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Relação entre sono e memória: Mais próximos do que você imagina

The relationship between sleep and memory: Closer than you think

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ABSTRACT

Hypnology (the study of sleep) is one area of medicine that permeates all others, as sleep is a fundamental part of every individual's life, since we spend a third of it sleeping. This is due to the circadian rhythm that is given to it. For this, the action of modulating neurons is fundamental, each with different neuromediators that emit axons, establishing synapses in large areas of the cerebral cortex and regions that extend from the thalamus to the spinal cord. In addition, there is an interaction of the organism with the environment that regulates the sleep-wake cycle in a more effective way. This interaction characterizes the timer systems, which have cells capable of detecting environmental variations - sensory cells, especially light variations, and the so-called oscillator cells or pacemakers, responsible for the cycle, regardless of external influences. Allied to this issue, there are also hormonal interactions that influence both the sleep-wake cycle and organic functions. It is essential to study these relationships to understand the different states and stages of sleep, namely: slow-wave sleep, also known as non-REM sleep and fast-wave sleep or REM sleep. Non-REM sleep is further subdivided into 4 stages, in which the human being starts waking and plunges into the various stages of depth. REM sleep, is the even deeper sleep, the phase of dreams, in which it is more difficult to wake the individual. In this last phase of sleep there are numerous formations of nervous circuits; it is the phase, even, responsible, in part, for the consolidation of memory. There are several types of memory: those acquired throughout life, conscious or not, are essential for the human being to maintain a good coexistence in society and form his individuality. The storage and evocation of memories depend on the emotions experienced by each person. This changes the storage process and the places where memories are stored in one's brain. There are essential regions common to all, such as the hippocampus and the amygdala, but the storage location of long-term memory depends on the

reaction of each one to a given situation and this will occur during the REM sleep phase. Becoming aware of this topic is key to understanding the importance of good sleep hygiene, fundamental to obtain a substantial improvement in the quality of sleep and, consequently, in the quality of life, whether in terms of mood, health, cognition, memory and its consequences, or aspects related to work or academicism.

Keywords: Sleep, Memory, Relationship between sleep and memory, Sleep hygiene.

1 INTRODUCTION

The study of sleep is a recent reality, but essential to understand the functioning of the organism, since the human being spends practically a third of his life sleeping. Understanding the entire sleep process and the implications due to its deprivation is an important tool to assist in sleep disorders and improve the quality of life of individuals, since it makes it possible to improve their activities during wakefulness (Do Valle et al; REIMÃO, 2000).

These studies happened more efficiently from 1950, when polysomnographic records of healthy individuals were used. Thus, it was necessary to observe their physical behaviors during sleep and also in their phase of falling asleep and upon waking. For this, they also used the electroencephalogram, the electro-oculogram and the electromyogram, which allowed a greater accuracy and precision of the observed phenomena (LENT, 2010).

From there it was possible to understand that sleep is divided into several phases and stages and that each of them interacts with external and internal mechanisms to happen. It is necessary to understand these particularities, to realize how sleep influences the mood, memory, cognition, emotion and health of each individual and the environment in which he lives. Similarly, it was possible to understand how sleep deprivation acts negatively on these aspects of life (do Valle et al; RIBEIRO 2000, REIMÃO, 2000).

The study of memory also has a wealth of detail that needs to be identified in order to be well understood. It is crucial to point out that there are several types of memories, each of them directly influencing the daily life of each person, according to their needs. To access a memory, it is necessary to activate several areas of the brain from the emotions felt by each person and the experiences lived (BEAR/CONNORS 2001; Lent, 2010; MACHADO/HAERTEL, 2013).

In this work it is possible to understand that for a memory to be stored, the individual needs a restful sleep. Only in this way will it be possible to store short and long-term memories, according to the emotions experienced by each one and, in this way, evoke them later, thus allowing the individual to relate in society and form their individuality (BEAR/CONNORS 2001; Lent, 2010; MACHADO/HAERTEL, 2013).

2 METHODOLOGY

This is a bibliographic survey, of the literature review type that aims to describe the relationship between sleep and memory. To this end, theoretical-descriptive research was carried out on both themes and the consequences of sleep deprivation on memory, a bibliographic survey was carried out in the databases of PubMed, LILACS and SCIELO, using the following keywords: "Sleep", "Memory", "Relationship between sleep and memory", "Sleep deprivation and memory", "Physiology of sleep", "Physiology of memory", "Memory". For this search, there was no delimitation of dates since the themes studied did not present alterations since their discovery.

