

# Prioritizing Sleep

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Central Bucks School District

February, 20, 2020

Brad Wolgast, PhD, CBSM

University of Delaware

“If you knew that in your child's school there was a toxic substance that reduced the capacity to learn, increased chances of a car crash and made it likely that 20 years from now he would be obese and suffer from hypertension, you'd do everything possible to get rid of that substance and not worry about cost. Early start times are toxic.”

Dr. Judith Owens  
Director of Sleep Medicine  
Boston Children's Hospital

# What about

- Licensed psychologist from Texas

behavioral sleep

De'

ally

nd h

in my field: high school  
sleep...



# What if....

- Your students could change one thing in one hour a day and...
  - Become better athletes, musicians, or just be funnier?
  - Become less depressed, less anxious and have fewer thoughts of suicide?
  - Decrease their likelihood of concussions and car accidents?

# Adolescent Sleep Needs

How many hours of sleep do you think are optimal for adolescents and young adults?

8.5 – 9.25 hours

Only about 9% of adolescents get at least 8 ½ hours of sleep each night.

On average, most teens sleep 6.75 hours on school nights



(Carskadon et al., 1980; National Sleep Foundation, 2009)

# History of High School Start Times in US

- Prior to the 1990s, most high schools started between 8:15 and 9:00 a.m.
- Early 1990s, school districts around the country experienced financial constraints while simultaneously experiencing growing student populations.

# History of High School Start Times in US

- PA Public School Code of 1949, *“School Boards may set the time the start and end times of each session day, but if the board does not set a different time, the school day is statutorily mandated to start at 9AM and end at 4PM”*
- The assumption that older students could handle the earliest start times was made without consulting the science available at the time.

# History of High School Start Times in US

- High School Sleep is a Social Justice Issue
- The more economically disadvantaged a student is, the more disproportionate the sleep loss they incur
- In addition, when their schools start later, they have disproportionately greater gains.
- Gains for academics (from GPA to SAT) are mild, other than for the students with lower socio-economic status.



# First, why does sleep matter?

What **worsens** when young adults aren't getting enough sleep?

- Worsened thinking skills – **cognition**
- Worsened academic performance and **GPA**
- Worsened **emotional** control
- Worsened **motor** skills – think: **driving a car**
- Worsened **perceptive** skills
- Worsened ability to make **good decisions, reasoning**
- Worsened ability to learn, and **make memories** of new information
- Worsened ability to do simple **arithmetic**
- Worsened ability to fight off colds – the **immune** system weakens

# Why does sleep matter?

- On the other hand, some things get **better** with **less sleep!**  
What are they?
- Increased ability to **gain weight** without trying
- More **impulsivity**
- More **toxins** in the brain
- More **accidents** and errors
- More prone to **depression**
- **Metabolic** and **endocrine** problems (think: **diabetes**)
- Increase the risk for **dementia**
- Increased likelihood of **heart disease**
- Increase the risk of multiple types of **cancer**

# Specifically Adolescents

- **Irritability / Behavior Problems** (Beebe, 2011; Sadeh et al., 2002; Stein et al., 2001)
- **Depression / Suicidal Ideation** (Buysse et al., 2008; Clarke et al., 2015; Liu 2004; Roberts & Doung, 2014; Silverstein, 2013)
- **Substance Use** (Bootzin & Stevens, 2005)
- **Poor Decision making and risk taking** (Baum et al., 2014; Venkatraman et al., 2007)
- **Compromised School Achievement** (Eide & Showalter, 2012; Wahlstrom, 1999, 2002)
- **Tardiness & Missed School** (Owens et al, 2010)
- **Poor Concentration / Memory Retention** (Baum et al., 2014; Lufi et al., 2011; Wolfson & Carskadon, 1998)
- **“It takes a sleepy student 5 hours to complete 3 hours of homework.” Judith Owens, MD**

# WHAT HAPPENS WHEN YOUR BRAIN DOESN'T SLEEP?

## LOST MEMORIES

The **hippocampus**, a moon-shaped structure in the temporal lobe, exhibits a distinct pattern of neural activity when the waking mind encodes (learns) new information. Scientists believe our brain later "replays" the same activity pattern while we're sleeping to help the info stick. Lose sleep, lose long-term memories.

