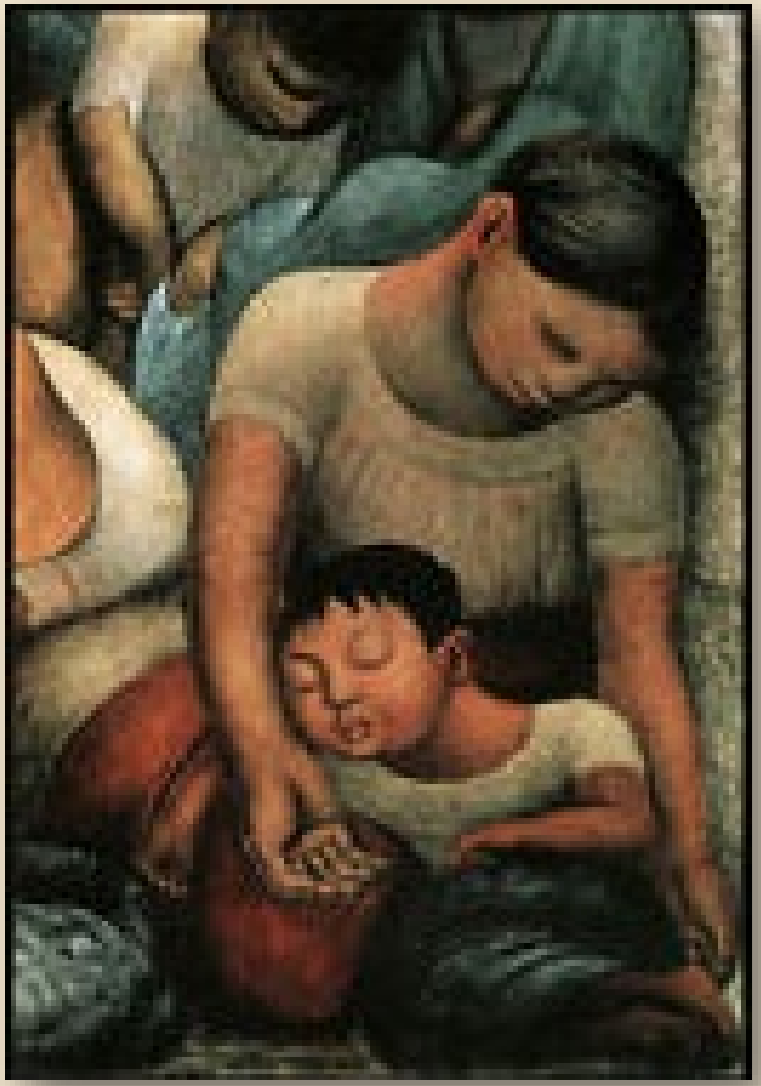


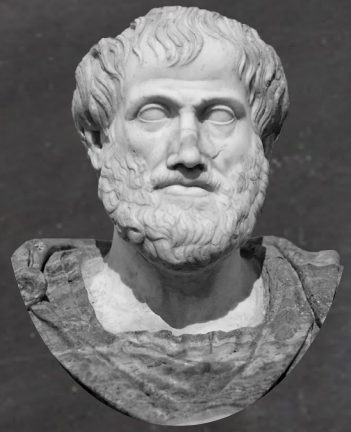
Diego Rivera

"Sleep is the golden chain that ties health and our bodies together."

Thomas Dekker

Mary ET Boyle, Ph. D.

Department of Cognitive Science,
University of California, San Diego

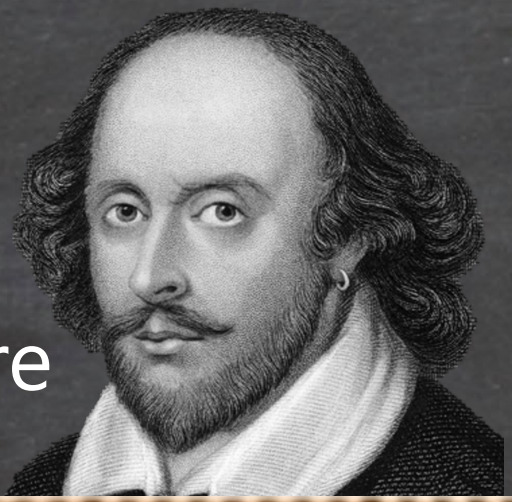


First, then, this much is clear, that waking and sleep appertain to the same part of an animal, inasmuch as they are opposites, and sleep is evidently a privation of waking.

Aristotle

Sleep dwell upon thine eyes, peace in thy breast! Would I were sleep and peace, so sweet to rest.

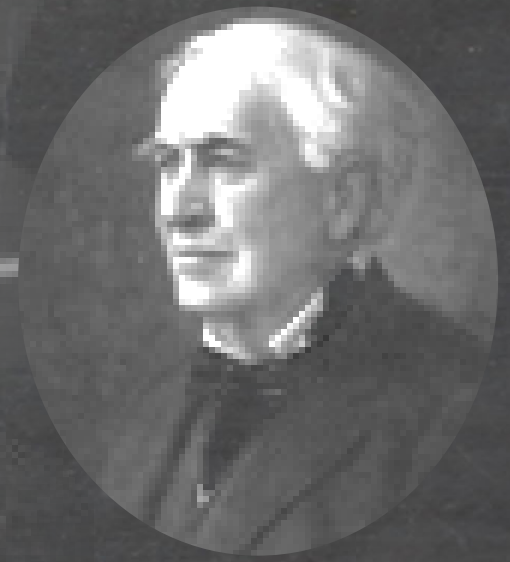
Shakespeare



Think in the morning.
Act in the noon.
Eat in the evening.
Sleep in the night.

William Blake

350 B.C. 1500's 1700's



Thomas Edison

"We are always hearing people talk about 'loss of sleep' as a calamity. They better call it loss of time, vitality and opportunities."

Photos: Henry Ford Museum

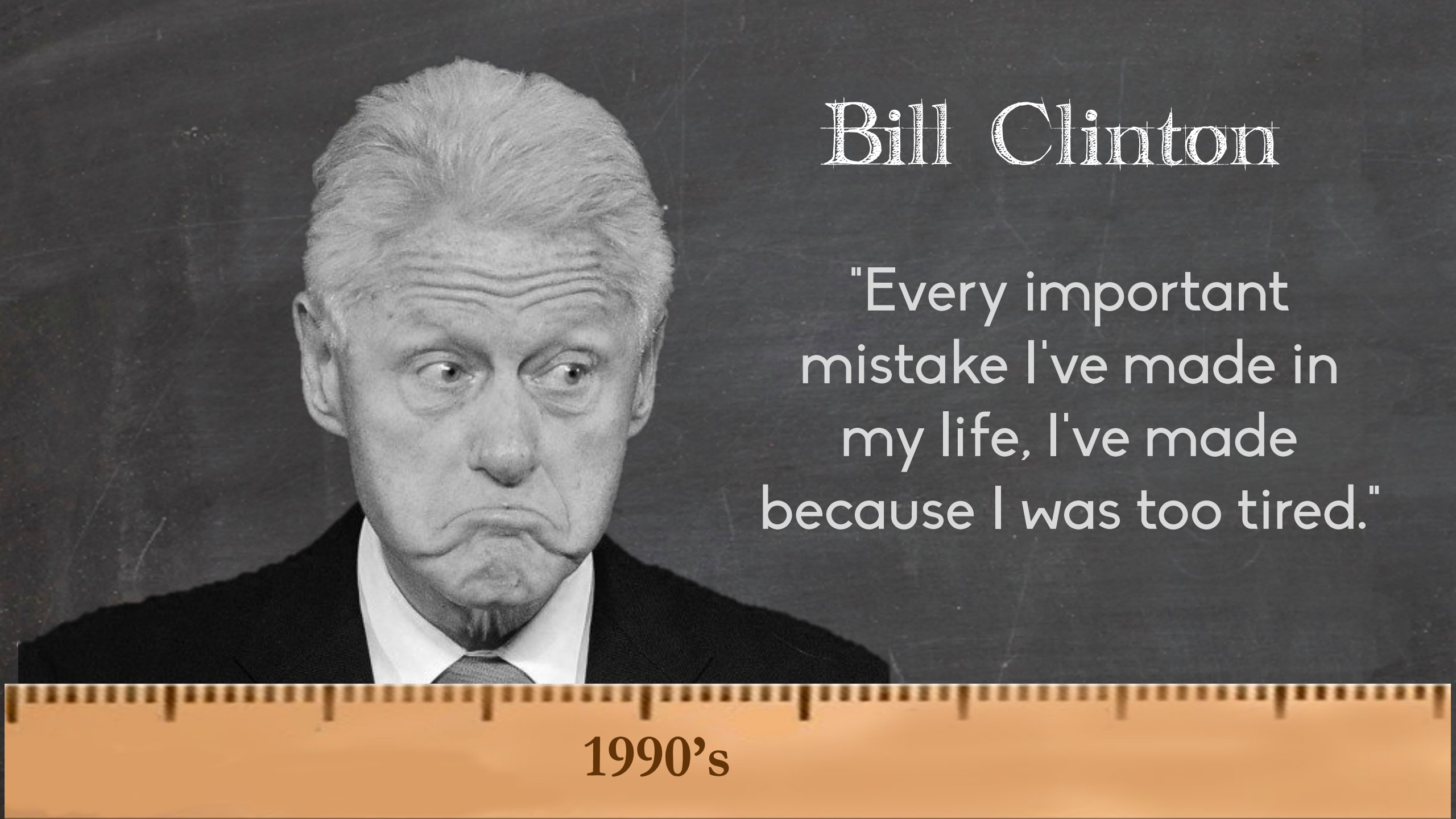
"Sleep is a criminal waste of time and a heritage from our cave days."

1800's

Margaret Thatcher

"Sleep is for wimps!"

1980's


Bill Clinton
"Every important mistake I've made in my life, I've made because I was too tired."
1990's

-sleep is essental

imprecase communication

Sleep deprived bees cannot communicate the direction of the food source when they are sleep deprived.

