**Публичные лекции по психологии**

**16 марта 2011**

# Нейроэкономические исследования социального влияния на поведение человека

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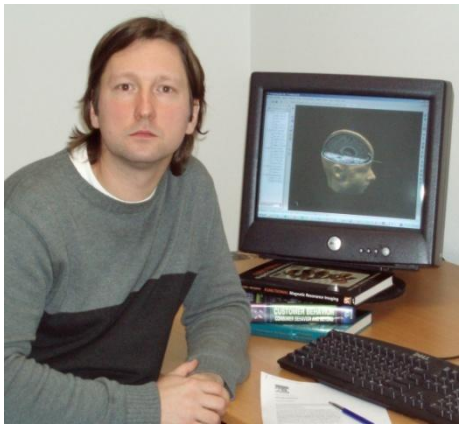
**Организатор:** Управление координации, планирования НИР и подготовки научных кадров
Московский городской психолого-педагогический университет
**www.mgppu.ru/lektoriy**

# Learning mechanism of social influence



**Василий Ключарев,**
Univerisity of Basel

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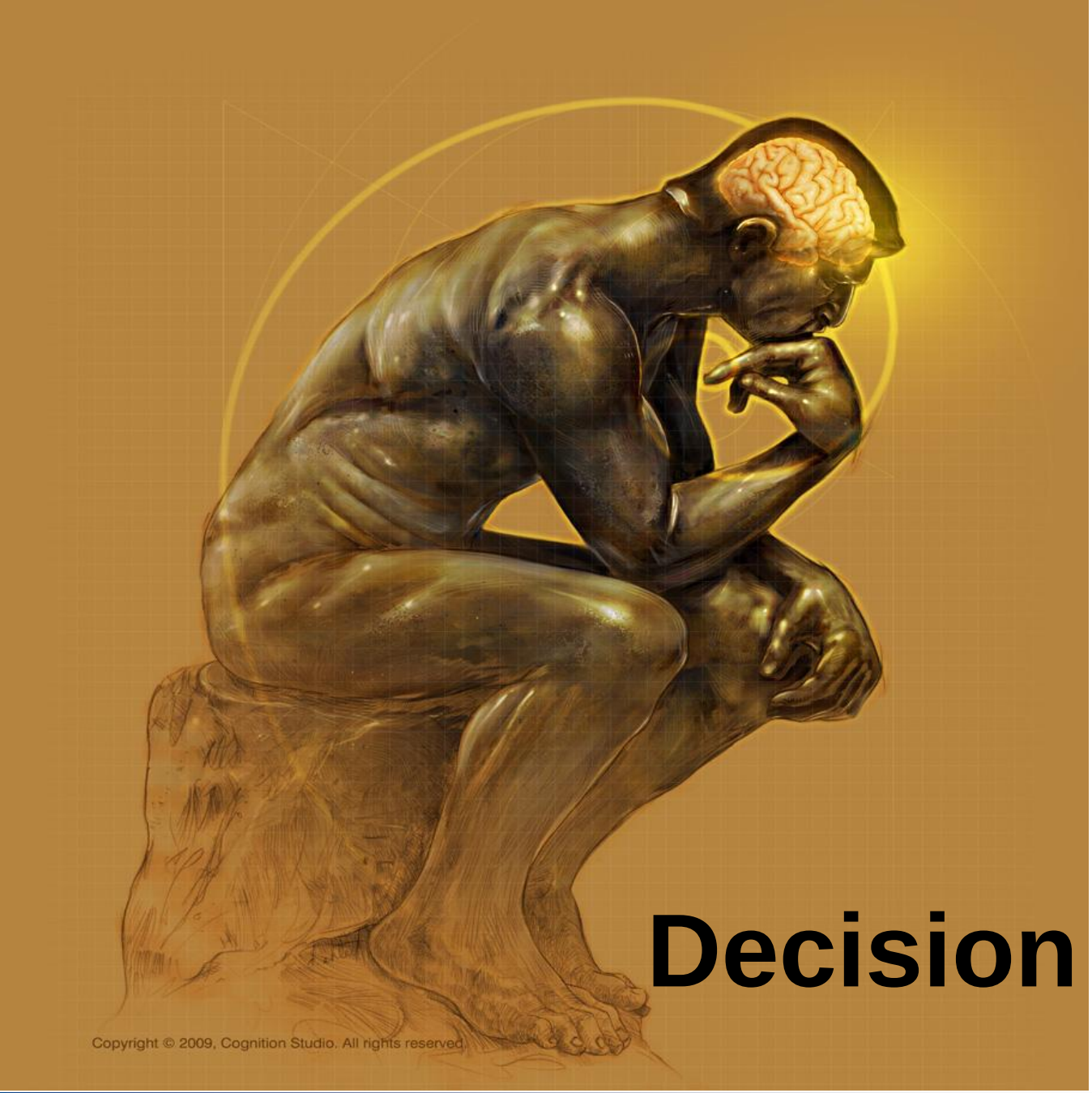
SPBU & MGPPU




# Decision making

# Neuroeconomics perspective:

- Economics, psychology, and neuroscience are converging today into a single, unified discipline with the ultimate aim of providing a single, general theory of human behavior - **neuroeconomics**.

- The goal of this discipline is to understand the processes that connect sensation and action by revealing the neurobiological mechanisms by which decisions are made.

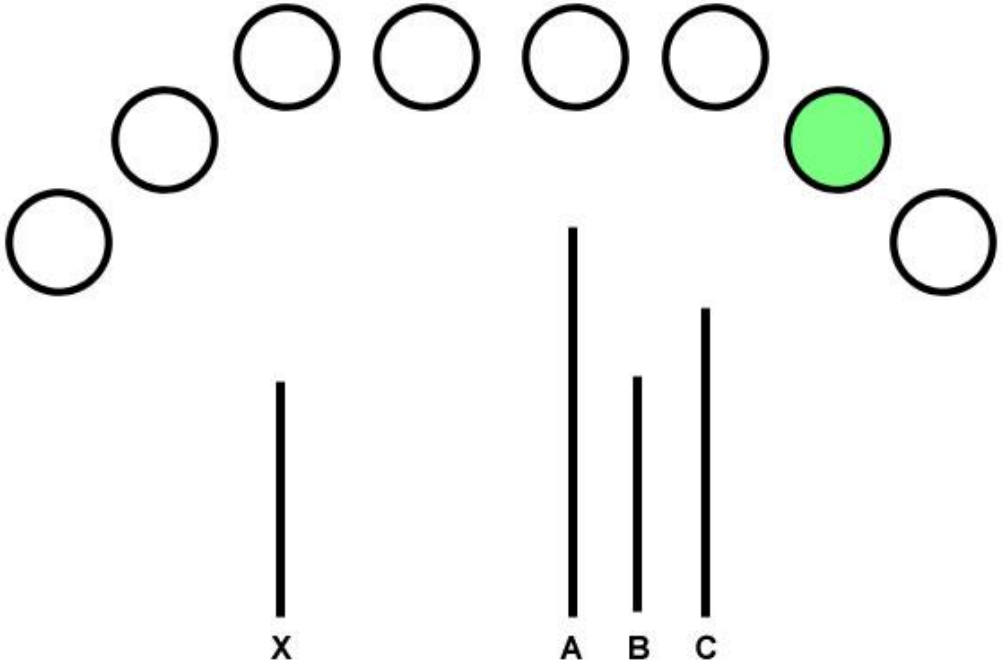
Adopted from Glimcher&Rustichini, Science 2004

# Neural correlates of social conformity

- BOLD precursors
- Electrophysiological precursors of social conformity

# Conformity

- Some forms of social influence evoke conflicts of opinions.
- How do we change our opinion?




Solomon Asch found that the (genuine) participants conformed on 32% of the trials and only 26% of people never conformed (1951).

# Definition

**Conformity** =

a type of social influence in which individuals change their attitudes, judgments, or behavior in order to adhere to existing social norms.

THE NEW YORK TIMES BOOK REVIEW

# Best Sellers

*August 6, 2006*

| | | | |
|---|---|---|---|
| 9 | **MYTHS, LIES, AND DOWNRIGHT STUPIDITY,** by John Stossel. (Hyperion, $24.95.) The "20/20" anchor questions conventional wisdom. | 9 | 11 |
| 10 | **THE LONG TAIL,** by Chris Anderson. (Hyperion, $24.95.) How the Internet has changed business so that its future requires "selling less of more." | 13 | 2 |
| 11 | **FEEDING THE MONSTER,** by Seth Mnookin. (Simon & Schuster, $26.) How the Red Sox finally did it. | 8 | 2 |

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| | | | | | |
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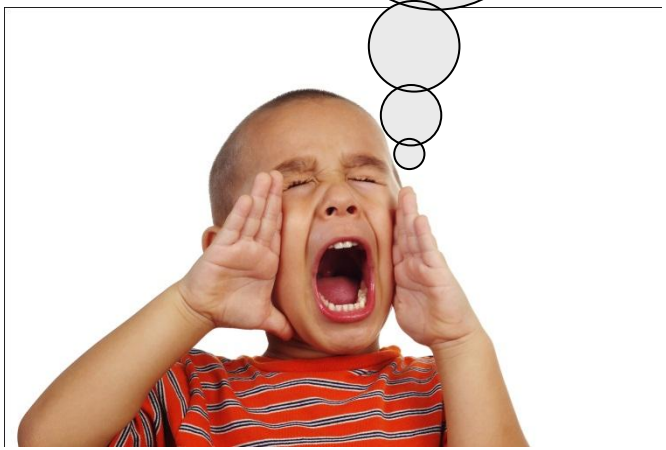
| ☐ | 1 | ANNU REV NEUROSCI | 0147-006X | 9652 | 26.077 |
| ☐ | 2 | NAT REV NEUROSCI | 1471-0048 | 13082 | 24.520 |
| ☐ | 3 | BEHAV BRAIN SCI | 0140-525X | 4721 | 17.462 |
| ☐ | 4 | NAT NEUROSCI | 1097-6256 | 26368 | 15.664 |
| ☐ | 5 | NEURON | 0896-6273 | 50707 | 13.410 |

# How do we update values/opinions based on social information?

# Learning mechanism of social influence

- Psychological studies emphasize the rewarding value of social approval or affiliation with others (Cialdini and Goldstein, 2004)
- Behavioral economics focuses more on the effects of punishment for violating the norm (Fehr and Fischbacher, 2004).
- Both approaches comply with a reinforcement learning mechanism: social norms selectively reinforce certain behaviors.

# How do we detect own violation of Norms?

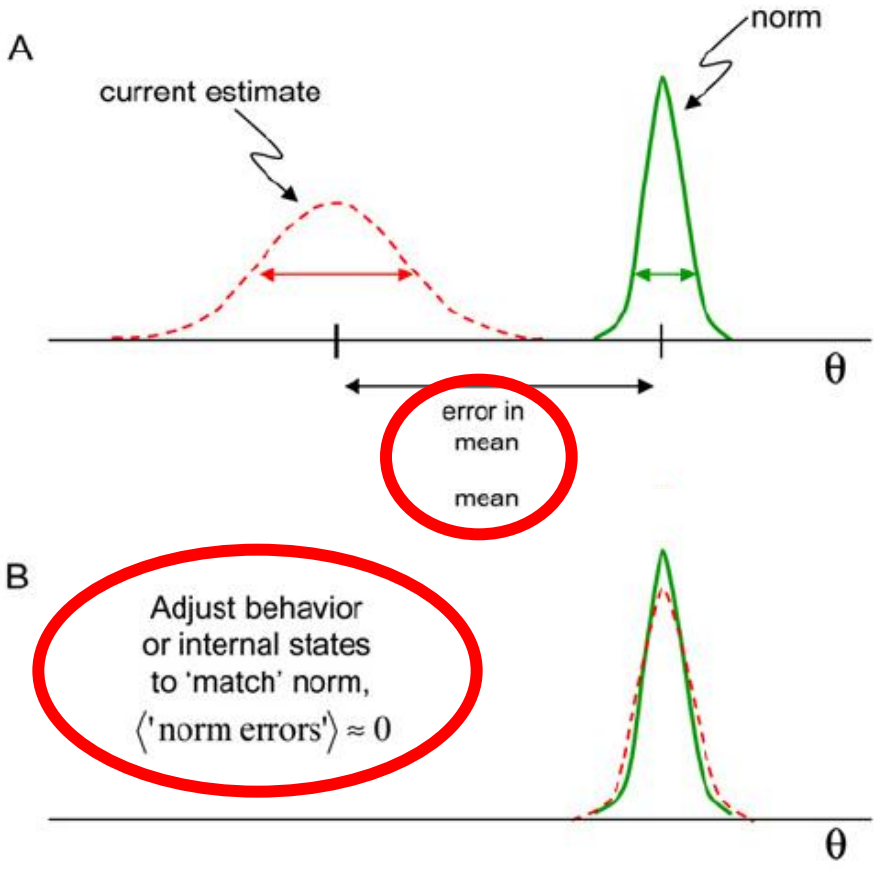


**To Detect and Correct:**
**Norm Violations and Their Enforcement**

P. Read Montague[1,*] and Terry Lohrenz[1]

Neuron 56, October 4, 2007

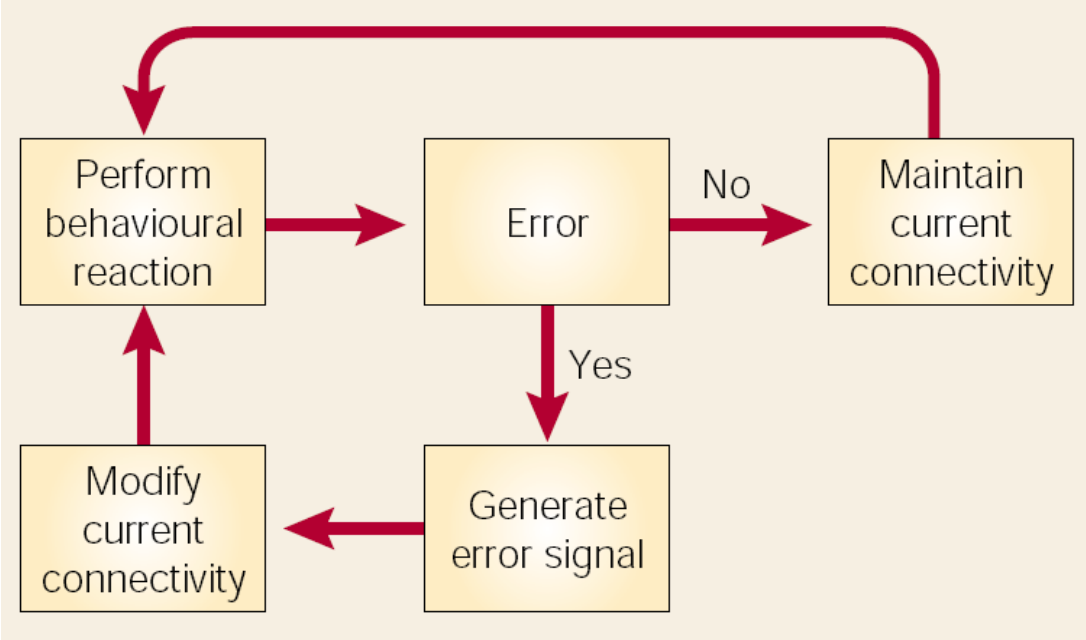
Neuron
Minireview



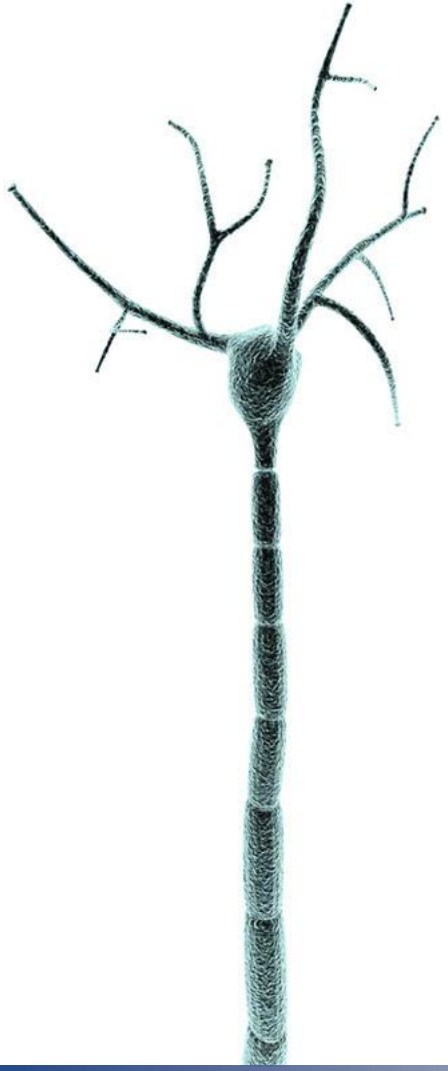
# Rescorla-Wagner model of classical conditioning

