Scripps Research Alcohol Center Neuroscience Course

Sleep

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Science Changing Life

Today's Topics

What is sleep?

Why do we sleep?

How do we study sleep?

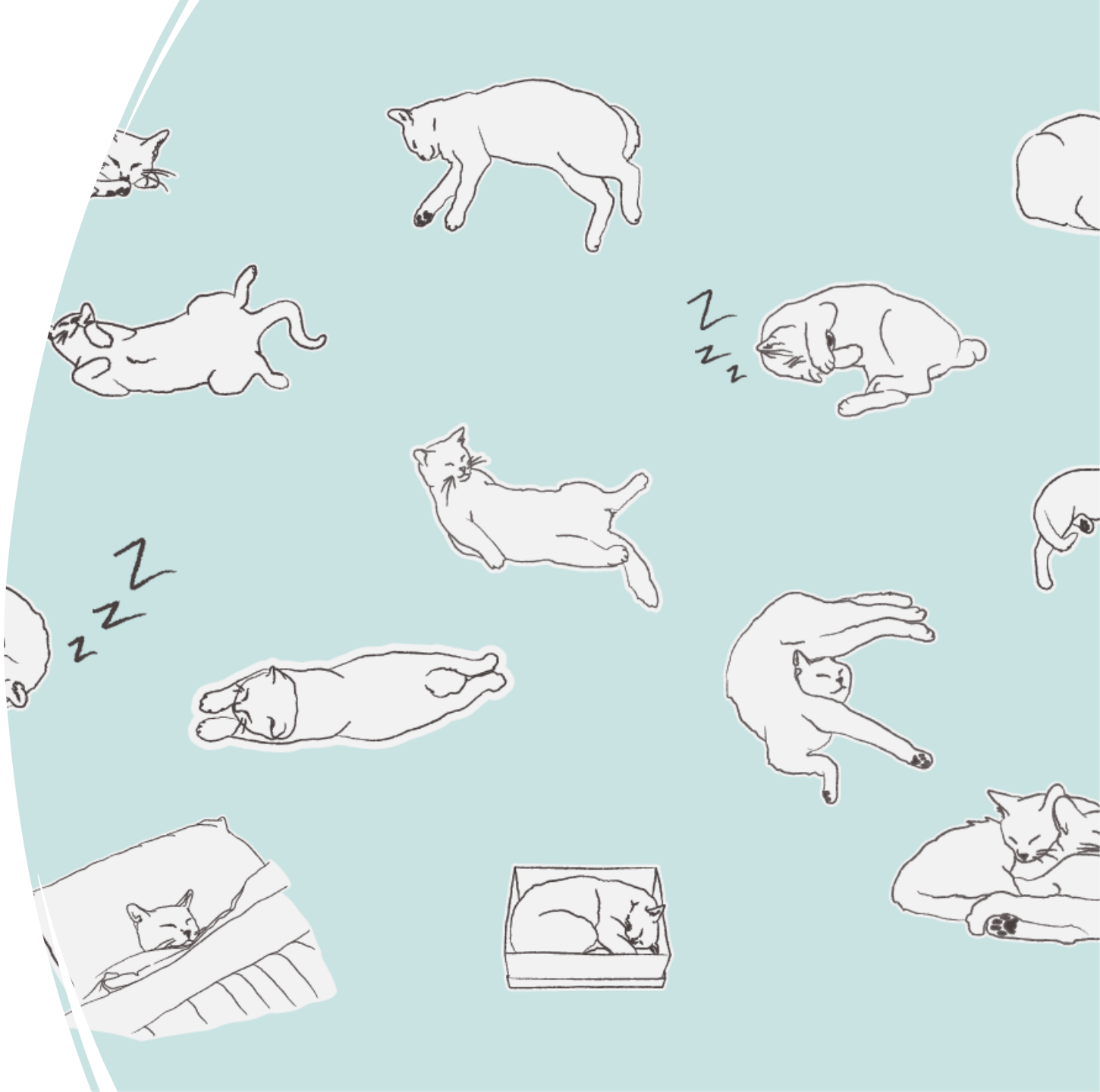
Alcohol & sleep

This week's project: Disorders of sleep

"I don't wake up at night to check my e-mail. I automatically have it forwarded to the people in my dreams and they read it to me."

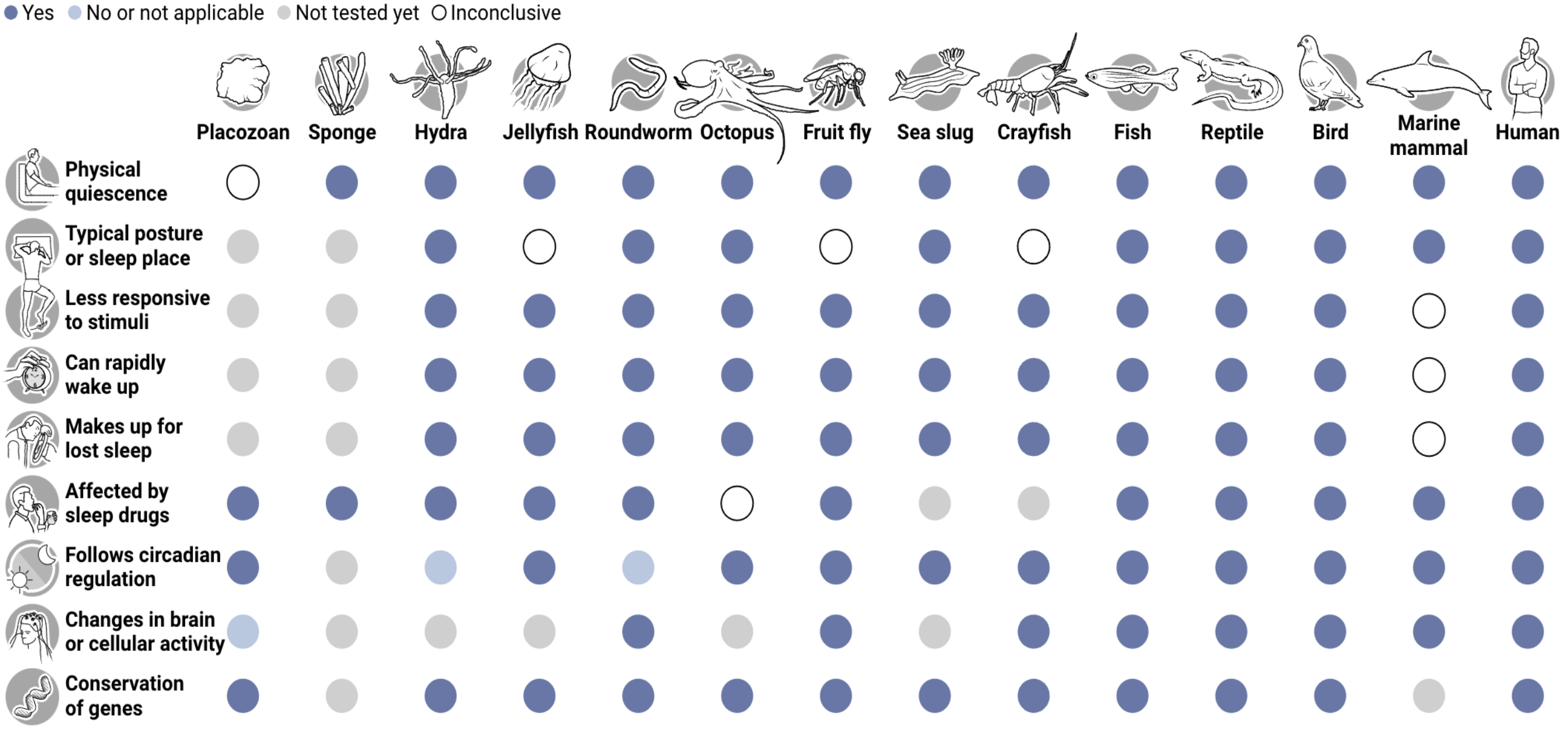
What is sleep?

- Complex biological process that involves a state of reduced mental and physical activity, altered consciousness, and inhibited sensory activity
- Periods of rest that are characterized by a typical posture, such as lying down with closed eyes, and decreased responsiveness to external stimuli
- The brain remains highly active and engaged in several life-necessary activities



Do all animals sleep?

