

Memory consolidation requires both rem and non-rem sleep essay



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Sleep is typically described as “ a reversible, temporary, unresponsiveness, and periodic state of suspended behavioral activity, and perceptual disengagement from the environment” (Maquet 1048). Although the sleeping individual is generally unconscious on the environmental events, he or she is most probably engaged in dreaming (Fischer, Wilhelm, and Born 223). A typical sleep at night is comprised of about ninety minute cycle periods of rapid-eye movement or REM sleep and non-REM sleep (Stickgold 1273). The first half in the human sleep is a SWS period with some REM sleep while the opposite of this pattern happens in the late sleep (Gais, Plihal, Wagner, and Born 1335).

The non-REM sleep has four stages wherein its third and fourth stages, called slow-wave sleep or SWS, are the deepest with 0.5 to 4.0 Hz of electroencephalogram or EEG oscillations (Stickgold 1273). Also, the non-REM stages varied significantly in dreaming intensity and frequency, muscle tone, EEG oscillations, cortical circuit neuromodulation, eye movements, memory system communication, and on the activation of regional parts of the brain (Sullivan and de Sa 3111). Further, the REM, SWS, and the non-REM second stage are directly related to memory processing.

These stages have respective cortical neuronal activation characteristics: the slow-wave traits in SWS, the REM theta rhythms and ponto-occipitogeniculate waves, and the spindles of non-REM second stage (Stickgold 1273). The first half in the human sleep is a SWS period with some REM sleep while the opposite of this pattern happens in the late sleep (Peters, Smith, and Smith 817). Memory is generally categorized into declarative and non-declarative memories. Declarative memory comprises

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the facts and events that are readily recalled by the individual while those normally applied in daily actions in the absence of conscious recollection are non-declarative memories (Walker and Stickgold 121).

Further, declarative memory is classified as semantic or word memory and episodic or scene memory. On the other hand, memory consolidation is supported by the processes which occur during the period of sleep (Gais, Plihal, Wagner, and Born 1335). Memory consolidation is the conversion of labile traces of memory into a refined form through the brain's neocortical areas and medial temporal lobes. The notion concerning sleep-dependent memory has been proposed as early as 1900 (Rauchs, Desgranges, Foret, and Eustache 123).

As theorized, SWS sleep is important for declarative memory consolidation. This includes memories for facts and events that are readily accessible. On the other hand, the non-declarative memory consolidation is directly enhanced not by non-REM sleep alone but also by REM with SWS sleep (Rauchs, Desgranges, Foret, and Eustache 123). This means that the amounts of SWS and REM sleep in both early and late sleep have significant contributions in memory consolidation.

On this basis, the "double-step" or "sequential" hypothesis was proposed that stressed the crucial role of harmonious REM and non-REM sleep sequence in the consolidation of memories (Rauchs, Desgranges, Foret, and Eustache 124). The stages of sleep were deemed essential despite of memory system types. Hence, REM and non-REM sleep are complementary; the night sequence of the sleep stages projects the neural processes

converting the labile trace memory into a more refined form (Rauchs, Desgranges, Foret, and Eustache 124). It was observed that human memory for both spatial and word pairs largely benefit from early sleep characterized mainly by slow-wave sleep or SWS than rapid-eye movement or REM-dominated sleep (Gais, Plihal, Wagner, and Born 1335).

Although this observation was associated with declarative memory and ascribed as a function of the structures of the temporal lobe and of the hippocampus, its relations with the procedural and non-declarative memory type were recently noted. Procedural memory is a pre-attentive or an implicit learning through motor and sensory skills. Also, it does not require the functions of the hippocampal but is merely dependent on the subcortical and neocortical structures (Gais, Plihal, Wagner, and Born 1335). Further, depending on the type of memory either of the REM and non-REM sleep plays a bigger role than the other. As such, the non-declarative memory takes advantage on non-REM sleep while the declarative memory gains higher benefits from SWS sleep.