Sleep deprivation impairs precision of waggle dance signaling in honey bees

Barrett A. Klein[a,1], Arno Klein[b], Margaret K. Wray[c], Ulrich G. Mueller[a], and Thomas D. Seeley[c]


Los Angeles Tim

Tuesday, January 28, 1986

Shuttle Explodes; All 7 Die

Teacher on Board as Challenger Blows Up on Liftof

Reagan Postpones Futur Flights Pending a Probe

By MICHAEL SEILER and PETER H. KING,
Times Staff Writers

KENNEDY SPACE CENTER, Fla.—The space shu Challenger exploded in a huge fireball less than two minu after takeoff today, with all seven crew members—includ New Hampshire teacher Sharon Christa McAuliffe—fea dead.

Airborne paramedics parachuted quickly into the c waters off Cape Canaveral in a vain search for survi Though there was no immediate announcement on the fat the crew, all were believed dead.

The disaster—the worst in the history of America's manned space program—came shortly after the Challenger blasted off on a cold

As the contrails formed to east of Cape Canaveral, a parach appeared in the clear blue

Sleep deprivation has been indicated as a cause in 7.8 percent of all the Air Force's Class A mishaps (Luna, 2003). Disasters such as Chernobyl, Three Mile Island, Davis-Besse, and Rancho Seco all occurred in the early morning (2:00 a.m. to 4:00 a.m.), a time when sleep deprivation effects are especially powerful, and all involved errors made by people working in groups (Harrison & Horne, 2000). Furthermore, sleep loss was specifically cited as a factor that contributed to the collective human error and poor judgment related to the Space Shuttle Challenger disaster (*Presidential Commission on Space Shuttle Challenger Accident*, 1986)

© *Academy of Management Review*
2009, Vol. 34, No. 1, 56–66.

SLEEP DEPRIVATION AND DECISION-MAKING TEAMS: BURNING THE MIDNIGHT OIL OR PLAYING WITH FIRE?

CHRISTOPHER M. BARNES
JOHN R. HOLLENBECK
Michigan State University

One Silicon Valley startup that encouraged its employees to think about work 24/7 found they missed market signals, tanked deals and became too irritable to build crucial working relationships.

https://www.npr.org/sections/health-shots/2016/04/26/475287202/many-grouchy-error-prone-workers-just-need-more-sleep

https://www.nytimes.com/2018/08/13/well/an-underappreciated-key-to-college-success-sleep.html

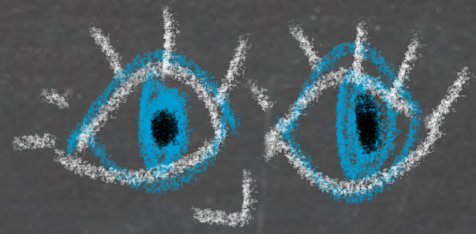
The New York Times

PERSONAL HEALTH

An Underappreciated Key to College Success: Sleep

Many college-bound students start out with dreadful sleep habits that are likely to get worse once the rigorous demands of courses and competing social and athletic activities kick in.

Studies show...



"sleep quantity and sleep quality outrank such popular campus concerns as alcohol & drug use in predicting student's grades & a student's chances of graduating."

NYT J. Brody

“ For me, nothing captures the idea of sleep debt quite like my years as a college student. In a story that repeated itself weekly, if not daily,...

I would squander my days soaking up the “college experience” (details spared) and spend all-nighters cramming, only to find myself wandering through a suffocating mire of brain fog as I walked into my exam the next morning.

Research has supported what I learned firsthand: **that sleeping too little (or not at all) can inhibit your productivity and ability to remember and consolidate information**.”

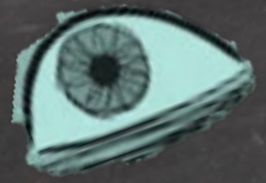
http://www.myhousecallmd.com/bq365-weeks-3-5-the-science-sleep/

Brian Kim, MD, MS

GEISEL OVERNIGHT
STUDY COMMONS

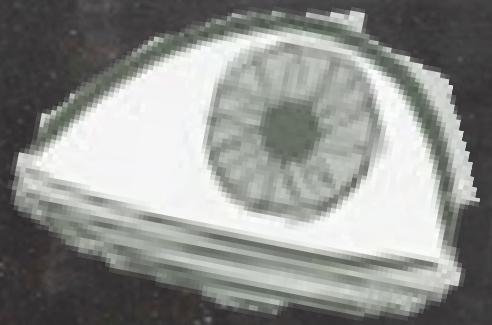
OPEN CONTINUOUSLY FROM 10 AM SUNDAY–6 PM FRIDAY

↑ This encourages all-nighters

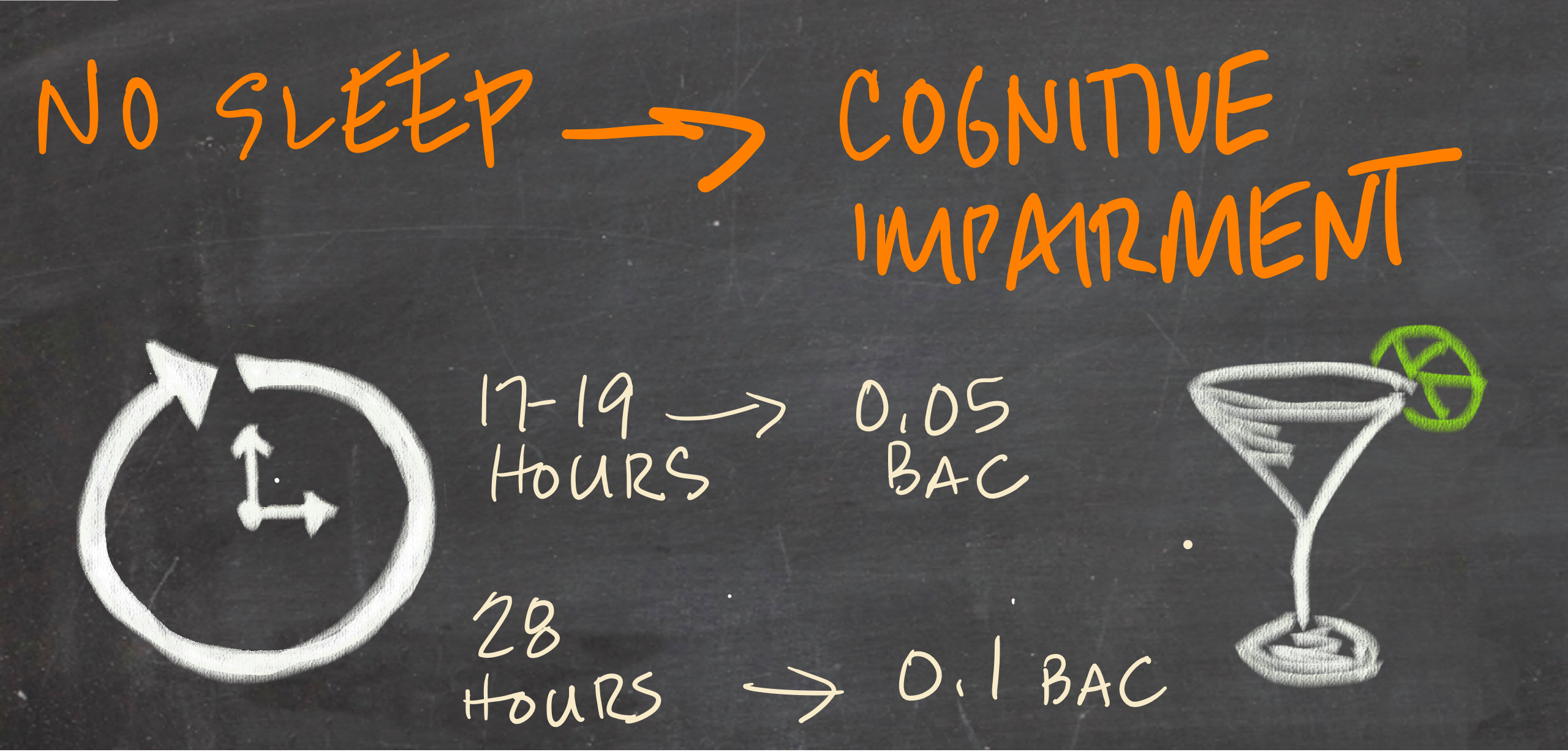


WHAT HAPPENS WHEN WE DON'T SLEEP?

1. cognitive & behavioral changes
2. ↓↓ ability to concentrate
3. ↓↓ short-term memory
4. Paranoia & hallucinations



http://www.online-clockalarm.com/facts/the-worlds-record-for-the-longest-sleep-deprivation-period-is-11-days



Occup Environ Med 2000;57:649–655

Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication

A M Williamson, Anne-Marie Feyer

Stanford study

EFFECTS OF SLEEP EXTENSION ON ATHLETIC PERFORMANCE

DOI: 10.5665/SLEEP.1132

The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players

Cheri D. Mah, MS[1]; Kenneth E. Mah, MD, MS[1]; Eric J. Kezirian, MD, MPH[2]; William C. Dement, MD, PhD[1]

[1]Stanford Sleep Disorders Clinic and Research Laboratory, Department of Psychiatry and Behavioral Sciences, School of Medicine, Stanford University, Stanford, CA; [2]Department of Otolaryngology—Head and Neck Surgery, University of California, San Francisco, CA

Study Objectives: To investigate the effects of sleep extension over multiple weeks on specific measures of athletic performance as well as reaction time, mood, and daytime sleepiness.

Setting: Stanford Sleep Disorders Clinic and Research Laboratory and Maples Pavilion, Stanford University, Stanford, CA.

Participants: Eleven healthy students on the Stanford University men's varsity basketball team (mean age 19.4 ± 1.4 years).

Interventions: Subjects maintained their habitual sleep-wake schedule for a 2-4 week baseline followed by a 5-7 week sleep extension period. Subjects obtained as much nocturnal sleep as possible during sleep extension with a minimum goal of 10 h in bed each night. Measures of athletic performance specific to basketball were recorded after every practice including a timed sprint and shooting accuracy. Reaction time, levels of daytime sleepiness, and mood were monitored via the Psychomotor Vigilance Task (PVT), Epworth Sleepiness Scale (ESS), and Profile of Mood States (POMS), respectively.

