

# SLEEP DEPRIVATION

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# INTRODUCTION

- Sleep is important for cognitive function and memory consolidation
- But yet 1/3 individuals are chronically sleep deprived
- Both acute and chronic sleep deprivation can give rise to cognitive impairment
- Recovery sleep on weekend after chronic sleep deprivation does not restore performance back to normal baseline

# MYTHS & MISCONCEPTIONS

- 1. Just one night without sleep is not going to hurt me, mom
- 2. I only need 4-6 hours of sleep. I will be fine.
- 3. Dad, I can catch up my sleep on weekend!
- 4. I can cram for final exam week without a problem

# WHY SLEEP

Sleep is considered to be important for energy conservation, thermoregulation, and tissue recovery

sleep is essential for cognitive performance, especially memory consolidation



# 1

## SLEEP NEEDS



**NEWBORNS**  
0-2 months

12 - 18 HOURS



**INFANTS**  
3 months to 1 year

14 - 15 HOURS



**TODDLERS**  
1 to 3 years

12 - 14 HOURS



**PRESCHOOLERS**  
3 to 5 years

11 - 13 HOURS



**SCHOOL-AGED CHILDREN**  
5 to 12 years

10 - 11 HOURS



**TEENS AND PRETEENS**  
12 to 18 years

8.5 - 10 HOURS



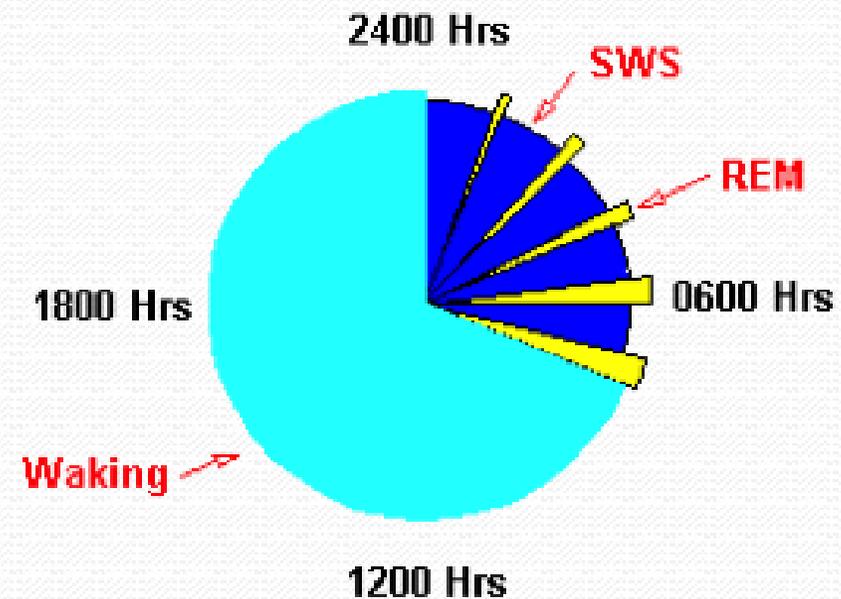
**ADULTS**  
18+

7.5 - 9 HOURS

During a normal night of sleep, a person will alternate between periods of NREM and REM sleep. Each cycle is approximately 90 minutes long, containing a 20-30 minute bout of REM sleep

### *The 24 Hour Sleep/Wake Cycle*

- The 24 hour sleep/wake cycle consists of sleep [slow wave sleep (SWS) alternating with rapid eye movement sleep (REM)] and waking.
- Sleep restores brain function, sustaining performance during subsequent waking.



# SLEEP

REM sleep is considered important for learning, memory consolidation, neurogenesis, and regulation of the blood-brain barrier function

Non REM sleep is related to hormonal release (e.g., growth hormone secretion), the decline in the thermal set point ,and is characterized by a reduction of cardiovascular pressure parameters(e.g. ,lowering of blood

# Prevalence

In 1990 the prevalence of insufficient sleep was 20.4% (16.2% in men and 23.9% in women).

*Sleep. 2001 Jun 15;24(4):392-400*

In 2005-2008 more than one-third of individuals reported sleeping less than seven hours per night on weekdays or workday nights

*MMWR Morb Mortal Wkly Rep. 2011;60(8):239.*



# Risk groups

Males and females of all ages

Adolescents, among whom restricted sleep times are common

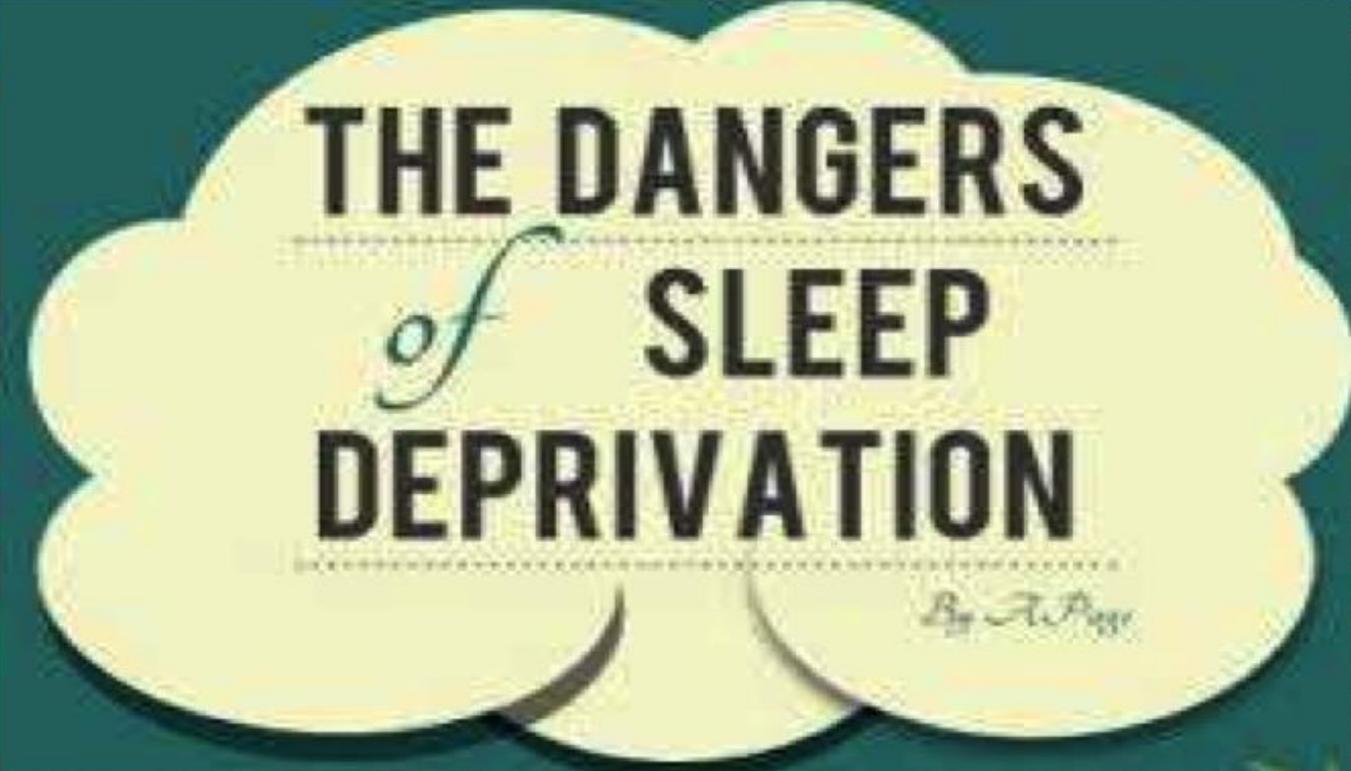
Caregivers who look after the needs of a family member who has a chronic illness

