

# 260-2017-02-24-sleep

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## Prelude

## Today's Topics

- Biological rhythms
- To sleep, perchance to dream...

## I got rhythm...

- Rhythms operate at multiple time scales
- Ultradian ( $> 1x$  day)
  - 90-110 min cycles of heart rate, day dreaming
- Circadian
  - Diurnal vs. nocturnal

## Biological rhythms

- Infradian ( $< 1x$  day)
  - Menstrual or estrus cycles
  - Circannual

## Factors influencing rhythms

- Endogenous factors
  - Internal oscillator or “clock”
  - “Free-running”
- Exogenous factors
  - “Zeitgeber” or “time-givers” reset clock (entrainment)
  - Or, independent of clock

## Mechanisms of biological timekeeping

- Endogenous
  - Cellular, neural oscillators
  - Genetic, hormonal variations
- Exogenous (external to organism)
  - Light
  - Temperature
  - Sound

## Physiological mechanisms

- Pineal gland & melatonin
- Suprachiasmatic nucleus (SCN) of the hypothalamus

## SCN Figure

[http://thebrain.mcgill.ca/flash/a/a\\_11/a\\_11\\_cr/a\\_11\\_cr\\_hor/a\\_11\\_cr\\_hor\\_1a.jpg](http://thebrain.mcgill.ca/flash/a/a_11/a_11_cr/a_11_cr_hor/a_11_cr_hor_1a.jpg)

## Pineal gland & melatonin

- Pineal gland
  - Input from SCN via sympathetic NS
- Melatonin
  - Secretion peaks at bedtime
  - Controls hibernation in some species

## Pineal gland figure

<http://images.radiopaedia.org/images/545341/8d9cf624be6236441fd0afcaecb18a.jpg>

## Sleep

- The structure of sleep
- The neuroscience of sleep
- Why do we sleep?

## Structure of sleep

- cyclic, has phases
- 90-110 min cycles

## Sleep structure figure

(Peplow 2013)

## Sleep phases

(Peplow 2013)

## Neuroscience of sleep

- Electroencephalogram (EEG) evidence
- EEG frequency bands
  - Delta: 1-4 Hz
  - Theta: 4-8 Hz
  - Alpha: 8-12 Hz
  - Beta: 13-30 Hz
  - Gamma: >30-50 Hz

## Sleep stages and EEG

(Klemm 2011)

## **Awake state**

- EEG
  - Low amplitude
  - High frequency
- Beta band: attentive state
- Alpha band: quiet rest

## **Stage 1 and 2**

- Stage 1
  - Drowsy, don't feel asleep
  - Theta wave
- Stage 2
  - Sleep spindles (12-14 Hz bursts)
  - K complexes

## **Slow-wave sleep (Stages 3 & 4)**

- EEG
  - Synchronized
  - Delta wave (1-4 Hz)
- Groggy if awoken
- Rarely report vivid dreaming

## **Sleep EEG figure**

(Hobson and Pace-Schott 2002)

## **Rapid Eye Movement (REM) Sleep**

- ~ 20% of sleep
- Desynchronized EEG
  - Similar to Stage 1

## **More on REM sleep**

- Muscular paralysis except eyes
- Vivid dream state
- Cortex activity > awake state
- “Paradoxical” sleep

## **REM sleep atonia circuit**

(McGregor and Siegel 2010)

## Brain systems and sleep

- Basal forebrain
  - Induces slow-wave sleep via GABA release?
- Hypothalamus
  - Coordinates between other areas
  - Orexin/hypocretin
- Thalamus
  - Reticular nucleus

## Thalamocortical circuits

(Hobson and Pace-Schott 2002)

## Other structures and their functions

- Pons
  - Triggers REM sleep
  - NE projection from Locus Coeruleus
  - Induces muscle atonia via strong GABA, glycine activation

## Inducing sleep

(Peplow 2013)

## Sleep and development

- Sleeping like a baby
  - Babies sleep 70% of the time
  - Mostly in REM
  - But, no stable pattern before 3.5-4 mos
- Sleep disorders common in elderly

## Sleep and development

(Peplow 2013)

## Sleeping around the animal kingdom

- Highly variable patterns
- Mammals and birds show SWS & REM

## Why do we sleep?

- Animals with higher metabolic rate -> more sleep
- Avoid predators
- Conserve energy
- Restore body
  - Growth hormones released, but

- Amount of exercise unrelated to sleep duration
- Consolidate learning & memory

## Sleep, Learning & Memory

(Diekelmann and Born 2010)

### Main points

- Sleep – Get some!
- Your brain needs it

### References

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