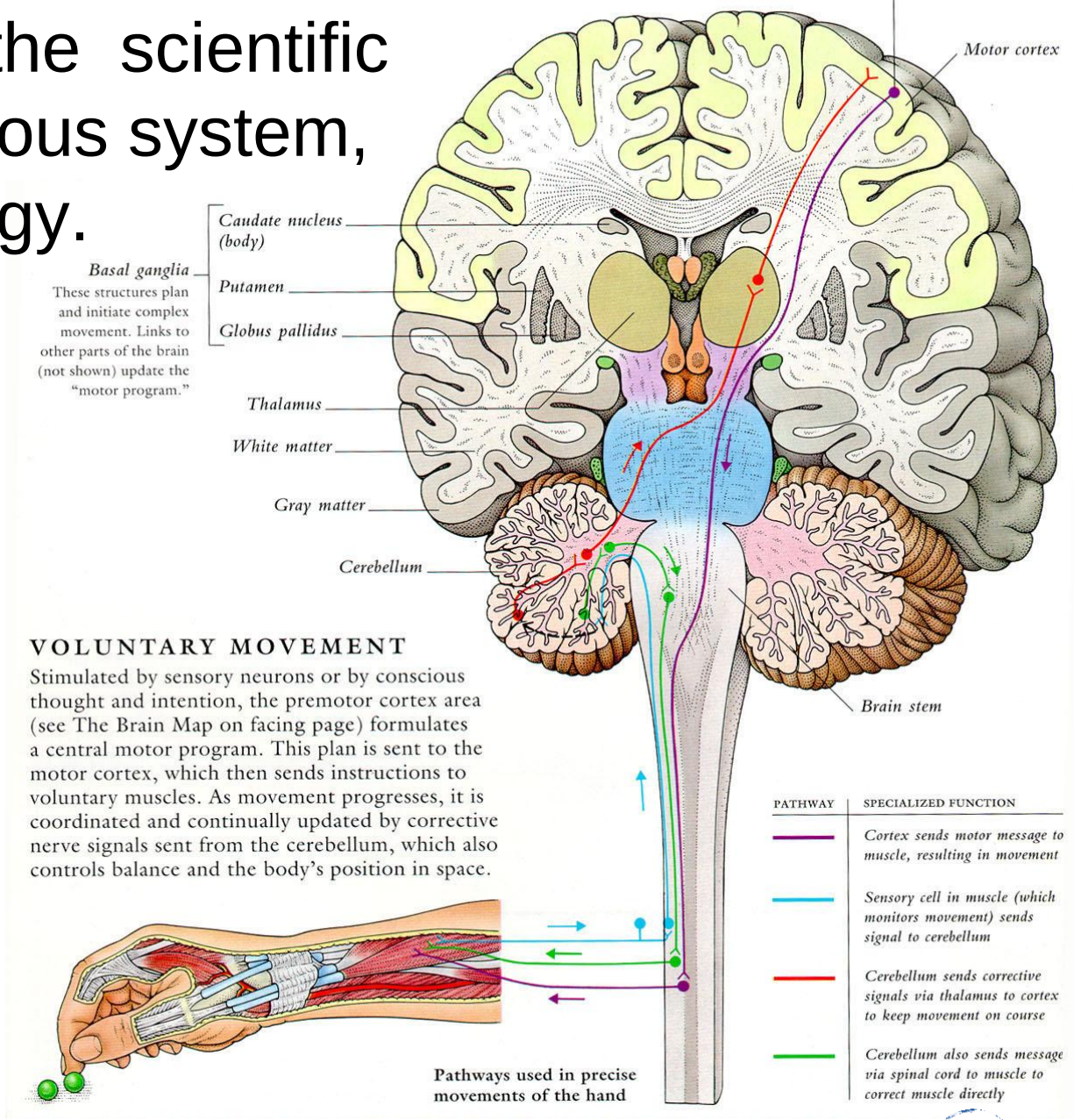
- The most intuitive way to learn to predict future reward and punishments is via error correction.
- The principle here is simple: make the best prediction you can, observe actual events and if your prediction was wrong, update your knowledge-base so that future predictions are more accurate.

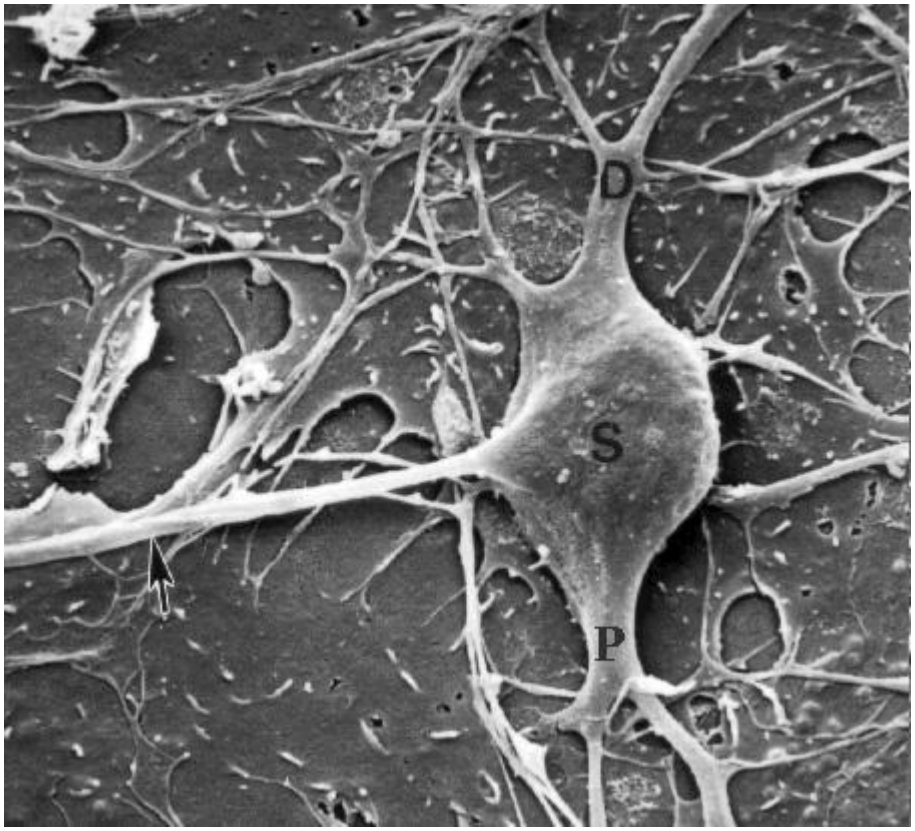
# Error detection as a component of Reinforcement learning models



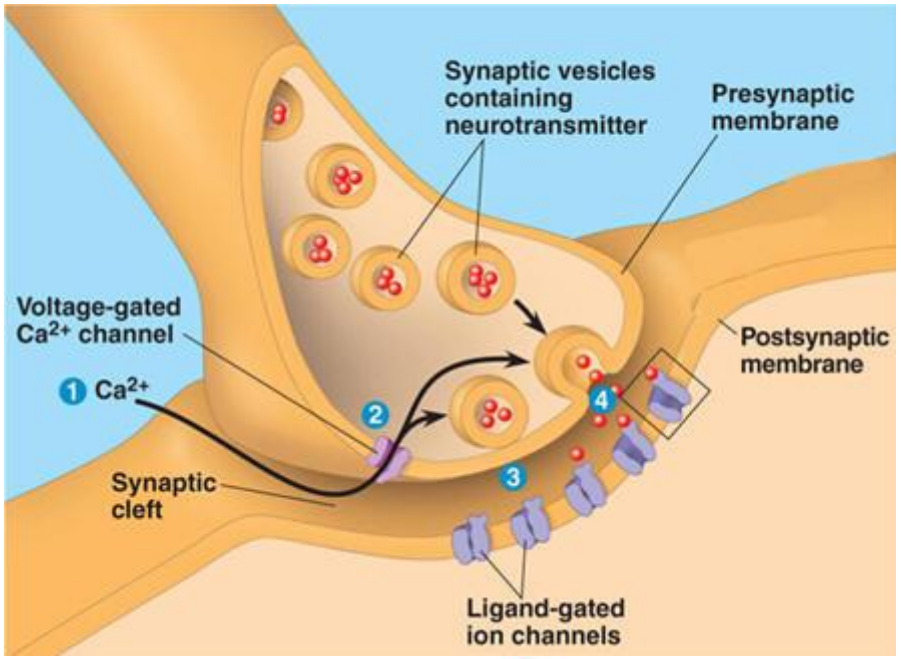
- Neuroscience – the scientific study of the nervous system, a branch of biology.



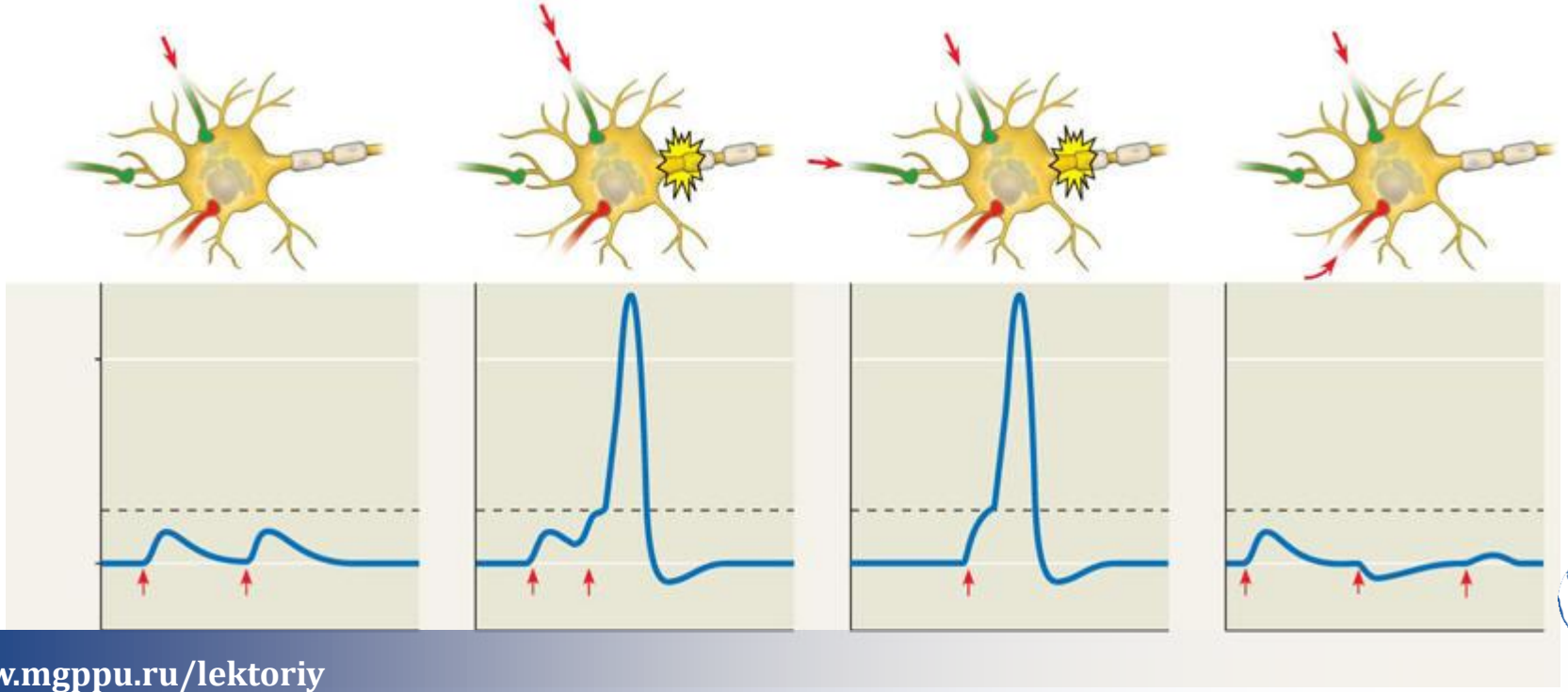


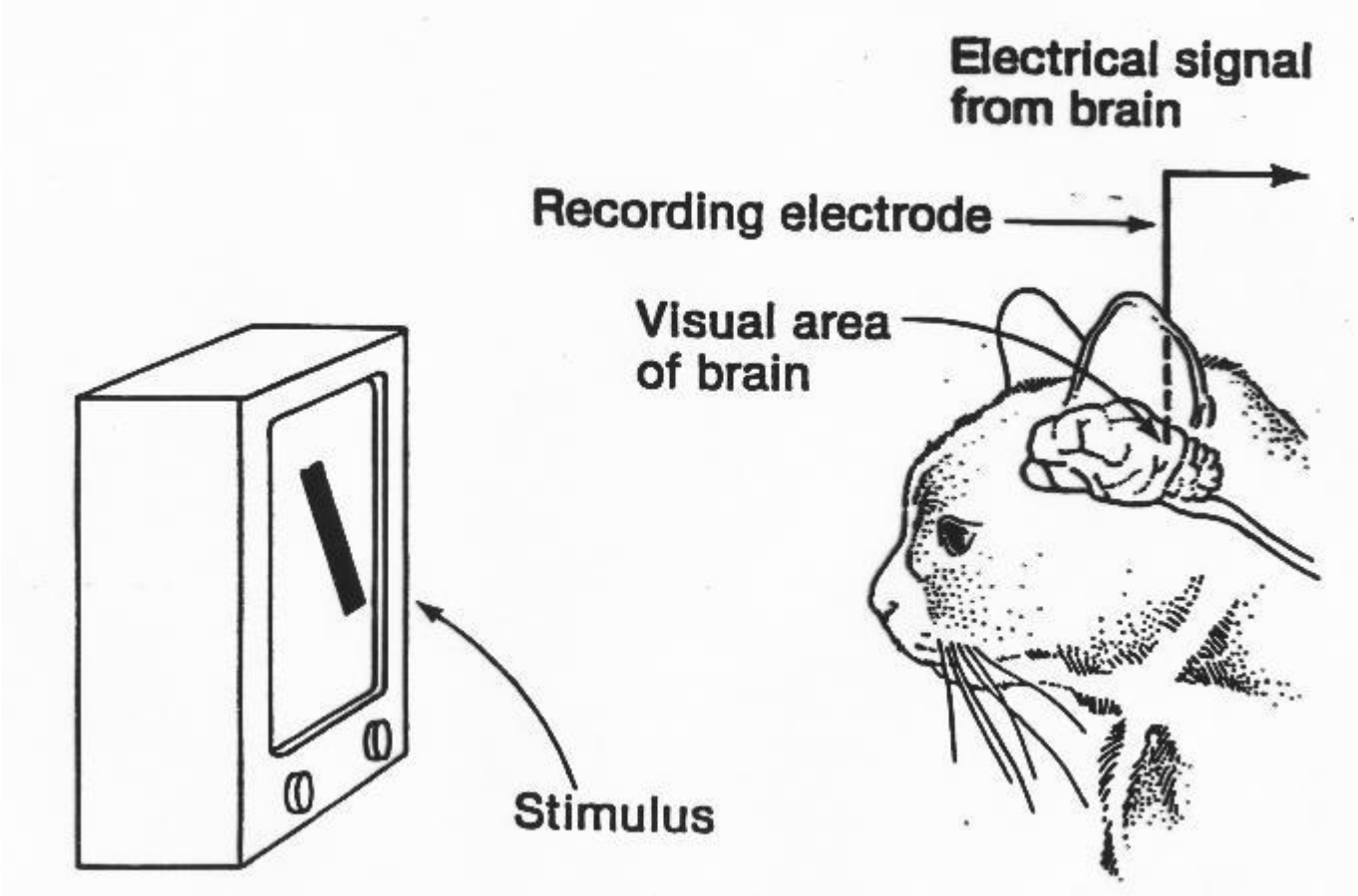



http://faculty.fortlewis.edu/KENDALL_D/Physiology%20Web

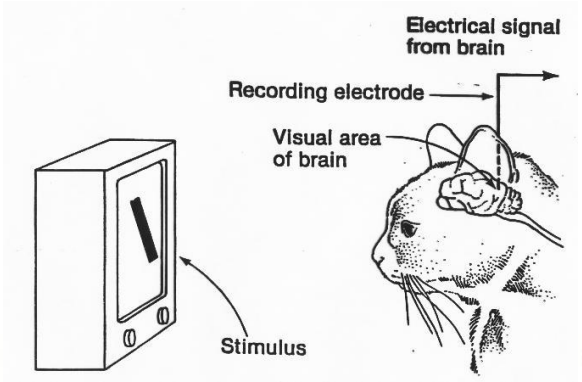


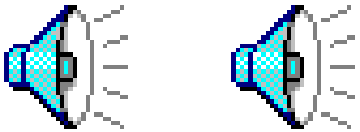

The neuron can be modelled as a computational element which sums its inputs within its time-constant and, whenever this sum, minus inhibitory effects, exceeds a threshold, produces an action potential which propagates to all of its outputs.



