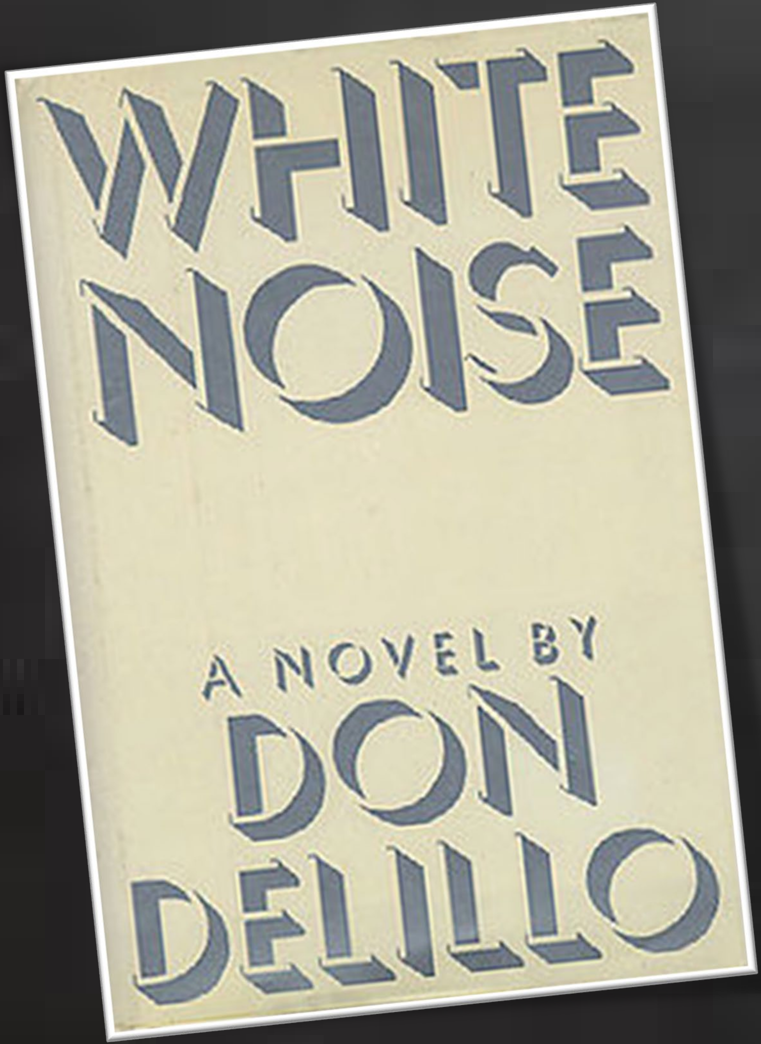
3

Influencing decisions



Who knows what I want to do? Who knows what anyone wants to do? How can you be sure about something like that? Isn't it all a question of brain chemistry, signals going back and forth, electrical energy in the cortex? How do you know whether something is really what you want to do or just some kind of nerve impulse in the brain. Some minor little activity takes place somewhere in this unimportant place in one of the brain hemispheres and suddenly I want to go to Montana or I don't want to go to Montana.

(*White Noise*, Don DeLillo)

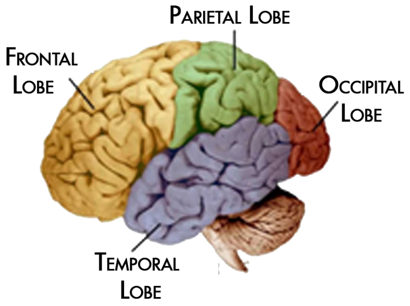
nature neuroscience

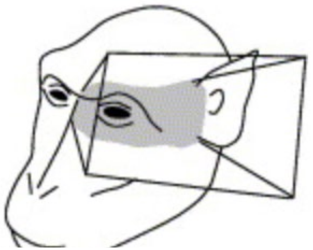
Microstimulation of macaque area LIP affects decision-making in a motion discrimination task

Timothy D Hanks[1], Jochen Ditterich[1,2] & Michael N Shadlen[1]

