UNIVERSIDAD DE CHILE Santiago
24-27 de Enero 2016
SEMINARIO INTERNACIONAL
Education, Society & Human Rights:
The contribution of Neuroscien
ce

TOWARD A NEUROSCIENCE OF ETHICAL NORMATIVITY?
tinkering with brain organisation

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INSTITUT FRANÇAIS CHILE

Institut Pasteur

Human Brain Project

SCIENCE vs MORALITY?

David Hume
«scientific activity establishes
what is or what is not?
the statements of a system of morality define
what ought to or what ought not to be done?»
prescribe rules -or norms- of conduct

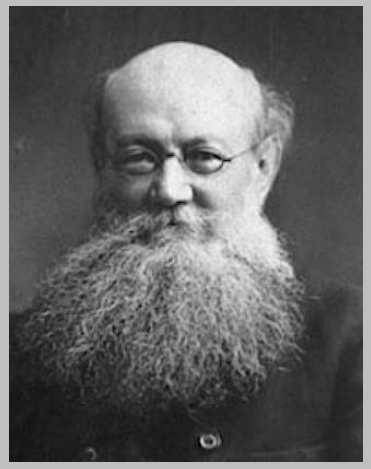
does this exclude a science of morality?

René Descartes
«la morale, présupposant une entière
connaissance des autres sciences,
est le dernier degré de la sagesse».

highest level of wisdom?
...of scientific knowledge?
(Auguste Comte)

SCIENCE vs MORALITY?

Normative ethics investigates how one ought to act morally?.



Piotr Kropotkin

« Why shall I be moral ? » Ethics 1921

« nature is the first master having tougth ethics to humans, the moral principle... social instinct, innate in humans as in social animals, the source of all ethics notions & subsequent evolution» in three successive steps:

1 sociability as mutual aid

2 sympathy & good will ... rules of justice & equality

3 generosity: the highest of moral evolution... »

Paul Ricoeur Soi-même comme un autre 1990

ethical intention is «a cognitive operation»: look for the adequate action which conciliates the interest of the individual with that of the social group.

a «good life with and for others in just institutions»

TOWARD A NEUROSCIENCE OF ETHICAL INTENTION & ETHICAL NORMATIVITY ?

Changeux & Ricoeur La nature et la règle 1988 O Jacob
What makes us think? 2002 Princeton UP

every actual aim must be submitted to the "sieve of the norm"
Paul Ricoeur *Oneself as Another*, 170).

:

the contribution of neuroscience to ethical normativity.

1. a multilevel evolutionary context

2. neural bases of «good life»

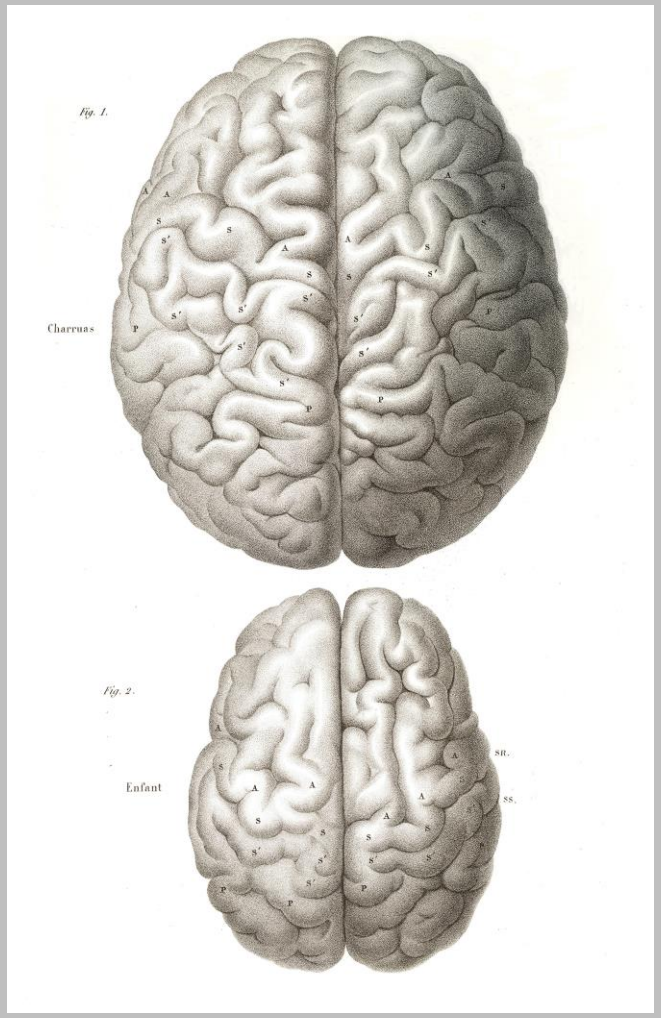
3. social relationships:

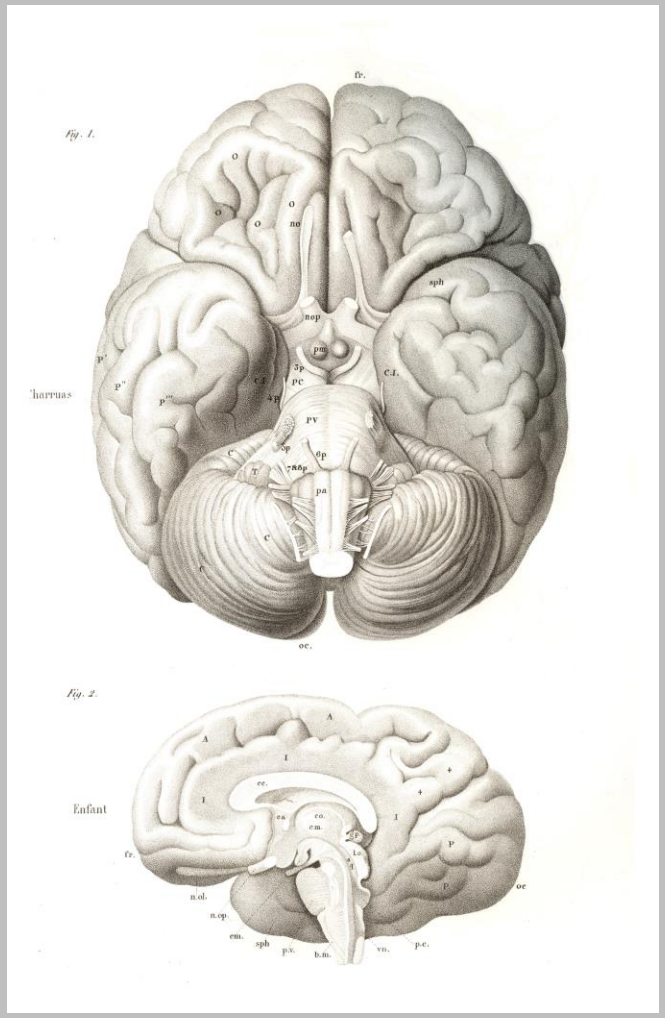
sociability as mutual aid
sympathy & good will ... rules of justice & equality
generosity: the highest of moral evolution...

4. just institutions
ethical rules & ethical innovation

A MULTILEVEL EVOLUTIONARY CONTEXT

THE HUMAN BRAIN





Leuret & Gratiolet 1839-1857

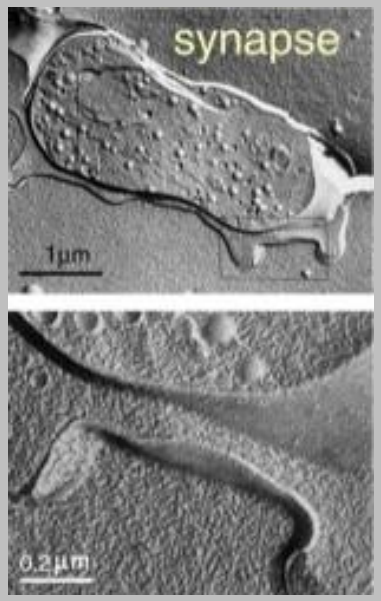
approx 86 billion neurons (S Herculano-Houzel) & approx 1 000 000 billion synaptic contacts in the brain:

