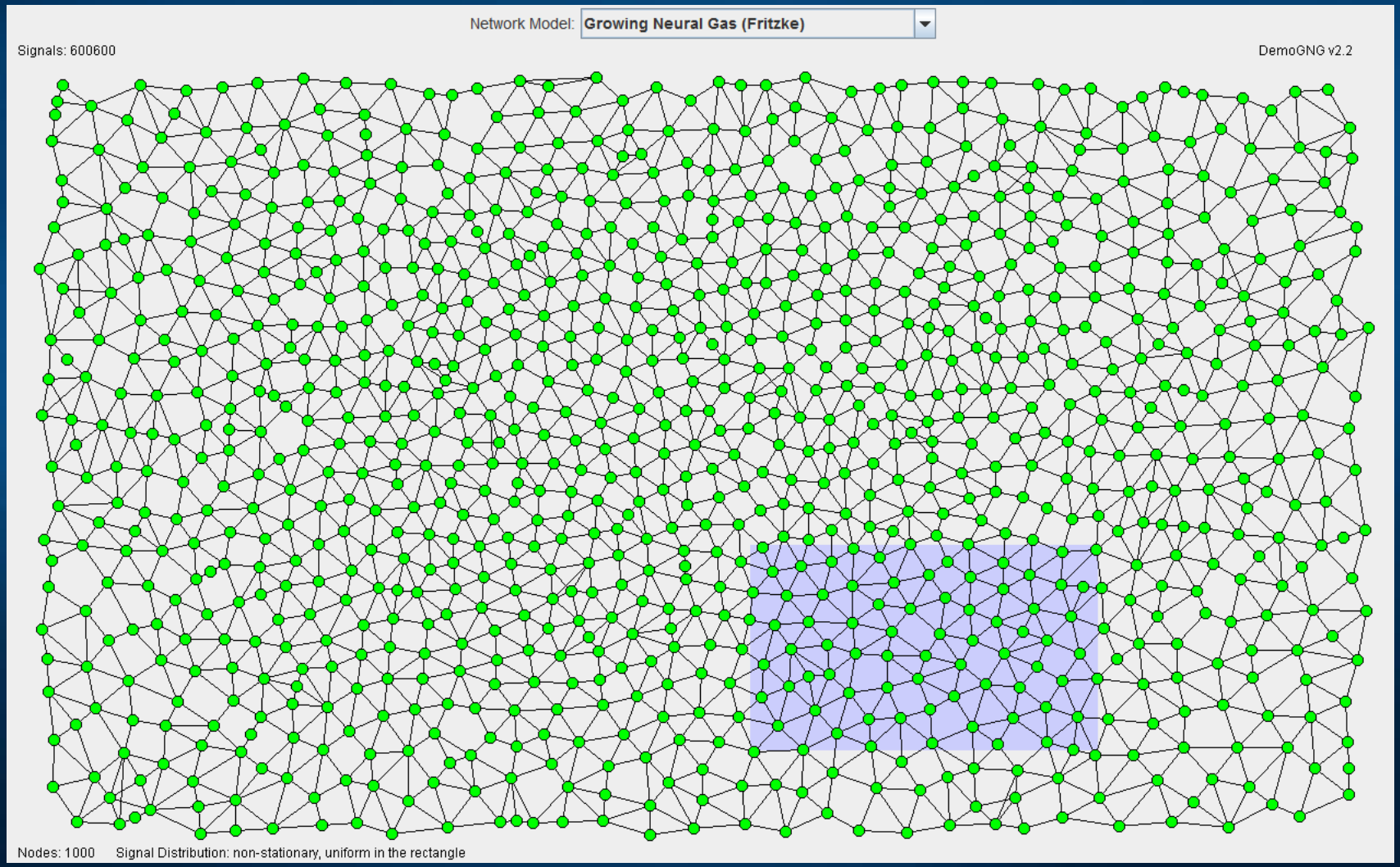


Conspiracy in the brain

- Emotions and uncertainty force the brain to increase plasticity, solutions should be quickly remembered.
- More neurotransmitters increases the speed of learning but also probability of wrong interpretation, accepting memes.
- Rapid changes, traumatic experiences reduce neuroplasticity, “freezing” current activation pathways.
- Forgetting the details leaves only strongest connections.
- Distorted information is repeated and becomes the basis for interpretation of many unrelated facts.
- Brains save energy, no thinking required, new patterns of activation – memes – are easily associated with complex patterns that have been created by conspiracy theory.

