

Neurobiology of Learning and Memory in Mentally Fatigued Truck Drivers

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Abstract

Sleep is the normal rest of an organism. There are two types of sleep. REM and NREM. REM is considered the deep sleep and NREM is considered the lighter sleep. Sleep is also, organized by the brain. You also can sleep what you eat, meaning that, whatever you eat can affect the way you sleep. Memory is the ability to attain, store, and retain and recall information and past experiences in the human brain. Sleep affects learning and memory in a cause and effect

situation, if one does not attain enough sleep, their memory or learning ability will not be sufficient. One can maintain healthy or improve their learning and memory function by eating healthy, exercising, keeping stress level low and improving sleep quality. College students can improve sleep quality by revising instead of cramming, being active on campus and stimulating their brains by learning new information.

Neurobiology of Learning and Memory

Sleep is the normal, regular, state of rest for an organism. Humans normally have two types of sleep. One type is non-rapid eye movement (NREM) sleep, and the other is rapid eye movement (REM). These normally happen in a cycle in which alternate turns. After one cycle of NREM, which is the cycle of a deep sleep, then the lighter sleep cycle, which is the REM comes after that. The time intervals for non-rapid eye movement and rapid eye movement are 90-120 minutes. The person may briefly wake up after each interval.

In addition to the cycles humans undergo while sleeping, each cycle has stages. In the article "SLEEP" by Funk & Wagnalls New World Encyclopedia states, "The brainwaves of a person go through certain changes in the course of the sleep cycle." (Funk&Wagnells). It goes on to say that the EEG a person's waking stage is characterized by alpha waves. Alpha waves are, the normal electrical activity of the brain

when conscious and relaxed. Sleep begins with stage one non-rapid eye movement (NREM), which is the lightest stage of sleep. During this stage you have desynchronized and low-voltage activity. After a few seconds or minutes is when stage two occurs. The journal article goes on to say that, "...stage 2, a pattern showing frequent spindle-shaped tracings on the EEG, called sleep spindles, at about 14 cycles/sec, and certain high-voltage spikes known as K-complexes." (Funk&Wagnells). Stage three is where the high-voltage activity takes place. This stage begins with the appearance of delta waves. Delta waves are, electrical activity of the brain at a frequency of around 1–8 Hz, typical of sleep. The delta waves frequency is higher than the alpha wave frequency, hence low and high voltage levels. The fourth stage, is simply where the delta waves occupy the major part of the record.

With sleep, sometimes comes dreams. Dreams occur in the REM cycle. The article states that, "Persons awakened during periods of REM sleep frequently—60 to 90 percent of the time—report that they have

been dreaming. Indeed, dreams appear to rarely occur in other stages of sleep.” (Funk&Wagnells). Humans REM is characterized by the EEG patterns of reminiscent of those in stage one. Rapid eye movement is the most interesting cycle. “REM **sleep** include irregularities in pulse rate, respiratory rate, and blood pressure; the presence of full or partial penile erections in the male; and generalized low muscular tone interrupted by movements in small muscle groups.” (Funk&Wagnells)

Sleep is something organized by the brain, it also can affect your health. In the journal article, “Sleep and Metabolism: you sleep what you eat” state that, “Sleep is generated by the brain, but sleep certainly does not only impact brain function. Several epidemiological studies and interventional studies have provided evidence for an association between sleep parameters and sleep duration, and outcomes such as body mass index and cardiovascular risk factors.” (Dijk 2014). What happens when you change your energy balance? Can a change in diet affect a person’s energy balance? Some speculators suggest that believe that our food intake is affecting how we sleep. The article goes on to say, “...between sleep measures and some metabolic measures, and primarily so in girls, and not in boys.” (Dijk 2014) Therefore longer sleep is associated with the larger body mass and the larger waist. Females mostly are the ones who have the wider hips and larger body mass. Because of this females sleep longer than males.