Results: Total objective nightly sleep time increased during sleep extension compared to baseline by 110.9 ± 79.7 min ($P < 0.001$). Subjects demonstrated a faster timed sprint following sleep extension (16.2 ± 0.61 sec at baseline vs. 15.5 ± 0.54 sec at end of sleep extension, $P < 0.001$). Shooting accuracy improved, with free throw percentage increasing by 9% and 3-point field goal percentage increasing by 9.2% ($P < 0.001$). Mean PVT reaction time and Epworth Sleepiness Scale scores decreased following sleep extension ($P < 0.01$). POMS scores improved with increased vigor and decreased fatigue subscales ($P < 0.001$). Subjects also reported improved overall ratings of physical and mental well-being during practices and games.

Conclusions: Improvements in specific measures of basketball performance after sleep extension indicate that optimal sleep is likely beneficial in reaching peak athletic performance.

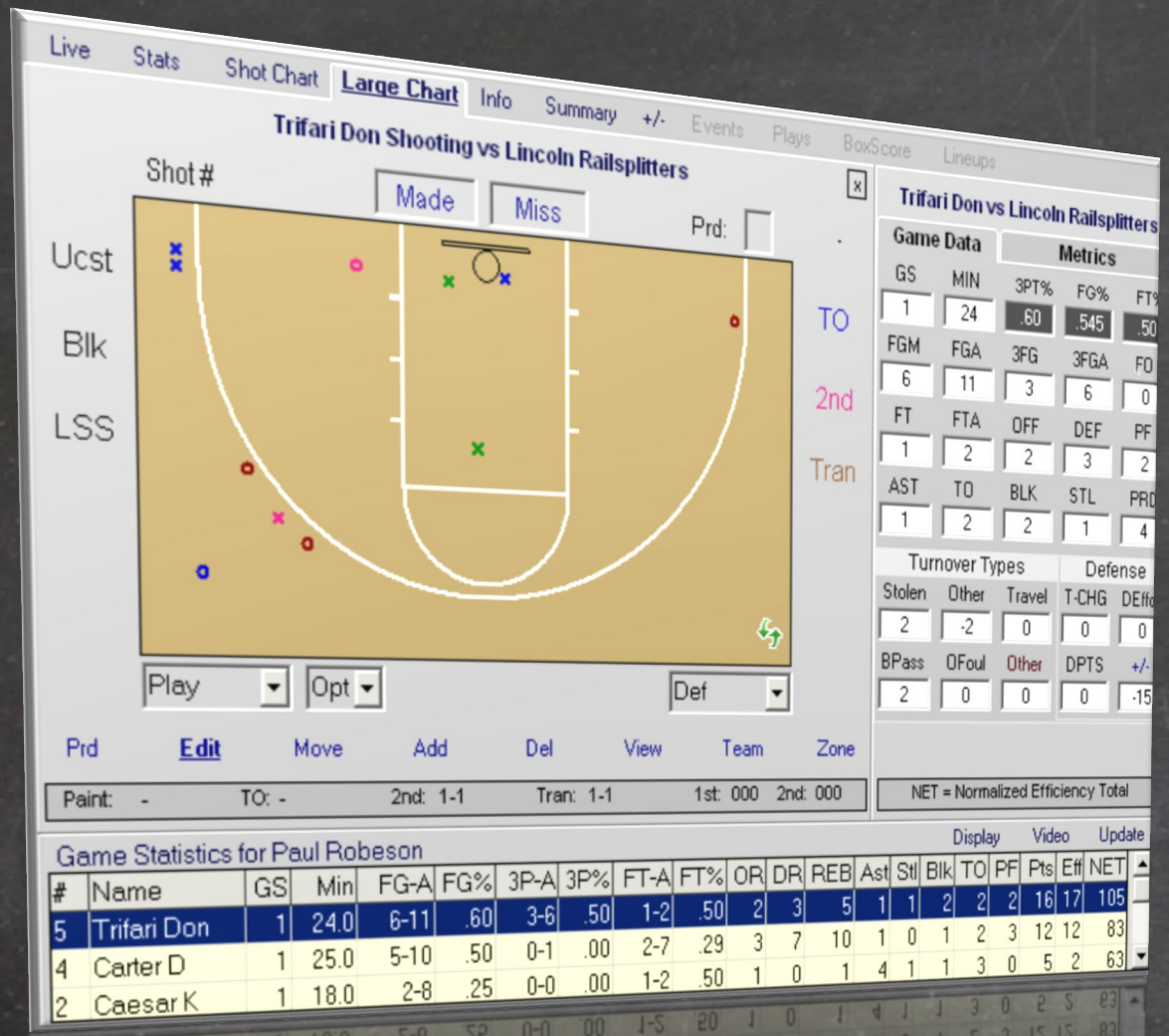
Keywords: Sleep extension, extra sleep, athletes, athletic performance, sports, basketball, collegiate, reaction time, mood, fatigue

Citation: Mah CD; Mah KE; Kezirian EJ; Dement WC. The effects of sleep extension on the athletic performance of collegiate basketball players. *SLEEP* 2011;34(7):943-950.

Participants: Eleven healthy students on the Stanford University men's varsity basketball team (mean age 19.4 ± 1.4 years).

Participants
stanford
men's
varsity
basketball
team

Interventions: Subjects maintained their habitual sleep-wake schedule for a 2-4 week baseline followed by a 5-7 week sleep extension period. Subjects obtained as much nocturnal sleep as possible during sleep extension with a minimum goal of 10 h in bed each night. Measures of athletic performance specific to basketball were recorded after every practice including a timed sprint and shooting accuracy. Reaction time, levels of daytime sleepiness, and mood were monitored via the Psychomotor Vigilance Task (PVT), Epworth Sleepiness Scale (ESS), and Profile of Mood States (POMS), respectively.