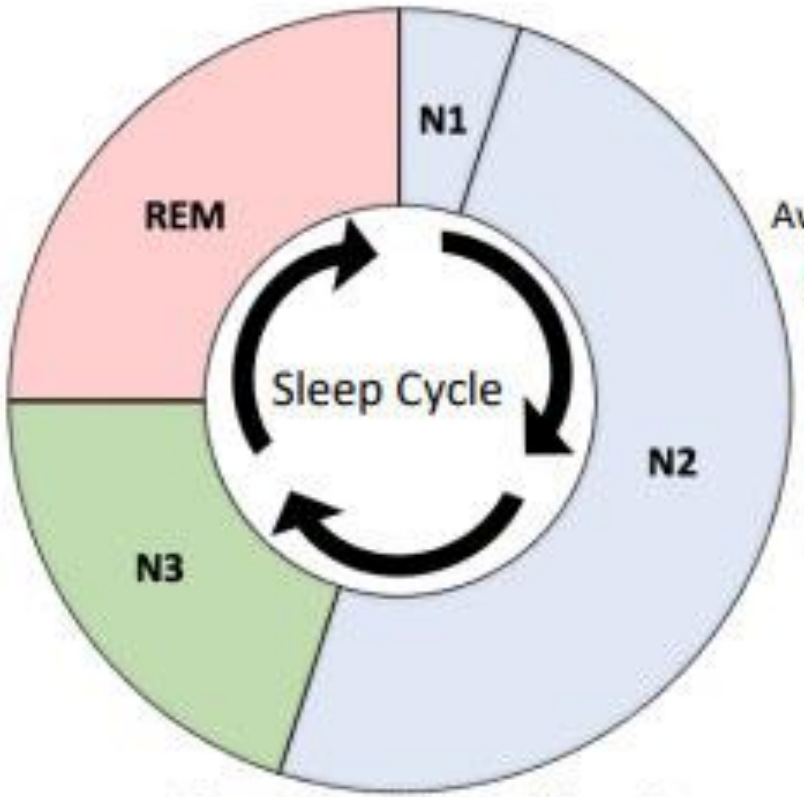
https://www.science.org/content/article/if-alive-sleeps-brainless-creatures-shed-light-why-we-slumber



Sleep stages

- Stage 1 (N1)
  - Short
  - transition from wakefulness to sleep
- Stage 2 (N2)
  - heartbeat and breathing slow, muscles relax, body temperature drops, and eye movements stop.
  - brain wave activity slows but is marked by brief bursts of electrical activity.
  - most sleep is stage 2
- Stage 3 (N3)
  - deep sleep that you need to feel refreshed in the morning
  - occurs in longer periods during the first half of the night
  - heartbeat and breathing slow to their lowest levels during sleep
  - muscles are relaxed and it may be difficult to be awoken
  - brain waves become even slower.
- REM
  - eyes move rapidly from side to side behind closed eyelids
  - mixed frequency brain wave activity becomes closer to that seen in wakefulness
  - breathing becomes faster and irregular, and your heart rate and blood pressure increase to near waking levels
  - most dreaming occurs during REM sleep
  - arm and leg muscles become temporarily paralyzed, which prevents you from acting out your dreams.

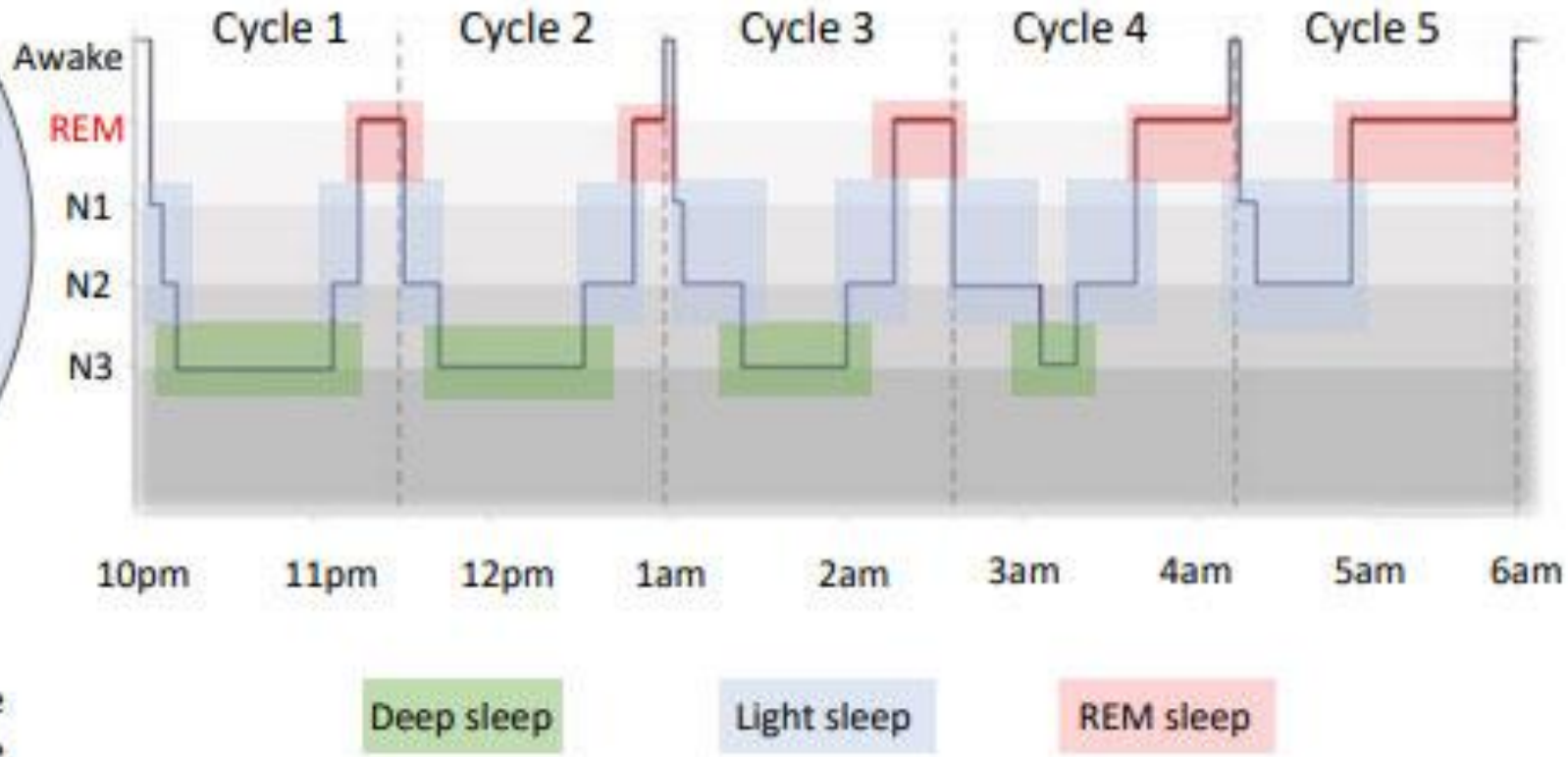
https://www.ncbi.nlm.nih.gov/books/NBK526132/



NREM

Stage **N1**: 2-5% Total sleep time
Stage **N2**: 45-55% Total sleep time
Stage **N3**: 10-20% Total sleep time