Learning is the acquisition of knowledge or skills through experience, study, or by being taught. The way a person learns and how long the person sleep, goes hand in hand. Studies show that the longer a person sleeps, the more rested they feel. In the journal entry, “Semester Long Changes In Sleep Duration For College Students” state

that, “...The overall prevalence of short sleep ranged from 23% to 30%, and students reported a mean of 3.39 (SD = 1.48) days per week where they awoke feeling rested.” (Liguori 2011). Studies have been taken, to show how people respond to loss of sleep, on the next day. People generally are too tired to do any work that requires a lot of effort. In the journal article, “The Effect of Sleep Loss on next Day Effort” states that, having being deprived from sleep with affect your efforts. (Engle-Friedman 2003). The experiment is done by looking at patients who have been sleep deprived, and the previous tasks that they have done. The article goes on to say, the people who are experiencing sleep loss tend to choose a simpler task. They become drained and don't feel like doing a lot of work. (Engle-Friedman 2003). The performance of the task is determined by the participant in control. All in all, the amount of sleep you get, will affect, your performance level of the following day.

College students at Baruch College Institutional Review Board agreed to be a part of an experiment that they will become sleep deprived, then try to do some follow up tasks the following day. The article, “The Effect of Sleep Loss on Next Day Effort” says, “The participants must add the four numbers, without the use of pencil and paper, within 15 s. Once a problem is answered, the participant immediately proceeds to the next addition problem. The MET has five levels of difficulty. Difficulty is determined by the value of the numbers presented. Each difficulty level is composed of randomly generated numbers from a particular range of values. The simplest level, Level 1, includes numbers 1–3; Level 2 includes numbers 3–9; Level 3 includes numbers 7–15; Level 4 includes numbers 7–25; and Level 5 includes numbers 7–35.” (Engle-Friedman 2003). This study shows that they returned to higher levels of difficulty on subsequent trials. The

timing and rhythm were more shallow and later when sleep was deprived.

This experiment also shows a difference in the behaviors between men and women.

There are many parts of the brain that help with learning. The frontal lobe assists your personality, also things like problem solving, language and impulse control. The temporal lobe assists with the things like organization, and speech. So basically, we learn from all areas of our brain. To help enlarge the growth of knowledge from your temporal lobe, such as language, the journal article, "The necessity of the medial temporal lobe for statistical learning", says that, two minutes of novel language is great for eight month old infant to understand words embedded therein. (Saffran, Aslin, & Newport, 1996). This form of learning is also robust in adults and is observed for many modalities and types of stimuli." (Schapiro).

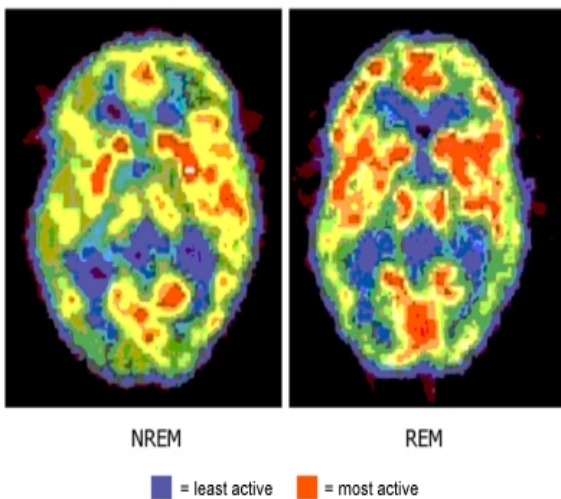
Memory is the faculty by which the mind stores and remembers information. Memory is the ability to store, retain and recall information and past experiences in the human brain. Memory is the sum total of what we remember, and it gives us the capability to learn and adapt for past experiences. Memory is a process of recalling to mind previously learned facts, experiences, impressions skills, and habits, according to human memory.com. Also according to human memory.com, in a neurological term, memory is at its simplest, a set of encoded neural connection in the brain. Memory is the reconstruction of past experiences by the synchronous firing of neurons (Hooper, 1986).