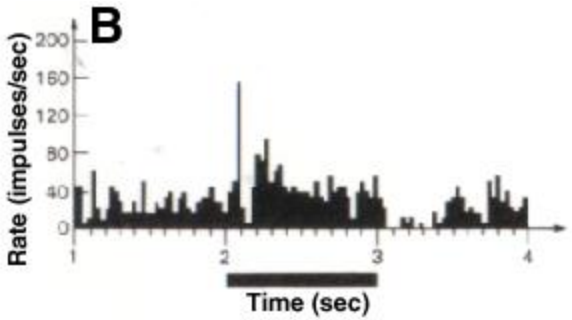


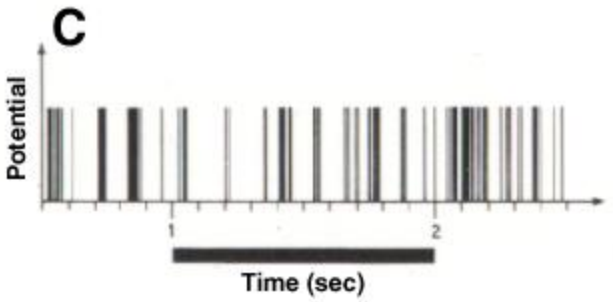

*www.caip.rutgers.edu/~feher/SandP/prep1_5.html*

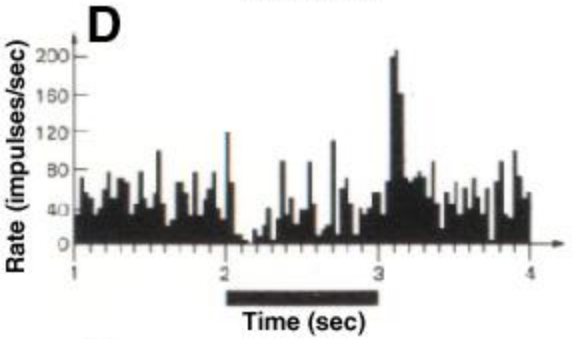

Electrical signal
from brain
Recording electrode
Visual area
of brain
Stimulus

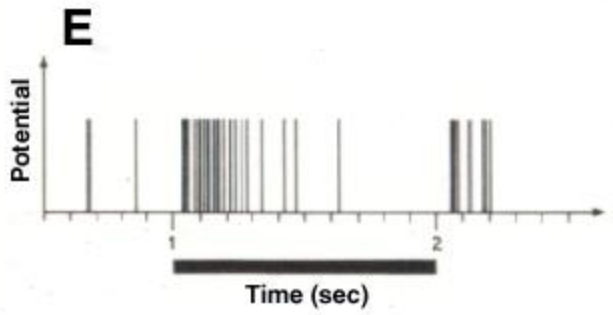


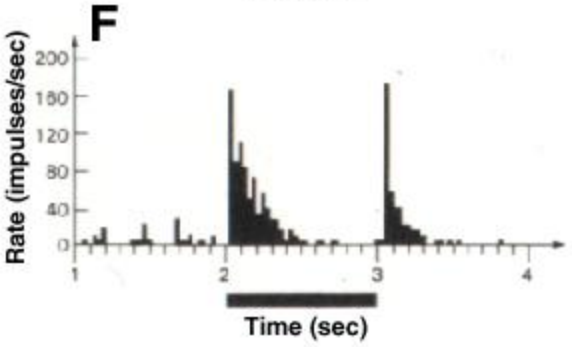
A
Potential
1
2
Time (sec)


B
Rate (impulses/sec)
200
160
120
80
40
0
1
2
3
4
Time (sec)

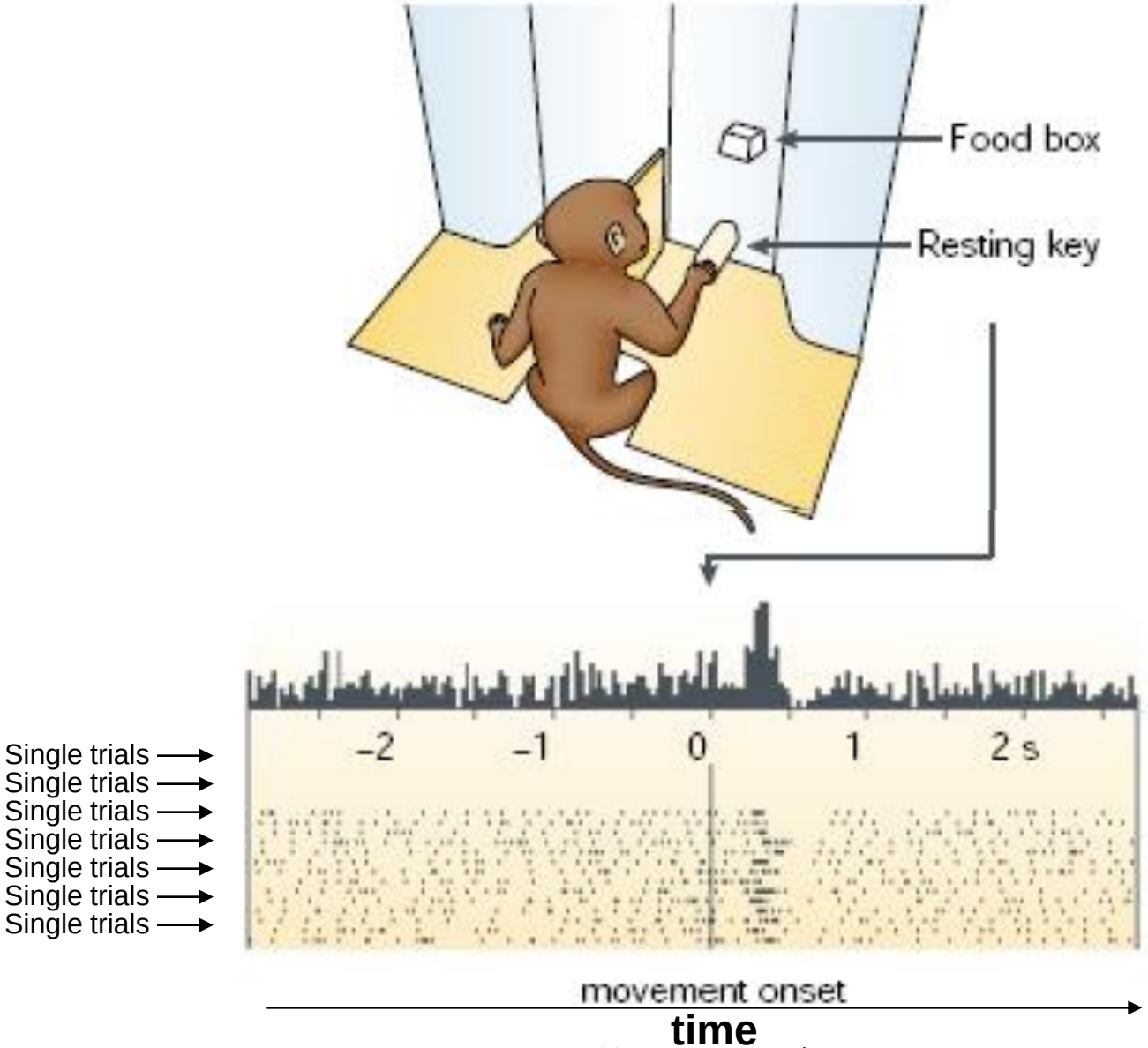

C
Potential
1
2
Time (sec)


D
Rate (impulses/sec)
200
160
120
80
40
0
1
2
3
4
Time (sec)


E
Potential
1
2
Time (sec)

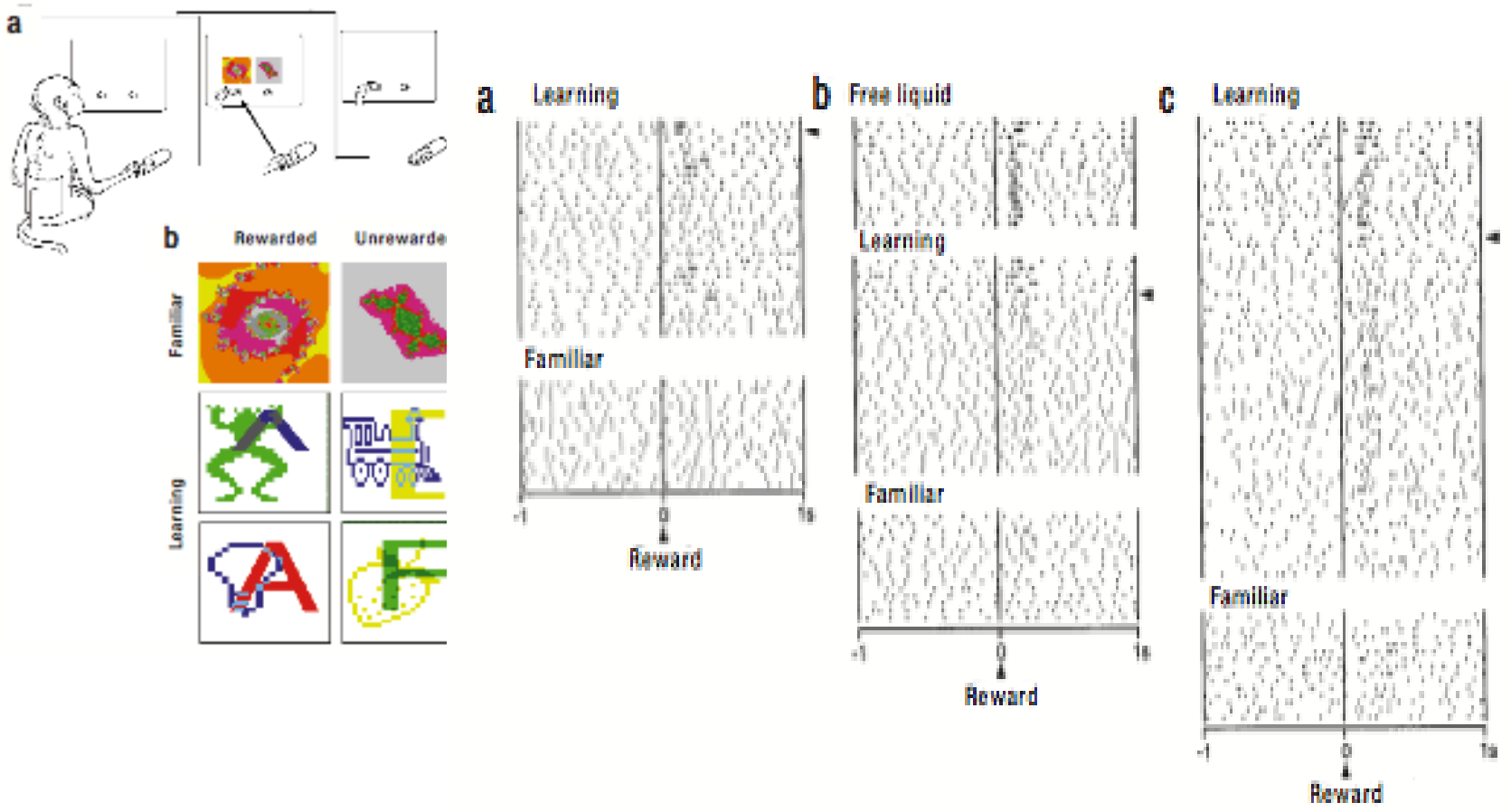

F
Rate (impulses/sec)
200
160
120
80
40
0
1
2
3
4
Time (sec)

Read electrophysiological results. Example of primitive neuroeconomical study
Phasic activations of neurophysiological impulse activity of neurons