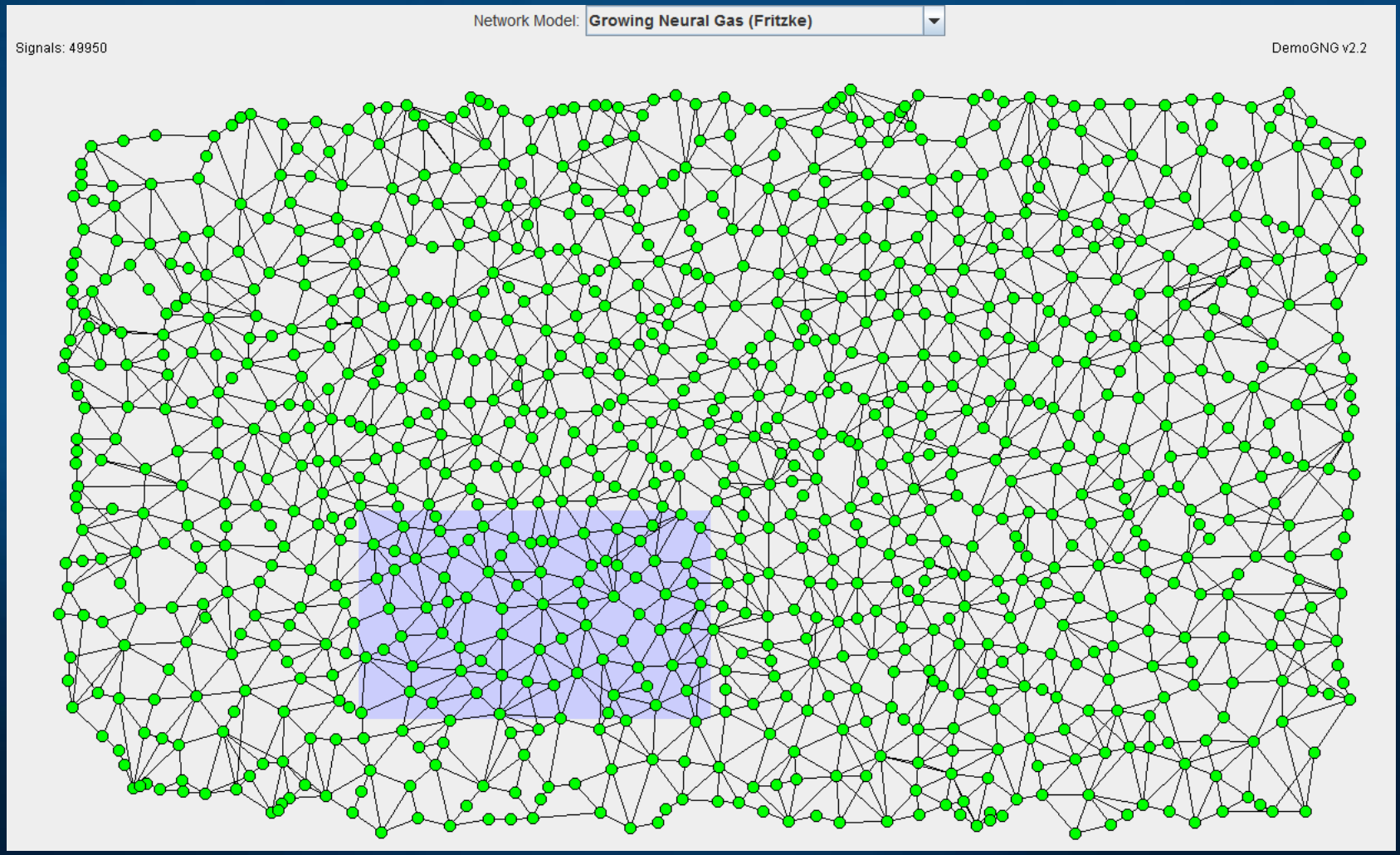
Internalization of environment

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



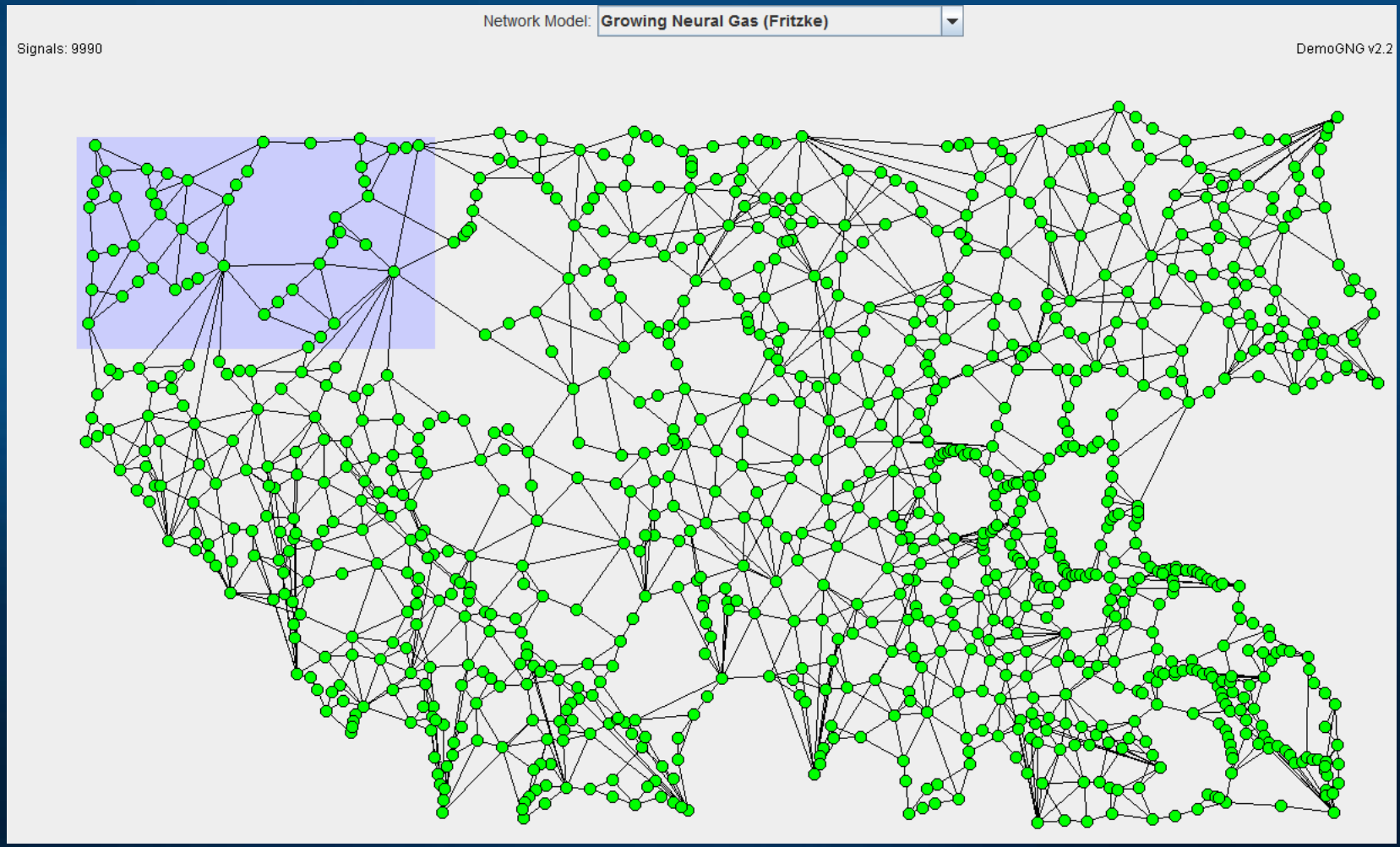
Small deformations

Culture and beliefs create some biases but still the picture is sufficiently faithful to make reasonable decisions.



