

SLEEP TO AWAKE- The Physiology of Sleep Lecture

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PRETEST:

1. Sleep is the time for the general body and brain to shut down and rest.
2. Getting one hour less sleep per night than needed will not affect daytime functioning.
3. The body can adjust quickly to changes in sleep schedules.
4. We need less sleep as we get older.
5. A “good night’s sleep” can cure problems with excessive daytime sleepiness.

“I used to suggest that sleep is the third pillar of good health, along with diet and exercise. But I don’t agree with that anymore. Sleep is the single most effective thing that you can do to reset your brain and body for health.”

Matthew Walker

Professor of Neuroscience and Psychology
University of California, Berkley

“To me, sleep is like the canary in the coal mine. Changes in sleep can create systemwide changes in the organism, and all of the stages of sleep affect the entire body and brain.”

David Schnyder

Professor of Neuroscience and Psychology
University of Texas, Austin

OUTLINE:

- A. The “What” About Sleep
- B. Sleep Need and Peak Performance
- C. Sleep Disorders
- D. Sleep Strategies

A. THE WHAT ABOUT SLEEP

Definitions:

- by Google- a condition of body and mind such as that which typically recurs for several hours every night, in which the nervous system is relatively inactive, the eyes closed, the postural muscles relaxed, and consciousness practically suspended.
- by NINDS- a complex and dynamic process that affects how the body functions; it is as essential to survival as food and water.
- by ASA- Sleep: A dynamic activity (Until the 1950s, most people thought of sleep as a passive, dormant part of our lives. We now that our brains are very active during sleep.)

The STATS: (National Sleep Foundation, CDC)

- An estimated 50% of Americans are sleep deprived
 - 30% average less than 6 hours per night
- Estimated 70 million with insufficient sleep
- 7 out of 10 have trouble sleeping
- 40 million suffer from some long term disorder

- 20 million experience occasional problems
- 1/3 of Americans have symptoms of insomnia
- 100,000 accidents and 1,500 fatalities from sleep problems per year
- The cumulative effects of sleep loss and sleep disorders represent an under recognized public health problem-
 - *It is the #1 health problem in the US.*

Why is Sleep Necessary?

One of the many important works of sleep, if not the most important, is to rid the brain of waste products.

- **G-lymphatic System-** glial cells with lymphatic-like function
 - removes the waste products by using the CSF to flush away by-products of metabolism that accumulate between cells

Areas in the Brain Involved in the Sleep/Wake Condition:

- The Hypothalamus-
- The Brain Stem
- The Thalamus
- The Pineal Gland
- The Basal Forebrain
- The Midbrain
- The Amygdala

Sleep inducing centers in the brain inhibit the arousal centers, thus the person goes to sleep.

Areas that promote "awakeness" inhibit the sleep inducing areas, thus the person goes to sleep.

Theories for Sleep/Wake Regulation (Edgar, DM; J Nerosci., 1993)

SIGNALS:

- Homeostatic Sleep Drive (Process S/H)**
 - Accumulation of *somnogens* in certain areas of the brain- e.g., Adenosine, TNF α , IL₁, PG-D₂;
 - Melatonin
- Circadian Drive for Wakefulness (Process C)- biological clock
 - Affected by light and dark (not always)
- Social Timing
- Distribution - chronotypes
- Taking of naps
- Genetics
- Quality of sleep

BRAIN Activity is measured by the EEG waves it makes.

Human Brain Waves:

Corresponding Activity

- | | | |
|-----------------|-------------|---|
| 1. Gamma waves- | 31 - 100 Hz | - Insight, peak focus, expanded consciousness |
| 2. Beta waves- | 16 - 30 Hz | - Alertness, concentration, cognition |
| 3. Alpha waves- | 8 - 15 Hz | - Relaxation, visualization and creativity |
| 4. Theta waves- | 4 - 7 Hz | - Meditation, intuition, memory |
| 5. Delta waves- | 0.1 - 3 Hz | - Detached awareness, healing sleep |

= Sleep spindle- 1 to 2 s burst of 12 - 14 Hz waves

= K complex- single large upward, then downward deflection

Other Waves Measured in Sleep Labs:

1. EEG- Electro-Encephalo-Gram- measures brain waves
2. EMG- Electro-Myo-Gram- measures muscle activity
3. EOG- Electro-Oculo-Gram- measures eye movements

SLEEP PATTERNS (Depending on Wave Patterns):

- 5 stages during a normal night
- Stages 1 - 4 (or non-REM), and Stage 5 (REM)
 - During non-REM sleep, many of the restorative functions of sleep occur
 - During REM sleep, memories and thought from the day are processed
- Stages progress cyclically- repeated up to 4-5x
- One complete cycle takes 90 - 110 minutes

STAGES OF SLEEP:

- | | Brain Waves (no Gamma in sleep) |
|---|---|
| • Awake but relaxed state | - Alpha waves (8 - 15 Hz) |
| • Non-REM (non-Rapid Eye Movement) <ul style="list-style-type: none">• Stage 1 (drowsiness)• Stage 2 (Light sleep)• Stage 3 (Medium to deep sleep)• Stage 4 (Deep sleep) | - Theta waves (4 - 7 Hz)
- Theta waves + spindle/K complexes
- Theta / Delta waves (4-7/0.1-3 Hz)
- Delta waves (0.1 - 3 Hz) |
| • REM (Rapid Eye Movement) | - Beta waves (16 - 30 Hz) |

DESCRIPTIONS OF SLEEP STAGES and BODY/BRAIN WORK:

- ★ Stage 1:
 - Light sleep, drift in and out, waken easily
 - Eyes move slowly, muscle activity slows
 - May experience a sense of falling followed by muscle contractions
 - High frequency but low amplitude waves
- ★ Stage 2
 - Eye movement stops
 - Brain waves are slower, occasional bursts of rapid waves (sleep spindles and K complexes)
- ★ Stage 3
 - Waves slowing down with interspersed smaller faster waves
 - Considered beginning deep sleep
 - No eye or muscle movement, difficult to awaken
 - Time when sleep walking, bedwetting, or terror occur
- ★ Stage 4
 - Considered deep sleep
 - No muscle movements
 - Increased wave amplitude

LOW-FREQUENCY SLEEP for PEAK DAYTIME PERFORMANCE:

1. Restoration and Growth
 - a. Blood supply to muscles is increased in deep delta sleep- recovery takes place
 - b. Body temperature is turned down to conserve energy.

- c. Metabolism is at its lowest to provide opportunity for tissue growth and repair.
- d. Secretion of Growth Hormone reaches peak in Stages 3 and 4
- e. DNA repair

2. Immunity to Viral Infection

- a. Increase of natural immune system modulators
 - i. Interleukin-2 and TNF α (Tumor Necrosis Factor- α)
- b. Modest loss of sleep reduces the body's immune responses
- c. Process is quickly reversible
- d. Sleep goes hand in hand with fever in an infection.

★ Stage 5

- Sympathetic NS is more active than in wakefulness.
- Blood flow to brain increases.
- Pulse, respiration, and blood pressure increase and become irregular.
- Temperature rises.
- Eyes under the closed lids dart back and forth
- Alpha and Beta waves indicating a wakefulness state without the muscle movements
- Experience dreams most frequently in REM sleep

HIGH FREQUENCY OR REM SLEEP for PEAK DAYTIME PERFORMANCE

1. Memory Storage and Retention

- a. Memory is moved from prefrontal cortex to hippocampus and then to cortex for long term storage.
- b. More intense REM activity following intensive learning.
- c. When sleep is disrupted, the brain's ability to transfer short-term to long-term memory is impaired.
- d. If skill training is intense prior to sleep, there is an increased REM sleep.
- e. Dramatic improvements in memory if there is enough REM sleep Memory Organization and Reorganization

2. Memory Organization and Reorganization

- a. We cannot learn new things during sleep.
- b. REM sleep provides an opportunity to file important memories of the previous day in long-term storage.
- c. Ideas (of the same line of thought) are organized or filed in associated networks already available in the brain.
 - i. Many scientists, novelists or musicians get their ideas during their dreams.
- d. Memory prioritization probably occurs in REM

3. New Learning and Retention Through Replenishment of Neurotransmitters

- a. Neurotransmitters- chemical messengers that enable neurons to communicate with each other.
 - i. Norepinephrine and serotonin, crucial and essential for new learning and memory.