Related Studies Since the consolidation of discrimination ability is predominantly strengthened by REM sleep, the sleep of the individual should be controlled in such a way that REM is more favored rather than SWS (Wright, Jr. 509). In connection to this, Gais, Plihal, Wagner, and Born (1335) designed a texture discrimination task on the basis of late and early sleep. For their control, the subjects were kept awake in the whole period of retention as the performance improvement was gauged using stimulus to mask onset asynchrony, SOA, or by time comparison of stimulus

presentation to discriminate its orientation prior to and after the retention. In <https://assignbuster.com/memory-consolidation-requires-both-rem-and-non-rem-sleep-essay/>

the basic texture differentiation, the improvement of one's performance is internally governed by the intricate neuron organization on the early part of the pre-attentive visual processing. The improvement of the task perception takes place not during the presentation of the visual stimulus but in more than eight hours after the task (Gais, Plihal, Wagner, and Born 1335).

This is an indication that the latent learning process takes effect gradually. In relation to this, the direct role of sleeping on the proper retention of the stimulus and in the performance improvement was theorized. While the REM-sleep disruption hinders the improvement of the stimulus perception, the disruption of the slow-wave sleep or SWS has no significant effect (Gais, Plihal, Wagner, and Born 1335). Thus, the texture discrimination task becomes a perceptual task through the neuron processes during REM sleep which in turn improves task performance. On the other hand, the REM sleep disruption was criticized for it supported both cognitive and emotional interferences in the retrieval testing of the task performance which made difficulties to arrive at a conclusive proof of the consolidation process. Gais, Plihal, Wagner, and Born (1336) found that performance improvement in the texture discrimination task was observed during the night sleep of the subjects with SWS early sleep experience.

As the subjects remained awake in the retention period, the ability for texture discrimination declined. Moreover, the circadian rhythms failed to affect the subjects' performance on discrimination task while the occurrence and deprivation of sleep was poorly correlated with the task's performance (Gais, Plihal, Wagner, and Born 1336). This study proved that sleep after stimulation has improved visual discrimination. In the comparison between <https://assignbuster.com/memory-consolidation-requires-both-rem-and-non-rem-sleep-essay/>

early and late sleep, it was revealed that the subjects in the late sleep group have three times greater improvement of performance than the subjects under early sleep (Gais, Plihal, Wagner, and Born 1338).

This improvement was not only ascribed with the length of the retention time but also on the consolidation process. Even though the study did not directly confirm the relationship between REM sleep and the improvement on visual discrimination but it reflected the significance of REM sleep in memory consolidation. On the other hand, REM sleep alone was inadequate for both visual discrimination learning and consolidations of memories (Gais, Plihal, Wagner, and Born 1338). As well, after early sleep, the texture discrimination consolidation was declined due to REM sleep arousals along with SWS instigated consolidation. As memory bits reinforce, the neocortical induction in REM sleep results to strengthening of memory traces (Gais, Plihal, Wagner, and Born 1338). However, the study was not designed to unravel the significance of SWS and REM respectively in late and early sleep.

The group of De Koninck reported that increased REM sleep after foreign language instruction has led to a good learning outcome (Walker 291). Similarly, the group of Born presented that the posttraining REM with SWS sleep has led to improved performance in word-pair associate task among their subjects (Walker 291). In addition, it was demonstrated that emotional declarative texts favorably retained through REM-dominated late-night sleep as compared with neutral texts (Walker 292). The review conducted by Rauchs, Desranges, Foret and Eustache (123) on various sleep researches, the four systems of long-term memory, based on the Tulving's SPI model, are benefited in not only in REM sleep but also in non-REM and SWS sleep. <https://assignbuster.com/memory-consolidation-requires-both-rem-and-non-rem-sleep-essay/>

The research group of Maquet in 2000, through serial reaction time or SRT task, made a positron emission tomography or PET study wherein the manifestation of the stimuli occurred based on probabilistic sequence (831).

They observed that specific brain parts of the subjects like the left supplementary motor area and the cuneus bilaterally that were activated in the training phase were also more active during their respective REM sleep. This was the first human study which showed that the training task recorded in the specific zones of the brain is repeated during sleep. In the following year, Laureys' research group dealt with the functional implications of the observed reactivations (521). They found that in the REM sleep of the subjects, the functions of the left premotor cortex was close to that of the left posterior parietal cortex as well as with the functions of bilateral presupplementary motor area. These functional implications were attributed to the collaborative optimization of the cerebral zones with the neural system which has connections with the visuomotor response of the subjects.