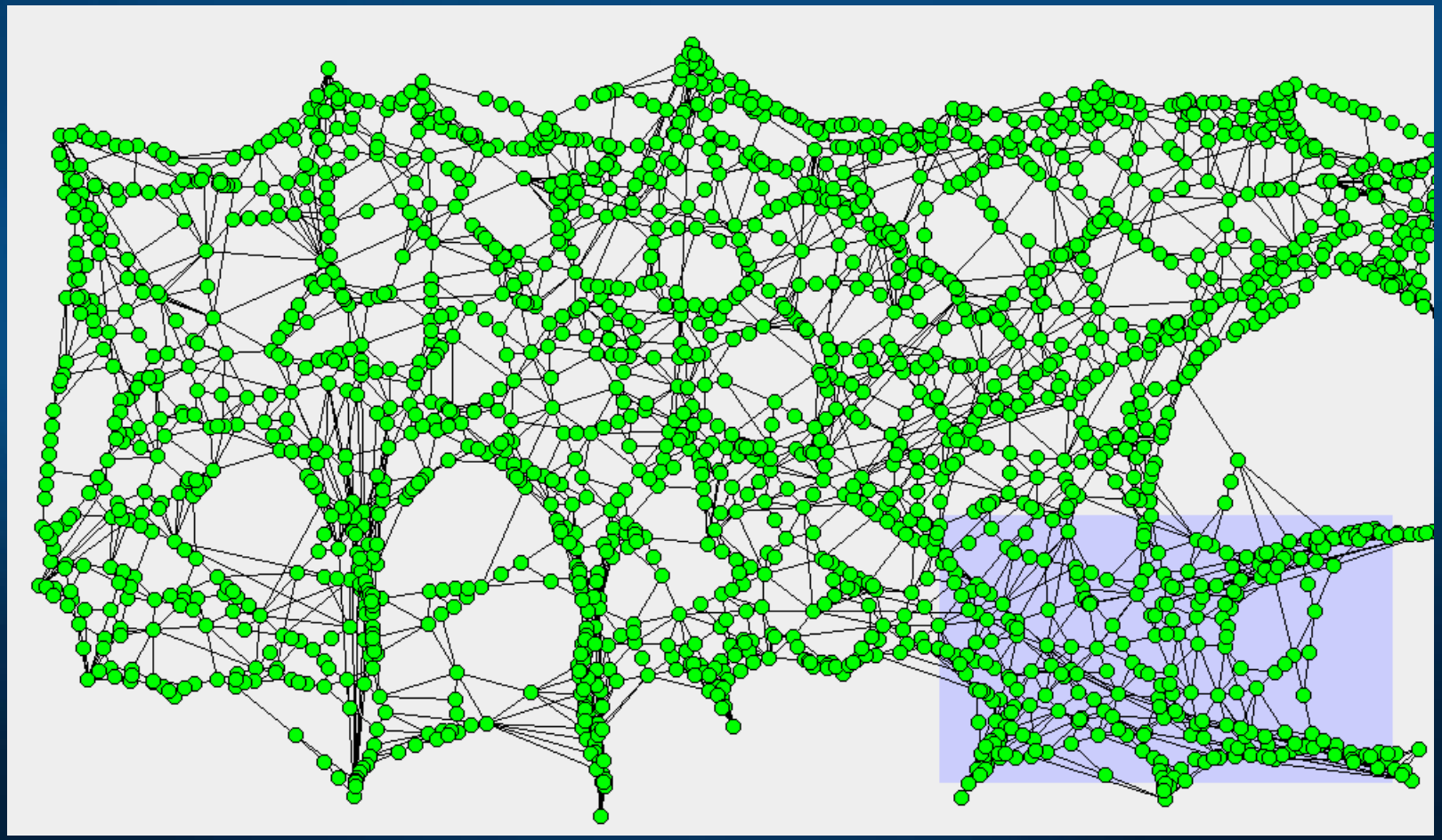
Extreme plasticity

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



