Decreased alertness changes brain network dynamics in passive movie-viewing

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INTRODUCTION

Decreased alertness is associated with poor behavioral performance and brain function[1].

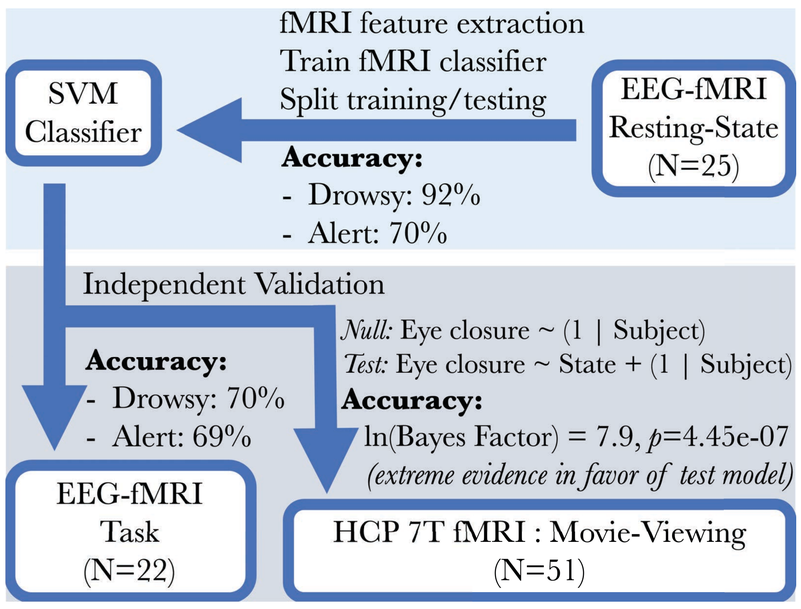
While these effects have been shown in event-locked experiments[2], it is unclear how decreased alertness modulates brain function in sustained passive tasks.

Naturalistic movie-viewing has continuous recruitment of task-related networks, including those involved in low-level sensory processing and high-level integration[3].

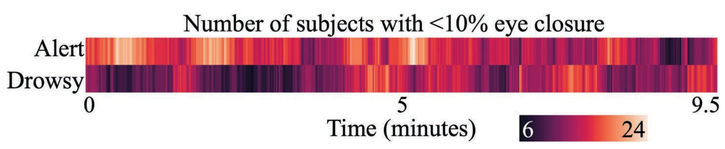
We hypothesize: 1) brain functional organization during passive movie-viewing depends on alertness level, and 2) these differences in functional organization are reflected in high-level functions of the visual attention network, as well as subcortico-cortico dynamics.

METHODS

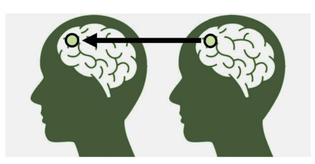
Classify 60-second windows of fMRI data as Alert or Drowsy: Train fMRI classifier on EEG-defined alert / drowsy states[4].



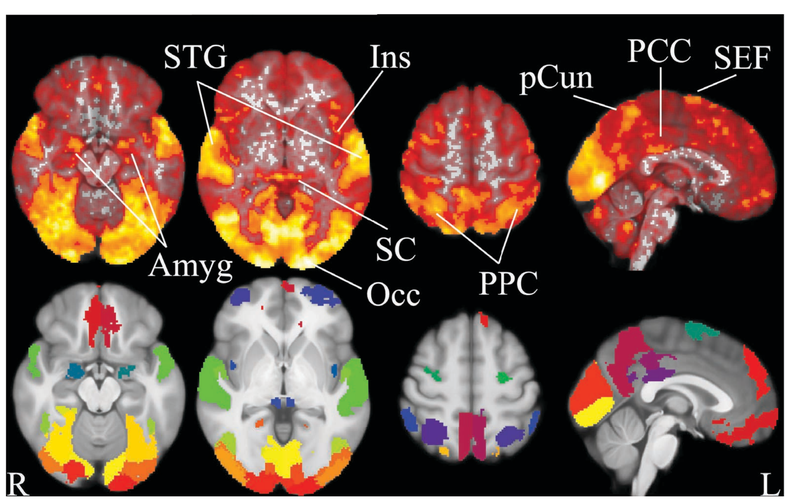
51 healthy adults from the HCP 7T fMRI Database[5] watched four movie clips (~10 min). 504 60-sec windows (1-sec step) were analyzed. Only subjects with <10% eye closure were included in each window.



Which brain regions are involved in passive movie-viewing?

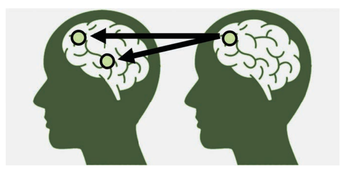


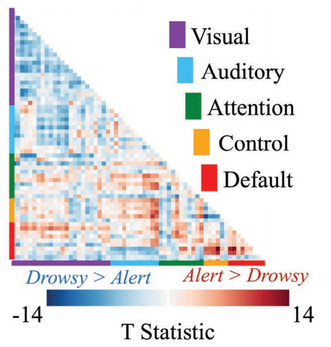
Inter-subject connectivity (ISC)[6,7]. Create masks of high-ISC regions. 66 regions of interest (ROIs) were created & grouped into 5 brain networks.