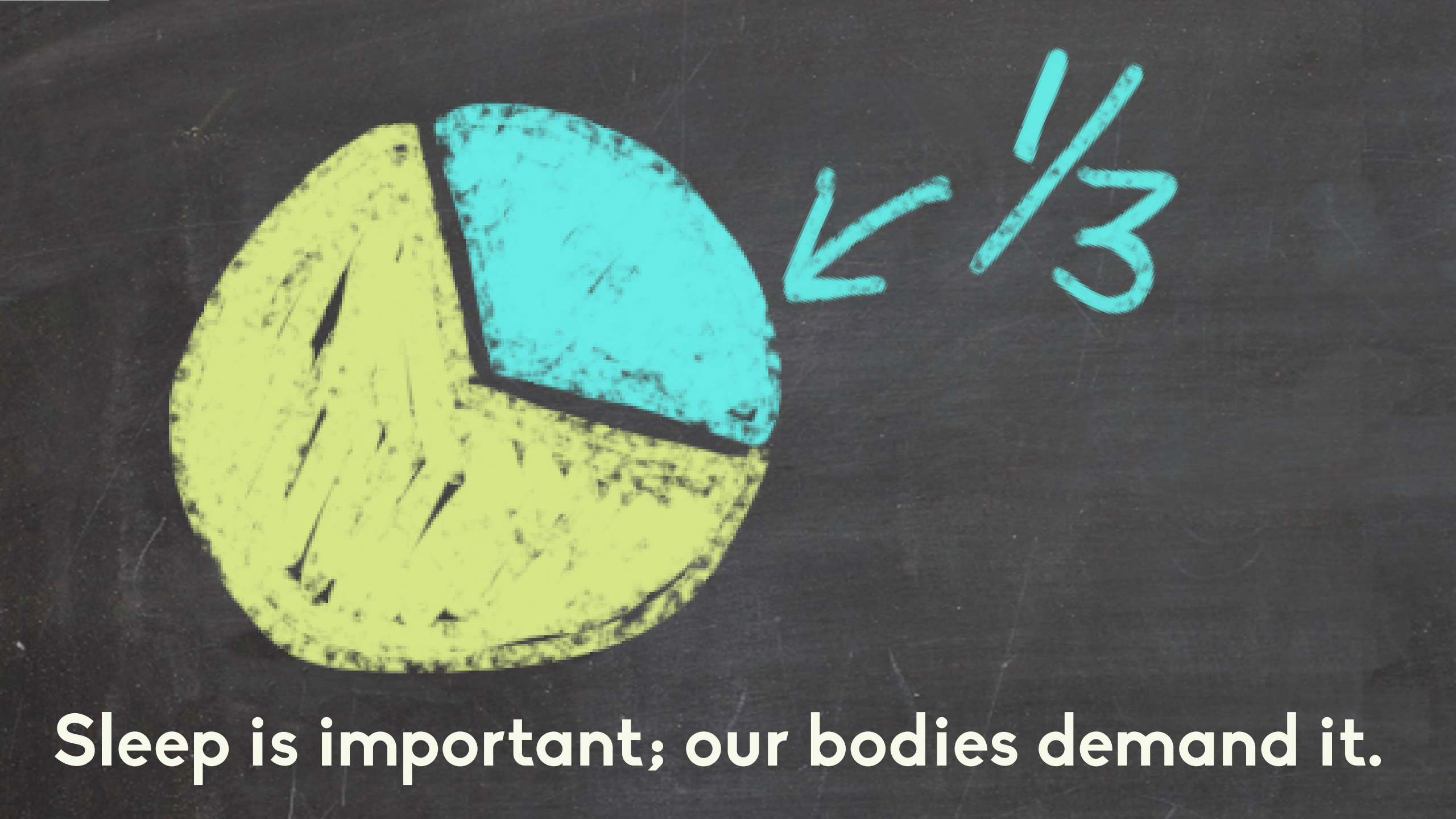


Results: STATS

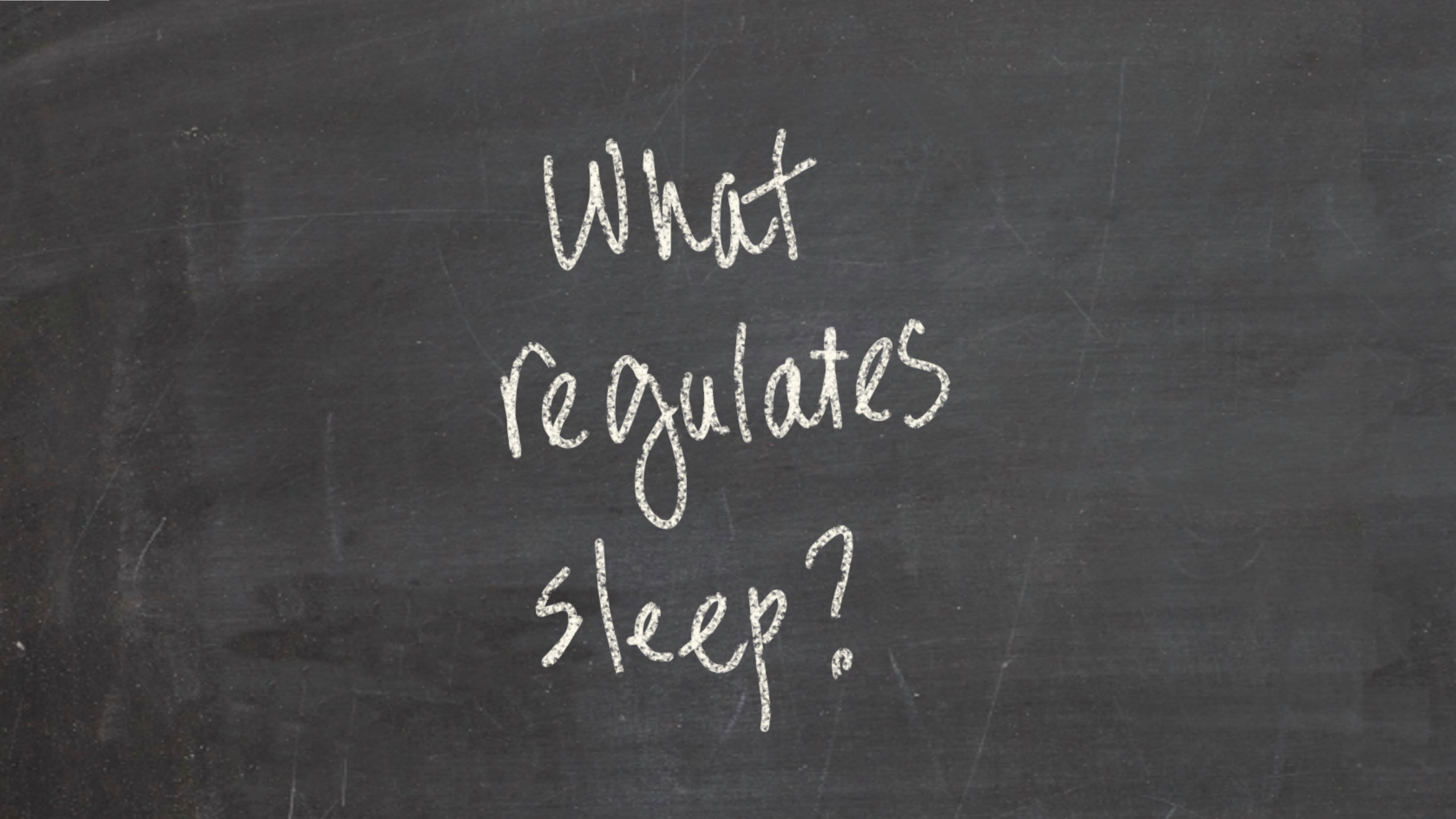
* more accurate shooting
* faster rxn time
* ↑ mental health
* ↑ physical well-being

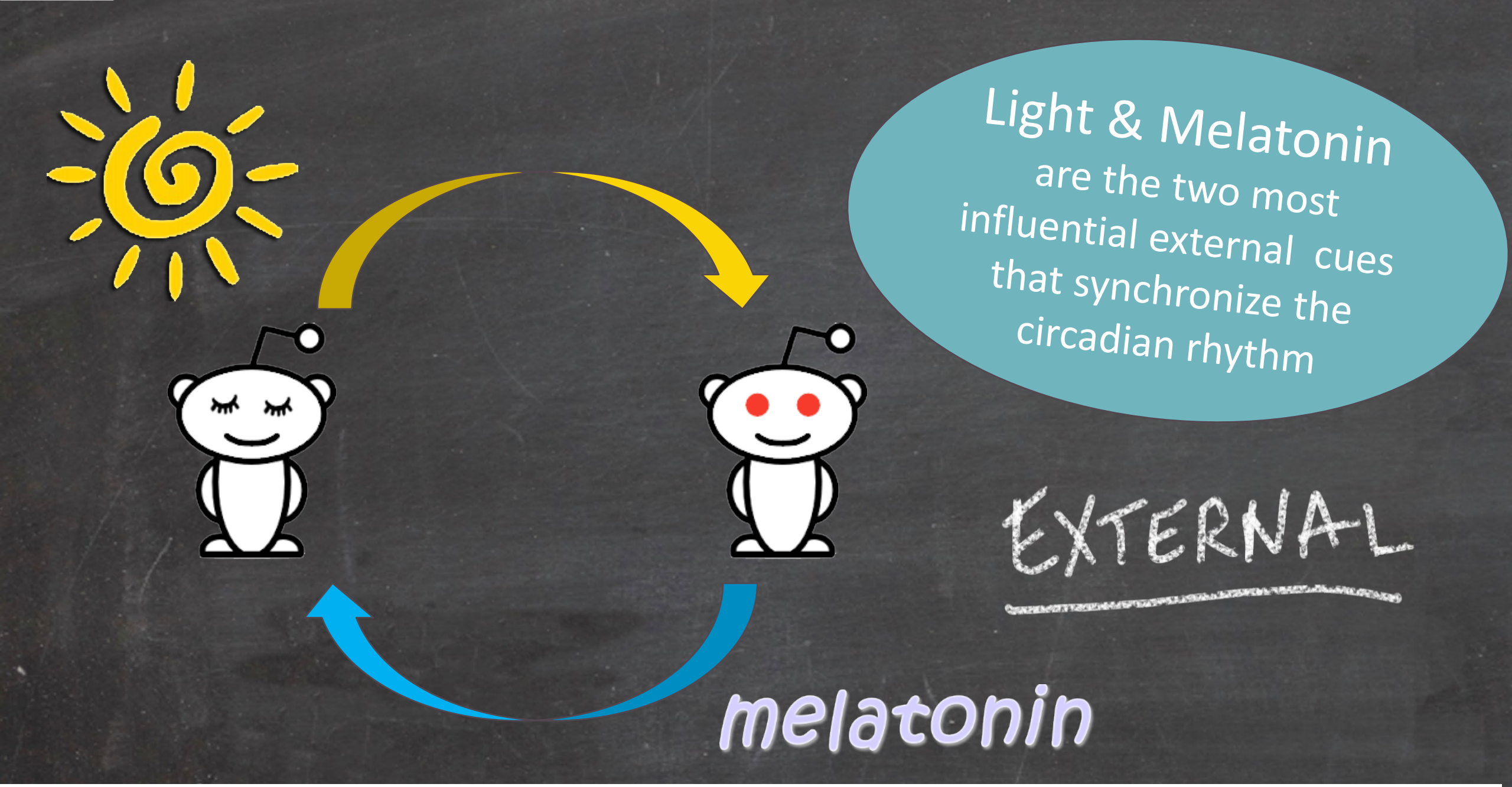
New WAY TO  ABOUT SLEEP

think

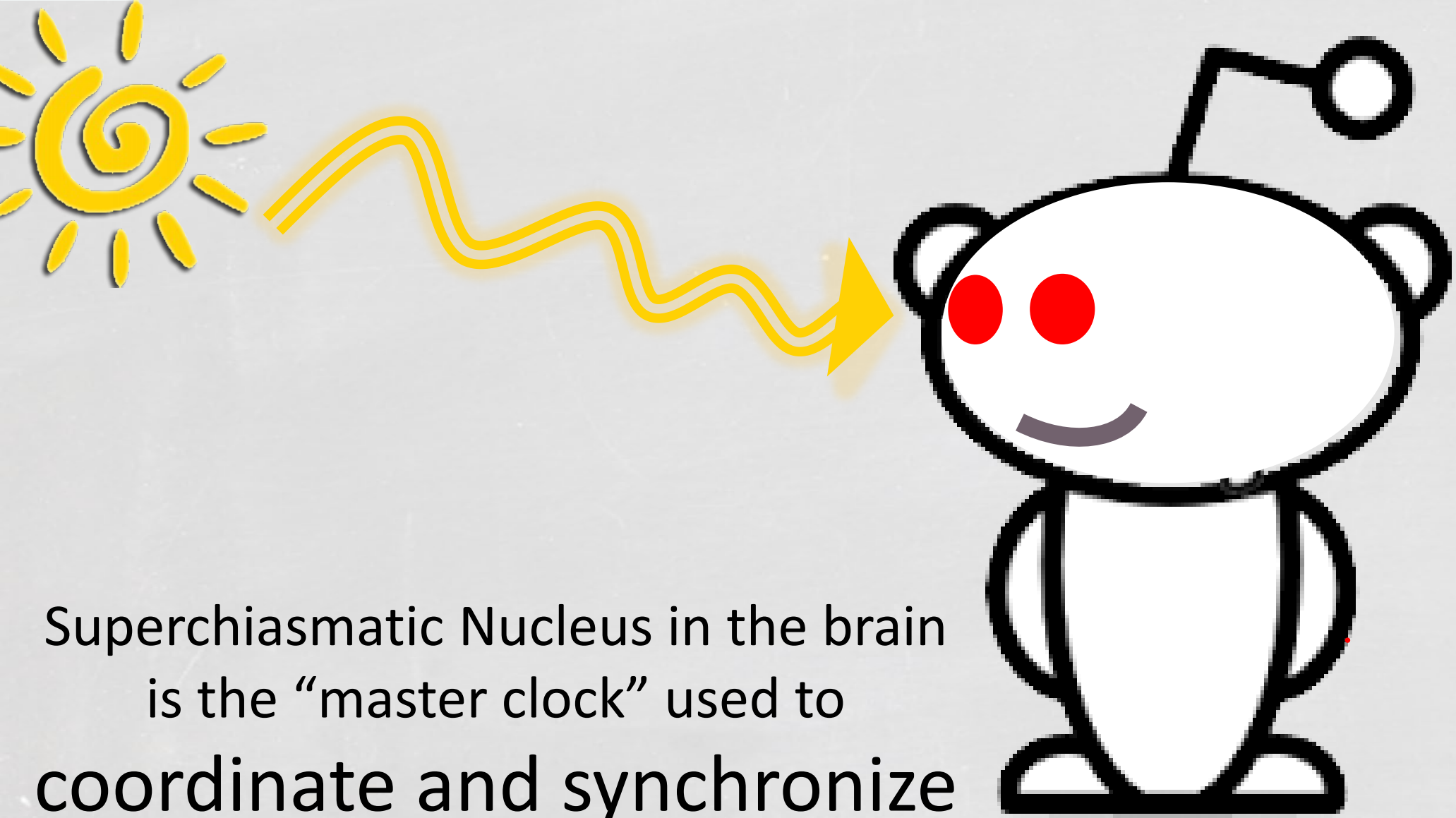


Sleep is important; our bodies demand it.


