Natural Patterns of Sleep

At a Glance

- Sleep was once considered an inactive, or passive, state in which both the body and the brain "turned off" to rest and recuperate from the day's waking activities.
- Scientists have since found that the brain goes through characteristic patterns of activity throughout each period of sleep, and that it is sometimes more active when we're asleep than when we're awake.
- Understanding these patterns, and the factors that affect them, may help in making choices that will lead to better quality sleep.

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Waking up to Sleep

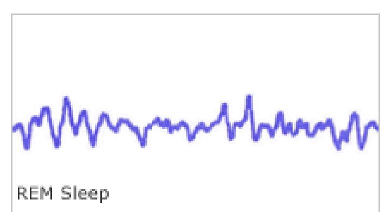
Our bodies require sleep in order to maintain proper function and health. In fact, we are programmed to sleep each night as a means of restoring our bodies and minds. Two interacting systems—the internal biological clock and the sleep-wake homeostat—largely determine the timing of our transitions from wakefulness to sleep and vice versa. These two factors also explain why, under normal conditions, we typically stay awake during the day and sleep at night. But what exactly happens when we drift off to sleep?

Prior to the era of modern sleep research in the early 1920s, scientists regarded sleep as an inactive brain state. It was generally accepted that as night fell and sensory inputs from the environment diminished, so too did brain function. In essence, scientists thought that the brain simply shut down during sleep, only to restart again when morning came.

In 1929, an invention that enabled scientists to record brain activity challenged this way of thinking. From recordings known as electroencephalograms (EEGs), researchers could see that sleep was a dynamic behavior, one in which the brain was highly active at times, and not turned off at all. Over time, sleep studies using EEGs and other instruments that measured eye movements and muscle activity would reveal two main types of sleep. These were defined by characteristic electrical patterns in a sleeping person's brain, as well as the presence or absence of eye movements.

EEGs are used in sleep studies to monitor brain activity during various stages of sleep.

The two main types of sleep are rapid-eye-movement (REM) sleep and non-rapid-eye-movement (NREM) sleep. On an EEG, REM sleep, often called "active sleep," is identifiable by its characteristic low-amplitude (small), high-frequency (fast) waves and alpha rhythm, as well as the eye movements for which it is named. Many sleep experts think that these eye movements are in some way related to dreams. Typically, when people are awakened from REM sleep, they report that they had been dreaming, often extremely vivid and sometimes bizarre dreams. In contrast, people report dreaming far less frequently when awakened from NREM sleep. Interestingly, during REM sleep muscles in the arms and legs are temporarily paralyzed. This is thought to be a neurological barrier that prevents us from "acting out" our dreams.



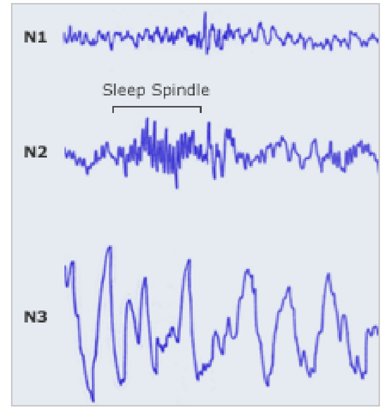
An EEG of typical REM sleep.

NREM sleep can be broken down into three distinct stages: N1, N2, and N3. In the progression from stage N1 to N3, brain waves become slower and more synchronized, and the eyes remain still. In stage N3, the deepest stage of NREM, EEGs reveal high-amplitude (large), low-frequency (slow) waves and spindles. This stage is referred to as "deep" or "slow-wave" sleep.

REM and NREM Sleep (1:21)
Dr. Thomas Scammell describes the different stages of sleep and their characteristics.
watch video

Cycling at Night

In healthy adults, sleep typically begins with NREM sleep. The pattern of clear rhythmic alpha activity associated with wakefulness gives way to N1, the first stage of sleep, which is defined by a low-voltage, mixed-frequency pattern. The transition from wakefulness to N1 occurs seconds to minutes after the start of the slow eye movements seen when a person first begins to nod off. This first period of N1 typically lasts just one to seven minutes. The second stage, or N2, which is signaled by sleep spindles and/or K complexes in the EEG recording, comes next and generally lasts 10 to 25 minutes. As N2 sleep progresses, there is a gradual appearance of the high-voltage, slow-wave activity characteristic of N3, the third stage of NREM sleep. This stage, which generally lasts 20 to 40 minutes, is referred to as "slow-wave," "delta," or "deep" sleep. As NREM sleep progresses, the brain becomes less responsive to external stimuli, and it becomes increasingly difficult to awaken an individual from sleep.



EEG recordings showing all three stages of typical NREM sleep.