## ANGER

Sleep loss primes us to focus on negative experiences, misinterpret facial expressions and pick fights. Emotional volatility may partly be a product of interrupted communication between brain regions. fMRI of the well-rested brain shows connectivity between the **amygdala**, a limbic system structure critical to emotional processing, and the **medial prefrontal cortex**, which helps regulate feelings (i.e., tells us to chill). Sleep deprivation cuts this connection, letting your revved-up amygdala (and your mood) run wild.

## IMPAIRED WIT

When you skimp on sleep, the clever commentary may not flow so easily. Sleep loss affects cognitive processes like divergent thinking, which helps us switch topics nimbly during conversation. Scientists found that activity in the **inferior frontal gyrus** increases when sleep-deprived people tried to list uses for different objects, suggesting the brain draws on divergent thinking to compensate for strained cognitive functioning.

## HALLUCINATIONS

The well-rested brain filters stimuli (noise, light, smell, etc.) to separate what matters from what doesn't and prevent sensory overload. When the brain can't filter the information coming in, chaos ensues. After pulling an all-nighter, people may begin to anticipate things that aren't there, including objects.

## HEAD IN THE CLOUDS

We all lose focus now and then, but brain activity linked to attention lapses changes when people sacrifice sleep. After a good night's rest, these lapses correspond to altered thalamus function and less-active frontal and parietal networks, which basically means we tune out when we're bored. But when sleep-deprived people space out, they also exhibit impaired visual sensory processing, suggesting a whole other

## FALSE MEMORIES

The sleep-starved brain may fail to encode memories successfully in the first place, thanks to altered function in the **hippocampus**, as well as **prefrontal cortex** and **parietal lobe** regions. One study found that people are more likely to incorporate misinformation into memories of events observed after a night without sleep.

## CEREBRAL SHRINKAGE

Healthy adults getting poor sleep lose volume in the **frontal**, **temporal** and **parietal** lobes, one study showed. Researchers don't yet understand if sleep loss causes shrinkage or vice versa.

## SLURRED SPEECH

The **temporal lobe**, the brain region associated with language processing, is highly active in well-rested people but inactive in their exhausted and enunciation-challenged counterparts.

## CRONUT BINGES

Sleep loss corresponds with decreased activity in the **frontal lobe**, which controls decision-making, and more activity in the **amygdala**, a key player in fear detection. Together, these neural changes create a brain mechanism that dulls judgment and ratchets up desire — the ideal mind-state for scarfing down fistfuls of bacon.

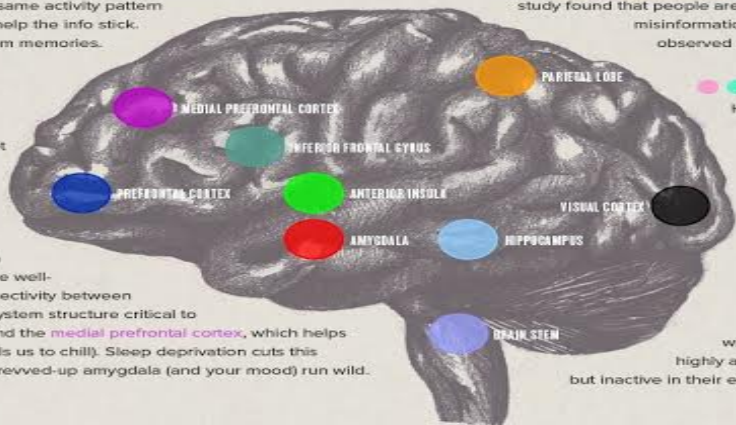
## RISKY DECISIONS

When sleep-deprived people prepare to make economic decisions, the brain's reward center in the **prefrontal cortex** lights up, suggesting they expect to win (e.g., make money).

But when risky choices don't pan out, people's brain activity decreases in the region related to punishment and aversion (the **anterior insula**), suggesting they don't care about losing money as much as they would on a good night's sleep.

