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Interactions between executive control and conscious perception

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Introduction

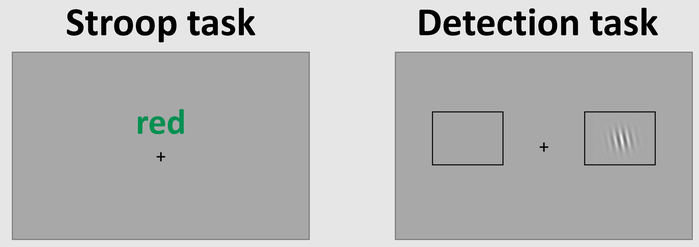
• One of the functions of attention is to select information for conscious processing[1]. Previous studies have demonstrated that alertness and orienting networks of attention can modulate the extent to which visual information access consciousness[2, 3].

• This line of research explores the relationship between the executive control network of attention, involved in conflict detection, and conscious perception.

• We hypothesize that executive control would modulate conscious perception both at behavioral and neural levels, as both processes are thought to rely on fronto-parietal brain regions[4].

Methods

- In the same paradigm, a Stroop task and a detection task of near-threshold Gabor stimuli were presented.

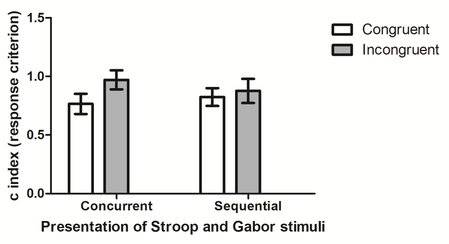


- We analyzed perceptual sensitivity and response criterion to detect the Gabor as a function of Stroop stimulus congruency.
- In addition, this paradigm was combined with neuroimaging techniques, such as electroencephalography (EEG), functional magnetic resonance imaging (fMRI), diffusion tensor imaging (DTI) and transcranial magnetic stimulation (TMS).

Results

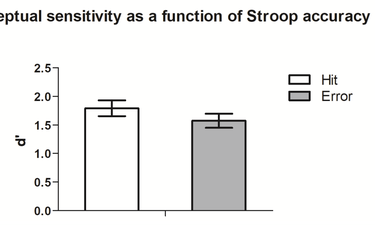
Experiment 1: Behavioral effects

Conflict elicited by incongruent Stroop trials modulated the response criterion to detect the Gabor when both tasks were presented concurrently.

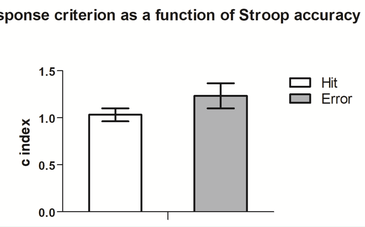


By contrast, conflict elicited by error commission impacted both perceptual sensitivity and response criterion to detect the Gabor stimulus.

Perceptual sensitivity as a function of Stroop accuracy

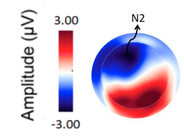


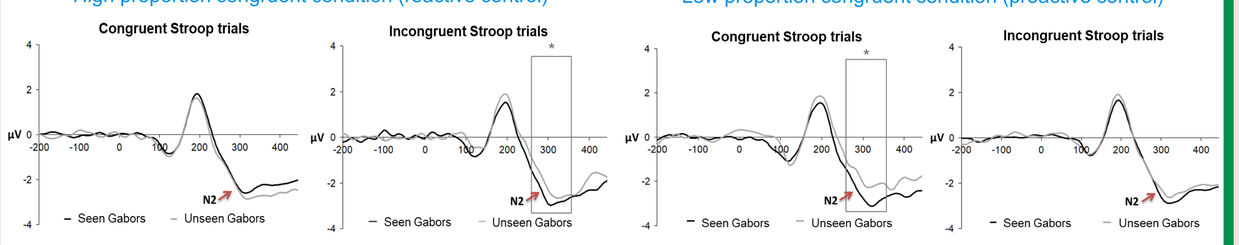
Response criterion as a function of Stroop accuracy