People who perform shift work

People who have a sleep disorder that causes insufficient sleep

People who have a medical condition that causes insufficient sleep

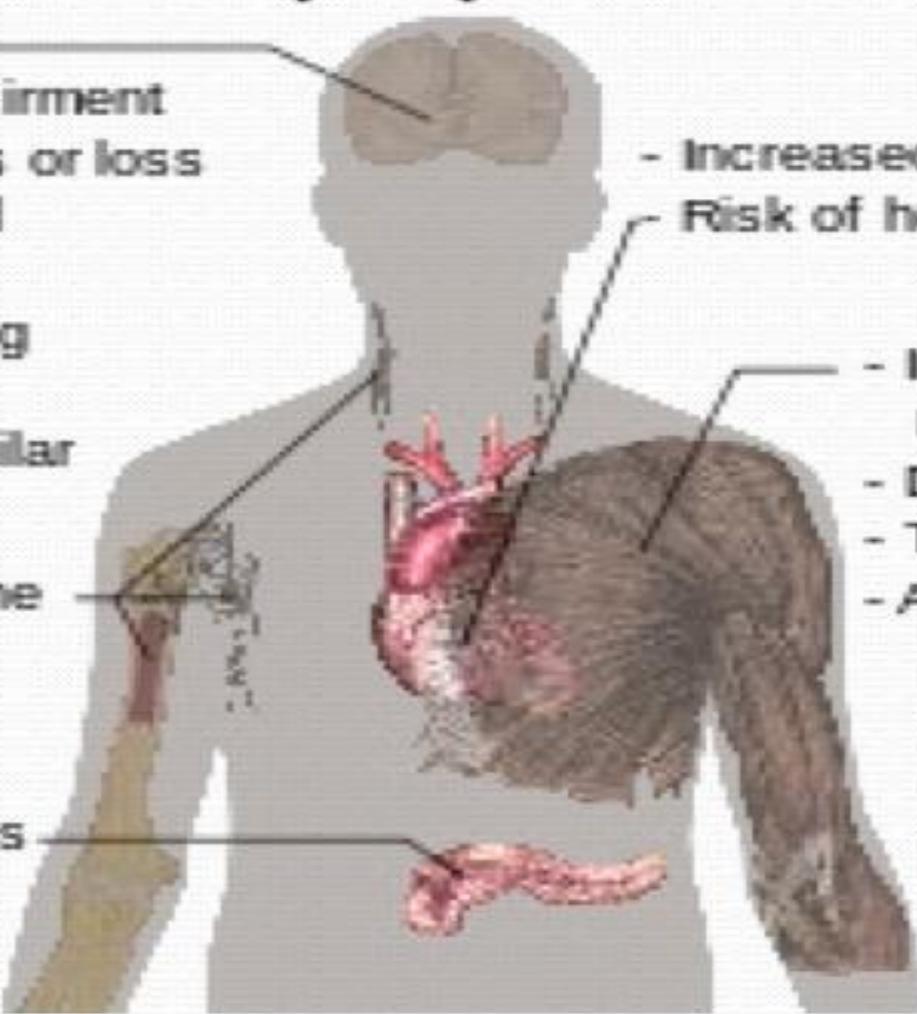




**THE DANGERS**  
*of* **SLEEP**  
**DEPRIVATION**

*By A. Page*

## Effects of Sleep deprivation

- 
- Irritability
  - Cognitive impairment
  - Memory lapses or loss
  - Impaired moral judgement
  - Severe yawning
  - Hallucinations
  - Symptoms similar to ADHD
  - Impaired immune system
  - Risk of diabetes Type 2
- Increased heart rate variability
  - Risk of heart disease
  - Increased reaction time
  - Decreased accuracy
  - Tremors
  - Aches
- Other:*
- Growth suppression
  - Risk of obesity
  - Decreased temperature

# Effects

## Performance

- o Lack of concentration
- o Attention deficits
- o Fatigue o Restlessness
- o Lack of coordination
- o Poor decisions
- o Increased errors
- o Forgetfulness Distractibility
- o Lack of energy



# DEFINITION

**Sleep deprivation** is the condition of not having enough sleep; it can be either chronic or acute.

Acute sleep deprivation refers to no sleep or a reduction in the usual total sleep time, usually lasting one or two days.

Chronic sleep deprivation (also called sleep restriction) exists when an individual routinely sleeps less than required for optimal functioning.



MYTH #1:

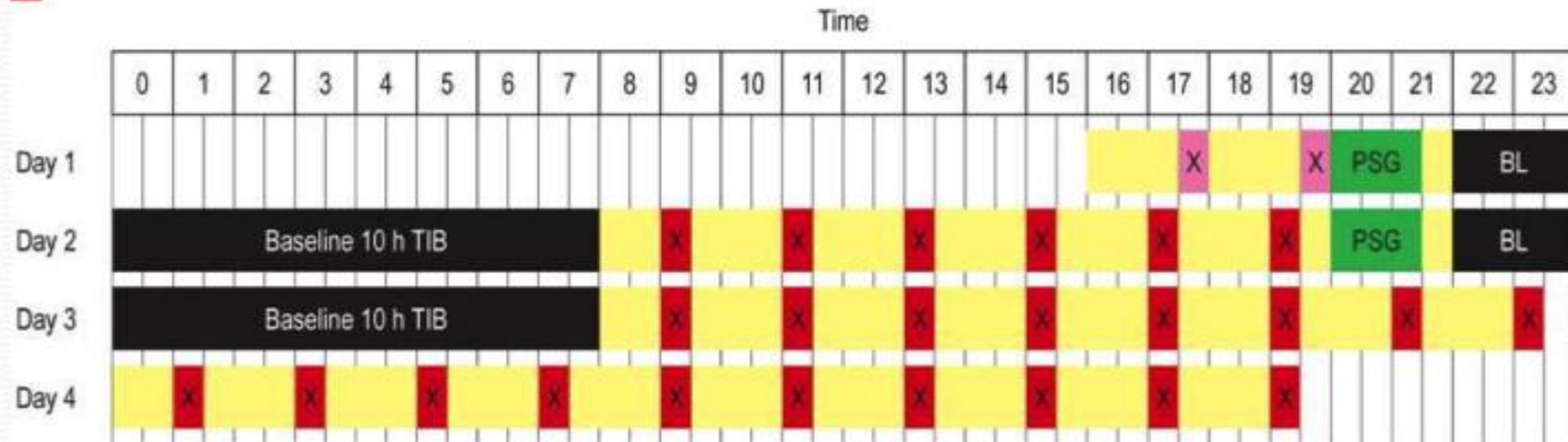
JUST ONE NIGHT WITHOUT  
SLEEP IS NOT GOING TO  
HURT ME



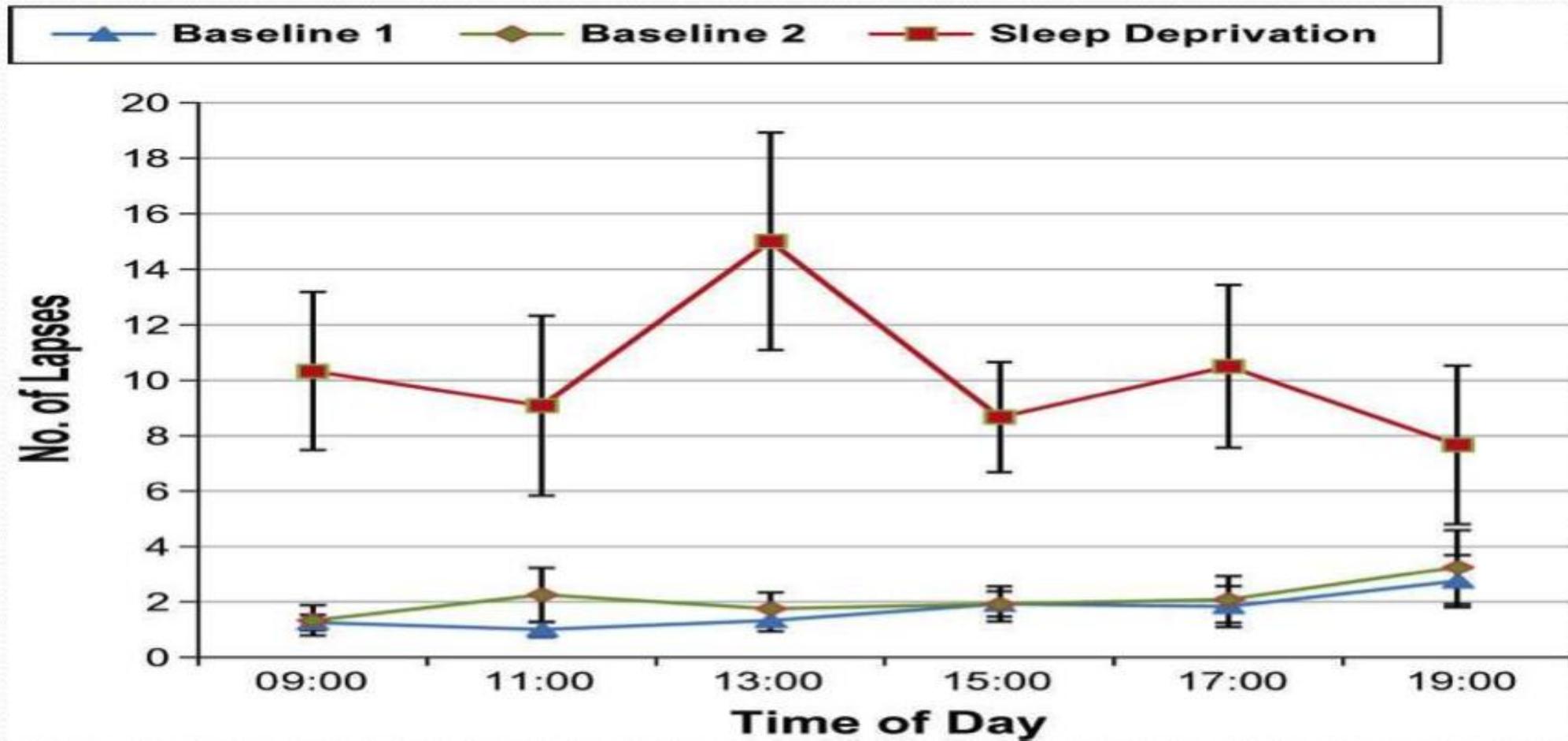
# The Effect of One Night's Sleep Deprivation on Adolescent Neurobehavioral Performance