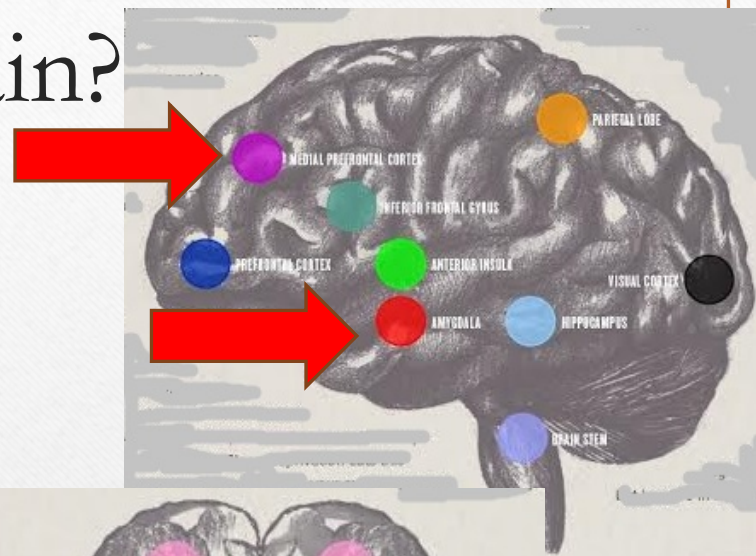
## BRAIN DAMAGE

Add all-nighters to the list of things that kill brain cells — in this case, in the **brain stem**. The damage may be irreparable, making "catching up on lost sleep" a poor excuse for snoozing till noon on the weekends.

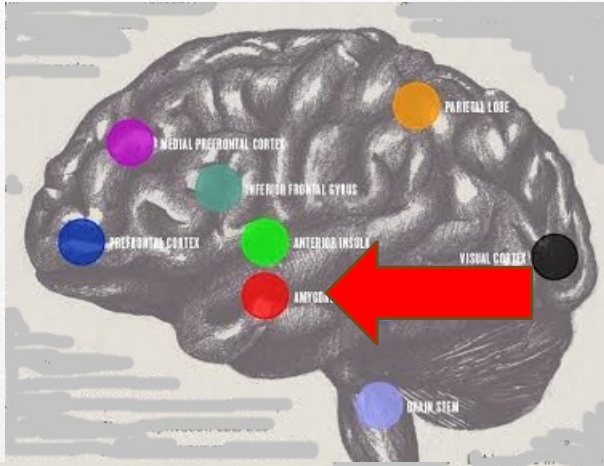


# What about the Brain?

- **Anger!**
- Sleep loss primes us to focus on negative experiences, misinterpret facial expressions and pick fights
- This happens because sleep debt cuts the connection between your amygdala and your medial prefrontal cortex



# What about the Brain?



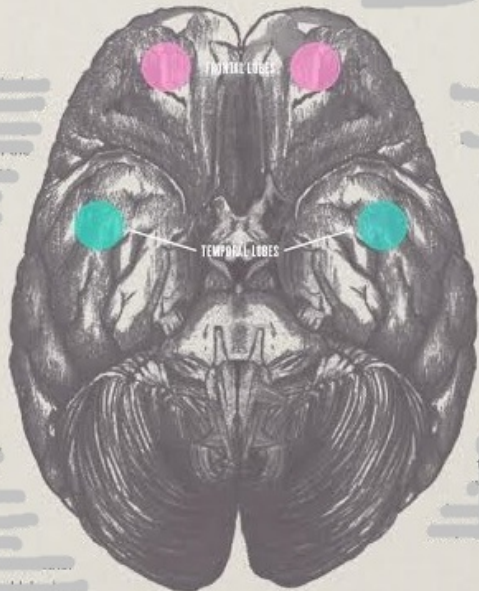
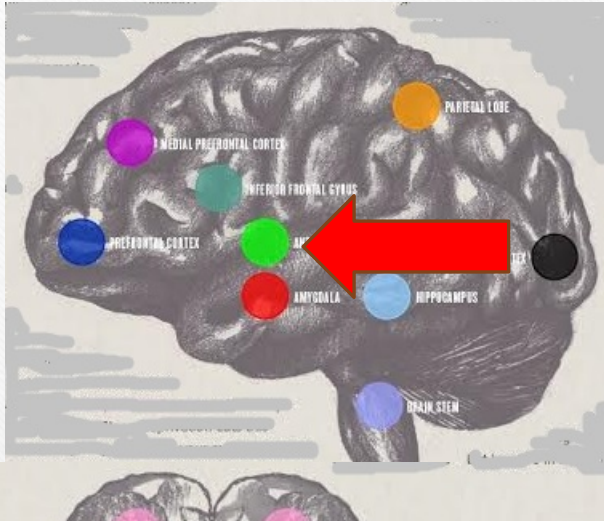
Donuts! Bacon!

