The contribution of neuroimaging and neuromodulation to management science

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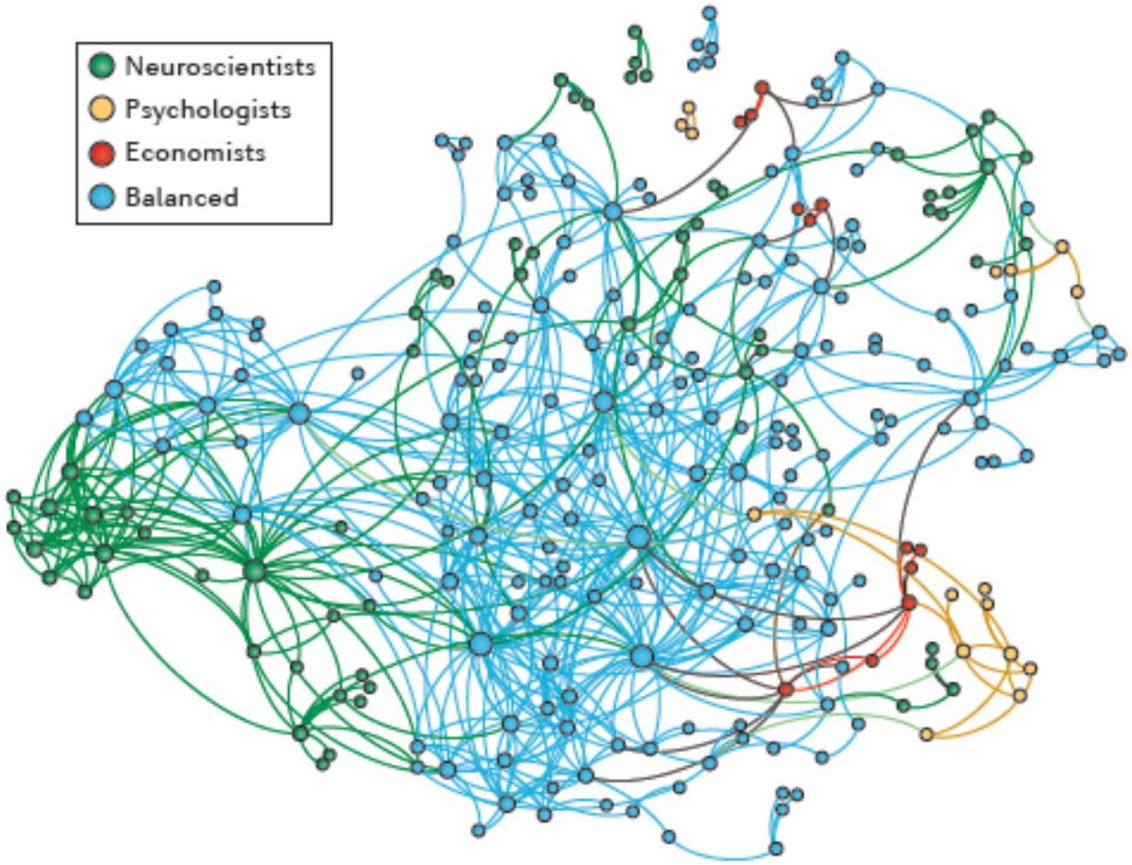
SCIENCE AND SOCIETY

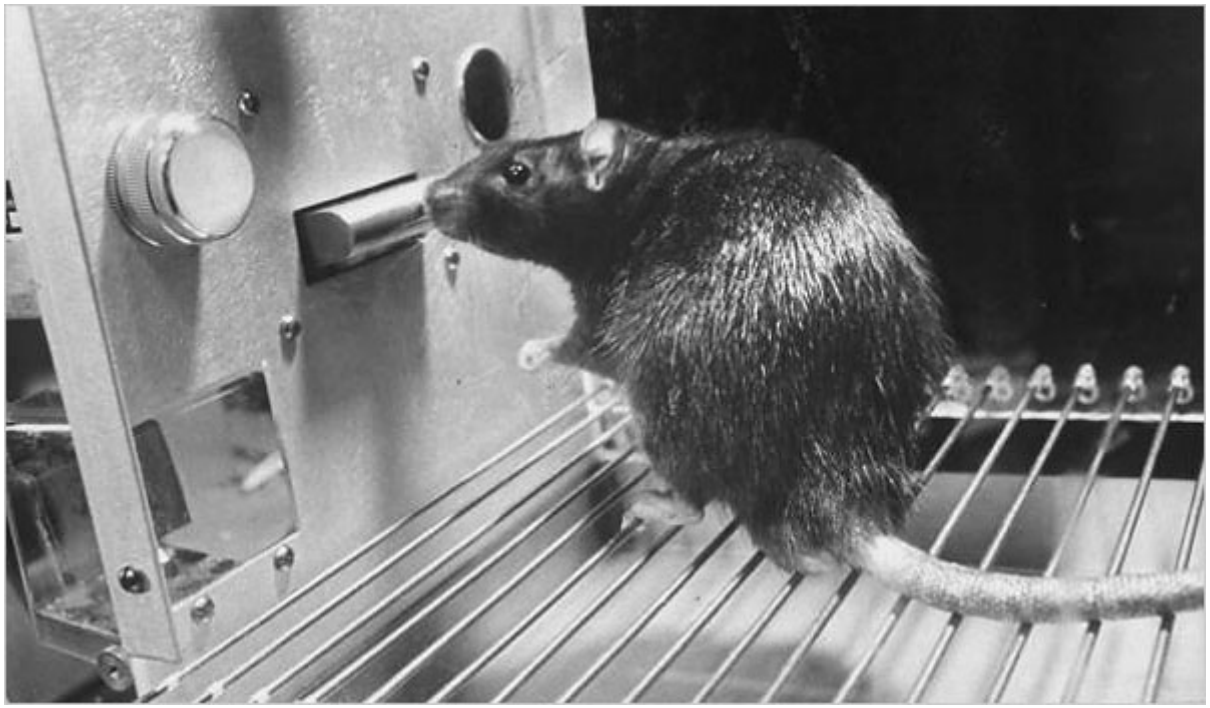
Translating upwards: linking the neural and social sciences via neuroeconomics

Clement Levallois, John A. Clithero, Paul Wouters, Ale Smidts and Scott A. Huettel



