

Whole-Night Continuous Rocking Entraines Spontaneous Neural Oscillations with Benefits for Sleep and Memory

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Abstract

Sensory processing continues during sleep and can influence brain oscillations. We previously showed that a gentle rocking stimulation (0.25 Hz), during an afternoon nap, facilitates wake-sleep transition and boosts endogenous brain oscillations (i.e., EEG spindles and slow oscillations [SOs]). Here, we tested the hypothesis that the rhythmic rocking stimulation synchronizes sleep oscillations, a neurophysiological mechanism referred to as "neural entrainment." We analyzed EEG brain responses related to the stimulation recorded from 18 participants while they had a full night of sleep on a rocking bed. Moreover, because sleep oscillations are considered of critical relevance for memory processes, we also investigated whether rocking influences overnight declarative memory consolidation.

We first show that, compared to a stationary night, continuous rocking shortened the latency to non-REM (NREM) sleep and strengthened sleep maintenance, as indexed by increased NREM stage 3 (N3) duration and fewer arousals. These beneficial effects were paralleled by an increase in SOs and in slow and fast spindles during N3, without affecting the physiological SO-spindle phase coupling.

We then confirm that, during the rocking night, overnight memory consolidation was enhanced and also correlated with the increase in fast spindles, whose co-occurrence with the SO up-state is considered to foster cortical synaptic plasticity. Finally, supporting the hypothesis that a rhythmic stimulation entrains sleep oscillations, we report a temporal clustering of spindles and SOs relative to the rocking cycle.

Altogether, these findings demonstrate that a continuous rocking stimulation strengthens deep sleep via the neural entrainment of intrinsic sleep oscillations.

Keywords: entrainment; memory; phase-amplitude coupling; sensory stimulation; sleep; slow oscillation; spindles.