an extraordinary complexity

THE BUILDING BLOCKS OF THE BRAIN

O.1mm

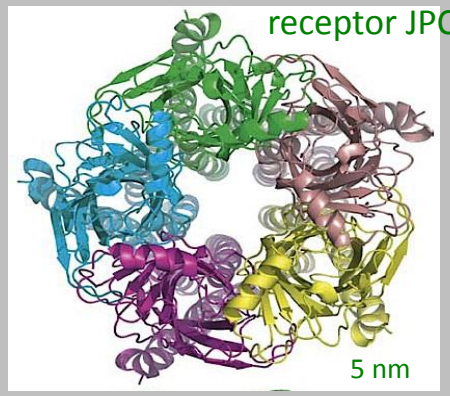
µm



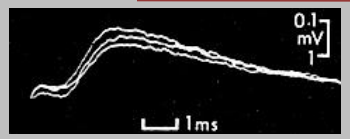
neurotransmitter
as chemical signal

rate limiting steps
in information processing
physical constraints

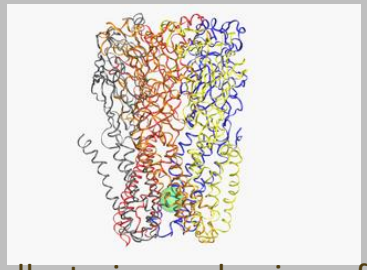
nm



Changeux &Taly 2009



chemical to electrical
conversion Katz 1966



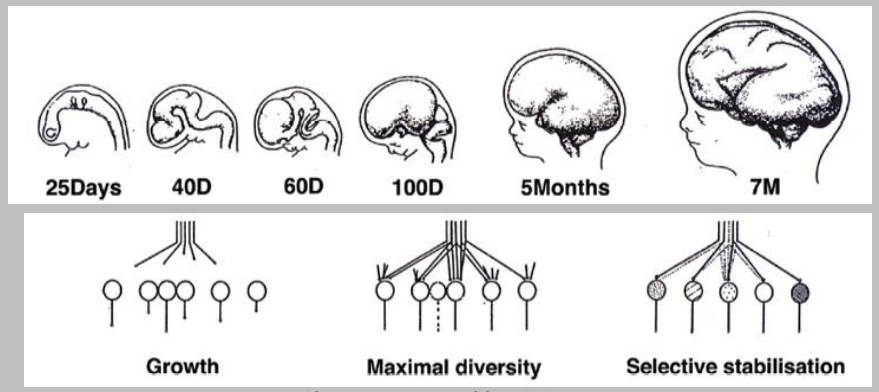
allosteric mechanism of
signal transduction JPC

…the molecular & cellular «components of thought»
P Gardenfors 2003

MULTIPLE LEVELS OF VARIABILITY NESTED WITHIN & BETWEEN HUMAN BRAINS

generalised darwinism

evolution of species: general brain organisation
variability of ***genome***: millions of years



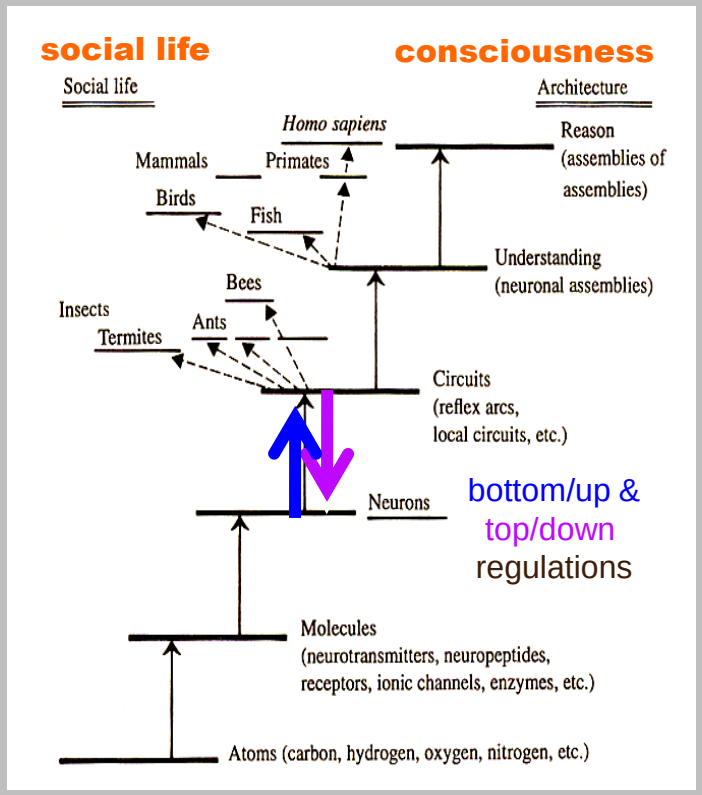
Changeux & Danchin 1976

ontogenetic development:
epigenetic variability of ***connections***:
days, years (15 years in humans)

dynamics of thought:
variability of spontaneous activity &
synaptic efficacies: 1 à 100 ms

social & cultural evolutions:
variability of synaptic efficacies &
extracerebral memories
100 ms to thousands of years

hierarchy & parallelism



Changeux & Connes1989

human brain: open, exploratory, self-organising & conscious system engaged in social communication & cultural transmission

TINKERING MODELS OF THE BRAIN

(Changeux The Physiology of truth 2002)

the aim:

.to represent a behavior or «mental» process,
on the basis of minimal yet realistic,
neural architectures and activity patterns,
if possible, in mathematical terms &
.to build a formal organism able to pass the task &
.to establish causal relationships
between a specific behavior or even
mental *subjective* processes and
***objective* neural measurements.**
.can be challenged experimentally,
from the molecular to the cognitive level,
on a well-defined experimental task

but:

best theoretical model will never give…
a complete & exhaustive description of reality

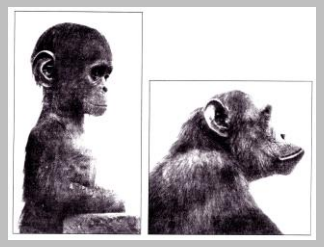
… ie «the brain IS a Turing machine»…= nonsense

NEURAL BASES OF ETHICAL INTENTION «GOOD LIFE»

unity of the human brain

genome level

BRAIN – GENOME COMPLEXITY



non linear evolution of
brain vs genome complexity

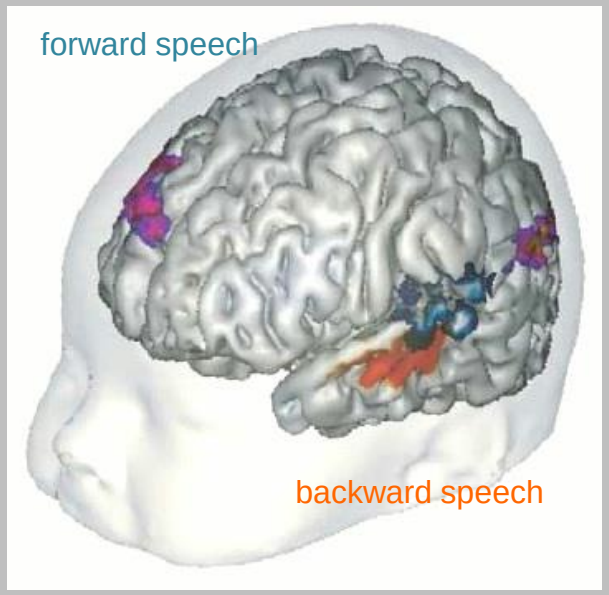
	GENOME SIZE	NUMBER OF GENES	NUMBER OF NEURONES
YEASTS	13.5 Mb	6.144	-
WORMS	97 Mb	18.266	302
FLY	165 Mb	13.338	250×10^3
MOUSE	2.5 Gb	20-25.000	40×10^6
HUMANS	2.9 Gb	20-25.000	$50\text{-}100 \times 10^9$

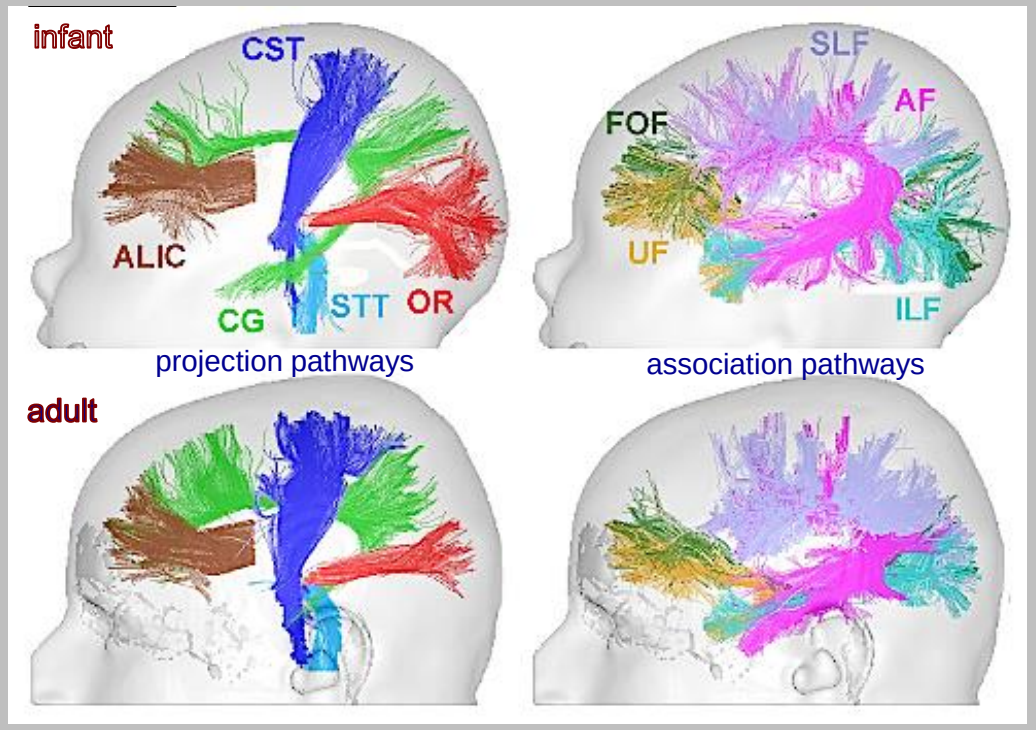
similar small number of structural genes in mice & men
1.2% sequence diff. between chimps & men! paradox?
regulation of gene expression

interacting genes = «nested coherent gene groups» model (Tsigelny & JPC)
no single genes for language, music, math…autism!

