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The neural tides of sleep and consciousness revealed by single-pulse electrical brain stimulation

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Abstract

Wakefulness and sleep arise from global changes in brain physiology that may also govern the flow of neural activity between cortical regions responsible for perceptual processing versus planning and action. To test whether and how the sleep/wake cycle affects the overall propagation of neural activity in large-scale brain networks, we applied single-pulse electrical stimulation (SPES) in patients implanted with intracranial EEG electrodes for epilepsy surgery. SPES elicited cortico-cortical spectral responses at high-gamma frequencies ($CCSR^{HG}$, 80–150 Hz), which indexes changes in neuronal population firing rates. Using event-related causality (ERC) analysis, we found that the overall patterns of neural propagation among sites with $CCSR^{HG}$ were different during wakefulness and different sleep stages. For example, stimulation of frontal lobe elicited greater propagation toward parietal lobe during slow-wave sleep than during wakefulness. During REM sleep, we observed a decrease in propagation within frontal lobe, and an increase in propagation within parietal lobe, elicited by frontal and parietal stimulation, respectively. These biases in the directionality of large-scale cortical network dynamics during REM sleep could potentially account for some of the unique experiential aspects of this sleep stage. Together these findings suggest that the regulation of conscious awareness and sleep is associated with differences in the balance of neural propagation across large-scale frontal-parietal networks.

brain waves, human electrocorticography, high-gamma activity, effective connectivity, causal interactions

Topic:

- consciousness related finding
- electric stimulation
- sleep stages
- rem sleep

wakefulness

brain

frontal lobe

parietal lobe

pulse

sleep

sleep, slow-wave

brain stimulation

electrocorticogram

asha council for clinical specialty recognition

fluid flow

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