Sleep on the Brain

Alexus Jones, Jennifer Grundman, Eric Lee, Christal Vo
Sleep. What is it?

- Viewed with: **EEG** – Electroencephalography
  - *Problem:* It’s only recording from the neocortex
    - not where sleep generation and regulation occurs
    - Neocortex is absent in invertebrates
- Types:
  - Cortical
  - Behavioral
  - Progressing SubCortical
  - Progressing Synaptic/ Functional
- **REM** aka REM/PS
  - EEG cannot show difference in wake state and REM sleep
  - Produce audio/visual **without** external stimuli

- **Non-REM**

- Differentiated by Behavior and Characteristic patterns of electrical activity in **Cortex**
Behavioral

- 6 Criteria
  - Reduced Mobility
  - Site Preference: bed, couch
  - Specific posture: lying
  - Rapid Reversibility: Ability to wake up
  - Increased arousal threshold: No environment perception
  - Homeostatic Control: Body is tired after deprivation

- Limited
  - Not Quantifiable
Where sleep comes from: (Conserved parts)

- **Brainstem**: Incredibly conserved in Vertebrates
  - **Pons**: Critical for sleep induction, arousal, muscle-tone control
- **Hypothalamus**

Neocortical output on EEG doesn’t account for the deep structures

“Progressing” Subcortical

- Need more developed brain imaging allowing for subcortical sleep understanding
“Progressing” Synaptic/Functional

- Synaptic level: Sleep is a reconstruction state
  - See conservation of sleep across circuits, developmental stages, evolution

- Problem: Subcortical definition does not involve invertebrates

- Looking for a “uniform” definition of sleep
Why are we sleeping?

- Main Role? Research is saying for Neural Plasticity
  - It reinforces cognitive focus, memory consolidation and learning
- Repair network.
  - Neurodevelopmental State Hypothesis
    - Repair networks while sleeping can repair, break, and make connections
- Why Repair during sleep?
  - Similar to road construction
  - Making, breaking and forming new connections cause disruptions in behavior and/or learning
- People can distinguish between words for objects and animals when in light sleep (i.e., not in deep sleep or in REM phases)
  - French researchers used EEG on volunteers’ brains to determine this
Another experiment

- Set up:
  - Words in French were spoken to a group of people who had to push a button with their right or left hands if the word denoted an object or an animal, which they had to do while falling asleep.
  - An EEG would let researchers know whether the subjects’ brains were about to signal for their hands to move.

![Cartoon of two people in bed with speech bubbles saying "Mieh mieh mieh... HELLO? Bleh bleh EMAIL! mieh mieh CONFERENCE CALL! Bleh bleh..."
with text below saying "Sleep multitasking."
- A later experiment built on this, separating subjects into three categories depending on whether they were in a light, heavy, or REM phase of sleep. Their task was the same, however.
  - *Results:* In REM and light non-REM sleep phases, subjects’ brains prepared motor movements, but not in heavy non-REM phases. Only prepared to move in REM if word had already been said.
- In addition, another experiment showed that the first night you spend in a new place, half of your brain stays active — it’s looking out for your safety in unfamiliar surroundings.
- Dolphins do something similar — they only sleep with half their brains
But wait — how is this possible? Not all stimuli are equally important.

- Usually, the brain has a thalamic gating mechanism that prevents you from recognizing external stimuli when you’re sleeping.

- Some stimuli are more important to the brain — e.g., your name. Might be important because you might need to recognize dangerous situations even when sleeping, but we don’t know the mechanism for how the brain determines this.
What does this potentially mean?

- “In [REM], information from the outside world may compete with (internally generated) dreams; in [non-REM], the brain experiences waves of hypersynchrony, in which ‘hundred of thousands of neurons are going silent at the same time.’”
  - Shows that the brain is capable of handling complicated external information even when asleep!
The Importance of Sleep

- As the day goes on, the pressure to sleep increases
- Without sleep, humans become “sleep drunk”, aka cerebral exhaustion
- Increase pressure to sleep leads to microsleep
Microsleep--what is it?