Bridging social and neural sciences

The biology of decision-making: goal-directed activity and motivation




NAT·
MDCCC
XXXIII
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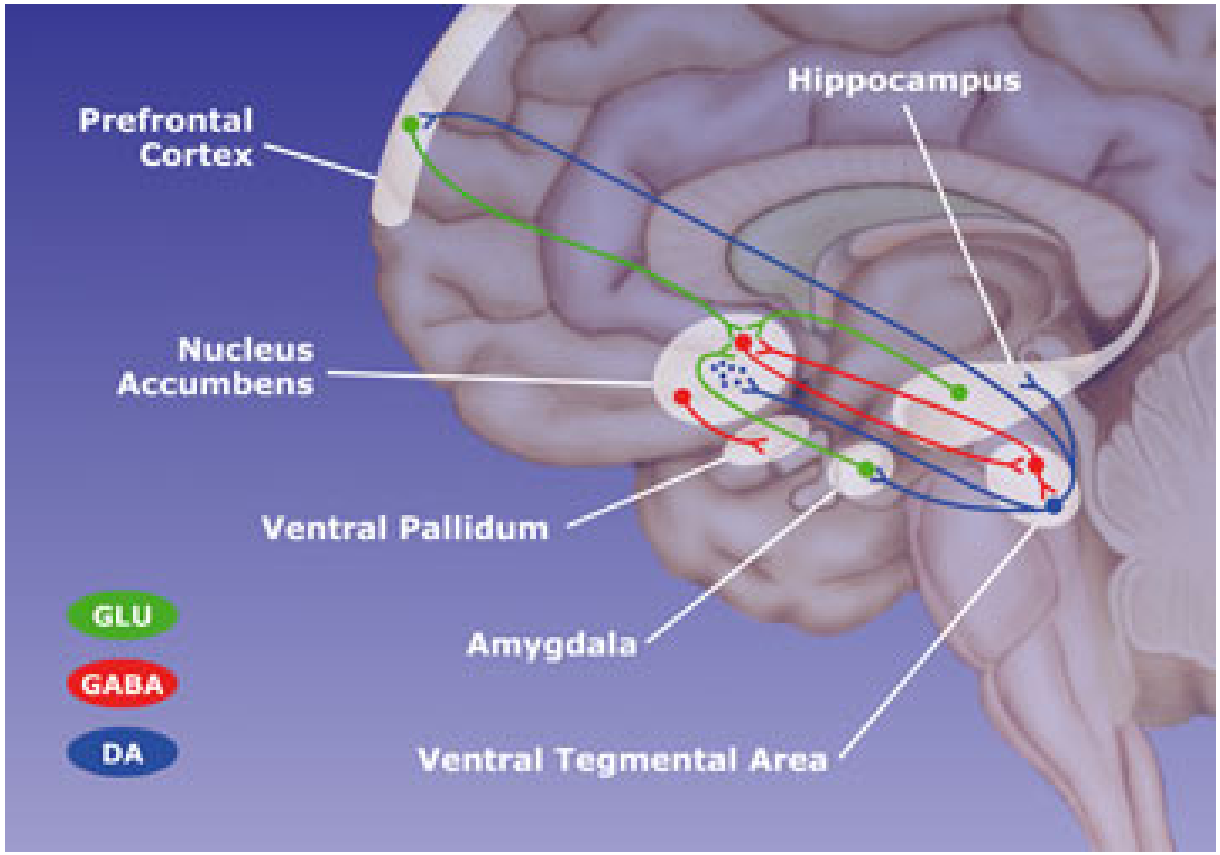
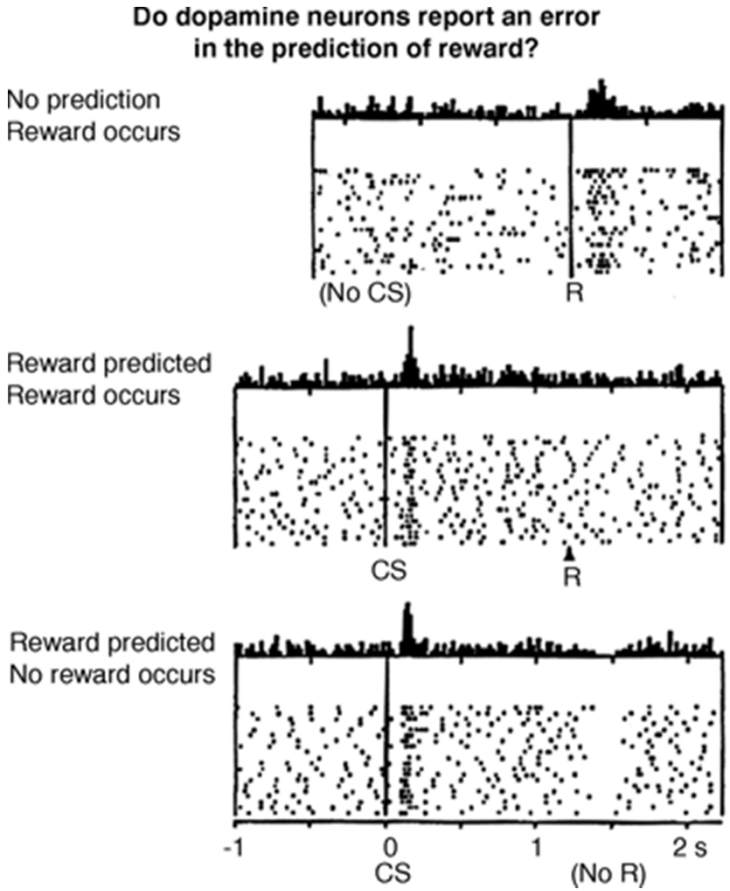
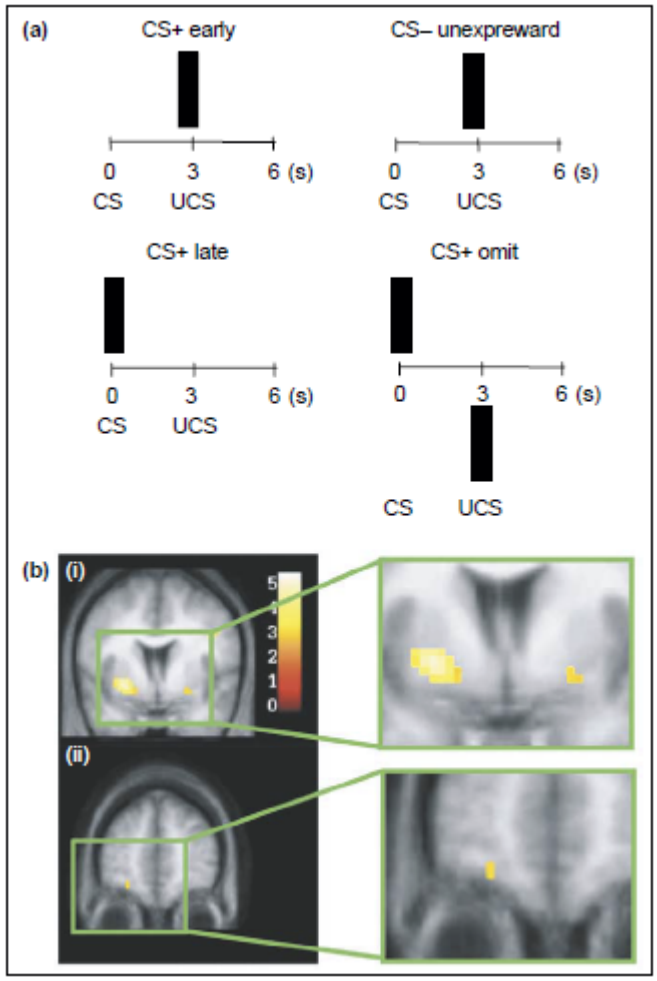
NOBEL

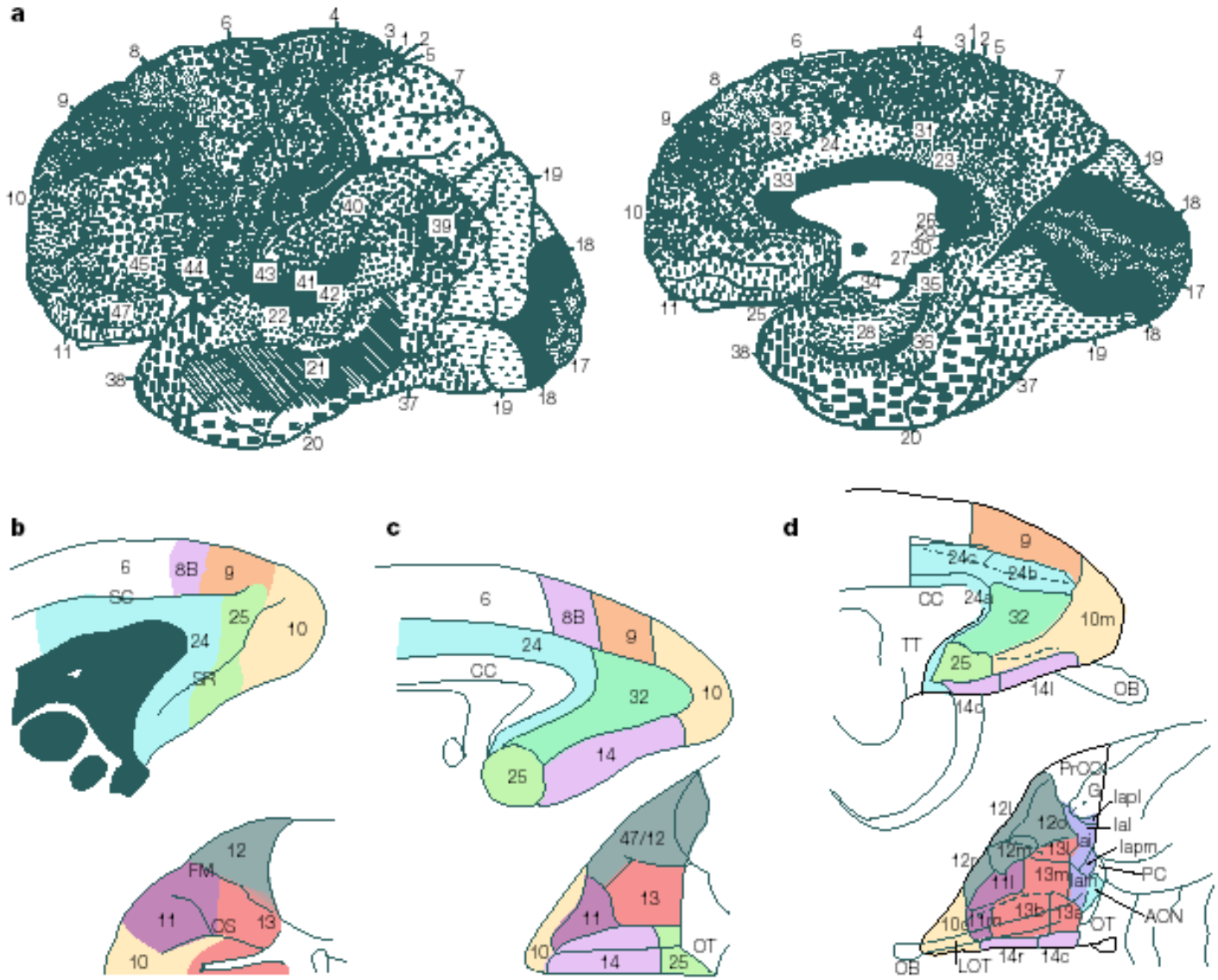

Prefrontal Cortex
Hippocampus
Nucleus Accumbens
Ventral Pallidum
Amygdala
Ventral Tegmental Area
GLU
GABA
DA

Temporal prediction error (Schultz et al., 1997)