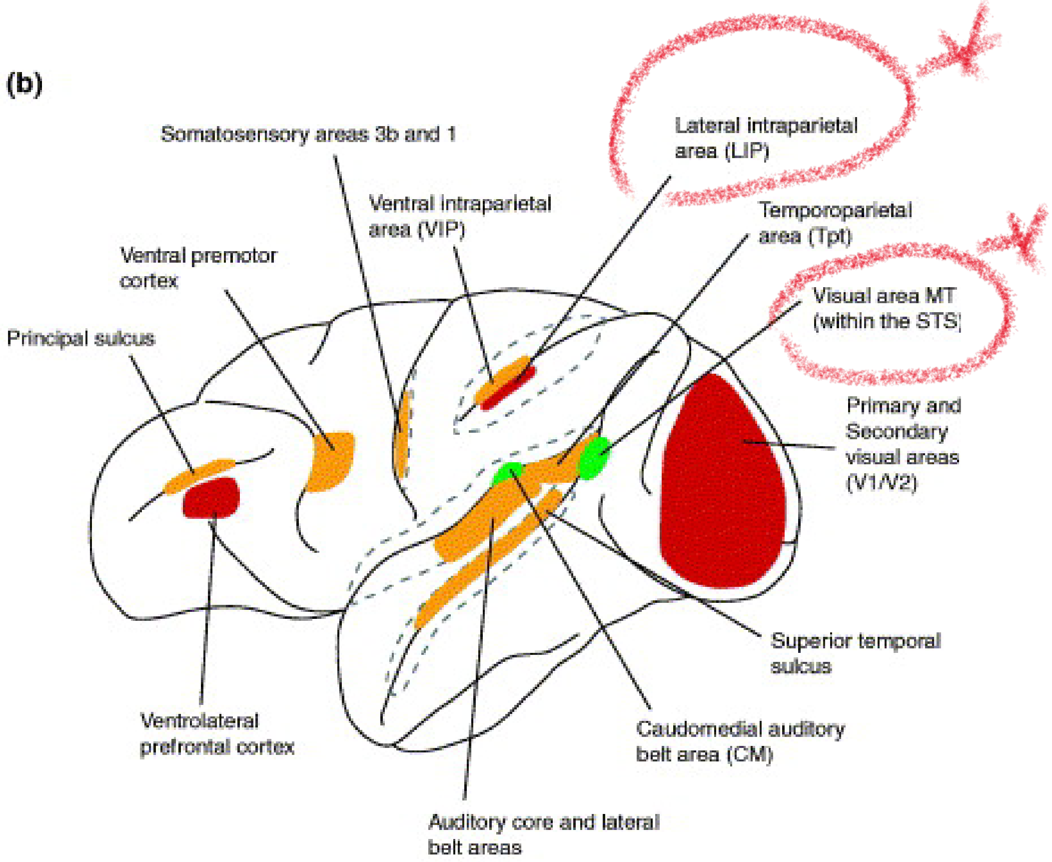
A central goal of cognitive neuroscience is to elucidate the neural mechanisms underlying decision-making. Recent physiological studies suggest that neurons in association areas may be involved in this process. To test this, we measured the effects of electrical microstimulation in the lateral intraparietal area (LIP) while monkeys performed a reaction-time motion discrimination task with a saccadic response. In each experiment, we identified a cluster of LIP cells with overlapping response fields (RFs) and sustained activity during memory-guided saccades. Microstimulation of this cluster caused an increase in the proportion of choices toward the RF of the stimulated neurons. Choices toward the stimulated RF were faster with microstimulation, while choices in the opposite direction were slower. Microstimulation never directly evoked saccades, nor did it change reaction times in a simple saccade task. These results demonstrate that the discharge of LIP neurons is causally related to decision formation in the discrimination task.

Hanks, T. et al (2006) Nature Neurosci. Vol 9 (5) 682-689



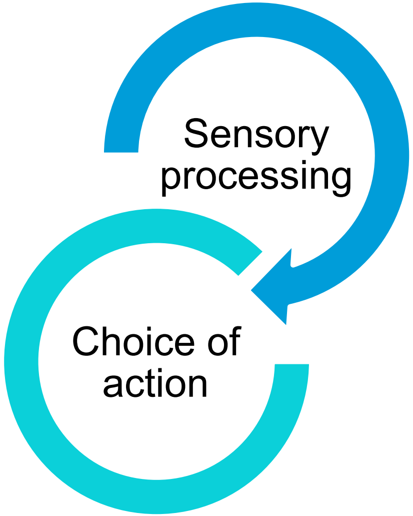


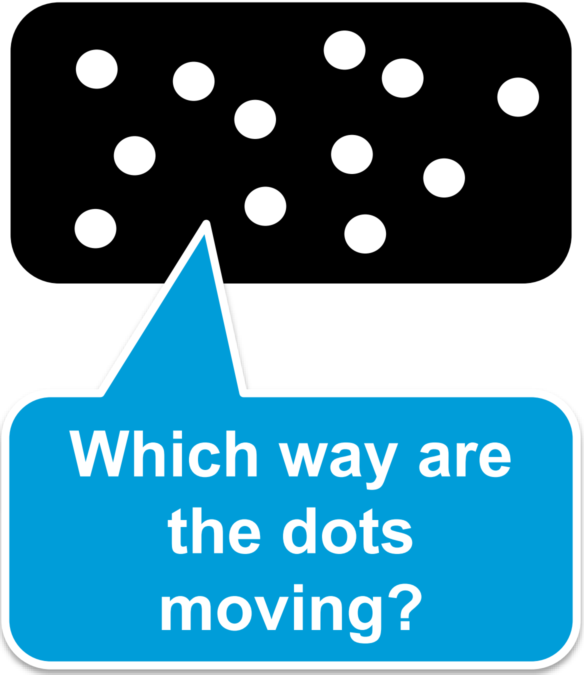
Key:
- Auditory, visual and somatosensory
- Auditory and visual
- Auditory and somatosensory



Ghaznfar and Schroeder (2006), *TICS*, Volume 10, Issue 6, p278–285

Neurobiology of decision-making





Brain must represent motion information (MT)