Experiment 2: EEG

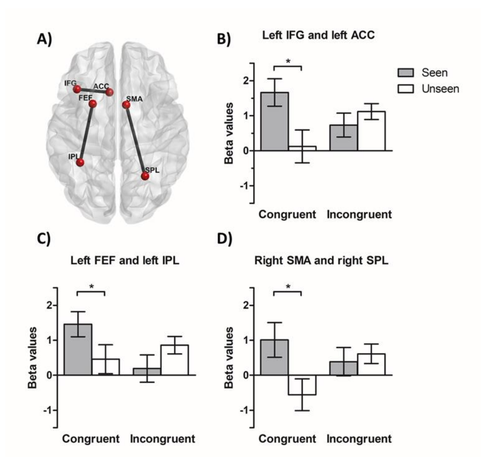
The conflict-related N2 component to the Stroop stimulus discriminated between seen and unseen Gabors.



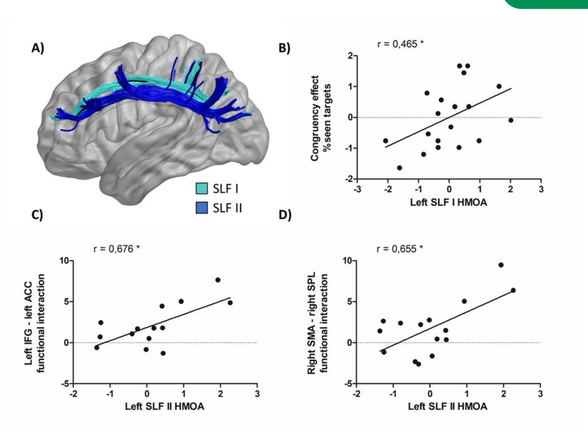


This modulation depended on the control mechanism recruited (reactive or proactive control).

Experiment 3: fMRI and DTI

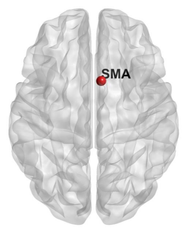


An interaction between executive control and consciousness was found in the functional coupling of fronto-parietal regions.



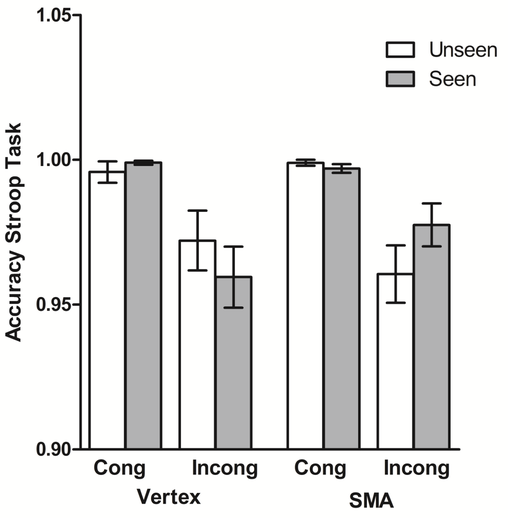
The integrity of the left SLF I and II was positively correlated with behavioural and neural measures of the interaction between executive control and consciousness

Experiment 4: TMS



Online inhibitory TMS was applied over Supplementary Motor Area (SMA) and a control region (Vertex).

While for the control TMS condition Stroop accuracy for incongruent trials was better when stimuli were unseen as compared to seen, TMS over the SMA reversed this effect.



Discussion and Conclusions

The implementation of the executive control network of attention modulated the decisional aspect of conscious perception of near-threshold stimuli. At the neural level, this modulation was reflected in the anterior N2 component, on the functional connectivity of fronto-parietal regions and on the activity of frontal regions such as the SMA or the ACC. These data suggest that executive attention and conscious perception could be implemented in partially overlapping brain regions[4].

References:

[1]Dehaene S, Naccache L. 2001. Cognition. 79:1–37. [2] Chica AB et al. 2016. Scientific Reports. 6:31868.

[3]Chica AB et al. 2012. Neuropsychologia. 50:621– 629. [4] Dehaene S, Changeux J. 2011. Neuron. 70:200-227.

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