

## Solving the Mystery of Sleep: Patterns, Habits, & Tools

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### My Interest in Sleep..

- Sleep is my "soap box" topic
- Part of the VFBA Domains of Wellness



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### Active Learning

- A focus of the Larner College of Medicine
- *"Active learning methods rely on student engagement to construct knowledge rather than passively absorb it from an expert. The focus of an active learning session is not on faculty transferring information, but on students developing skills such as clinical reasoning, analysis, and application."*
- Pre-/Post-questions during this talk



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### Active Learning Practice Test

- The tests will include True/False questions and multiple choice questions. For the True/False questions, when I ask them, please raise your hand when asked to indicate whether you believe a statement to be true or false. For the multiple choice questions, please discuss briefly with your neighbors and then one of you can hold up the corresponding laminated letter card in front of you to indicate your answer.



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### Active Learning Practice Test

- True or False: My name is Pamela Swift
- What will we be learning about tonight?
  - A. What sleep is
  - B. Why we sleep
  - C. How much sleep we need
  - D. All of the above



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### What is Sleep?

- Lack of consciousness
- Lack of wakefulness
- Dreaming
- Muscle paralysis
- REM and NREM
- Circadian rhythm/ cycle
- Super important
- Something I don't get enough of



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## What is Sleep?

- Sleep accounts for about 1/3 of our existence
- It plays some role in / is subsequently affected by nearly all physiological and psychological process
- To put most succinctly "sleep is a biological state consisting of NREM and REM sleep"
  - Defined by behavioral phenomena
    - Minimal movement
    - "Typical" sleep posture
    - Reduced responsiveness to external stimuli
    - Reversibility with intense stimulation

## Why Do We Sleep?

- All mammals have REM and NREM sleep to some degree

"IF SLEEP DOES NOT SERVE AN ABSOLUTELY VITAL FUNCTION, THEN IT IS THE BIGGEST MISTAKE THE EVOLUTIONARY PROCESS EVER MADE."

ALLAN RECHTSCHAFFEN



## Why Do We Sleep?

- Restoration/Recovery?
  - But we don't know what is restored/recovered
- Energy Conservation
  - But quiet rest
- Memory Consolidation
- Various other functions?
  - Brain / other physical growth (e.g., pituitary gland releases growth hormone at high rates)
  - Discharging emotions

HOMER1a drives homeostatic scaling-down of excitatory synapses during sleep

Ultimately, we are not totally sure!

## Why Do We Sleep?

- When we do not sleep enough, our bodies *crave* sleep
- If we do not get *any* sleep, we could die
  - Ex: *Fatal Familial Insomnia*
  - Animal studies
- "When sleep goes, everything goes."

EURO 2012

**Euro 2012 Superfan Dies from Sleep Deprivation**  
Jiang Xiaoshan went 11 nights without sleep to watch the tourney

## What is Sleep, Physically? How is it Measured?

## Active Learning: Pre-Test

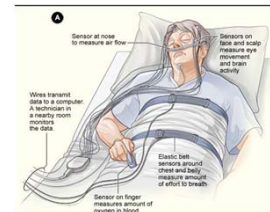
1. True or False: If you want a good night of restorative sleep, you need to spend most of it in REM.
2. In order to stage sleep, it is best to have what information?
  - A. EEG data
  - B. Respiratory data
  - C. Heart rate data
  - D. All of the above

## Sleep Cycle

- Several stages of sleep
    - Stage 1
    - Stage 2
    - Stage 3 / 4
    - Rapid Eye Movement (REM)
- NREM Sleep

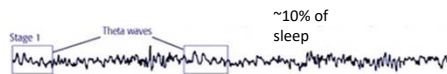
## How do we Stage Sleep?