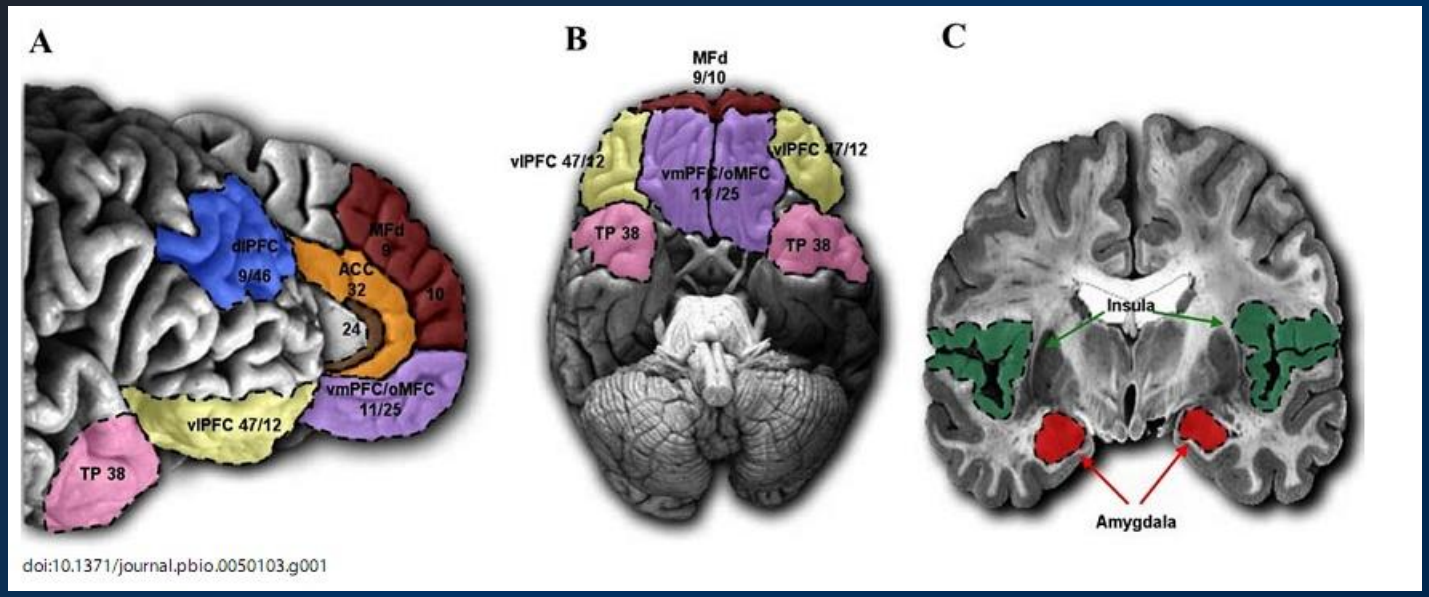
Conspiracy views

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.