There are several types of memory. These eleven different types of memory include: Sensory, short term (working), long term, explicit, implicit, declarative, procedural, episodic, semantic, retrospective, and prospective memory. The most thought of memory is long term memory, short term memory, and sensory memory. Sensory

memory is the process in which it must be worked through before long term memory is established. All the different types of memory have their own particular mode of operation, but they all co-op in the process of memorization. Long term memory is parted into four main types. These types are; explicit or declarative, and implicit or procedural. Declarative memory is remembering facts and events, and remembering memories that can be recalled or "declared". It is also sometimes called explicit memory. It consist of information that is explicitly stored and retrieved. Declarative memory can further be subdivided into episodic memory and semantic memory. Procedural memory is knowing how the unconscious memory of skills bike. This memory is acquired through repetition and practice. This memory is composed of automatic sensorimotor behaviors that are so embedded that we are not aware of it. These memory allows us to carry out previous experiences aid in the act of a task without explicit and conscious awareness of previous experiences (MacDonald, 2008)

Episodic memory represents our memory of experiences and specific events in time in a serial form. Autobiographical events can be explicitly stated through this type of memory. Semantic memory is more structured record of facts, concepts, and meanings and knowledge about the external world that we have taken in. it refers to the general knowledge that we have shared with others. Semantic memory stores information that we learn in school or factual information about the world, and other economic information. Also, personal information is stored through semantic memory. The semantic memory is derived from the episodic memory, in that we learn new facts or concepts from our experiences.

Retrospective memory is where the content to be remembered is in the past the recollection of past episodes. This memory includes semantic, episodic, and autobiographical memory, and declarative memory. It can also either be explicit or implicit. Prospective memory is where the content is to be remembered in the future. It can be referred as remembering to remember, or remembering to perform to do an intended action. Retrospective and prospective memory are not independent entities and certain aspects of retrospective memory are



usually required for prospective memory (Robinson, 2008).

The human brain is interconnected but the major components are the cerebrum, the cerebellum, and the brain stem. The brainstem includes the medulla, the pons and the midbrain. It controls breathing, heart rate, digestion, and other autonomic process, as well as connecting the brain with the spinal cord, and the remainder of the body. The cerebellum plays an important role in balance, but is also involved in some functions such as attention, language, emotional functions, and in the process of procedural memories. The cerebrum, which is also called the forebrain, makes up 75% of the brain by volume and 85% by weight. It is divided by a large groove, known as the

longitudinal fissure, into two distinct hemispheres. The left and right hemispheres are linked by a bundle of nerve fibers called the corpus callosum, and also by other smaller connections called commissures.

Sleep, learning, and memory are complex occurrences that are not fully understood. Human studies advocates that the quantity and quality of sleep have a large impact on learning and memory. If an average person gets the right amount of sleep, they are more likely to have a better memory and achieve more academically. Their G.P A. is more likely to be higher and they are more likely to go throughout the whole day without being tired Research submits that sleep helps learning and memory in two types of ways. First, a sleep-disadvantaged person cannot focus attention undividedly and therefore cannot learn efficiently. Secondly, sleep itself has a role in the organization of memory, which is important for learning new information. Statics shows that getting an average amount of sleep, eight hours per day, may help maintain memory in life. Although the exact devices are not known, learning and memory are often described in terms of three functions. Acquisition mentions to the outline of new information into the brain. Consolidation represents the processes by which a memory becomes stable. Recall refers to the ability to access the information after it has been stored. All three these steps are necessary for proper memory function. Acquisition and recall occur only during wakefulness, but research suggests that memory consolidation takes place during sleep through the strengthening of the neural connections that form our memories. Low-quality sleep negatively impacts our mood, which has consequences for learning. Alterations in mood affect our ability to attain new information and later to remember that information. Although sleep deprivation affects different individuals in a variety of ways, it is clear that a good night's rest has a

solid impact on learning and memory. Evidence recommends that various sleep stages are involved in the consolidation of different types of memories and that being sleep deprived reduces one's ability to learn. Sleep is essential for proper memory function. Lack of sufficient sleep affects mood, motivation, judgment, and our awareness of events (Teresi, 1986).

