Role of sleep spindles in motor memory consolidation

Sleep benefits motor memory consolidation, which is thought to be mediated by thalamo-cortical spindle activity (~11-16 Hz) and associated reactivations of task-related neural patterns during non-rapid-eye movement (NREM) sleep. However, direct experimental evidence supporting the contribution of such sleep-dependent physiological mechanisms to motor memory consolidation in humans is lacking. Also, the particular role of NREM-stage2 and NREM-stage3 sleep spindle activity upon this mnemonic process remains controversial. Hence, we combined EEG and fMRI sleep recordings following practice of a motor sequence task to determine whether stage-specific sleep spindles mediate motor memory consolidation by reactivating and transiently synchronizing specialized cortical and subcortical networks. To this end, we conducted EEG source reconstruction on spindle epochs in both cortical and subcortical regions using deep-source localization techniques. Coherence-based metrics were adopted to estimate functional connectivity between cortical and subcortical structures in the spindle frequency band. Our findings provided evidence that NREM-stage2, but not NREM-stage3, sleep spindles are involved in motor memory consolidation by rhythmically reactivating and functionally binding specific task-relevant cortical and subcortical regions within networks including the hippocampus, putamen, thalamus and motor-related cortical regions.