O’Doherty et al., 2004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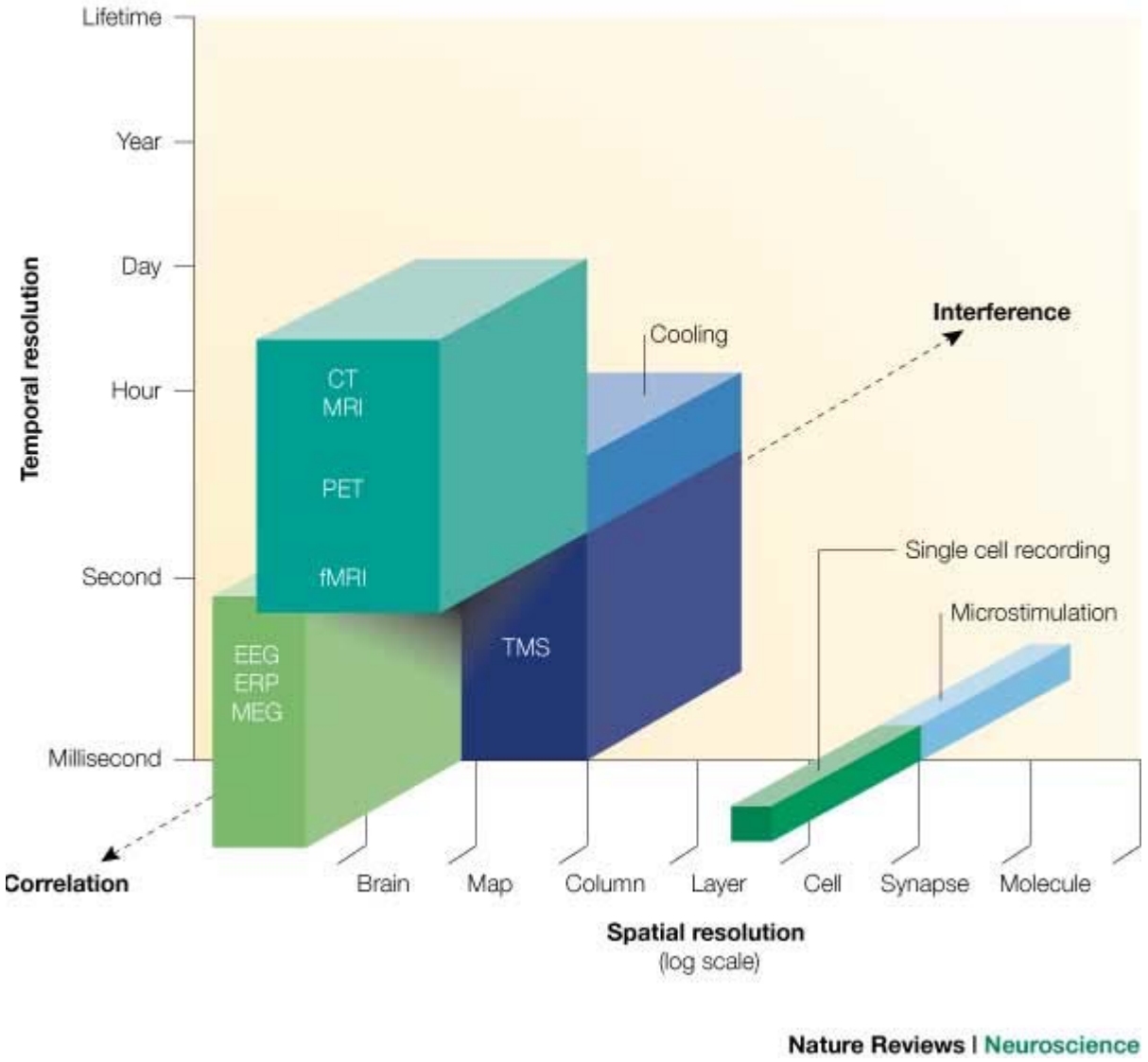
Cognitive neuroscience and windows into the brain in action

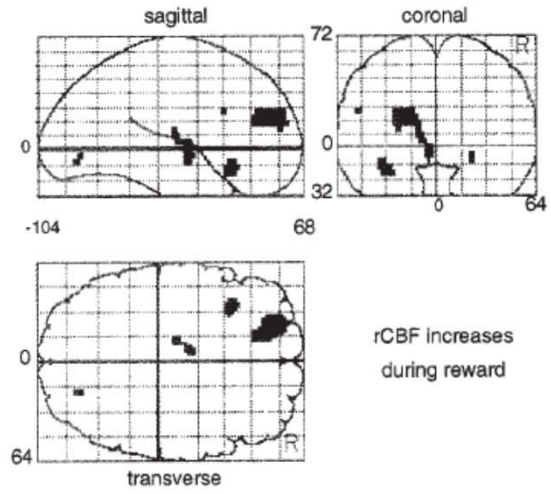


First principle.
Functional segregation

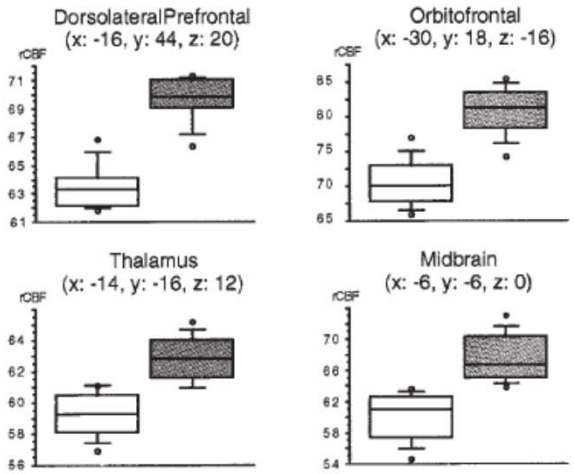
The brain is not a bowl of porridge

- Or an organ, such as the liver or the kidney

- The brain has structure, and this is reflected in its function as a complex system



A:



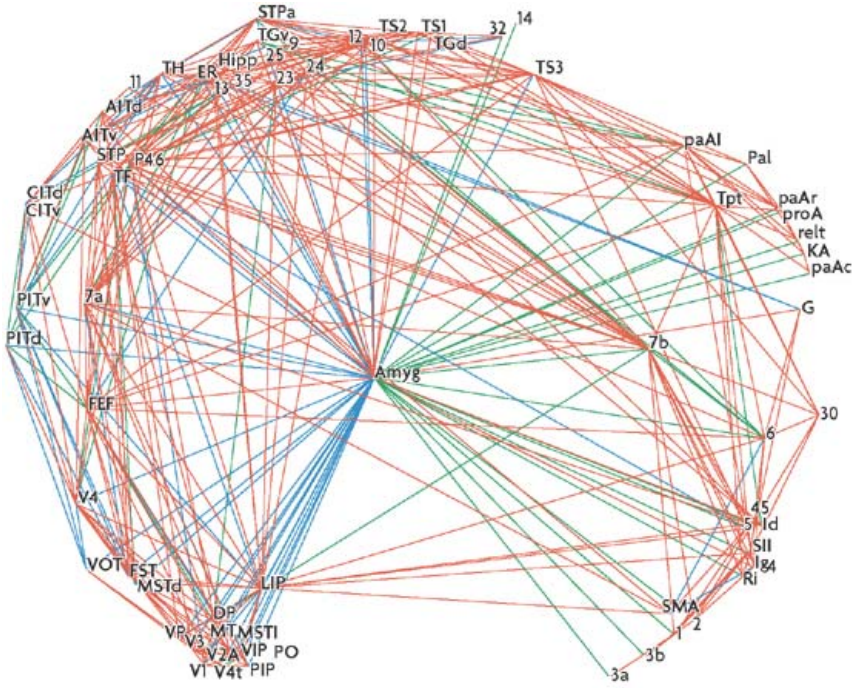
B:

NeuroReport 8, 1225–1228 (1997)

Activation of the human brain by monetary reward

Gregor Thut, Wolfram Schultz,[1] Ulrich Roelcke, Matthias Nienhusmeier, John Missimer, R. Paul Maguire and Klaus L. Leenders[CA]

Second principle.
Functional integration

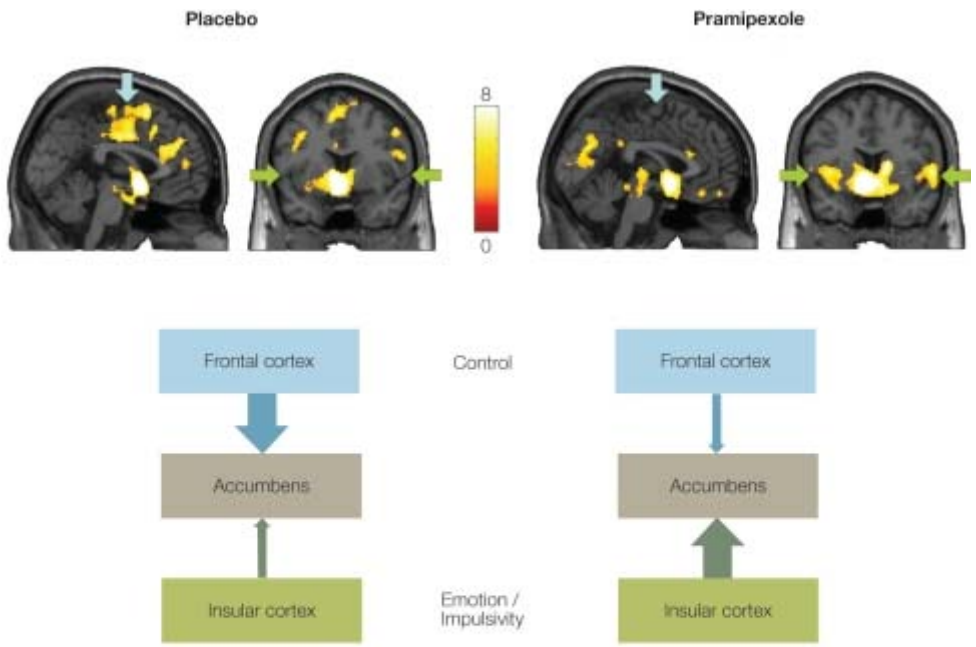


Nature Reviews | Neuroscience

Connectivity in functional MR

- functional connectivity: *correlations between spatially remote neurophysiological events (data driven)*

