Task switching increases theta power in a human prefrontal-subthalamic circuit

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Introduction

▶ Cue based (reactive) task switching: shifting between task sets in response to an explicit instruction.

▶ In monkeys: neurons in a dorsomesial-prefrontal-subthalamic network increase their activity during such process [1].

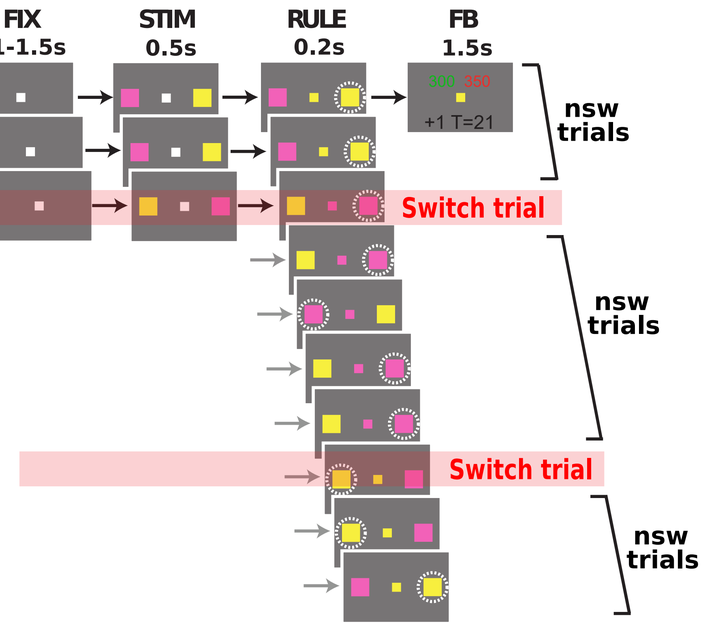
▶ In humans: neural dynamics associated with task switching remains unclear [2,3].

▶ Here, we demonstrate a critical role of theta oscillations in the subthalamic nucleus (STN) and the dorsomesial prefrontal cortex (dmPFC) during task-set reconfiguration [4].

Method

▶ We recorded invasive field potentials from :
- the STN of four patients with obsessive compulsive disorder (OCD)
- the dmPFC of three epileptic patients (EPI).

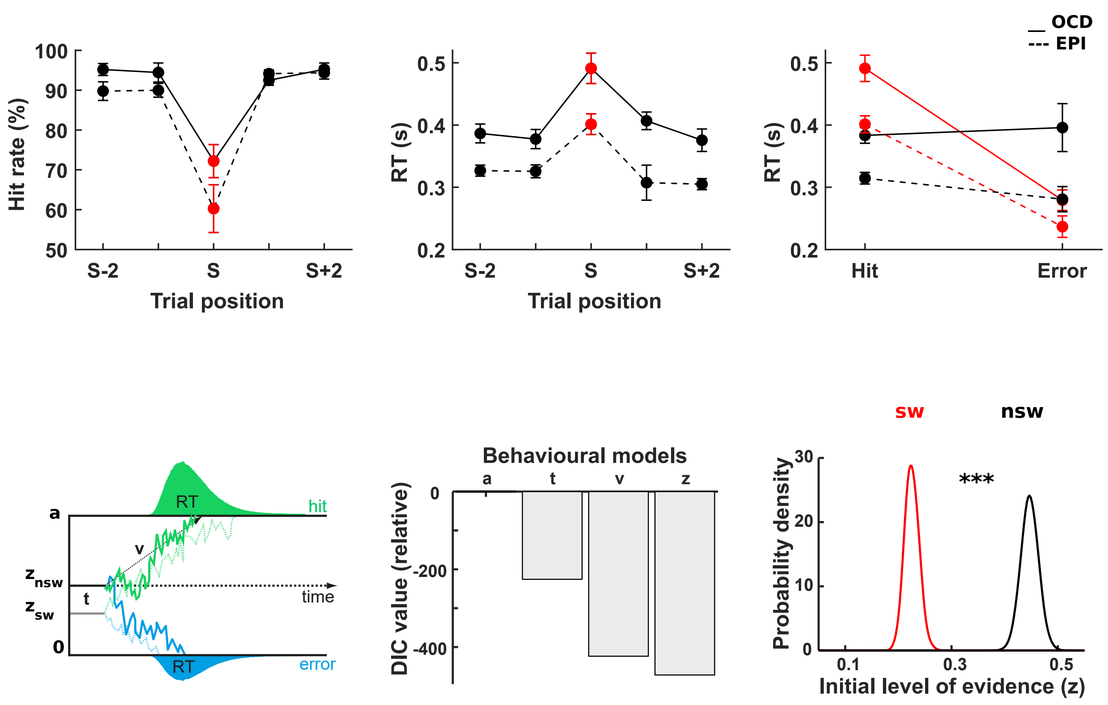
▶ We fitted a drift diffusion model (DDM) to patients'choice behavior to investigate the neuro-computational mechanisms underlying task-switching [5].