REM: 20-25% Total sleep time



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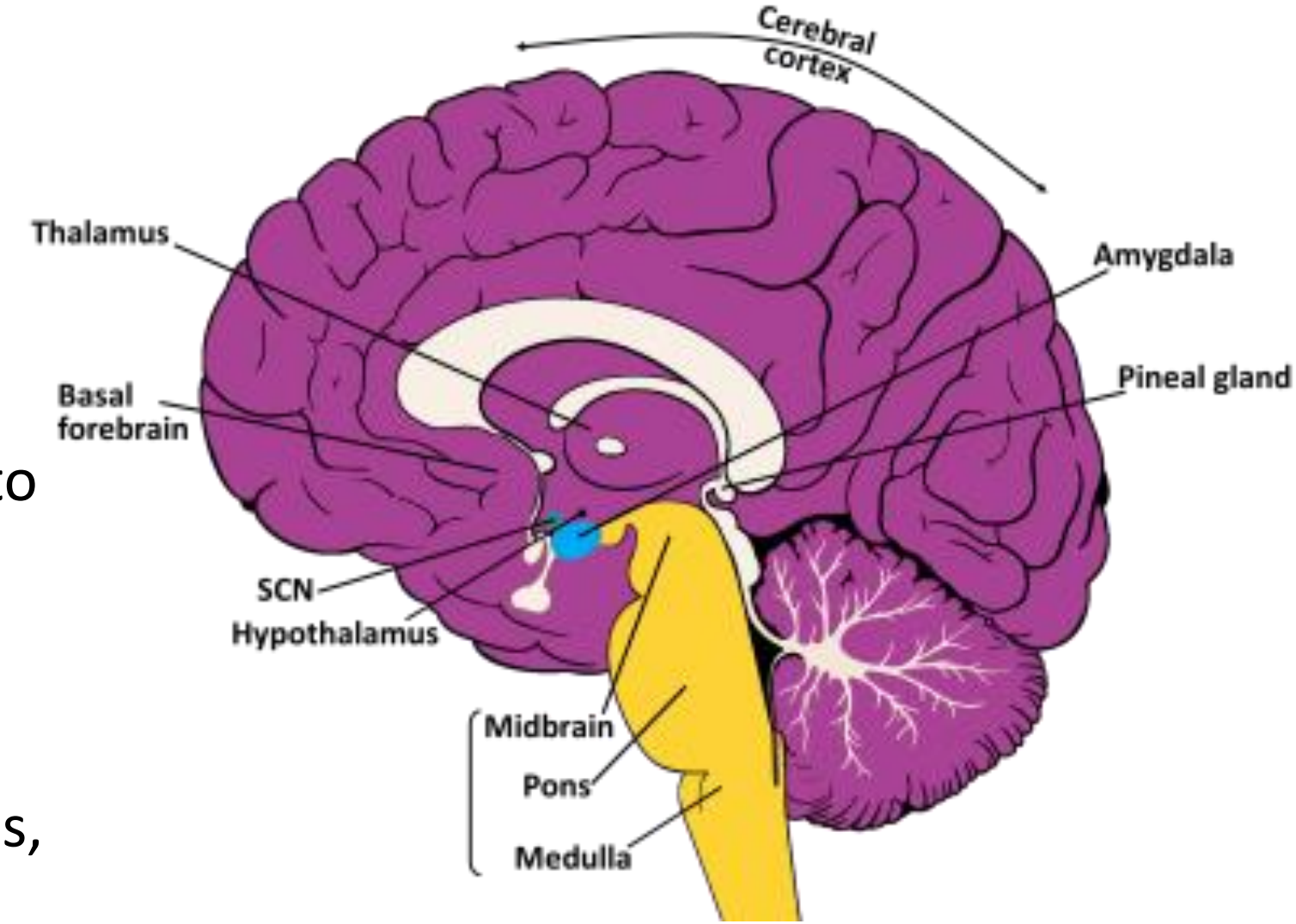
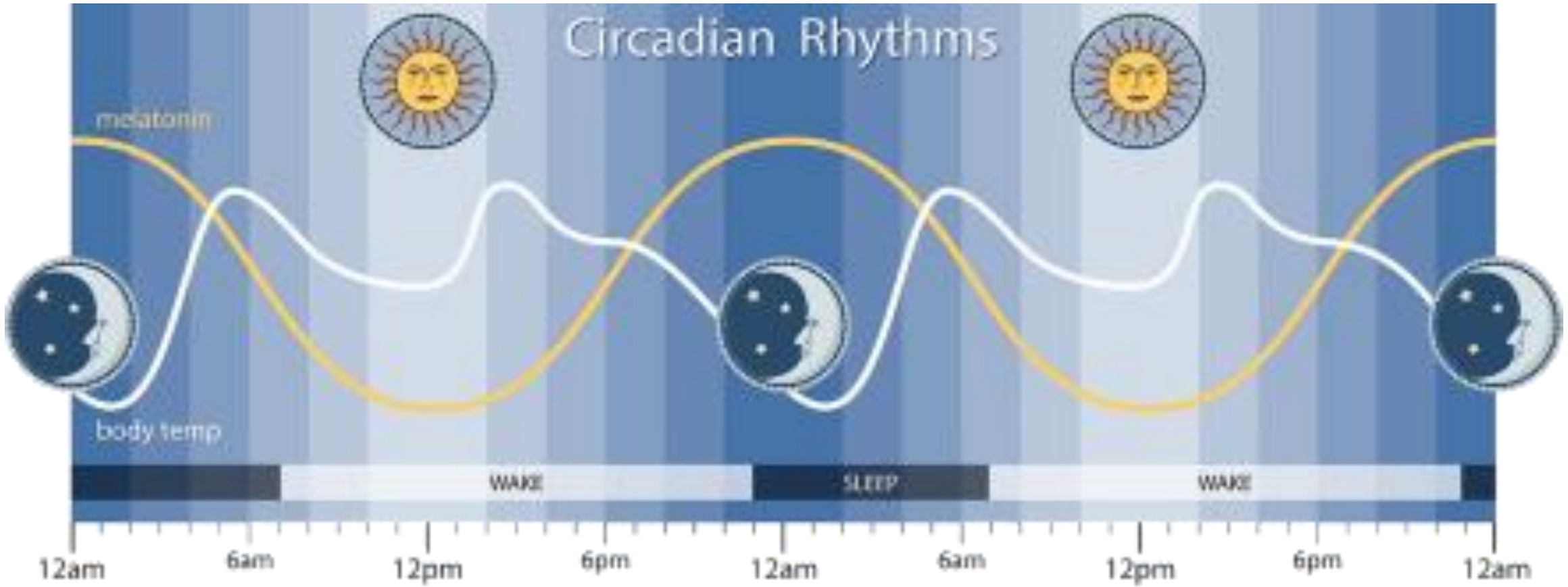
Driller, Matthew & Dunican, Ian C & Omond, Shauni & Boukhris, Omar & Stevenson, Shauna & Lambing, Kari & Bender, Amy. (2023). Pyjamas, Polysomnography and Professional Athletes: The Role of Sleep Tracking Technology in Sport. Sports. 11. 10.3390/sports11010014.

The brain and sleep

- Hypothalamus: Control center
- SCN: circadian rhythm
- Brain stem: sleep/wake transitions & sends signals to relax muscles during REM
- Thalamus: relays sensory info to cortex (active during REM)
- Pineal gland: melatonin
- Basal forebrain: sleep drive
- Amygdala: processing emotions, active during REM



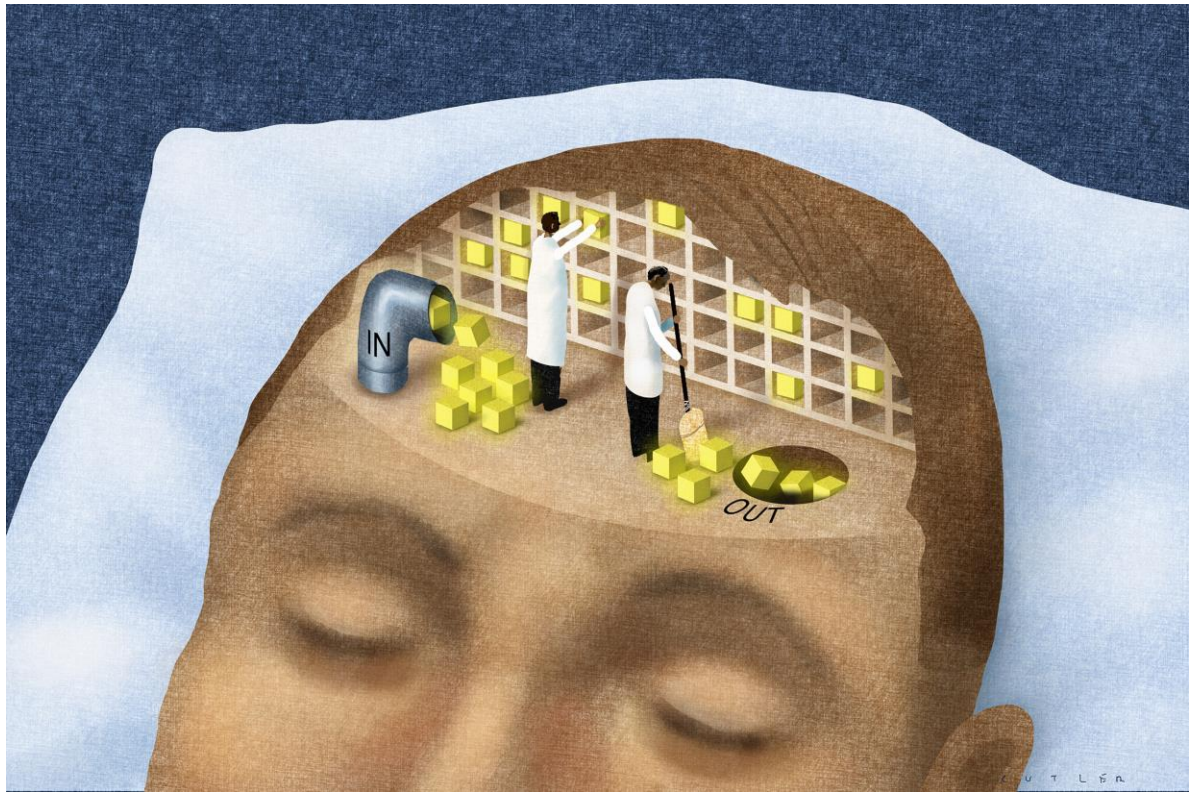
https://www.ninds.nih.gov/health-information/public-education/brain-basics/brain-basics-understanding-sleep