- Sleep loss corresponds with decreased activity in the frontal lobes, which controls decision making
- AND more activity in the amygdala – a key player in fear detection
- Put together, these changes create a brain mechanism that **dulls judgement** and **ratchets up desire** which can lead to **hunger**

# What about the Brain?

## Risky Decisions

- In a study, when sleep deprived people prepared to risk their money they expected to win more than those who weren't sleep deprived.
- When they lost their money, their brains had a diminished reaction (in the anterior insula) to losing compared to those who had slept well



# Melatonin Secretion



ADOLESCENT SLEEP  
@DrMikeFarquhar

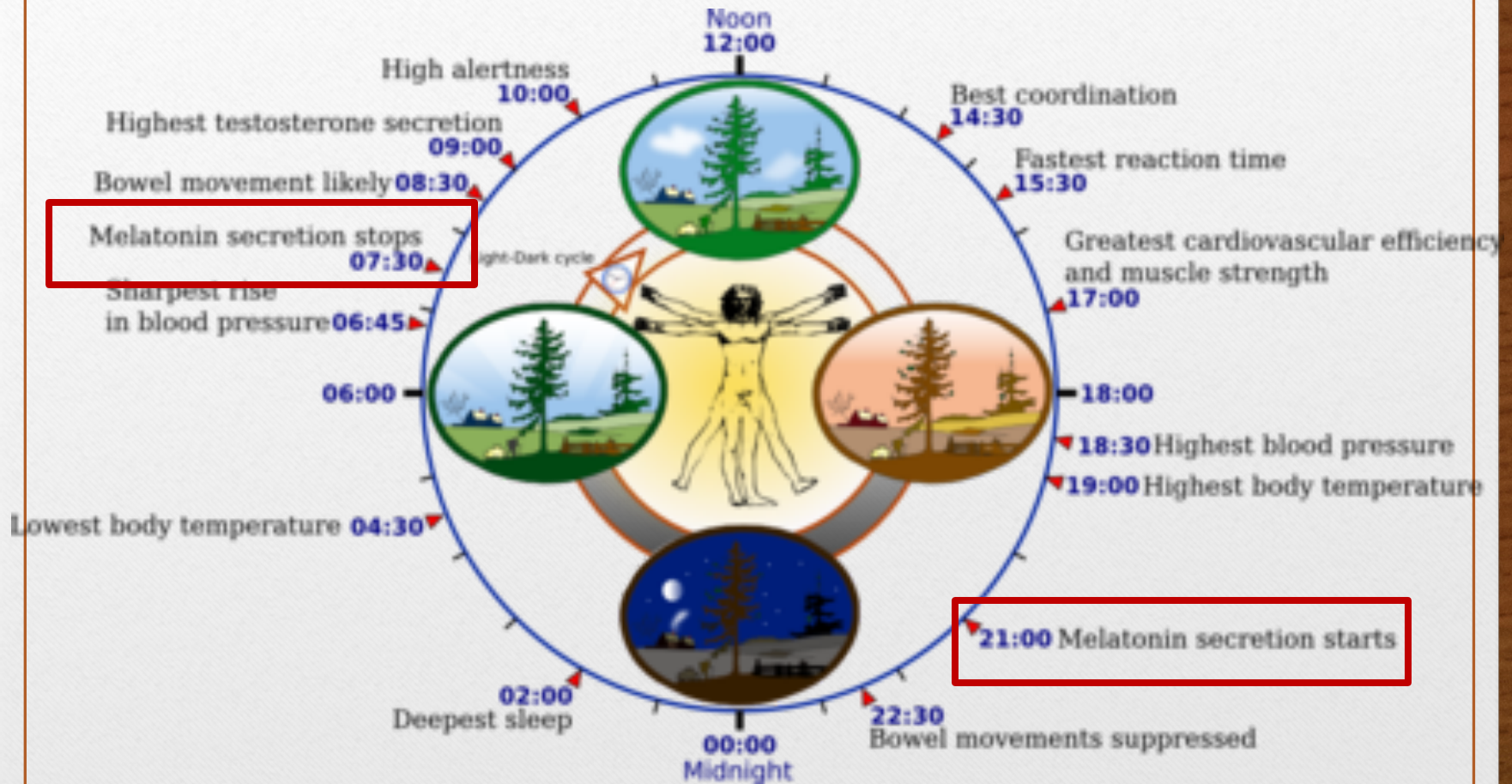


NHS  
Guy's and St Thomas'  
NHS Foundation Trust



# Adult Human Biological Clock

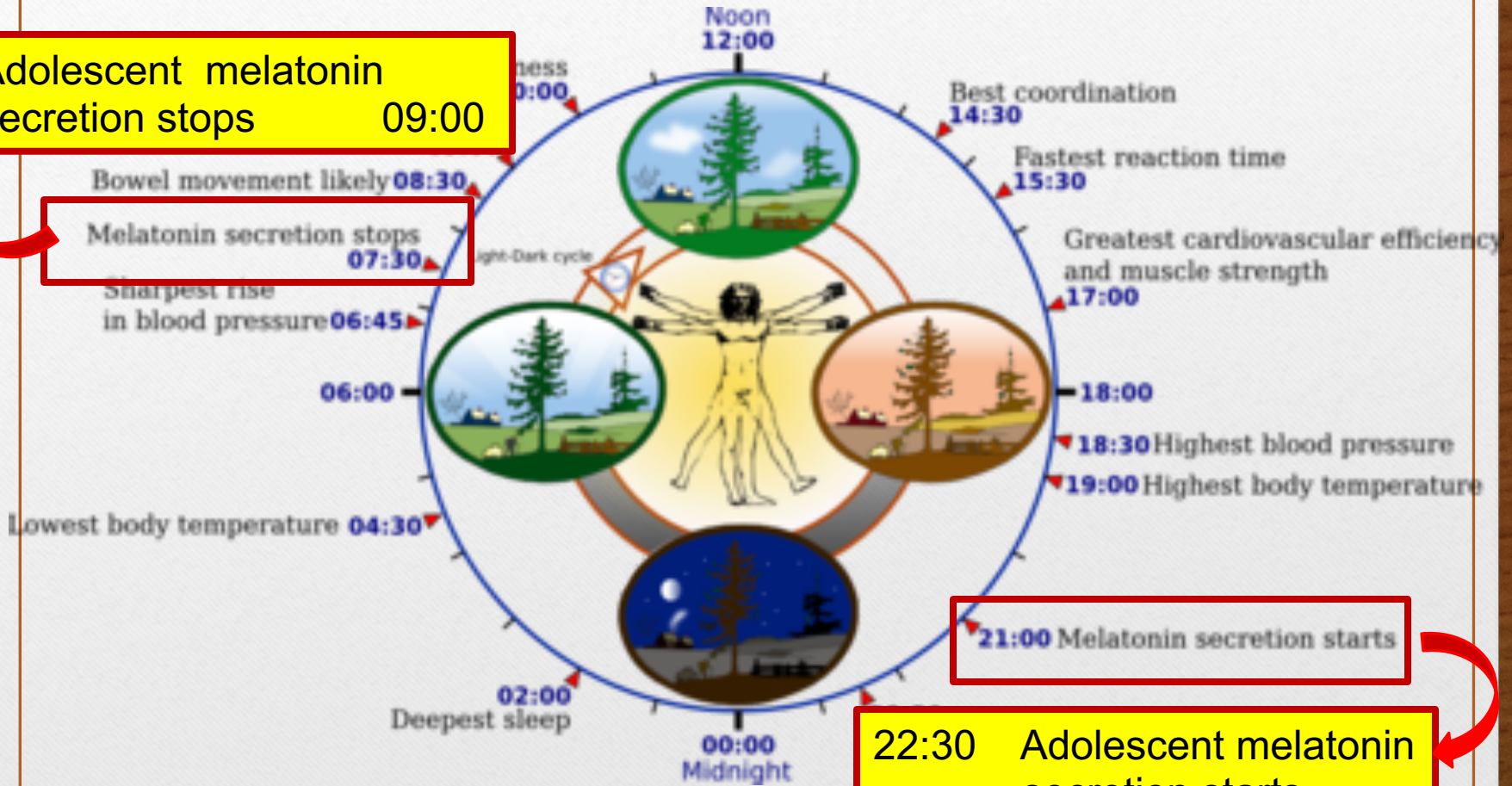
(Smolensky and Lamberg, 2000)