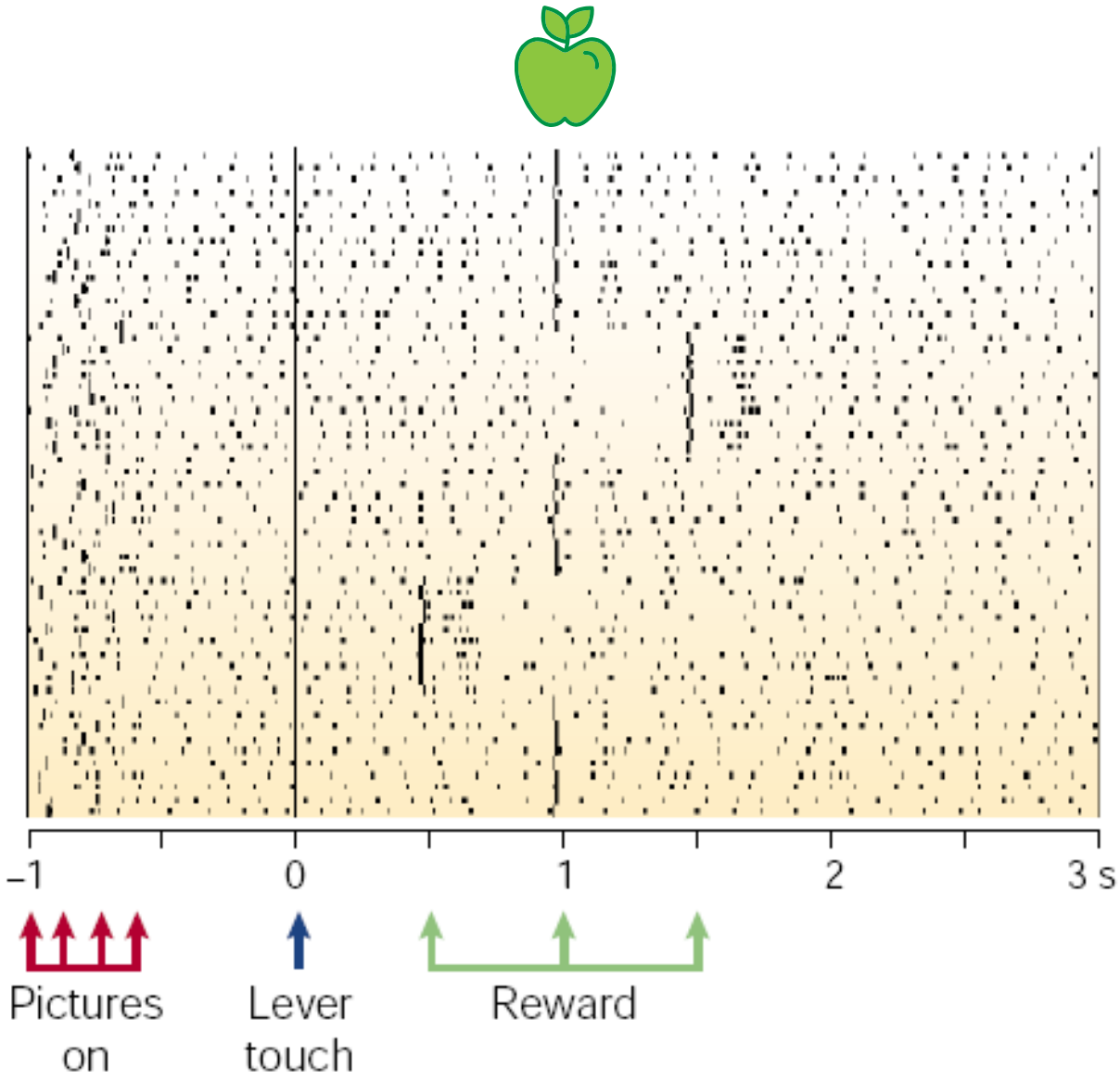



**Histogram**

# Learning a reward value of stimuli

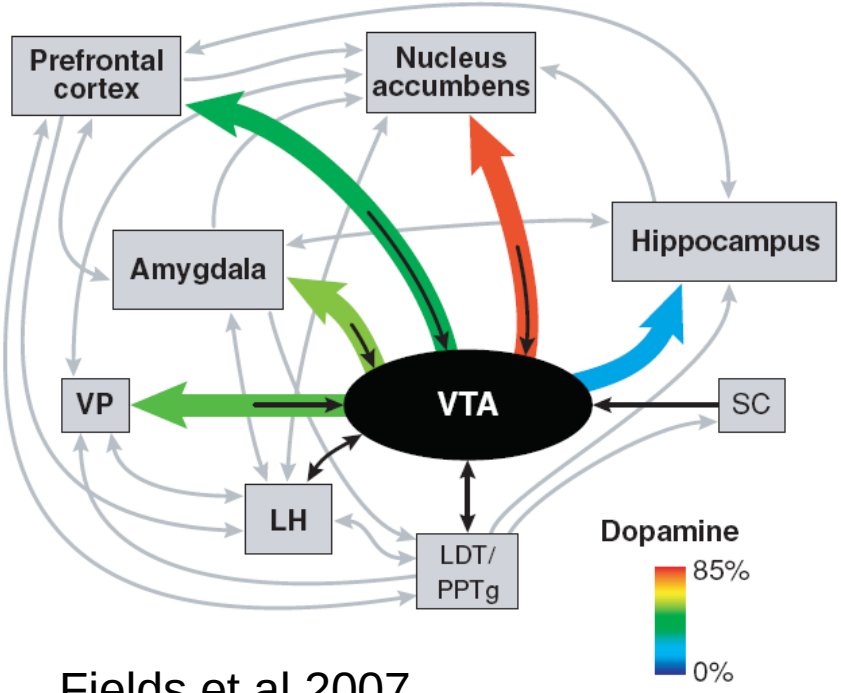



Hollermanan and Schultz 1998 Nature Neurosci

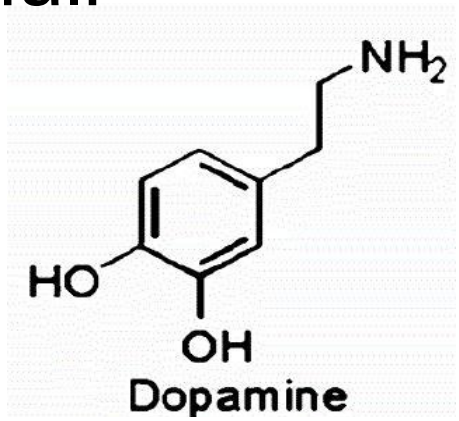


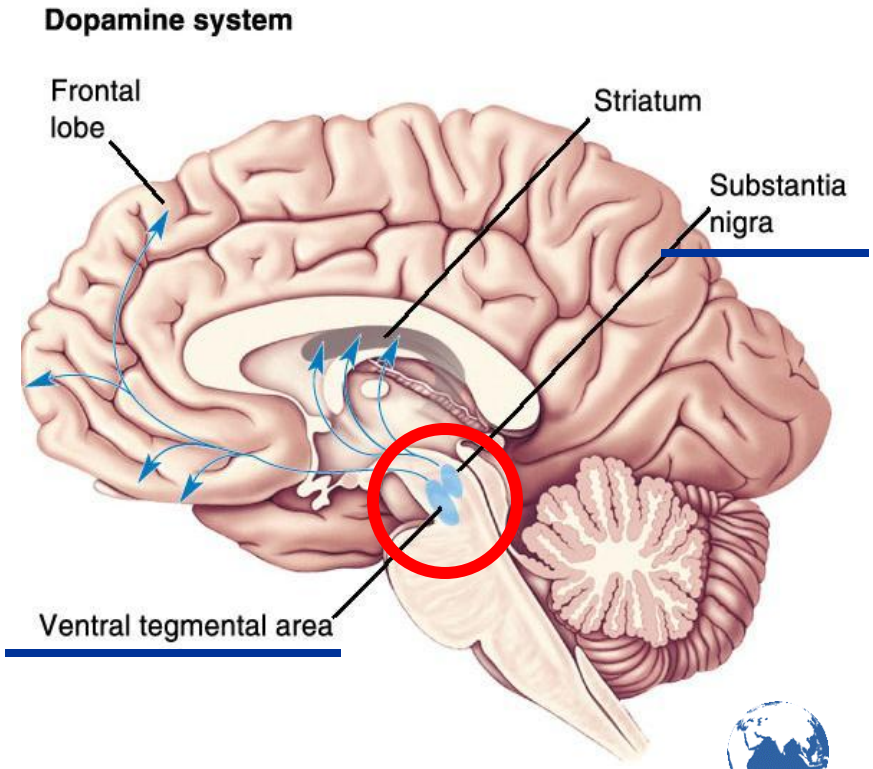

Hollermanan and Schultz 1998 Nature Neurosci

- Learning a reward value of stimuli




Fields et al 2007

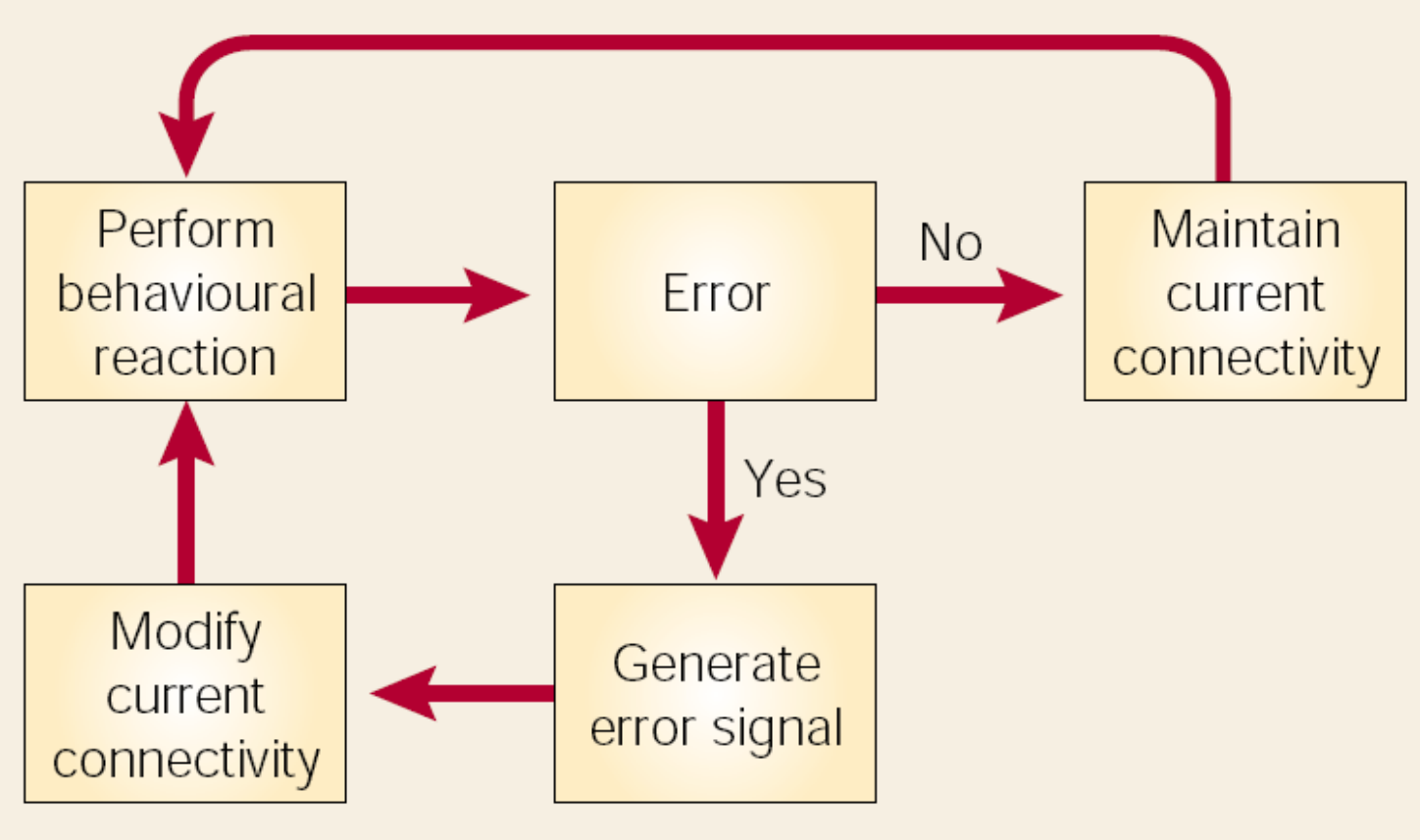


# Dopamine response = Reward occurred – Reward predicted

Prediction error – the discrepancy between an actually received reward and its prediction.

Learning is proportional to the prediction error.




NATURE REVIEWS | NEUROSCIENCE
VOLUME 1 | DECEMBER 2000

# Role of Dopamine

***The anhedonia hypothesis.***

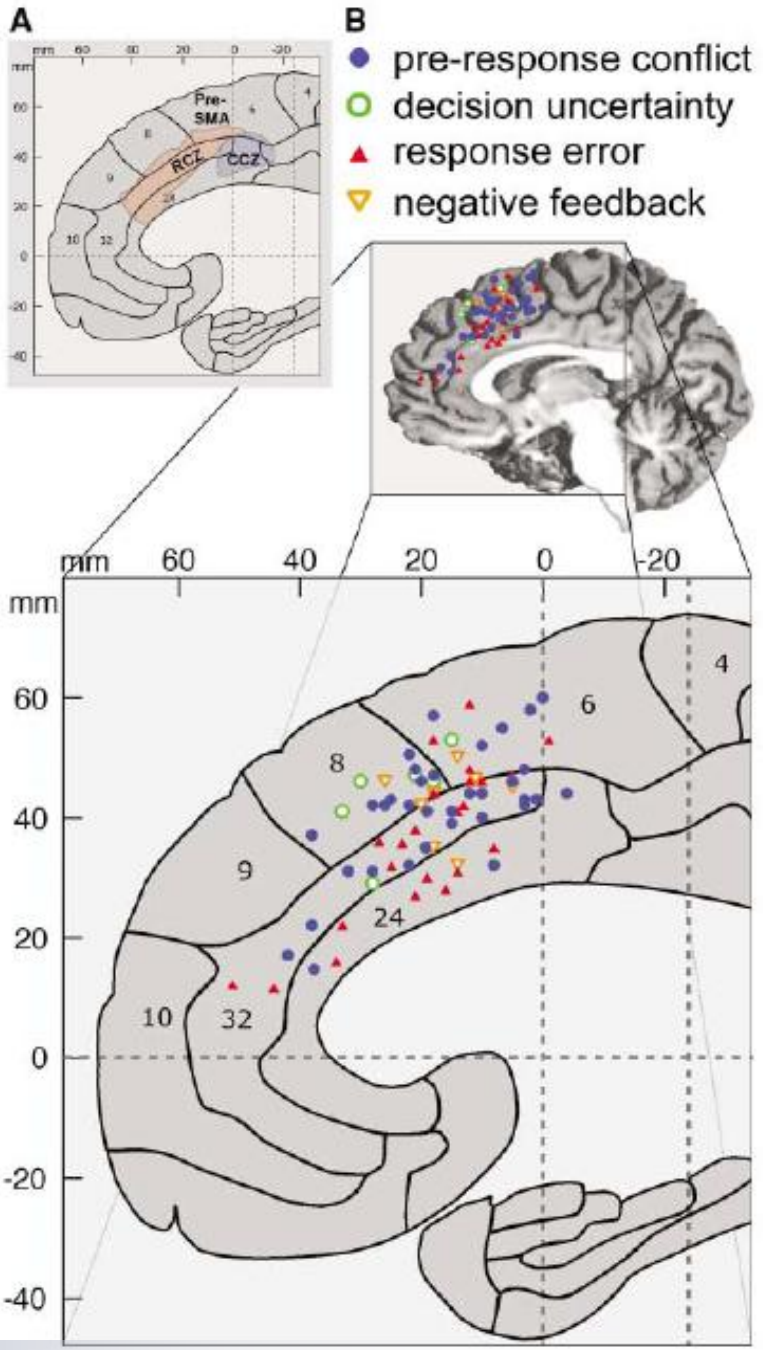
- Rewards are usually associated with a subjective feeling of pleasure or euphoria. The anhedonia hypothesis (Roy Wise, 1978) posits that dopamine is important for this pleasure.
- **N.B.** Brain imaging studies have indicated that stimulant-induced euphoria is loosely correlated with the degree of drug-induced dopamine release.
- On present evidence, it seems best to suggest that elevations in brain dopamine are only loosely correlated with subjective pleasure.

# Reward-prediction theory of dopamine

- Dopamine neurons report rewards relative to their prediction rather than signaling primary rewards unconditionally...
  - The dopamine response is positive (activation) when primary rewards occur without being predicted.
  - The response is nil when rewards occur as predicted.
  - The response is negative (depression) when predicted rewards are omitted.
- These characteristics have been demonstrated repeatedly for midbrain dopamine neurons. Indeed, the presentation of a predictive cue elicits a burst of activity from these neurons, the size of which is proportional to the magnitude, probability and even delay of the predicted reward

# Working Hypothesis

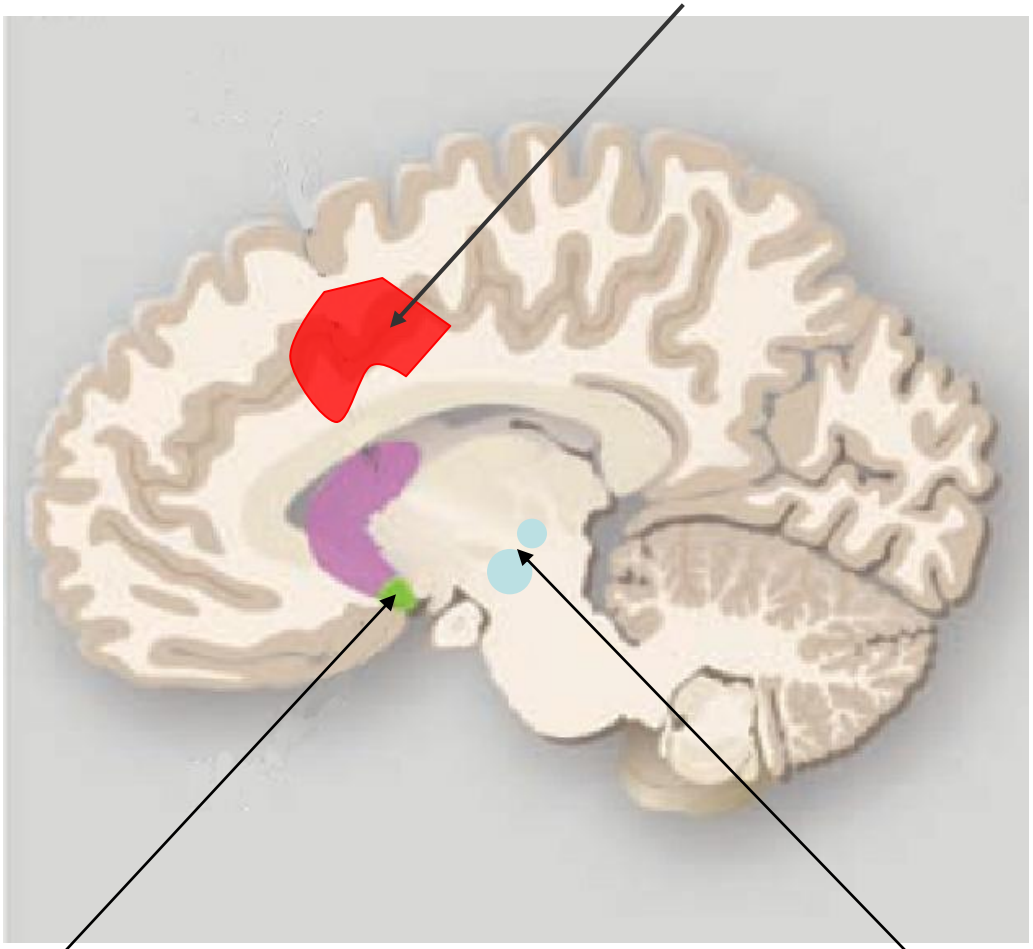
- Does social influence modulate our opinions using the same fundamental mechanisms and neural networks that underlie reinforcement learning?




SCIENCE VOL 306 15 OCTOBER 2004

K. Richard Ridderinkhof,[1,2]* Markus Ullsperger,[3] Eveline A. Crone,[4] Sander Nieuwenhuis[5]

Rostral cingulate zone (RCZ)



Nucleus accumbens (NA)

Ventral tegmental area
Substantia nigra

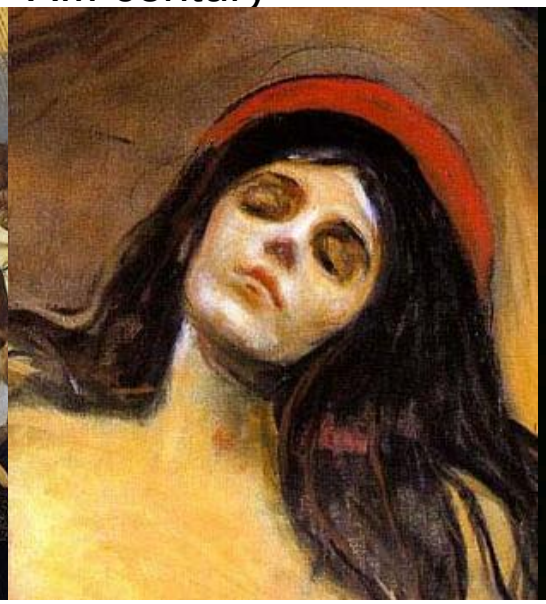
# Madonna evolution…

Roman catacombs
IV century

DUCCIO di Buoninsegna
XIII century

Jan van EYCK
XIII century

Sandro BOTTICELLI
XVI century

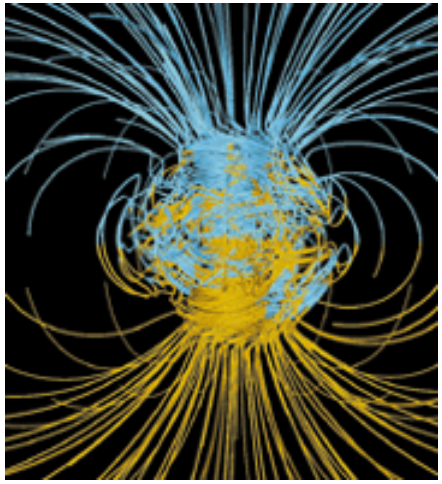


Edvard MUNCH
XIX century

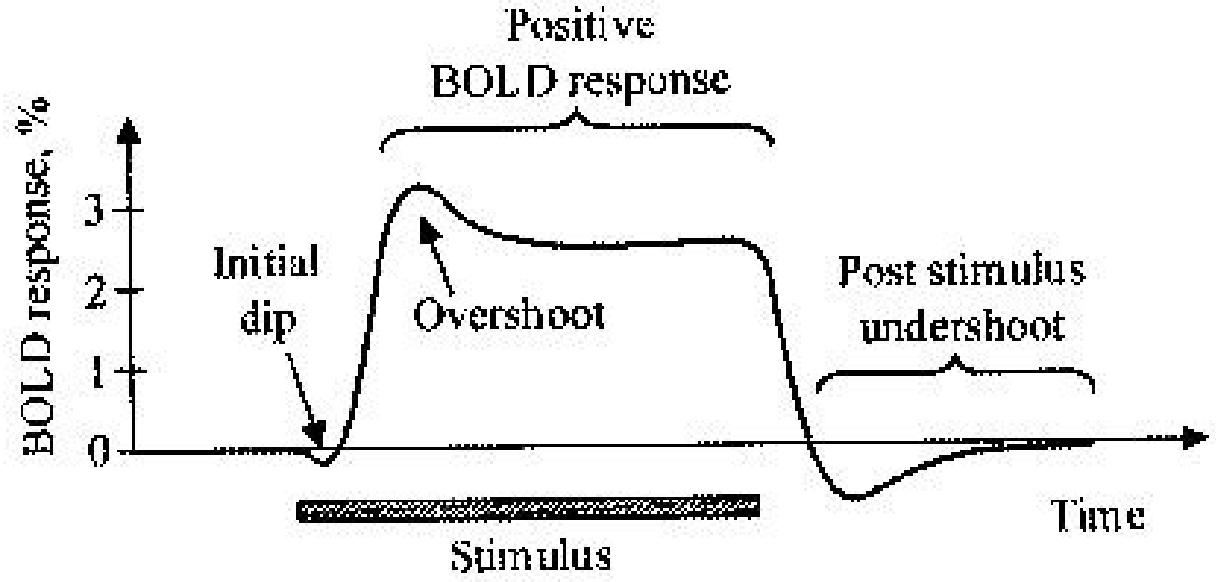
XX century

# fMRI

4 Tesla = 4 x 10,000 ÷ 0.5 = 80,000X Earth's magnetic field



# Hemodynamic Response Function




% signal change

= (point – baseline)/baseline
usually 0.5-3%

initial dip

-more focal and potentially a better measure
-somewhat elusive so far, not everyone can find it

time to rise

signal begins to rise soon after stimulus begins

time to peak

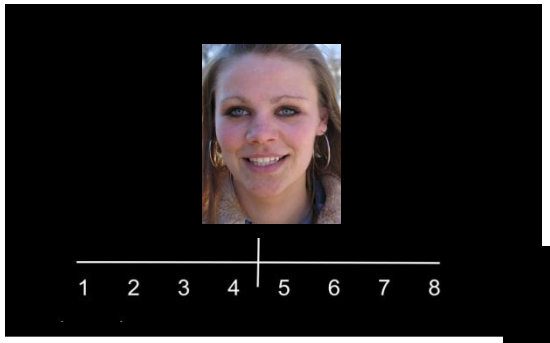
signal peaks 4-6 sec after stimulus begins

post stimulus undershoot

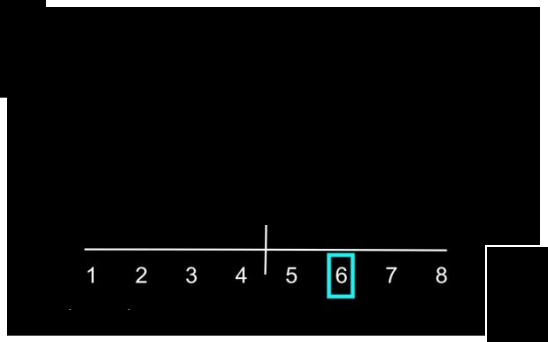
signal suppressed after stimulation ends