- Direct a wide variety of functions from daily fluctuations in wakefulness to body temperature, metabolism, and the release of hormones
- Control your timing of sleep and cause you to be sleepy at night and your tendency to wake in the morning without an alarm
- Your body's biological clock, which is based on a roughly 24-hour day, controls most circadian rhythms
- Circadian rhythms synchronize with environmental cues (light, temperature) about the actual time of day, but they continue even in the absence of cues

https://www.ninds.nih.gov/health-information/public-education/brain-basics/brain-basics-understanding-sleep

Why do we sleep?



1. Brain development
2. Facilitation of learning and memory
3. Targeted erasure of synapses to "forget" unimportant information that might clutter the synaptic network
4. Clearance of metabolic waste products generated by neural activity in the awake brain
5. Conservation of metabolic energy
6. Strengthening of the immune system
7. Allowing the body to rest and recuperate

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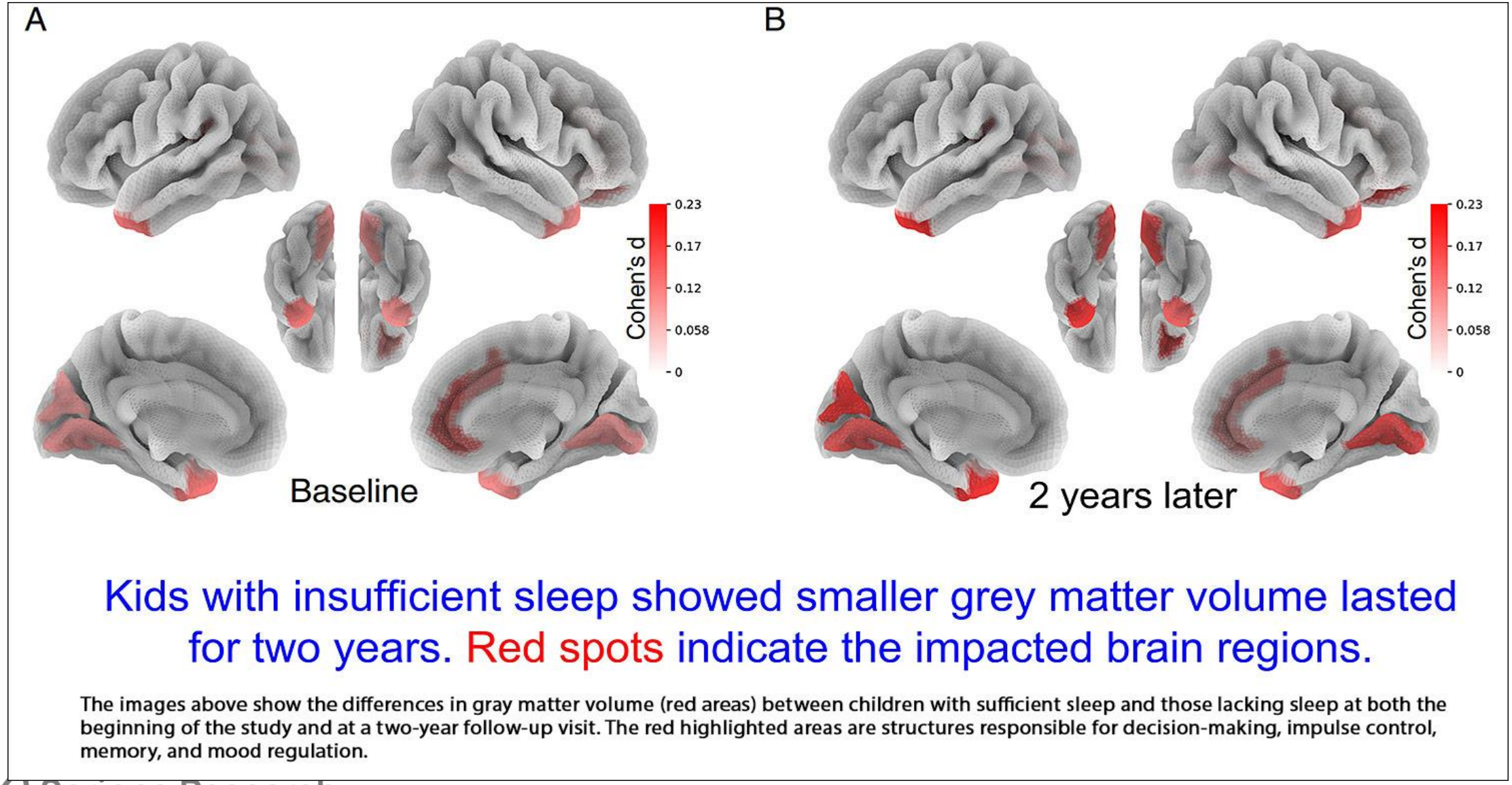
https://www.ncbi.nlm.nih.gov/books/NBK526132/

Sleep & brain development



Kids with insufficient sleep showed smaller grey matter volume lasted for two years. Red spots indicate the impacted brain regions.

The images above show the differences in gray matter volume (red areas) between children with sufficient sleep and those lacking sleep at both the beginning of the study and at a two-year follow-up visit. The red highlighted areas are structures responsible for decision-making, impulse control, memory, and mood regulation.

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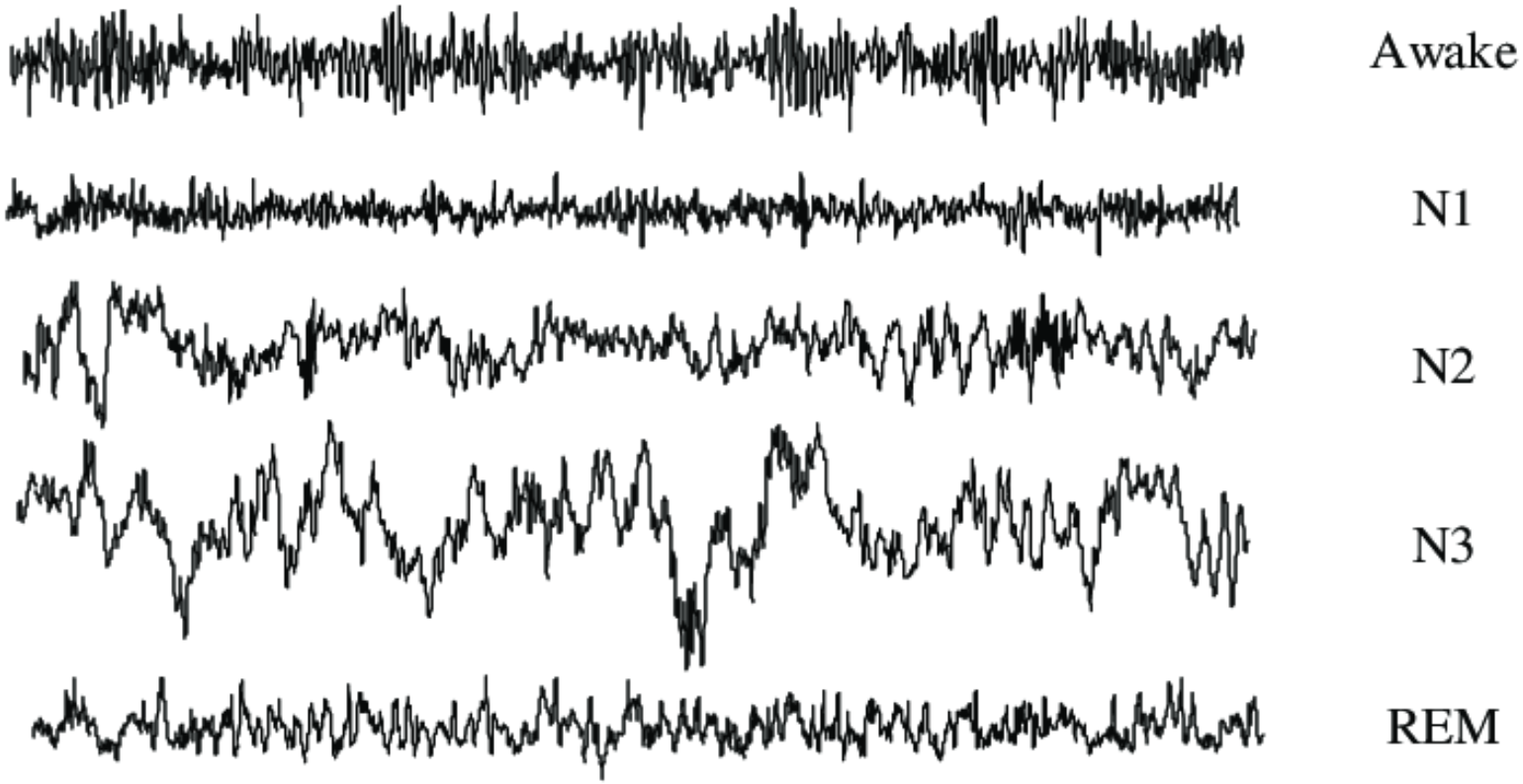
https://www.umaryland.edu/news/archived-news/august-2022/too-little-sleep-harms-kids-brain-development.php