Memory and learning go hand in hand and they are closely related. Memory is vital to learning

as it allows you to retrieve the information you have learned. The way information is learned affects how it is remembered. If information is repeatedly revised and studied, it is easier for it to be remembered. Students for example often forget information that has been taught. However, if the lesson is revised multiple times before a test it will be easy to remember the content of the lesson. According to Education Winter "When the long term memory system receives new information, the brain's structure is changed - is reconstructed. New associations are formed, and learning is expanded" (White, 1996). There are three stages of memory, which help us to remember. The first stage is encoding. During this stage, the information is sent to the brain. The second stage, storage, the information is kept in the brain. The last stage is retrieval, which allows regaining the information that was stored. It is impossible for memory to occur without learning. The stages of memory allow recalling knowledge that has been learned in the past or in recent times.

It is important to maintain healthy learning and memory functions. Learning and memory are very important to our daily lives. To ensure learning and memory is healthy it is imperative that we eat healthy, exercise, keep stress level low and improve sleep quality. Eating healthy entails eating from all five of the food groups. The five food groups are fruits, vegetables, proteins, grains

and dairy. A main point in eating healthy is moderation. Eat the correct amount of food from each group and only eat the amount your body requires. Eat more healthy fats such as monounsaturated and healthy carbohydrates such as whole grains and less unhealthy ones. Healthy fats such as olive oil, nuts and fish and lean protein will improve brain health, more specifically memory. Water makes up 75% of the body hence it is well needed in

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To maintain healthy learning and memory function one has to keep stress level low. Brain regions, which are involved in memory function, also affect the stress response. Excessive stress results in changes in the related brain region; this affects memory. According to a study done Behavioral Neuroscience, stress affects declarative memory, which is one of the two types of long-term memory. Low stress levels will result in better learning and memory. The quality of sleep one gets per night is crucial to learning and memory. The quality of sleep includes sleep duration, sleep efficiency and sleep disturbance. 7.5-9 hours of sleep is required for adults per night. Not getting enough sleep will affect memory, critical thinking skills and learning. To improve the quality of sleep get on a regular sleep schedule- go to bed at the same time

every night, avoid screens for at least an hour before bed- the blue light emitted by gadgets trigger wakefulness and suppress melatonin and avoid caffeine (found in coffee, tea, chocolate, and some pain relievers) nicotine and alcohol as they are stimulants and they interfere with sleep. Furthermore, to improve sleep quality make your bedroom a sleep-conducive environment- A cool, quiet and dark environment results in a more peaceful sleep and Avoid stressful stimulating activities before bed, instead, engage in soothing activities such as taking a bath. Exercise training improves sleep quality. A study done by Journal of Physiotherapy revealed that participating in exercise training has positive effects on sleep quality in middle-aged and older adults. In addition, exercise can be an alternative method for dealing with sleep disorders.

It is fundamental that college students improve their learning and memory. This, in the end will result in better grades. College students often make the mistake of cramming the night before an exam or test. This is disadvantageous; instead, students should revise. Cramming will cause lower test scores, high anxiety and no long-term retention. Revising is rereading work done to improve knowledge. Studying a little each day can have a major impact on how information is remembered. When information is learned the main goal is to be able to remember it, not only for exams but so that it can be applied to lives daily; revising will help this as the more you read the information the better you will remember. A schedule can be made to help with revising; revising at the same time in a learning inductive environment such as the library each day is very beneficial to learning and memory. Being active helps to improve learning and memory. College students tend to be complacent when it comes to exercising. Students should make use of the gyms, track, fields and other facilities