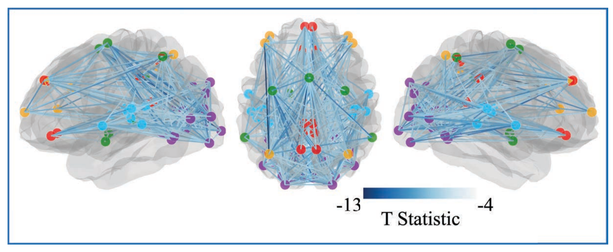
RESULTS

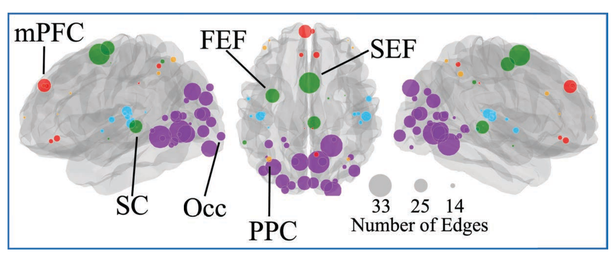
When alertness decreases, how does **inter-subject functional connectivity (ISFC)** change between ROIs involved in movie-viewing? Which ROIs are most involved in this change?



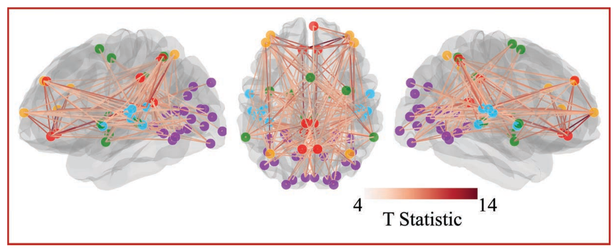


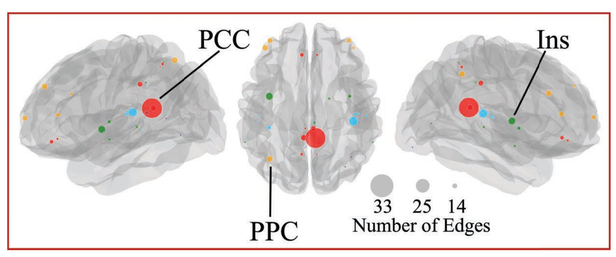
Drowsy > Alert



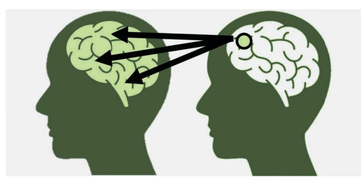


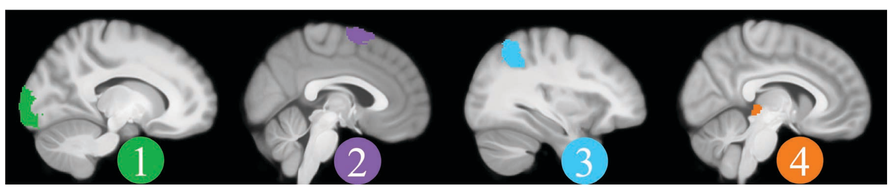
Alert > Drowsy





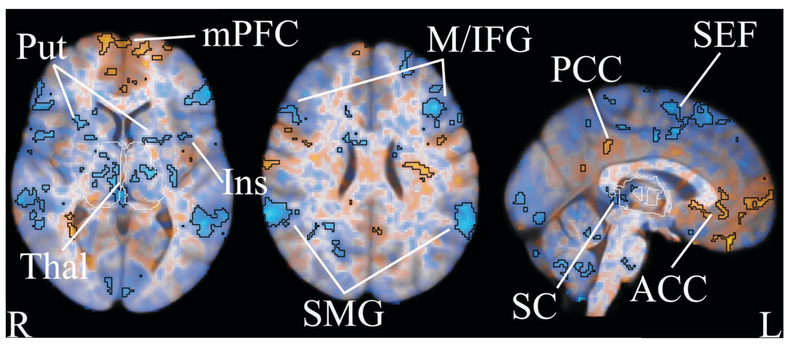
When alertness decreases, how are these most involved ROIs interacting with the subcortex and the rest of the brain (**seed-based ISFC**)?