Sleep Deprivation

How do we study sleep?

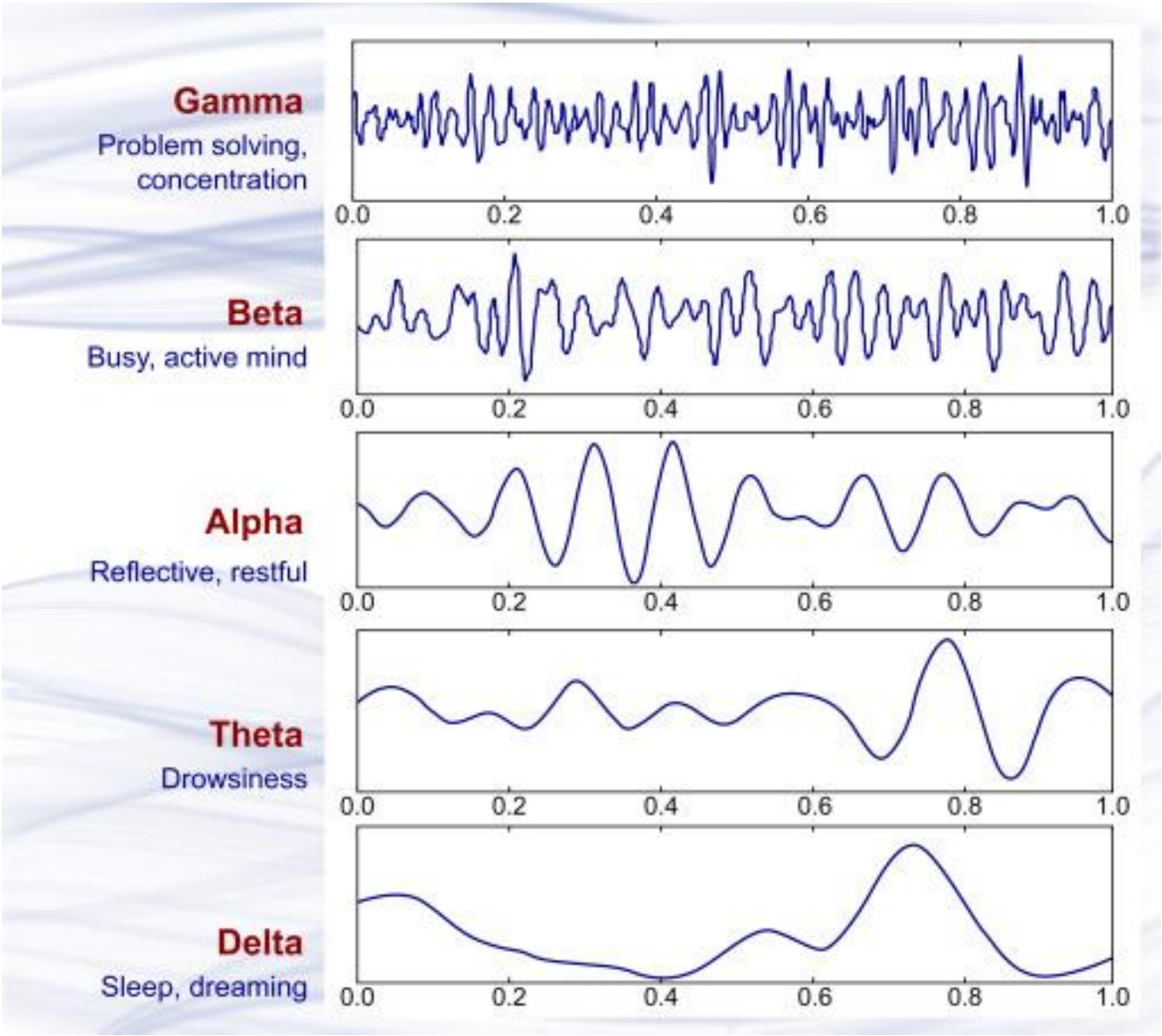
Electroencephalography (EEG)



Khalighi, Sirvan & Sousa, Teresa & Pires, Gabriel & Nunes, Urbano. (2013). Automatic Sleep Staging: A Computer Assisted Approach for Optimal Combination of Features and Polysomnographic Channels. Expert Systems with Applications. 40. 7046–7059. 10.1016/j.eswa.2013.06.023.

