Overview of the Psychology of Sleep

What is sleep?

How do we know someone is sleeping?

So, how to “diagnose” the sleep state?

- Unresolved until chance discovery Eugene Aserinsky.
- Polysomnography:
  - Electroencephalogram (EEG)
  - Electrooculogram (EOG)
  - Electromyogram (EMG)

What is an EEG?

1. A neuron fires cyclically, giving off a corresponding cyclical electrical voltage to surrounding tissue than can be measured on the scalp.

2. Neurons in a given brain area often fire synchronously (in phase), amplifying the voltage (micro-volts) in that area.

3. Each EEG “channel” is an electrical circuit between a scalp location above a brain area of interest and a neutral location. That circuit drives a pen on the EEG machine up and down. The pen records both the extent of synchronized neuron firing (voltage amplitude) and frequency of synchronous firing measured in Hertz (cycles per second) in that location.

4. Some EEG machines can record up to 256 channels simultaneously.
EOG and EMG operate on the same electrical principles as the EEG.

- For EOG, voltage measures eye position; voltage changes index eye movements.
- For EMG, voltage amplitude indexes muscle tension.

An awake Polysomnogram result

**Sleep Stages**

**Awake and NREM sleep:**

Waking: Beta EEG waves (16-25 Hz), irregular, low amplitude.
Normal eye movements (EOG), high EMG amplitude.

Relaxed: Alpha EEG waves (8-12 Hz), regular, high amplitude.
Awake: Normal eye movements, moderate EMG.

Stage 1: Theta EEG waves (3-7 Hz), irregular, medium to low amplitude.
Eyes closed, drowsy state, subjectively not always asleep. EOG shows slow rolling eye movements, moderate EMG.
Stage 2: Light sleep, theta waves continue, spindles and K-complexes. No eye movements, moderate EMG.

Stage 3: Delta EEG waves (1 to 4 Hz), somewhat regular, high amplitude. No eye movements, moderate to low EMG amplitude.

Stage 4: More intense stage 3 sleep. Still delta. “NREM Dreams.” Sleep walking, talking, night terrors, teeth grinding

Slow Wave Sleep: Stages 3 and 4 of NREM sleep combined are often referred to as slow wave sleep (SWS), or delta sleep.

Sleep Stages

- Sleep Spindle: brief (.5-1.5 s), regular, 12-14 Hz, moderate intensity. May coincide with onset of stage 2 sleep. May be involved in learning.

- K-complex: brief (.5 s), large amplitude, very low frequency wave of only one cycle. Stage 2-4 sleep. Can occur in response to auditory stimuli.

Brief, distinct EEG patterns
The progression from NREM 1 to 4 can be characterized as a progression from “shallow” to “deep” sleep.

- Tapping data accuracy (SWS deepest)
  - 100% awake
  - 50% stage 1
  - 5% stage 2
  - 0% SWS
- Difficulty waking / grogginess (stage 1 easiest; SWS hardest)
- Neural activity transmission (SWS deepest)
  - TMS study

Rapid Eye Movement Sleep (REM sleep, or REMS) is a distinct type of sleep that is interleaved with NREM sleep over the course of the night.

- Dominantly theta wave sleep.
- Characterized by rapid eye movements (REMS) that are similar to stage 1 NREM sleep but more jagged.
- EMG is at lowest; full paralysis of major muscle groups (tonic)
- REM Dreams occurs.
In summary there are seven distinct states in the wake-sleep cycle as identified by the polysomnogram: Awake, Relaxed, NREM 1, NREM 2, NREM 3, NREM 4, and REMS.

Tonic (constant) aspects of REMS: theta waves, muscle paralysis, elevated brain temperature.

Phasic (intermittent) aspects of REMS: rems, muscle twitches, PGO waves, sexual arousal.
Sleep Cycle

- W → 1 → 2 → SWS → 2 → REM → 2 → REM → 2 → REM → 2 → W
- 90 minutes = “biological hour”
- State shifts sometimes punctuated by body movements and brief awakenings
- Across night, decreasing SWS & increasing REMS

Developmental aspects of sleep

- Sleep time across the nychthemeron

http://www.sleephomepages.org/sleepsyllabus/fr-c.html

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Developmental aspects of sleep

- Newborns: multiple sleep episodes; no diurnal pattern; 16-18 hours total
- By about 4 years old, adult diurnal pattern emerges, but still some naps; 10-12 hours total.
- By 10 years, < 10 hours total.
- Adulthood (20-50 years), about 8 hours on average is needed.
Developmental aspects of sleep

• Developmental changes in % REM sleep:

http://www.sleephomepages.org/sleepsyllabus/fr-e.html

Developmental aspects of sleep

• Infants: ≈50% of sleep is REM
• Two years and older: ≈20% REM sleep
• Not clear why infants have more REM sleep. Speculation:
  – REM important for cerebral and oculomotor maturation
  – May help prevent SIDS

Developmental aspects of sleep

• With increasing age, progressively less stage 4 NREM sleep and more frequent awakenings.