# fMRI session

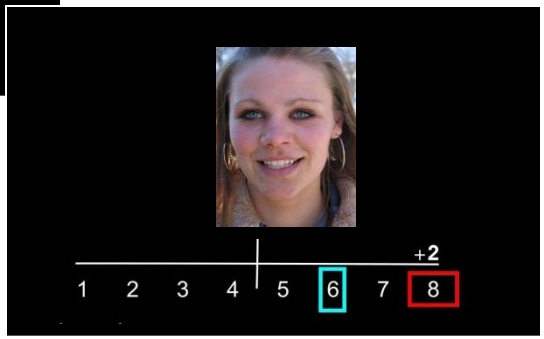
*Face (**S1**)*
*2 sec*




*Attractiveness rating*

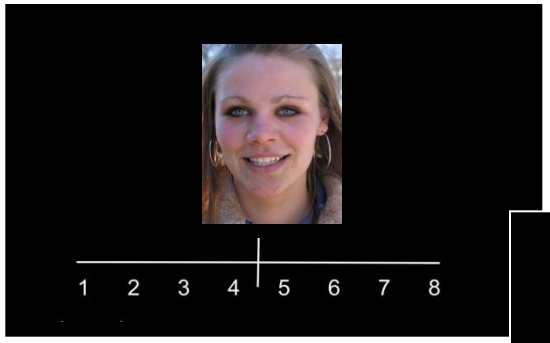



*Normative rating + Face (S2)*
*2 sec*

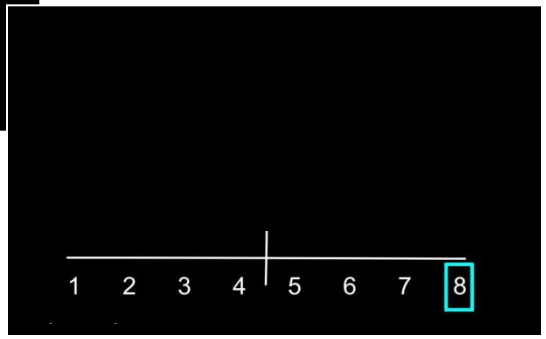


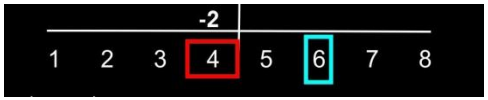

***conflict***

*Face (**S1**)*
*2 sec*




*Response*



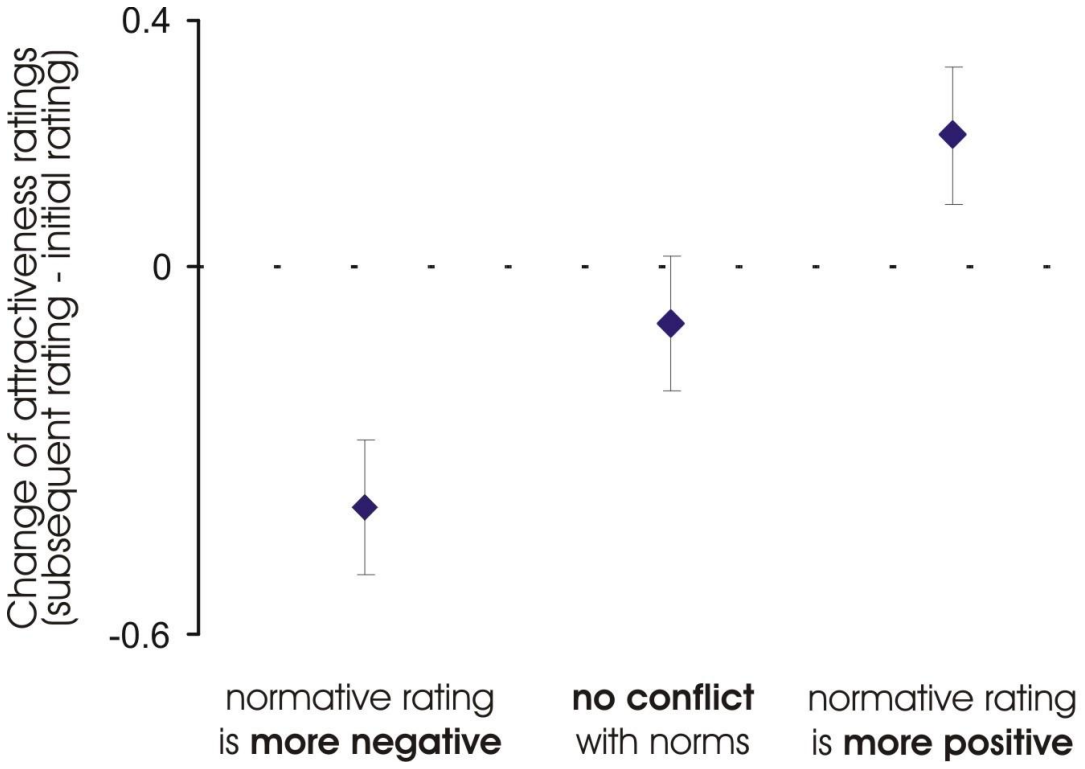

***conflict***

OR

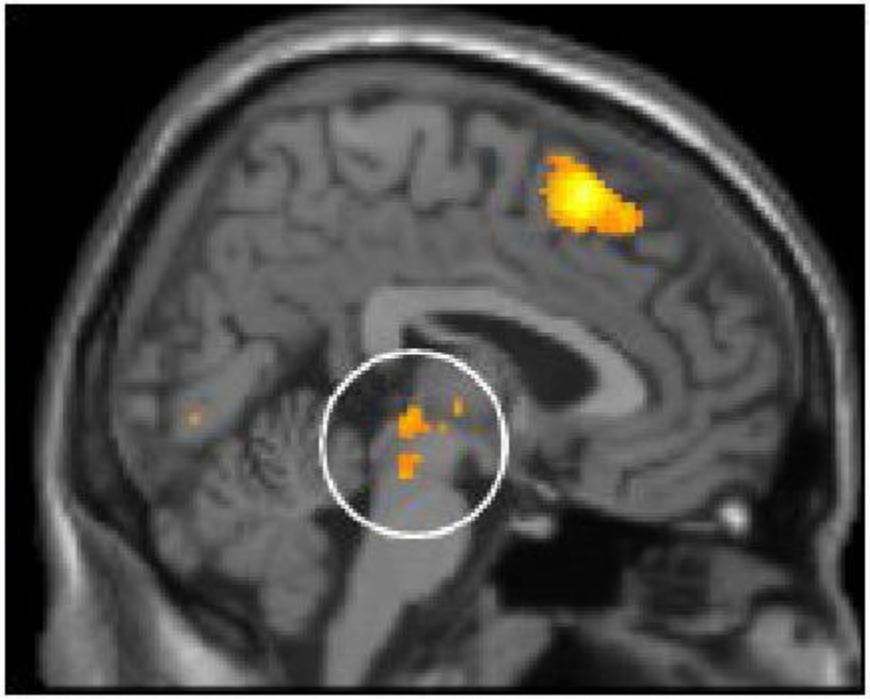
***no conflict***

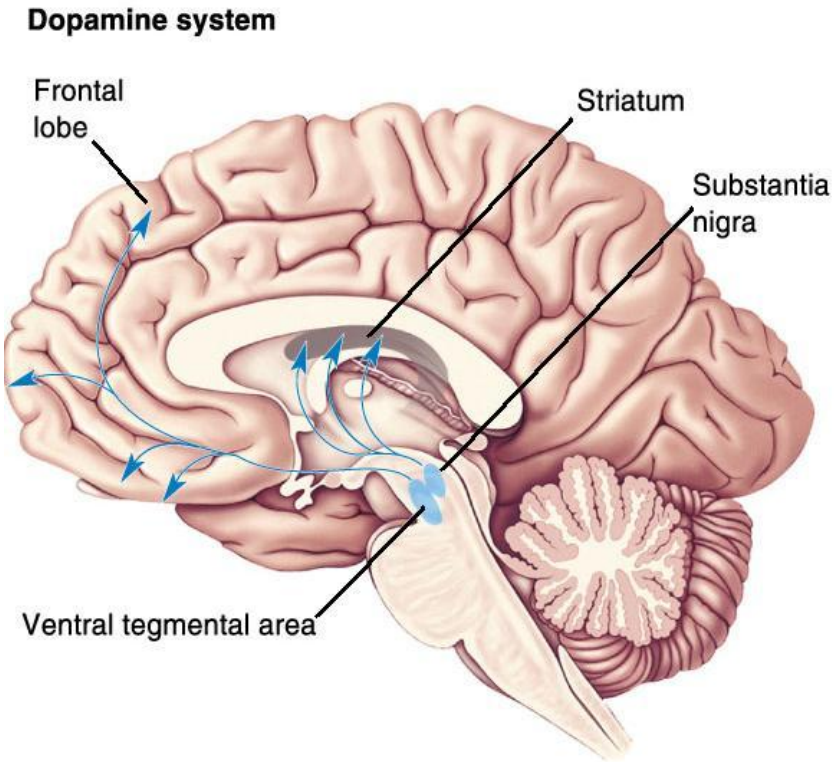
# Behavioural session

# Behavioral Effects: changes of attractiveness ratings induced by normative (group) ratings.



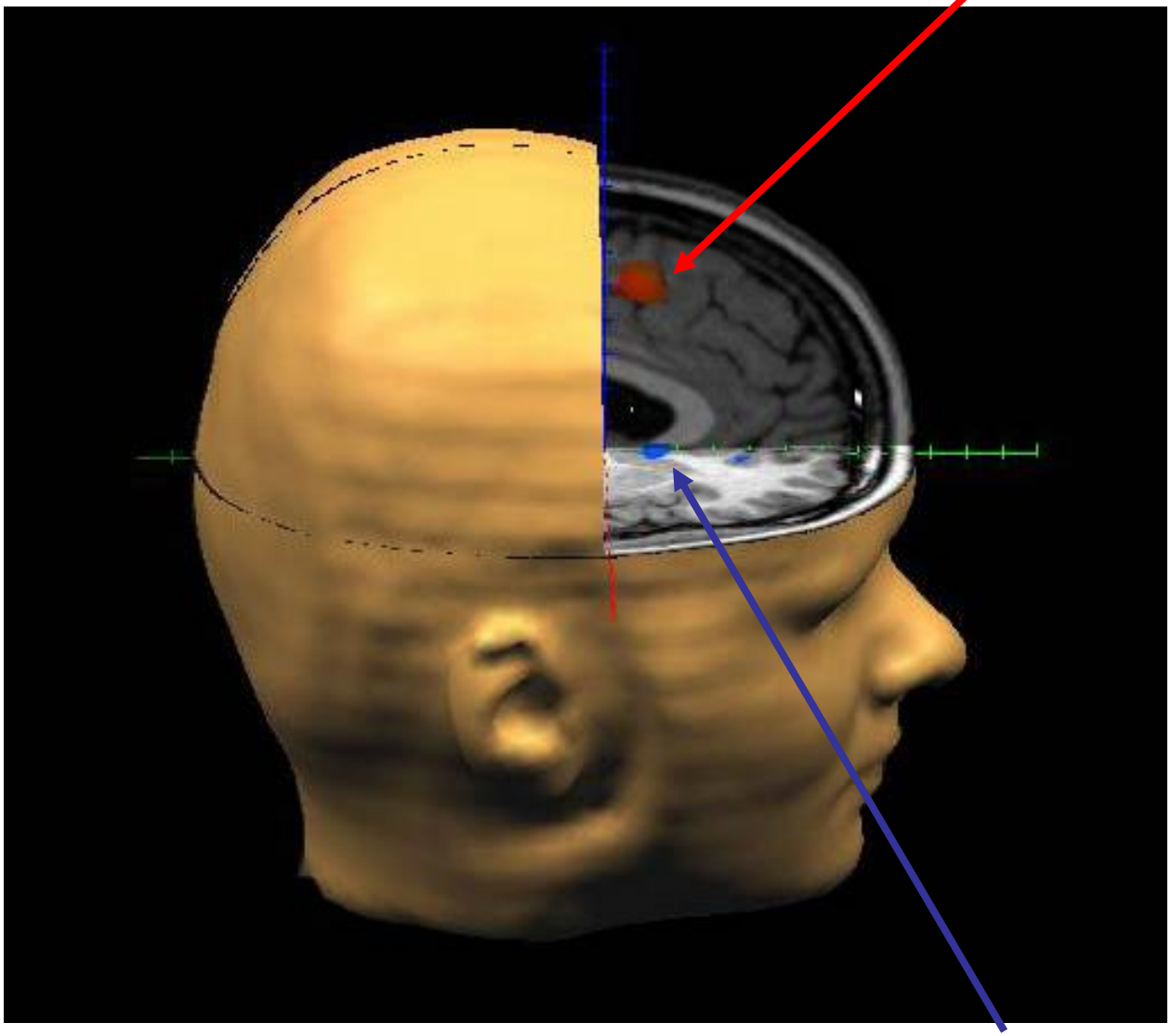
# Social Conflict






Klucharev et.al. 2009

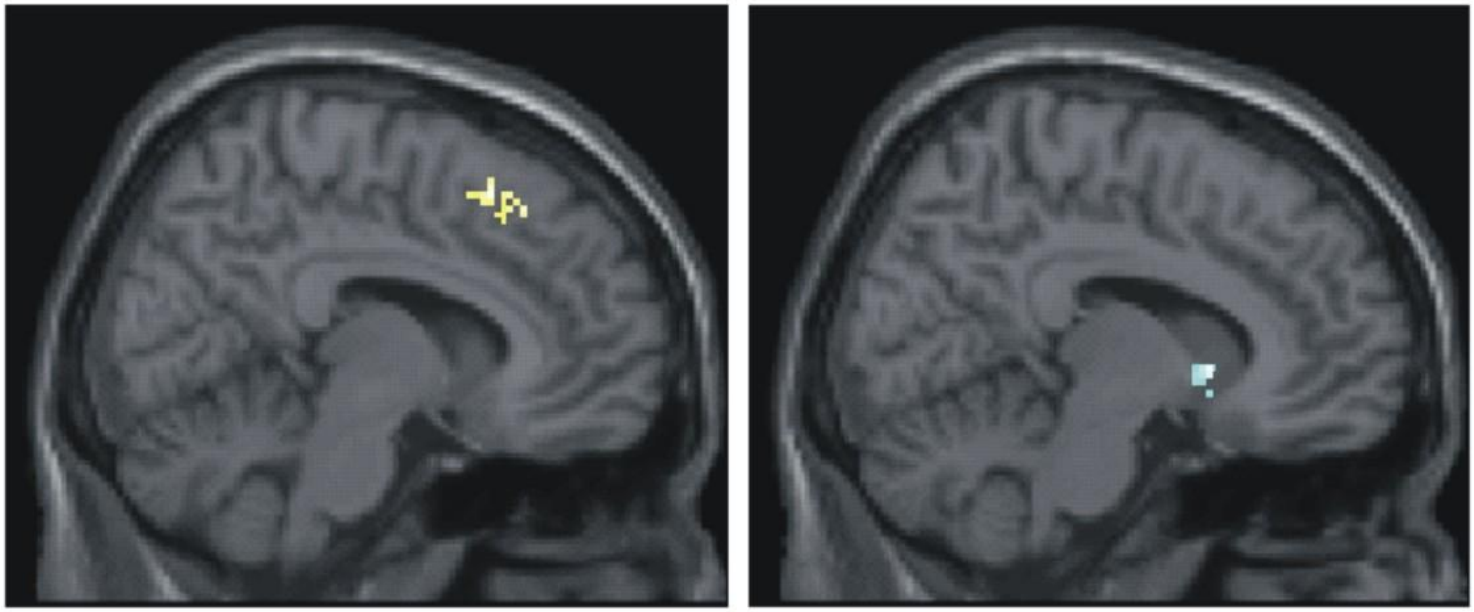
Activation of the Rostral Cingulate Zone