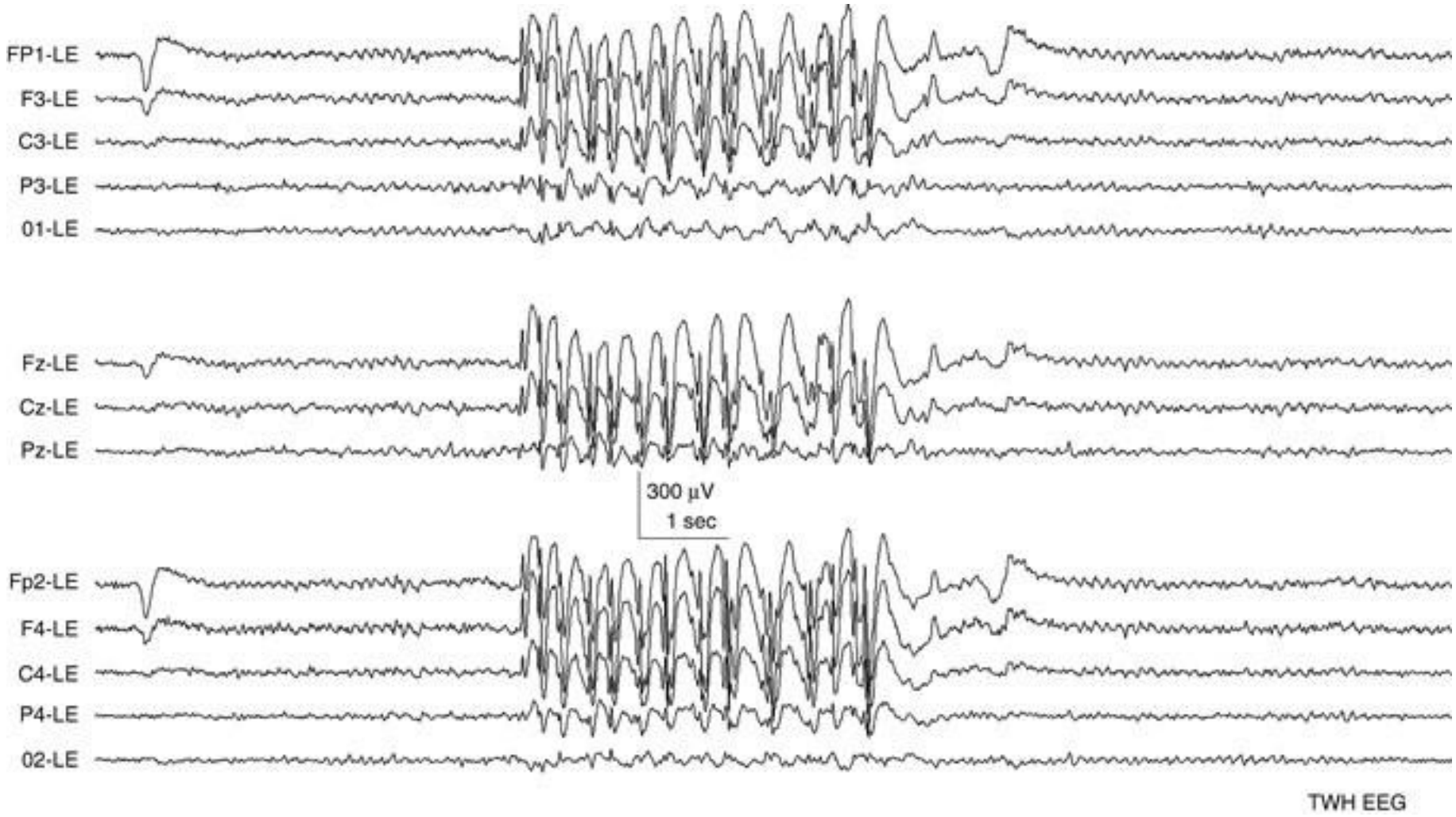
Brain Waves

Oscillating electrical voltages in the brain



https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/brain-waves

EEG also used to detect seizure activity in the brain



A sudden, uncontrolled burst of electrical activity in the brain that can cause temporary changes in behavior, feelings, movements, and levels of consciousness

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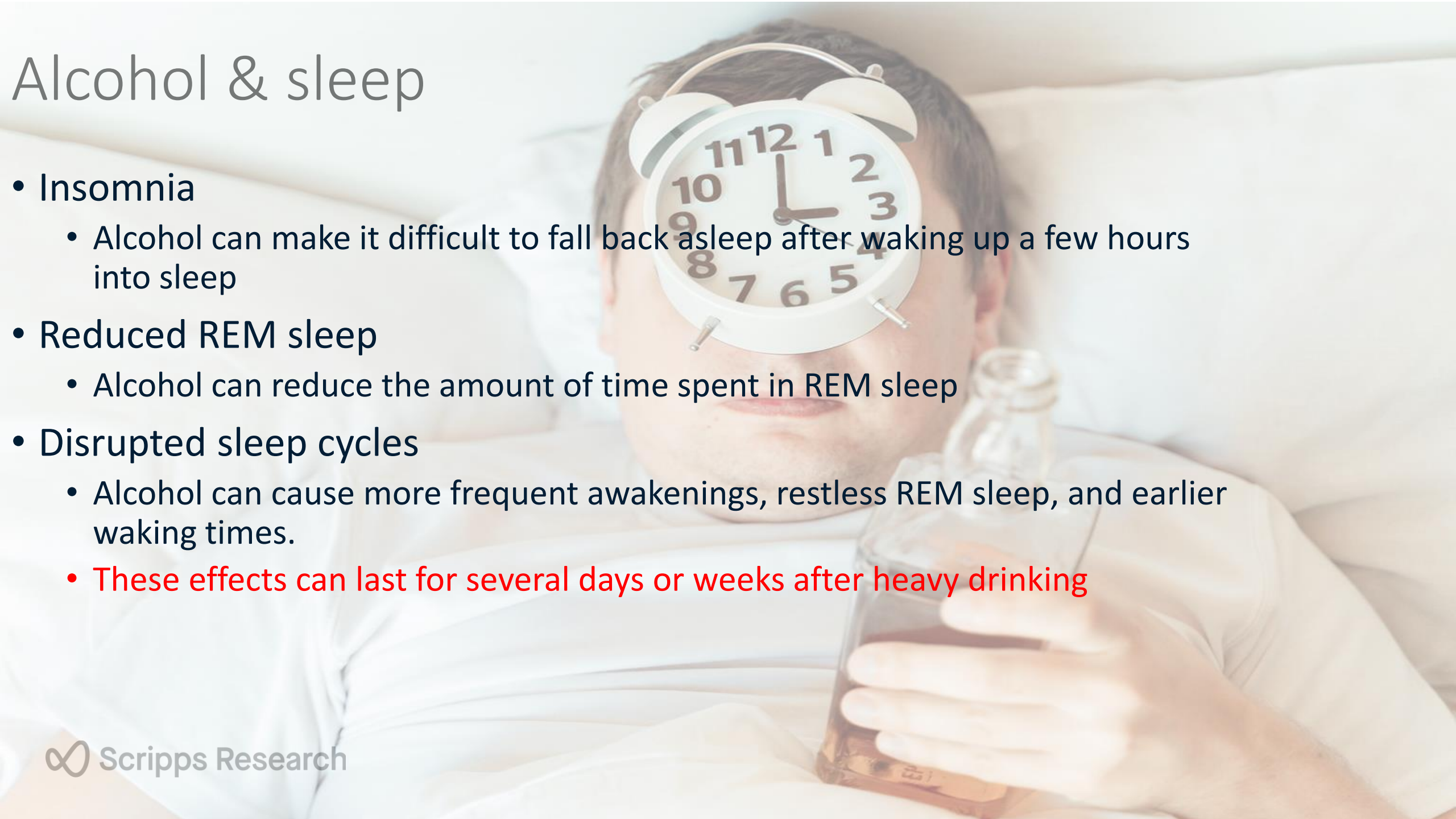
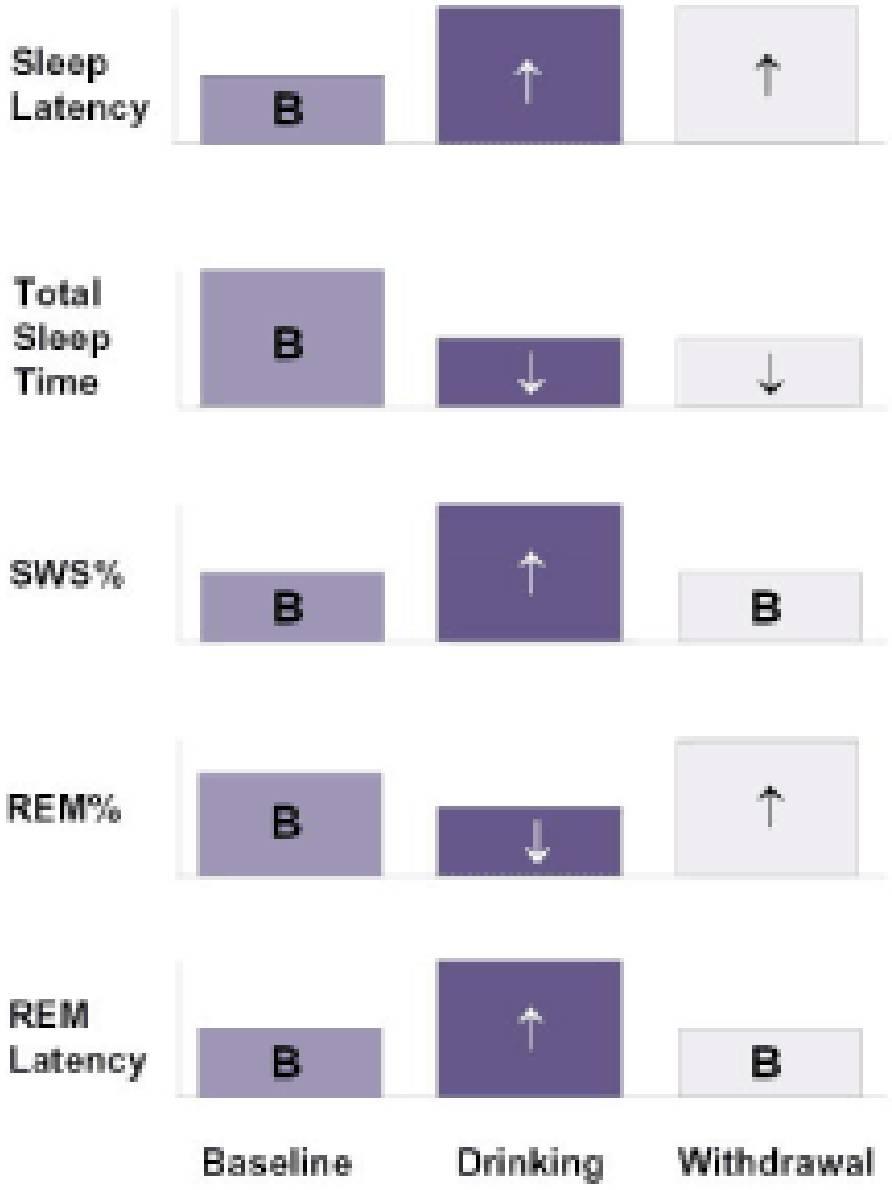
Hoppe, M., Wennberg, R., Tai, P., Pohlmann-Eden, B. (2009). EEG in Epilepsy. In: Lozano, A.M., Gildenberg, P.L., Tasker, R.R. (eds) Textbook of Stereotactic and Functional Neurosurgery. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-69960-6_153

