Sleep Science: Sleep, Sleepiness, and Sleeplessness

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• for lecture 4

• select Course Materials

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• select 1 mg Melatonin Schedule and print
Sleep II

you are busy when you are asleep
ontogeny of sleep
sleep stages
Hypnogram

Kales & Kales, 1984
sleep stages across the lifespan

- child
- adult
- infant
- older adult

- NWAK
- WASO
- N3
For most people, the following statement is true at any point in their life.

I sleep better now than I ever will again.
sleep duration
Table 2: Expert panel recommended sleep durations.

<table>
<thead>
<tr>
<th>Age</th>
<th>Recommended, h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborns 0-3 mo</td>
<td>14 to 17</td>
</tr>
<tr>
<td>Infants 4-11 mo</td>
<td>12 to 15</td>
</tr>
<tr>
<td>Toddlers 1-2 y</td>
<td>11 to 14</td>
</tr>
<tr>
<td>Preschoolers 3-5 y</td>
<td>10 to 13</td>
</tr>
<tr>
<td>School-aged children 6-13 y</td>
<td>9 to 11</td>
</tr>
<tr>
<td>Teenagers 14-17 y</td>
<td>8 to 10</td>
</tr>
<tr>
<td>Young adults 18-25 y</td>
<td>7 to 9</td>
</tr>
<tr>
<td>Adults 26-64 y</td>
<td>7 to 9</td>
</tr>
<tr>
<td>Older adults ≥65 y</td>
<td>7 to 8</td>
</tr>
</tbody>
</table>

circadian rhythm
dreams
topics

- What is a dream?
- Why don’t we always recall our dreams?
- What is the meaning of dreams?
what is a dream?
dream research methodology

- awakening or diaries
- Dement & Wolpert, 1958
  - eye movements are “watching” the dream
  - modest influence of external stimuli on dream
definition: mental activity during sleep

rating scale
1. no dream
2. disconnected thought fragments
3. short dream sequence
4. detailed story of 5 or more scenes

stages of sleep
- ratings 1 – 3: NREM
- ratings 3 -4: REM
- emotion: REM
dream types

- hypnagogic (sleep onset) and hypnopompic (sleep offset) reverie
  - N1 & N2
- night terrors
  - N3
- nightmares
  - REM
  - PTSD
- lucid dreams
  - REM or less often N2
  - awareness of dreaming and control dream
- dreams
Why don’t we always recall our dreams?
dream recall

- stage of sleep
  - REM
- immediate recall
  - don’t delay
- intent
  - motivation
- gender
  - women
- personality
  - much research
  - not much progress
What is the meaning of dreams?
Dreams as Wish-Fulfillment
(Freud’s Royal Road to the Unconscious)

- Dreams express unconscious wishes, usually disguised.  
  - sex, aggression

- Manifest Content
  - Conscious dream content that is remembered after awakening

- Latent Content
  - The unconscious, censored meaning of a dream

- No evidence for this theory
dream content

- negative vs positive
  - 4:1

- familiar vs unfamiliar
  - 2:1

- human vs animal
  - 10:1

- recency
  - 50% comes from the preceding day
sleep and health
Sheldon Cohen's cold research

inadequate sleep and colds

https://vimeo.com/231905695
❖ 153 healthy adults recorded TST & SE for 14 days
❖ viral nasal drops & quarantine for 5 days
❖ 35% of subjects developed a cold

What do we learn from this study?
The next time someone asks if they can inject a virus into your nose, don’t say OK unless you have been sleeping really well.
Poor sleep compromises immunity

“Sleep deprivation and naturalistic disturbance of sleep (i.e., short sleep duration or reduced sleep efficiency) impair adaptive immunity; this impairment is associated with reduced response to vaccines and increased susceptibility to infectious disease.”

Evidence is beginning to accumulate that indicates improving sleep improves immunity.

Irwin, 2015
It is usually unclear if ...

- poor sleep causes the disorder.
- the disorder causes poor sleep.
- neither causes the other.

Comorbidity is easy to demonstrate; causation much harder.
A risk factor is any attribute, characteristic or exposure of an individual that increases the likelihood of developing a disease or injury.

– WHO (World Health Organization)
the more churches in a city, the greater the number of homeless people

equations of risk factors

the more people smoke, the greater the likelihood of cancer
causal influence of sleep disorders in illness

- results are inconsistent
- many studies of treated sleep apnea
  - daytime sleepiness sometimes remits
  - high blood pressure sometimes remits
- many studies of treated insomnia
  - quality of life sometimes improves
  - depression sometimes improves
sleep disorders associated with illness I

- heart disease
  - sleep apnea
  - short sleep (< 6 hr)
  - long sleep (> 9 hr)
- high blood pressure
  - sleep apnea
  - short sleep
- stroke
  - sleep apnea
- substance abuse
  - insomnia
- substance abuse relapse
  - insomnia
- depression & suicide
  - insomnia
- reduced quality of life
  - insomnia
sleep disorders associated with illness II

- breast cancer
  - shiftwork
- diabetes
  - short sleep
- car wrecks
  - sleep apnea
  - short sleep
- chronic pain
  - insomnia
- medical errors
  - sleep apnea
  - short sleep
- all cause mortality
  - short sleep (< 6 hours)
  - long sleep (> 9 hours)
  - difficulty falling asleep (Ge et al., 2019)
sleep and overweight

- short sleep leads to overweight
  - leptin inhibits appetite ↓
  - ghrelin stimulates appetite ↑

- short sleep slows weight loss diet
  - short sleepers lose less weight
  - short sleepers lose less % body fat
brain basics
the brain has 100 billion neurons

Trying to understand how the brain functions by studying a few brain structures is like trying to understand how to send a rocket to the moon by making a paper airplane.
suprachiasmatic nucleus (SCN) & ventrolateral preoptic nucleus (VLPO)
hypothesalamus
hypothalamus

- thin sliver
  - 4 grams
  - 3.5 mm thick
  - almond size
- neurotransmitters
  - adenosine
  - orexin/hypocretin
  - GABA
- suprachiasmatic nucleus (SCN)
- ventrolateral preoptic nucleus (VLPO)
adenosine

- accumulates with increasing wake time
- depleted by sleep
- Process S, sleep homeostat
  - caffeine counteracts adenosine
orexin/hypocretin

- promotes arousal
- released at end of sleep period
- loss of orexin cells related to narcolepsy
produced in VLPO (and other sites)
- promotes sedation
- GABA receptors widely dispersed in brain
- sedative/hypnotics that work on GABA receptors promote general sedation
Suprachiasmatic Nucleus (SCN)

- SCN projects to
  - Pineal gland (melatonin)
  - VLPO

- SCN receives photic input from optic nerve (melanopsin), blue spectrum

- SCN (via light) “entrains” one’s circadian rhythm
Located near the SCN
Called the “sleep switch”
- Wake-promoting VLPO neurons
- Sleep-promoting VLPO neurons
VLPO helps “switch” from:
- wake to sleep
- sleep to wake
- NREM to REM
other structures
Pineal Gland

- Located near hypothalamus
- Secretes melatonin, sleep promoting
  - Light $\rightarrow$ SCN $\rightarrow$ Pineal gland $\rightarrow$ melatonin$\downarrow$
Reticular Formation

Located in the brainstem:
- medulla, pons, midbrain

Also referred to as reticular activating system (RAS)

Promotes alertness

Promotes atonia in REM

Dysfunction to this area produces:
- Chronic Fatigue
- Hypersomnolence
sleep/wake system

complex interplay between a series of structures and chemicals that balance wake promotion and sleep promotion
let’s learn about sleepiness next time