Twelve healthy adolescents (6 male), aged 14-18 years

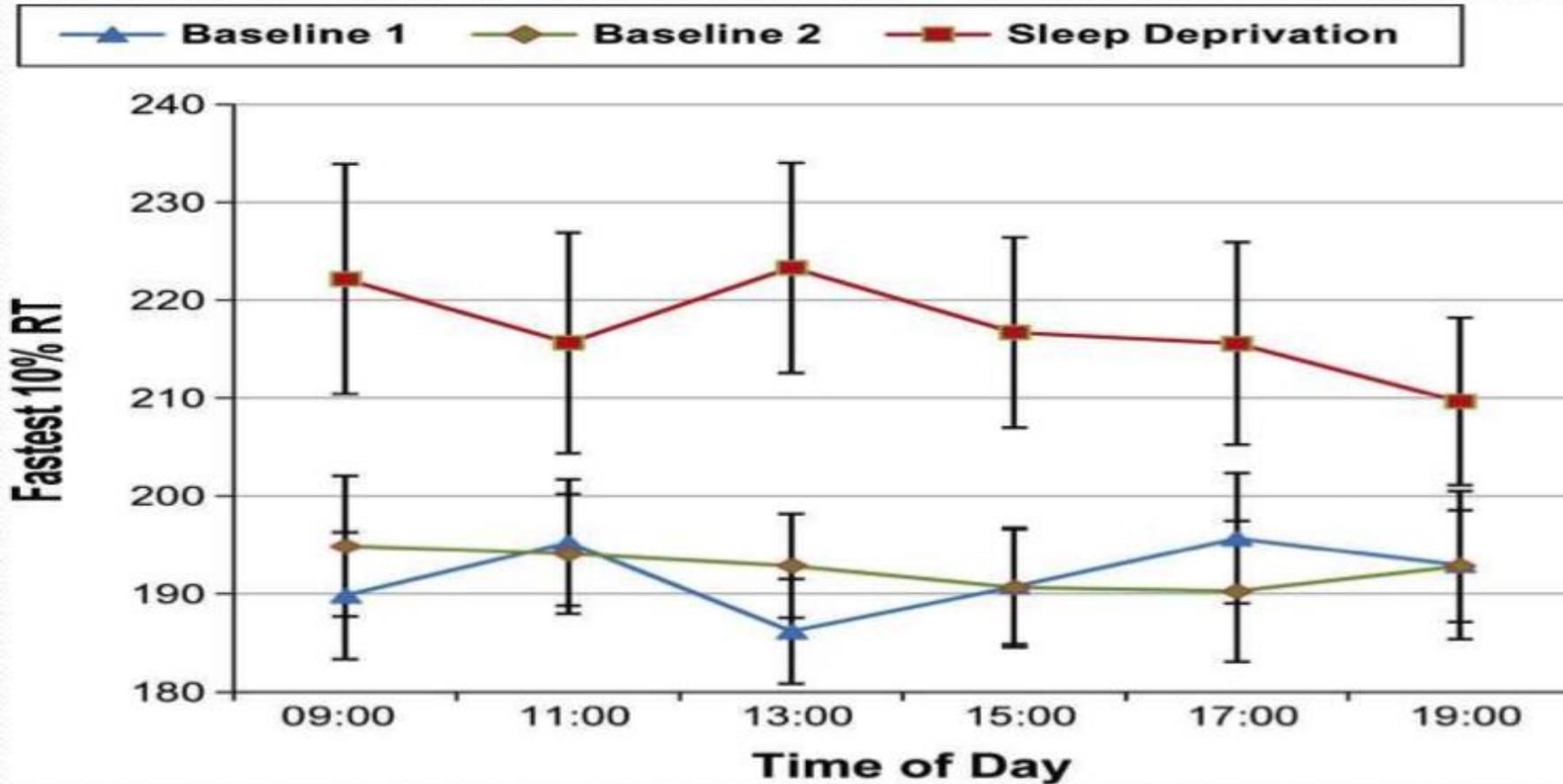
- Practice Neurobehavioral Test Battery (NTB)
- Neurobehavioral Test Battery



The estimated marginal means ( $\pm$  standard error) of Psychomotor Vigilance Task (PVT) lapses at each time point across baseline and sleep deprivation days.



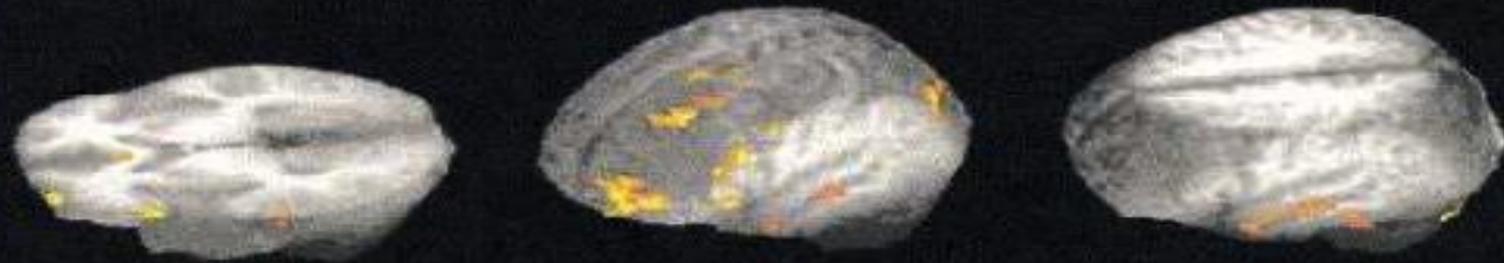
The estimated marginal means ( $\pm$  standard error) of Psychomotor Vigilance Task (PVT) fastest 10% reaction time at each time point across baseline and sleep deprivation days



With respect to cerebral activation, the results showed activation in

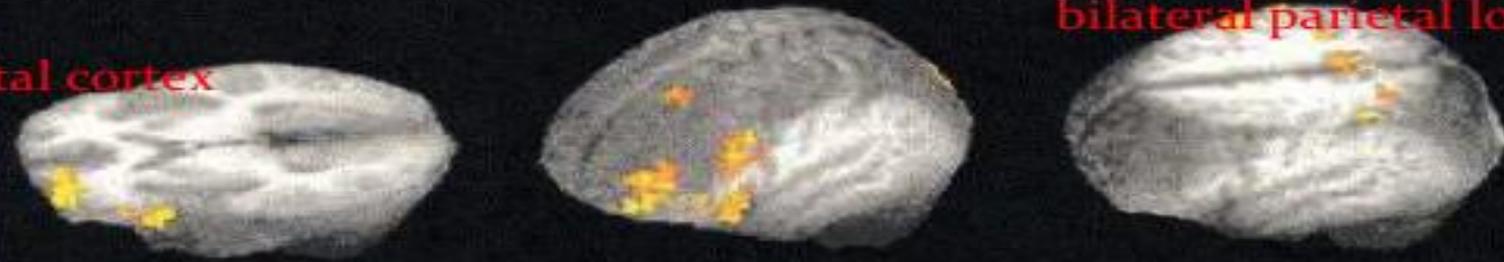
Normal > TSD (top)  
TSD > Normal (bottom)

Normal night



prefrontal cortex

Total Sleep  
Deprivation



bilateral parietal lobes

left inferior frontal gyrus

## Divided attention

Divided attention task required more attentional resources following TSD than after normal sleep.

*J Sleep Res.* 2001 Jun;10(2):85-92

MYTH #2:

I ONLY NEED 4-6 HOURS  
OF SLEEP. I WILL BE  
FINE!



# CHRONIC SLEEP DEPRIVATION

The chronic sleep restriction experiment involved randomization to one of three sleep doses (4 h, 6 h, or 8 h time in bed per night), which were maintained for 14 consecutive days.

The total sleep deprivation experiment involved 3 nights without sleep (0 h time in bed).

Each study also involved 3 baseline days and 3 recovery days

# CHRONIC SLEEP DEPRIVATION

The neurobehavioral assessment included **psychomotor vigilance task** to measure behavioral alertness. The PVT measures simple reaction time to a visual stimulus, presented approximately 10 times/minute. Lapses (reaction times greater than 500 ms) indicative of reduced behavioral alertness.

# CHRONIC SLEEP DEPRIVATION

The neurobehavioral assessment also include a computerized **digit symbol substitution task** to measure working memory.

This subject-paced task involves the matching of digits (0-9) to symbols (circle, triangle, etc.).

The number of correct responses in 1.5 min was counted to measure working memory performance.

**A serial addition/subtraction task** was included in the assessment to measure cognitive throughput.

# Conclusion

Chronic restriction of sleep periods to 4 h or 6 h per night over 14 consecutive days resulted in **significant cumulative, dose-dependent deficits in cognitive performance on all tasks.**

*Sleep. 2003;26(2):117.*

# MYTH #3

I CAN CRAM FOR THE  
FINAL EXAM WEEK  
WITHOUT A PROBLEM



# Memory

Long-term memory can be divided between declarative and non-declarative .

