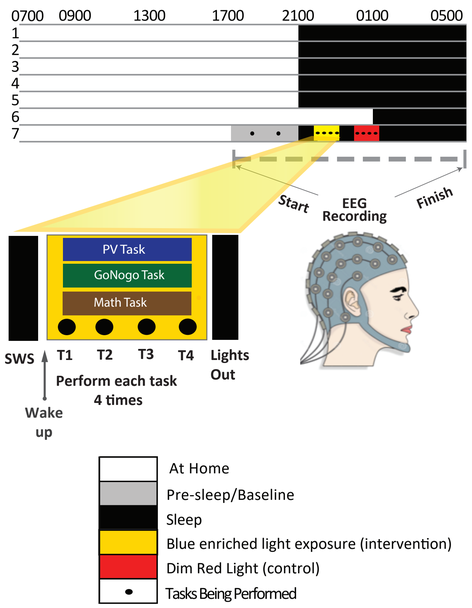
Brain Networks After Abrupt Awakening with Enriched Blue Light Exposure Under Different Task Demands

L. O. Jimenez[1,2], K. Bansal[1,2,3], C. L. Hilditch[4], N. L. Shattuck[5], J. O. Garcia[1,2], E. E. Flynn-Evans[6]

Background

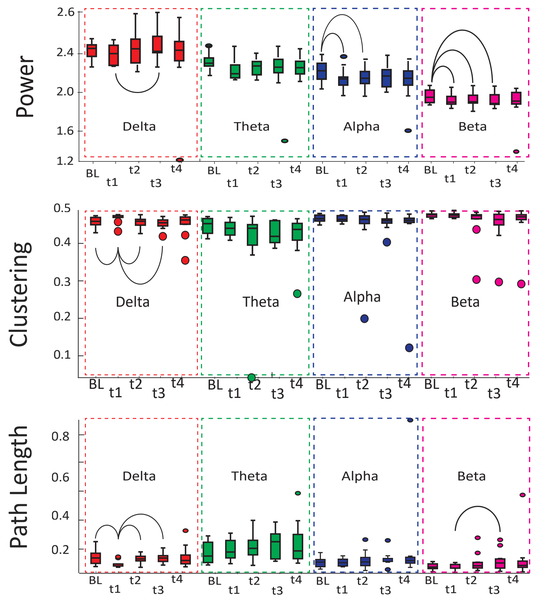
Sleep inertia refers to the state of transition between sleep and wake characterized by impaired alertness, confusion, and reduced cognitive and behavioral performance. While the neurobehavioral symptoms of sleep inertia are well-described, less is known about the impact of blue-enriched light on this profile, and the cognitive specificity of these effects. Here we explore the waking brain from a graph theoretical perspective. We assess two key network properties after abrupt waking: the clustering coefficient, which measures how likely two network regions are connected to one another, and average path length, which measures the average shortest path between pairs of regions. With this approach, we describe how exposure to blue-enriched light during sleep inertia attenuates changes in clustering and path length of brain networks while engaging in different cognitive tasks.

Methods

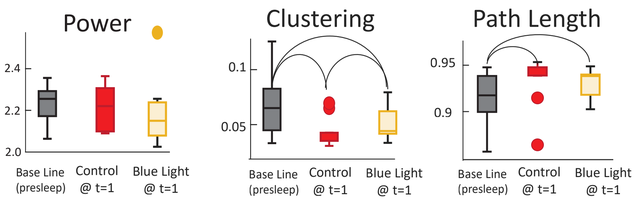


PV Task

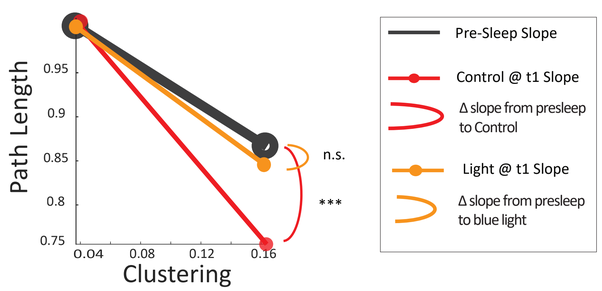
1 Comparison for Power, Clustering and Path Length across time for all frequencies in the control condition (dim, red light) *while performing a PV task*



2 Comparison of power, clustering and path length during pre-sleep, control at time 1 and light at time 1 for the delta frequency, *while performing a PV task*