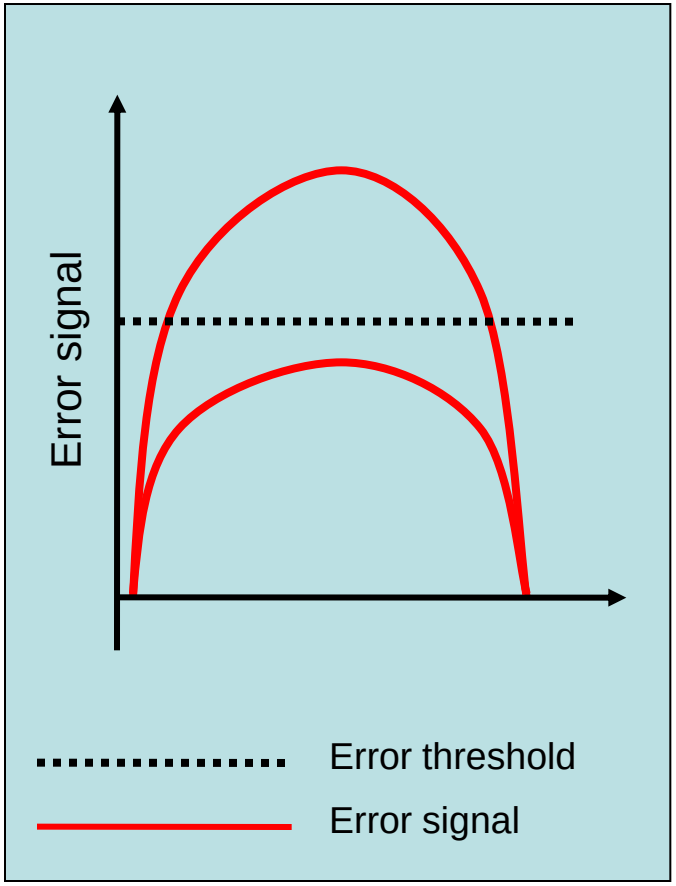
# Social Conflict with Group Norms

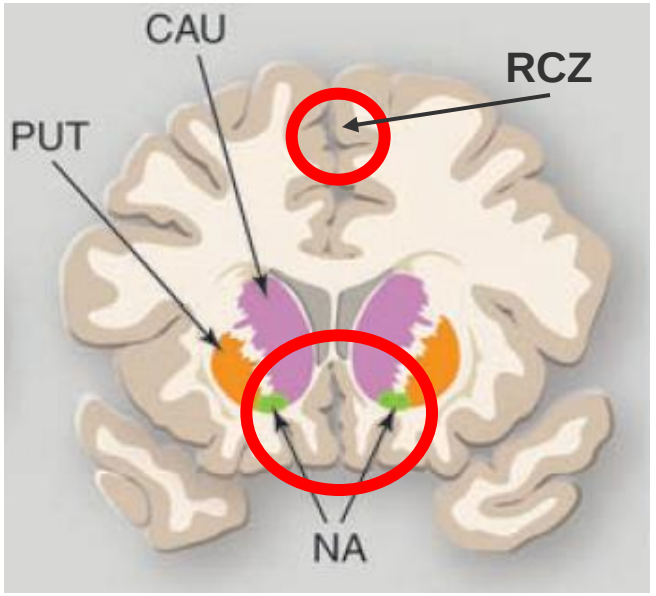
Deactivation of Nucleus Accumbens

# Conjunction of *conflict* & *conformity*



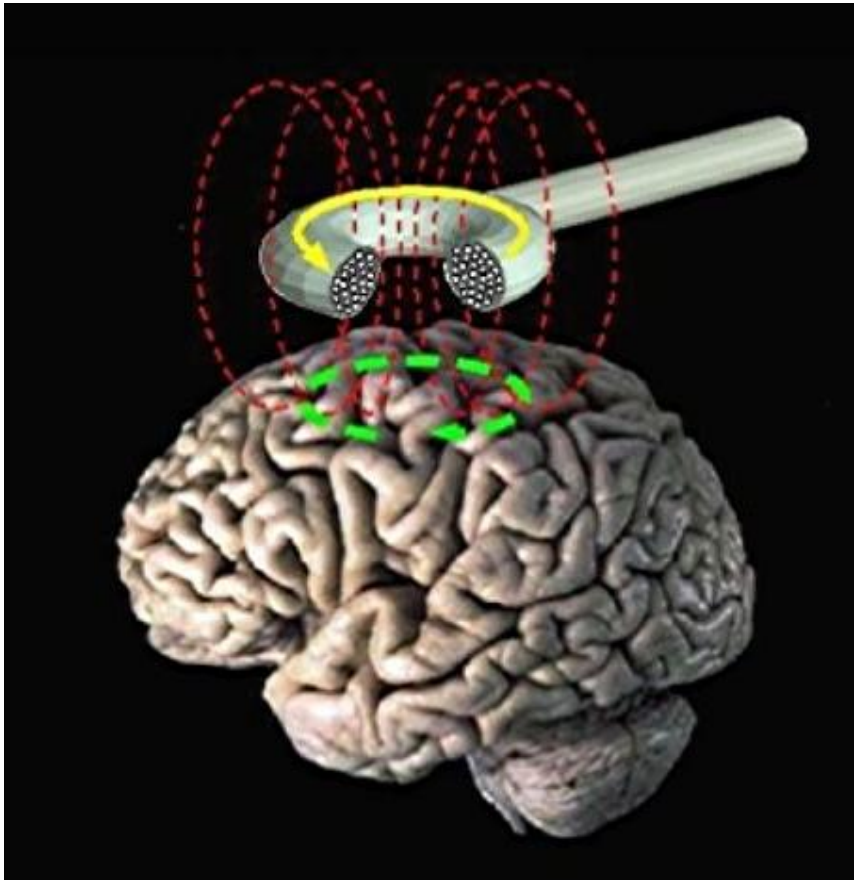
Klucharev et.al. 2009


Error signal
Error threshold
Error signal


CAU
RCZ
PUT
NA

# TMS – Transcranial Magnetic

**TMS** - rapidly changing magnetic fields (electromagnetic induction) induce weak electric currents in the brain, i.e. affect neurons.



# Navigated TMS. nTMS

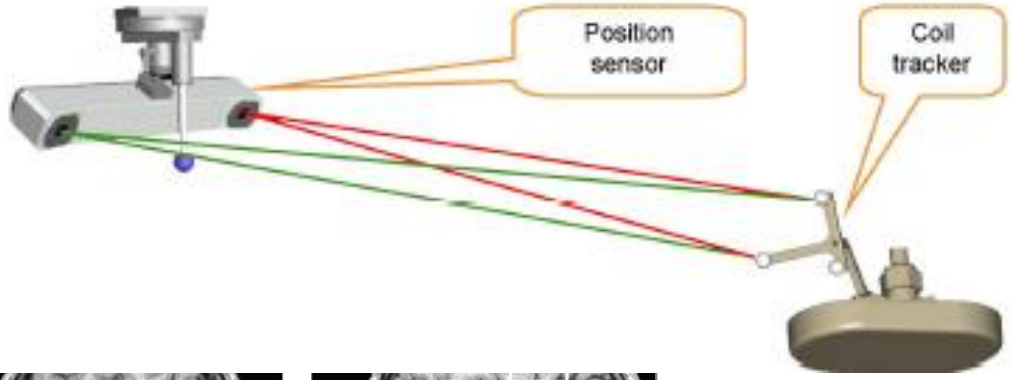
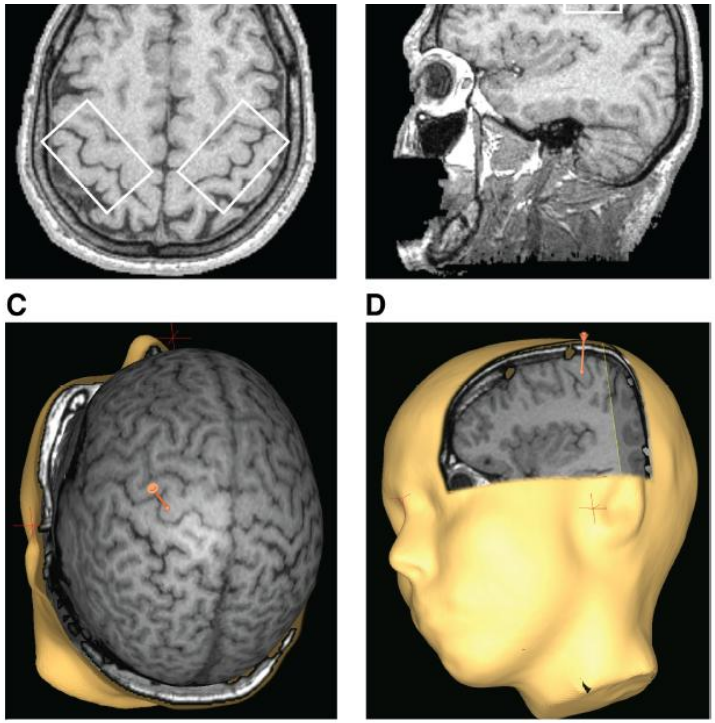
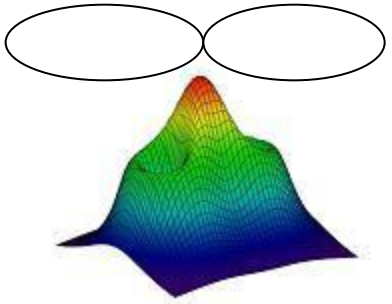



Figure-of-eight-coil

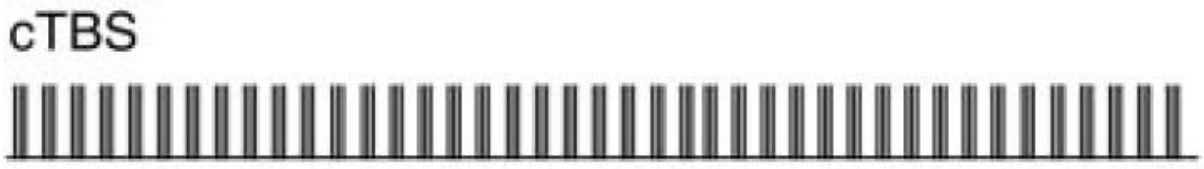


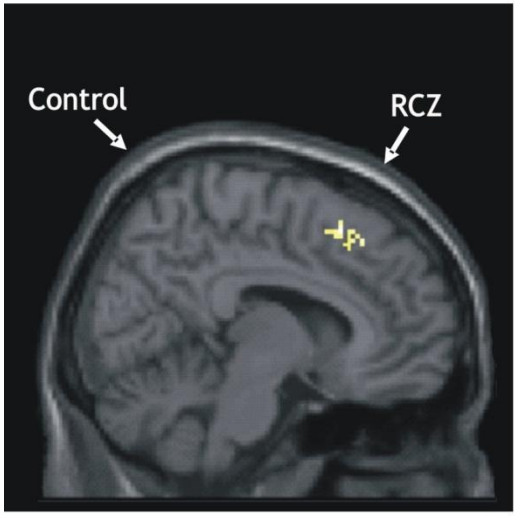

Induced E



# Design/Materials/Procedure/Subjects

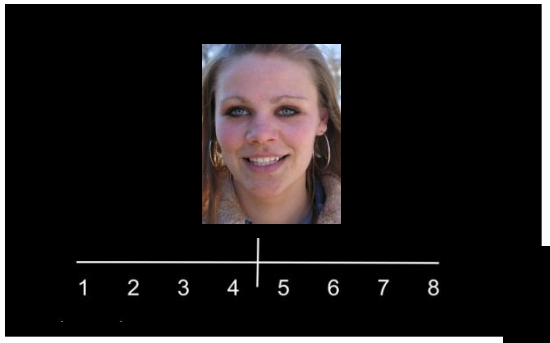
- **Continuous theta burst stimulation paradigm (cTBS, Huang et al., 2005) - a 40 s train of uninterrupted TBS (600 pulses).**



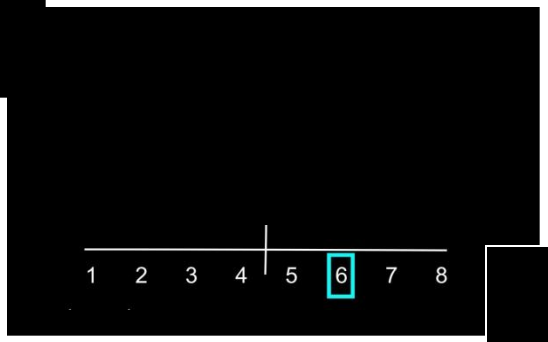



# Experimental task

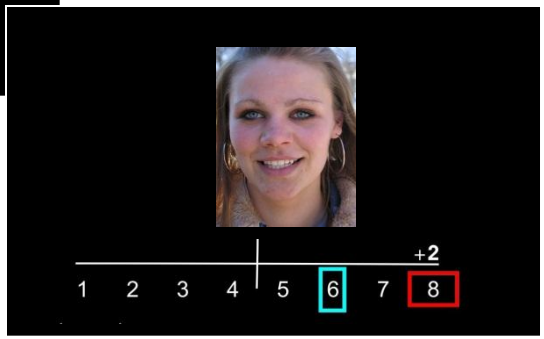
*Face (**S1**)*
*2 sec*




*Attractiveness rating*

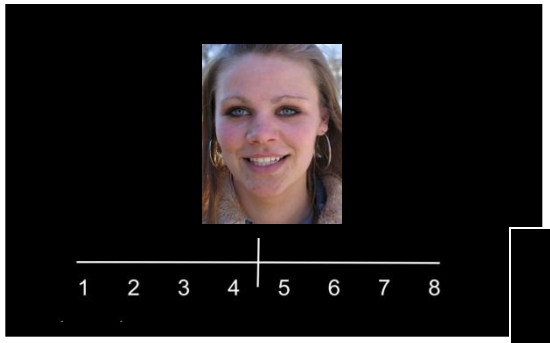



*Normative rating + Face (S2)*
*2 sec*

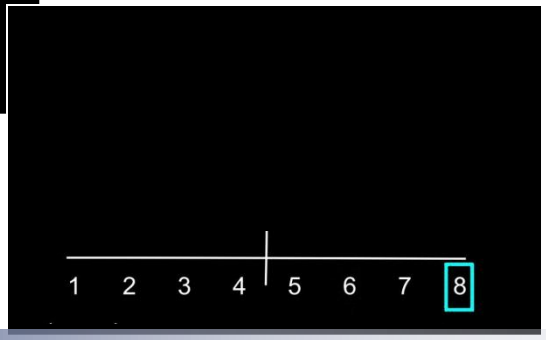


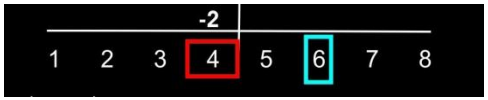

***conflict***

*Face (**S1**)*
*2 sec*

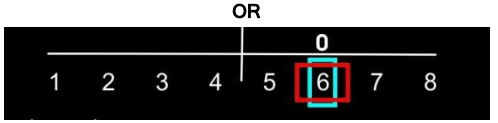



*Response*



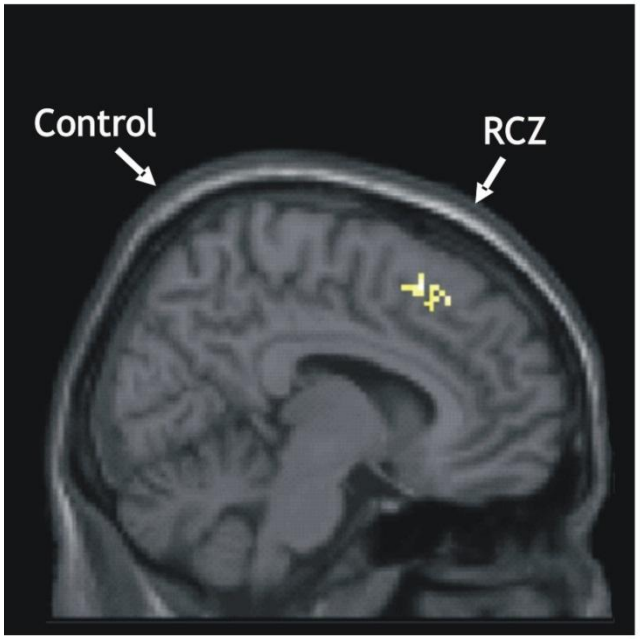



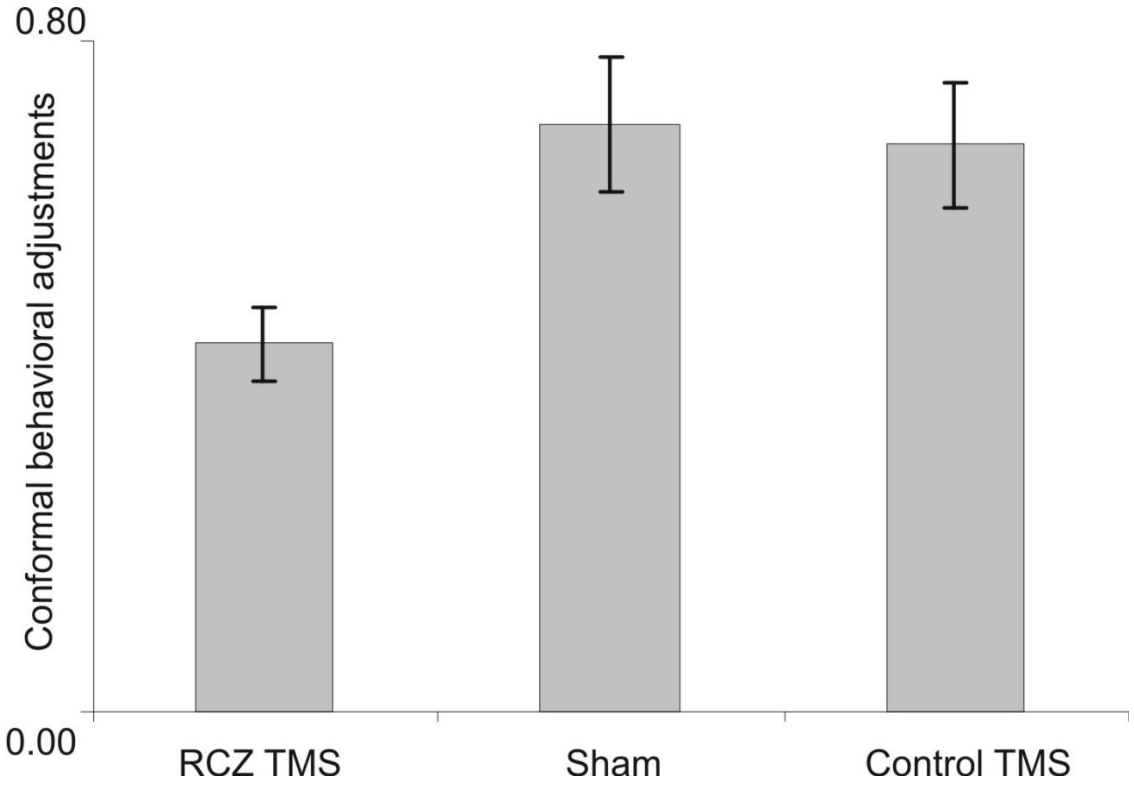

***conflict***




***no conflict***

# Behavioural session


Control
RCZ


0.80
Conformal behavioral adjustments
0.00
RCZ TMS
Sham
Control TMS

ГЕН
ВСЕ
ВЛАСТИЯ

# Results:

- Down-regulation of the RCZ suppresses subjects' conformal behavior.
- Overall, results show that social conformity complies with the principles of the reinforcement learning.

