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ELECTROPHYSIOLOGICAL NEUROIMAGING REVEALS RE-SET, RE-ACTIVATION AND RE-PROCESSING OF PROCEDURAL AND DECLARATIVE MEMORY TRACES DURING POST-TRAINING SLEEP

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Objectives: Experience-dependent cortical plasticity observed during post-training sleep has been hypothesized to be part of the global process of memory consolidation. Combining the temporal resolution of microstructure detectors and the spatial resolution of low-resolution brain electromagnetic tomography (LORETA) makes it possible to investigate when and where the experience-dependent reactivation occurs under normal (undisturbed) sleeping conditions.

Methods: After an adaptation night, in the 2nd and 3rd night 48 young healthy volunteers were randomly assigned either to a control condition or to an experimental condition (declarative memory task: paired-associate word list or procedural memory task: mirror tracing). Sleep stages and sleep microstructures (slow waves, spindles and theta bursts) were detected automatically by means of the Somnolyzer 24x7. Changes in LORETA sources (experimental minus control night) were correlated with changes in memory performance (morning minus evening recall).

Results: Overnight improvements in the mirror tracing task were correlated with increased slow-wave sources in the right posterior parietal cortex ($r=.70, p< 0.01$) during NREM sleep and with desynchronized ($r=-.76, p< 0.01$) and synchronized ($r=.62, p< 0.01$) rolandic mu rhythm sources during periods with theta bursts in REM sleep. Overnight improvements in the declarative memory task were significantly correlated with increased spindle sources ($r= .52$, $p< .01$) in frontal, temporal and cingulate brain regions.

Conclusions: The present study supports the hypotheses of (1) a use-dependent reset of synaptic plasticity during slow-wave sleep (restorative function), (2) an experience-dependent reactivation during spindle episodes (stabilizing function) and (3) an off-line neuronal reprocessing during REM sleep (improvement without further training for novel tasks).

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