# Human Biological Clock: Adult vs. Adolescent

Adolescent melatonin secretion stops 09:00

Melatonin secretion stops 07:30

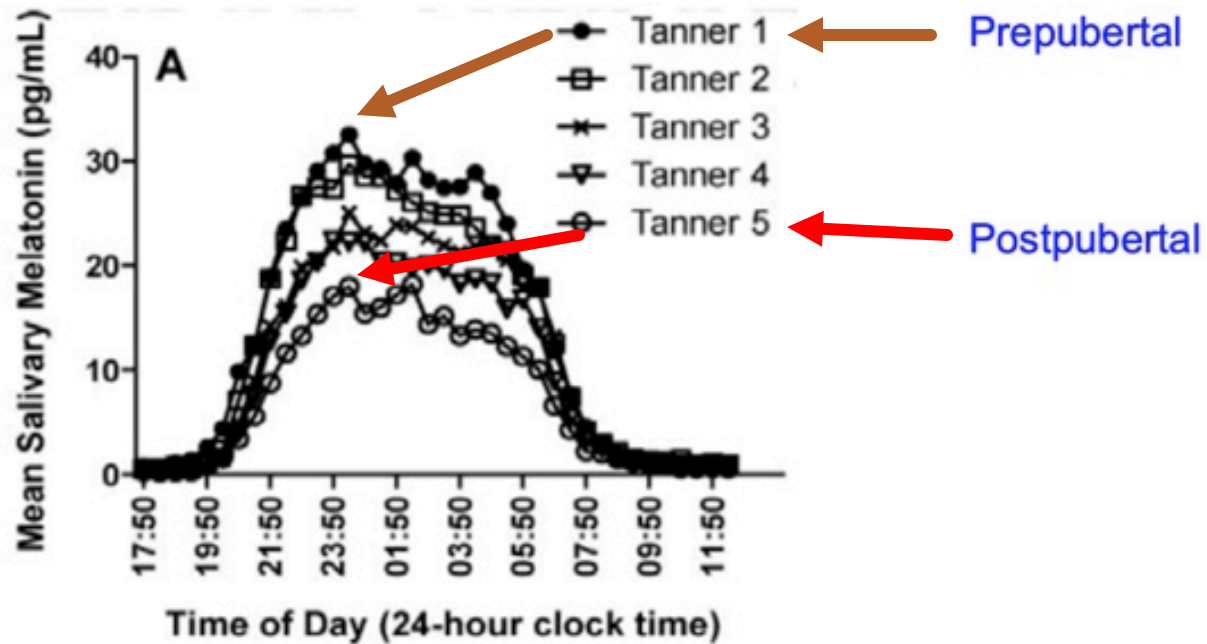


# To put it in perspective...

- Your son or daughter waking up at 6:45 am is about the same as you or I waking up to go to work at about
- 5:15 am (two hours and fifteen minutes before our melatonin production ends)
- Also: you can then go to bed more easily that night than your son or daughter.



# Adolescent Melatonin Amplitude



## In summary, Adolescent sleep is different

- Change in phase-dependent sensitivity to light exposure - And later melatonin secretion
- Diminished amplitude of the melatonin rhythm
- Longer longer internal day length
- Bedtime becomes later
- Rise time becomes earlier (school dependent)
- Total sleep time is reduced
- Chronic insufficient sleep affects morning alertness most, especially when waking before the body expects

What happens  
when Later Start  
Times are Used?

-Athletics

-Auto Accidents

# Sleep and Sports

68% fewer sports injuries among teens with more sleep than their peers

*“We were surprised to find that sleep played such an important role in athletic injury.”* (Milewski interview)



# Sleep and Sports

- PA district that moved to later start times noted a 30% reduction in concussions for all students compared to the last year with early start times.
- In the second year with later start times, the 30% reduction in concussions continued





# Sleep and Sports - Anecdotal

- The year Wilton, CT switched to later high school start time, the district won several state championships
- In Los Angeles, a formal complaint was filed against a school with new later start times citing the additional sleep as an unfair advantage against teams with early start times.



# Auto Accidents: Kentucky

- Fayette County, Kentucky, two-year study, 1998
  - Auto accident rates decreased by 16.5% when high school start time went from 7:30 am to 8:30 am.
  - Auto accidents of teens in the rest of state **increased 7.8%**
  - A comparable decrease of 24.3%

(Danner and Phillips, 2008)



# Auto Accidents: Minnesota

In 2005 the Mahtomedi School District moved start times from 7:30 am to 8:00 am

During that school year, auto accidents among 16-18year olds in the district decreased by 65%

(Wahlstrom et al, 2014 – UMN CAREI Studies)



# Auto Accidents: Wyoming

In 2012 the Jackson Hole School District moved start times from 7:35 am to 8:55 am.

