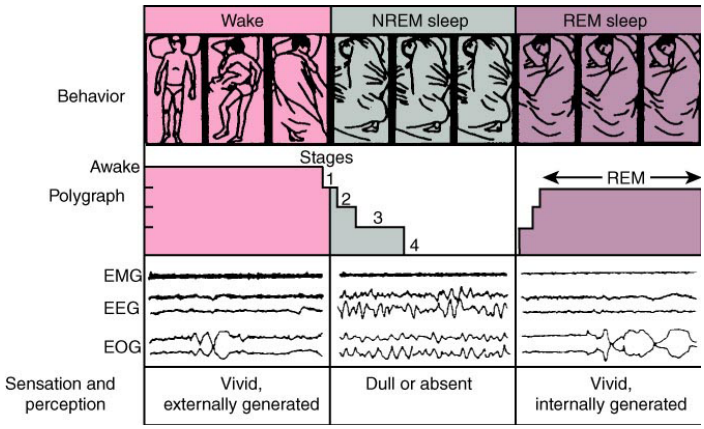
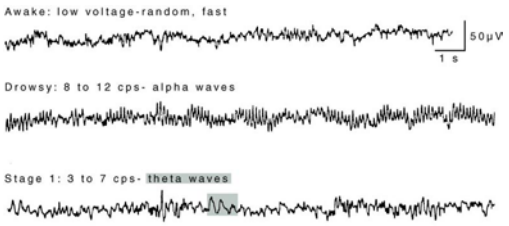
Stages of Sleep



Stages of Sleep

<u>Non-REM sleep has four stages</u>

Stage 1: transition from wakefulness to the onset of sleep.



EEG: Slower frequency emerges, mixed-frequency pattern.

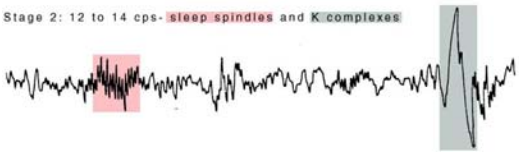
EMG: Some activity of skeletal muscle

EOG: no rapid eye movement, slow rolling eye movement

Stages of Sleep

Non-REM sleep has four stages

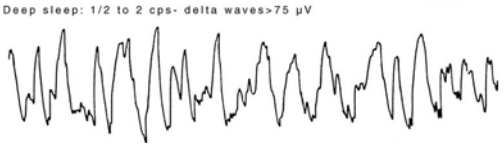
Stage 2: EEG shows burst of sinusoidal waves (sleep spindles) and high-voltage biphasic waves (K complexes)



Stage 3: EEG shows high-amplitude, slow delta waves

Stage 4: slow-wave activity increase and dominates the EEG record.

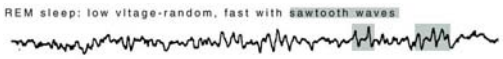
In human, stage 3 & 4 are also called slow-wave sleep.



Stages of Sleep

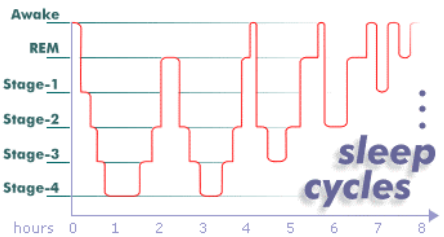
REM sleep : the active form of sleep (body temp. and metabolic rate rise)

REM sleep EEG patterns are similar to those during wakefulness.



Neurons in the pons, the LGN, and the occipital cortex fire more intensely than during wakefulness (PGO waves).

- Easily aroused by meaningful stimuli; if awakened, appears alert and attentive.
- Dreaming
- Complete sleep cycle ~90 min
- Each cycle ~20 min REM
- Slow-wave sleep occurs mostly during first half of night.

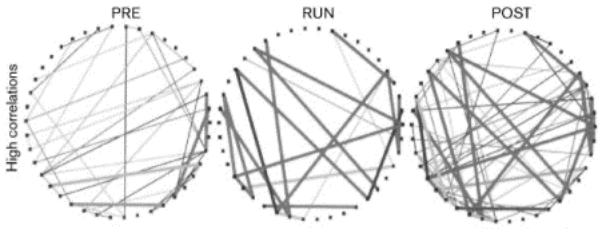


Sleep and memory consolidation

Suggested by Roffwarg, Musio and Dement in 1966 that repetitive firing of neurons during REM sleep in human fetuses was associated with neuron growth and development, and this synaptic reinforcement continued in adult life during REM sleep.

By studying patients with retrograde amnesia, it was determined that the "replay" of information in the hippocampus leads to permanent storage of information in the neocortex.

Experiments done in rats revealed similar brain activity during learning and during sleep after learning. (Bruce McNaughton)



REM Sleep and memory consolidation

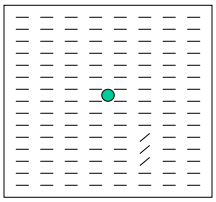
Significant increase in post-training REM sleep after intensive foreign language learning, with the degree of successful learning correlating with the percentage increase of REM sleep.