What
regulates
sleep?



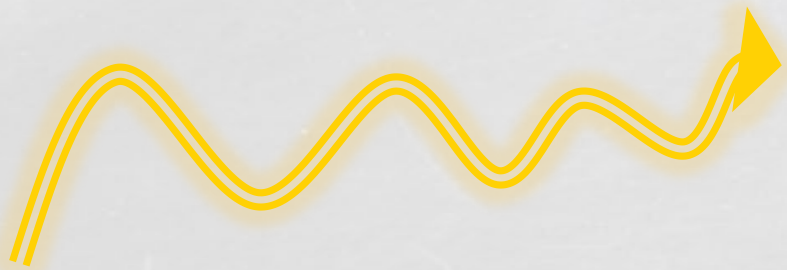
Sleep wake cycle is regulated by the circadian system.



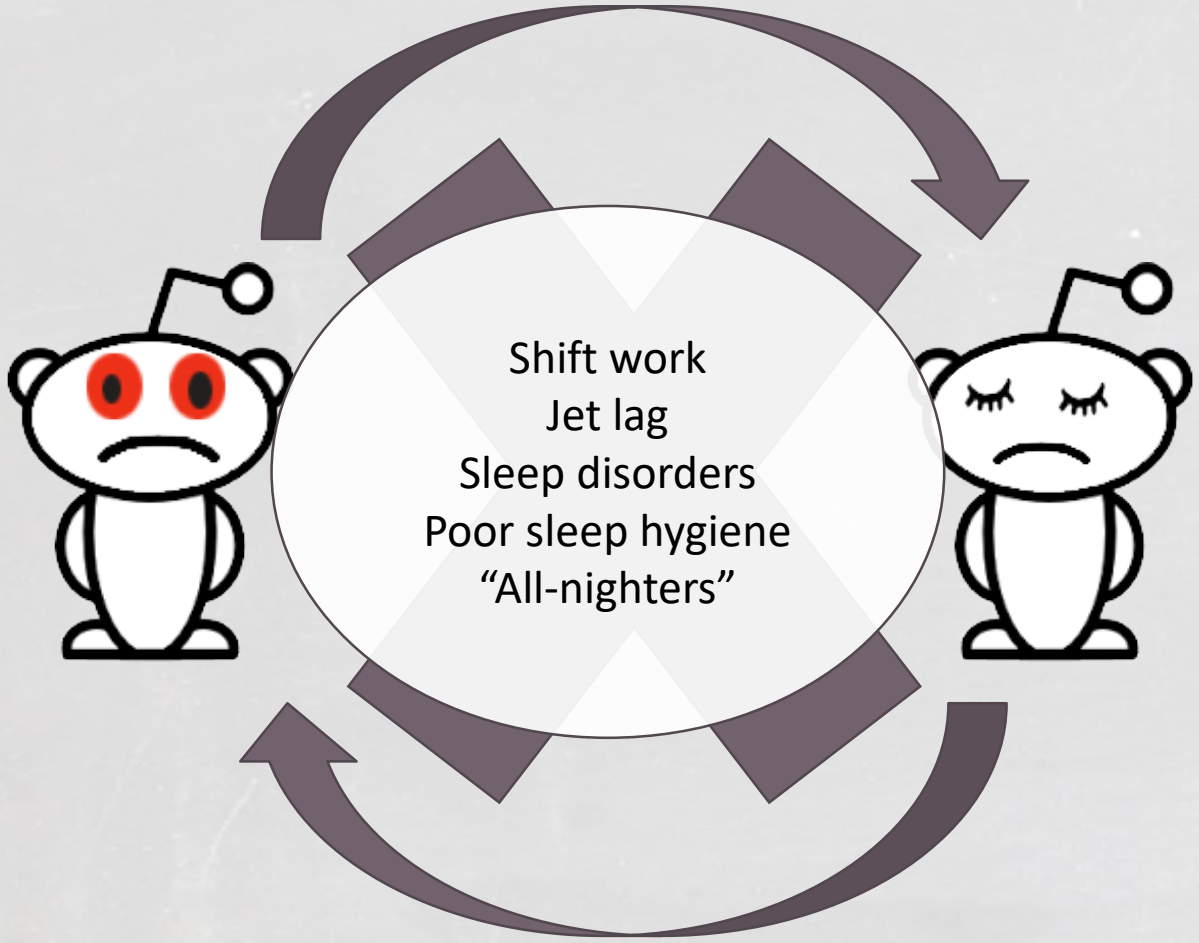
Superchiasmatic Nucleus in the brain is the “master clock” used to

coordinate and synchronize

most of the body clocks in the periphery.



