Sleep

Intro Psychology
Georgia Tech
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Today

• What is Sleep?
• Why do we sleep?
• Dreams

What is Sleep?

• A natural and periodic state of rest during which consciousness of the world is suspended
• Characterized by inactivity of the body, and by changes in the patterns of brain activity, as compared to active or awake periods

Circadian Rhythms

• Sleep is periodic—it is required, on average, about every day
• Humans, like all mammals, have a 24 hour biological clock
  – If people are placed in an environment without any access to daylight, clocks, etc, they follow an activity/rest cycle of about 24.5 hours (Kleitman, Mammoth Cave Study)

Control of Cycles

• Sleep/wake cycle seems controlled by suprachiasmatic nucleus (SCN) of Pons.
  – Lesions eliminate sleep/wake cycle

Description of Brain Waves

• Two basic parameters
  – Frequency - waves per second (Hertz, Hz)
  – Amplitude
• Synchronization
  – Synchronized waves are aligned with each other (e.g., different brain areas)
Brain Waves

- Beta waves
- Alpha waves
- Theta waves
- Spindles
- Delta waves
- REM sleep

Non-REM Sleep

- Alpha, delta, theta activity in the EEG
  - Stages 1 and 2: theta
  - Stages 3 and 4: delta activity (synchronized)
  - Termed slow-wave sleep (SWS)
- Light, even respiration
- Muscle control is present (toss and turn)
- Very little dreaming seems to occur

REM sleep

- Presence of beta and theta activity (desynchronized)
- Enhanced respiration and blood pressure
- Rapid eye movements (REM)
- Loss of muscle tone (paralysis)
- Vivid, emotional dreams
- Signs of sexual arousal

Ratio of Sleep Stages

Sleep in Bottle-Nose Dolphins

Figure adapted from Mukhametov, L.M. in Sleep Mechanisms, edited by A.A. Borbely and J.L. Valatx. Munich: Springer-Verlag, 1984.
What is the Function of Sleep?

- Sleep as an adaptive response?
  - Found in all vertebrates (REM in mammals)
  - Kept our ancestors out of predators way?
- Restoration and repair?
  - Reduced brain activity during Slow Wave Sleep
  - Changes in sleep during prolonged bed rest (no real changes in SWS)
    - Exercise (temperature inc. => inc. SWS)
    - Mental activity increases SWS

Sleep deprivation

- Animal studies report that rats die after 2 weeks of total sleep deprivation
  - Specific physiological cause is open to dispute
  - May be decreased immunological functioning that causes increased rate of infections of normally benign pathogens
- No human deaths in sleep deprivation studies lasting as long as 11 days.

After Sleep Deprivation

- Subject kept awake for 264 hours
- After deprivation – night 1 slept 15 hours, night 2 – 10 hours, then back to normal.

REM Sleep seems necessary

- Normally about 20% of total sleep
- Research participants that are woken up as soon as they enter REM sleep show REM rebound on subsequent days (e.g., proportion may rise to 50-60% of sleep time)
- Rebound also seen when REM sleep inhibitors (alcohol, sleep aids) are discontinued.

REM and Dreams

- Subjects woken during REM sleep report vivid dreams
- Subjects woken during slow-wave sleep report very vague disconnected dreams, if anything (but it takes a long time to wake someone up...)

FOREBRAIN PROCESSES IN NORMAL DREAMING - INTEGRATED MODEL
Memory Functions of Sleep?

• Wilson & McNaughton
  – Simultaneous recording from more than 100 cells in hippocampus.
  – In rats, hippocampus cells selectively fire as the rat moves about the environment.
  – Ensemble of cells that code a location should get more cohesive (e.g., code location better) with learning.

Memory Functions?

• Interesting coincidence?
  – Long term potentiation – strengthening of synapses between hippocampus cells
  – Most effective when cells are stimulated at the “theta” rhythm (same frequency as found during REM sleep)
  – Could REM sleep function as a consolidation of learning during the day?

Do Rats Dream?

• Back to Wilson & McNaughton
  – Record 100 cells in hippocampus.
  – Compute correlation of cells (e.g., when one cell fires, what other ones do?)
  – Correlation – ensembles at work.

Do Rats Dream?

Correlation between cells when the rat is dreaming
PRIOR to exposure to new spatial environment

Do rats dream?

• Back to Wilson & McNaughton

Correlation between cells when the rat is running around
DURING exposure to new spatial environment

Do rats dream?

• Sleep reactivates (strengthens) existing connections
Upcoming

• Learning
• Sensation & Perception