In addition, 11 textbooks were consulted, namely: ROBERTO LENT, One Hundred Billion Neurons; REIMÃO, Sleep Medicine; REIMÃO, Themes of Sleep Medicine; RIBEIRO, The Seed of Victory; MARQUES, Alzheimer's type dementia: diagnosis, treatment, and social aspects; ROLAK, Secrets in Neurology; MACHADO/HAERTEL, Functional neuroanatomy; MENESES, Neuroanatomy; BEAR/CONNORS, Neurosciences; MERRIT, Treatise on Neurology; HARRISON, Clinical Neurology.

Still on the formation of the theoretical framework for this work, the possibility of presenting a clinical case was excluded, since a clinical case would address the context of a specific disease, escaping from the proposed objective, which is to address a physiological consequence that any individual can present from the moment they deprive themselves of sleep, regardless of previous comorbidities, age, social class, education level or any other stereotype.

This context allowed the conceptual and problematic foundation of sleep and its consequences on memory, for the elaboration of this work. This literature review is subdivided as follows: concept of sleep, its cycles and internal and external influences; concept of memory, its formation, forms and places of storage in the nervous system; relationship between sleep and memory, in addition to the consequences of sleep deprivation on memory and its social implications; forms of sleep hygiene.

3 RESULTS AND DISCUSSION

Until almost the middle of the twentieth century, it was believed that sleep was a passive phenomenon that occurred due to the lack of sensory stimulation. This reality changed from an epidemic of lethargic encephalitis that occurred in 1918 and 1919, the so-called Sleeping Sickness, when the Austrian neurologist Constantin Von Economo performed necropsies of patients affected by the disease and realized that the different clinical findings – insomnia and

lethargy – were due to specific lesions in different regions of the brain: one responsible for the state of insomnia and the other for the state of lethargy. When he announced then to have discovered the "sleep center" (LENT, 2010).

In 1922 the Swiss Walter Hess realized that these different regions are close to the hypothalamus. In 1949, Giuseppe Moruzzi and Horace Magoun identified very close areas in the brainstem, but with antagonistic and complementary actions, the mesencephalic reticular formation that, through stimuli, generated modifications in the electroencephalogram and tonic activities responsible for wakefulness. This region, called the ascending reticular activating system (ARDS) is able to activate the cerebral cortex, keeping the individual awake. On the other hand, if areas of the reticular formation of the bulb and pons are stimulated, they will cause sleep (LENT, 2010; REIMÃO, 2000; MACHADO, 2013; MACHADO/HAERTEL, 2013).

In this context, it is noteworthy that during wakefulness the rate of firing of the action potentials of hypothalamic neurons is very high, indicating that the cortex is being activated. This is the "mode of transmission" of these neurons. That is, there is permanent activation of thalamocortical pathways by glutamatergic synapses, which are excitatory, of afferent fibers. These potentials are stimulated through the retina, auditory neurons, somesthetics, among others, so that they have a high level of excitability (MACHADO/HAERTEL, 2013; LENT, 2010).

Another mode of operation of thalamocortical neurons is through "cluster firing mode", which is characteristic of sleep. This mode makes neurons less excitable, so they can only fire action potentials occasionally, in clusters, according to continuous and irregular afferent impulses. (LENT, 2010).

To control these modes of operations of these neurons is that there are nuclei in the thalamus (already mentioned reticular nucleus) and nuclei in the brainstem. Most reticular neurons have GABA as a neurotransmitter and are therefore inhibitory. The reticular nucleus receives cholinergic and aminergic afferents from the diffuse system. These brainstem aminergic modulators extend axons to reticular neurons and thalamus, activating the inhibitory neurons of the reticular nucleus, hyperpolarizing thalamocortical cells, which start firing in clusters, causing the individual to leave wakefulness. (LENT, 2010).

Still on wakefulness, there are the histaminergic neurons of the posterior hypothalamus as an important activating pathway of the cerebral cortex. Therefore, these histaminergic neurons keep the individual awake, with desynchronized EEG and important activity in EOG and EMG (LENT, 2010).

When the GABAergic neurons of the anterior hypothalamus send inhibitory innervation to the histaminergic modulator systems, the wave pattern in the EEG begins to change, and the human being enters the stage of slow-wave sleep (LENT, 2010).

To complement these EEG changes, there are cholinergic neurons, also located in the anterior hypothalamus, which extends its action from the brainstem to the basal forebrain. These mechanisms contribute to a synchronization of the EEG, causing the individual to leave wakefulness and fall asleep (LENT, 2010).