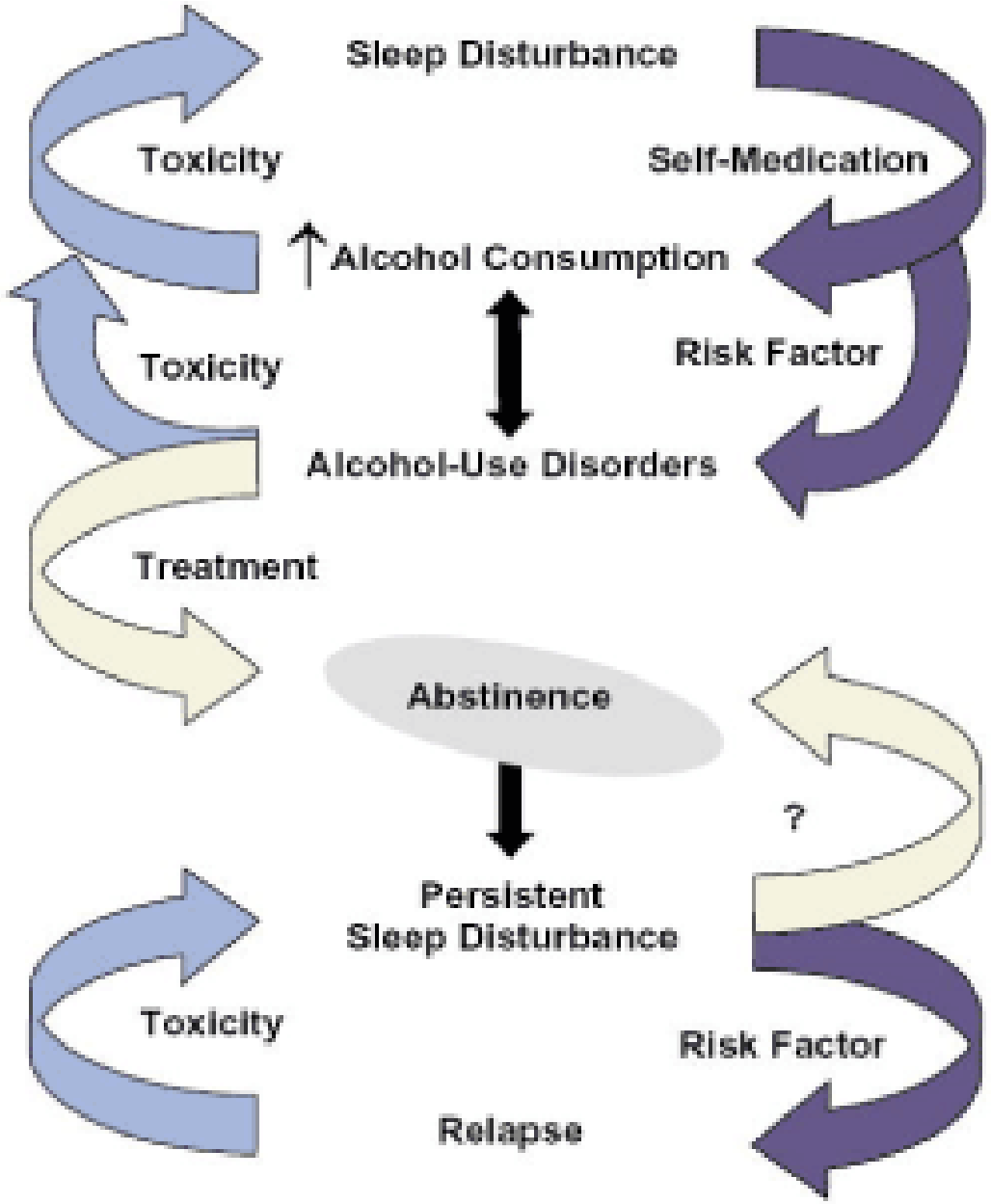
Alcohol & sleep



- Insomnia
  - Alcohol can make it difficult to fall back asleep after waking up a few hours into sleep
- Reduced REM sleep
  - Alcohol can reduce the amount of time spent in REM sleep
- Disrupted sleep cycles
  - Alcohol can cause more frequent awakenings, restless REM sleep, and earlier waking times.
  - These effects can last for several days or weeks after heavy drinking

Alcohol & sleep





https://www.oatext.com/pdf/MHAR-3-162.pdf

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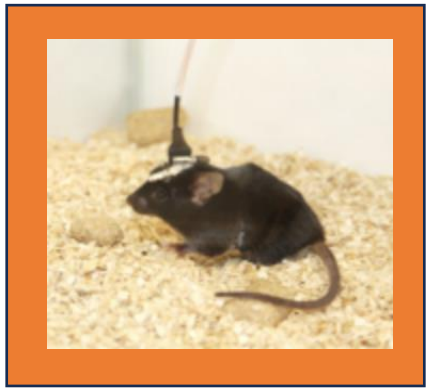
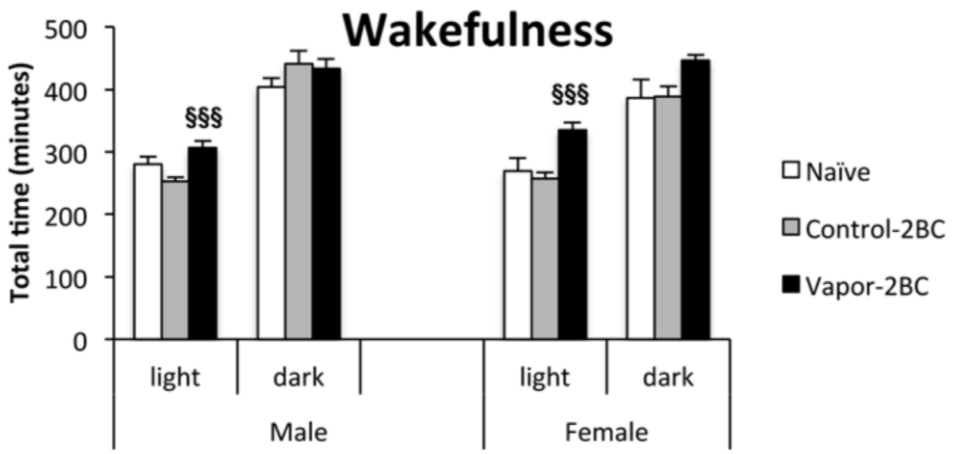
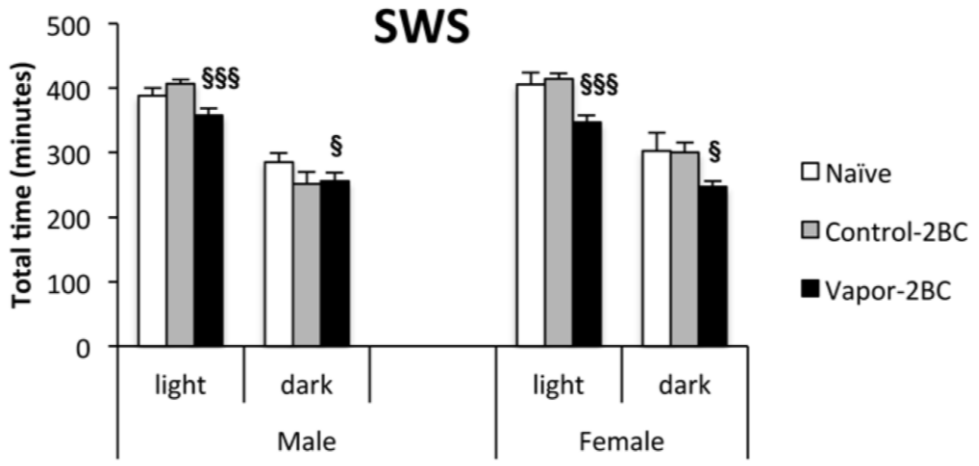
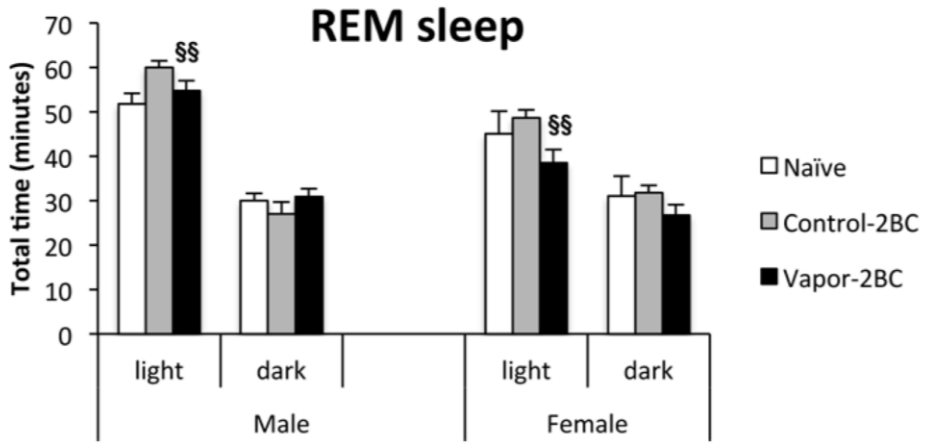
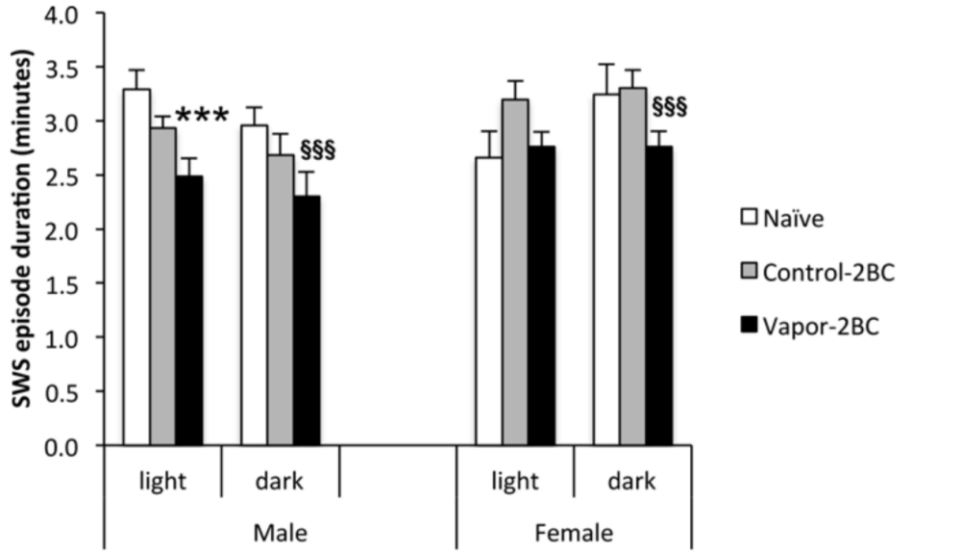
Sleep in mice 1 week into abstinence from chronic alcohol











