



Could slumber be the key to effective learning?

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are related to sleep, and I wanted to learn more about how REM (rapid eye movement) sleep links to memory and learning. This is a stage of sleep when the majority of dreaming occurs and when the brain is most active during the night. It has been hypothesised that REM sleep plays an important role in the transfer of information from short to long-term memory.

It is important to understand how memories are formed. For a memory to reach long-term storage, it must undergo a process called consolidation. A 2001 journal article from Science (1) states that during consolidation, memories are analysed and reactivated so they can be transferred from the hippocampus (short-term) to the prefrontal cortex (long-term). This is believed to occur during REM sleep due to the low-level external interruptions, as

discussed by Walker in a 2006 paper (2). Following on from this, the high level of the neurotransmitter acetylcholine in the brain during REM sleep has been shown to increase local plasticity, which allows memory consolidation to occur. The movement from short to long-term memory is beneficial for learning, as it clears space in the hippocampus to accommodate new memories; it also decreases the likelihood of forgetting the information in the near future.

Throughout the night, five sleep cycles occur, in which the body transitions from light sleep through stages I-IV of non rapid eye



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Life-long learning is a key part of all healthcare professions; whether it be learning anatomical structures or specific assessments for different maladies, effective learning is highly valuable in a field that contains such a wealth of knowledge. Having the ability to quickly absorb and accurately recall information is essential in medicine. Hence, I decided to research how one can improve their learning capability, and I was stunned by how important sleep hygiene is in memory. I found that memory, understanding, focus and motivation are the four most important aspects of learning that

movement(NREM) sleep, then into REM sleep and finally returning to light sleep. The third and fourth stages of NREM, also known as slow-wave sleep (SWS) have been hypothesised to be linked to memory consolidation by Rasch and Born in 2008 (3); they suggested that the low level of acetylcholine and cortisol in the brain during SWS links to increased plasticity of information in the brain. My opposing theory that I came up with states that SWS is still involved by facilitating the high level of acetylcholine in REM sleep, and thus it has indirect involvement in the process. I have adapted the graph in Figure 1 to show how the level of acetylcholine and how memory consolidation varies over the night through the cycles.

Understanding is of paramount importance for reliably and accurately absorbing new information, and it also provides foundations

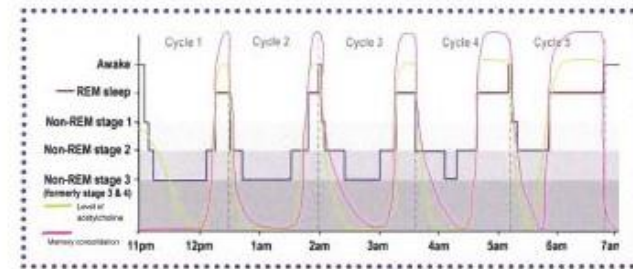


Figure 1. Acetylcholine levels during sleep cycles.

for applying new information - which is, of course, rife in medicine. The process of memory consolidation reactivates and links memories together, which helps individuals gain new perspectives, aiding understanding. This is where the phrase 'sleep on it' arose from. Not only does understanding make applying knowledge easier, but it also makes memorising information easier. If you understand why something is the way it is, it will aid transfer to long-term memory - this is why it is not advised to rely on rote memorisation for complex subjects. A Spanish study (4) showed that sleep

strengthens relevant neural pathways and weakens irrelevant ones, resulting in better understanding and memory.

It is well established that there is a correlation between lack of sleep and lack of focus, which is necessary for retaining information from studying. A lack of focus will mean you become easily confused and will struggle to make logical connections with the material at hand. In Walker's book 'Why We Sleep' (5), he discusses how the symptoms of sleep deprivation are identical to those of ADHD; for example, erratic and hyperactive behaviour. These negative impacts seldom result in focussed work, thus it is important to get sufficient sleep if you want to focus. Although there are methods to combat poor focus, preventing the issue in the first place is more effective than any remedy, so it is ill-advised to rely on caffeine or other such means to improve focus.



deprivation and a lack of effort. Sleep deprivation reduces the effectiveness of learning by negatively impacting motivation, thus being well-rested will increase drive and create spur for persistent effort.

Improving sleep hygiene will allow an individual to capitalise upon the benefits discussed above, eventually improving their learning. Reducing exposure to artificial light 1-2 hours before bedtime will make falling asleep easier and also improve sleep quality, as it ensures that melatonin (the sleep hormone) is released early. Sleeping in a cool environment around 18°C will improve sleep quality drastically because body temperature naturally fluctuates in a cycle where sleep is onset upon a drop in body temperature. Having a regular sleep pattern allows for optimal sleep quantity as it aids habit formation to stabilise the circadian rhythm, the body's natural clock. Similarly, being exposed to bright light early in the morning kick-starts the circadian rhythm and will facilitate early melatonin release in the subsequent evening.

In conclusion, sleep is highly important for ensuring one's learning is effective. Bettering sleep hygiene will improve memory, understanding, focus and motivation, which all contribute to successful learning in an academic field overflowing with information. Sleep is the solution to many issues related to learning, so investing your time into building healthy sleep habits is a simple way to fuel success in your future career. ●

Motivation is a pivotal part of education - being driven carries such a copious amount of weight that it has been suggested that it is more influential on success than natural intelligence. Although it is not the most powerful factor involved, it has been shown that sleep has a marked impact on motivation (6). Firstly, when sleep-deprived, an individual experiences an increase in perception of fatigue, which decreases their ability to persevere with a task. Secondly, there are fewer energy resources available for cognitive functions when sleep-deprived, so friction due to fatigue is encountered more often, and motivation is needed to overcome this. Lastly, there is a correlation between sleep



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