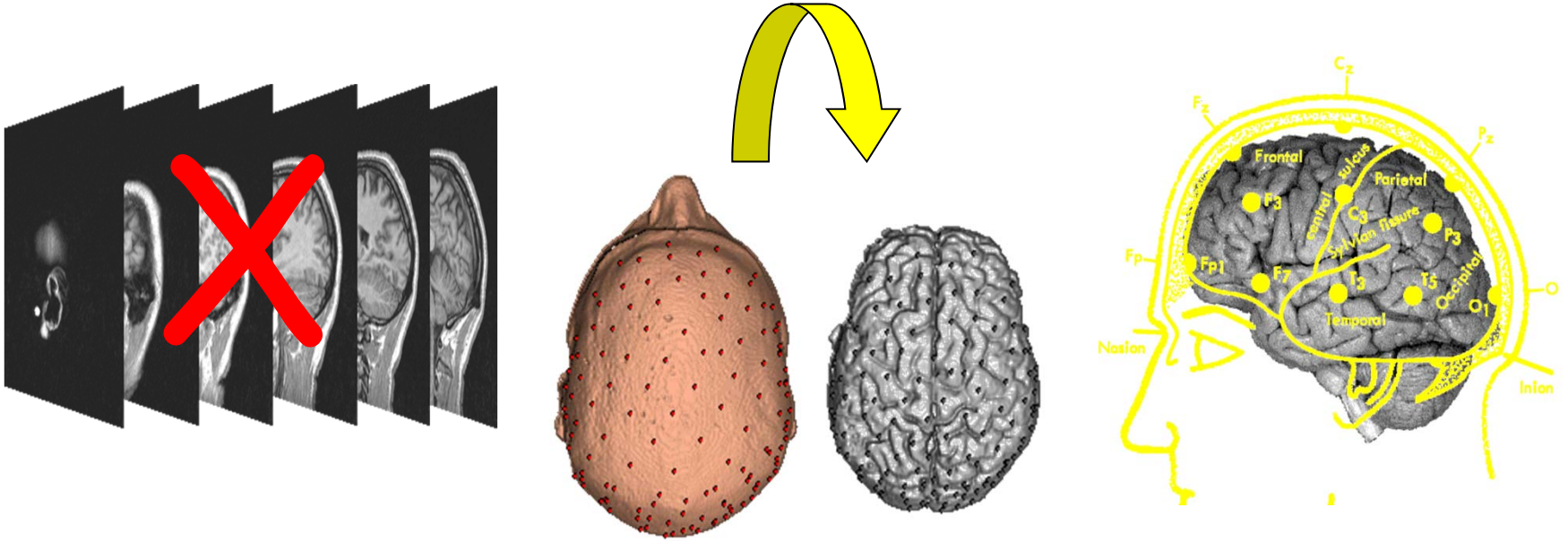
- effective connectivity: *influence one neuronal system exerts over another (hypothesis driven)*



Camara et al., 2009

Third principle.
Testing for causality

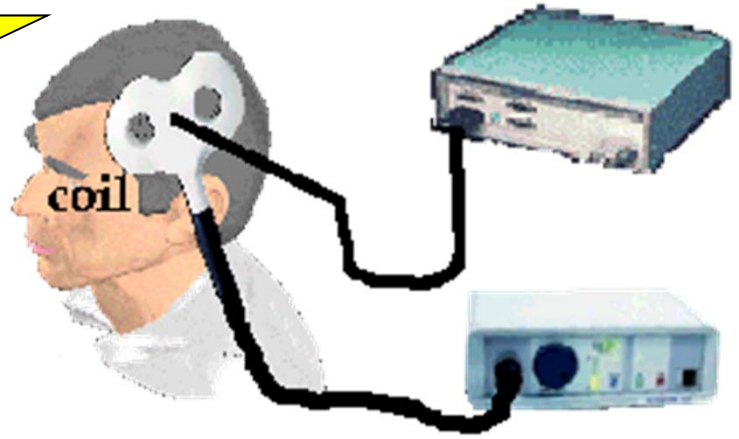
TMS with a MRI template

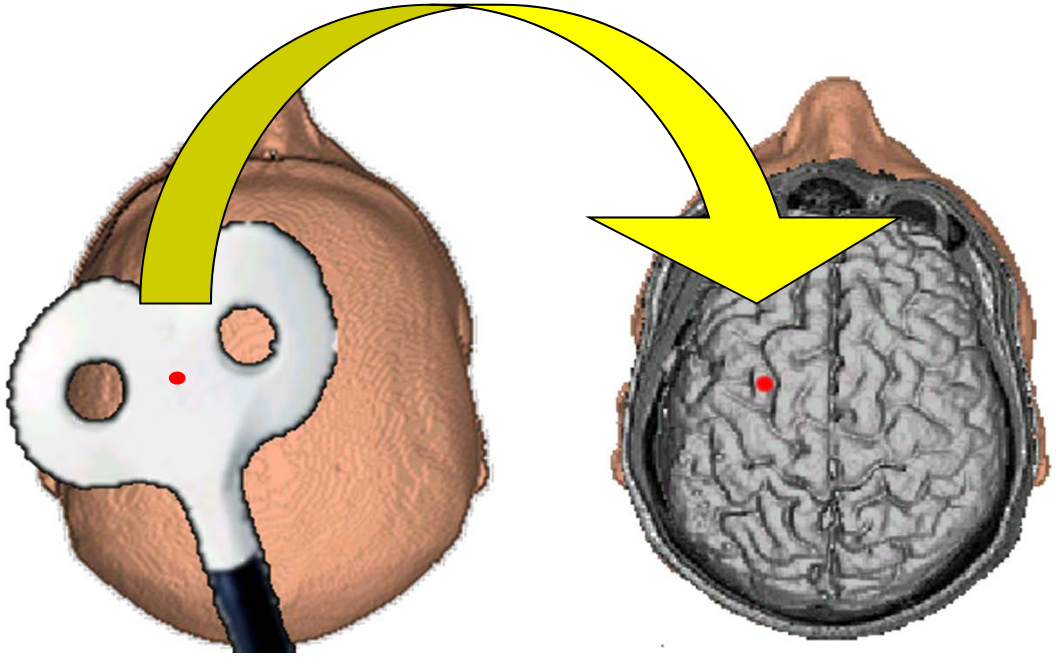


SofTaxic Navigator system

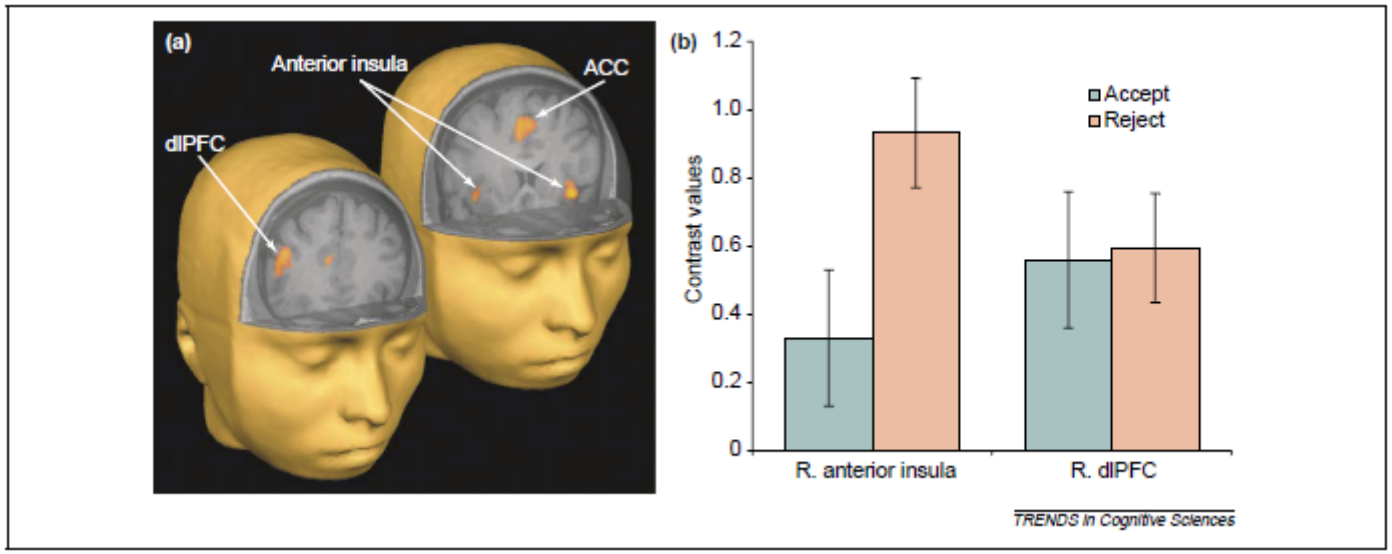
based on digitized skull landmarks (nasion, inion and two pre-auricular points) and about 40 scalp points (Fastrak Polhemus digitizer)