REM is associated with the consolidation of non declarative (implicit) memories.

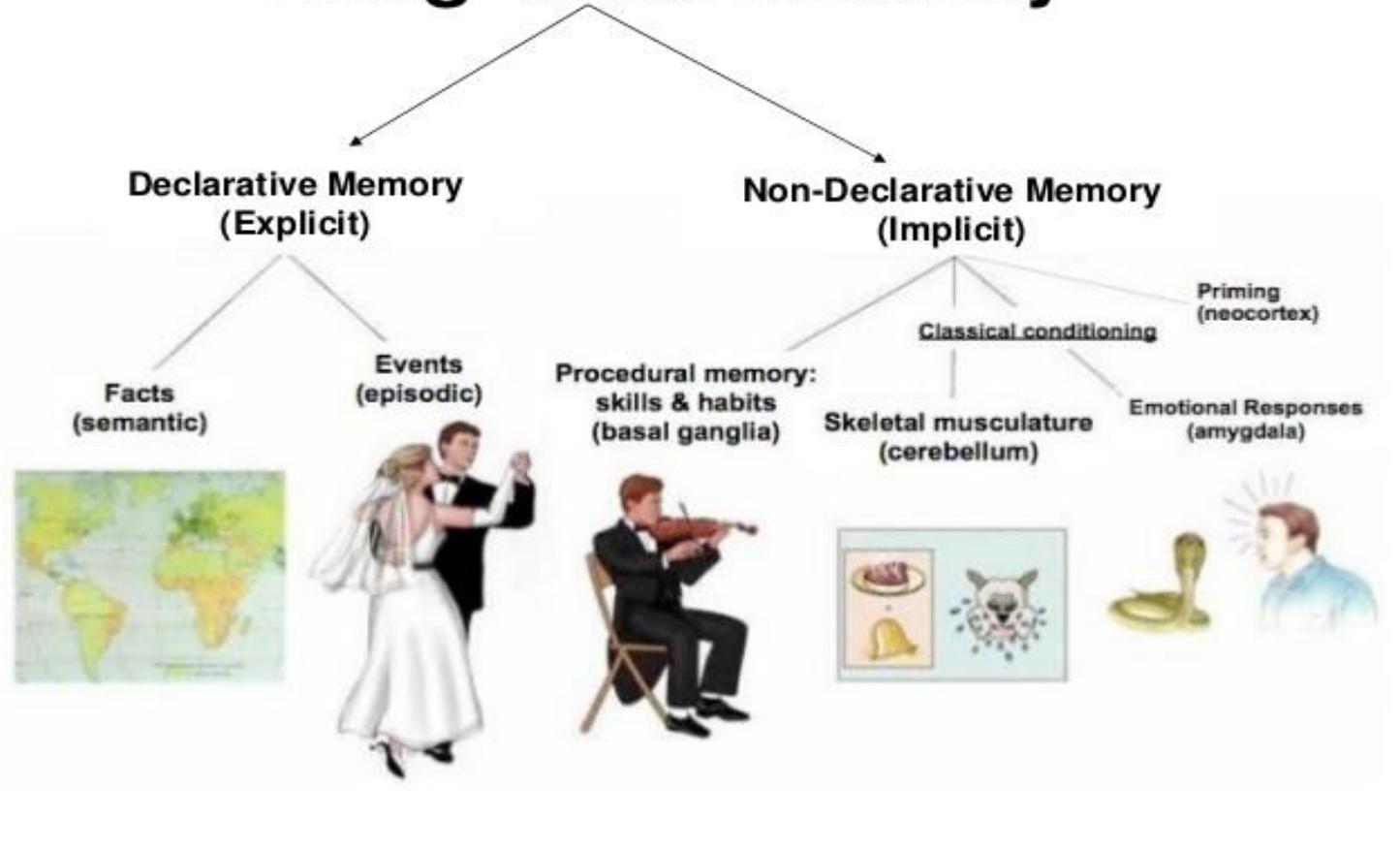
An example would be a task that we can do without consciously thinking about it, such as riding a bike.

Slow-wave, (NREM) sleep, is associated with the consolidation of declarative (explicit) memories.

These are facts that need to be consciously remembered, such as dates for a history class

Diekelmann, S., & Born, J. (2008)

# Long-Term Memory

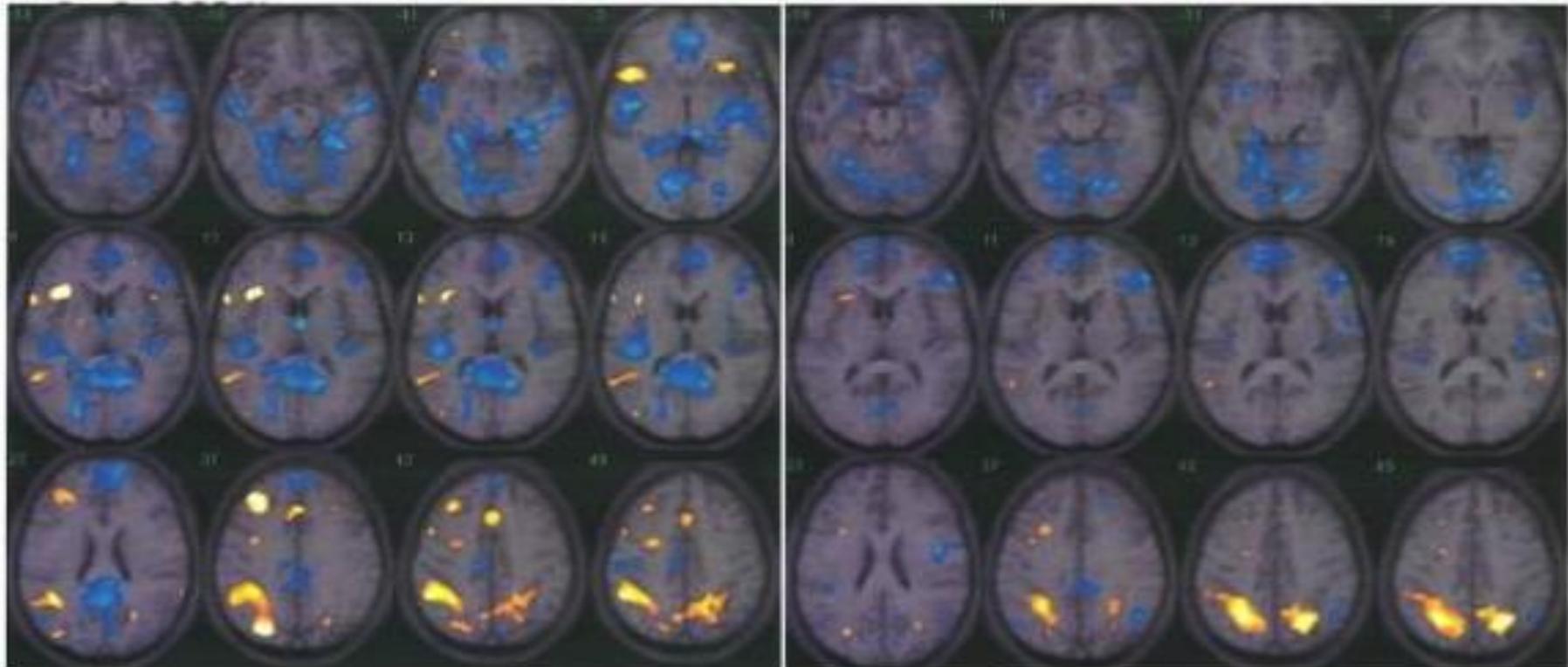


## Preliminary fMRI findings in experimentally sleep-restricted adolescents engaged in a working memory task

20 healthy adolescents underwent a 3-week protocol which included a baseline week, followed in random order by a sleep restriction week (SR) and a healthy duration week (HD)

Behav Brain Funct. 2009;5:9

**Composite activation/deactivation maps, showing contrast of 2-back task with 0-back task in each experimental sleep condition. Warm colors (orange to yellow)**



**Sleep Restriction Condition**

**Healthy Sleep Duration Condition**

# Conclusion

Regions that are normally active during an attention-demanding working memory task in the well-rested brain became even more active to maintain performance after chronic sleep restriction.

In contrast, regions in which activity is normally suppressed during such a task in the well-rested brain showed even greater suppression to maintain performance after chronic sleep restriction.