melatonin



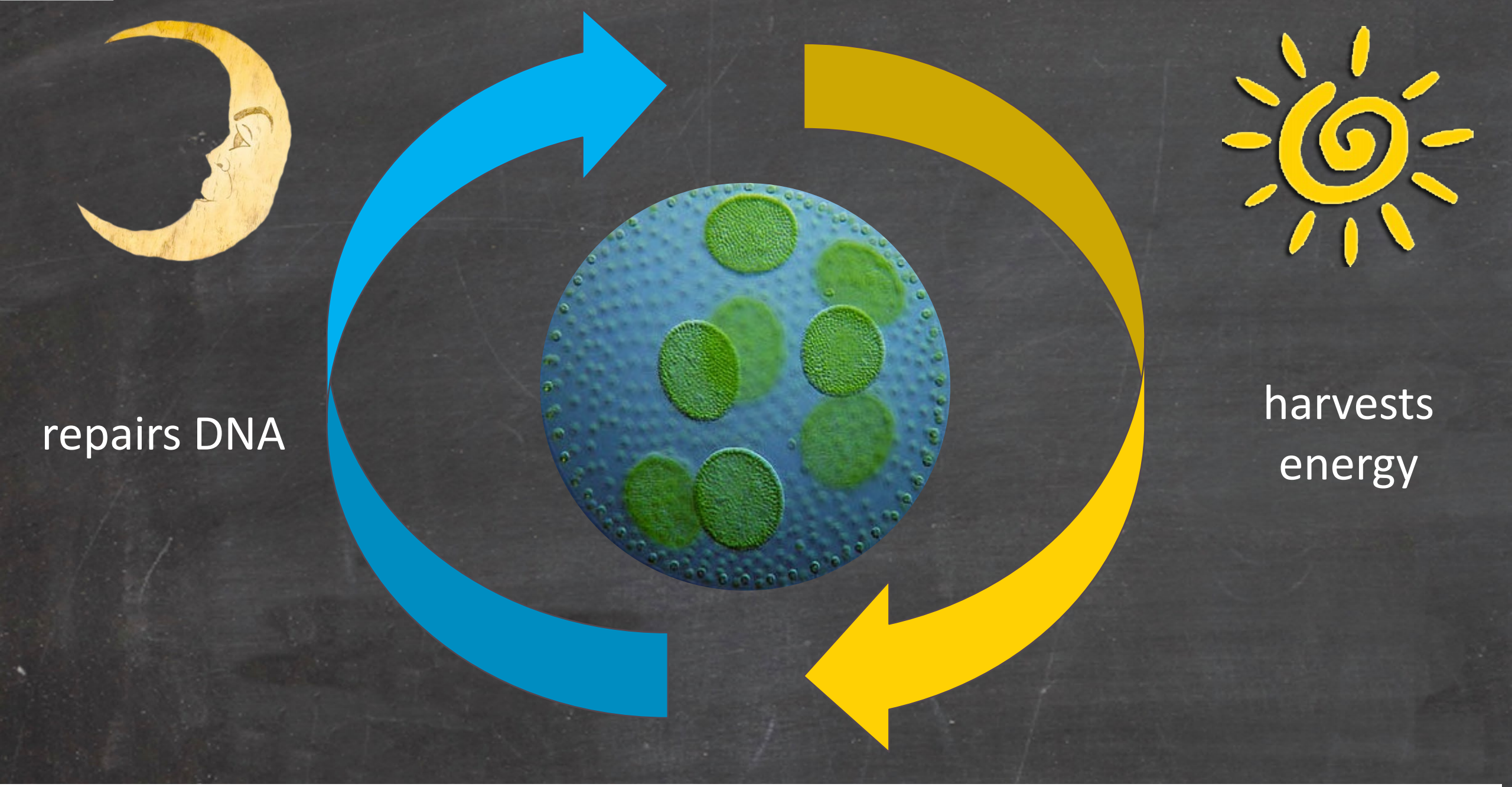
metabolic disruption

weight gain, obesity

impaired immunity

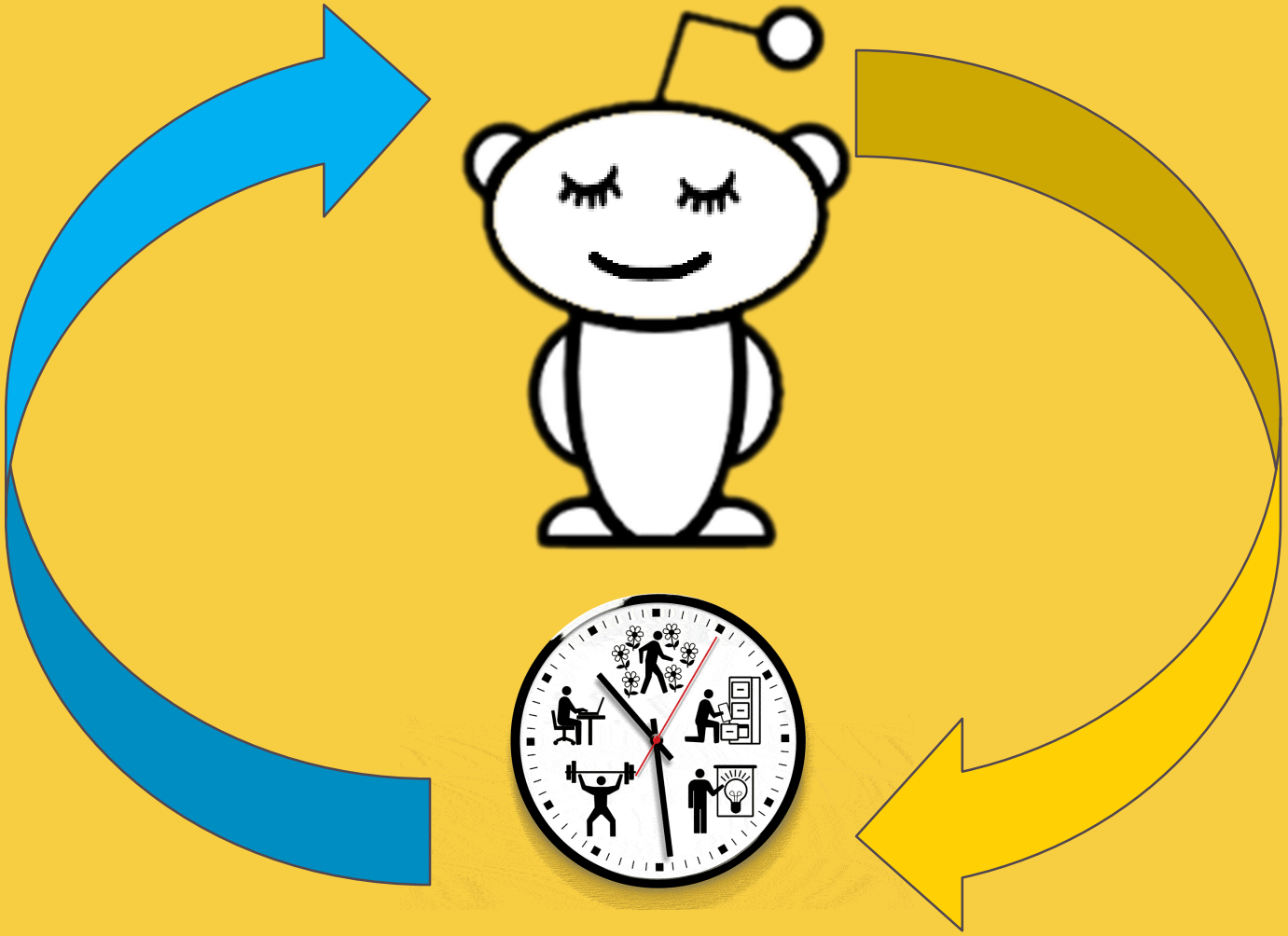
cognitive malfunction

If the sleep wake cycle is disrupted it can cause metabolic dysregulation



Sleep wake cycle is regulated by the circadian system.

- Fasting
- Release of hormones
- Immune system activity
- Resting



Eating

Exercising

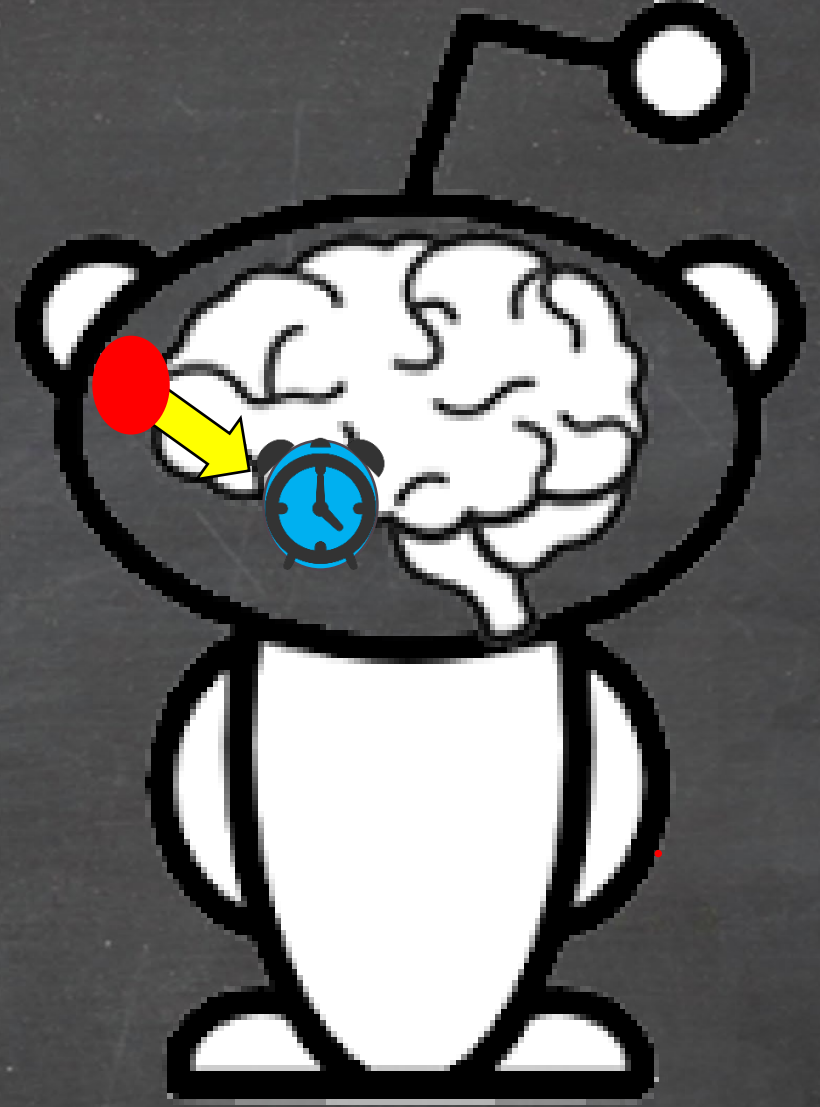
Thinking

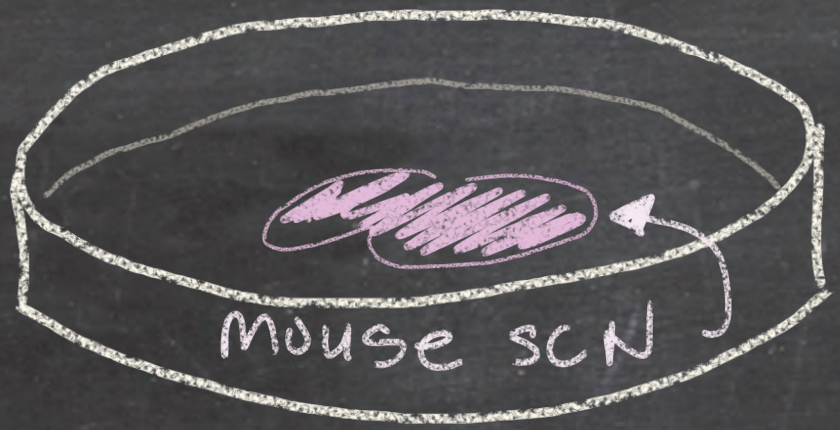
Working

(GIF: DOUG CHAYKA)

Our metabolic clocks are based on the diurnal rhythm – it is in our genes.