One of the hypotheses currently used for this EEG pattern change, for sleep to occur, is the presence of adenosine, a nucleoside present in all cells of the human organism, concentrated in the extracellular space of some excitable tissues. This adenosine, when recognized by specific metabotropic receptors, hyperpolarizes the membrane, controlling cellular hyperactivity, since it is closely related to ATP and ADP, molecules that store energy (LENT, 2010; Harrisson 2015).

In addition, the cholinergic neurons of the basal forebrain were sensitive to the action of adenosine, through specific receptors of this nucleoside in the neurons, which is another indication that sleep occurs by its action (LENT, 2010; Harrison 2015).

In this way, caffeine, which functions as an antagonist of adenosine receptors, acts as an attenuator of the signals of sleep homeostasis, which would normally come from the basal forebrain. Thus, the person who makes use of caffeine, can stay awake for longer, even when the concentrations of extracellular adenosine are large due to intense cellular activity (HARRISSON, 2015; LENT 2010).

Another characteristic that marks paradoxical sleep is the absence of muscle electrical activity recorded by EMG. To this end, the cholinergic cells of the pons activate a downward pathway consisting of a sequence of excitatory and inhibitory neurons. These inhibitory neurons are the glycinergic and GABAergic neurons, which act directly on the medullary motoneurons, blocking them (LENT, 2010).

To end this cycle and the individual wakes up, all these mechanisms already mentioned act together. Therefore, intense signals from the external environment are transmitted to the sensory systems, in addition to the decrease in the concentration of adenosine levels by the tissues, and the natural circadian system itself that indicates the end of sleep and thus the person awakens (LENT, 2010).

With regard to Memory, we know that it is the capacity that man has to acquire and store information to evoke them later, what we call remembrance. This is an adaptive process that allows humans and other animals to relate to the environment in which they live, adapting to

adversity. In addition, memory is responsible for the personality of each individual, since it is stored in different locations of each person's brain, as will be seen later (BEAR/CONNORS 2001; Lent, 2010; MACHADO/HAERTEL, 2013).

In 1940, Canadian psychologist Donald Hebb believed that memory was stored in different parts of the brain, according to where the information entered, and when it was first perceived, it would stimulate circuits in the neocortex. In addition, he laid the conceptual foundation for synaptic plasticity when he stated that more active connections would be strengthened and stable in the brain, while less used ones would be inactivated. Thus, the activation of only part of the circuits would be enough to evoke the entire event (LENT, 2010).

After that, in the 1970s, another psychologist, David Marr suggested the idea of neural networks, which would be neuronal circuits capable of storing information to be used later. These Hebb/Marr models have been criticized on the grounds that the number of events we are able to store would require many neuronal circuits, above our biological capacity. It was then when Marr suggested the presence of a separate processor, such as the RAM of a computer, capable of storing the memories temporarily, which would be the regions of the frontal lobe and the temporal lobe (LENT, 2010).

From these experimental theories, we tried to explain the mnemonic processes – a set of techniques used to explain the process of memorization. The first of these processes is acquisition, which is characterized by the input of any event into memory-related neural systems. These events can come from the external environment through the senses, or from the internal environment by thoughts and emotions (LENT, 2010).

During the acquisition, there is a selection process. This selection allows only remarkable events in some way to be acquired, either by the attention we give to these events, the focus, the emotions they transmit, their relevance to learning or some other unknown form (LENT, 2010).

After this phase, there is the process of memory retention, in which there is storage of the selected events for some time, either a few seconds or for a lifetime, to be remembered at the right times. This memory retention capacity varies for each person and according to the moment and significance that the event has for him, in addition to the type of memory, which may have limited capacity of some items, as is the case of the working memory that will be seen next, or unlimited retention capacity. This retention is also influenced by elements that distract the individual, the greater the amount of these elements, the lower the retention. In addition, the order of presentation of the elements also influences the retention capacity of each person (LENT, 2010).

When these aspects begin to disappear from memory, it is called forgetfulness. Forgetting protects brain structures from overloads on systems related to memory storage, and also acts as a filter for the aspects that matter most to each individual. From this, we have two important concepts: "Amnesia when the individual presents too much forgetfulness" and Hypermnesia when the opposite occurs" (LENT, 2010).

It is now known that the main area of the Central Nervous System involved in processes related to long-term memory is the hippocampus. The main type of this long-term memory, or remote memory, is explicit memory, already seen earlier. It works in parallel with ultrafast memory and working memory, but unlike these, explicit memory goes through a more rigorous process for storage (LENT, 2010).

