

Physiology of Behavior Book Notes

Sleep is considered a behavior-there is a change in consciousness, but there is still behavior

Stages of Sleep:

Wakefulness- show **alpha wave** activity (smooth electrical activity of 8-12 Hz; produced by brain when it is resting quietly, not particularly aroused/excited by any stimuli or mental activity; more prevalent when eyes are closed) and **beta wave** activity (irregular, mostly low amp waves of 13-30 Hz; shows desynchrony and reflects that many different neural circuits in brain are processing info; occurs when a person is alert and attentive to events in environment or actively thinking)

Stage 1- starts with drowsiness, marked by increased **theta wave** activity (indicates the firing of neurons in the neocortex are becoming more synchronized, about 3.5-7.5 Hz); this stage is transition from awake to sleep

Stage 2- Happens about 10 minutes after Stage 1 begins; periods of theta activity, **sleep spindles** (short bursts of waves from 12-14 Hz that occur b/w 2-5 times per minute during stage 1 and 4 of sleep, appear to play role in consolidation of memory-correlation b/w increased # S.S. and higher test scores) and **K complexes** (sudden and sharp waveforms, usually found only in stage 2 sleep, 1 per minute but can increase with sound stimulus; forerunner of delta waves which appear in deepest levels of sleep; consist of isolated periods of neural inhibition)

-sound asleep, but if awoken now would report that they weren't sleeping at all

Stage 3- 15 minutes after Stage 2 starts; signaled by occurrence of high amp **delta waves** (less than 3.5 Hz; regular, synchronous activity) contains 20-50% delta activity; considered one part of "slow wave sleep" along with stage 4

Stage 4/REM (rapid eye movement) Sleep- deepest stage of sleep; easily awakened by meaningful stimuli, i.e. someone calling their name, appears alert and attentive when awoken from REM; dreaming occurs during REM, most are narrative with story-like progression of events; lasts about 20-30 minutes; most of spinal and cranial nerves are inhibited during this time (except oculomotor and respiration) causing paralysis; consumption of oxygen and blood flow accelerate; links to penile erection/sexual arousal during REM (wet dreams, vaginal discharge/orgasm, etc.); desynchronized EEG activity

Slow Wave Sleep-

Consists of sleep stages 3 and 4

Most important feature are slow oscillations lower than 1 Hz; each osc consists of a single high-amp **biphasic (down and up) wave**

Down State- period of inhibition during which neurons in the neocortex are absolutely silent; neocortical neurons are put to rest

Up State- period of excitation during which the neocortical neurons briefly fire at a high rate

Disorders of Sleep

Insomnia:

- difficulty falling asleep after going to bed or after awaking during night
- particular form is called sleep apnea: caused by an inability to breathe and sleep at the same time; CO₂ receptors in brain wake person up when levels get too high, they gasp for air and then go back to sleep; can be fixed by surgery or mask

Narcolepsy:

- neuro disorder characterized by periods of sleep at inappropriate times
- primary symptom is known as *sleep attack*: overwhelming urge to sleep that can be triggered by boring/monotonous conditions
- another symptom is *cataplexy*: person sustains varying amounts of muscle weakness during an attack; some cases person will become completely paralyzed and fall to floor, can be conscious the entire time; thought to occur due to muscular paralysis that is similar to what happens in REM sleep
- another symptom is *sleep paralysis*: inability to move just before onset of sleep or right after waking up
- hypnagogic hallucinations*: symptom of narcolepsy where vivid dreams occur just before person falls asleep, accompanied by sleep paralysis
- gene on chromosome 6 affected, hereditary, also environmental; loss of *orexinergic* neurons is mainly the cause; most patients are born with the neurons, but during puberty the immune system attacks them
- studies: cause for canine mutation found on orexin B receptor

REM Sleep Behavior Disorder:

- neuro disorder in which person doesn't become paralyzed in REM sleep and acts out their dreams
- appears to be a neurodegenerative disease with genetic component; can be caused by brain damage as well

Problems Associated with Slow Wave Sleep:

- bedwetting, sleepwalking, and night terrors
- sleep-related eating disorder*: person leaves bed and seeks/eats food, recalls nothing the next day

Why Do We Sleep?

- most researchers believe primary function of SWS is to let brain rest
- primary role of sleep doesn't seem to be rest/recuperation of the body, but of the mind and cognition
- after sleep deprivation, people generally sleep longer for the next few days, but never make up their lost sleep
- long periods of waking activity causes sleep deprivation: waste products made by high metabolic rate turn into free radicals (highly reactive oxidizing agents, can bind with electrons from other cells and damage those cells) → during SWS, lower metabolic rate allows brain to damage some free radicals before they hurt brain/body
- fatal familial insomnia: fatal inherited disorder characterized by progressive insomnia; causes damage to thalamus; deficits in attention/memory, then dream-like state, then loss of control of ANS/endocrine system; first sign of sleep disturbances are reduction in sleep spindles and K complexes
- after a period of cerebral effort/work, slow wave sleep becomes more intense/restorative

Functions of REM Sleep

- rebound phenomenon: increased frequency/intensity of a phenomenon after it has been temporarily suppressed → increase in REM sleep seen after a period of REM deprivation

Sleep and Learning:

- REM sleep strongly facilitates consolidation of nondeclarative memory (memories gained through experience/practice) → SWS facilitates consolidation of declarative memories (memories of past episodes in life, memories you can talk about)
- brain appears to rehearse new info/learned info during SWS

Chemical Control of Sleep

- adenosine: nucleoside neuromodulator in brain that might play primary role in the control of sleep; inhibits neural activity
- astrocytes maintain a stock of glycogen; during times of increased brain activity, glycogen is provided to fuel neurons → prolonged wakefulness causes decrease in glycogen levels and leads to emotional/physical effects of being tired; decrease in glycogen signals increase of adenosine
- adenosine deaminase: breaks down adenosine, genetic; some people have more, some less