During that school year, auto accidents among 16-18 year olds in the district decreased by 70%

(Wahlstrom et al, 2014 – UMN CAREI Studies)



What happens when  
schools begin later start  
times?

# Experiences of other districts

## In 1997...

Minneapolis Public School District's 7 high schools  
changed from:

**7:15 am - 1:45 pm school days**

to

**8:40 am - 3:20 pm school days**



(Affecting 18,000 students)

## In a study 4 years later:

“Contrary to the fears and expectations that a later start would result in students staying awake an hour later on school nights...

*Minneapolis high school students get **five more hours of sleep per week** than their peers [with early school start times].”*

(Wahlstrom, 2003)



# Benefits of Later Start Times

In Minneapolis (statistically measured):

- Increased total sleep
- Increased attendance
- Reduced tardiness
- Reduction in dropout rates
- Less depression
- Fewer disciplinary referrals
- Less sleeping in class
- Homework completed in less time due to alertness & efficiency



Despite earlier concerns of busing, athletics, child care:

**92% of parents preferred later times after one year**



# Benefits of Later Start Times

## Anecdotal and Survey Reports from Minneapolis

- According to the faculty and staff:
  - Fewer students falling asleep in class
  - Students more alert during first two periods
  - Improved student behavior
  - Quieter hallways
- According to the students:
  - Learning was 'easier'

(Wahlstrom, 2003)



# Benefits of Later Start Times

University of Minnesota Study, 2014

- Dr. Kyla Wahlstrom, Center for Applied Research and Educational Improvement (**CAREI**)
- First long-term study measuring impact of later start times of high school on academic achievement
- Edina, suburban district and Minneapolis Public Schools
- Studied work, sleep, and school habits of 12,000 secondary students, over 3,000 teachers, and interview data from 750 parents for 5 years (1997-2001)

# Benefits of Later Start Times

## CAREI 2<sup>nd</sup> Study (2014)

- First study to examine multiple schools across U.S.
- Eight public high schools, three states (Colorado, Wyoming, Minnesota)
- 9,000 students
- Three-year study funded by CDC
- Switching to later start time **confirmed previous study results.**
- Also found less caffeine consumption.

# Excuse 1: Rising Early Teaches Teens Responsibility

- Teen brains are still developing. The developing front cortex is responsible for judgment and reasoning.
- Asking teenagers to deprive themselves of sleep to “prepare” for the real world is like asking toddler to skip their naps to prepare for 5th grade.
- 30% of adults leave their house for work after 8 AM according to the Census Bureau.
- Duke University banned all classes before 8:30 AM in 2009.
- At Texas A & M, only 5% of all class sections begin at 8 AM.

## Excuse 2: Later Start Times will lead to later Bed Times

- Out of the 11 studies published on this issue as of May 2016, weekday bedtimes stayed the same in 11 studies and in 2 studies students reported slightly earlier bedtimes.
- At the same time, students are using the extra time in the morning to sleep, which means that **delayed school start times accomplish the goal of increasing sleep duration for adolescents.**
- In fact, researchers have determined that, as opposed to parenting methods, academic workload, and extracurricular activities, school start time has the **single largest effect on how long adolescents sleep each night.**

So what do the experts say?

**School should start after 8:30 am for 6<sup>th</sup>  
through 12<sup>th</sup> grades.**

- National Sleep Foundation, 2009
- Arne Duncan, US Secretary of Education, 2013
  - American Academy of Pediatrics, 2014
  - American Medical Association, 2016
  - Center for Disease Control, 2016
    - And many more

**ADOLESCENT SLEEP TRENDS AND PATTERNS**

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**JAMA Journal of Clinical Sleep Medicine**

COMMENTARY  
**Driving Drowsy**  
Christopher P. Langdon, M.D., M.P.H.

As a member of the Sleep Medicine Society, I am often asked if drowsy driving is a real problem. The answer is a resounding yes. Drowsy driving is a leading cause of motor vehicle crashes, and it is a preventable problem. This article discusses the risks of drowsy driving and offers strategies to reduce them.

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**FIGURE 1** Distribution of school-night total sleep: Early- versus late-starting middle schools.