fMRI studies: activated areas

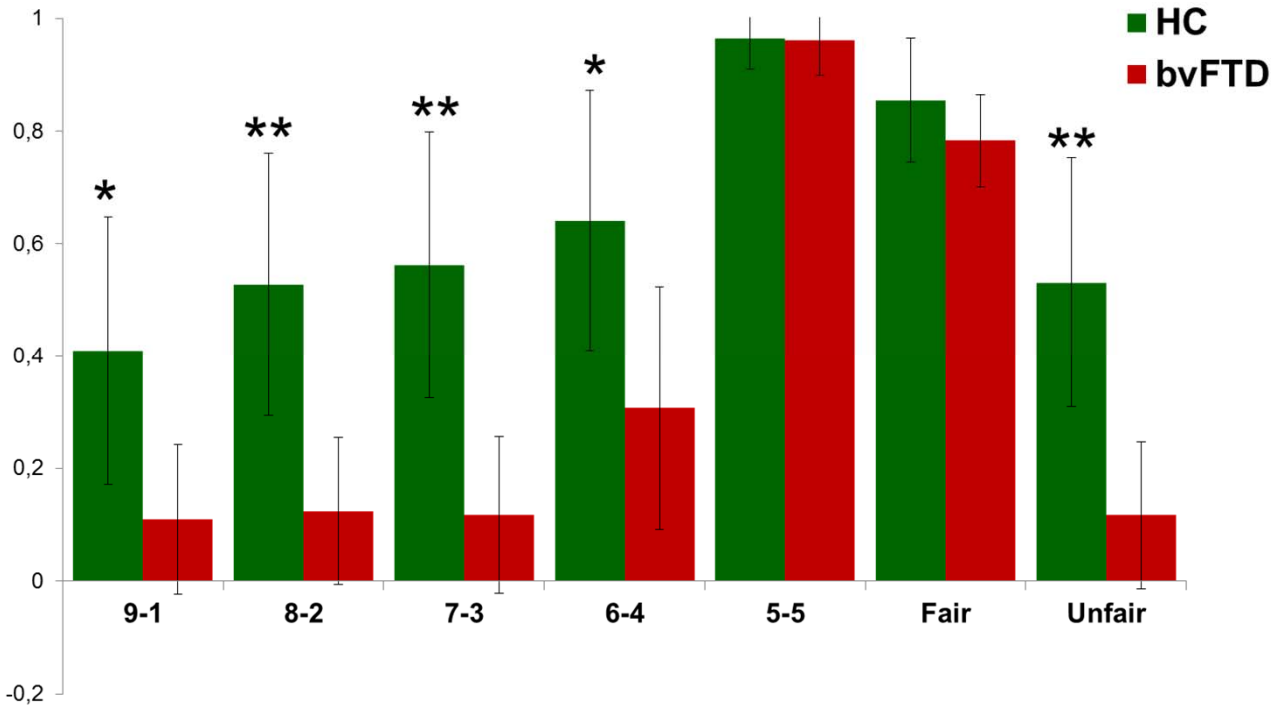




Behavioural changes?



Sanfey et al., 2006


HC
bvFTD
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0,6
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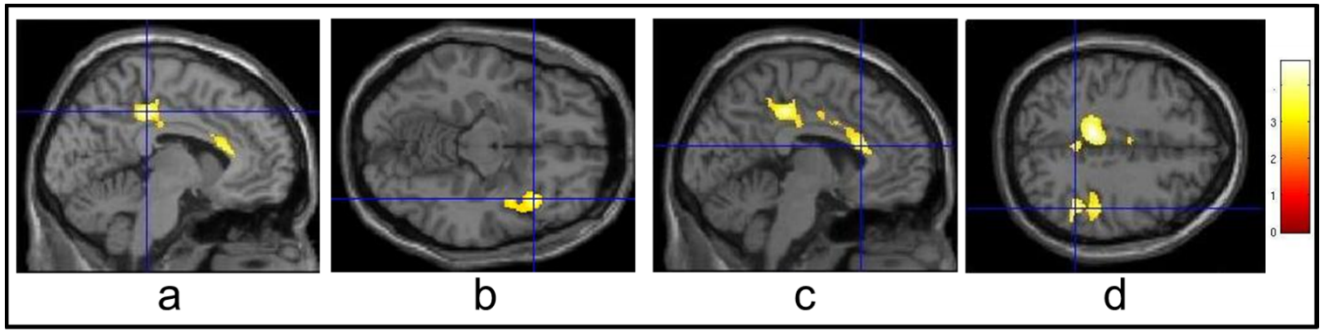
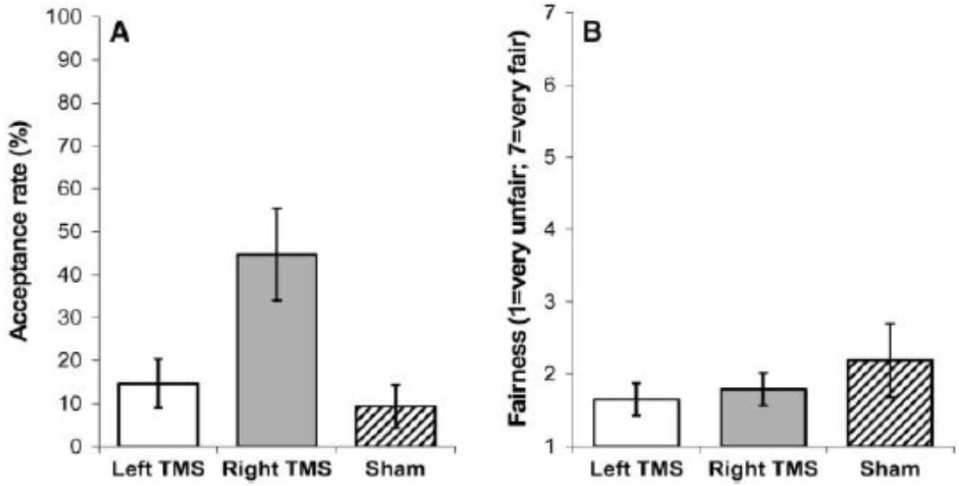
*
**
9-1
8-2
7-3
6-4
5-5
Fair
Unfair


a
b
c
d

Diminishing Reciprocal Fairness by Disrupting the Right Prefrontal Cortex

Daria Knoch,[1,2,3]* Alvaro Pascual-Leone,[4] Kaspar Meyer,[1] Valerie Treyer,[5] Ernst Fehr[1,3]*



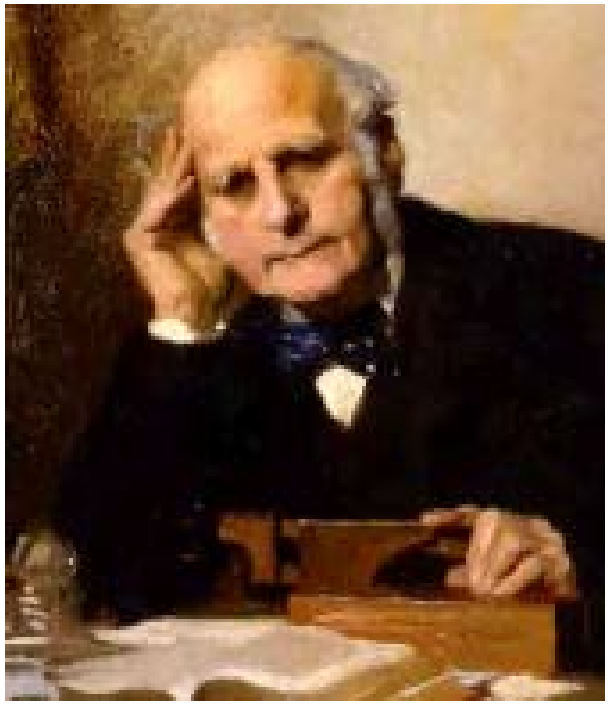
Neuroscience of management. Normative or applicative?

Normative aspects

- Mechanistic understanding of the neural mechanisms involved in analysis, decision and action at the individual and group level

  - Assessing magnitude and probability of reward
  - Evaluation of risk and uncertainty
  - Exploitation and innovation
  - Goal reassessment

Applications: from psychology to neurology of individual differences



INTERNATIONAL HEALTH EXHIBITION, 1884.

ANTHROPOMETRIC LABORATORY,

Arranged by FRANCIS GALTON, F.R.S.

Sex Colour of eyes

Date Initials

EYESIGHT.

	right eye	left eye
Greatest distance in inches, of reading "Diamond" type		
Colour sense, goodness of		

JUDGMENT OF EYE.

	in three parts	in two parts
Error per cent. in dividing a line of 15 inches		
Error in degrees of estimating squareness		

HEARING.

Keenness can hardly be tested here owing to the noises and echoes.

Highest audible note between 0.000 and 0.000 vibrations per second.

BREATHING POWER.

Greatest expiration in cubic inches

SWIFTNESS

of blow of hand in feet per second

STRENGTH

of squeeze in lbs. of	right hand	of pull in lbs.
	left ,,	

SPAN OF ARMS

From finger tips of opposite hands feet, inches.

HEIGHT

Sitting, measured from seat of chair feet, inches.

Standing in shoes feet, inches.

less height of heel..... inches.

Height without shoes feet, inches.

WEIGHT

in ordinary in-door clothing in lbs.