- Polysomnography (primarily using the EEG data)



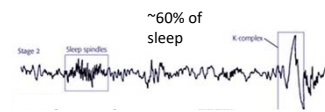
## Sleep Stages

- Stage 1
- Stage 2
- Stage 3 / 4
- Rapid Eye Movement (REM)



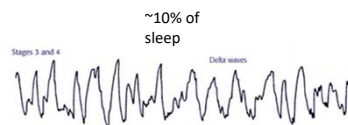
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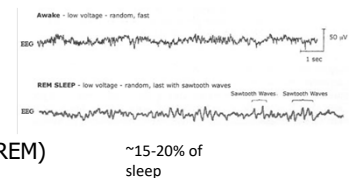
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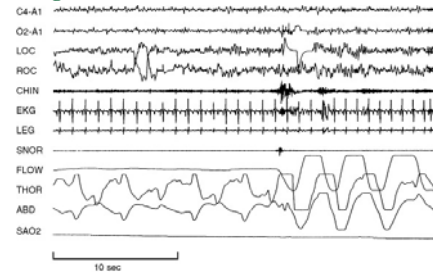


## How Is Sleep Measured?

- Polysomnography (PSG)



## Polysomnogram



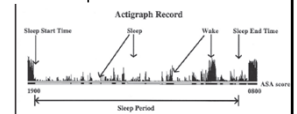
## Sleep Cycle

- Each cycle lasts (on average) 90-120 minutes
  - Stage 1 / 2 thru REM
- Amount of time spent in REM increases as the night goes on



## Actigraphy

- Typically used in research/clinical labs to assess sleep
- Monitor movement via accelerometer
  - Many also have light sensors



Costly; upwards of \$1000 and no other real bells or whistles

Sleep/Wake Patterns Derived from Activity Monitoring and Maternal Report for Healthy 1- to 5-Year-Old Children

Christine Kohler, PhD, and Susan, PhD, Donald Sells, PhD, Chris Tschann, PhD, Abigail Fisher, PhD, Mary J. Canham, PhD

## Sleep Gadgets

- Multiple kinds; some simply require your cell phone while others require a fitness tracker and a linked smartphone app
  - Accelerometer
  - Heart rate monitor
  - Audio recordings
- Accuracy is *very* debatable

## Sleep Gadgets

Table 1—Comparison of sleep outcomes for PSG, Fitbit Ultra Normal and Fitbit Ultra Sensitive modes (n = 49, controlling for age and sleep-disordered breathing status).

Sleep Outcome	PSG Mean (SE)	Fitbit Ultra Normal Mean (SE)	Fitbit Ultra Sensitive Mean (SE)	F (df = 2, 45)	P
TST (min)	420.4 (9.5)	461.6 (5.3)	315.7 (8.9)	39.9	< 0.001
WASO (min)	65.3 (6.7)	33.1 (3.8)	171.7 (8.5)	28.8	< 0.001
Sleep Efficiency (%)	83.4 (1.7)	91.8 (0.8)	62.7 (0.2)	39.3	< 0.001

“Sensitive” setting on Fitbit is marketed as being recommended for people with suspected sleep disorders...

Comparison of a Commercial Accelerometer with Polysomnography and Actigraphy in Children and Adolescents

Lisa J. Meltzer, PhD, Laura E. Haines, PhD, Kristin A. J. J. PhD, Lindsay Montgomery-Cook, PhD, John V. Mateika, PhD

### Active Learning: Post-Test

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  - D. All of the above

### Biological Basis of Sleep

### Active Learning: Pre-Test

1. True or False: Our bodies run on basically a 24-hour schedule or rhythm (give or take 20-30 min)
2. The area of the brain that is our "clock setter" is called the..
  - A. Suprachiasmatic Nucleus
  - B. Retina
  - C. Thalamus
  - D. Timex

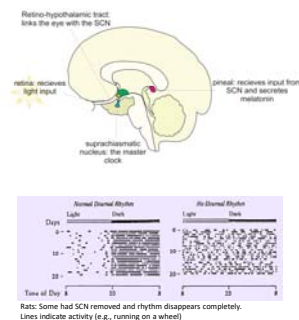
### The Brain and Sleep

- Synchronized to the solar clock
  - E.g., runs on a ~24 hour phase (entrainment)
  - *Circa* (about) *diem* (day)
- Three components
  - Central component: biochemical
  - Input pathways: environmental cues
  - Output pathways: signals to change behavior, physiology, etc.
- Exogenous or endogenous?

