

260-2017-02-24-sleep

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2017-02-21 10:41:47

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

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

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