Convergent functional network connectivity changes in stimulus-driven attention and awareness

Jocelyn Sy[1], Hongyang Sun[2], Doug Godwin[1], Hana Eaton[1], Padma Raghavan[2], René Marois[3,4]

[1]Vanderbilt University Department of Psychology, [2]Vanderbilt University Department of Electrical Engineering and Computer Science,
[3]Vanderbilt Center for Integrative and Cognitive Neuroscience, [4]Vanderbilt Vision Research Center

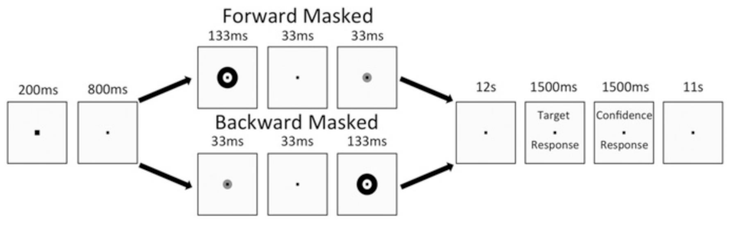
1 Introduction

- We recently showed that awareness of a task-relevant target is associated with a widespread increase in functional connectivity across neural networks of the cerebral cortex (Godwin et al., *PNAS*, 2015)
- Conscious perception of a target is not the only event that captures the mind. The presentation of task-irrelevant but salient and unexpected events are known to powerfully capture attention and disrupt goal-oriented behavior.

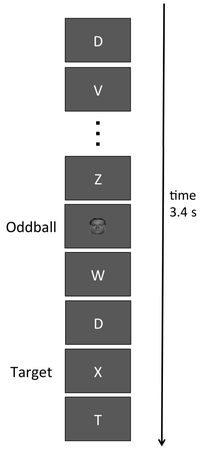
Does such attention capture by 'oddball' events also lead to widespread changes in functional brain connectivity?

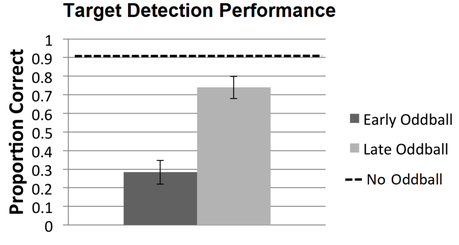
2 Methods

Awareness paradigm (n=28)



Attention Capture paradigm (n=25)

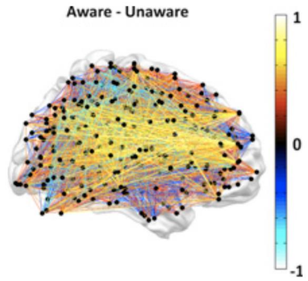




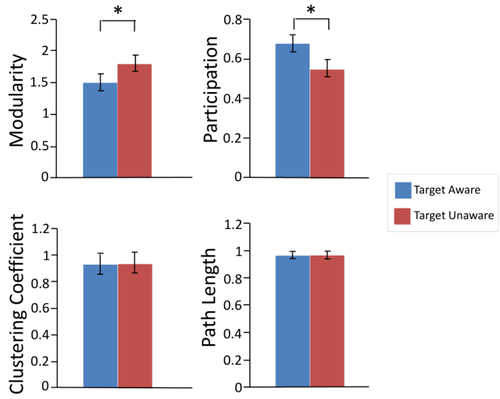
Early Oddballs (#1-2) were separated from Late Oddballs (#3-6) and from No-Oddball trials before submitted to graph theory analysis of functional connectivity.

3 Results

Awareness Experiment



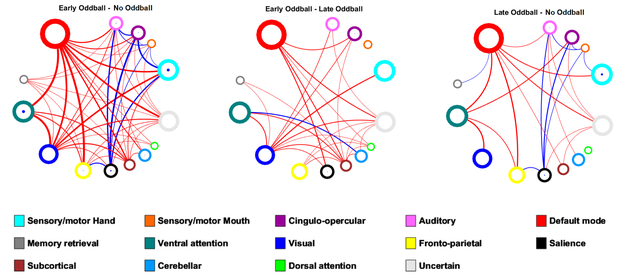
Hot colors: stronger connections for the aware than unaware condition
Cool colors: unaware connections greater than aware



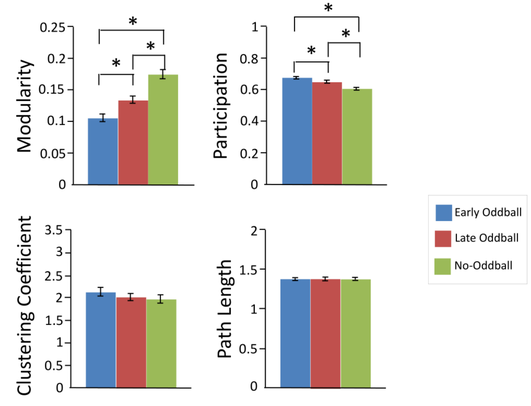
With Target Awareness
- Decrease in network Modularity
- Increase in Participation (intermodular connectivity)

Perceptual awareness is associated with increased functional network integration

Attention Capture Experiment



Red edges: connectivity strength difference is positive
Blue edges: connectivity strength difference is negative



Under Greater Attention Capture (Early > Late > No Oddball)
- Decrease in network Modularity
- Increase in Participation (intermodular connectivity)

Attention capture by salient 'oddballs' lead to a breakdown of functional network modularity

4 Conclusion

- Both awareness of a target and the capture of attention by an unexpected event are associated with an increase in functional integration of the brain's neural networks
- This suggests that increases in widespread broadcasting of neural information may be mediated via common neural principles of functional connectivity changes.

5 References + Funding

Godwin D, Barry RL, Marois R (2015) Breakdown of the brain's functional network modularity with awareness. Proc Natl Acad Sci USA. 112(12): 3799-3804

P30-EY008126 to VVRC, NSF CCF 1719674 award, NSF grant 0094992, NIMH grant R01 MH70776, NIH grant 5R01EB000461