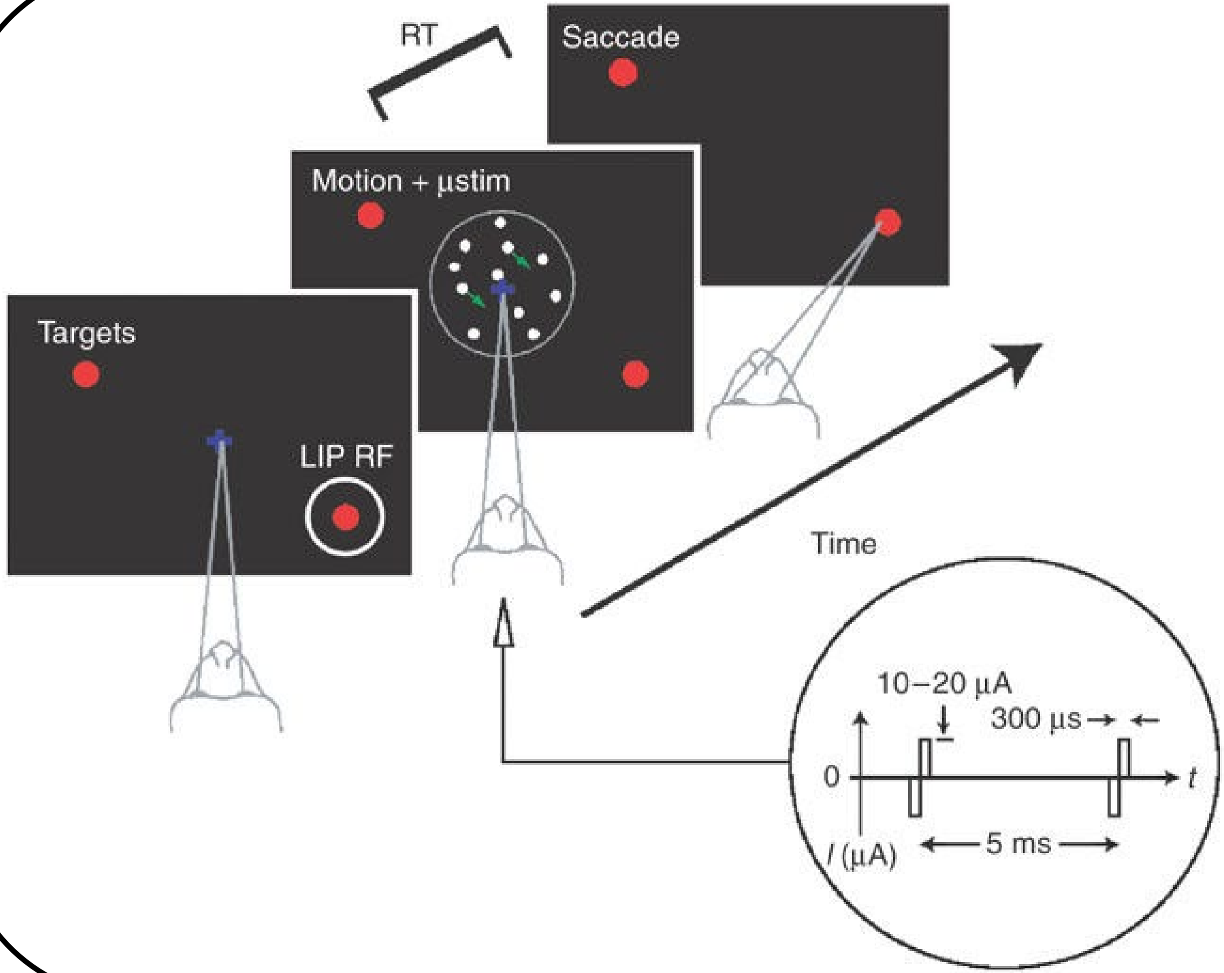
↓

Interpret the information

↓

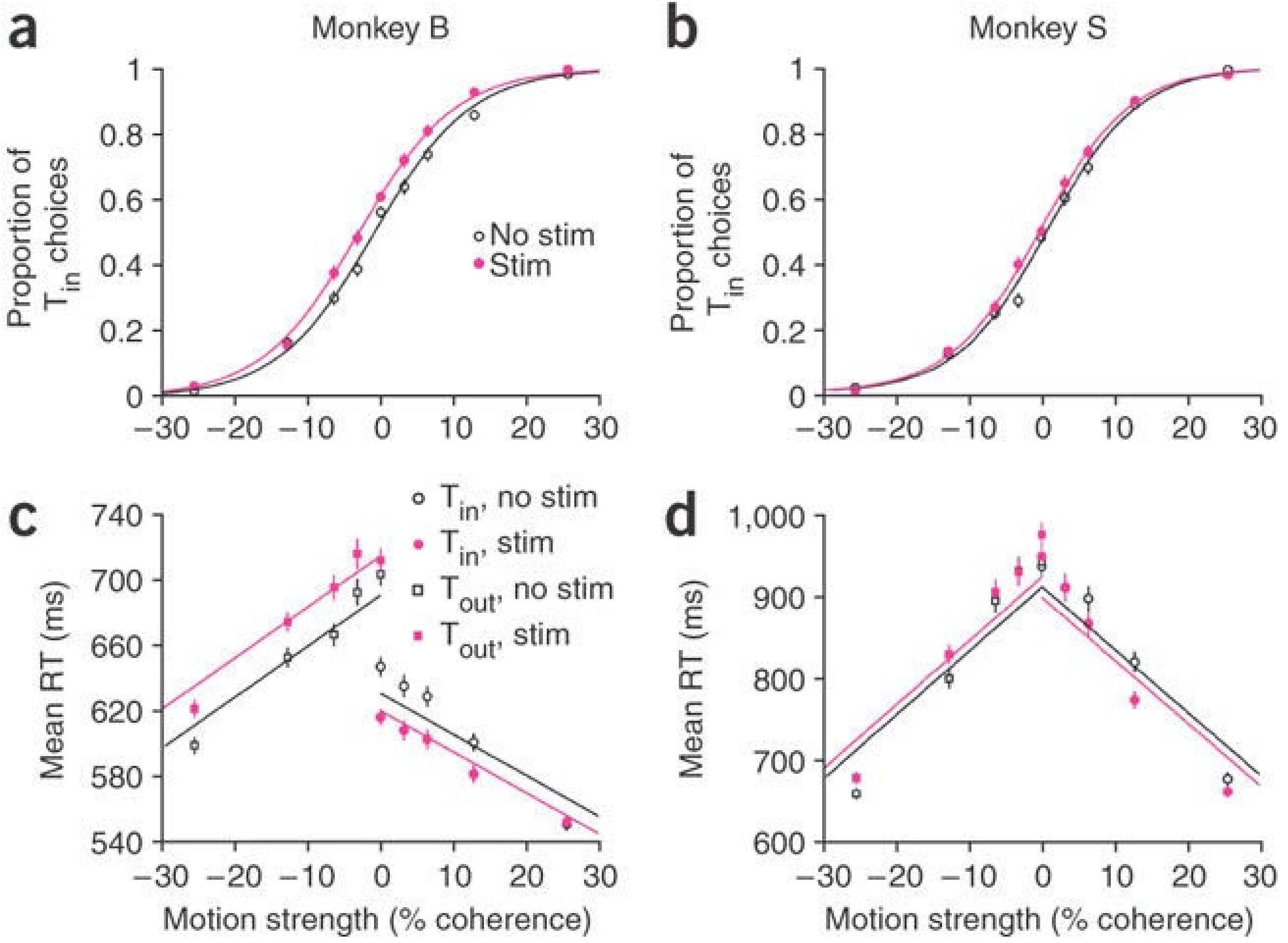
Commit to a choice (LIP)

https://www.youtube.com/watch?v=rRDDKKqkdTg



A single microelectrode for recording and stimulating was advanced into the ventral portion of area LIP to identify a cluster of neurons with similar RFs. The monkey performed a direction discrimination task with several levels of task difficulty randomly interleaved. The monkey could respond at any time after onset of the random-dot motion, and it indicated its decision with a saccadic eye movement. One of the two choice targets was placed in the RF of the LIP neurons. On a random half of the trials we applied microstimulation, as shown, from the onset of the motion stimulus until the initiation of the saccade.

Microstimulation biased the monkeys to choose the direction of motion associated with the T_{in} choice target.