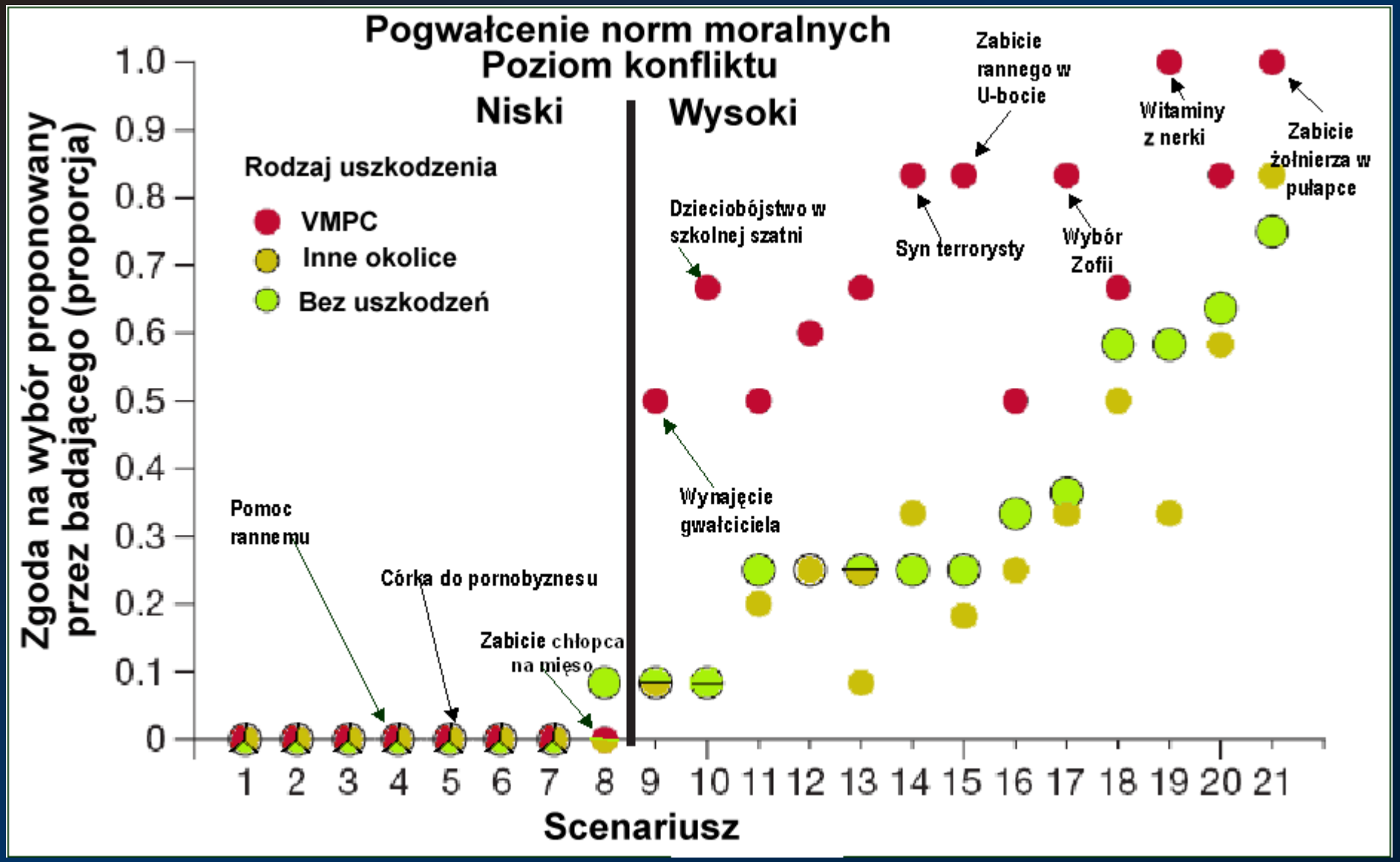
Brains and antisocial behavior

Mobbs D, Lau HC, Jones OD, Frith CD,
Law, Responsibility, and the Brain. PLoS Biology (2007)



Prefrontal cortex (PFC) activity is required for moral reasoning and rational action. PFC damage leads to acquired sociopathy.
Lesions of amygdala reduce empathy & fear levels.
Psychopaths do not show emotions. Such problems may be due to problems at birth or traumas. These two categories are responsible for about ~25% of cases of felons in the USA jails, .

VMPC damage and morality



Meditation and emotions

"Investigating the Mind" MIT- Cambridge, MA (2003)