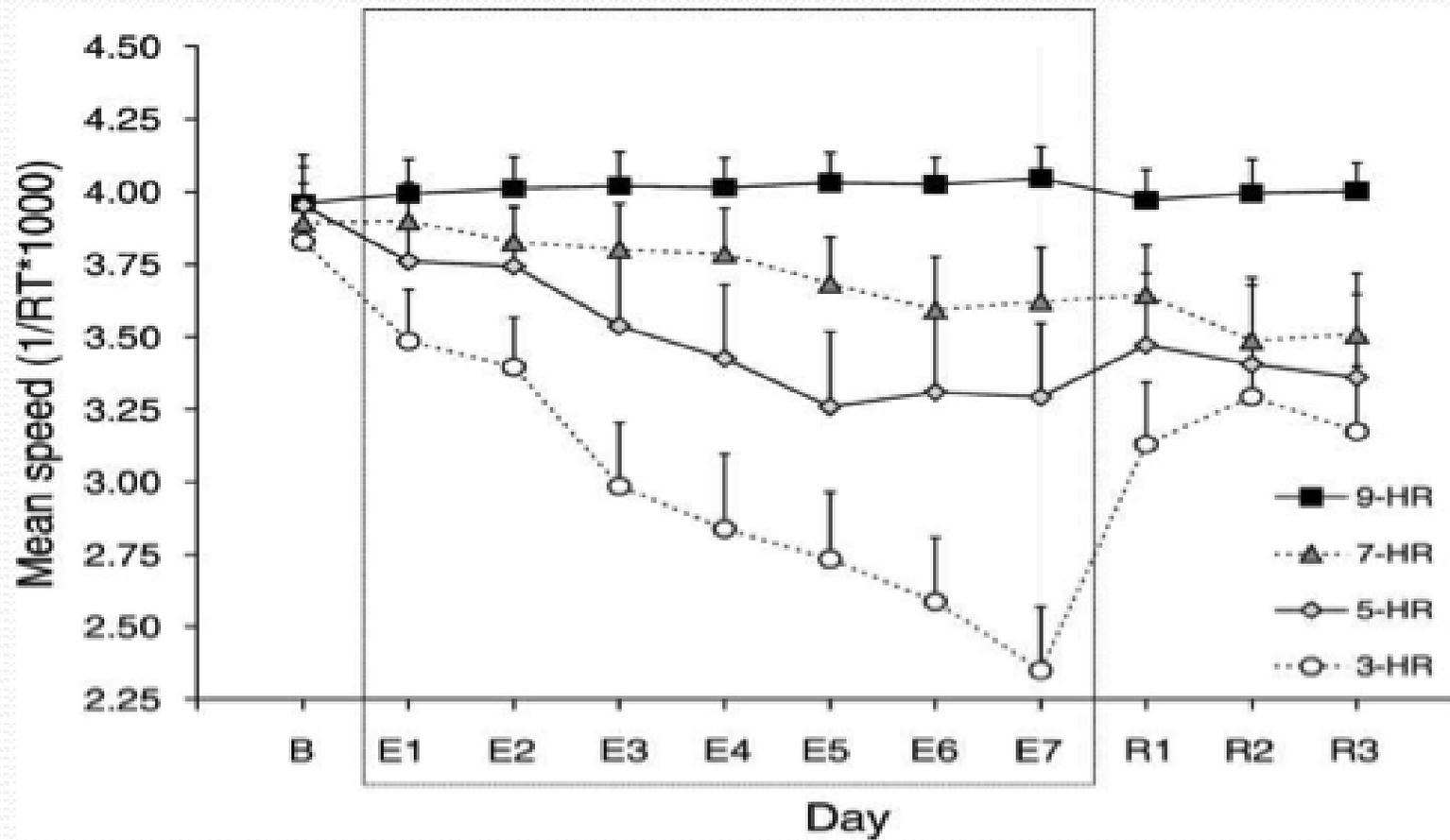
*Behav Brain Funct.* 2009;5:9

MYTH #4:

I CAN CATCH UP  
WITH MY SLEEP ON  
WEEKEND



With mild to moderate sleep restriction (7- and 5-h TIB), performance initially declined and, after a few days, appeared to stabilize at a lower-than-baseline level for the remainder of the sleep restriction period. In contrast, with severe sleep restriction (3-h TIB) performance declined continuously



Teenager Post # 12756

Me every night: I don't  
need to sleep.

Me every morning:  
I need to sleep for  
3 days straight.

[/teenagerposts.tumblr.com](http://teenagerposts.tumblr.com)

# CONCLUSION

- Sleep is important for cognitive function and memory consolidation
- But yet 1/3 individuals are chronically sleep deprived
- Both acute and chronic sleep deprivation can give rise to cognitive impairment
- Recovery sleep on weekend after chronic sleep deprivation does not restore performance back to normal baseline

THANK YOU



# SLEEP DEPRIVATION AN EPIDEMIC

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# CASE

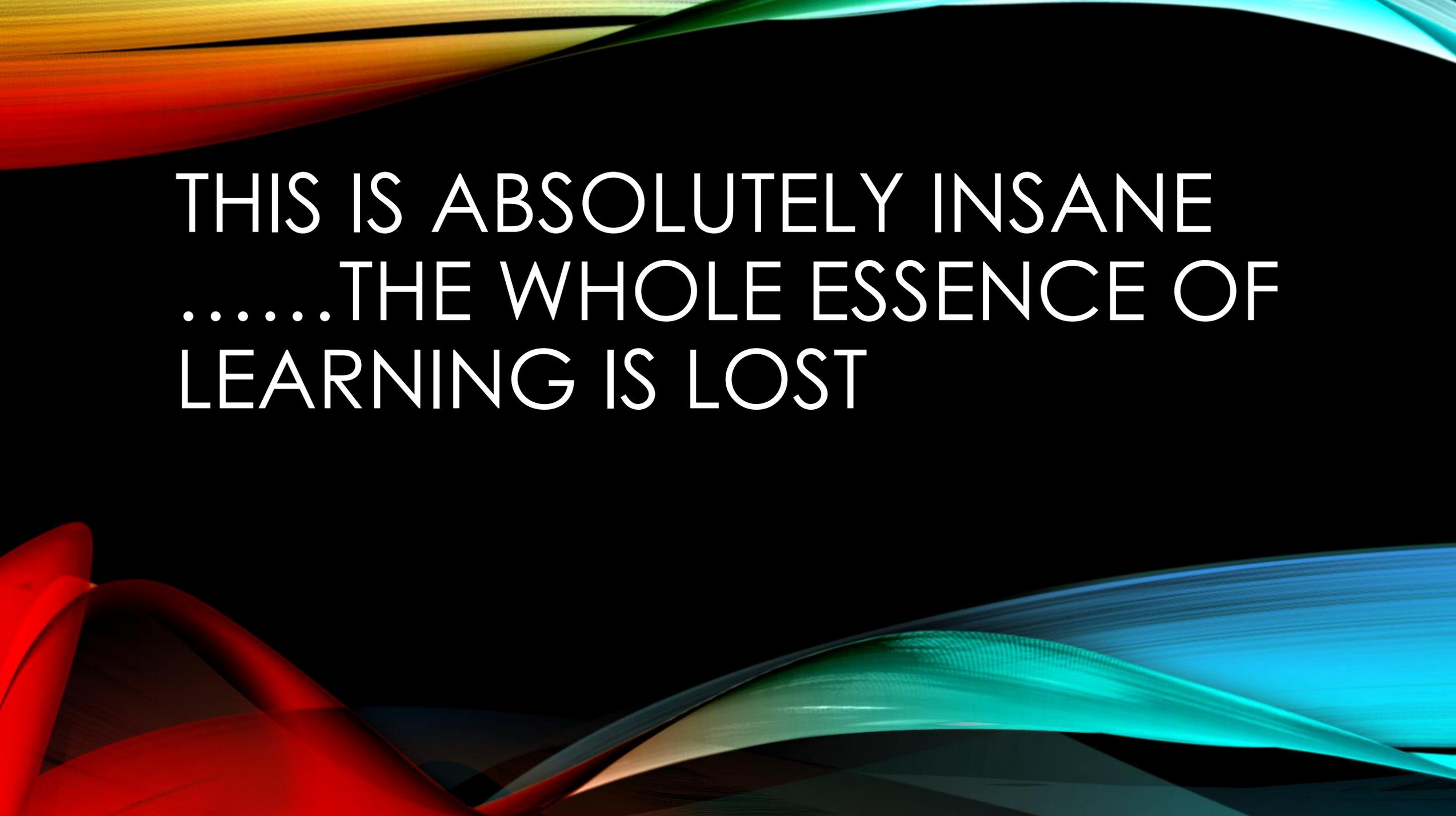
- Carolyn is a 17 year old, often reach a breaking point around 11:30 PM, when she collapses in tears. For the next 10 minutes, she just sits at her desk and cries, overwhelmed by her unrelenting school demands. She is desperately tired and longs for sleep. But she knows she must move through it, because more assignments in calculus and French still await for her.



- 
- The next morning, she fights to stay awake in her first period US history class, which begins at 8:15 AM. She is unable to focus on what's being taught, and her mind drifts.

- She remarks, “ You feel so tired and exhausted, your mind is obsessed with sleep. But you still need to get through the day so you can go home and sleep.” That night, she will have to try to catch up on what she missed in class. And the vicious cycle begins again.....