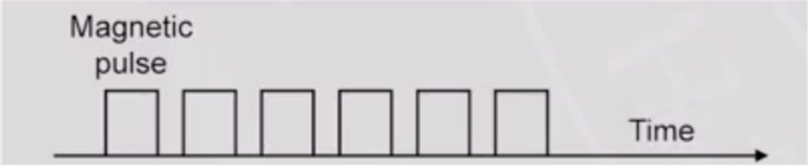
Issues with Direct Brain Stimulation

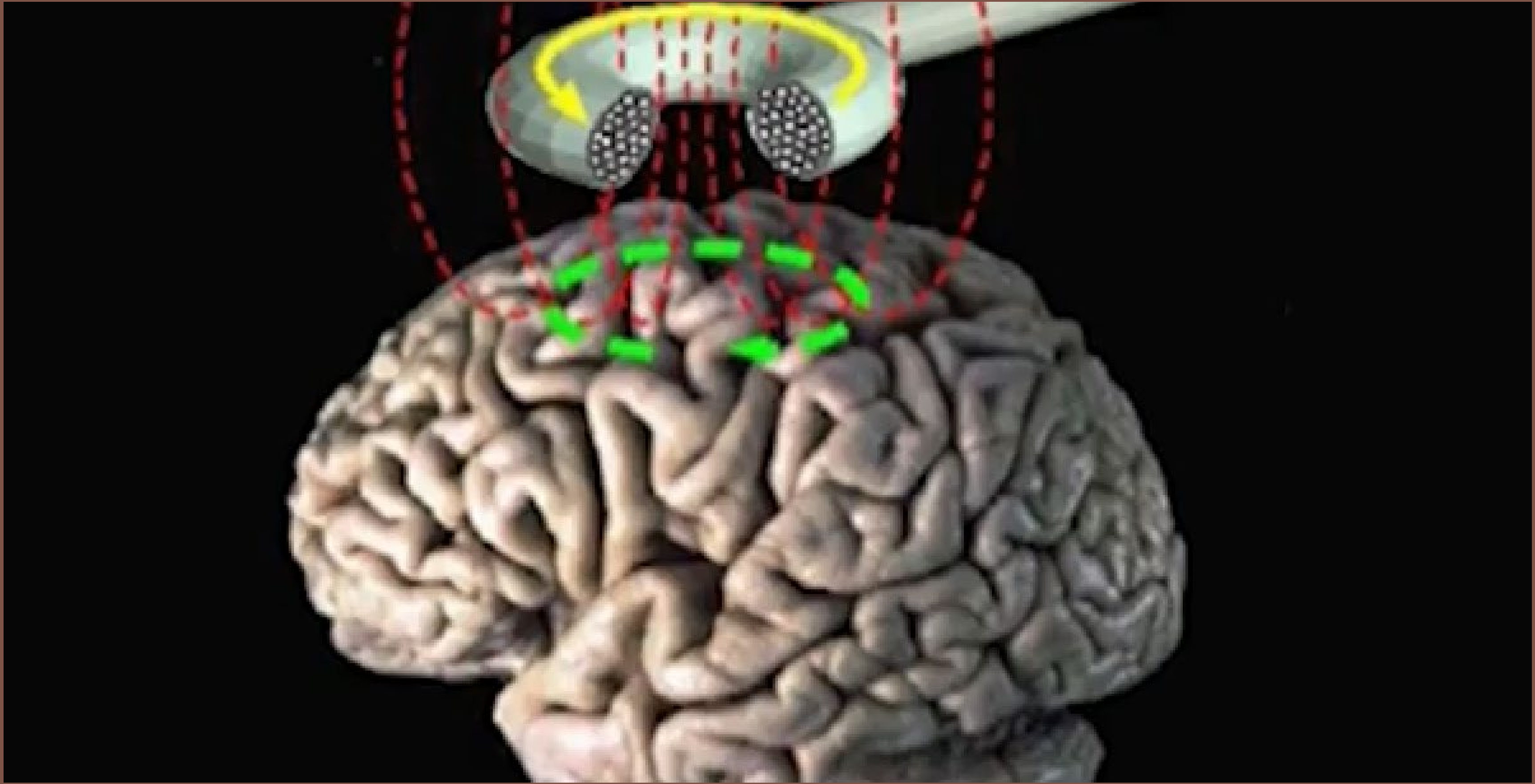
- ❑ Short term effects
- ❑ Invasive – can destroy tissue
- ❑ Cannot perform this work on humans
- ❑ Difficulty with precision
- ❑ Interpretations can be difficult (similar to lesion studies.)

