Memory consolidation across the sleep-wake cycle. A neuroimaging perspective.

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During the last decade, functional brain imaging techniques have provided strong support to the hypothesis that sleep participates in the off-line processing of recently acquired memory traces. Functional neuroimaging results indicate that learning-dependent modulations in cerebral activity during human sleep reflect the offline processing of recent memory traces, which eventually leads to the plastic changes underlying the subsequent improvement in performance. Sleep-memory relationships have been also probed by investigating the effect of post-training sleep deprivation on cerebral activity and performance. Results showed that covert reorganization of brain patterns underlying navigation following sleep is not necessarily accompanied by overt changes in behaviour, and indicated that information progressively transfers from hippocampal to neocortical stores during sleep episodes. Additionally, interactions between wake- and sleep-dependent processes are determinant in memory consolidation. Functional MRI data show that brain activity elicited during new learning episodes modulates brain responses to unrelated cognitive tasks during the waking period that follows the end of practice, and that sleep-dependent processes are triggered by wake signalling neural and behavioural mechanisms. These findings should now be integrated with novel data highlighting specific neural substrates for inter-individual circadian differences in cognitive processes. As a whole, neuroimaging findings indicate that long-term persistent neural activity in learning-related networks after practice has ended constitutes a fundamental mechanism of information maintenance on the long-term -- on a time scale of hours, nights and days, which initiates/accompanies the cascade of wake- and sleep-related processes that supports dynamic consolidation of recent memories.