THIS IS ABSOLUTELY INSANE  
.....THE WHOLE ESSENCE OF  
LEARNING IS LOST

- 
- Carolyn is among a generation of teens growing up chronically sleep deprived.
  - >87% of high school students in the US get far less than the recommended 8-10 hours of sleep, a serious threat to their health, driving safety and academic success.
  - It is a public health epidemic

- 
- After an evening with 4-5 hours of homework, Carolyn turns to her cellphone for relief. She talks or texts to friends and surfs the Web to watch a funny YouTube video

- 
- Social and cultural factors, as well as the advent of technology, all have collided with the biology of the adolescent to prevent teens from getting enough rest. Teens have a biological tendency for delay sleep phase by as much as 2 hours later than their younger counterparts.

Teenager Post # 13081

6 am: tired

9 am: tired

11 am: tired

3 pm: tired

7 pm: tired

9 pm: tired

bed time: ENNERRGY

[//teenagerposts.tumblr.com](http://teenagerposts.tumblr.com)

## DISTURBING TRENDS

- 92 % of US teens have cellphones and 24 % report having multiple devices that they use simultaneously
- 72% brings their cellphones into their bedrooms and use them when they are trying to sleep
- 28% leave their phones on all night only to be awakened at night by texts, calls or email

## DISTURBING TRENDS CONTINUE

- 64% use electronic music devices, 60% use laptops and 23% play video games in the hour before they went to sleep
- >50% reported texting in the hour before they went to sleep
- They are less likely to get a good night's sleep and feeling refreshed in the morning

# SLEEP DEPRIVATION

- This disrupted rhythm, as well as the shortage of sleep, can have far-reaching effects on adolescent health and well-being.
- It certainly plays into learning and memory. It plays into appetite and metabolism and weight gain. It plays into mood and emotion, which are already heightened at that age. It also plays into risk behaviors — taking risks while driving, taking risks with substances, taking risks maybe with sexual activity.
- Many studies show students who sleep less suffer academically, as chronic sleep loss impairs the ability to remember, concentrate, think abstractly and solve problems.

LOL, SO TRUE: POST 11468

**When people try to make  
me get up:**



[lol-sotrue.tumblr.com](http://lol-sotrue.tumblr.com)

# FIVE SCARY HEALTH EFFECTS OF SLEEP DEPRIVATION DURING THE TEEN YEARS

## 1. Mental health issues

- A study of nearly 28,000 suburban high school students, published earlier this year in the *Journal of Youth and Adolescence*, found that each hour of lost sleep is associated with a 38 percent increased risk of feeling sad or hopeless and a 58 percent increase in suicide attempts.
- Teens who sleep an average of six hours per night are also three times more likely to suffer from depression.

Teenager Post # 3305

I'm TIRED. (T)icked off.  
(I)mitated. (R)eady to cry.  
(E)xtremely upset. (D)one.

//teenagerposts.tumblr.com

# FIVE SCARY HEALTH EFFECTS OF SLEEP DEPRIVATION DURING THE TEEN YEARS

## 2. Issues with learning and behavior

- Roughly one in four teens goes to bed after 23.00 on weeknights, and those who do tend to perform worse at school and experience greater emotional distress.
- Younger teens who don't get enough sleep are also more likely to be inattentive, impulsive, hyperactive and oppositional. It should come as no surprise that teens who aren't getting enough sleep won't be at their best academically or behavior-wise.

# FIVE SCARY HEALTH EFFECTS OF SLEEP DEPRIVATION DURING THE TEEN YEARS

## 3. Substance use and abuse

The relationship between sleep loss and substance abuse in teens is a two-way street, with sleep deprivation increasing the risk of drug use and dependence, and drug use in turn fueling sleep troubles.

One study found that for every 10 minutes later that a teenager went to bed, there was a 6 percent increase in the chance they'd used alcohol or marijuana in the past month, while other research showed that sleep difficulties predicted substance-related issues like binge-drinking, drinking and driving, and risky sexual behavior.

# FIVE SCARY HEALTH EFFECTS OF SLEEP DEPRIVATION DURING THE TEEN YEARS

## 4. Higher risk of obesity

Losing sleep can also have a long-term negative effect on a young person's physical health, with poor sleep quality being linked to diabetes and obesity risk for teens. High school students who skimp on sleep may be at a higher risk of diabetes and obesity in adulthood, and among teens who are already obese, not getting enough sleep can increase the risk of later developing diabetes. Among teens already suffering from diabetes, losing sleep can exacerbate their health issues.

# FIVE SCARY HEALTH EFFECTS OF SLEEP DEPRIVATION DURING THE TEEN YEARS

## 5. Dependence on sleep and anxiety medications

While prescription sleep aids aren't approved for use among people under the age of 18, many teens are being prescribed medication for sleep, the long-term effects of which are still largely unknown. But one short-term effect to be aware of is the risk of prescription pill abuse. A study last year found that teens who are prescribed sleeping pills or anxiety medication, which can be highly habit-forming, are 12 times more likely to abuse those medications than teens without a prescription.

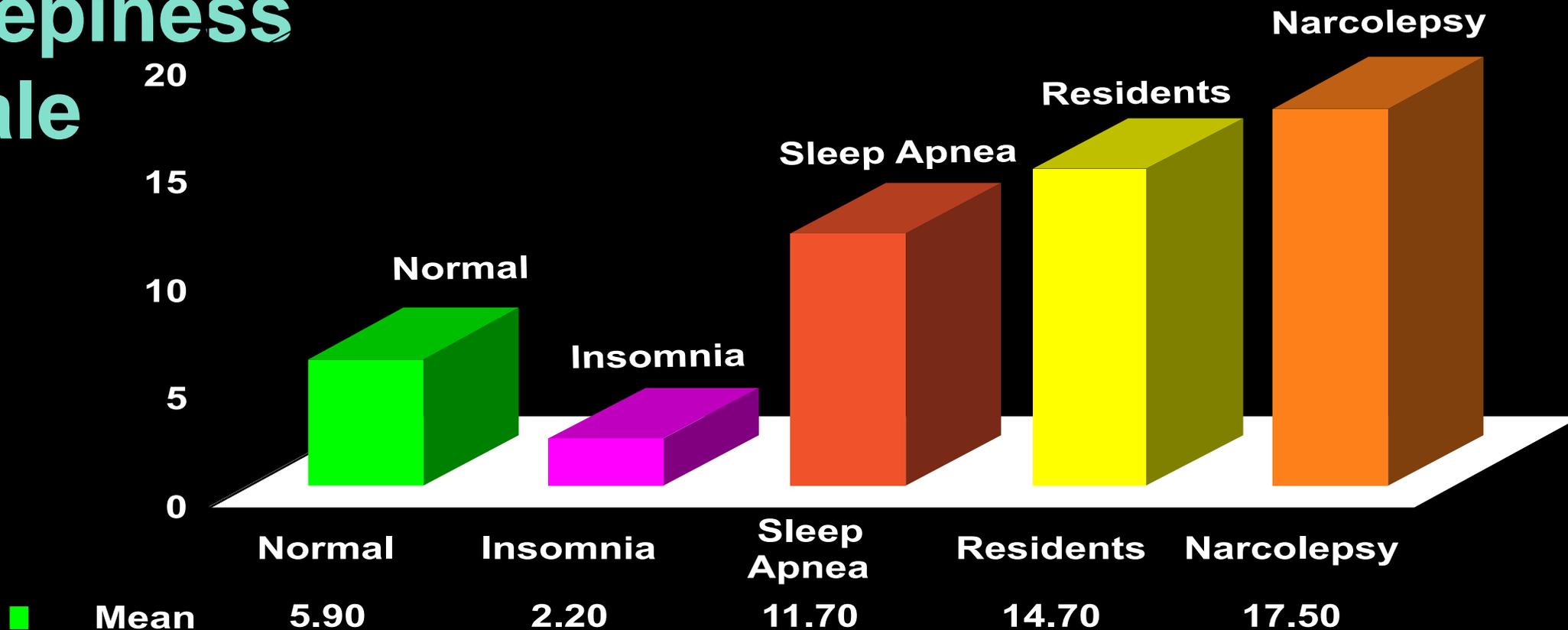
# MEDICAL RESIDENTS



“... When you dig up all the old sixties research on how do you brainwash someone? They will tell you. Number 1: You sleep deprive them. Number 2: You feed them bad food and then you repeat things over and over again. It’s like that during residency.”