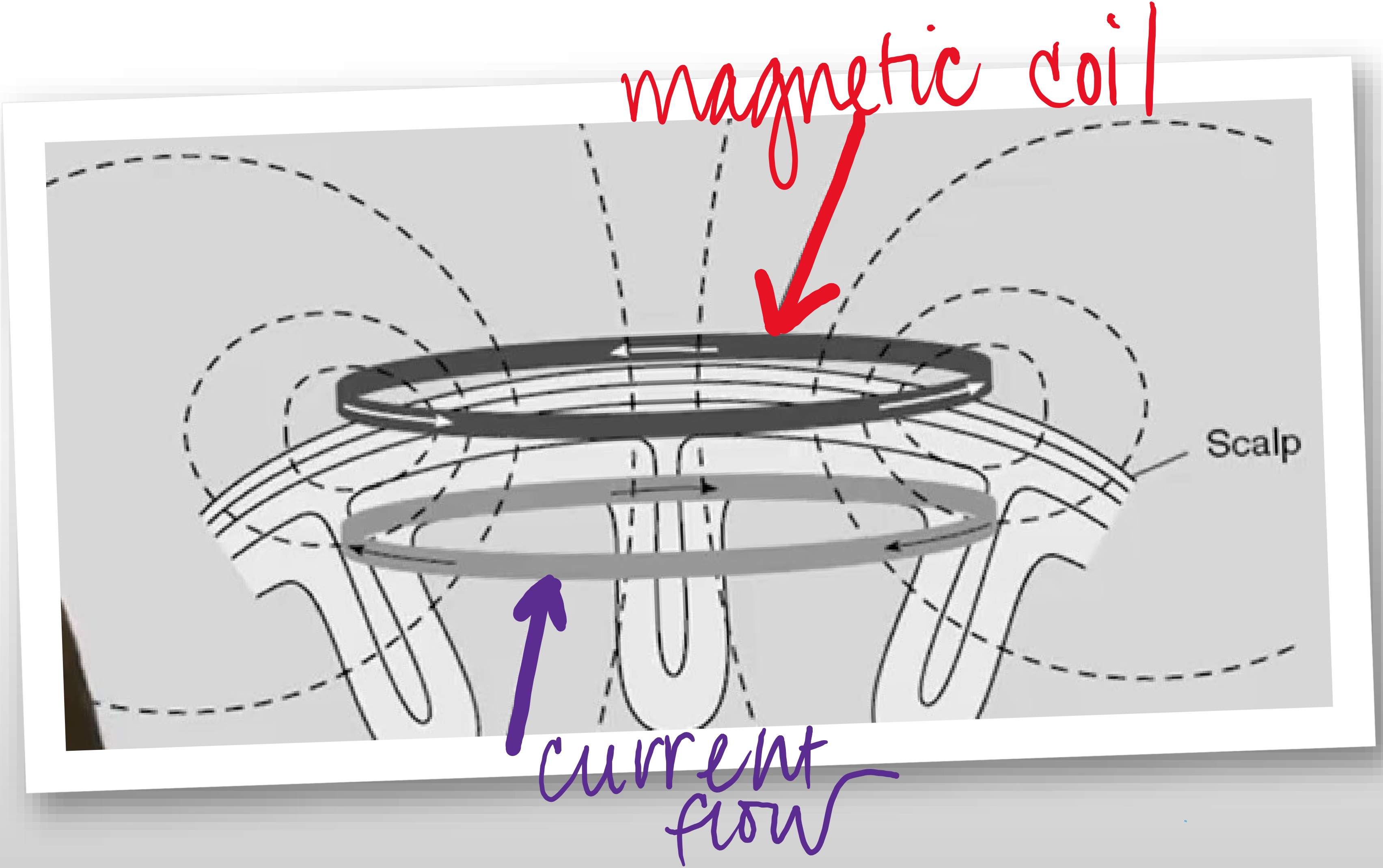
Transcranial Magnetic Stimulation

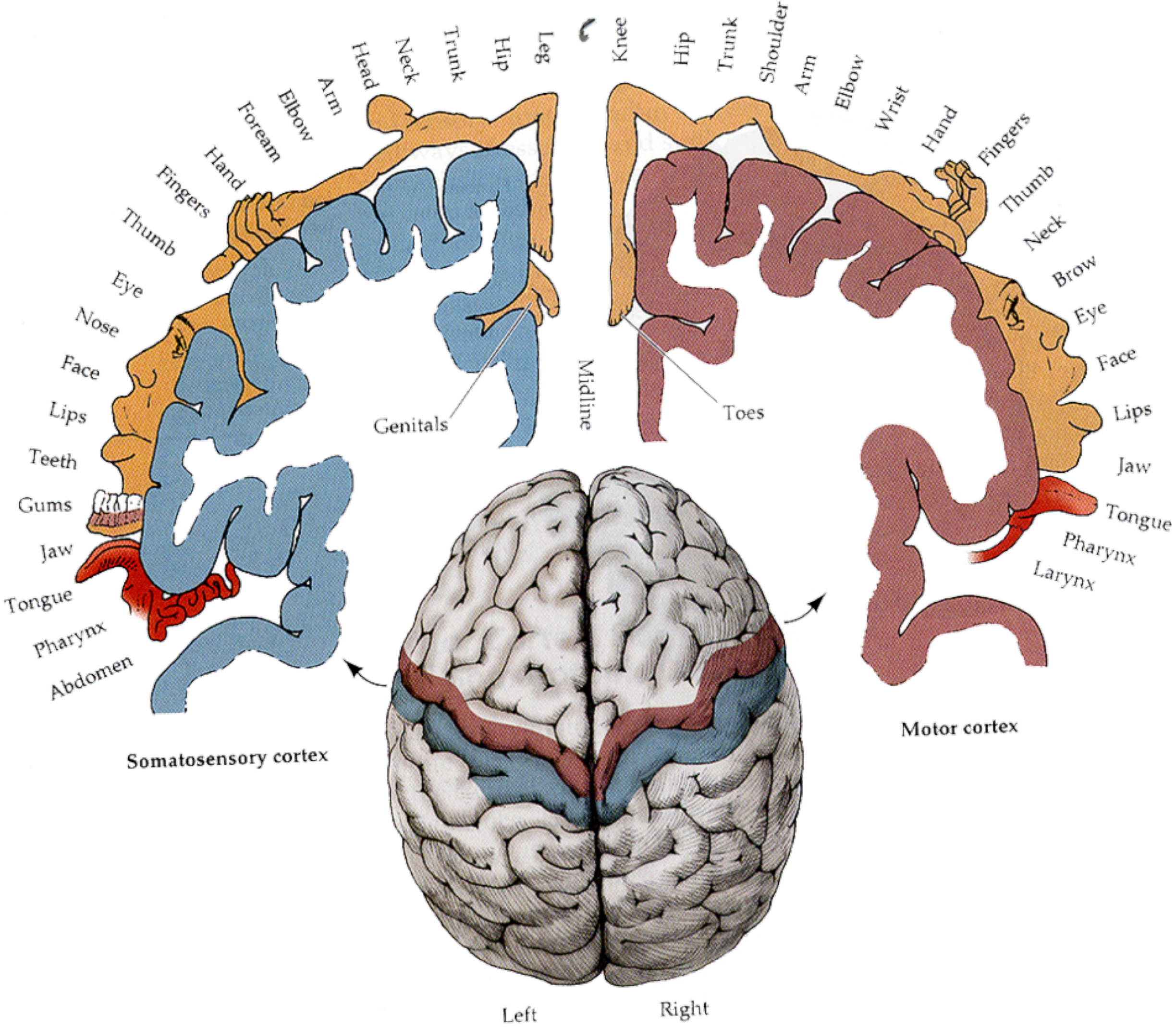
TMS - rapidly changing magnetic fields (electromagnetic induction) induce weak electric currents in the brain, i.e. affect neurons.