REPORTS  
Stability, Precision, and  
Near-24-Hour Period of the  
Human Circadian Pacemaker

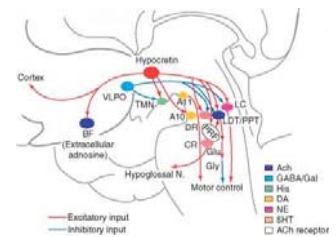
### The Brain and Sleep

- Where is this clock? (Endogenous)
- Anterior hypothalamus /  
suprachiasmatic nucleus
  - Located immediately above the optic chiasm
  - If destroyed, amount of sleep/wake time does not change much, *but the 24 hour clock does*



### The Brain and Sleep

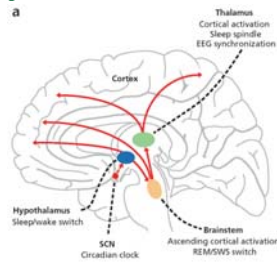
- Evidence for the Hypothalamus
  - Ventrolateral preoptic area (GABA)
    - Insomnia
  - Lateral hypothalamus (hypocretin)
    - Narcolepsy



Sleeping with the hypothalamus: emerging therapeutic targets for sleep disorders

## The Brain and Sleep

- Signaling Sleep/Wake

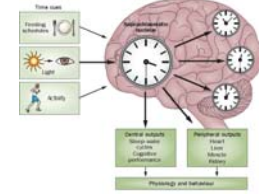


Sleeping with the hypothalamus: emerging therapeutic targets for sleep disorders

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## The Brain and Sleep

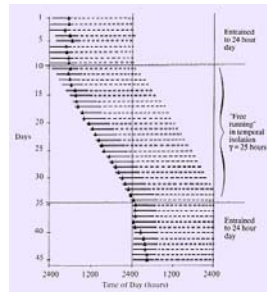
- Our brain plays an important role in sleep/wake, but there are external/exogenous players, too
  - "Zeitgebers"



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## The Brain and Sleep

- What if we remove the *zeitgebers*?
  - Jean-Jacques D'ortous de Mairan (18<sup>th</sup> century Swiss astronomer): diurnal leaf movements in plants
  - Nocturnal rodents in continuous darkness
  - Rhythmic organization of activity still exists; Period (length) of activity starts to differ



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## The Brain and Sleep



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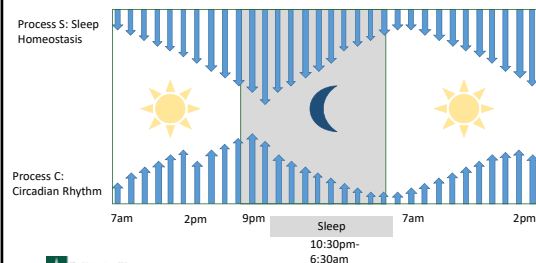
## The Brain and Sleep

- **Process C:** Sends alerting signals over the day: increase over day starting when we wake; decrease over night until early morning (small dip in mid-afternoon)
- **Process S:** Builds up over course of day starting at awakening
  - Example: Can be slowed by caffeine as this blocks adenosine



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## The Brain and Sleep



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### Active Learning: Post-Test

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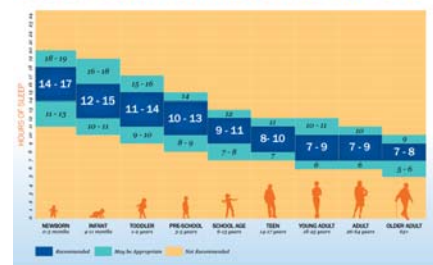
### How Much Sleep Do I Need?

