

Sleep: The Evolution of Sleep Medicine in Neurology (Part Two)

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Introduction

In this follow up to The Evolution of Sleep Medicine in Neurology, we will explicitly cover Circadian Rhythm & Sleep/Wake Homeostasis. Sleep is regulated by two body systems: sleep/wake homeostasis and the circadian biological clock. Circadian Rhythm is a necessary biological process that oscillates in 24 hour patterns. It is necessary for organisms to coordinate their biology and behavior with daily environmental changes in the day-night cycle. The circadian rhythm dips and rises at various points throughout the day, so adults' strongest sleep drive generally occurs between 2:00-4:00 am and in the afternoon between 1:00-3:00 pm.

A. Circadian clocks are the central mechanisms that drive our circadian rhythms. They consist of three major components:

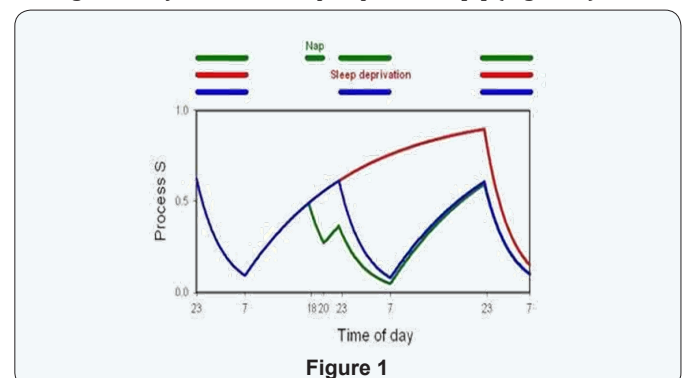
- a) A central biochemical oscillator with a period of about 24 hours that keeps time
- b) A series of input pathways to this central oscillator to allow entrainment of the clock
- c) A series of output pathways tied to distinct phases of the oscillator that regulate overt rhythms in biochemistry, physiology, and behavior throughout an organism.

Our circadian biological clock is controlled by a part of the brain called the Suprachiasmatic Nucleus (SCN), a group of cells in the hypothalamus that respond to light and dark signals. Through the optic nerve of the eye, light travels directly to the SCN, signaling that it is time to be awake to the internal clock. As a result of this, the Suprachiasmatic Nucleus (SCN) will signal to other parts of the brain that control hormones, body temperature, and other functions that play a role in making us feel sleepy or awake. [1] Cromie, William (1999-07-15). "Human Biological Clock Set Back an Hour". Harvard Gazette.

In fact, this signaling of light to our core central nervous system transmitters is so powerful that it is recommended to

people who suffer from daytime sleepiness to expose themselves to morning sun. This is called a "sleep hygiene" measure amongst many others. The SCN responds to light by delaying the release of other hormones like melatonin, which is associated with sleep onset. It is crucial to maintain a regular sleep schedule in order to avoid having consequent daytime sleepiness, difficulty thinking, and performance challenges. Circadian disruptions such as jet lag are due to the shift in time and light cues on the brain forcing the body to alter its normal pattern to adjust. However, these symptoms can also occur in everyday life, when the circadian rhythm is disrupted by keeping long and irregular hours. Sleep Medicine Specialist will recommend a regular sleep schedule to patients as part of another "sleep hygiene" tool.

Sleep homeostasis denotes a basic principle of sleep regulation. A sleep deficit provokes a compensatory increase in the intensity and duration of sleep, while excessive sleep reduces sleep propensity. Early experiments have shown that sleep deprivation has major effects on the homeostatic regulation of sleep [2]. For example, early experiments in two different rat strains showed that doubling the rotation rate of a slowly turning cylinder used to sleep deprive the animals had no additional effect on recovery, and that rats which had no circadian organization of their sleep-wake cycle still showed a compensatory increase of slow waves during recovery from the sleep deprivation [3] (Figure 1).



It is still unresolved whether REM sleep has a homeostatic regulatory component of its own. REM sleep loss does lead to an increase in the tendency to enter REM sleep, and its loss is compensated up to a certain extent only, with some species differences. However, in contrast to non REM sleep which has an intensity dimension, there is no evidence for an intensity dimension of REM sleep.

References

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