Repetitive **TMS** (rTMS) – repetitive TMS pulses. rTMS produce longer lasting changes.






magnetic coil
Scalp
current flow



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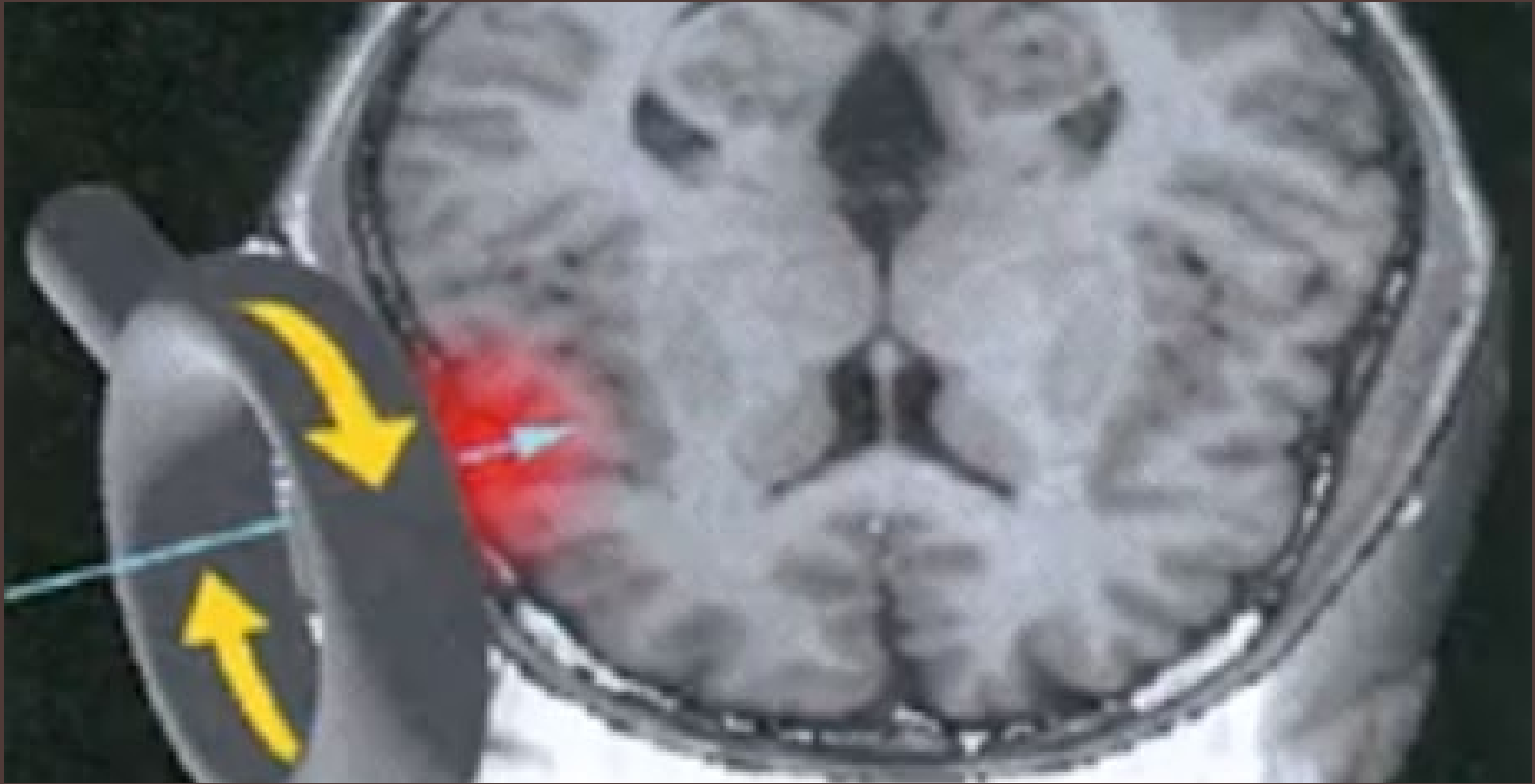
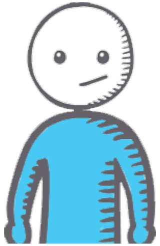
Foream
Hand
Fingers
Thumb
Eye
Nose
Face
Lips
Teeth
Gums
Jaw
Tongue
Pharynx
Abdomen
Genitals
Midline
Knee
Hip
Trunk
Shoulder
Arm
Elbow
Wrist
Hand
Fingers
Thumb
Neck
Brow
Eye
Face
Lips
Jaw
Tongue
Pharynx
Larynx
Toes
Somatosensory cortex
Motor cortex
Left
Right

https://www.youtube.com/watch?v=qkNbYHu_STU https://www.youtube.com/watch?v=FMR_T0mM7Pc



Ultimatum game

economic experiments



The first player (the proposer) conditionally receives a sum of money and proposes how to divide the sum between the proposer and the other player.