Watch brain ticking

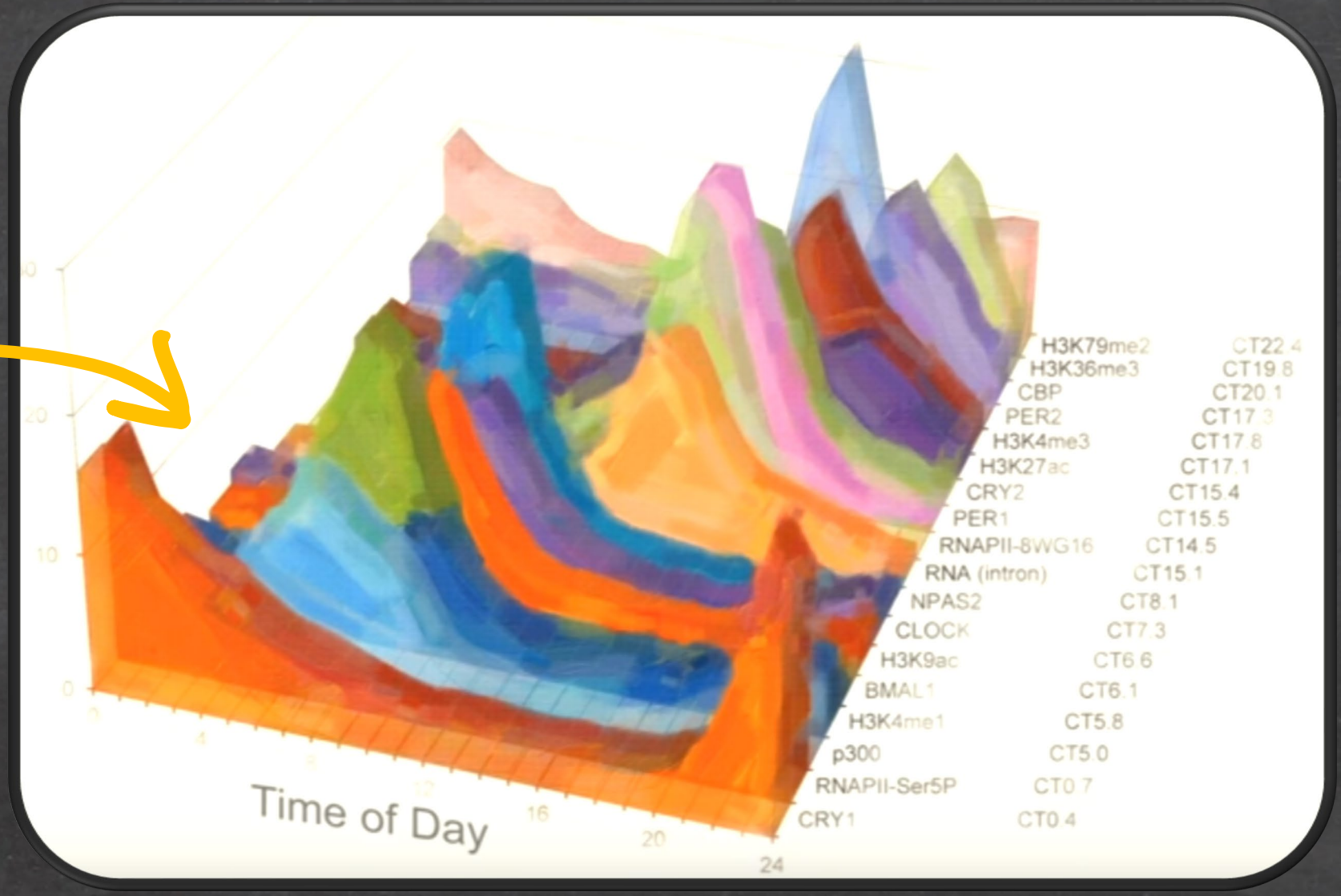




Video: J. Takahashi (2013) https://www.youtube.com/watch?v=ocqn3wYTCRM#

Day in the life of a cell 0-24 hours

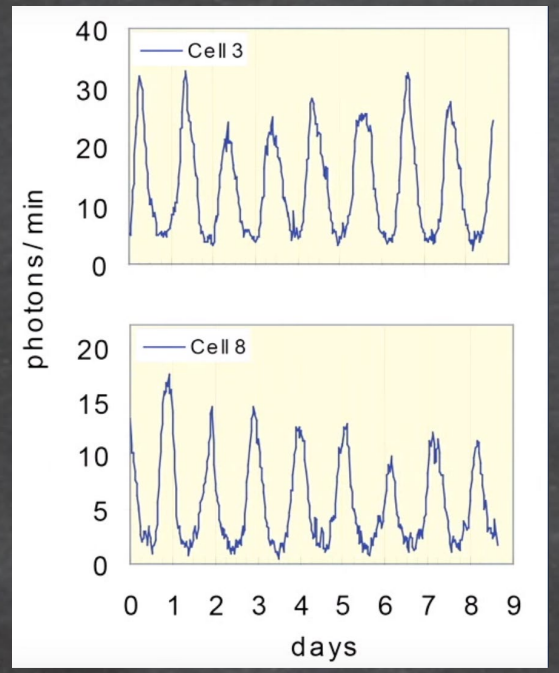
Genes in cells cycle on and off every 24 hours



J. Takahashi (2013)

Every cell has it's own clock!

SKIN CELLS



video recorded for 42 days!

Data from: David Welsh; Video: J. Takahashi (2013) https://www.youtube.com/watch?v=ocqn3wYTCRM#

Effects of insufficient sleep on circadian rhythmicity and expression amplitude of the human blood transcriptome

Carla S. Möller-Levet, Simon N. Archer, Giselda Bucca, Emma E. Laing, Ana Slak, Renata Kabiljo, June C. Y. Lo, Nayantara Santhi, Malcolm von Schantz, Colin P. Smith, and Derk-Jan Dijk

Insufficient sleep and circadian rhythm disruption are associated with negative health outcomes, but the mechanisms involved remain largely unexplored. We show (pp. E1132–E1141) that one wk of insufficient sleep alters gene expression in human blood cells, reduces the amplitude of circadian rhythms in gene expression, and intensifies the effects of subsequent acute total sleep loss on gene expression. The affected genes are involved in chromatin remodeling, regulation of gene expression, and immune and stress responses. The data imply molecular mechanisms mediating the effects of sleep loss on health and highlight the interrelationships between sleep homeostasis, circadian rhythmicity, and metabolism.

One week of insufficient sleep alters gene expression in human blood cells.

Intensifies the effects of **subsequent total sleep loss** on gene expression

Immune and stress response

Shift workers are more prone to developing metabolic disorders

Alcoholic liver disease

40% more likely to have: cardiovascular disease

Higher incidence of Diabetes Type II

Higher risk of cancer – melatonin disruption

Puttonen S, Härmä M, Hublin C.Scand J Work Environ Health. 2010 Mar; 36(2):96-108. Epub 2010 Jan 20.
The Health Survey for England (2013);
Davis S, Mirick DK.Cancer Causes Control. 2006 May; 17(4):539-45.

Circadian rhythm disruptions
Body temperature
Respiratory rate
Hormonal production
Menstrual cycle
Urinary excretion
Cell division

Brain effects
Sleep loss
REM sleep reduction
Stage 2 sleep reduction
Fatigue
Reduced brain volume

Mental Health
Stress
Anxiety
Depression
Neuroticism
Reduced vigilance
'Burnout syndrome'

Gastrointestinal disorders
Dyspepsia
Heartburn
Abdominal pains
Flatulence

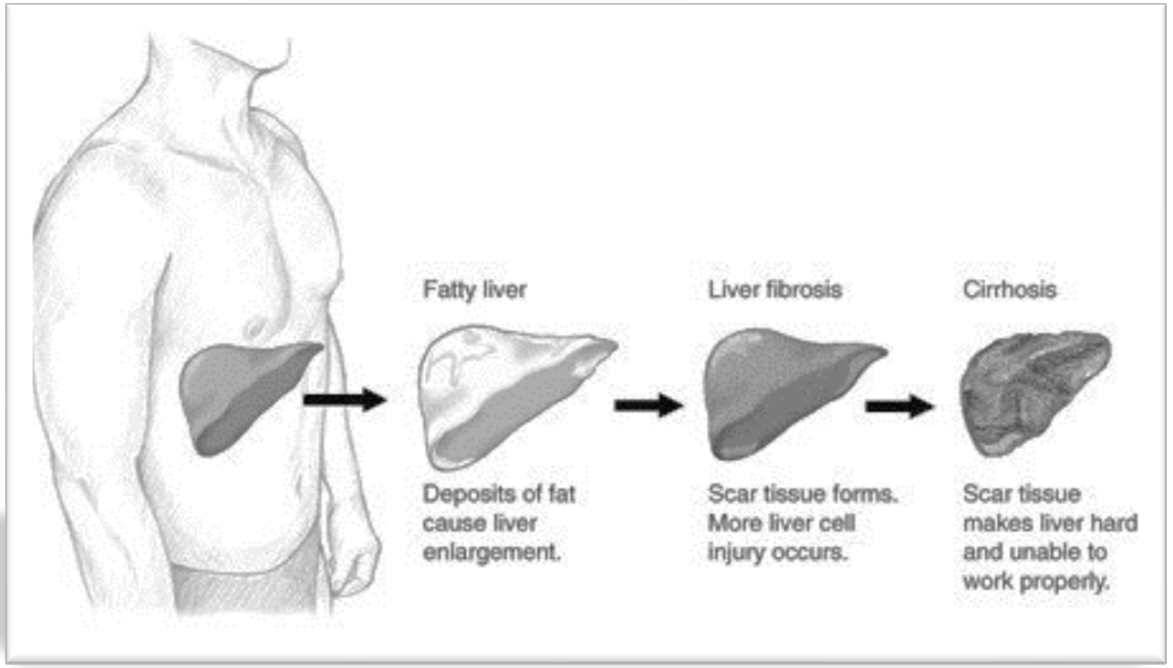
Reproductive effects
Spontaneous abortion
Low birth weight
Prematurity

Cardiovascular disorders
40% increased risk for:
Angina pectoris
Hypertension
Myocardial infarction

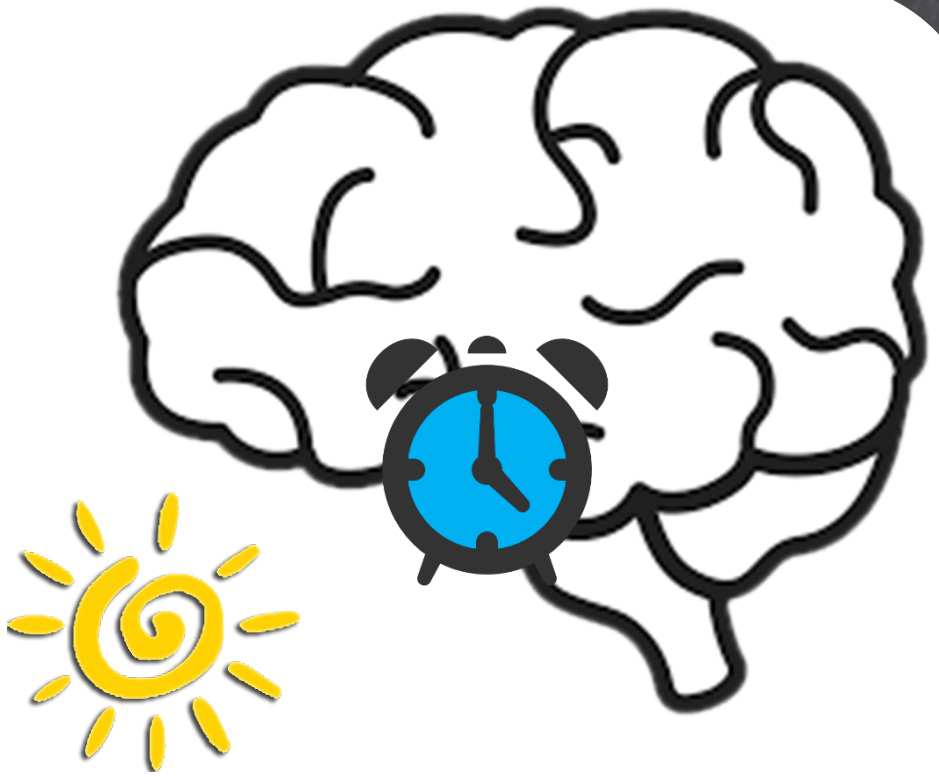
Increased cancer
Breast cancer
Colorectal cancer

Adapted from: Nature Neuroscience Reviews

Disruption of the Circadian Clock in Mice Increases Intestinal Permeability and Promotes Alcohol-Induced Hepatic Pathology and Inflammation



Summa, K. C., et al. (2013) PLoS One 8 (6) e67102



zeitgeber

Food can be a zeitgeber for the gut.

intestinal activity and its ability to absorb nutrients are dependent on the time of day.

SCN is not the only clock in the body

GLUCOSE

FAT

Cellular response to INSULIN is dependent on the circadian cycle.