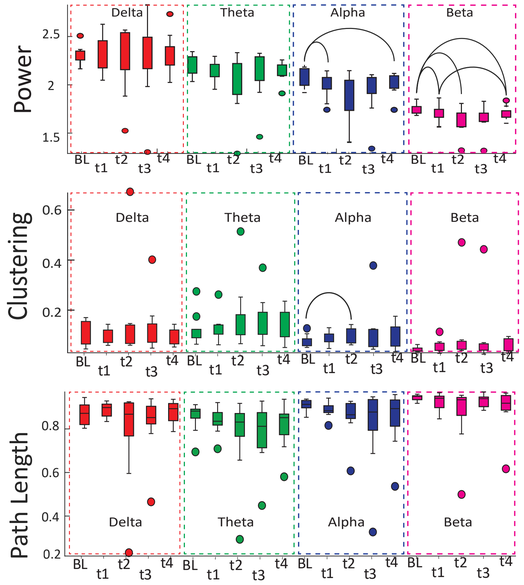


3 Differences in the slope of path length Vs. clustering in the delta frequency *while performing a PV task*

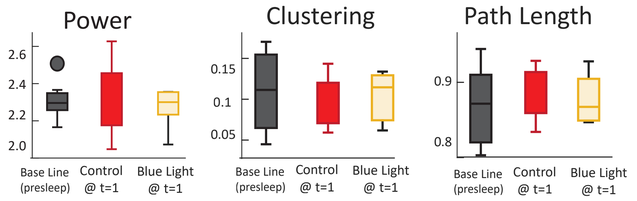


Go Nogo Task

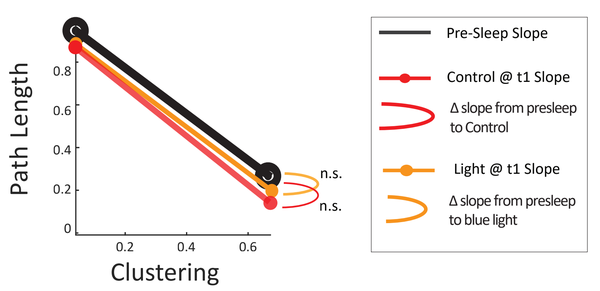
4 Comparison for Power, Clustering and Path Length across vtime for all frequencies in the control condition (dim, red light) *while performing a GoNogo task*



5 Comparison of power, clustering and path length during pre-sleep, control at time 1 and light at time 1 for delta frequency, *while performing a GoNogo task*

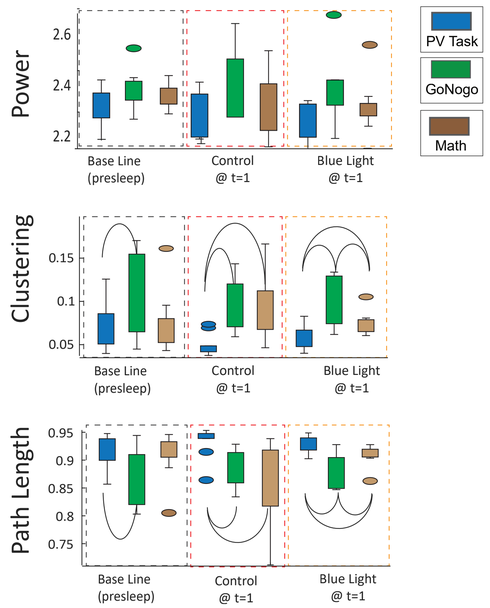


6 Differences in the slope of path length Vs. clustering in the delta frequency *while performing a GoNogo task*



Comparing Tasks

7 Comparing power, clustering and path length across tasks for the delta frequency during pre-sleep baseline, control at time 1 and light at time 1



Discussion

Given the consistency of the power effects observed accross tasks, there may exist a component of the brain that is always impacted by abrupt awakening, regardless of the cognitive demands required after waking. This component of the brain, however, is not affected by blue light intervention.

Together, these results suggest that another neural scheme exists where the brain becomes sensitive to both sleep inertia and intervention but only under certain cognitive states.

References

- Hilditch, Cassie J., et.al. 2022; "Rise and Shine: The Use of Polychromatic Short-wavelength-enriched Light to Mitigate Sleep Inertia at Night Following Awakening from Slow-wave Sleep." Journal of Sleep Research
- Bassett, Danielle Smith, and Ed Bullmore 2008 "Small-World Brain Networks." The Neuroscientist
- Hilditch, Cassie J, and Andrew W McHill 2019. "Sleep Inertia: Current Insights." Nature and Science of Sleep

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