The second player (the responder) chooses to either accept or reject this proposal.

If the second player accepts, the money is split according to the proposal.

If the second player rejects, neither player receives any money.

The game is typically played only once so that reciprocation is not an issue.

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]*

Humans restrain self-interest with moral and social values. They are the only species known to exhibit reciprocal fairness, which implies the punishment of other individuals' unfair behaviors, even if it hurts the punisher's economic self-interest. Reciprocal fairness has been demonstrated in the Ultimatum Game, where players often reject their bargaining partner's unfair offers. Despite progress in recent years, however, little is known about how the human brain limits the impact of selfish motives and implements fair behavior. Here we show that disruption of the right, but not the left, dorsolateral prefrontal cortex (DLPFC) by low-frequency repetitive transcranial magnetic stimulation substantially reduces subjects' willingness to reject their partners' intentionally unfair offers, which suggests that subjects are less able to resist the economic temptation to accept these offers. Importantly, however, subjects still judge such offers as very unfair, which indicates that the right DLPFC plays a key role in the implementation of fairness-related behaviors.

Science 03 Nov 2006: Vol. 314, Issue 5800, pp. 829-832 DOI: 10.1126/science.1129156

Acceptance rates of unfair financial offers across treatment groups.

Subjects whose right DLPFC is disrupted exhibit a much higher acceptance rate than those in the other two treatment groups.

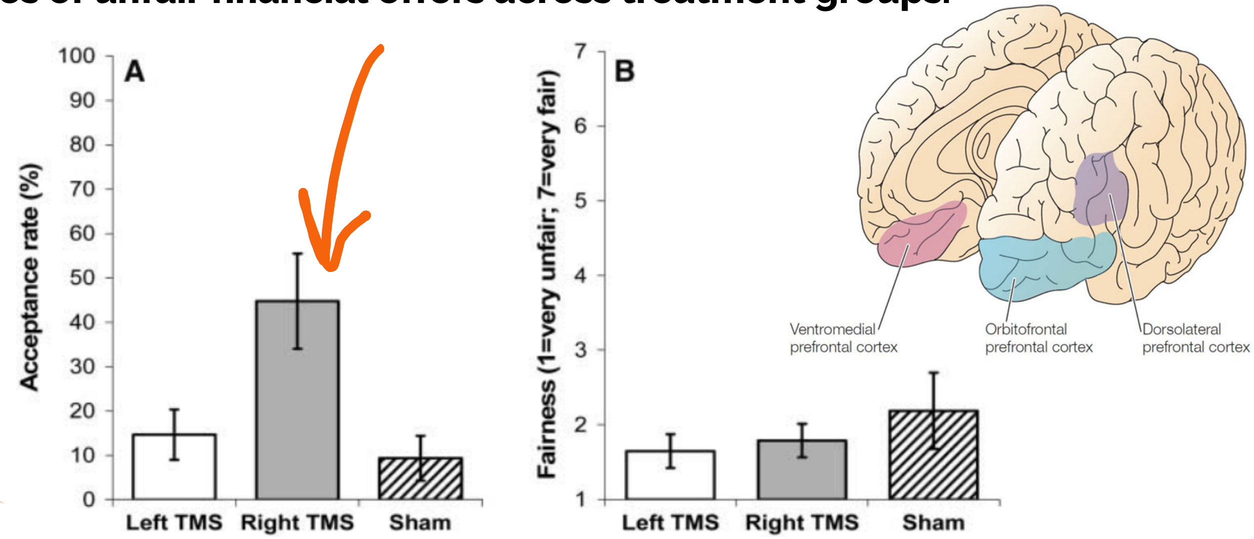


Fig. 1. Behavioral responses and fairness judgments (means ± SEM) related to the most unfair offer of CHF 4 in the human offer condition. (**A**) Acceptance rates across treatment groups. Subjects whose right DLPFC is disrupted exhibit a much higher acceptance rate than those in the other two treatment groups (Mann-Whitney *U* tests, two-tailed, $P < 0.05$). (**B**) Perceived unfairness across treatments (1 = very unfair; 7 = very fair). Subjects in all three treatment groups perceive an offer of 4 as very unfair, and there are no significant differences across groups.

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Pros and Cons: TMS

- Can have transient or long-term effects.
- Show causal neural mechanisms.
- Difficult to stimulate deep brain areas.
- Limits on how much magnetic field stimulation is acceptable.
- Risk of inducing epileptic seizure.