Age last birthday? _____

Married or unmarried? _____

Birthplace? _____

Occupation? _____

Residence in town, suburb or country? _____

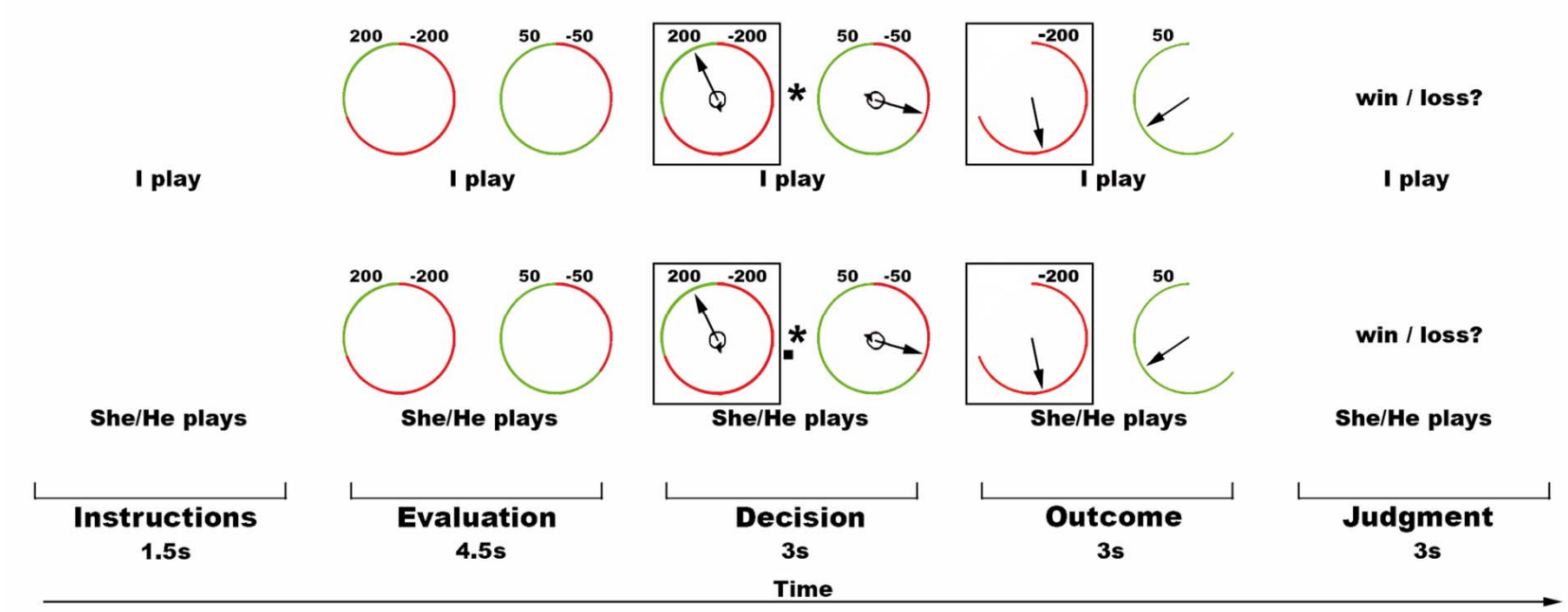
Main variables

(usually considered in neuroscience studies)

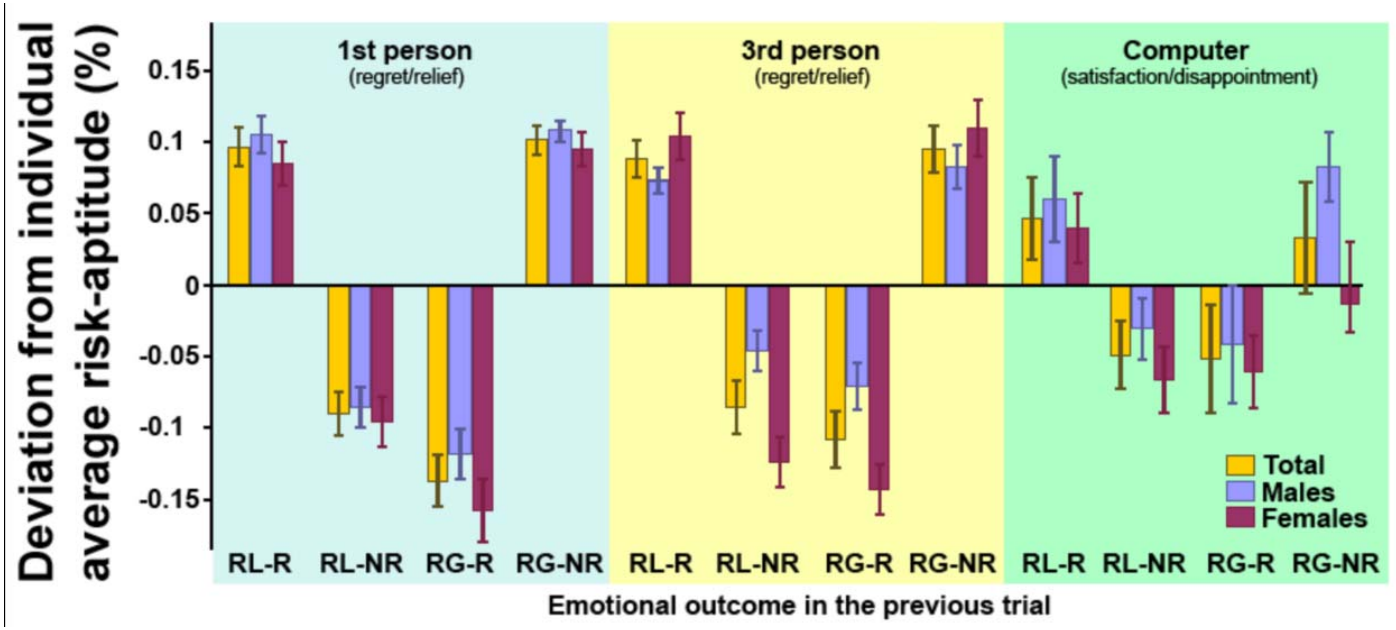
- Age
- Gender
- Education/occupation
- Linguistic background

Gender and decision-making

- Playing a gambling task: 1st person regret/relief
- Observing the outcomes of another player (3rd person "shared" regret/relief)
- Observing the outcomes of random choices by the computer (no responsibility, "shared" disappointment/satisfaction)



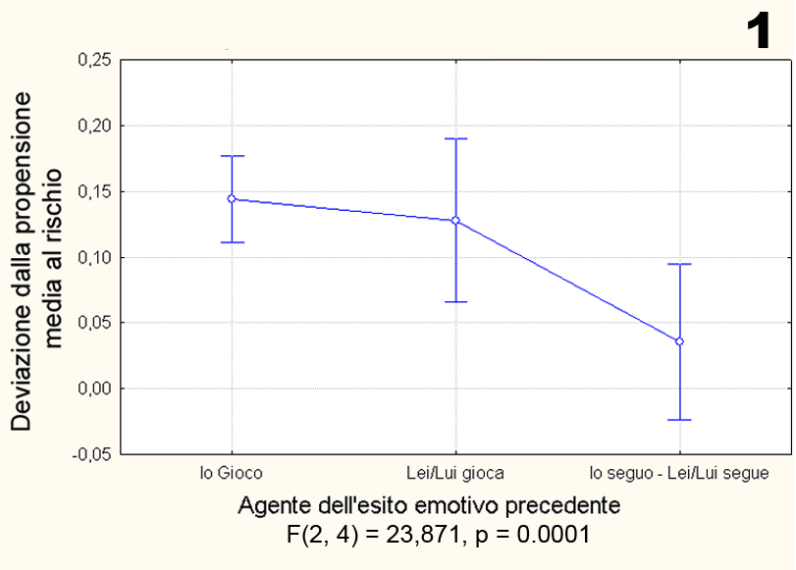
Effects of experienced and attended emotional outcomes on risk-aptitude



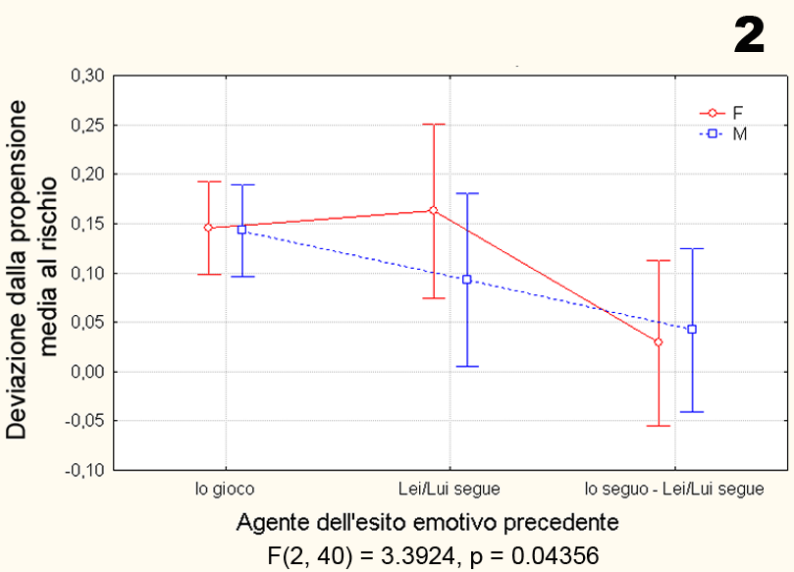
- Changes in risk-taking coherent with the preceding outcomes:

- Increased risk-seeking after relief for a risky choice or regret for a non-risky choice, and viceversa, only if the agent is human (both 1st and 3rd person)

Gender behavioral effects



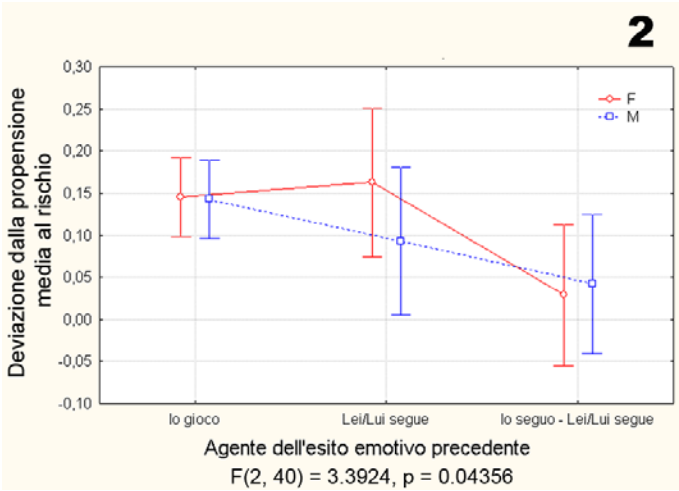
- No significant difference between the effects of experienced and attended outcomes; both larger than the effect of random choices by the computer