INNATE UNIVERSAL DISPOSITIONS OF THE HUMAN NEWBORN

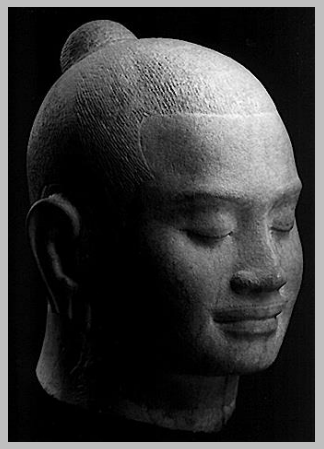
Dehaene-Lambertz et al 2006; Dubois et al 2011, 2014





“core knowledge”:
for grasping & breast sucking,
for distinction between living/inanimate objects, recognition of human faces,
for language acquisition
for conscious access, empathy and sympathy…

BUT genetic variability among individuals

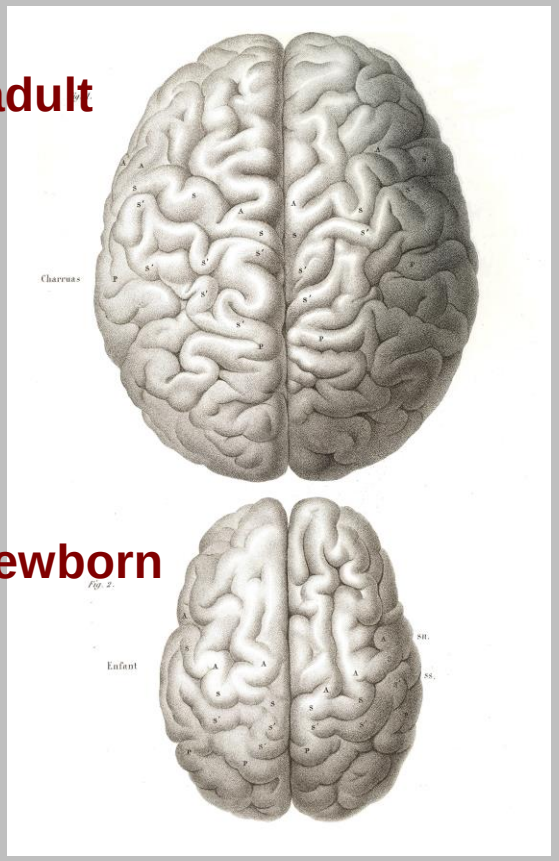


epigenetic diversity?

neuronal networks level

POSTNATAL EPIGENESIS & CULTURAL EVOLUTION

adult



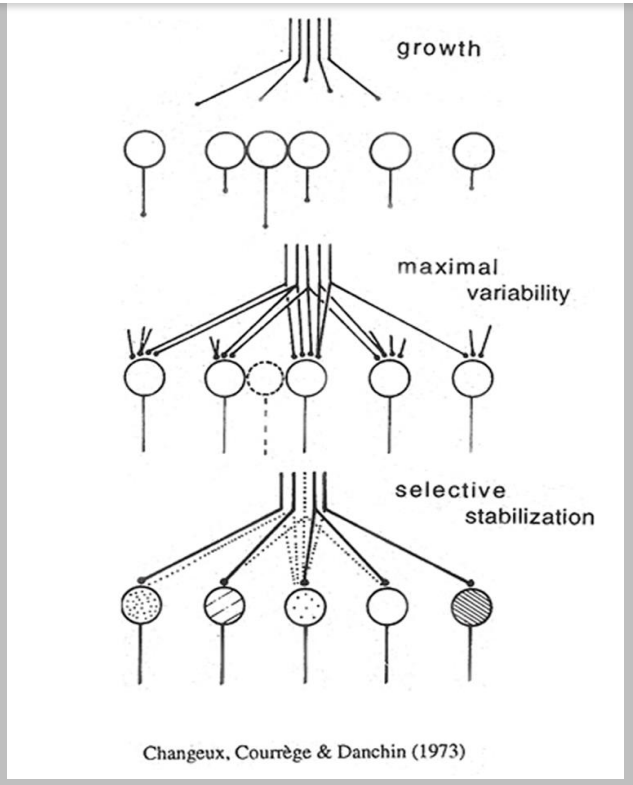
newborn

newborn to adult: brain weight x 5

ca 10 million synapses/second

Lagercrantz et al 2010

selective stabilisation of synapses



nested processes of active synapse selection

evidence for synapse elimination/pruning

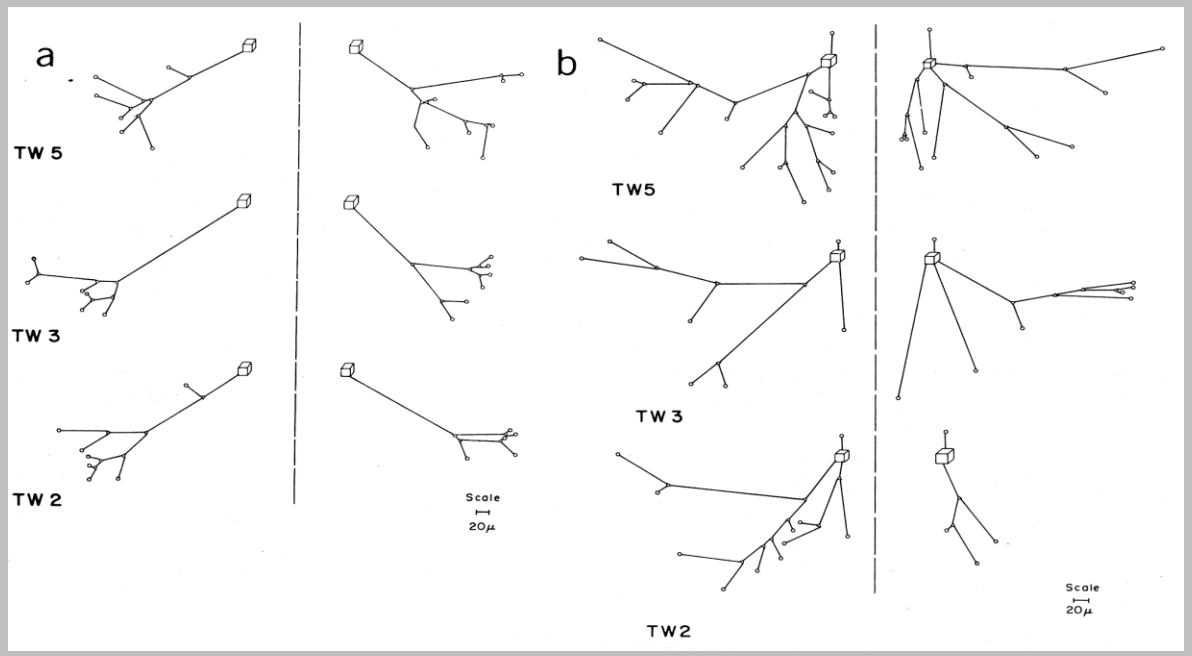
prolonged postnatal development in humans (15 years)
associated with acquisition of basic knowledge,
genesis & internalization of culture (Vygotsky 1978)

VARIABILITY THEOREM

Changeux,Courrège & Danchin 1973

«different learning inputs may produce different connective organisations & neuronal functioning abilities, but the same behavioral abilities»