Behavioural results

▶ The task induced a robust switch cost for all participants: a lower hit rate and a higher reaction time (RT) during correct switch trials. RTs for incorrect switch responses were the lowest, thus indicating errors reflected premature response.

▶ Model comparison comfirmed task condition (sw/nsw) modulated the initial level of evidence (z). Participants displayed lower values of z for switch trials.



Conclusion

Theta power in the dorsomesial-prefrontal-subthalamic network modulates the initial level of evidence for the correct responses during reactive task switching. This could reflect a simple mechanism through which the dmPFC could rapidly activate the STN during rule-updating to rapidly overcome prepotent responses.

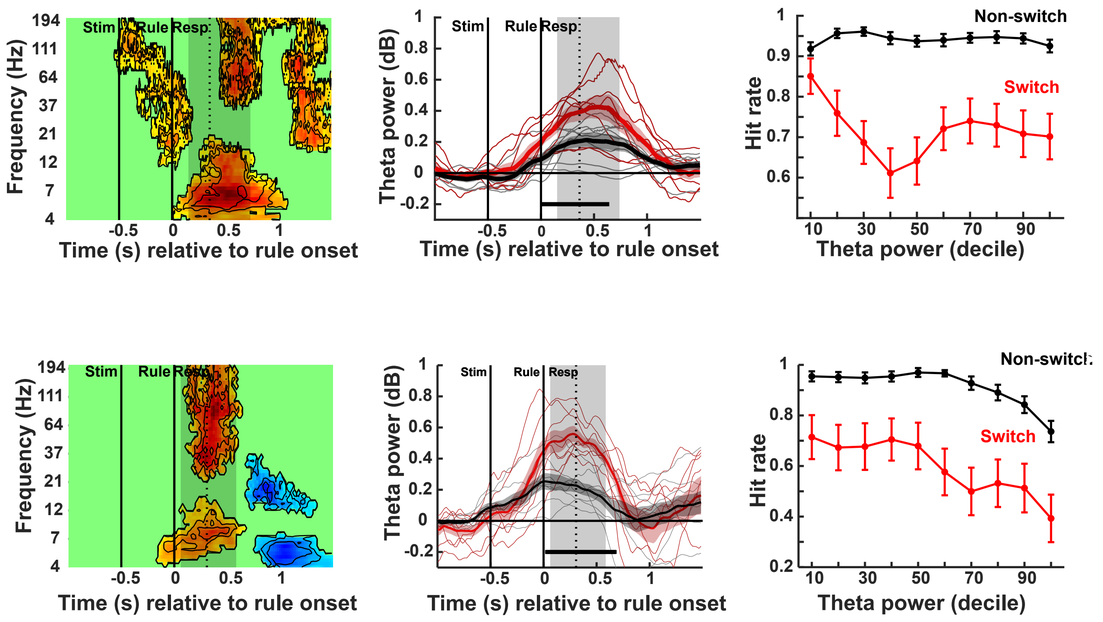
Limitations and perspectives

The paradigm we employed did not allow us to distinguish task set reconfiguration from action selection processes.

Neural results

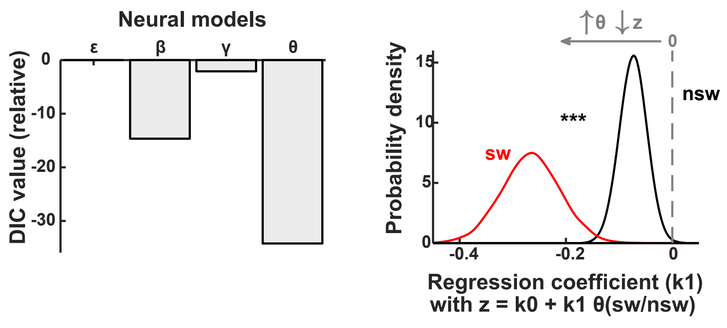
▶ In the STN, the power estimated across multiples frequencies
- θ:5-10Hz
- β:15-35Hz
- ɣ:60-200Hz

was significantly modulated when contrasting correct switch and non-switch trials, with a prominent increase of theta power at rule onset which was also visible in the dmPFC.



▶ Yet, in both regions (STN, dmPFC), we found a negative correlation between θ power (deciles estimated within experimental conditions) and hit rate during switch trials.

▶ Model comparison showed that injecting θ power at rule onset was the most likely model. We found a negative correlation between θ power and the initial level of evidence : the higher θ power, the lower z, and thus the higher the error rate.



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