This is clearly necessary when one thinks that this type of memory will be stored for many years, so that the individual can access it whenever he needs it, and therefore the more useful information he can store, the better for his personal performance and relations with society. Therefore, the filter for this remote storage must be rigid.

Therefore, it is necessary to understand the relationship of the hypothalamus with the amygdala. The amygdala is the brain region responsible for emotions. The hypothalamus receives afferent fibers from this region, thus modulating the most important information for the individual. There is also an important connection of the hippocampus with the ventral tegmental area and with the nucleus accubens, regions associated with pleasure events, which reinforces the consolidation of memories that have a pleasurable characteristic (MACHADO/HAERTEL, 2013).

Thus, the relationship between sleep and memory exists in several forms, namely the recording of unconscious memories, and to one of these forms we do not have access, and influence of our life. They are: phylogenetic, ontogenetic, atavistic of intrauterine life and the unconscious memory that goes from birth to the phase of speech, the latter includes emotional memory. The atavistic is related to the ability to adapt to the environment (REIMÃO, 2000).

Other types of unconscious memory are experiential memories, which happen from the child's verbal period. These memories also have important influence of emotions to be stored and evoked. Some authors argue that the way to access these unconscious memories is through dreams, which connects the conscious to the unconscious. The dream is also considered as a memory of an awakened brain that is attached to a paralyzed body, which would characterize REM sleep, in which the EOG is in constant movement while, at EMG, the individual is stationary (REIMÃO, 2000; RIBEIRO, 2003; BIRTH, 2014; JUNIOR/FARIA, 2014).

But the study of dreams is still a little-known area. It is known, however, that during dreams, there is intense activation of neural networks, resulting in brain changes. This further contributes to the idea that it is in this phase of sleep, REM sleep, that memories are stored, where neuroplasticity occurs, in which the brain shows intense brain activity, compared to wakefulness. Proof of this is that there is a higher prevalence of this stage of REM sleep in the first days and years of life, which indicates the need for REM sleep to develop and mature the brain (REIMÃO, 2000; RIBEIRO, 2001; RIBEIRO, 2003; PINTO, 2009; BIRTH, 2014; JUNIOR/FARIA, 2014).

In contrast, in the rest of life, REM sleep has the function of reprogramming and restoring instinctive behaviors, in addition to having the ability to store short- and long-term memory in different brain areas. That is why it was observed that during learning processes, the percentage of REM sleep increases during two to three days, when memory fixation happens, so the more learning there is during the day, the greater the need for REM sleep at night (MARQUES, 1997; REIMÃO, 2000; RIBEIRO, 2003).

The limbic system plays an important role during REM sleep. This is perceived by the electroencephalographic tracing, which is fast and low voltage during sleep, contrasting with wakefulness. While in the hippocampus, which is responsible for memory formation and retrieval of stored knowledge, the electroencephalographic tracing has a higher frequency of discharge during REM sleep, compared to wakefulness and non-REM sleep (REIMÃO, 2000; RIBEIRO, 2001; GIACOBBO, 2015).

Another area of important influence on memory is the amygdala which, as well as in the hippocampus, has higher frequency electroencephalographic tracing during REM sleep. When this region receives information from the hippocampus, it can trigger diverse emotions because of the evoked memory. The opposite is also true, that is, it is possible to evoke memories, from emotions felt at the moment, emotions that have direct reactions in the amygdala (MARQUES, 1997; REIMÃO, 2000; BARRETO/SILVA, 2009).

Thus, the amygdala not only influences emotions, but also short- and long-term memories. In addition, this process is not static, so it is possible to modify a memory through the emotion of the moment, giving it another meaning or even deconstructing it. The amygdala can also be a place of storage of a first element of memory, the first memories with emotional charge (MARQUES, 1997; REIMÃO, 2000; BARRETO/SILVA, 2009).

Thus, it is possible to understand that both the hippocampus and the amygdala are responsible for the storage of experiential memory. This memory requires special attention from

each individual to consolidate the learning process. That is why each person learns a certain experience in a unique way, according to the attention that is given to it, even if several people are experiencing the same experience (MARQUES, 1997; REIMÃO, 2000).

So what can be done to try to get around this situation? Sleep hygiene is the first step and sanitizing sleep means creating habits before bed and during sleep, in order to have a more peaceful and restful sleep, so that awakenings are avoided during the night, and restore the energies spent the day before. Sleep hygiene is essential not only for those who already have problems with sleep, but also to avoid extrinsic disorders caused by inadequate sleep hygiene (ROLAK, 1995; RIBEIRO, 2000).

