Multimodal mapping of visual motion perceptual decision: Dissecting the role of different motion integration areas in visual surface reconstruction

ABSTRACT:

Background
Neural models of perceptual decision are often studied using bistable perceptual decision paradigms. Causal bottom vs top-down mechanisms remain to be elucidated.

Aims
We asked whether hMT+ is pivotal for perceptual integration of motion signals in terms of bottom-up vs top-down interactions. Moreover, if middle temporal cortex (hMT+) is indeed a causal hub in the decision-making network, then it should also provide long range integration at the interhemispheric level, which is a testable prediction. We tested whether one can find fingerprints of perception related to neural coherence. Finally, we aimed to elucidate the general relation between sensory and decision modules within saliency and frontoparietal networks.

Method
We combined EEG and fMRI methods, to understand perceptual decision mechanisms, their neural correlates and functional connectivity (with a focus on interhemispheric interactions).

Results
We found out that human hMT+ is a causal hub which contributes to maintain perceptual representations when other competing percepts are available for cognition. We further confirmed the prediction that it should also subserve long range perceptual integration, through increased interhemispheric connectivity between left/right hMT+. EEG data revealed that bound perceptual interpretations relate with parietal beta power under ambiguous conditions. Together with our findings using other decision paradigms inside and outside the visual domain, we showed a modular architecture of perceptual decision-making network.

Conclusion
Our work provides a clear-cut functional segregation at different time scales between sensory representations, and the role of the general decision modules within saliency and frontoparietal networks.

Keywords
Perception, Decision-making, EEG, fMRI, Granger causality analysis, Visual motion, Bistability

Published Work:

Costa, G. N., Duarte, J. V., Martins, R., Wibral, M., & Castelo-Branco, M. (2017). Interhemispheric binding of ambiguous visual motion is associated with changes in beta oscillatory activity but not with gamma range synchrony. *Journal of Cognitive Neuroscience, 29*(11), 1829-1844. doi: 10.1162/jocn_a_01158

Duarte, I. C., Afonso, S., Jorge, H., Cayolla, R., Ferreira, C., & Castelo-Branco, M. (2017). Tribal love: the neural correlates of passionate engagement in football fans. *Social Cognitive and Affective Neuroscience*, *12*(5), 718-728. doi: 10.1093/scan/nsx003

Duarte, J. V., Costa, G. N., Martins, R., & Castelo-Branco, M. (2017). Pivotal role of hMT+ in long-range disambiguation of interhemispheric bistable surface motion. *Human Brain Mapping, 38*, 4882-4897. doi: 10.1002/hbm.23701

Sousa, T., Amaral, C., Andrade, J., Pires, G., Nunes, U., & Castelo-Branco, M. (2017). Pure visual imagery as a potential approach to achieve three classes of control for implementation of BCI in non-motor disorders. *Journal of Neural Engineering*, *14*(4):046026. doi: 10.1088/1741-2552/aa70ac

Intaite, M., Duarte, J., & Castelo-Branco, M. (2016). Working memory load influences perceptual ambiguity by competing for fronto-parietal attentional resources. *Brain Research, 1650*, 142-151. doi: 10.1016/j.brainres.2016.08.044

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