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COGNITION IN SLUMBERLAND
INTRODUCTION TO THE SPECIAL ISSUE

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Sleep occupies a prominent part of our life. Particularly abundant in the neonate, it undergoes a series of qualitative and quantitative changes that accompany the main steps of every individual's development and aging, from childhood to adolescence and through adulthood to seniority. One is therefore led to believe that sleep plays a series of important functions. Among several non mutually exclusive proposals, it has been hypothesized that sleep is useful for, e.g., energy conservation (Berger & Phillips, 1995), brain thermoregulation (McGinty & Szymusiak, 1990), brain detoxification (Inoue, Honda, & Komoda, 1995) and tissue restoration (Adams, 1980). Beyond these physiological processes however, scientific evidence suggests that the mind remains active in the sleeper, including elaborate processing of external stimulations, dreams, revival of experiences and consolidation of memories. In this Special Issue of *Psychologica Belgica*, we will keep company with Little Nemo, the character created by the foremost precursor of modern comics, Winsor McCay (1867-1934), as he experiences incredible adventures every night again in the dream world of Slumberland. To do so, a series of contributions has been gathered with the primary goal of offering an integrative view on the various mechanisms of information processing in the sleep-wake cycle.

In 1867, Hervey de Saint-Denys posited that sleep without dreams cannot exist, just as wake state without mentation does not exist. How to access the content of these dreams in the sleeping subject continues to pose gordian methodological problems nowadays. Here, *Sophie Schwartz* introduces the advantages of lexical statistics for a scientific analysis of dreams, assuming that cognition during sleep can be inferred from typical or common features in dream reports. Since immaterial cognitive processes cannot be segregated from their neurophysiological counterparts, she also proposes that the peculiar features that characterize our dreams reflect the transient activity of specialized brain regions during sleep. But does it mean that Slumberland is a physiological state during which our interactions with the real world are suspended? The answer appears to be no, at least to some extent. In his review

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of event-related potentials (ERPs) studies in sleeping subjects, *Fabien Perrin* clearly demonstrates that the human brain can process external auditory information during sleep, and even carry out some semantic analysis of these stimuli.

Looking at these same issues from a different perspective, *Christian Cajochen, Katharina Blatter and Dieter Wallach* remind us that a definitive feature of sleep is that sleep and wake periods occur at specific times of the circadian cycle. Because human sleep mostly occurs at night, the effect of specific sleep mechanisms on cognition might be confounded by the influence of the circadian phase. The data presented here show that both the circadian cycle and the time spent awake (i.e., the sleep pressure) exert an influence on a series of neurobehavioral functions during wakefulness, but also suggest that circadian rhythms interact with sleep stages for the consolidation of some procedural skills. This last point motivates the hypothesis that sleep processes contributes to brain plasticity and memory consolidation (for a thorough review see Maquet, Smith, & Stickgold, 2003), a theme specifically shared by the last three contributors. According to the "sleep for memory" hypothesis, memory traces formed during a learning episode in the awake state stay in a fragile state until the first post-training sleep episode, during which the new information will be strengthened and consolidated in long-term memory. At this point however, it should be remembered that sleep, like memory, is not an unitary phenomenon. It is therefore likely that specificities of each sleep stage differently contribute either to the processing of different type of memories or at different processing stages in the way leading to the long-term consolidation of recently learned information, or both. *Carlyle Smith, Jocelyn Aubrey and Kevin Peters* propose here an original model to conceptualize the respective roles of Stage 2 sleep and rapid-eye-movement (REM) sleep for the consolidation of motor procedural memories. In their view, neurophysiological and neurochemical differences between these sleep stages explain their respective importance at different steps of the consolidation process, according to the degree of novelty of the task to the participant. Based on evidence for a sleep-dependent consolidation of perceptual visual memories, *Steffen Gais and Jan Born* likewise propose that memory consolidation during sleep requires a two-step process, initially dependent on slow-wave sleep (SWS) and, in a later phase, on REM sleep. Electrophysiological, neuromodulatory, and neuroendocrine mechanisms that may work on a newly acquired memory trace during sleep stages in man and animals are discussed and confronted to the multi-step hypothesis. Finally, *Philippe Peigneux, Gwenaëlle Melchior, Christina Schmidt, Thanh Dang-Vu, Mélany Boly, Steven Laureys and Pierre Maquet* discuss the contribution of functional brain imaging studies to the identification of several determinants and outcomes of memory reprocessing during sleep, with a special emphasis on sleep mechanisms deemed potentially important to support sleep-related brain plasticity and memory consolidation.

The papers included in this issue offer a overview (admittedly non exhaustive) of cognitive processes and their neurophysiological counterparts during sleep. Despite increasing attention, the topic has been overlooked by many psychologists and neuroscientists for many years. Hopefully, we will convince them to join Little Nemo in Slumberland, at least occasionally, to think carefully about the effects that sleep and circadian rhythms may exert on cognitive processes and their underlying mechanisms.

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