During sleep, we allow the autonomous system to restore all the energy that has been expended by our body during the day. A restful sleep behaves as a kind of health maintenance, a medicine that does not pay for itself and can be acquired by anyone, regardless of social class or belief. A peaceful and organized sleep allows better quality of life, since it improves health, memory, well-being, mood, performance in activities and prevents some chronic diseases (RIBEIRO, 2000).

Changes in habits are difficult to achieve without any effort in postmodern society, where little sleep has become synonymous with success. People are working late, or using the cell phone, or other light stimuli, which causes sleep to take longer to arrive, resulting in greater tiredness and inattention the next day, making it necessary to have more hours awake to be able to meet the next day's work goal, again impairing sleep (RIBEIRO, 2000).

One of the most important points for a good quality of sleep is the performance of physical exercises during the day. However, you should know what to do and the most appropriate times. Aerobic activity, for example, should not be performed after 6 p.m., since this type of exercise increases the amount of stimulating hormones in the body, which gives a lot of energy and can agitate sleep. Therefore, aerobic exercises should be performed during the day, so that it promotes enough energy that will be spent throughout the daily activities. Thirty minutes of walking a day is a good alternative, since it relaxes body and mind (MARQUES, 1997; REIMÃO, 2000; RIBEIRO, 2000; OLIVEIRA et al, 2007; SOUSA et al, 2009).

On the other hand, physical activities that require localized muscular effort can be performed after this time. Since this type of exercise helps to spend energy, leaves the body tired and at the same time relaxed, which favors sleep, allowing a better use of it (RIBEIRO, 2000).

4 CONCLUSION

Understanding the functioning of sleep and its role in memory storage is of fundamental importance. It is necessary, therefore, not only to educate health professionals on the subject, but also to initiate a program of continuing education in schools and workplaces, so that, in this way, each individual, better understanding this circadian cycle, can be active in their personal sleep hygiene, and thus improve their quality of life.

Sleep deprivation, whether due to some well-established disorder or not, causes important damages that Müller and Guimarães cited as three levels. The first is the immediate consequences, namely: irritation, tachycardia, fatigue, alteration in memory, cognition, mood and concentration. The second level is related to medium-term consequences, such as absences from work and traffic accidents. The third level refers to later consequences, such as job loss, sequelae of accidents, health problems, among others (MÜLLER/GUIMARÃES, 2007).

It was possible to observe that most people do not perceive their own sleep disturbances, since this is a topic still neglected. Many are unaware of sleep disorders as a treatable clinical condition, not only lay individuals, who often do not even complain about it during a medical consultation, but also the health professionals themselves, who at the slightest sign of insomnia, prefer to medicate rather than try a well-oriented sleep hygiene (REIMÃO, 2001; MÜLLER/GUIMARAES, 2007).

Understanding and putting into practice sleep hygiene is a fundamental point to improve the quality of life. Practicing exercises daily and at the appropriate times, maintaining a healthy diet, avoiding the use of nicotine, caffeine and alcohol, in addition to maintaining an environment conducive to sleep, without noise or light, always going to sleep at the same time, are simple measures that can modify the whole life of the individual (SOUSA / FERREIRA; REIMÃO, 2000; RIBEIRO, 2001).

It is clear, from the already explained, that it is not only the amount of hours of sleep that interfere with daily activities, but rather the habits performed daily to improve the quality of sleep. Since to fall asleep it is not enough to close your eyes, it is necessary to create a routine, to do a whole ritual. These improvements will have positive consequences in the life of each one, since the individual will be able to have a restful sleep, improving, mainly, the neuroplasticity, fundamental for the consolidation of memory. (SOUSA/ FERREIRA, REIMÃO, 2000; RIBEIRO, 2001; OLIVEIRA et al, 2007).

It is worth noting that the person may even be able to sleep in an inappropriate environment, with a lot of noise, light on, during the day, hungry or any other adverse situation.

But for this to happen, a much higher energy expenditure than expected is required. Thus, sleep loses its role of reestablishing the energies spent during the day and of reestablishing the psychosomatic balance, keeping the organism in a true imbalance (REIMÃO, 2000; RIBEIRO, 2001).

It can be concluded, then, that to live well it is necessary to sleep well. Sleep is part of the circadian cycle of humans - it is a natural, physiological need. The body of all individuals asks for this, some require more hours of sleep than others. It is well established that when one goes through a day with a greater load of information, it becomes necessary more hours of sleep during the night for the storage of this new learning. But it is essential that it occurs fully and deeply, so that all the memories necessary for life are stored.

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