This phenomenon was hypothesized as the primary reason for the performance improvement in the SRT task in the following training sessions. The study then confirmed the crucial role of REM sleep in memory consolidation. Ficca, Lombardo, Rossi and Salzarulo conducted a study wherein the subjects undergone a verbal training and a verbal recall of the learned material was induced after three different night sleep: interrupted fragmented, undisturbed, and fragmented without sleep cycles. They found that among the considered variables, only the amount of REM and non-REM cycles or sleep organization has direct impact on the verbal recall (Ficca, Lombardo, Rossi and Salzarulo 161). This observation was postulated with <https://assignbuster.com/memory-consolidation-requires-both-rem-and-non-rem-sleep-essay/>

the connection among intra-sleep memory consolidation, sleep cycles, and protein synthesis (Ficca, Lombardo, Rossi and Salzarulo 161). In the end, they concluded that the verbal recall of the learned material after different types of sleep is largely governed by sleep organization.

Sleeping, Dreaming and Memory In sleeping, the individuals generally experience dreams. Thus, we may logically infer that dreaming is a consequence of memory consolidation process. The analysis of dreaming in relation to the physiological phenomenon of REM sleep is a great advancement in the avenue of scientific dream studies (Franklin and Zyphur 61). The state of dreaming was defined as the experiences occurring in the subjective conscious state of an individual in sleeping while REM sleep refers to the physiological state of sleep (Franklin and Zyphur 61).

Various dream reports proved that during REM sleep, dreaming occurs. As such, dreaming was described as non-static process with discrete phases as indicated by physiological measurements (Franklin and Zyphur 61). Even though most of the time we could hardly remember every detail of our own dreams, we generally remember the parts prior to our awakening. Through our very own dreams, we experienced the emotion, cognitive, kinesthetic, visual, tactile, metacognitive, tactile, and other sensory attributes while dreaming (DeGracia 2).

Since consciousness is a physiological condition which encompasses the mental, sensory, and emotional aspects of the individual, dreaming then is a conscious experience during sleep (DeGracia 2). Dreams occur not only in REM sleep but also in non-REM sleep with respective occurrence probability

of 80% and 30% (DeGracia 2). The application of electro-oculography or EOG, EMG or electromyography, and electroencephalography respectively for eye movement, muscle movement and brain activity was found to be functional in the differentiation of arousal states during sleep (Franklin and Zyphur 61). In particular, the REM sleep is the hyperactivated stage as characterized by alpha and beta EEG activities similar to the conscious state, deterred muscle activity due to induced paralysis, and movements of the eyes (Franklin and Zyphur 61). The application of electroencephalography or EEG in the field of dream research in 1960s has led to the discovery of electrophysiological attributes and in-depth understanding of dreams (DeGracia 3). As well, the development of scientific views on dreaming was ascribed to the intensive dream researches conducted in various fields related to brain studies like in psychoanalysis, neuropsychology, and other specialized psychological fields (DeGracia 5).

Since Freud made the pioneering methodological works on dream analysis, dream studies were generally categorized into pre-Freudian and post-Freudian periods (DeGracia 5). Meanwhile, the discovery of sleep cycle in 1950s marked the downfall of Freudian influence in dream studies and paved for the emergence of psychophysiological approach in dream analysis (DeGracia 5). In psychophysiological approach, dreams were treated as products of physiological processes which in turn generate sleep cycle (DeGracia 5). This view was found limited through the discovery that dreams do not only occur in REM sleep but also observed in non-REM sleep. Hence, at present time, dream occurrence is viewed as a process independent from the EEG observed responsible process for sleep cycle (DeGracia 5).

Moreover, researches in cognitive science showed that the psychological constructs of dreams are identical to the psychological principles underpinning the normal conscious state of any individual such as in the use of language and other aspect of sensory perceptions (DeGracia 5).

In 1980, the most significant contribution of dream research in the 20th century was the successfully made by experimental demonstration of a subject that can directly communicate with other individuals while in the state of dreaming (DeGracia 5). Sleep is described as a reversible, temporary, unresponsiveness, and periodic state of suspended behavioral activity, and perceptual disengagement from the environment while the state of dreaming is defined as the experiences occurring in the subjective conscious state of an individual while sleeping. Even though the individual is temporarily disconnected from his or her surrounding during sleep, he or she generally experience dreams. On the other hand, not only REM with SWS sleep has direct role in memory consolidation but also non-REM sleep was consistently correlated with the same function.