available to them on campus. Playing sports will also help, as this is another way to be active. Studying is a key factor to college students, studying is done to learn and memorize information. There are many ways for students to study; students should find and use a studying technique that best suits them. Instead of sitting and rereading books constantly, online studying can be done. In addition, students can create their own quizzes and exams in which they can share with their classmates and peers. Studying in groups should also be done to improve learning and memory. The previously listed techniques proves to be effective as information is retained well when peers explain it in simple everyday terms. For college students to improve their learning and memory their brains have to be stimulated, which is learning new things. Students should engage in meaning full conversation, which can broaden their horizons. It is imperative to join organizations on campus, getting involved will open doors to learning new information. Another way to improve learning is to think outside of the box; students should be more open-minded, learn about different cultures, tradition and history.

The above methods to improve learning and memory in college students will work. They have been done by college students and prove to be effective.

Getting adequate sleep is essential to optimum learning and memory function. According to Journal of Sleep Research “Sleep is an active state that plays an important role in the consolidation of memory. It has been found to enhance explicit memories in both adults and children” (Ashworth, Anna). Sleep deprivation will result in not being alert and focused; it will also affect mood which affects learning. Sleep gives our body time to rest and recharge; it increases the brain’s ability to learn and remember information. The brain is

the key organ in the body for learning and memory hence it is wise to give it the correct amount of rest each day; Overworked neurons cannot function to coordinate information properly. Several studies done have shown that sleeps helps your vision, hearing and ability to retain and information. A study done by the University of California shows that students who napped during the day before class grasped and remember information better than those who did not. Furthermore, studies have revealed that rapid eye movement sleep (REM) and slow wave sleep (SWS) are involved in declarative memory processes. Dementia is a general term that describes brain conditions that affects thinking and memory. One type of dementia is Alzheimer’s disease; this affects approximately 5 million Americans. Other types of dementia include vascular dementia, Parkinson’s disease and mixed dementia. Dementia is caused by damage to the brain cells; brain cells lose the ability to stay healthy and communicate. The symptoms of dementia are poor judgment, confusion about whereabouts, memory loss, speaking and writing problems. According to American Journal of Public Health “Dementia is affected by age and genetics, this cannot be controlled. Other factors such as diet, exercise and cardiovascular risk affect dementia and can be controlled. Dementia incidence increased through ages 85 to 89 years and 90 years or older Life expectancy without dementia and percentage of total life expectancy without dementia decreased with age. Life expectancy with dementia was longer in women and people with at least a college degree.” (Tom, 2015) Food intake affects the brain; having a better diet will improve the brain health. Exercising on a regular basis also improves brain health. Since blood vessels nourish the brain, it is vital that blood vessels are not damaged. Managing diet, exercise and cardiovascular

systems will lessen the chance of having dementia.

Getting sleep is also essential for Truck Drivers and their mental ability to be able to see the hazards on the roads and respond accordingly. According to research conducted by Gharagozlou, a study on the mental fatigue of truck drivers showed that as physiological mental fatigue levels increases, the relative power of theta, alpha and beta rhythms decrease, but the relative power in delta rhythm increases (Gharagozlou et al 2015). In this study, twelve vigorous male drivers were placed in a virtual reality simulator, driving on a tedious road, while EEG and EOG recordings took place. A Fatigue Visual Analog Scale (F-VAS) was used in conjunction with EEG and EOG recordings to monitor the drivers face and behavior while in the simulator to gain a better understanding of the driver's mental fatigue. Gharagozlou concluded that the increase in alpha power in the final section of driving indicates the decrease in the level of alertness and attention and the onset of fatigue, which was consistent with F-VAS and video ratings (Gharagozlou et al 2015). Also, the variations in alpha power can be used as an indication of driver mental fatigue.

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