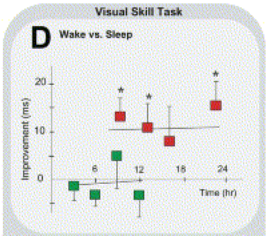
Other learning tasks that can be improved by REM sleep:

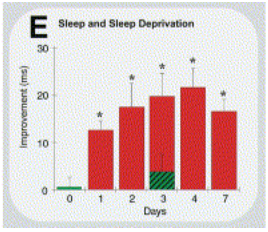
1) Motor sequence learning
2) Visual discrimination task

REM Sleep and memory consolidation

Impaired learning and memory after sleep deprivation.







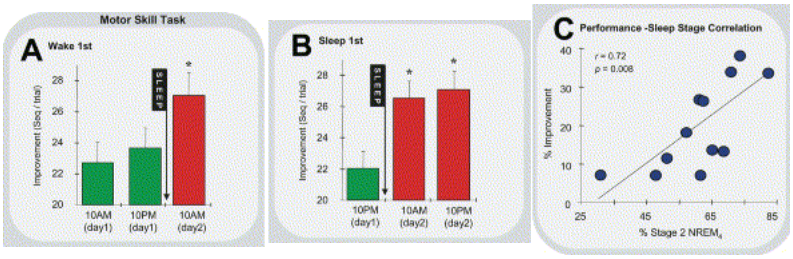
Experiments on humans found that REM sleep deprivation leads to poor performance on a variety of recall tests or logical tasks. It has also been found that memory loss occurs when sleep is deprived on the same night or two nights after material has been learned.

However…

1) Increased REM sleep after intensive learning could be caused by moderate stress induced by learning, but not learning *per se*.
2) Whether evidence for involvement of the “replay” activity in the brain in plasticity has not being directly demonstrated.
3) Human subjects who are awaken from REM sleep show fewer than 10% of dream reports contained any reference to a task just learned. A recent review of the literature found that few dreams are linked to recent experiences, including new experiences that are subsequently remembered. Dream reports that do incorporate experiences from the prior day or two are rarely a “replay” of events, but more likely to be linked to the emotions correlated with the learning experience.
4) REM-sleep deprivation studies can not rule out the effect of stress on learning. (“platform technique” used by some studies to deprive REM sleep in rodents)

Non-REM sleep and memory

A possible role of synchronous discharge in reinforcing synaptic connections in the hippocampus and neocortex.



Sleep and memory consolidation

Evidence for requirement of sleep in memory consolidation is quite strong. However, whether REM sleep is the important part remains controversial. It is possible that certain learning tasks requires REM sleep, while others require slow-wave deep sleep.

<u>Counter theory</u>

An alternative theory suggests that REM sleep functions to dispose of unwanted memories through a mechanism called reverse learning. Reverse learning operates during REM sleep to prevent the brain from being overloaded with massive amounts of information stored during wakefulness.

Direct test is difficult, remains speculative…

Sleep deprivation mimics aging?

A report in the medical journal *The Lancet*, said that cutting back the standard 8 hrs down to 4 hrs of sleep each night produced striking changes in glucose tolerance and endocrine function that mimicked many of the landmarks of aging.

"…we suspect that chronic sleep loss may not only hasten the onset but could also increase the severity of age-related ailments such as diabetes, hypertension, obesity and memory loss."

Eve Van Cauter, professor of Medicine

Univ. Chicago

What's the minimum amount of sleep?

Minimum sleep for normal performance in a detection task after 1 night of reduced sleep is 3 hrs. There is little REM during the first 3 hours of sleep.

Minimum sleep for normal performance in a detection task after several nights of reduced sleep is 5 hrs.

Sleep disorders

Narcolepsy

-The disease is principally characterized by a permanent and overwhelming feeling of sleepiness and fatigue.
- Affects 1 in every 2000 Americans.
- Involve abnormalities of dreaming sleep, such as dream-like hallucinations and finding oneself physically weak or paralyzed for a few seconds

-Some symptoms

- •Abnormal REM sleep
- •Excessive sleepiness
- •Cataplexy (a pathological equivalent of REM sleep atonia unique to narcolepsy, is a striking, sudden episode of muscle weakness triggered by emotions).
- •Sleep paralysis (a frightening symptom considered to be an abnormal episode of REM sleep atonia, the patient suddenly finds himself unable to move for a few minutes, most often upon falling asleep or waking up).
- •Hypnagogic hallucinations (patients experience dream-like auditory or visual hallucinations, while dozing or falling asleep).

-Recent research found a link between Orexin and narcolepsy.

Neurons containing the neuropeptide orexin (hypocretin) are located exclusively in the lateral hypothalamus and send axons to numerous regions throughout the central nervous system, including the major nuclei implicated in sleep regulation.

Orexin (named after Greek *orexis* for “appetite”) also regulates food intake and autonomic activity.