# Conclusions

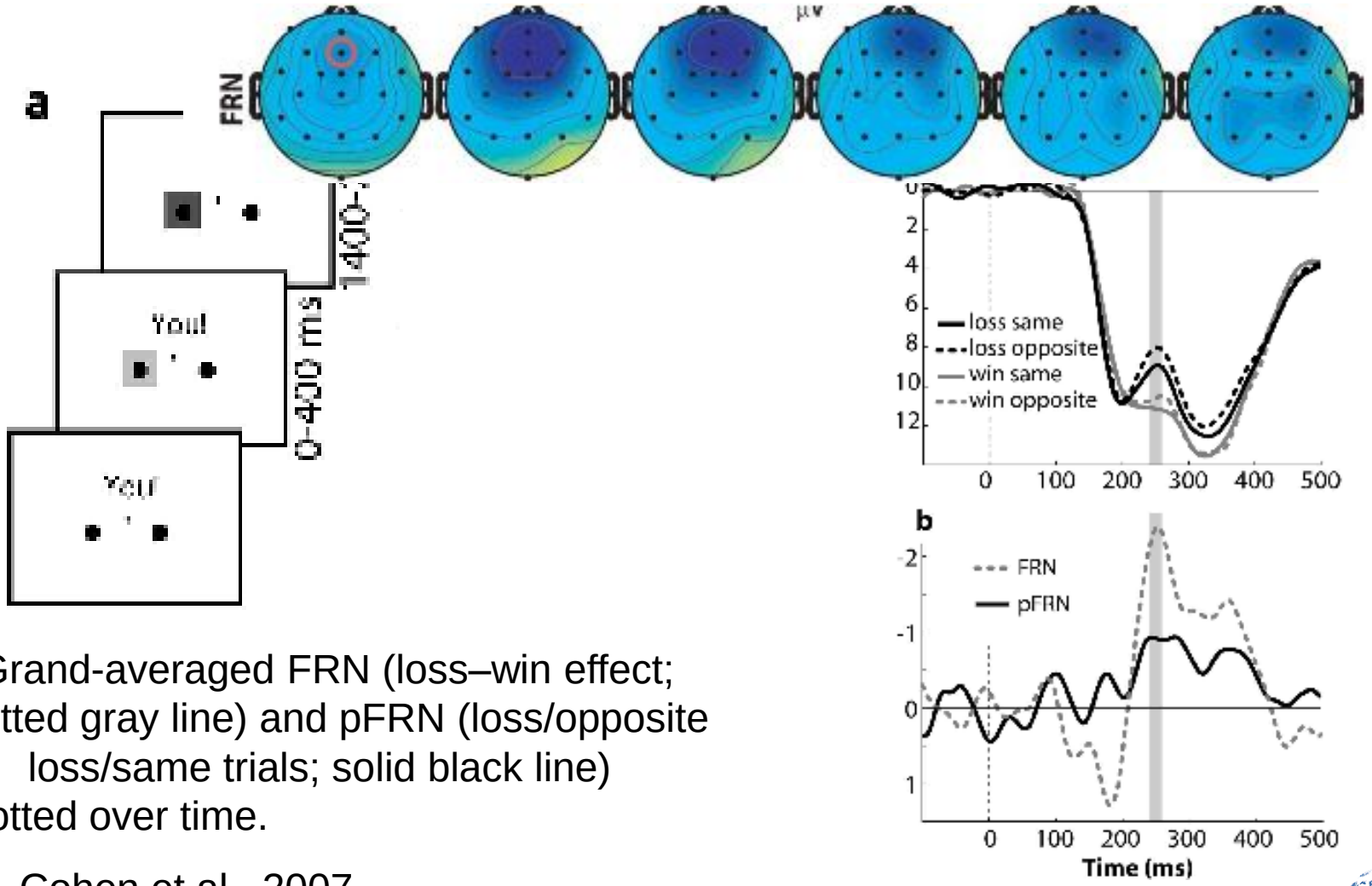
- ✓ The RCZ is an important target of social influence.
- ✓ TMS of the medial prefrontal cortex reduces social influence on our judgments.
- ✓ Our results support the hypothesis that social influence (including peer group influence, advice taking, cognitive dissonance, etc.) is underlined by the general reinforcement learning mechanism.

# Neural correlates of social conformity

- EEG precursors of social conformity

FP1-F3
FP2-F4
F3-C3
F4-C4
C3-P3
C4-P4
P3-O1
P4-O2
FP1-F7
FP2-F8
F7-T3
F8-T4
T3-T5
T4-T6
T5-O1
T6-O2

# FRN

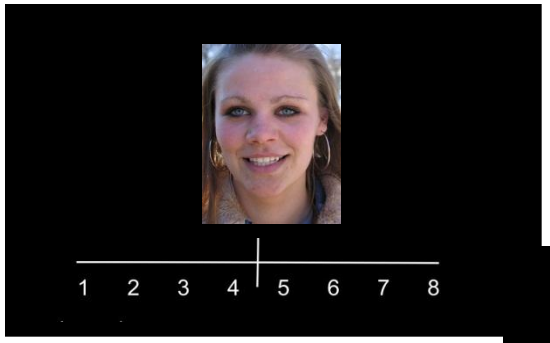



, Grand-averaged FRN (loss–win effect; dotted gray line) and pFRN (loss/opposite  loss/same trials; solid black line) plotted over time.

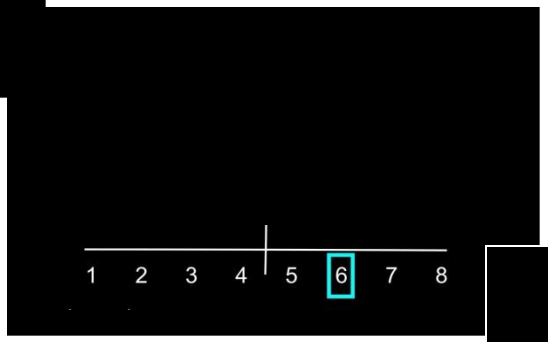
Cohen et al., 2007

# Experimental task

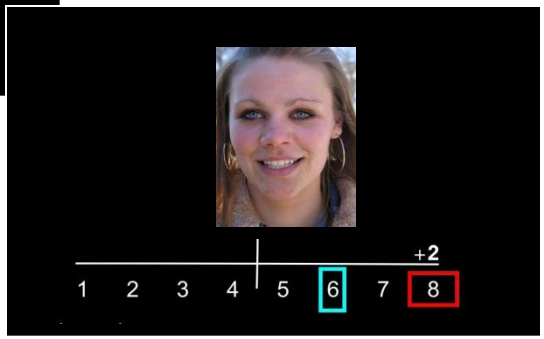
*Face (**S1**)*
*2 sec*




*Attractiveness rating*

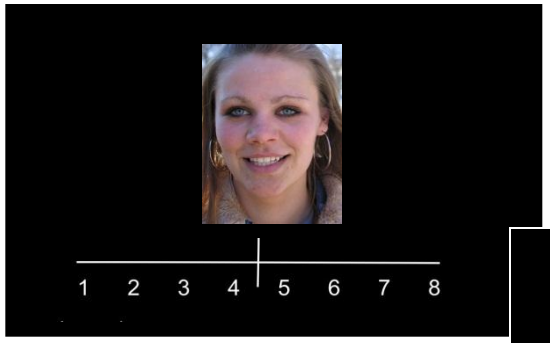



*Normative rating + Face (S2)*
*2 sec*

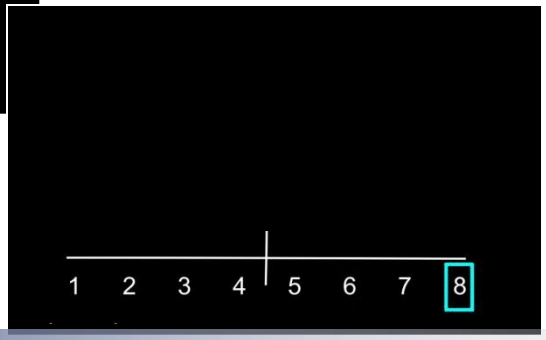


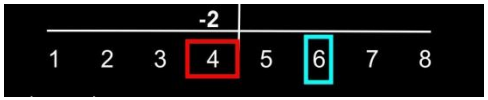

***conflict***

*Face (**S1**)*
*2 sec*




*Response*



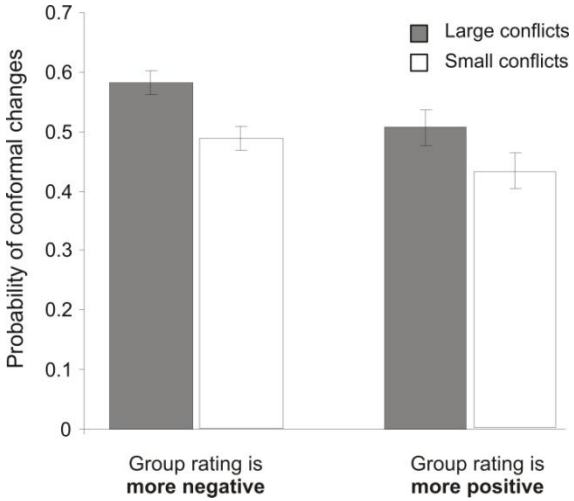

***conflict***

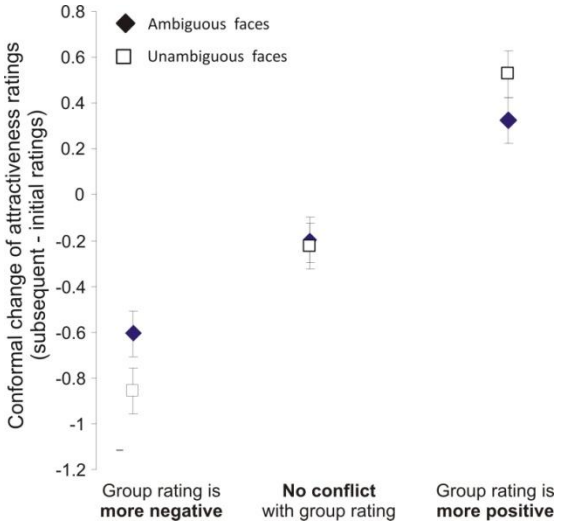
OR

***no conflict***

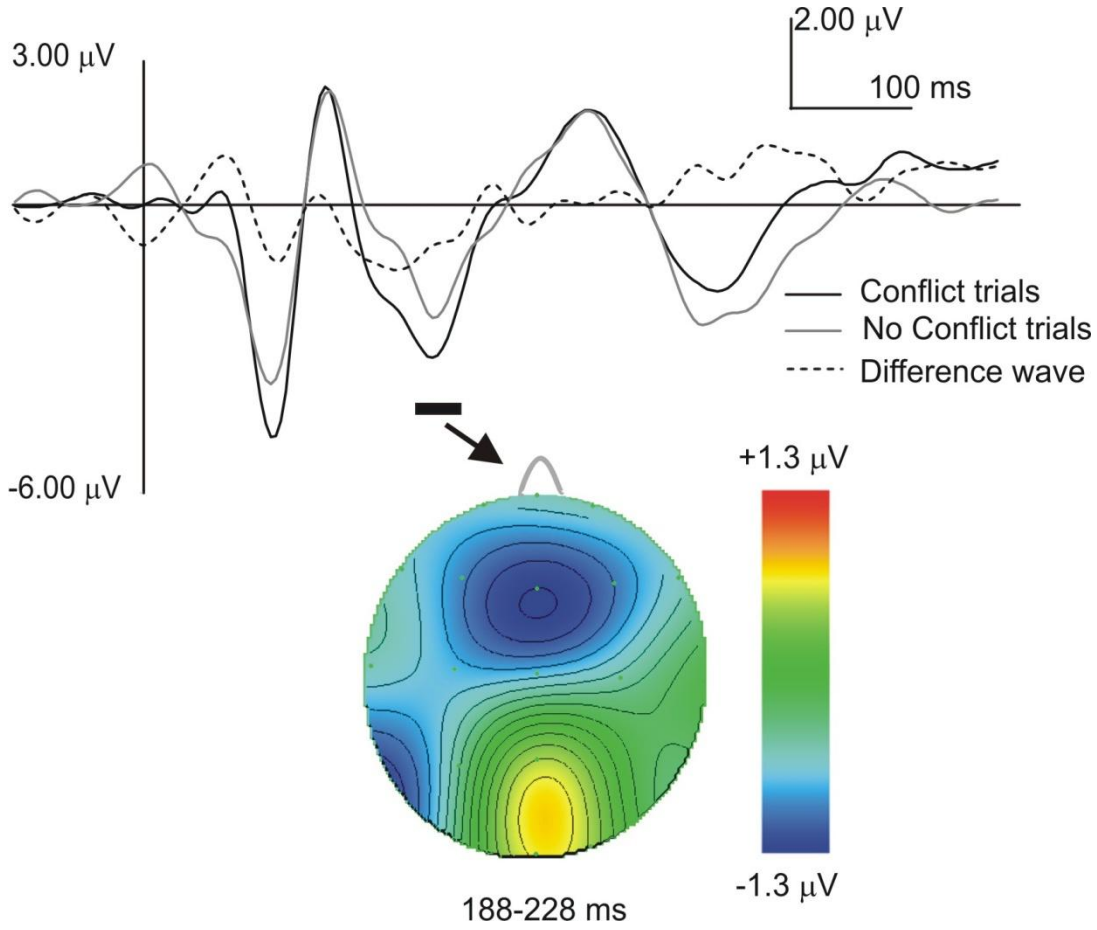
# Behavioural session

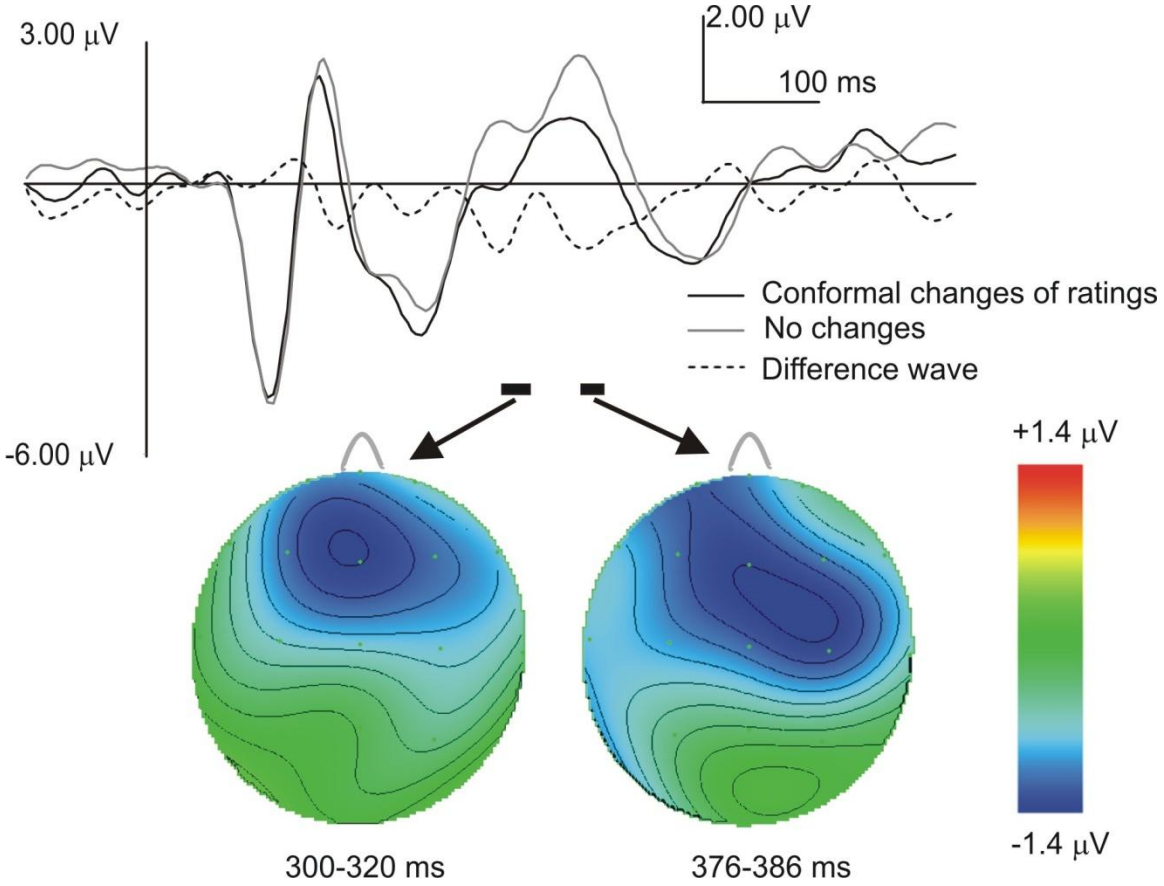
# Electrophysiological precursors of social conformity

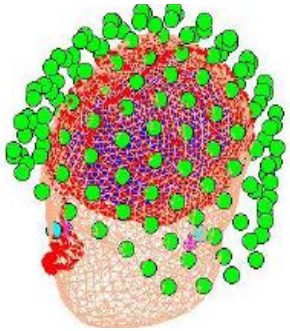



Anna Shestakova, Jörg Rieskamp, Sergey Tugin and Vasily Klucharev


3.00 μV
-6.00 μV
2.00 μV
100 ms
Conflict trials
No Conflict trials
Difference wave
+1.3 μV
-1.3 μV
188-228 ms


3.00 μV
2.00 μV
100 ms
-6.00 μV
Conformal changes of ratings
No changes
Difference wave
+1.4 μV
-1.4 μV
300-320 ms
376-386 ms