# SLEEPINESS IS EQUIVALENT TO PATIENTS WITH SERIOUS SLEEP DISORDERS

## Epworth Sleepiness Scale



Sleepiness among residents is equivalent to that found in patients with serious sleep disorders. Mustafa and Strohl, unpublished data. Papp, 2002

# Why ?

- **Most programs do not recognize and address the problem of resident sleepiness.**
- **The culture of medicine says:**
  - **“Sleep is “optional” (and you’re a wimp if you need it)”**
  - **“Less sleep = more dedicated doc”**

# EXCESSIVE DAYTIME SLEEPINESS AMONG RESIDENTS

**Insufficient Sleep**  
(on call sleep loss/inadequate recovery sleep)



**EXCESSIVE DAYTIME SLEEPINESS**



**Circadian Rhythm Disruption**  
(night float, rotating shifts)

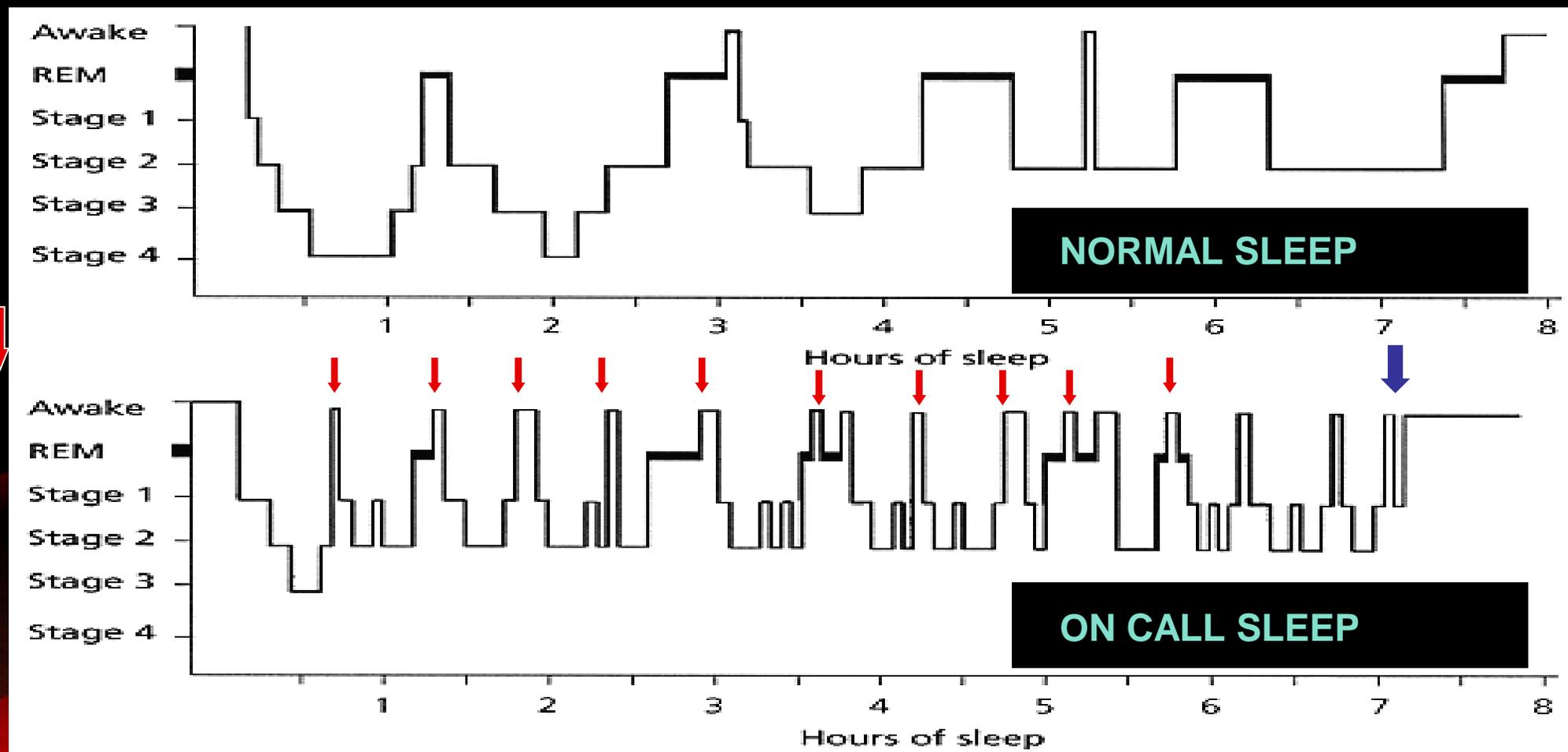
**Fragmented Sleep**  
(pager, phone calls)



**Primary Sleep Disorders**  
(sleep apnea, etc)

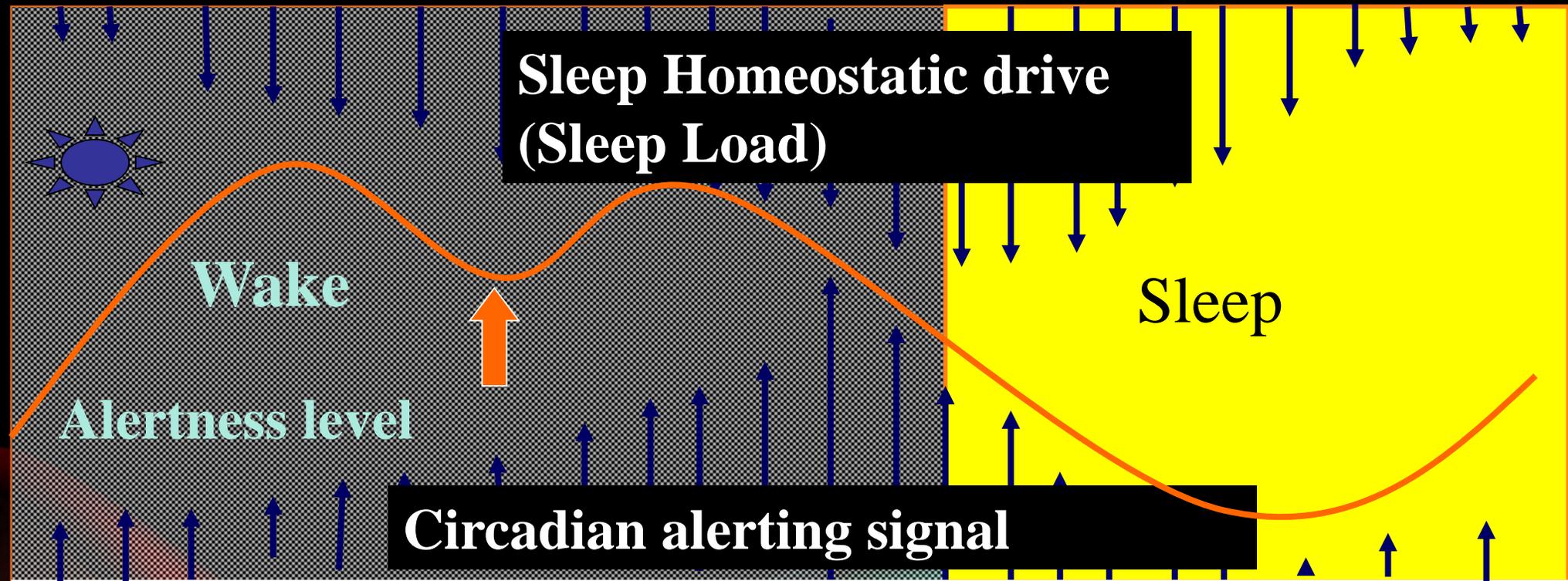


# Sleep Fragmentation during call night



MORNING  
ROUNDS

# Interaction of Circadian Rhythms and Sleep



9 AM

3 PM

9 PM

3 AM

9 AM

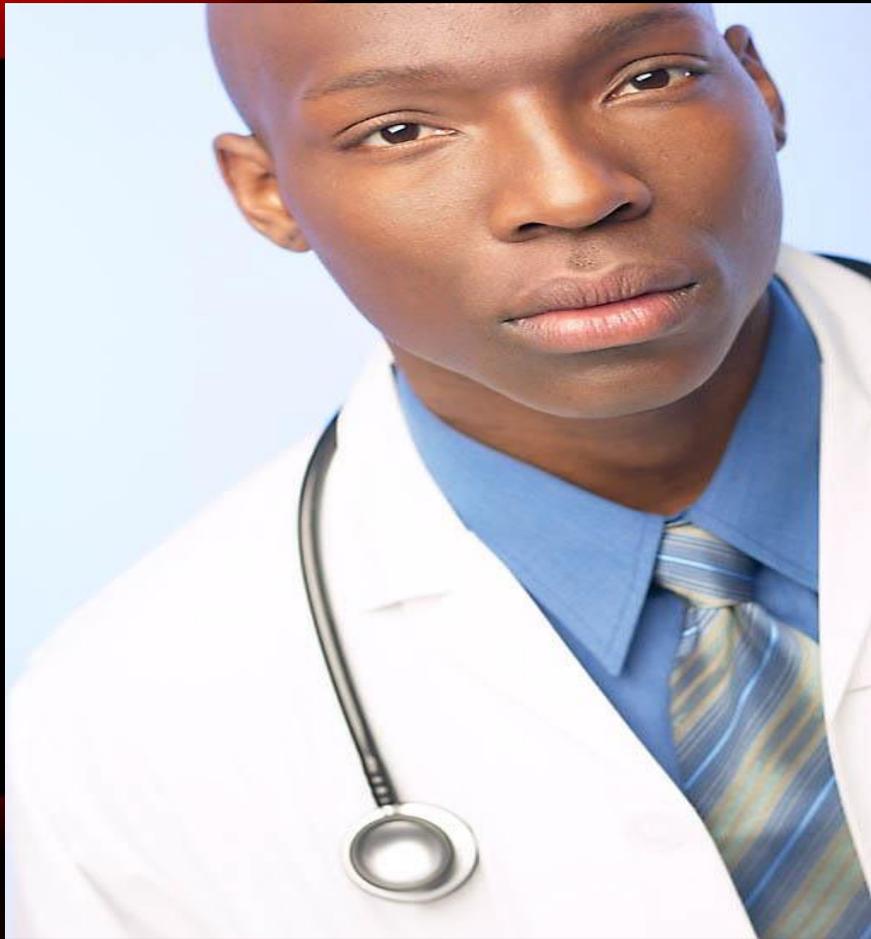
Time



# Impact on Medical Education



“We all know that you stop learning after 12 or 13 or 14 hours. You don’t learn anything except how to cut corners and how to survive.”