***Poecilia formosa* isogenic individuals**
identifiable motor neurons dendrites
Müller 4 Müller 1



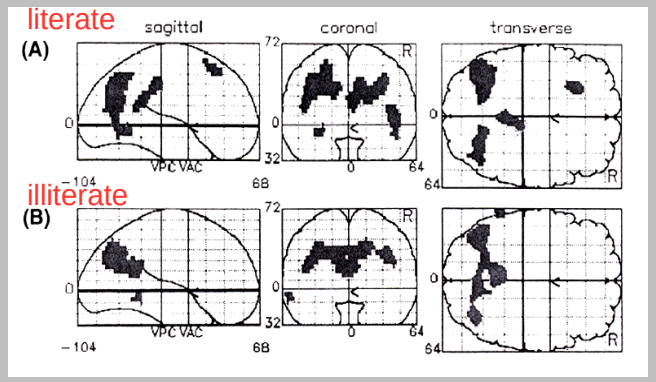
Levinthal, Macagno & Levinthal 1976

considerable epigenetic variability of the connectivity between individual brains yet with behavioral invariances

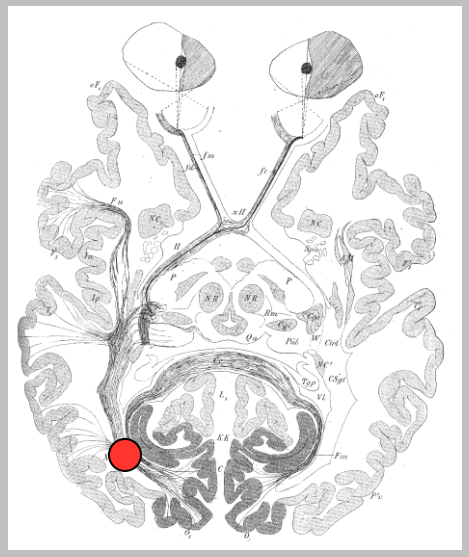
POSTNATAL SELECTION OF CULTURAL CIRCUITS

the example of writing & reading

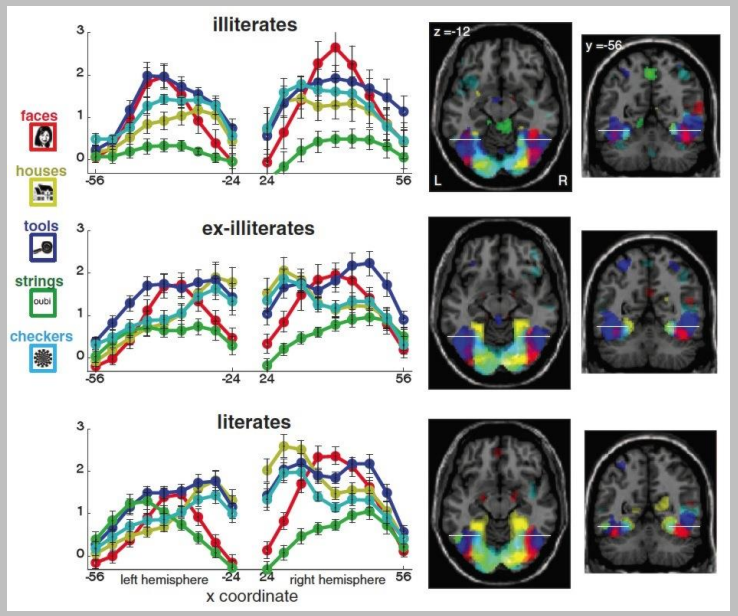
Jules & Augusta Dejerine



Castro-Caldas, Peterson, Reis, Stone-Erlander & Martin Ingvar 1998



Dejerine 1901



Dehaene, Pegado, Braga, Ventura, Nunes Filho, Jobert, Dehaene-Lambertz, Kolinsky, Morais & Cohen 2010

● **lesion giving alexia without agraphie**

reading & writing = epigenetic appropriation of developing neural circuits

Elisabeth-Louise Vigée-Lebrun Portrait de sa fille

cognition

access to consciousness

internal & external worlds

LEVELS & EVOLUTION OF «CONSCIOUS ACCESS»

J.Barresi & C.Moore 1996; Zelazo's 1996; Lagercrantz & Changeux 2009

LEVEL 1: *minimal consciousness* :

newborn & simple organisms
intentional representation of objects, anticipations
approach & avoidance behavior, delayed-response tasks
but ***unreflective* species without social life**: i.e.mice & rats

LEVEL 2: *recursive consciousness*:

8-15 months infant imitative organisms with shared intentional relations to object
holding two representations in working memory
shared attention but **without mutual understanding**
i.e.vervet monkeys,

LEVEL 3: *self-consciousness*:

2 year old child & chimps imagination & the self-other distinction
concept of intentional agent, self recognition on mirror tests

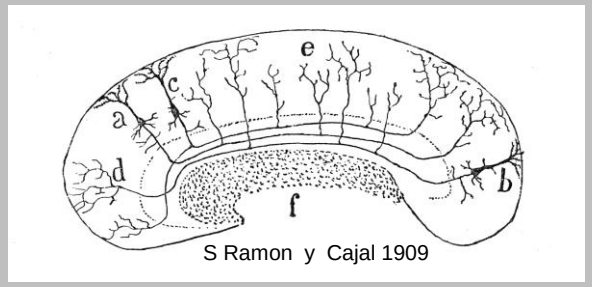
LEVEL 4: *reflective consciousness* & theory of mind:

3-5 year child full conscious experience

«GLOBAL NEURONAL WORKSPACE» HYPOTHESIS

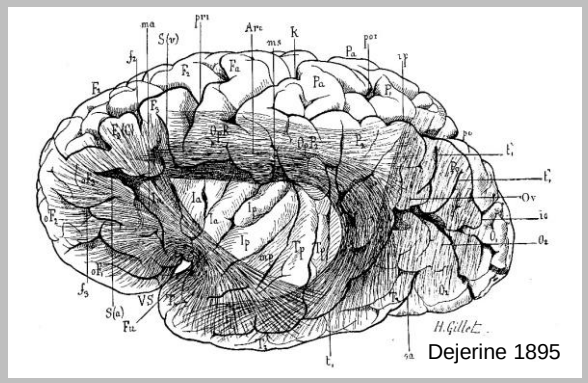
long range brain connectivity & conscious access

(Dehaene, Kerszberg & Changeux 1998. Dehaene & Changeux Neuron 2011)

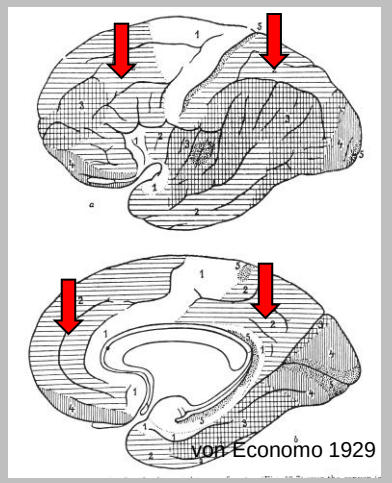


S Ramon y Cajal 1909

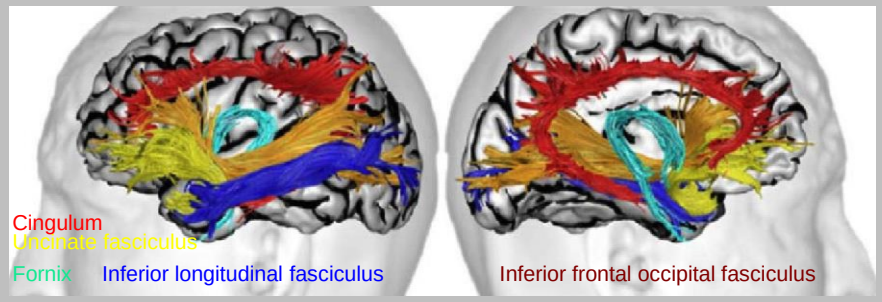
layers 2-3 pyramidal neurons from PFC



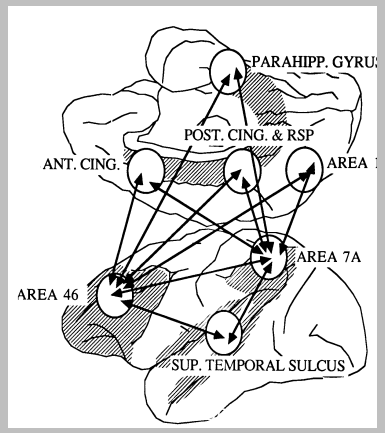
Dejerine 1895



von Economo 1929

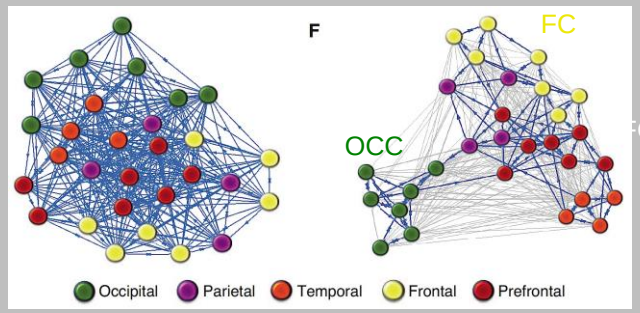


Pugliese et al. (2009)



spatial network model of the cerebral cortex:
24% strongest links
consistent with GNW