- **Microsleep** is when the brain falls asleep briefly
  - Occurs during monotonous tasks
  - **Examples:** driving for long periods of time, listening to a boring speaker, operating a machine for hours
  - Lasts between 1.1 and 6.3 seconds
  - People won’t feel or remember being unconscious

- **Microsleep Experiment**
  - Participants tracked a target’s movement for 50 minutes with a joystick
  - On average, the participants had 79 microsleep episodes per hour
  - Decrease in performance
Can neurons fall asleep?

- Neuron activity when awake vs. asleep
  - Awake: irregular activity
  - Asleep: distinct on/off periods
- Neuroscientists discovered “sleepy neurons” in animals who weren’t sleeping
  - Microwires were implanted into the frontal motor cortex of rats
  - Local field potential (LFP) and spike activity of nearby nerve cells recorded
- An interesting discovery: sporadic OFF periods of neurons while awake
  - The more tired the subject, the more likely neurons will go silent
Local field potential: "summed electrical activity of large populations of nerve cells"
Neurons CAN fall asleep, but at what cost?

- Is there a decrease in performance?
  - Researchers trained rats to retrieve food pellets from a narrow opening
  - The task engages the *motor cortex*, which changes as a result of learning
  - More neuronal OFF periods decrease success with the task

- Conclusion
  - As the pressure to sleep increases, neuronal OFF periods increase, and we enter microsleep
Do you like to dream?

-David Gelernter in “Tides of Mind”

-Studying the mind requires creativity!

-Dreams include rational, methodical thought to nightmares

-“Dreaming is the endpoint of the spectrum of consciousness, the smooth progression from one type of consciousness to the next, that we each experience daily.”
What about dreaming?

-Oneirology is study of dreaming

-Dreams act out unconscious desires in safe place

-Dreams occur in REM (rapid eye movement) sleep in 1953 by Eugene Aserinsky

-Why can’t we move our bodies when we dream?

-Weird dreaming?
What’s so interesting about dreaming?

-Dreaming is difficult to deduce

-Based on experiences

-Random....

-Anyone have weird dreams?
What happens when we dream?

- Dreaming is the endpoint of the spectrum of consciousness, that we experience

- Our mind concentrates and diffuses, wanders as memory grows increasingly vibrant and distracting when we sleep

- Then our thinking becomes hallucinatory

- At end of spectrum, our minds our dominated by experience
Why do we dream?

- Greatest gift ever? Worst gift?
- By-product of REM Brain responding to chemicals creating an extension of reality.
Why do we dream?

- To Remember
- To Solve Problems
- To Rehearse
- To Fulfil Our Wishes
- To Forget
- To Keep Our Brains Working
- To Heal
What do dreams tell about us?

-Nightmares? Why?

-Types of dreams and what they mean?

Ex: falling, slow motion, being chased, flying, stuck in a maze, being attacked
How do drugs affect dreaming?

- Usually affects REM sleep
- Alcohol
- Anti-depressants
- Need more studies
Why is it hard to deduce dreaming?

- Upper spectrum includes thinking direct thoughts with no feelings
- Lower spectrum is experience, so far, software cannot delve into this.
- Happiness and pain are states that have causes but are about nothing

**Spectrum of Consciousness**
Can we record our dreams?
- “What Lies Sleeping”

- “Brain Listens During Sleep”
  http://www.the-scientist.com/?articles.view/articleNo/46320/title/Brain-Listens-During-Sleep/

- “Sleeping While Awake”

- “In Your Dreams”
  http://www.the-scientist.com/?articles.view/articleNo/45357/title/In-Your-Dreams/

- https://sleepfoundation.org/sleep-news/your-dreams/page/0/2
How Do Dolphins Sleep?

https://www.livescience.com/44822-how-do-dolphins-sleep.html

Why do we dream?

https://www.youtube.com/watch?v=7GGzc3x9WJU&t=328s

https://www.youtube.com/watch?v=2W85Dwx218

https://www.psychologytoday.com/blog/sleep-newzzz/201502/why-do-we-dream

Could we record our dreams?

https://www.youtube.com/watch?v=wgylhpLoFFU

Dreams


http://dreammoods.com/cgi-bin/fallingdreams.pl?method=exact&header=dreamid&search=fallingintro

https://www.psychologytoday.com/blog/dream-catcher/201112/psychopharmacology-rem-sleep-and-dreams