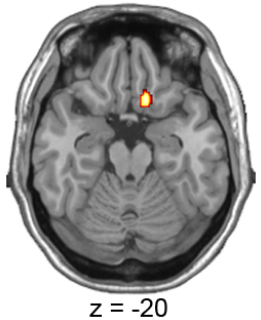
- Stronger influence from others' outcomes in female than male subject; no significant interaction with outcome-type

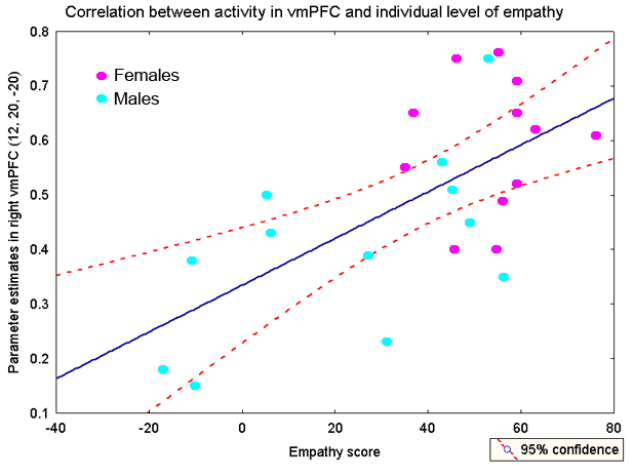
Gender effects in learning not to risk from others' past experience

- Stronger influence from others' outcomes in female than male subject; no significant interaction with outcome-type
- Stronger activation of the mOFC, reflecting the effect of previous outcome that behaviorally decrease risk-seeking, in female than male participants
- Significant correlation with empathy (BEES) scores



Gender effects: females > males RL-R or RG-NR

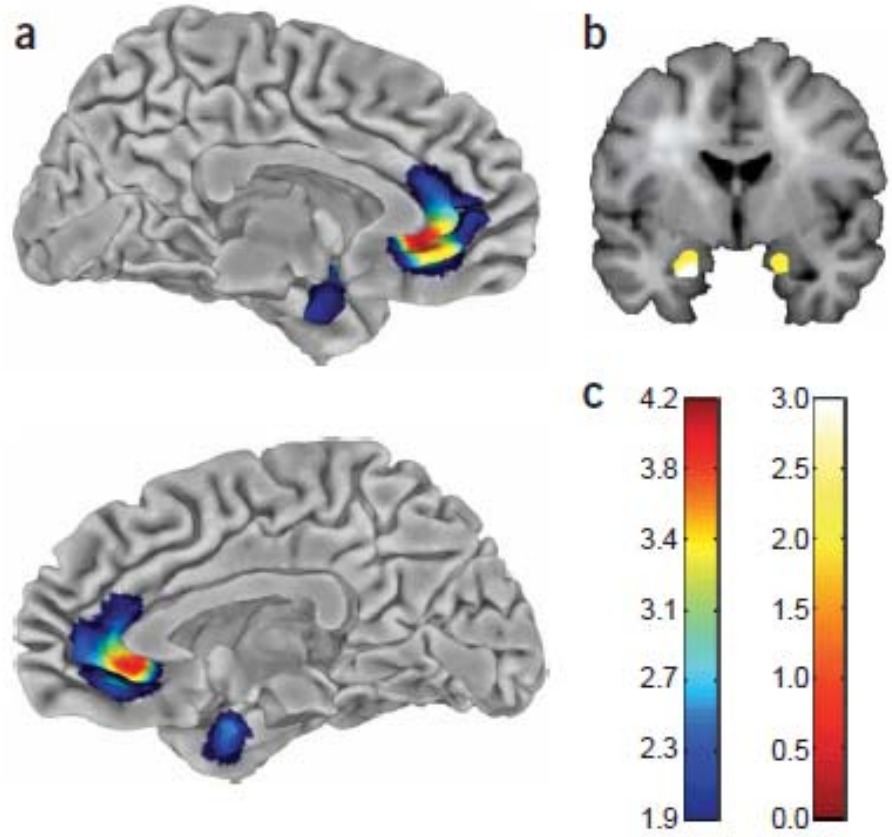




Additional variables (starting to be considered)

- Genetic background
- Temperament
- Specific skills
- Motivation
- …

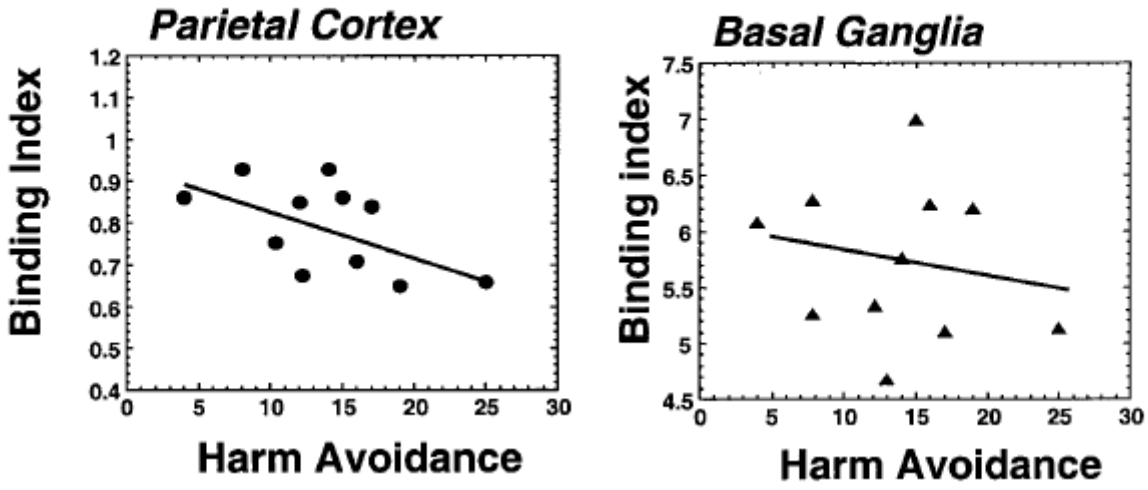
Genetics and brain structure



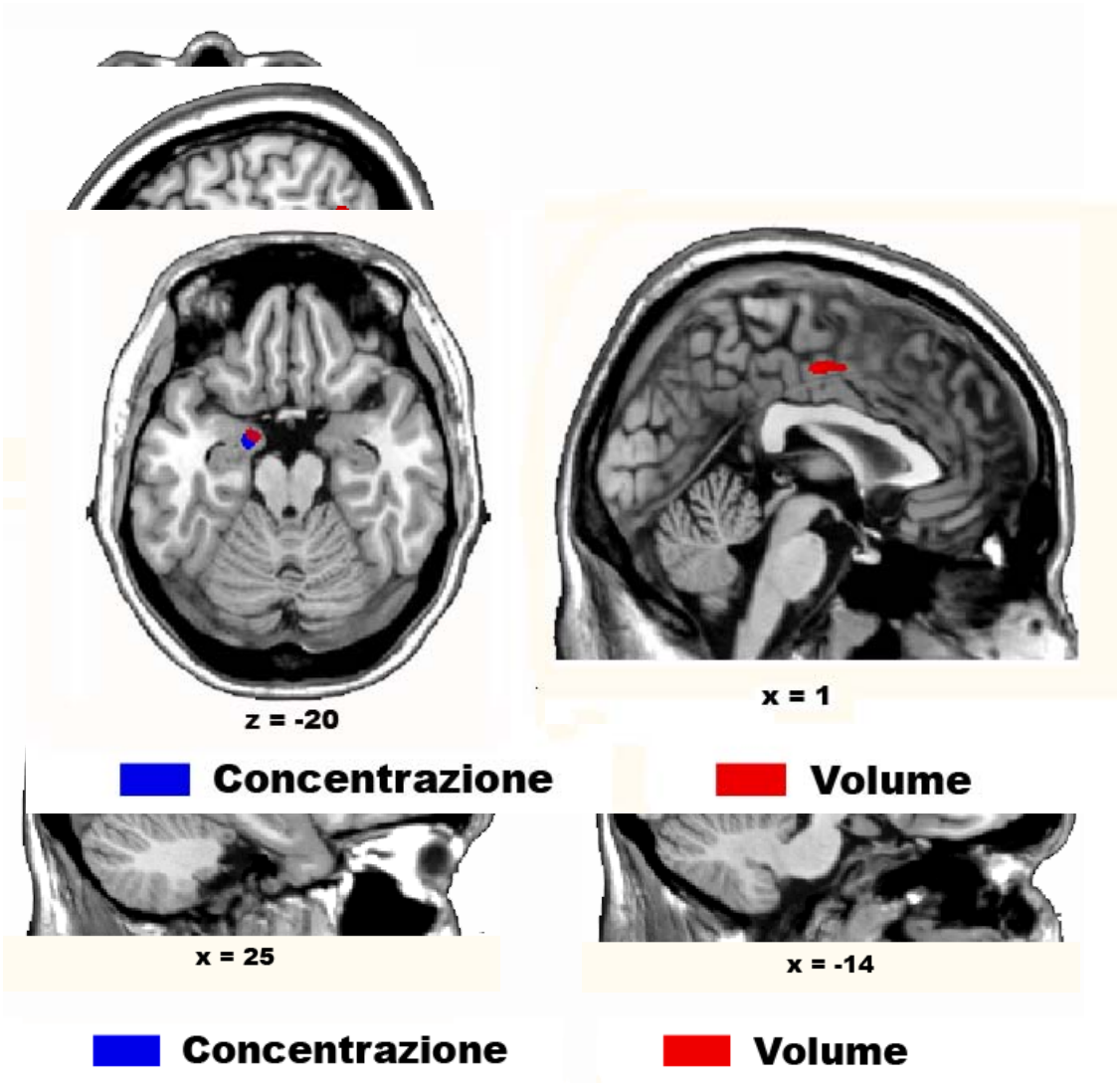
5-HTTLPR polymorphism impacts human cingulate-amygdala interactions: a genetic susceptibility mechanism for depression