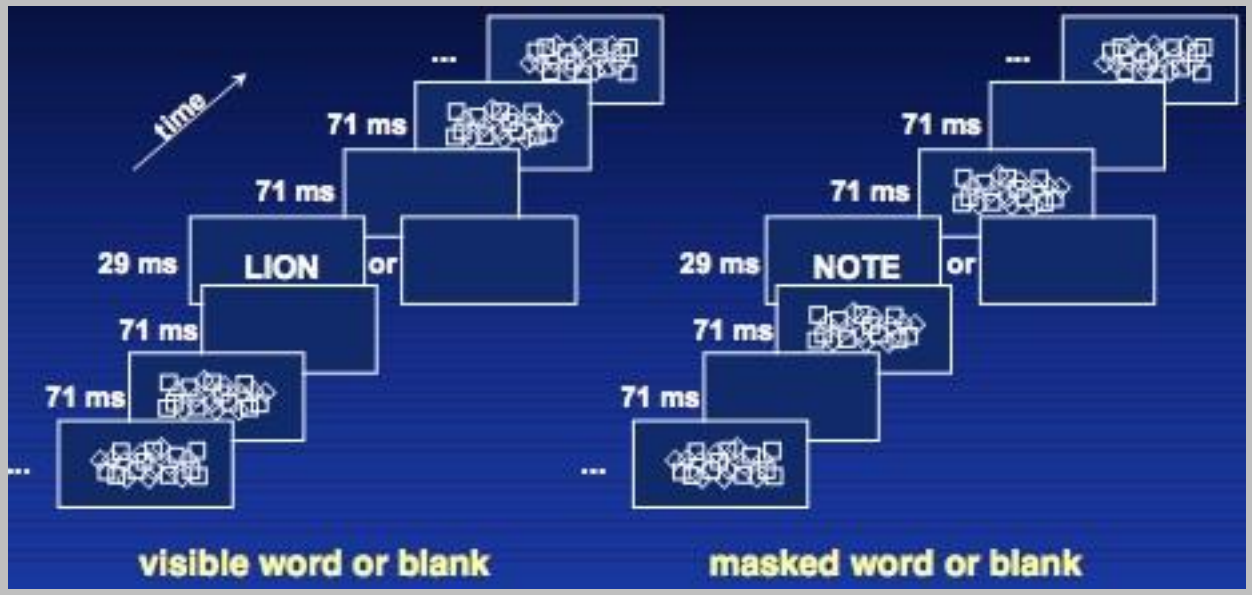
Markov, Ercsey-Ravas, Van Essen, Knoblauch, Toroczkai, Kennedy 2013

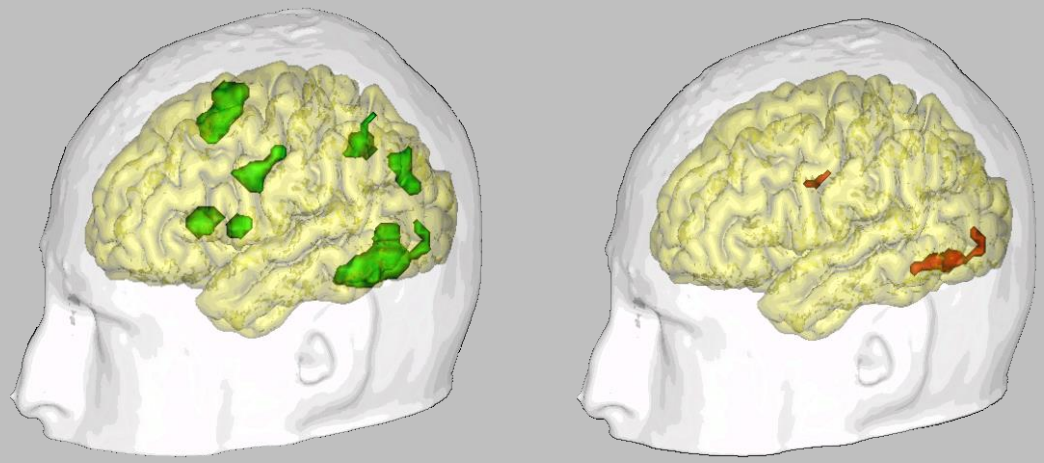


hypothesis: **long range axon neurons broadcast signals to multiple brain areas yielding subjective experience = conscious access**

BRAIN IMAGING (fMRI) OF CONSCIOUS ACCESS

Dehaene et al 2001



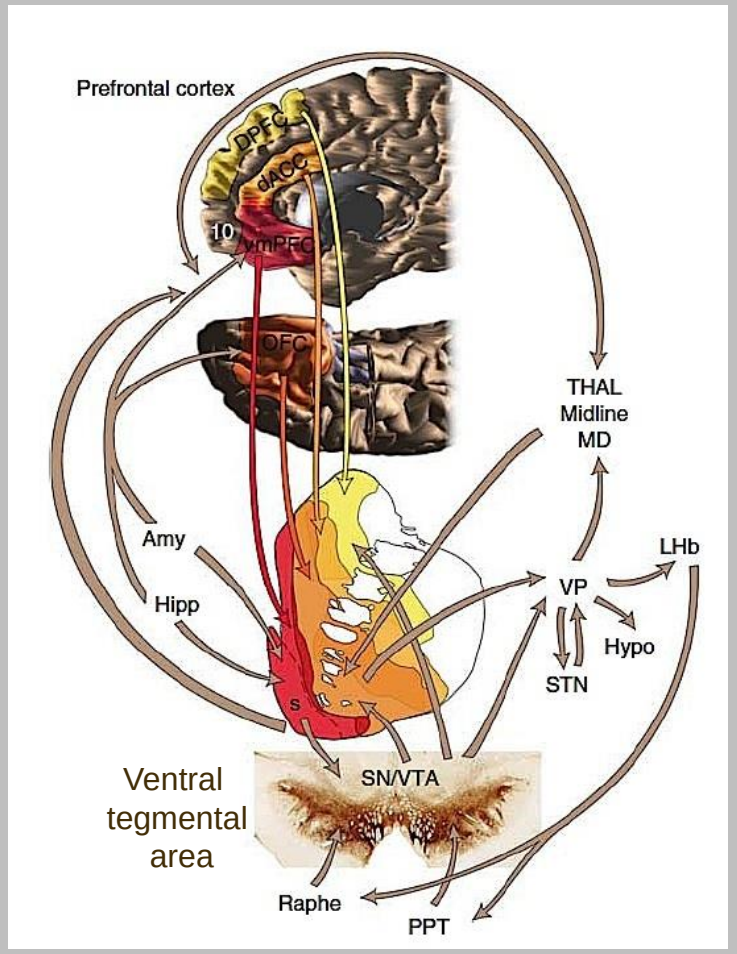


differents brain circuits for conscious vs non-conscious processing
distinguish inner vs outer worlds

