NEUROPHYSIOLOGY

Are you one of 70% people that want to learn a foreign language: Have a nap and learn

New foreign words and their translated words could be stored into memory as associations during a midday nap.

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Seventy percent of the population is interested in learning another language; however, most people do not have enough time[2]. As opposed to the standard 40 hours workweek, the average American works a 47-hour per week, which is equivalent to working an extra day[3]. Forty seven percent of workers argue that they do not have enough free time; American mothers only have an estimated 36 minutes of leisure time[4]. If humans cannot find a time during the day to learn a few new words, is it possible to store new information during sleep? This was the research question of a scientist from the University of Bern in Switzerland. Most sleep research focuses on the consolidation (strengthening) and stabilization of memories that are formed during periods of consciousness. However, the examination of learning during sleep is rarely performed. For the first time, Katharina Henke and her colleagues showed that new foreign words and their translated words could be stored into the memory as associations during a midday nap[1]. Following waking, when represented with formerly sleep-played foreign words, participants were able to reactivate the sleep-formed associations to access word meanings which suggest that memory formation does not appear to require consciousness.

There are two types of sleep: non-rapid eye movement (NREM) and rapid eye movement (REM) sleep. NREM is considered a deep sleep, which is divided into further stages representing a continuum of relative depth. The interesting thing about deep stages is that our brain cells changing its activity every half-second, depicting as waveforms of varying frequency and amplitude[6,7]. Those cells transition from activate states ("up-state") to inactive states ("down-state) to active again and so on.

To perform the experimental goal, 41 physically and mentally health native German speakers, between age 19 and 32, were recruited. Participants were asked to have 4 hours of sleep the night before the experiment to increase their propensity to sleep. Once subjects arrived at the sleep laboratory, they were outfitted with electroencephalogram (EEG) electrodes and in-ear headphones. Then they were asked to take a nap. The EEG allowed the scientists to monitor the different stages of sleep for each participant. As a subject reached the criterion for slow-wave sleep (up-state) each pair of pseudowords and real German words were repeated four times in sequence, changing the order of presentation each time (pseudoword – a German word, German word – pseudoword). The study introduced to participants as an investigation of "how sleep contributes to the ability to correctly guess the meaning of foreign words from a language one has never encountered before." Therefore, contributors were unaware that words had been presented to them while they were asleep. That was done to prevent subjects from consciously trying to attend to the sleep-played words in future awake-learning test. The experiment stopped when the

EEG showed signs of arousal depicted as the reappearance of slow-waves. The subject's data were analyzed only if at least 20 sleep-played word pairs were played. After waking up, participants took an implicit memory test. Pseudowords were presented both acoustically and visually to the subjects who were asked to decide the meaning of the word. During this awake-learning test, functional magnetic resonance imaging (fMRI) was used to decode areas of the brain that were involved in the recruitment of the memory.

The researches were examining whether a sleeping person can form new semantic associations between played foreign words and translated words during the brain cells' up-states (Figure 1). Semantic associations refer to something that is logically related to the meaning of the word. The scientists found that those association can be stored only if the second word of a pair was repeatedly played during an active state of deep sleep. For instance, a sleeping person, heard the word "tofer" paired with its translated word "house" or "guga" – "key", after waking up was able to categorize with a better-than-chance accuracy whether those foreign words denominated something large ("tofer") or small ("guga"). The overall success rate was found to be 60%.

Physiologically speaking, scientist found that language areas of the brain and the hippocampus, the brain's essential memory hub, were activated during retrieval of sleep-learned vocabulary where these brain structures usually mediate wake-learning vocabulary[8,9,10].

This study opens up a door to a new world of memory formation regardless of consciousness or unconscious. From now on, sleep will no longer consider as unproductive time and can be used, not only to relax, but also to learn new foreign words. As Henke said, it is essential to examine how deep sleep can be utilized for the acquisition of new information and with what consequences.

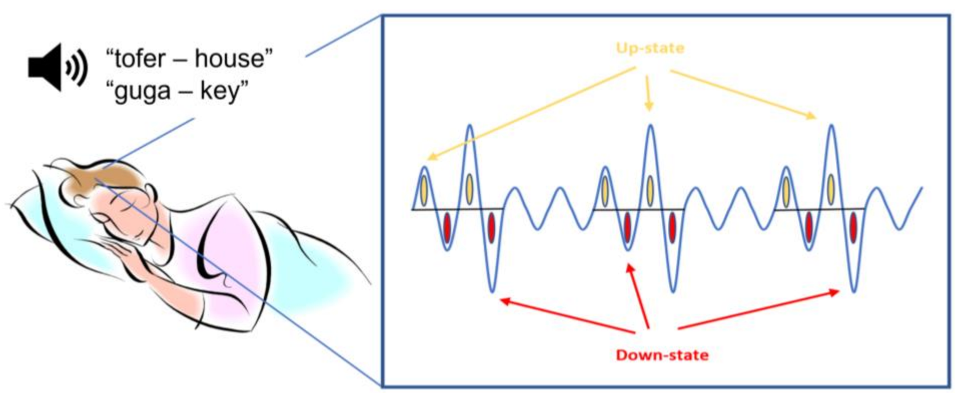

Figure 1. Representation of the EEG study during sleep. The figure represent sleeping person during deep sleep where brain electrical activity recording is performed using electroencephalogram (EEG). Left side of the image shows sleeping person being introduced to a pseudoword and a German translation word. Right side of the image shows electrical activity of the brain which denotes in waveform where slow oscillatory high-amplitude waves appears during deep sleep. Yellow ovals represent highly active phase (up-state) and red ovals indicates passive phase (down-state). A word pairs were played during slow wave peak (Up-state).

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