### Active Learning: Pre-Test

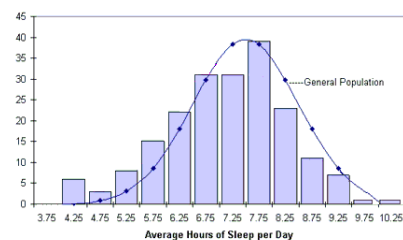
1. True or False: Older adults require less sleep than young- and middle-aged adults.
2. Adolescent sleep is characterized by
  - A. Advancement of sleep phase
  - B. Delay of sleep phase
  - C. Decreased time asleep/increased sleepiness
  - D. Both B and C are true

### NATIONAL SLEEP FOUNDATION

#### SLEEP DURATION RECOMMENDATIONS

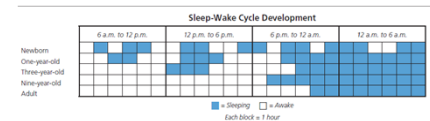


### "Actual" Sleep Needs



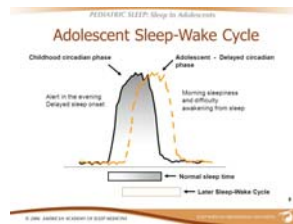
### Sleep Needs

- Infants/Toddlers
  - Sleep needs are high
  - Becomes more consolidated after newborn stage and continues to consolidate into early childhood
  - Circadian rhythm arises around 2-3 months
    - Cycles are shorter (about 50min) until 9 months old; split REM/NREM more evenly



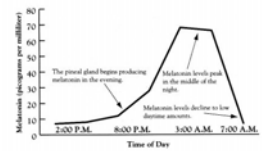
## Sleep Needs

- Adolescents
  - "Developmental Phenomenon"
  - Melatonin is released later, prompting nighttime behaviors later in adolescents
    - Over-the-counter "Clock setting" dose of melatonin: 0.3-0.5mg
  - Makes getting to bed on time in order to get to school VERY difficult

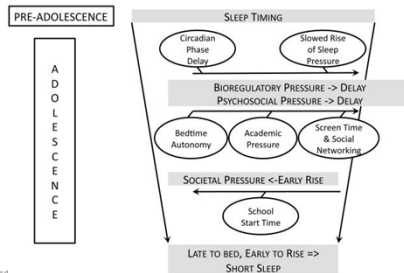


## Note on Melatonin

- Chronobiotic: helps define whether it is night or day/what activities our bodies should be doing
  - Morning Lark or Night Owl?
  - Tied to circadian rhythm
- If these levels are low or not being released at the right time, will lead to changes in sleep timing

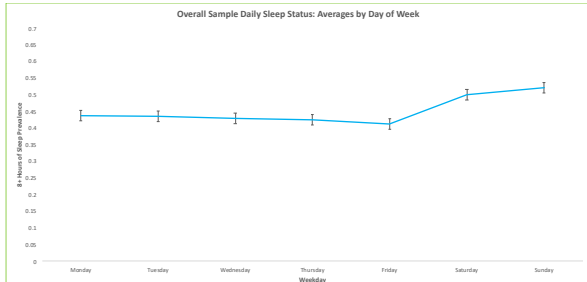
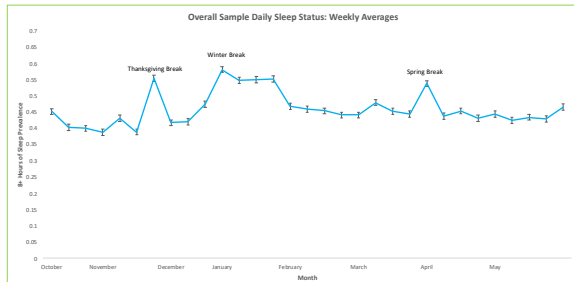