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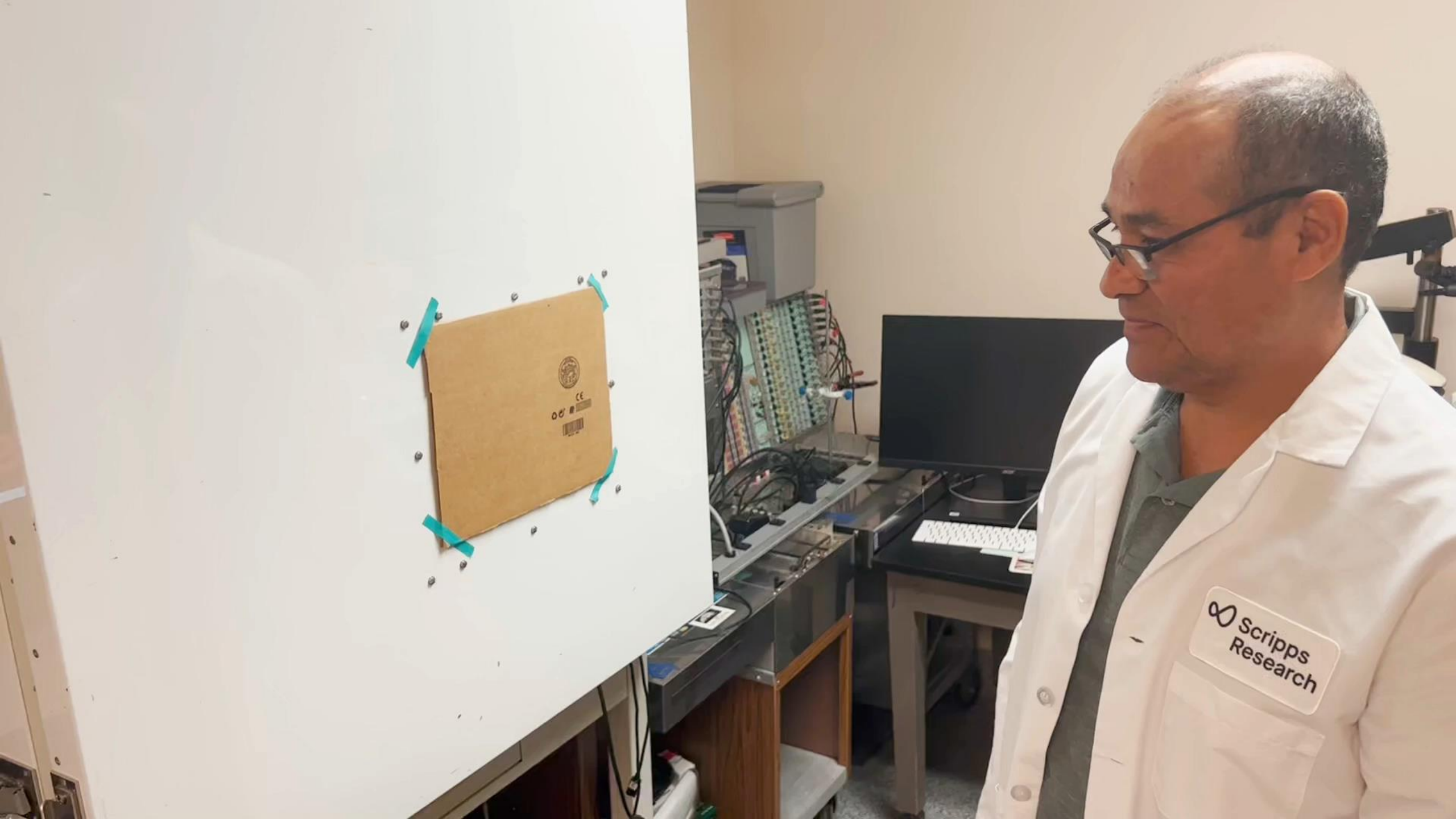
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TWO WEEK SLEEP DIARY

AASM | SLEEP EDUCATION

INSTRUCTIONS:
(1) Write the date, day of the week, and type of day: Work, School, Day Off, or Vacation. **(2)** Put the letter "C" in the box when you have coffee, cola or tea. Put "M" when you take any medicine. Put "A" when you drink alcohol. Put "E" when you exercise. **(3)** Put a "B" in the box to show when you go to bed. Put a "Z" in the box that shows when you think you fell asleep. **(4)** Put a "Z" in all the boxes that show when you are asleep at night or when you take a nap during the day. **(5)** Leave boxes empty to show when you wake up at night and when you are awake during the day.

SAMPLE ENTRY BELOW: On a Monday when I worked, I jogged on my lunch break at 1 PM, had a glass of wine with dinner at 6 PM, fell asleep watching TV from 7 to 8 PM, went to bed at 10:30 PM, fell asleep around Midnight, woke up and couldn't got back to sleep at about 4 AM, went back to sleep from 5 to 7 AM, and had coffee and medicine at 7 AM.

Date	Day of the week	Type of Day (Work, School, Day Off, Vacation)	Noon	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM	Midnight	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM
sample	Mon.	Work		E					A	Z			B		Z	Z	Z	Z		Z	Z	C M				

week 1

Choose one of the following to make an infographic to educate your peers (use at least 4 reputable sources)

- Insomnia
- Sleep apnea
- Restless leg syndrome (RLS)
- Hypersomnia (for example narcolepsy)
- Circadian rhythm disorders
- Sleep talking
- Sleepwalking
- Night terrors
- Sleep paralysis
- Rapid eye movement (REM) sleep behavior disorder (RBD)
- Jet lag