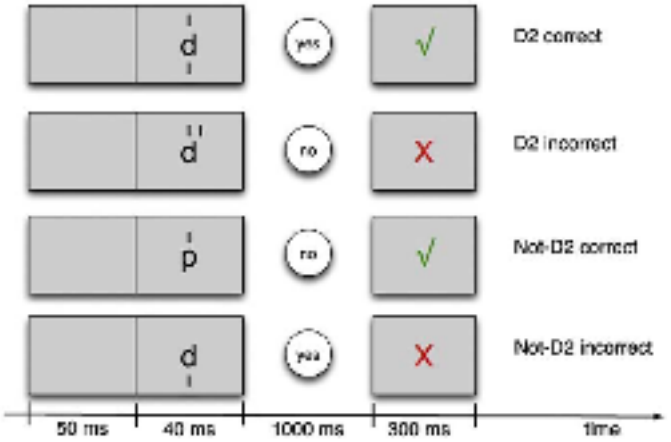
# **306-channel Vectorview system** –an example of Magnetoencephalographic system

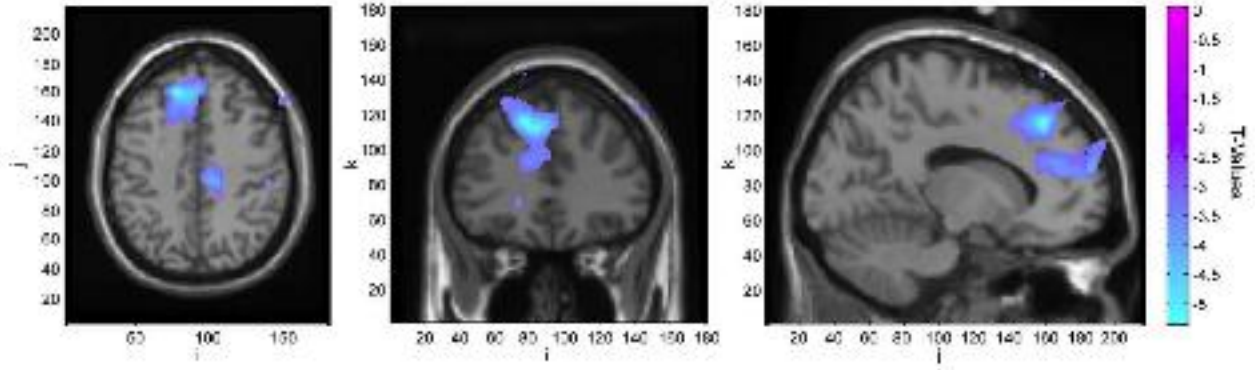
BioMag Laboratory Университет Хельсинки, Хельсинки 1994

MRC-CBU, Cambrdige, 2008

NB! Московский Городской Психолого-Педагогический Университет, Москва 2010

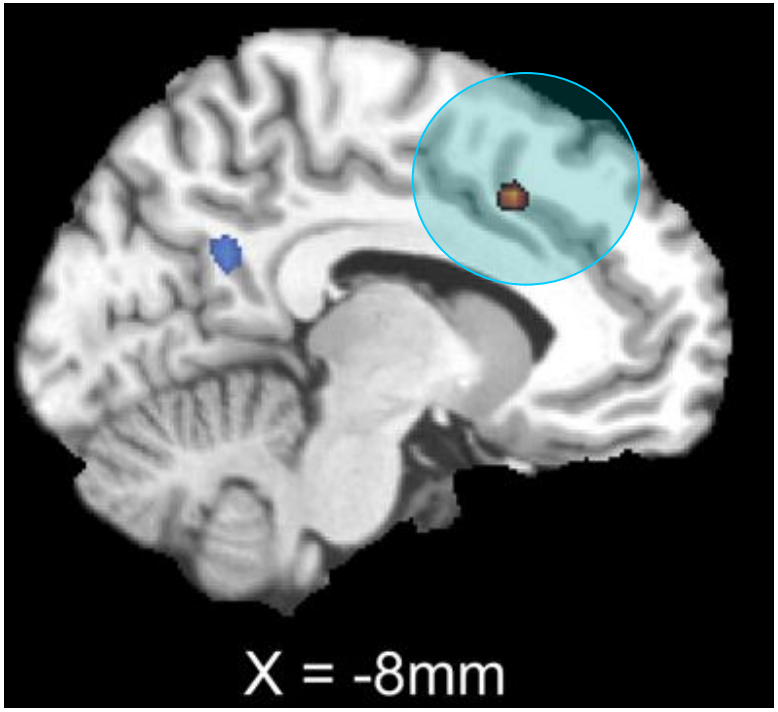
# Localization of the magnetic equivalent of the ERN and induced oscillatory brain activity

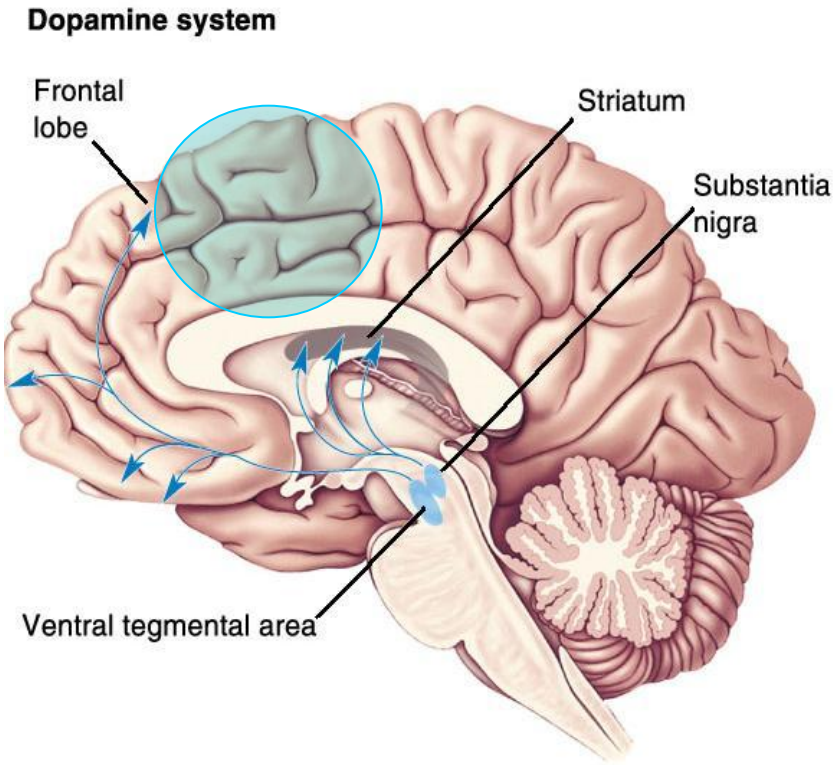


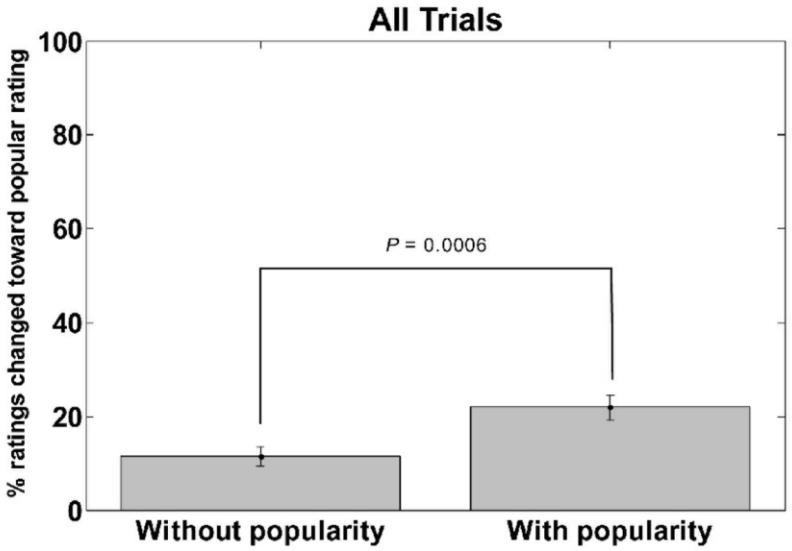
Julian Keil et al 2010

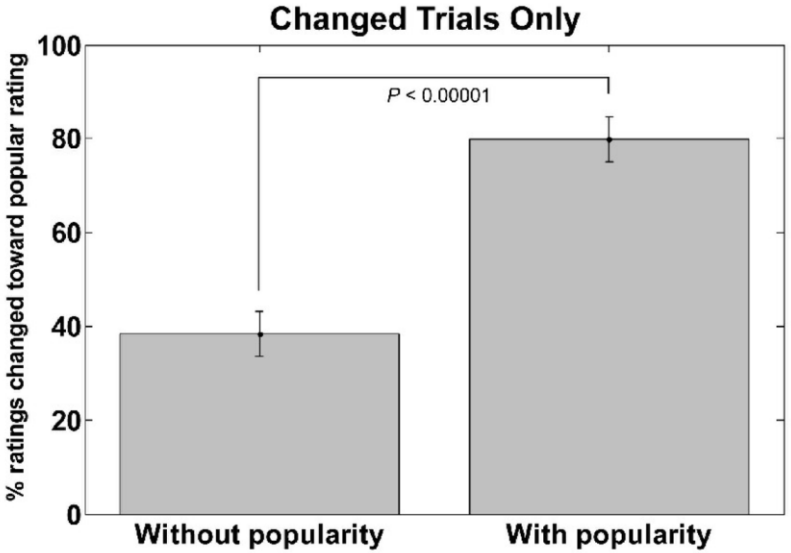
# Individual sensitivity to popularity X effect of popularity information

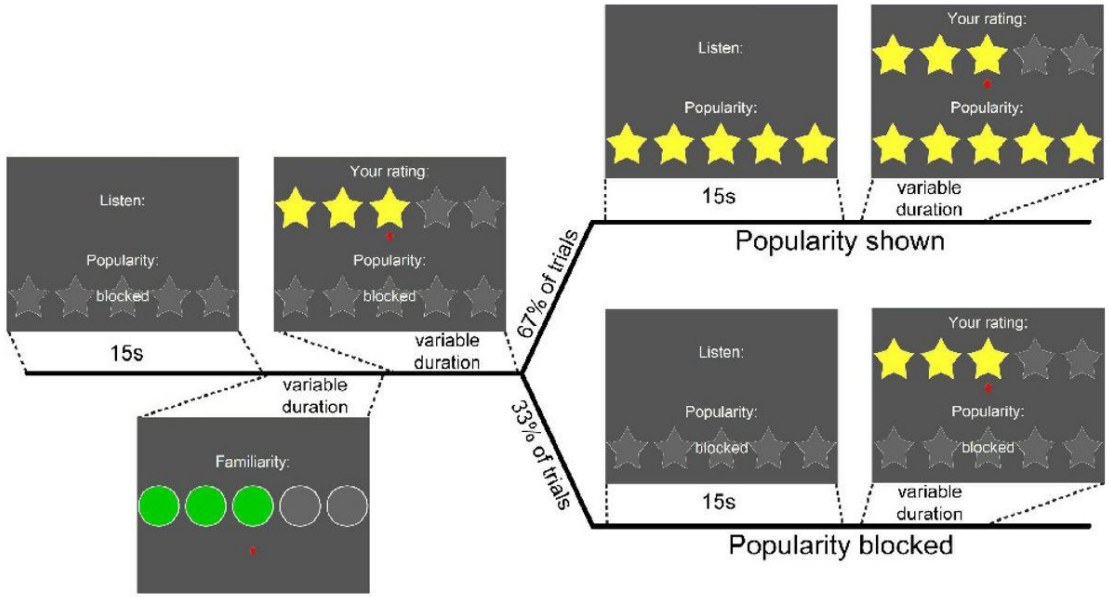



G.S. Berns et al. *NeuroImage* (2010)c



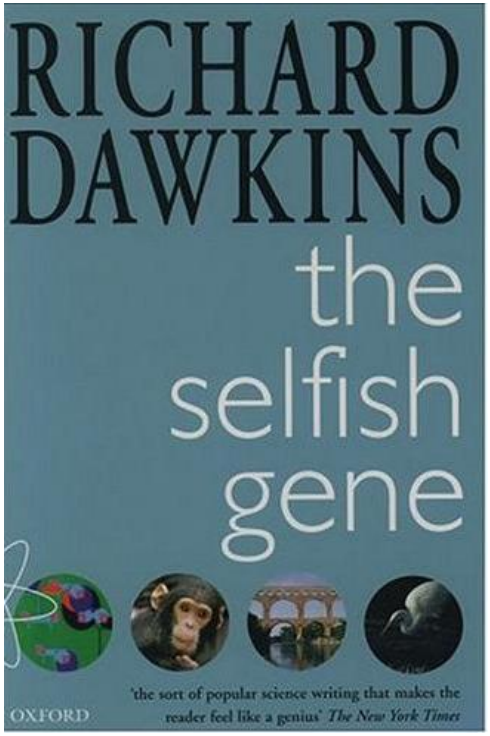




G.S. Berns et al. *NeuroImage* (2010)c

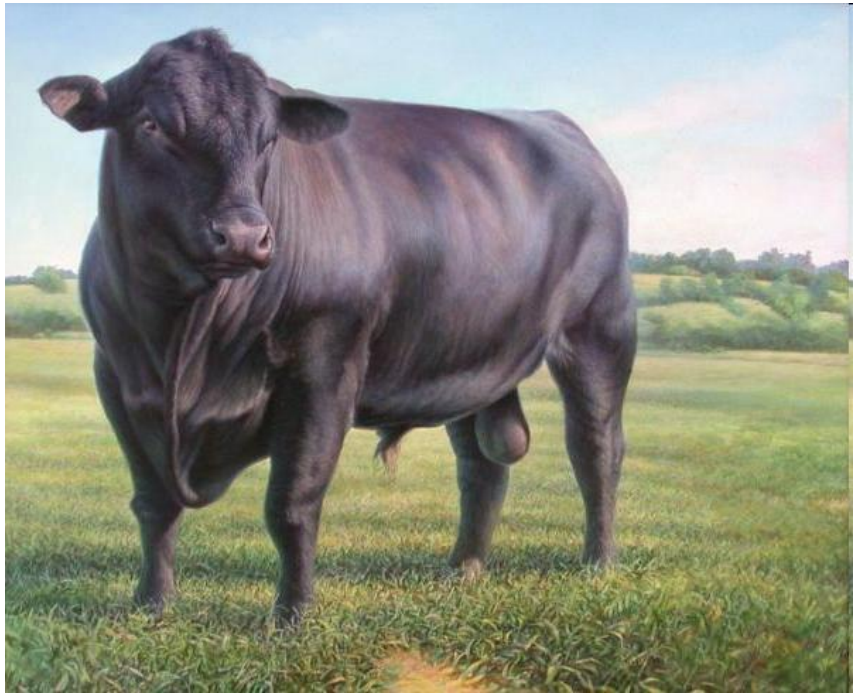
# **Social conformity**:
# why is it so difficult to be different?

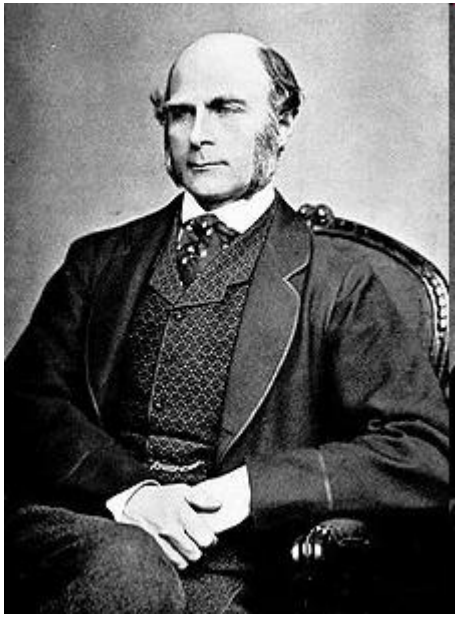
# Why? RICHARD DAWKINS: The Selfish Gene.

- An **evolutionarily stable strategy** – a strategy which, if most members of a population adopt it, cannot be bettered by an alternative strategy.
- “best strategy for an individual depends on what the majority of the population are doing.”
- Since each individual is trying to maximize his own success, the only strategy that persists will be one which, once evolved cannot be bettered by any deviant individual.
- … selection will penalize deviation from it.



# Wisdom of the crowd





**Francis Galton**
1822 –1911

*Distribution of the estimates of the dressed weight of a particular living ox, made by 787 different persons.*

| Degrees of the length of Array 0°—100° | Estimates in lbs. | Centiles: Observed deviates from 1207 lbs. | Centiles: Normal p.e =37 | Excess of Observed over Normal |
|---|---|---|---|---|
| 5 | 1074 | −133 | −90 | +43 |
| 10 | 1109 | − 98 | −70 | +28 |
| 15 | 1126 | − 81 | −57 | +24 |
| 20 | 1148 | − 59 | −46 | +13 |
| $q_1$ 25 | 1162 | − 45 | −37 | + 8 |
| 30 | 1174 | − 33 | −29 | + 4 |
| 35 | 1181 | − 26 | −21 | + 5 |
| 40 | 1188 | − 19 | −14 | + 5 |
| 45 | 1197 | − 10 | − 7 | + 3 |
| $m$ 50 | 1207 | 0 | 0 | 0 |
| 55 | 1214 | + 7 | + 7 | 0 |
| 60 | 1219 | + 12 | +14 | − 2 |
| 65 | 1225 | + 18 | +21 | − 3 |
| 70 | 1230 | + 23 | +29 | − 6 |
| $q_3$ 75 | 1236 | + 29 | +37 | − 8 |
| 80 | 1243 | + 36 | +46 | −10 |
| 85 | 1254 | + 47 | +57 | −10 |
| 90 | 1267 | + 52 | +70 | −18 |
| 95 | 1293 | + 86 | +90 | − 4 |

$q_1$, $q_3$, the first and third quartiles, stand at 25° and 75° respectively.
$m$, the median or middlemost value, stands at 50°.
The dressed weight proved to be 1198 lbs.

Real weight 1198 lb

Thank you very
much for your attention!