## Sleep Needs



## Sleep Needs

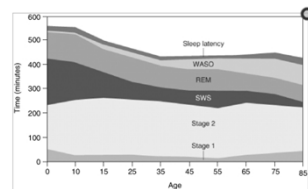
- Young Adults/College Students
  - Independence to define schedule
  - Dorm room/shared living environments
  - Social stressors
  - Academic stressors
- Some similar concerns for young adults in work/military, but not generally as many





## Sleep Needs

- Adults
  - As adults age, sleep *needs* do not change much
  - Sleep *timing* and *architecture* does
- Shift work
- Pregnancy/Postpartum
- Jet lag



**SLEEP DISORDERS AND SLEEP DEPRIVATION**  
AN URBAN PUBLIC HEALTH PROBLEM

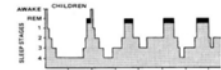
49

## Sleep Changes

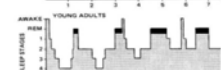
- Older Adults

### Normal Sleep Cycles

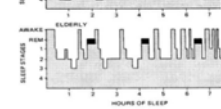
Children



Young Adults



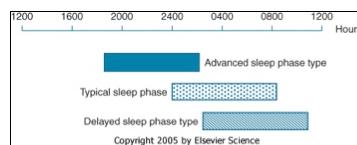
Elderly



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## Sleep Needs

- Older Adults
  - Advanced Sleep Phase Syndrome



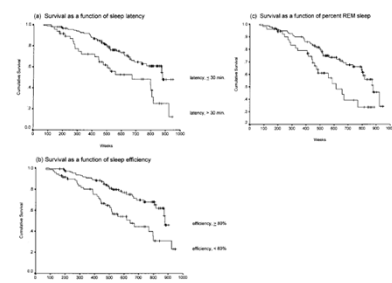
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HOME / SLEEP TOPICS / AGING AND SLEEP  
**AGING AND SLEEP**

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## Sleep Needs

- Older Adults



Healthy Older Adults' Sleep Predicts All-Cause Mortality at 4 to 19 Years of Follow-Up

## Active Learning: Post-Test

- True or False: Older adults require less sleep than young- and middle-aged adults.
- Adolescent sleep is characterized by
  - Advancement of sleep phase
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  - Both B and C are true

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What Can I Do to Get a Better Night's Sleep?

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### Active Learning: Pre-Test

1. True or False: Cognitive Behavioral Therapy for Insomnia (CBT-I) is the treatment of choice for a number of sleep disorders.
2. A characteristic of good sleep hygiene may be..
  - A. Drinking a large amount of water to stay hydrated before bed
  - B. Having 3-4 glasses of wine to help fall asleep
  - C. Going to bed and waking up at the same time each day
  - D. Sleeping in a very warm room

### Sleep Hygiene

- “..set of behavioral and environmental recommendations intended to promote healthy sleep”
- Caffeine
- Nicotine
- Alcohol
- Exercise
- Meals/Liquids
- Stress
- Bedroom environment
- Naps
- Timing of sleep

### Sleep Hygiene

- Caffeine: lowers sleep drive (Adenosine) making it harder to go to bed
  - Consider half-life (~5 hours) when having afternoon cup
- Nicotine: stimulant; alters sleep drive and make it hard to go to bed
- Alcohol: depressant; makes you sleepy, but will drastically throw off sleep architecture, lead to more awakenings, etc.

### Sleep Hygiene

- Exercise: very helpful to engage in during the day
  - Light exercise before bed may actually improve sleep onset
- Meals/Liquids: avoid in excess before bed
  - Light, carb-heavy meal may benefit sleep (diminishes any chance of overnight hunger)
  - Want to avoid frequent bathroom trips/awakenings

### Sleep Hygiene

- Stress: don't bring your problems to bed
  - Stimulus control
  - “It is a bad thing to be awake when reason sleeps.”
- Bedroom environment
  - Cool, quiet, and dark



### Sleep Hygiene

- Naps: try to avoid if you can
  - Want to build up sleep drive; naps interfere
  - “Power nap” or “Caffeine nap”
- Timing of sleep: **consistency is key!**
  - Sleep debt and sleeping in
  - Paying back sleep debt is best done through consistent scheduling, NOT sleeping extra