In sum: Adequate REM sleep is vital for memory storage and retention, memory organization and reorganization, and new learning.

B. SLEEP NEED & PEAK PERFORMANCE

Randy Gardner, 17 y/o (1967)- science experiment - “No-sleep challenge”

- done Dec. 28/63 - Jan. 8/64 → 265 hours = 11+ days
- 2nd day- eyes lost focus; next he lost the ability to identify objects by touch
- 3rd day- moody and uncoordinated
- 11th day- struggling to concentrate; problems with short-term memory; became paranoid and started hallucinating.

Maureen Weston, Guinness World Record Holder (Rocking Chair challenge)

- 449 hours = 18 days, 17 hours
 - reported paranoia and hallucinations
 - But because staying awake for such long stretches poses so many physical and mental health risks, Guinness chose to no longer acknowledge sleep deprivation records.
 - So Weston’s (pre-viral internet) feat got lost in the dusty book pages and was all but forgotten.
- “Everyone should know exactly how much sleep he or she requires to feel wide awake, dynamic, and energetic all day long.

Everyone should know the strategies and techniques for getting quality nocturnal sleep for maximum daytime performance.

And everyone should know how to cope with sleep deprivation when it does occur.” JBMaas, Power Sleep

How many hours of sleep do we need?

SLEEP DEBT BANK ACCOUNT

- Most people need to deposit at least 8 hours of sleep in the account to cancel the sleep debt incurred by sixteen hours of continuous alertness.
 - “You need to obtain the amount of sleep each night that does not create a carry-over sleep debt.” Dr. William Dement, Stanford U
- Contrary to popular belief, a sleep debt does not dissipate by itself over time, and it’s cumulative.
 - It takes some time to repay debts and establish a good schedule, but it can be done.***
- It is profound to find out that you can really be awake!

Sleep Requirements for Optimal Performance

- 10 hours of sleep is operationally defined as our need because that is what is often required for optimal performance.
 - 8-hour sleepers who claim they are well rested, claim their alertness, energy, vigilance and effective processing information significantly increased, as are thinking skills and creativity, that is with 2 hours additional sleep.

Timothy Rohrs & Thomas Roth, Sleep Disorders Research Center, Henry Ford Hospital, Michigan

Daylight Savings Time and Traffic Accidents

- There is a 7% increase in accidents immediately after the spring forward for DST compared with the previous week→ due to lack of sleep.
- There was also a marked decrease in accidents just after the fall back for DST → due to an additional hour of sleep.

Stanley Coren, PhD, University of British Columbia, Vancouver, BC

SLEEP DEPRIVATION and PERFORMANCE:

- Daytime drowsiness
- Micro sleeps
- “Sleep seizures”
- Mood shifts, including depression, increased irritability, and loss of sense of humor
- Stress, anxiety, and loss of coping skills
- Lack of interest in socializing with others
- Weight gain
- Feelings of being chilled (cold)
- Reduced immunity to disease and viral infection
- Feelings of lethargy

SLEEP DEPRIVATION AND REDUCED PRODUCTIVITY:

- Reduced ability to concentrate
- Reduced ability to remember (esp. short-term memory)
- Reduced ability to handle complex tasks
- Reduced ability to think logically
- Reduced ability to assimilate and analyze new information
- Reduced ability to think critically
- Reduced decision-making skills
- Reduced vocabulary and communication skills
- Reduced creativity
- Reduced motor skills and coordination
- Reduced perceptual skills

SLEEP DEPRIVATION AND DISEASE STATES:

1. **4-fold** overall increase in mortality
2. **Stroke**- increased by a factor of 4x
3. **Obesity**- by an increased ghrelin, which is a hunger hormone
4. **Diabetes**- increased because sleep deprivation increases insulin resistance
5. An increased risk of **cancers**- colon, gastric, breast, bladder, prostate, and salivary glands
6. **Memory loss**- is accelerated. Not only early cognitive loss, but also early brain deterioration.
7. **Osteoporosis**- increased, with changes in bone mineral density- in animal studies as early as 3 months
8. **Cardiac disease**- increased; early cardiac death increased by 48% as well as cardiac-related diseases

Sleep Deprivation: It's Scariest Than You Thought

Sleep loss is truly a killer



<https://www.ncbi.nlm.nih.gov/pubmed/16585410>

SLEEP DEBT INDICATORS:

- Multiple Sleep Latency Test (MSLT)- checks how soon you fall asleep on demand; measures brain waves, muscle tone and eye movement activity
 - If you do not fall asleep at any given time in the test, you are not sleep deprived.
 - Dr. Roth of Henry Ford Hospital found that 34% of young adults were severely deprived.