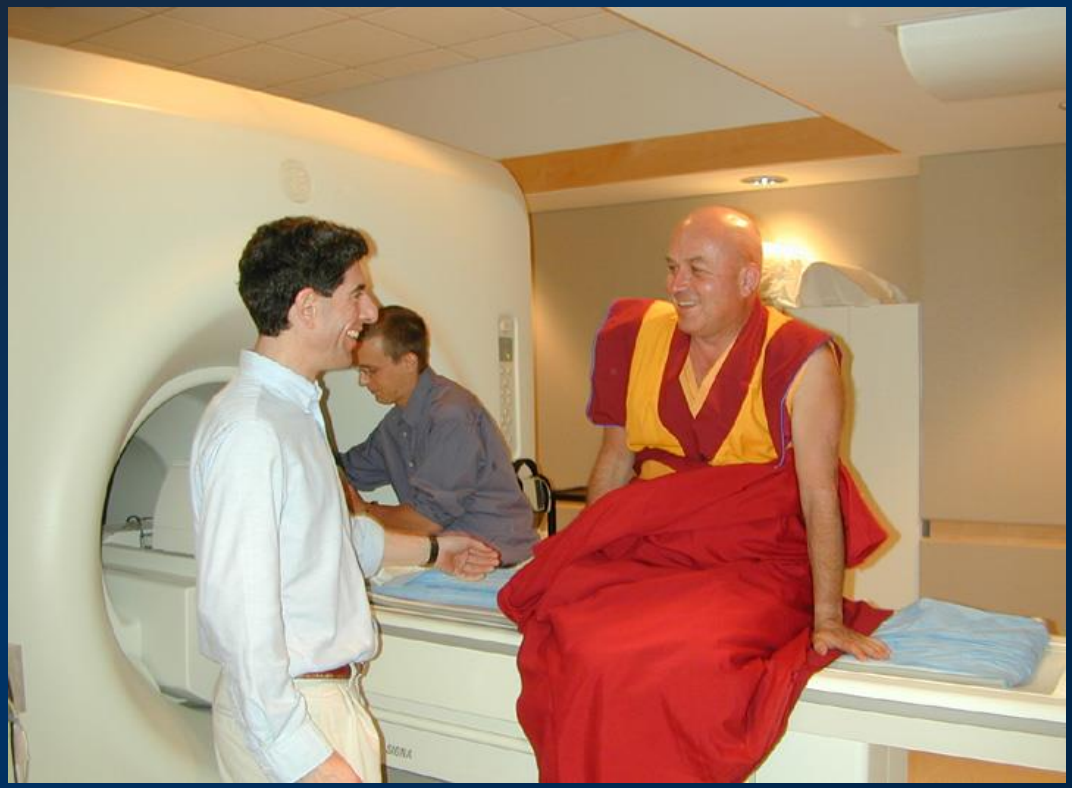
"The Science and Clinical Application of Meditation" SFN-Washington (2005). Regulation of emotions requires training – and who has the best methods?

Monk in the scanner

Even happiness can be learned!

Regulation of will and emotions, self-reflection are important components of this process.

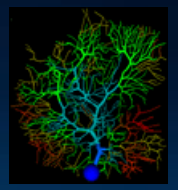
Matthieu Ricard, Happiness: A Guide to Developing Life's Most Important Skill (2006).



Richard Davison & Matthieu Ricard

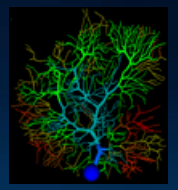
Brain Imaging Laboratory, University of Wisconsin-Madison

Questions/ideas



- Strong coupling with artifacts and environment leads to the extended mind, tools change us (Heidegger). How do modern tools like computers and the Internet influence cognition?
- What can we know about ourselves through the internal flow of information and what can we learn by external observations of our activity and observation of results of our actions?
- How can we use computing artifacts to regulate our behavior?
- How can we monitor ourselves, be aware of more information about our own behavior, adding additional feedback loops?
- How to encourage positive behavior that maximizes long-term chances of happy and meaningful life?

More questions/ideas



- How have different societies regulated behavior of their members in the past, what practices have they developed to increase social well-being?
- How to replace positive practices that has lost their appeal to modern man with technology-based interactions?
- How to build cheap tools that will encourage curiosity and exploration of the world in infants and children – the problem of 200 mln neglected children.
- Develop techniques that present objective view of people's behavior, remind them of their goals – augmented conscience?
- Alter ego: train your own avatar, remember important things.

More homework …

- Assistive technologies to change one's own character in a positive way.
- Assistive technologies that play the role of "guarding angels" and advise people in making important decisions.
- US army has already a lot of sensors that monitor physiological state of a soldier and could be used for self-monitoring.
- Induce brain plasticity in a controlled way …
- Assistive technologies for strong will, understanding of emotions, spiritual development?
- How to build a society that does not waste human potential?

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