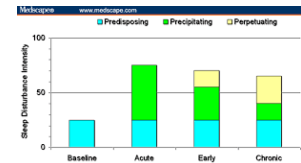
## Sleep Debt

- Say you are usually an 8-hour sleeper (11pm-7am)...
  - Go to bed late on Friday night, but wake up at usual time on Saturday because of some commitment
    - 6 hours sleep; 1am-7am
  - Similarly, on Saturday night you stay up late again, but choose to sleep-in Sunday to make up for lost sleep
    - 10 hours sleep; 1am-11am
  - Sunday night: Will you be able to go to bed at 11pm?

## CBT-I

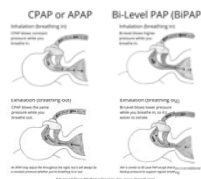
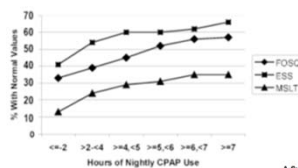
- Cognitive Behavioral Therapy for Insomnia
  - Framework

- Four main components
  - Sleep Hygiene/Education
  - Sleep Restriction\*
  - Stimulus Control
  - Cognitive Therapy



## CPAP/BiPAP

- Treat obstructive sleep apnea (OSA)
- Many different styles of machine
- Adherence is a major concern



A Systematic Review of CPAP Adherence Across Age Groups: Clinical and Empiric Insights for Developing CPAP Adherence Interventions

## Medications

- Over-the-Counter
- Melatonin
  - Can be purchased at any pharmacy/grocer; typically 1-3mg doses
  - Benefit some sleep disorders (jet lag, circadian rhythm disorders, insomnia in elderly)
    - Questionable/negligible support for others (e.g., insomnia in children/adolescents)
  - Timing is crucial

## Medications

- Benzodiazepines
  - Clonazepam, triazolam, temazepam, etc.
  - Bind to GABA receptors and have sedative qualities
  - Suppress NREM3/REM while increasing NREM2
- Act quickly, short half-life
  - Especially useful for individuals having trouble falling asleep
- Habit forming (addiction, tolerance, withdrawal)
  - Also need to be careful of how combined with other substances

## Medications

- Non-Benzodiazepines
  - Zopiclone, eszopiclone, zolpidem, zaleplon
  - Clonidine, Trazodone\*
- Hypnotics unrelated to benzos, barbiturates, or other hypnotics
- Interacts with GABA receptor complex
- Side effects can be concerning
  - Sleep-state confusion, sleep walking, talking, driving, eating (other behaviors while sleeping), "Ambien blackouts"

### Medications

- Modafinil
  - Shift work disorder, narcolepsy, OSA
  - “Wake-Promoting” agent
- Not entirely clear on mechanism of action
  - Increase hypothalamic histamine and norepinephrine
  - Increase glutamate, decrease GABA

### Other Alternatives

- Light therapies
  - Seasonal Affective Disorder
  - Advanced Sleep Phase Syndrome
- Herbal supplements
  - Valerian, chamomile, etc.: need more research and some can have negative interactions with other medications/are not safe for some groups
- CBD
  - Some evidence for perceived increases in sleep quality, but need more research!

### Active Learning: Post-Test

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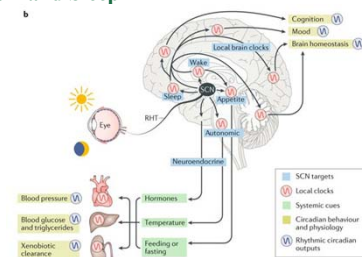
**Thank You!**

Questions??



The University of Vermont  
LARNER COLLEGE OF MEDICINE

### The Brain and Sleep





## Drugs and Sleep



Polysomnographic Sleep Disturbances in Nicotine,  
Caffeine, Alcohol, Cocaine, Opioid, and Cannabis  
Use: A Focused Review