- Surgery: 20% more errors and 14% more time required to perform simulated laparoscopy post-call (two studies) Taffinder et al, 1998; Grantcharov et al, 2001
- Internal Medicine: efficiency and accuracy of ECG interpretation impaired in sleep-deprived interns Lingenfelter et al, 1994
- Pediatrics: time required to place an intra-arterial line increased significantly in sleep-deprived Storer et al, 1989

# Anesthesia Resident Study

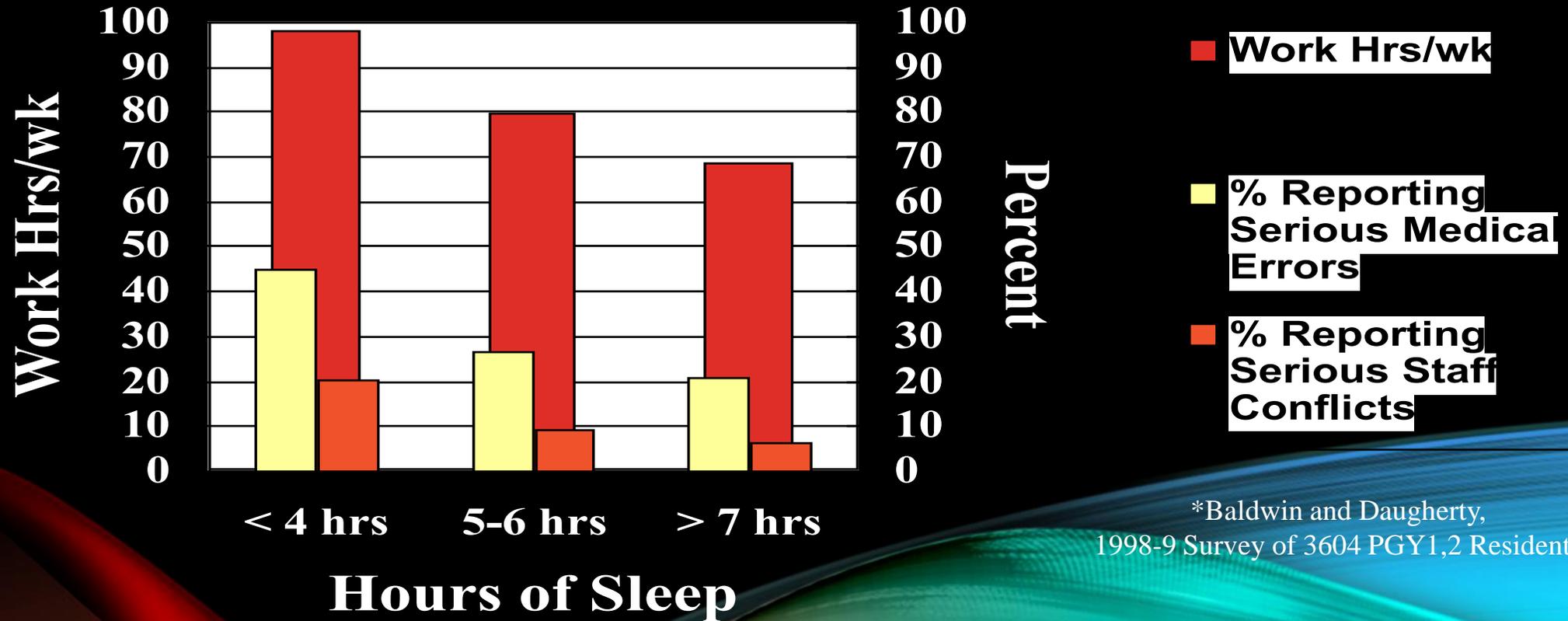
- Residents did not perceive themselves to be asleep almost half of the time they had actually fallen asleep.
- Residents were wrong 76% of the time when they reported having stayed awake.

Howard et al 2002

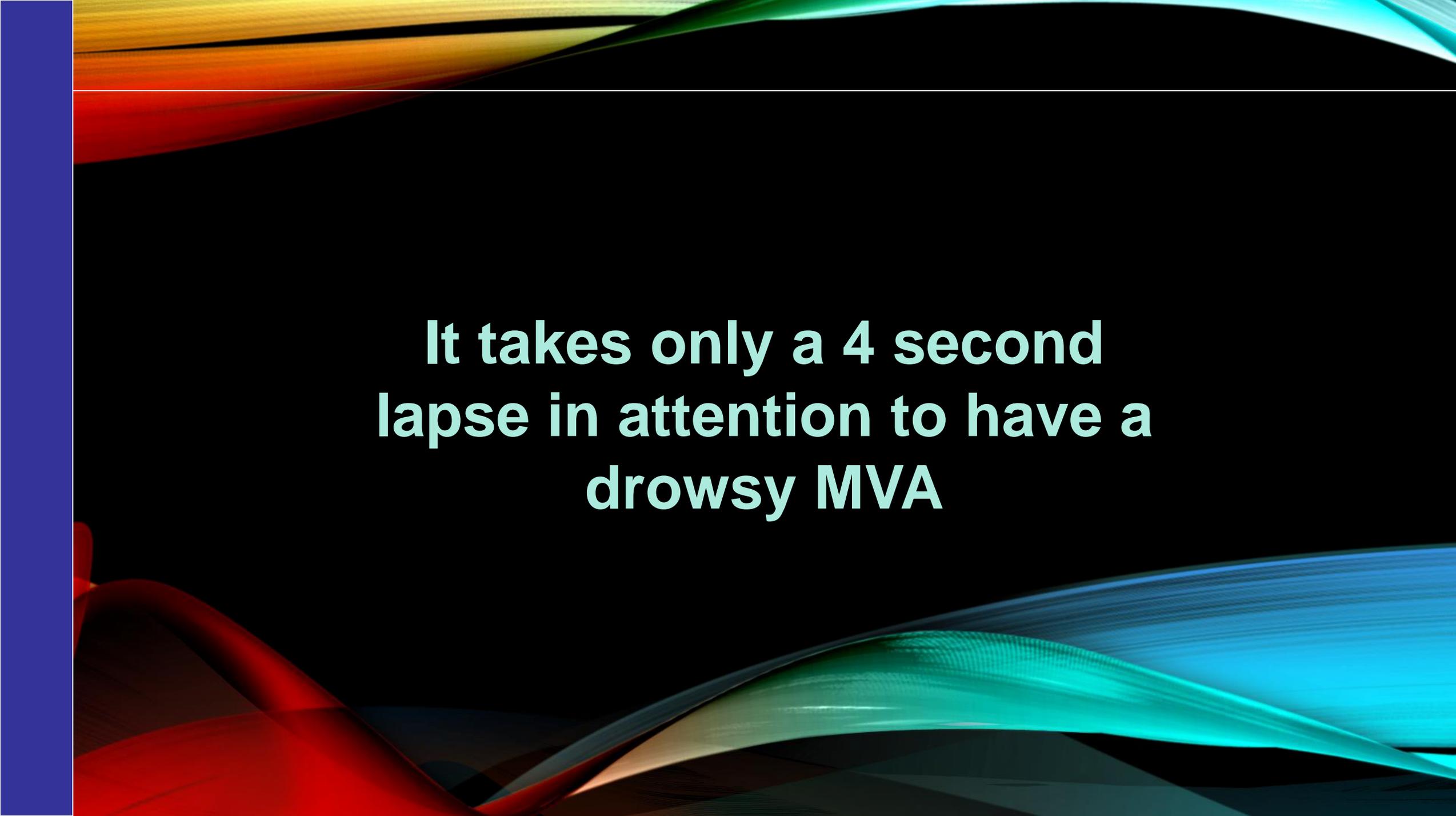
# Impact on Professionalism

“Your own patients have become the enemy...because they are the one thing that stands between you and a few hours of sleep.”

# Work Hours, Medical Errors, and Workplace Conflicts by Average Daily Hours of Sleep\*



\*Baldwin and Daugherty, 1998-9 Survey of 3604 PGY1,2 Residents



**It takes only a 4 second  
lapse in attention to have a  
drowsy MVA**

# YOU JUST CAN'T AFFORD FALLING ASLEEP ON THE ROAD





## **Bottom Line:**

You need to be alert to take the best possible care of your patients and **yourself.**

THANK YOU