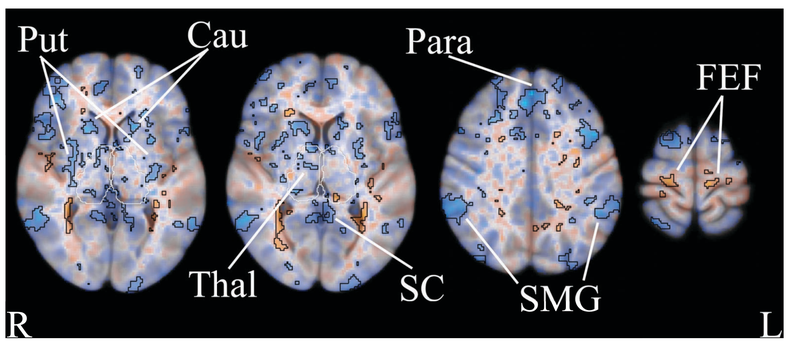




1 Left Occipital Pole

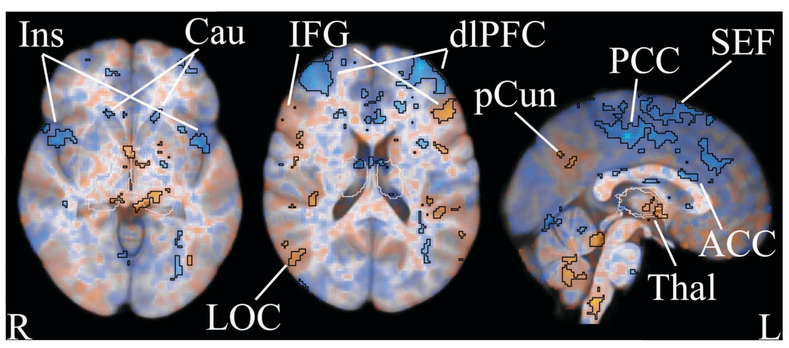
2 Supplementary Eye Field

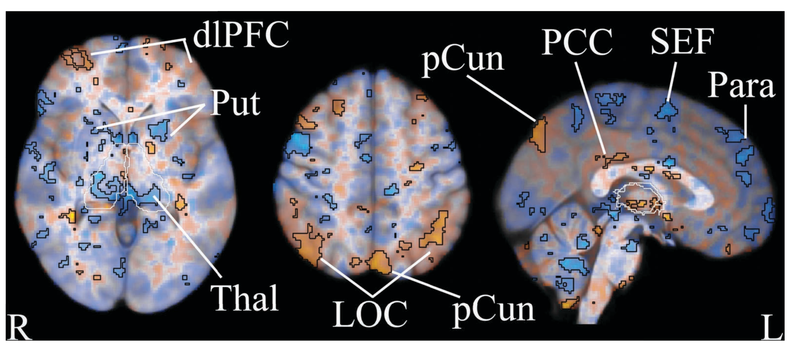




3 Left Posterior Parietal Cortex

4 Right Superior Colliculus

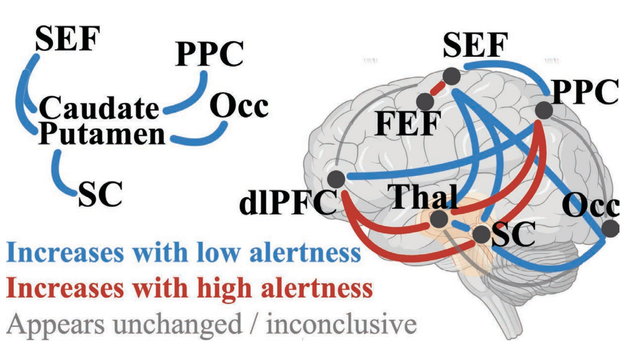




Amyg: amygdala; **ACC**: anterior cingulate; **Cau**: caudate; **dlPFC**: dorsolateral PFC; **FEF**: frontal eye fields; **IFG**: inferior frontal gyrus; **Ins**: insula; **LOC**: lateral occipital cortex; **mPFC**: medial PFC; **MFG**: middle frontal gyrus; **Occ**: occipital pole; **Para**: paracingulate gyrus; **PCC**: posterior cingulate; **pCun**: precuneus; **PFC**: prefrontal cortex; **PPC**: posterior parietal cortex; **Put**: putamen; **SEF**: supplementary eye field; **SC**: superior colliculus; **SMG**: supramarginal gyrus; **STG**: superior temporal gyrus; **Thal**: thalamus

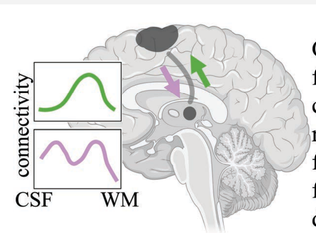
CONCLUSION

With low alertness, long-range functional connectivity increases in the visual attention network, and subcortico-cortical connectivity is altered among high-level brain regions.



Next Steps

When alertness decreases, is passive viewing enabled by increased top-down modulation, e.g., between cortex and subcortex?



Cortical layer functional connectivity reveals feedforward/ feedback directionality[8]

1. Oken et al., 2006, Clinical Neurophysiology
2. Canales-Johnson et al., 2020, JNeuro
3. Finn et al., 2021, NeuroImage
4. Jagannathan et al., 2018, NeuroImage
5. Van Essen et al., 2013, NeuroImage
6. Nastase et al., 2019, SCAN
7. Cox, 1996, Computers and Biomedical Research
8. Huber et al., 2021, Prog in Neurobiol