Selective Activation, Collective Suppression: Provisional Evidence for Broad Modulation of Large-Scale Networks from Within-Individual Analysis of the Default Network

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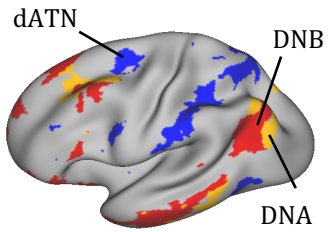
Introduction

- Two large-scale distributed brain networks, the Default and Dorsal Attention Networks, have been linked to competitive modes of processing for internal and external attention[1].
- Within-individual analyses revealed that the Default Network comprises two distinct, functionally specialized networks (DNA & DNB)[2,3].
- We aimed to test whether DNA & DNB show collective or differential suppression during externally oriented tasks previously known to suppress the broadly-defined Default Network
- Using fMRI, DNA and DNB activation patterns were characterized during two external attention tasks (2-Back working memory task and a Visuomotor processing task).

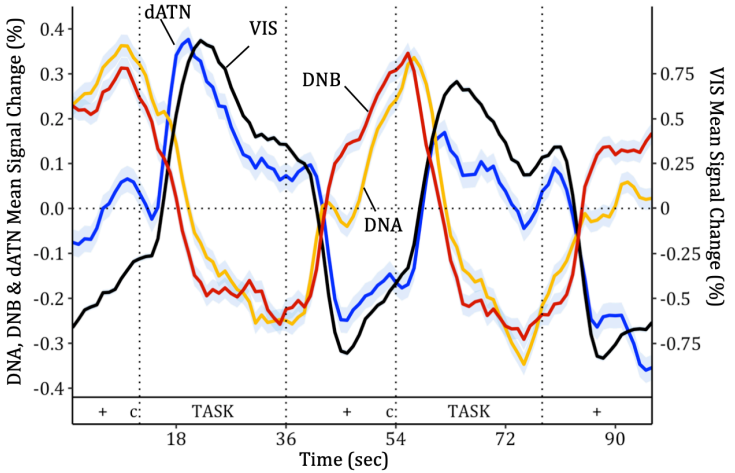
Within-Individual Identification of Large-scale, Distributed Networks



- Using resting-state connectivity, DNA, DNB and the Dorsal Attention Network (dATN) were estimated within individuals (n=10 subjects, 4 scanning sessions/subject) using kmeans parcellations.
- In all subjects, DNA & DNB are composed of closely juxtaposed and interdigitated networks distributed across zones spanning the prefrontal cortex (PFC), posterior parietal cortex (PPC), lateral temporal cortex (LTC), posteromedial cortex (PMC), and medial prefrontal cortex (MPFC)

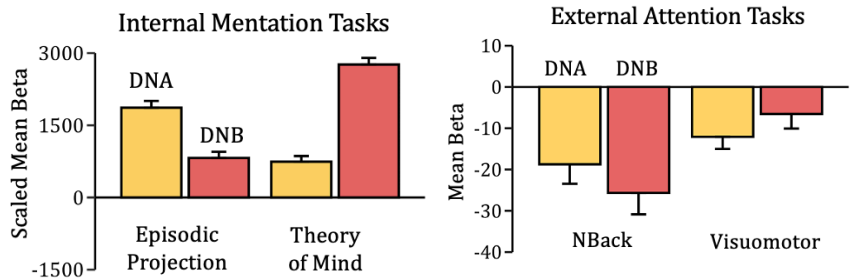
DNA & DNB Anticorrelated with External Attention Networks

- Each network's mean BOLD signal time course was averaged across all non-excluded task runs, baseline normalized, and averaged across subjects.
- During external attention (2-Back Task visualized), DNA & DNB are closely coupled and anticorrelated with external attention networks (dATN & the visual cortex)
- DNA & DNB show similar patterns of increased signal change during fixation and decreased signal change during task blocks.



Selective Activation & Collective Suppression of DNA & DNB

- Each network's mean beta values (output from block-design GLM) for each task run were computed across individuals. Group-level beta values are plotted below.
- For internal mentation tasks, DNA & DNB show functional specialization[3].
- or external attention tasks, DNA & DNB exhibit patterns of joint suppression for region-specific and network-level analyses.



Conclusion

- In conjunction with prior findings of functional double-dissociation for internal mentation tasks[3], we show that DNA & DNB exhibit collective task-related suppression for external attention tasks, and functional anti-correlations with the external attention networks.
- These findings suggest an antagonistic relationship between large-scale networks broadly involved in internal and external modes of processing.
- Future Directions: Are these networks differentiated at birth in humans? Are these networks differentiated in other primates? What mechanisms are responsible for driving the broad suppression of the Default Networks?

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[1] Fox MD, Snyder AZ, Vincent JL, Corbetta M, Essen DCV, Raichle ME (2005) The human brain is intrinsically organized into dynamic, anticorrelated functional networks. PNAS 102:9673–9678.
[2] Braga RM, Buckner RL (2017) Parallel Interdigitated Distributed Networks within the Individual Estimated by Intrinsic Functional Connectivity. Neuron 95:457-471.e5.
[3] DiNicola LM, Braga RM, Buckner RL (2020) Parallel Distributed Networks Dissociate Episodic and Social Functions Within the Individual. Journal of Neurophysiology doi:10.1152/jn.00529.2019