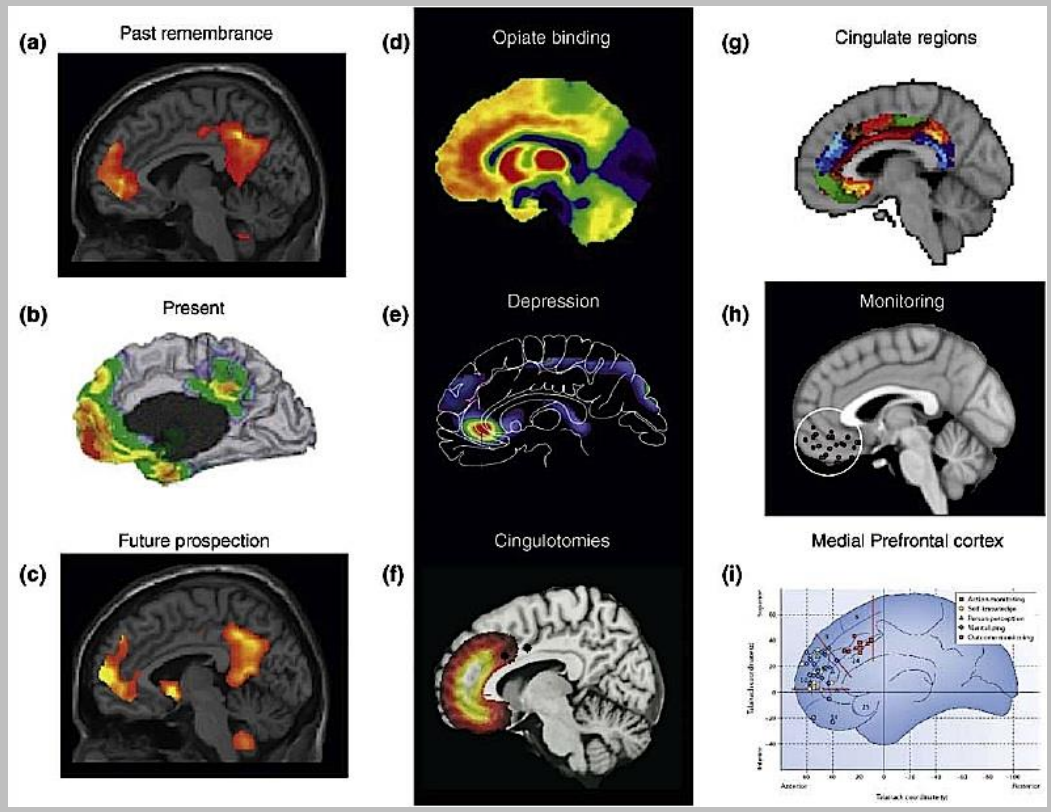
«GOOD LIFE»

reward circuits & pleasure (dopamine)

happiness



Haber & Knutson 2010



Kringelbach & Berridge 2009

enhancement by drugs, electrical stimulation, videos…?

different neuronal circuits for hedonism (pleasure, *plaisir*) & eudemonism (happiness, *bonheur*)

a neuroscience of good life?

«WITH & FOR OTHERS»

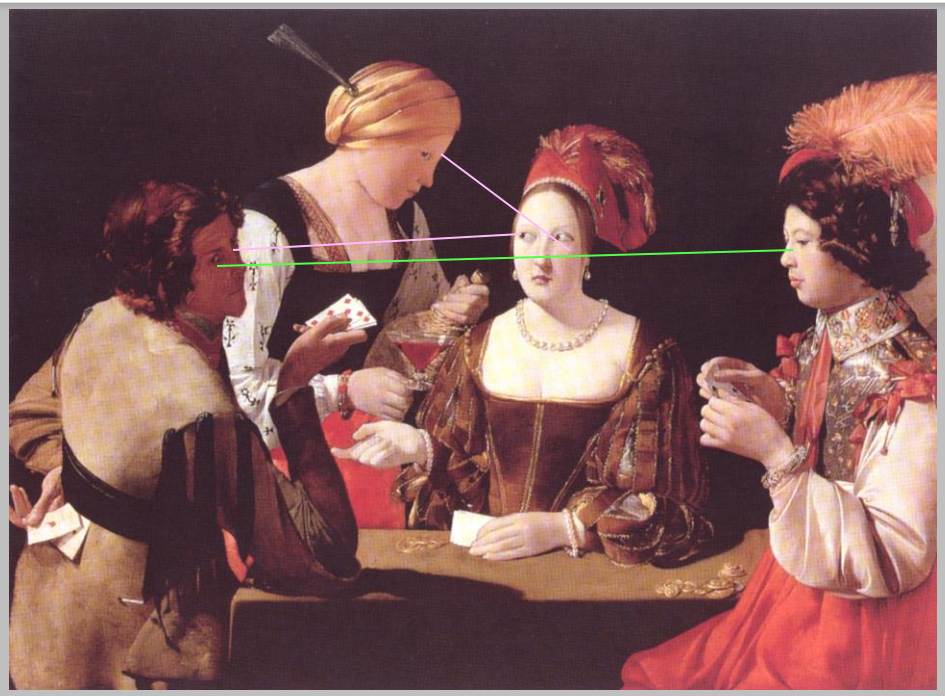
(Ricoeur)

SOCIAL RELATIONSHIPS

«sociability, sympathy & good will, generosity: highest of moral evolution»

(Kropotkine)

ONESELF AS ANOTHER
& THE NOTION OF «MIND READING»



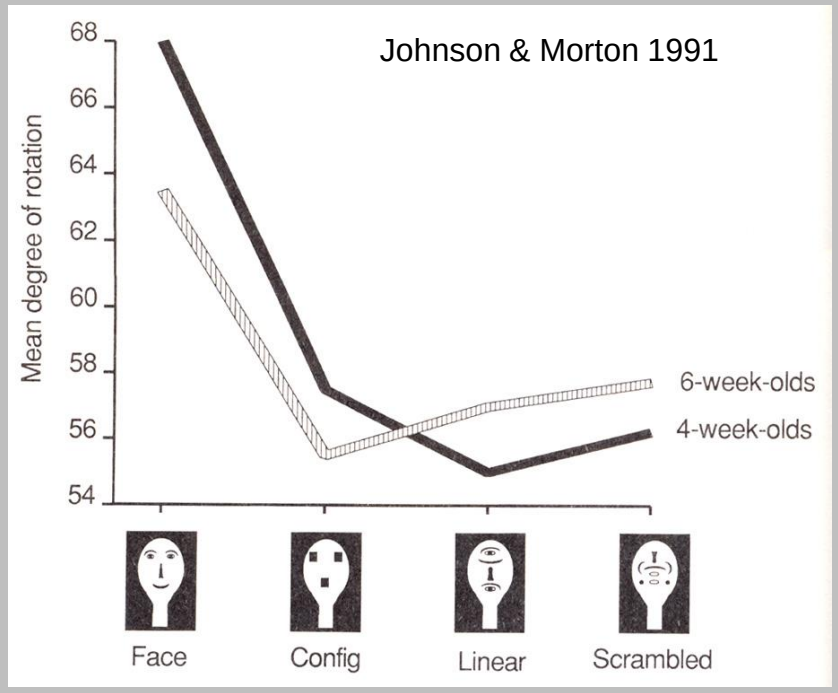
Le tricheur à
l'as de carreau
George de La Tour

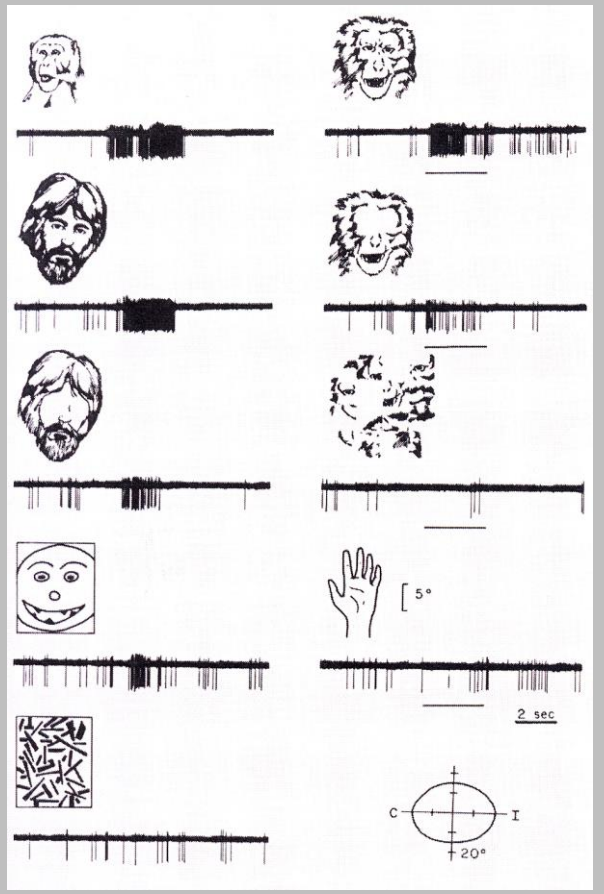
attribution of mental states to another
(Premack & Woodruff 1978)

mind reading:
an innate disposition to put oneself to the place of the other,
yet, without necessarily sharing the emotions

WHO IS THE OTHER?

