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Toward a complete taxonomy of resting state networks across wakefulness and sleep: an assessment of spatially distinct resting state networks using independent component analysis

Evan Houldin, Zhuo Fang, Laura B Ray, Adrian M Owen, Stuart M Fogel

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Abstract

Resting state network (RSN) functional connectivity (FC) has been investigated under a wealth of different healthy and compromised conditions. Such investigations are often dependent on the defined spatial boundaries and nodes of so-called canonical RSNs, themselves the product of extensive deliberations over distinctions between functional magnetic resonance imaging (fMRI) noise and neural signal, specifically in the context of the healthy waking state. However, a similar unbiased cataloging of noise and networks remains to be done in other states, particularly sleep, a healthy alternate mode of the brain that supports distinct operations from wakefulness, such as dreaming and memory consolidation. The purpose of this study was to explicitly test the hypothesis that there are RSNs unique to sleep. Simultaneous electroencephalography (EEG) and fMRI was used to record brain activity of non-sleep-deprived participants. Independent component analysis was performed on both rapid eye movement (REM; $N = 7$) and non-REM sleep stage fMRI data (non-REM2; $N = 28$, non-REM3; $N = 11$), with the resulting components spatially correlated with the canonical RSNs, for the purpose of identifying spatially distinct RSNs. Surprisingly, all low-correlation components were positively identified as noise, and all high-correlation components comprised the canonical set of RSNs typically observed in wake, indicating that sleep is supported by much the same RSN architecture as wakefulness, despite the unique operations performed during sleep. This further indicates that the implicit assumptions of prior studies, i.e. that the canonical RSNs apply to sleep FC analysis, are valid and have not overlooked sleep-specific RSNs.

EEG, fMRI, sleep, resting state network, REM, non-REM, EEG-fMRI, ICA

Topic:

electroencephalography

wakefulness

noise

sleep

functional magnetic resonance imaging

Issue Section: Basic Science of Sleep and Circadian Rhythms

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