C. SLEEP DISORDERS

1. **Dyssomnias-** disorders that are characterized by disturbances in the amount, quantity or timing of sleep:
 - a. **Insomnia-** most common - 50% of Americans experience this
 - b. **Obstructive Sleep Apnea-** weak throat muscles; 1:200 Americans
 - c. **Narcolepsy-** recurrent cataplexy, daytime sleepiness; 1:2,000 or 250,000 Americans
 - d. **Restless Legs Syndrome-** aching, tingling, itching legs, prior to onset of sleep; 5-15% of population
 - e. **Periodic limb movement disorder-** periodic jerking of legs; mostly in elderly
 - f. **Hypersomnia-** excessive sleepiness night and day
 - g. **Delayed or advanced sleep phase syndrome-** sleeping before or after everyone is asleep
2. **Parasomnias-** sleep disorders that are not associated with the process of sleep per se, but rather are physical abnormalities that occur for the most part during sleeping:
 - a. **REM Sleep Behavior Disorder-** physically acting dreams
 - b. **Sleep Terrors-** sudden arousal from a slow-wave sleep with fear not from a dream, rather a panic attack in sleep
 - c. **Sleepwalking (Somnambulism)-** initiated in slow-wave sleep; can also include sleep talking; eyes open; not acting out their dreams; do not awaken except in an emergency
 - d. **Tooth-grinding (Bruxism)-** 80-90% of people
 - e. **Bed-wetting (Enuresis)-** disorder if after the age of 5; 1% is from emotion problems
 - f. **Sudden Infant Death Syndrome-** several theories as to cause- not specifically related to sleep

D. SLEEP STRATEGIES

Golden Rules of Sleep:

1. Get an adequate amount of sleep every night.
2. Establish a regular sleep schedule.
3. Get continuous sleep.
4. Make up for lost sleep.

SLEEP STRATEGIES:

1. Reduce stress as much as possible.
2. Exercise to stay fit.
3. Keep mentally stimulated during the day.
4. Eat a proper diet.
5. Reduce caffeine intake.
6. Stop smoking.
7. Avoid alcohol at bedtime.
8. Take a warm bath before bed.
9. Maintain a relaxing atmosphere in the bedroom.
10. Establish a bedtime ritual.
11. Consider your share of the bed.
12. Avoid an environment of king cats or dogs
13. Clear your mind at bedtime.
14. Try some bedtime relaxation techniques- Progressive muscle relaxation, mental imagery
15. Avoid trying too hard to get to sleep. RELAX!
16. Limit your time in bed.
17. Learn to value sleep
18. Use the Peak Performance Sleep Log.
19. If necessary, consult a Sleep Specialist.

DEALING WITH NIGHT SHIFT PROBLEMS:

- Bedroom should be quiet and dark.
- The ideal temperature of room should be 65°
- Humidity level 60-70%.
- Illuminated clocks should be hidden from view.*
- Color and decor akin to peace and rest.
- Put on comfortable nightclothes.
- Clean cool bedsheets.
- Check pillows- comfortable to back and neck.
- Get a good mattress.
- “Most sleep experts agree that sleeping pills should be used only in the smallest effective dose, for the shortest clinically necessary period of time, in specific situations, and with extreme caution. Many sleep specialists advise ‘never taking pills for sleep, period’.”
- (Tips in this section were suggested by several researchers, as well as “Bedroom: Tips for a Sound Night of Sleep,” Shuteye Newsletter (Chicago: Searle, 1996).”)

MELATONIN- the repair hormone produced by the pineal gland has been used as sleeping pill supplement

Vegan Source: YES!