Sleep Patterns Across the Night (0:46)
Dr. Thomas Scammell describes the cycles of REM and NREM sleep that occur throughout the night.
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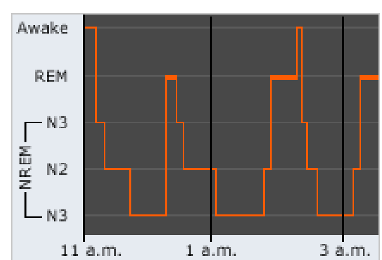
Following the N3 stage of sleep, a series of body movements usually signals an "ascent" to lighter NREM sleep stages. Typically, a 5- to 10-minute period of N2 precedes the initial REM sleep episode. REM sleep comprises about 20 to 25 percent of total sleep in typical healthy adults.

NREM sleep and REM sleep continue to alternate through the night in a cyclical fashion. Most slow-wave NREM sleep occurs in the first part of the night; REM sleep episodes, the first of which may last only one to five minutes, generally become longer through the night. During a typical night, N3 sleep occupies less time in the second cycle than the first and may disappear altogether from later cycles. The average length of the first NREM-REM sleep cycle is between 70 and 100 minutes; the average length of the second and later cycles is about 90 to 120 minutes. The reason for such a specific cycling pattern of NREM and REM sleep across the night is unknown. Some scientists speculate that specific sequences of NREM and REM sleep optimize both physical and mental recuperation as well as some aspects of memory consolidation that occur during sleep, but this has not been confirmed.

Shifting Sleep Patterns

Sleep patterns can be affected by many factors, including age, the amount of recent sleep or wakefulness, the time of the day or night relative to an individual's internal clock, other behaviors prior to sleep such as exercise, stress, environmental conditions such as temperature and light, and various chemicals.



This hypnogram shows the typical patterns of REM and NREM sleep throughout the night.

For example, for the first year of life, sleep often begins in the REM state. The cyclical alternation of NREM-REM sleep in newborns is present from birth but at 50 to 60 minutes is much shorter than the 90-minute cycles that occur in adults. Consolidated nocturnal sleep and fully developed EEG patterns of the NREM sleep stages emerge only after two to six months. Slow-wave sleep is greatest in young children and it decreases steadily with age, even if sleep duration does not change. This may be related to changes in the structure and function of the brain.

Sleep history—the quantity and quality of an individual's sleep in recent days—can also have dramatic effects on sleep patterns. Repeatedly missing a night's sleep, an irregular sleep schedule, or frequent disturbance of sleep can result in a redistribution of sleep stages, for instance, prolonged and deeper periods of slow-wave NREM sleep. Drugs may affect sleep stages as well. For example, alcohol before sleep tends to suppress REM sleep early in the night. As the alcohol is metabolized later in the night, REM sleep rebounds. However, awakenings also become more frequent during this time.

To learn more about the many factors that affect sleep patterns, see External Factors That Influence Sleep.

Daytime Napping

Although it is common for people in many western societies to sleep in a single consolidated block of about eight hours during the night, this is by no means the only sleep pattern. In fact, following this schedule and foregoing an afternoon nap would seem highly abnormal to many people around the world.

In many cultures, particularly those with roots in tropical regions, afternoon napping is commonplace and is built into daily routines. And although the exact timing of naps is not officially scheduled, it is not uncommon for stores and government offices to close and for many activities to stop for an hour or two every afternoon.

Afternoon naptime typically coincides with a brief lag in the body's internal alerting signal. This signal, which increases throughout the day to offset the body's increasing drive to sleep, wanes slightly in mid-afternoon, giving sleep drive a slight edge. Napping also typically happens during the warmest period of the day and generally follows a large mid-day meal, which explains why afternoon sleepiness is so often associated with warm afternoon sun and heavy lunches.

Afternoon naps for most people typically last between 30 and 60 minutes. Any longer and there is a risk of falling into deep sleep and having a difficult time waking. Following a nap, having dissipated some of the accumulated sleep drive, many people report feeling better able to stay awake and alert in the late afternoon and evening. This increased alertness typically causes people to go to bed later and generally to sleep less at night than people who do not take naps.

According to sleep experts, napping can be a good way for people who do not sleep well at night to catch up. They do caution, however, that people with insomnia may make their nighttime sleep problem worse by sleeping during the day. Otherwise, they generally recommend naps for people who feel they benefit from them.

To learn more about other patterns associated with sleep, go to the Sleep Lab, The Characteristics of Sleep, and Changes in Sleep with Age.

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This content was last reviewed on December 18, 2007

Daytime napping helps to restore one's energy and alertness.

Bookshelf

Aserinsky E, Kleitman N. 1953. Regularly occurring periods of eye motility, and concomitant phenomena, during sleep. Science. 118:273-274.

Iber Ancoli-Israel S, Chesson AL, Quan SF. 2007. The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specification. American Academy of Sleep Medicine: Westchester, IL.

A resource from the Division of Sleep Medicine at Harvard Medical School

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