« the relationship to a face is right away ethical» Emmanuel Lévinas

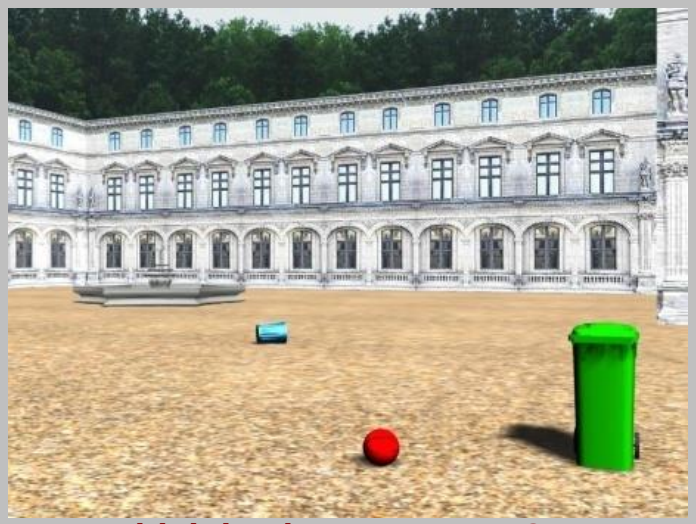




Gross et al 1981

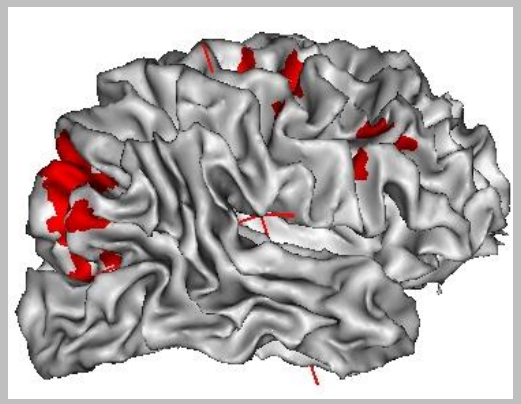
innate disposition to recognize «the other»

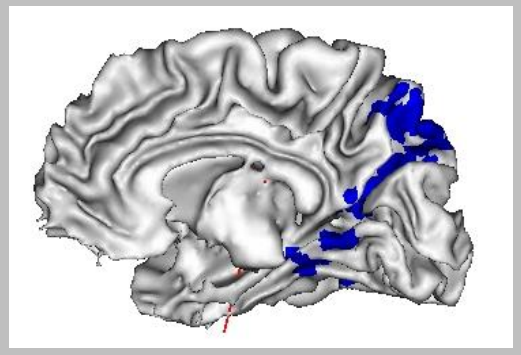
EGO- vs ALLO-CENTRIC REPRESENTATIONS



1. which is closest to you ?
2. which is closest to the red ball

brain imaging fMRI
identification of objects
in an architectural space





Commiteri, Galati, Pizzamiglio,
Berthoz, Lebihan, Paradis 2004

egocentric

hippocampus

allocentric

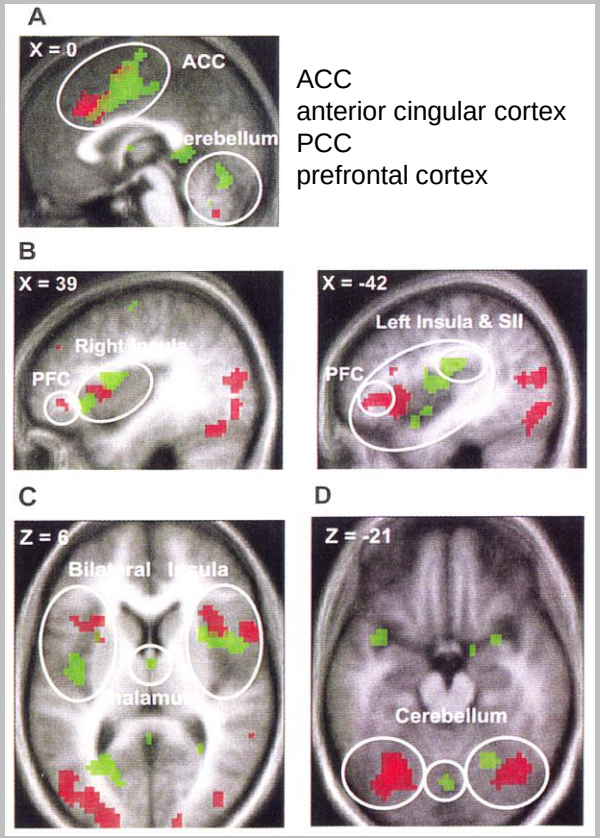
para-hippocampic

bilateral median temporal

“oneself” vs the “other”

under the control of prefrontal cortex?

EMPATHY FOR SUFFERING



ACC
anterior cingular cortex
PCC
prefrontal cortex

Singer, Seymour, O'Doherty, Kaube, Dolan & Frith 2004

apply electrical stimulus
to self or to other partner

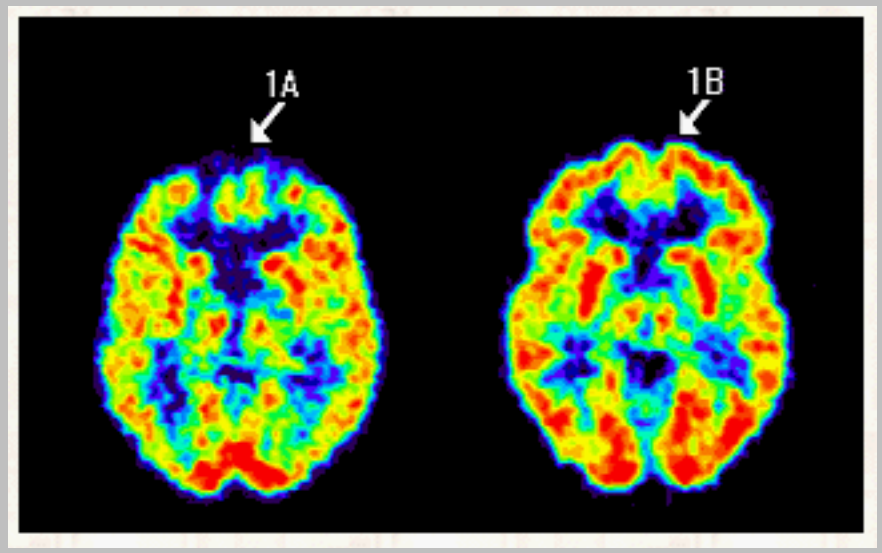
red: pain/ self green: pain/ the other

neural circuits of empathy?

SOCIOPATHY & VIOLENCE INHIBITOR

lesion left orbitofrontal cortex
sociopathic personnality

normal



Adrian Rayne 1997

sociopathy: antisocial personality, aggressivity, *eg* serial killer, lack of remorse, though capacity of attribution preserved = violence inhibition altered

neural circuits of sympathy?

neural circuits of self-other recognition & evaluation

DEHUMANIZED PERCEPTION

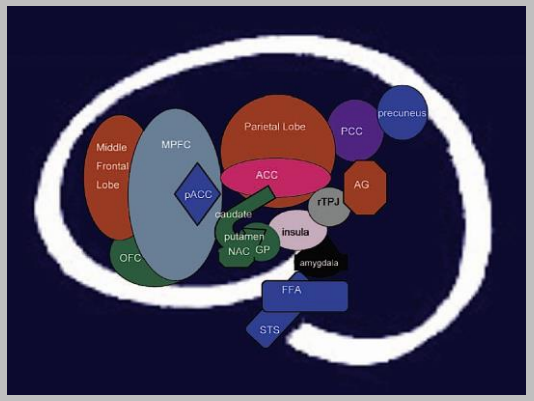
Harris & Fiske 2006
Fried 1997

empathy does not necessarily mean sympathy

Terror in France 1793
Armenian genocide, nazi Holocaust, Red Khmers, Rwanda, Bosnia, Daech...

dehumanization: a person is viewed as a non-human without internal life, mental states, thoughts & feelings and without an identity as a person.

no longer compassion or other moral responses.



reduced medial prefrontal cortex activation
also amygdala & insula involved
in dehumanized perception

CAN WE BE EPIGENETICALLY PROACTIVE?