**Examining the Impact of Later High School Start Times on the Health and Academic Performance of High School Students: A Multi-Site Study**

Final Report  
February 2014

Kyle L. Wahlstrom, Ph.D.  
Project Director/Lead Investigator

This study examined the impact of later high school start times on the health and academic performance of high school students. The study included 10,000 students across four sites. The results showed that later start times were associated with increased sleep duration, reduced daytime fatigue, and improved academic performance.

**CAREI CENTER FOR APPLIED RESEARCH AND EDUCATIONAL IMPROVEMENT**

This center is dedicated to advancing research and improving educational outcomes. We offer a variety of services and programs to support schools and districts.

**High School Start Times**

Summary of Findings

Does changing school schedules make a positive approach affect academic achievement, behavior, and educational improvement (CARE) at the University of Minnesota has studied these issues among both suburban and urban schools. (Wahlstrom and Freeman, 1997) Current data reveals that after daily high school schedules are delayed from early morning start times:

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ADOLESCENTS LIVING THE 24/7 LIFESTYLE: Efficacy of Caffeine and Technology on Sleep Duration and Daytime Functioning

Abstract: While there is widespread concern about the effects of caffeine and technology on sleep, little is known about how they affect sleep patterns in adolescents. This study examined the effects of caffeine and technology on sleep duration and daytime functioning in adolescents living the 24/7 lifestyle. The study included 100 adolescents (50 males and 50 females) aged 16-18 years old. The study was conducted over a 4-week period. The participants were randomly assigned to two groups: a control group and an intervention group. The control group did not use caffeine or technology, while the intervention group used caffeine and technology. The study found that the intervention group had significantly lower sleep duration and higher daytime fatigue compared to the control group.

**FIGURE 1** Distribution of school-night total sleep: Early- versus late-starting middle schools.

Insufficient (<8 h TST)	Borderline (8-9 h TST)	Sufficient (≥9 h TST)
(time) 23.15 hours (121.7%) <sup>a</sup>	22.15 hours (61.0) <sup>a</sup>	21.38 hours (63.7)
(m) 21.6 (18.0)	30.8 (22.8)	21.1 (8.0)
(m) 07.02 hours (51.2) <sup>a</sup>	07.10 hours (47.0) <sup>a</sup>	07.27 hours (48.6)
(m) 07.15 hours (66.8) <sup>a</sup>	07.25 hours (59.7)	07.35 hours (58.7)
(time) 00.58 hours (174.1) <sup>a</sup>	23.32 hours (150.8)	23.46 hours (169.0)
44.3 (54.5) <sup>a</sup>	25.0 (29.8)	20.2 (21.2)
8.3 (2.2) <sup>a</sup>	9.2 (1.6)	9.4 (1.5)
10.01 hours (182.7)	09.31 hours (146.3)	09.27 hours (143.8)
10.30 hours (174.9)	09.57 hours (150.4)	09.47 hours (157.1)
12.02 (7) <sup>a</sup>	1.9 (0.7)	1.7 (0.8)
1.0 (9) <sup>a</sup>	1.6 (0.9)	1.5 (0.8)
1.9 (0.9) <sup>a</sup>	1.2 (0.8)	1.0 (0.8)
7.9 (9) <sup>a</sup>	1.3 (0.9)	1.0 (0.9)
1.1 (0)	1.5 (0.8)	1.3 (0.9)
1.0 (0)	0.8 (0.9)	0.6 (0.9)
4.0 (0) <sup>a</sup>	13.2 (3.4)	11.7 (4.7)
0.19) <sup>a</sup>	0.79 (0.17)	0.76 (0.19)
1.4)	12.3 (8.8)	11.0 (2.9)

<sup>a</sup>Values below by parenthesis indicate that values correspond to boys and girls separately in the same row if girls' prevalence ratio is more than twice that of boys.

**ARCHIVES & ADOLESCENT MEDICINE**

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**Middle School Start Times: The Importance of a Good Night's Sleep for Young Adolescents**

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**SLEEP AND BIOLOGICAL RHYTHMS**

Abstract: Sleep and biological rhythms are closely linked. Disruptions in sleep patterns can lead to health problems and affect the body's internal clock. This article discusses the relationship between sleep and biological rhythms and offers strategies to improve sleep quality.

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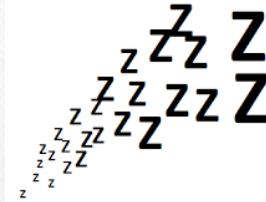
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# Sleep well!

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