Lukas Pezawas[1,3], Andreas Meyer-Lindenberg[1,3], Emily M Drabant[1], Beth A Verchinski[1], Karen E Munoz[1], Bhaskar S Kolachana[1], Michael F Egan[1], Venkata S Mattay[1], Ahmad R Hariri[2] & Daniel R Weinberger[1]

Temperament and neurotransmitter binding



Empathy score and brain structure



Negative correlation

Right temporal pole

Left temporo-parietal junction

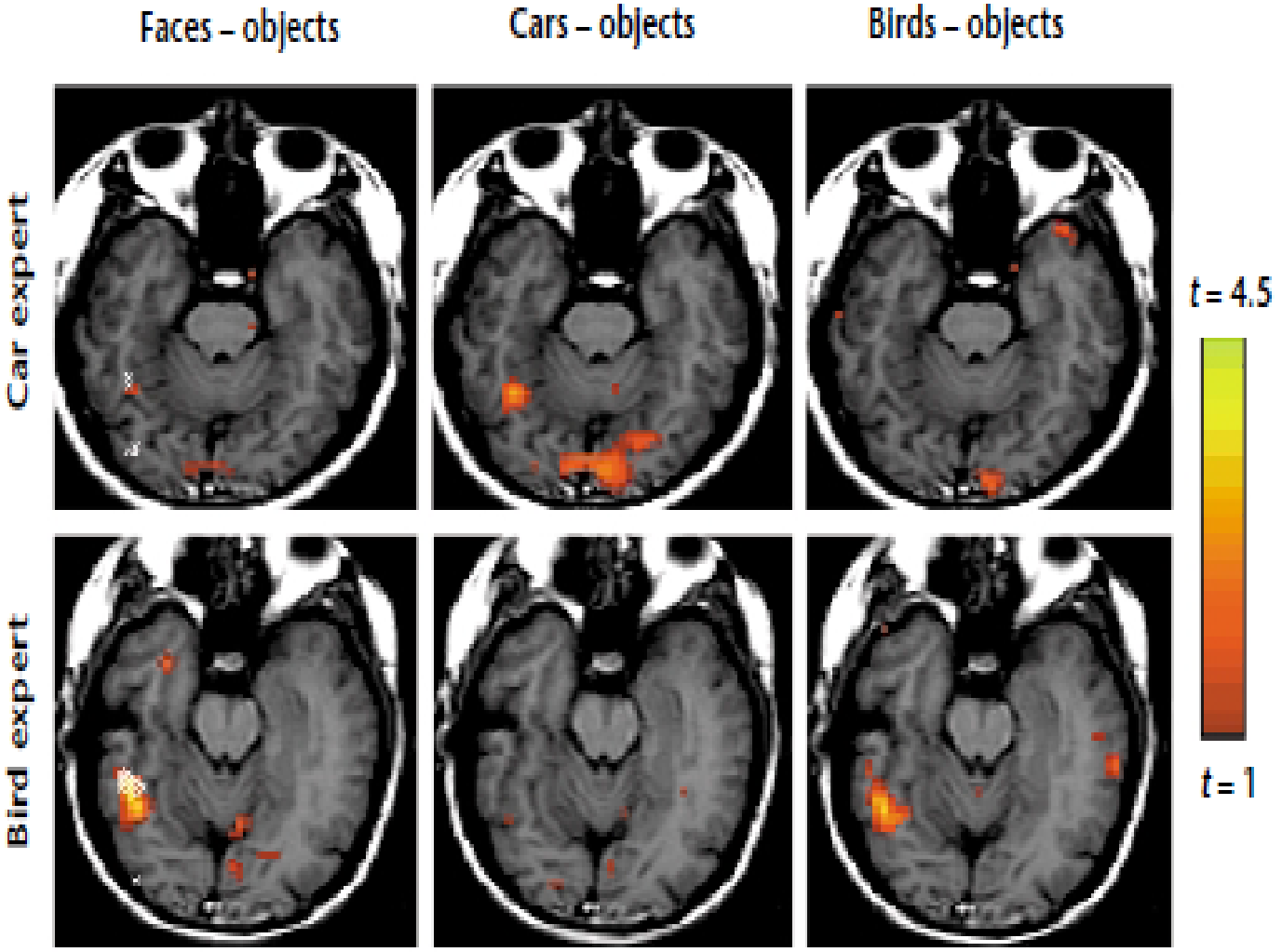
Positive correlation:

Left amygdala, middle cingulate

Right parahippocampal gyrus

Left SMA

Expertise and brain activation



Expertise for cars and birds recruits brain areas involved in face recognition

Isabel Gauthier[1,2], Pawel Skudlarski[2], John C. Gore[2] and Adam W. Anderson[2]

Università Commerciale
Luigi Bocconi


ETH-RAT

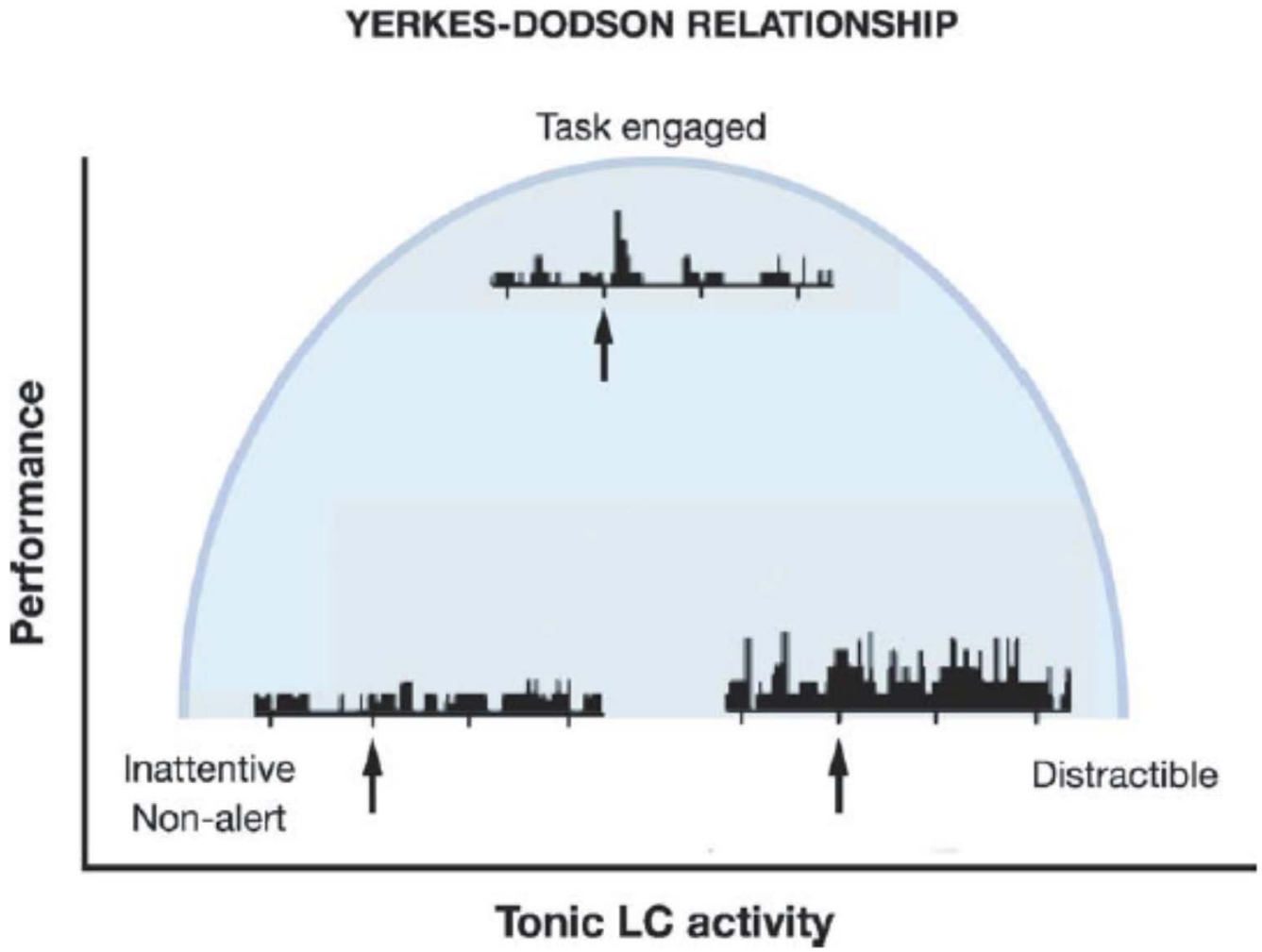
ORGANIZATION SCIENCE
Vol. 2, No. 1, February 1991
Printed in U.S.A.

EXPLORATION AND EXPLOITATION IN ORGANIZATIONAL LEARNING *

JAMES G. MARCH

Graduate School of Business, Stanford University,
Stanford, California 94305

Locus Coeruleus projections


YERKES-DODSON RELATIONSHIP
Task engaged
Performance
Inattentive
Non-alert
Distractible
Tonic LC activity

To summarize…

- Neuroscience knowledge is infiltrating any science dealing with human activity, including management
- Knowledge of the potentials and of the limits is necessary to critically evaluate any claim
- A better understanding of the neural mechanisms involved in complex human behaviors may be beneficial, both at the theoretical and application level