Evers & Changeux 2015

combinatorial explosion of possible representations in the brain

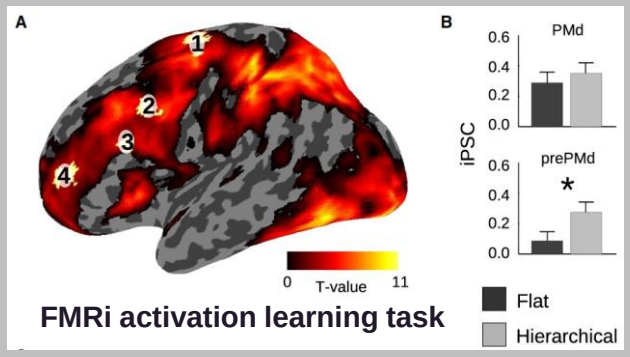
selection & storage in memory of an «efficient rule» that limits, constrains and organize underlying representations

Changeux the Physiology of Truth 2004

"epigenetic rules" as acquired patterns of connections hypothetically stored in frontal cortex long-term memory regulate decision-making in a top-down manner.

frontal cortex & the discovery of abstract action rules

Koechlin et al 2003;
Badre, Kayse & D'Esposito 2010



FMRi activation learning task

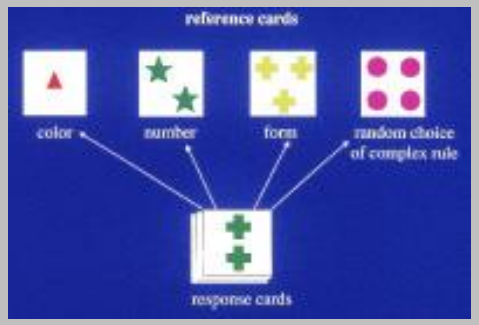
being **"epigenetically proactive" =** let us reciprocally adapt our social structures, in both the short and the long term, to benefit, influence and constructively Interact with our ever-developing brain architecture

MODEL OF «MENTAL DARWINISM»

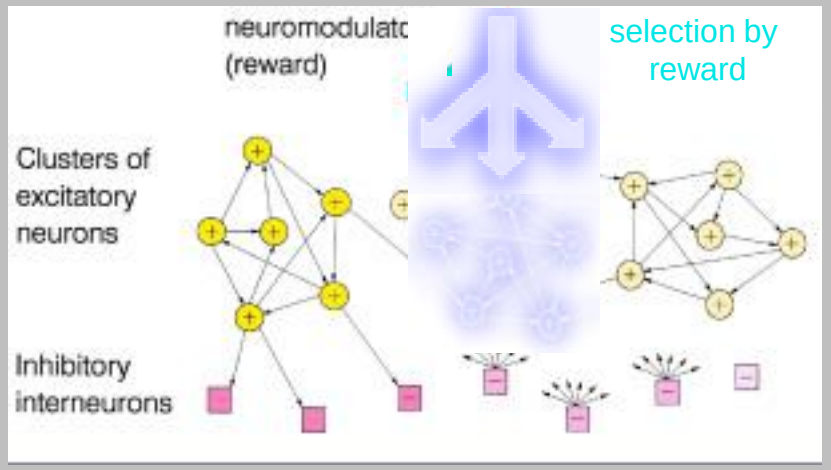
Dehaene & Changeux 1991

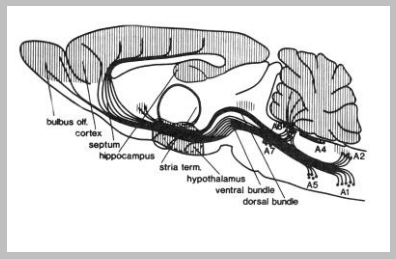
rules
for colour, number, shape..

Wisconsin card sorting task



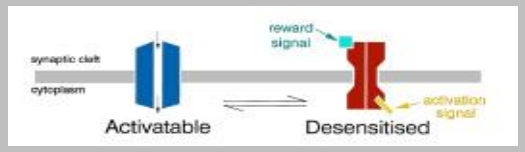
importance of spontaneous activity
= variable pre-representations coded by coherent *clusters* of excitatory neurons





dopaminergic reward neurons

selection by reward
of representations matching the outer world



allosteric receptors as signal integrators

role of reward (& anticipation of) in the selection of rules

The School of Athens: Pythagoras
by Raphaël

THE AGORA

(J-P Vernant)

multiplicity of schools of thought
public debate & open critics
Interacting brains within intentional framework

selection of the solution which works the best

the most adequate to the real world
beyond social conventions & religious myths
thus the most universal

in constant revision &
in constant progress…

the search for objective truth
together with inter-subjective good

ethics committees…
a mondial ethics committee?

IN JUST INSTITUTIONS
ethical rules & ethical innovation

THE GOLDEN RULE : EAST-WEST

Confucius 551– 479 BC

«do not do to others what you do not wish done to you»

Mô-Tzu 470 BC – ca. 391 BC

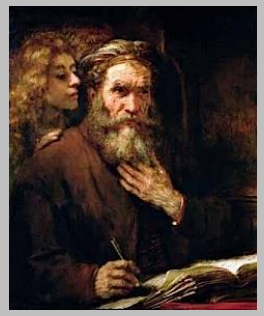
«he who loves others will be loved in his turn;
he who causes others to profit will profit in his turn»

Leviticus 19 8 ca. 400 (538–332) BC

«love your neighbor as you love yourself»

Hillel 110 BC-10 BC Babylonian Talmud

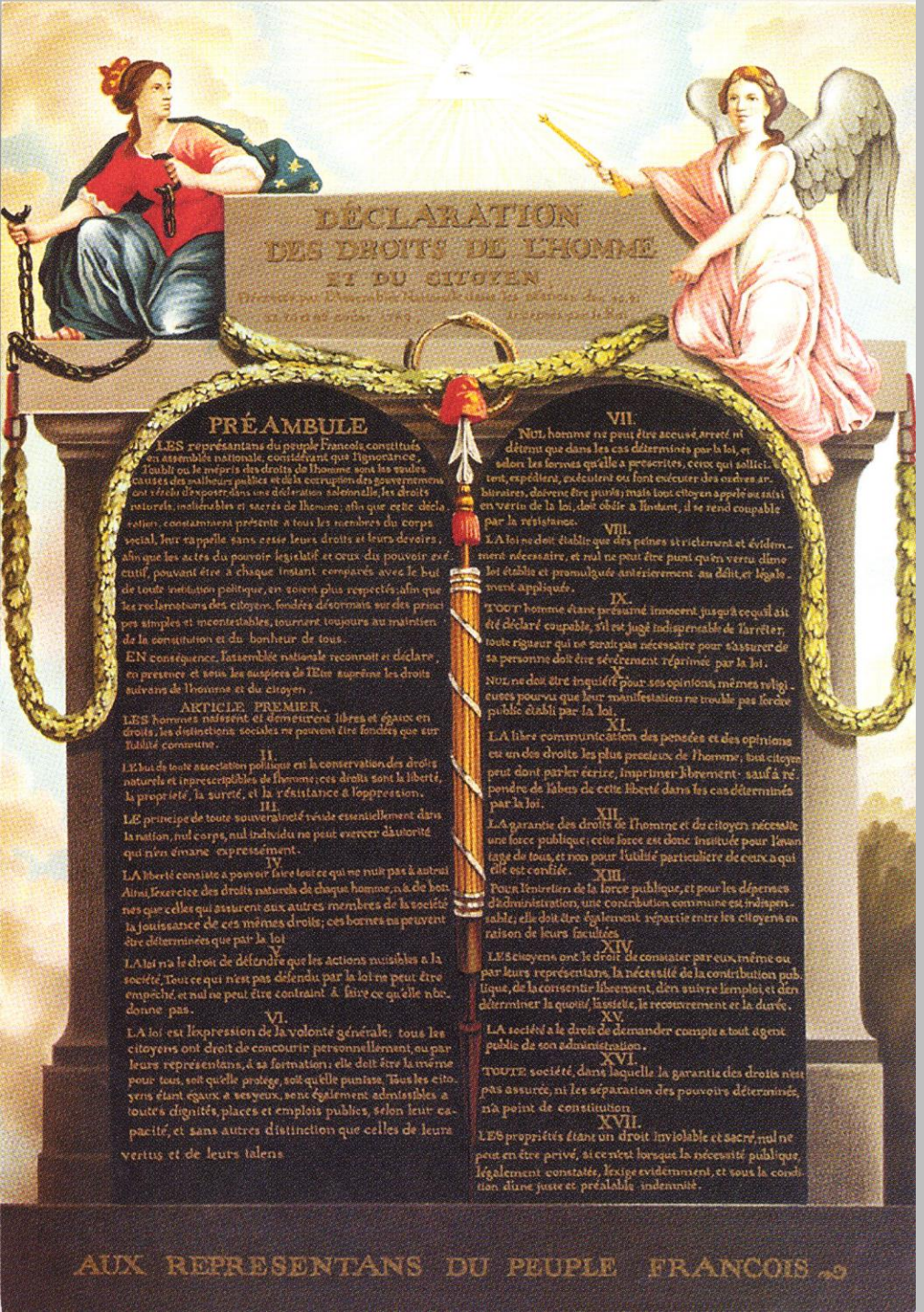
«what is hateful to you, do not do to your neighbor»



Matthew 7:12 80-95 AD

«do unto others as you would have them do unto you»

norm of reciprocity in the social group based upon the understanding of one-self in relation to others & «enlarging sympathy» (Darwin The Descent of Man 1871)



DECLARATION OF HUMAN RIGHTS 1789

liberté, égalité, fraternité

UNIVERSAL DECLARATION OF HUMAN RIGHTS 1948

Eleanor Roosevelt & René Cassin

toward a universal ethics?

to be epigenetically proactive? Keith HARING