Johnston, J. (2014) Nutrition Research Reviews, 27, 107–118

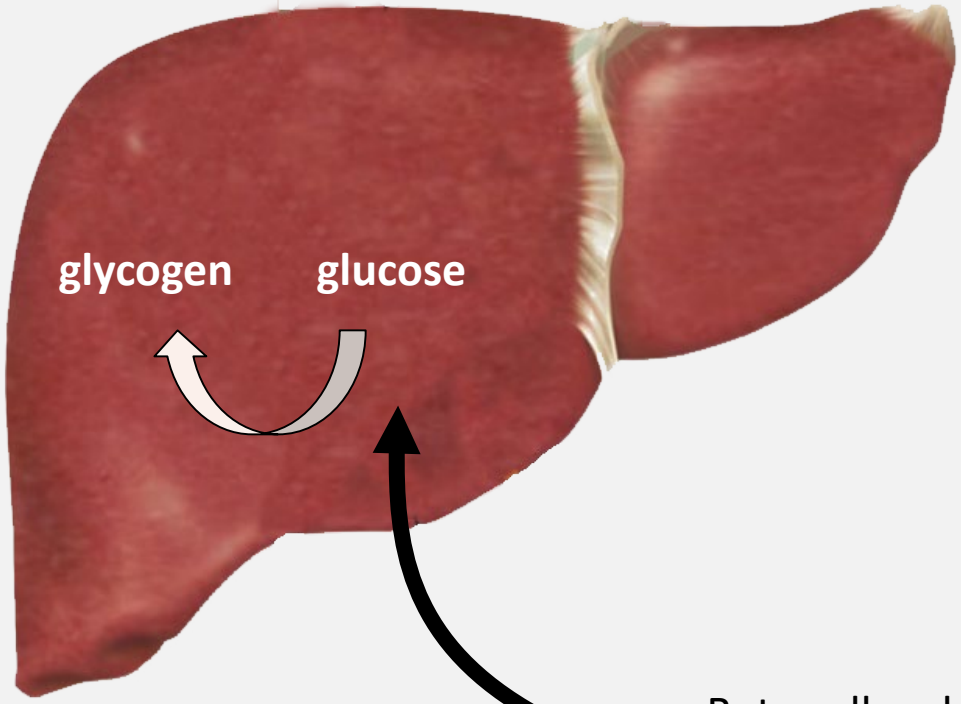
Time of eating has a huge effect on the liver and insulin efficacy

Insulin-sensitivity is dependent on the peripheral clock in muscle cells.

Johnston, J. (2014) Nutrition Research Reviews, 27, 107–118

Glucose uptake in muscle is dependent on the circadian rhythm.

high blood glucose



Beta cells release INSULIN

Insulin stimulates the liver to remove glucose from the blood and stores it as glycogen

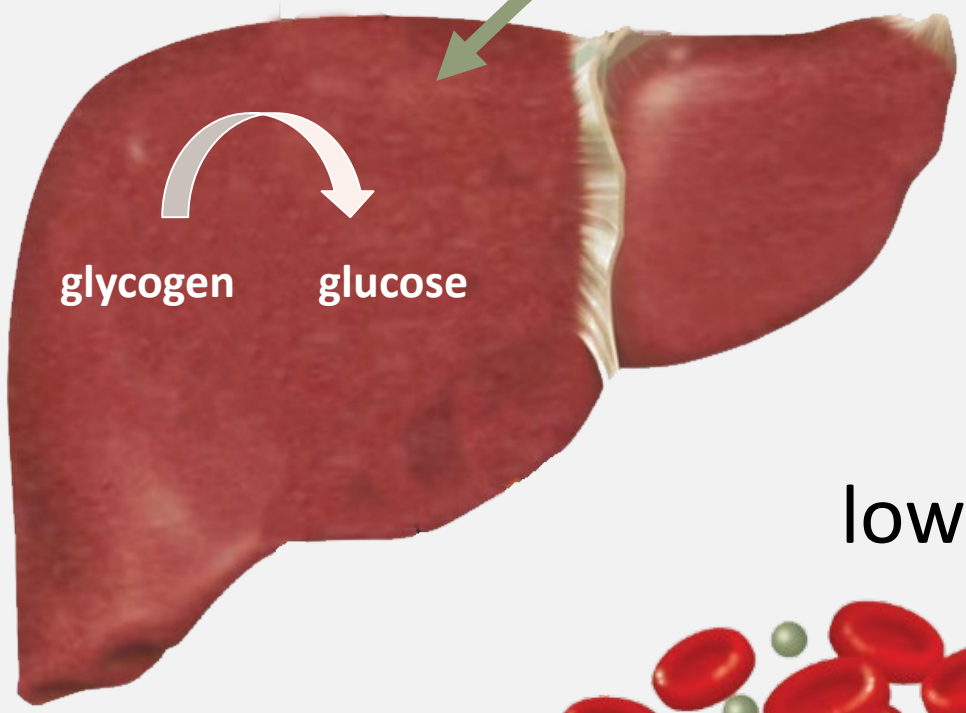
Tissues take up glucose from blood

Lowers glucose levels in blood

Figure adapted from Kaidanovich-Beilin, O. et al 2012

Glucagon stimulates the conversion of stored glycogen in the liver into glucose.

Increases glucose levels in blood



Alpha cells release GLUCAGON

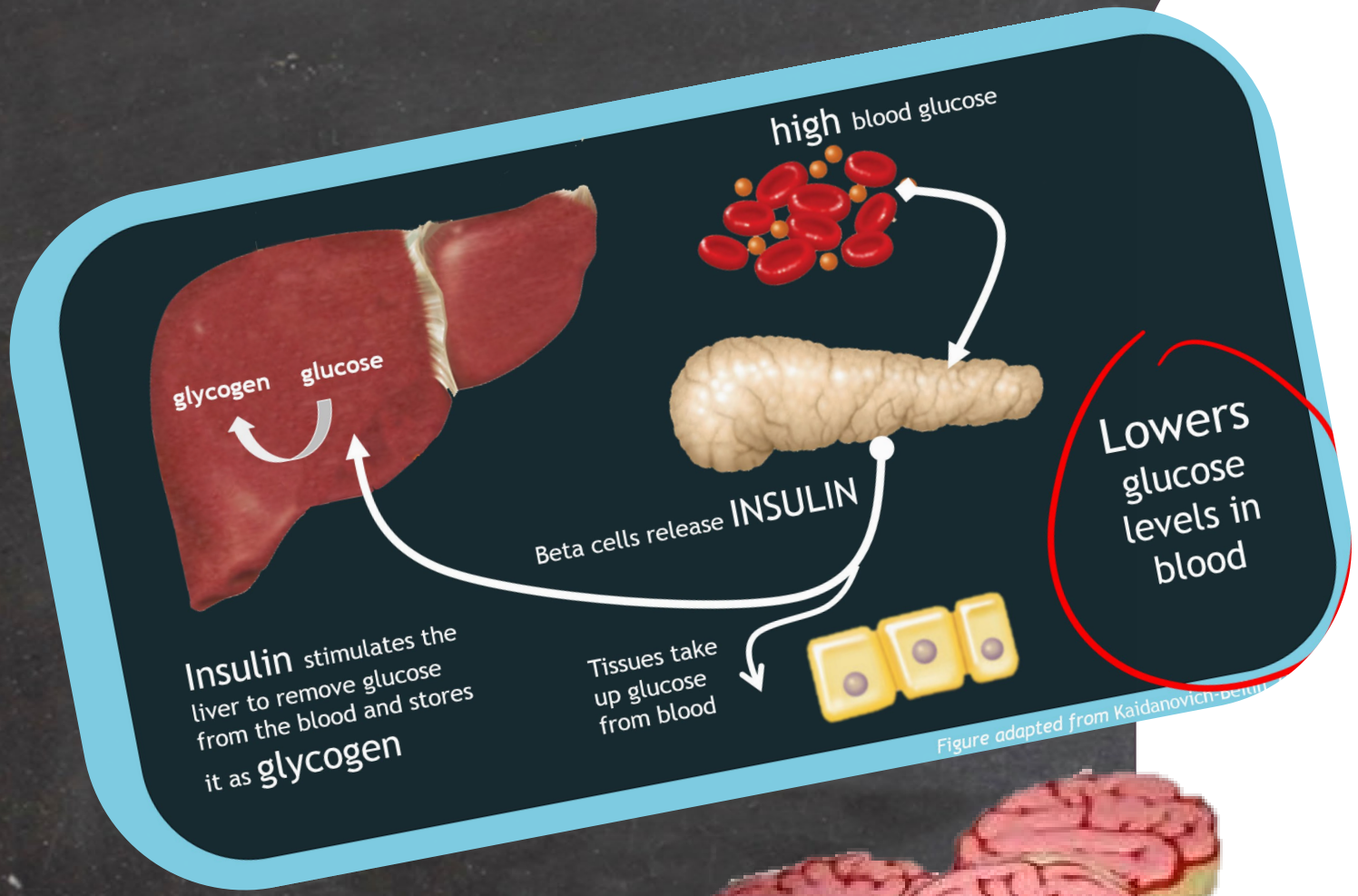
low blood glucose

Figure adapted from Kaidanovich-Beilin, O. et al 2012

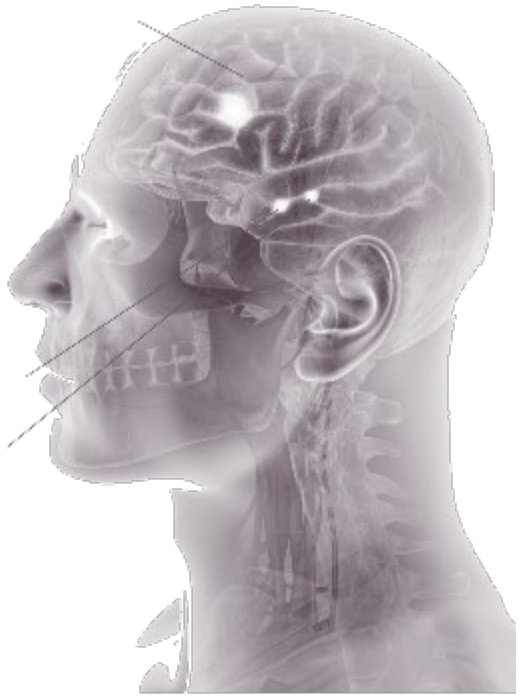
When you eat sugar determines how your body will respond

EATING SUGAR AT NIGHT → HIGHER BLOOD SUGAR

Gif: JOHN KUCZALA



Insulin activates insulin receptors in the brain → affects feeding behaviors, reward, body metabolism, normal emotion & cognitive behaviors.



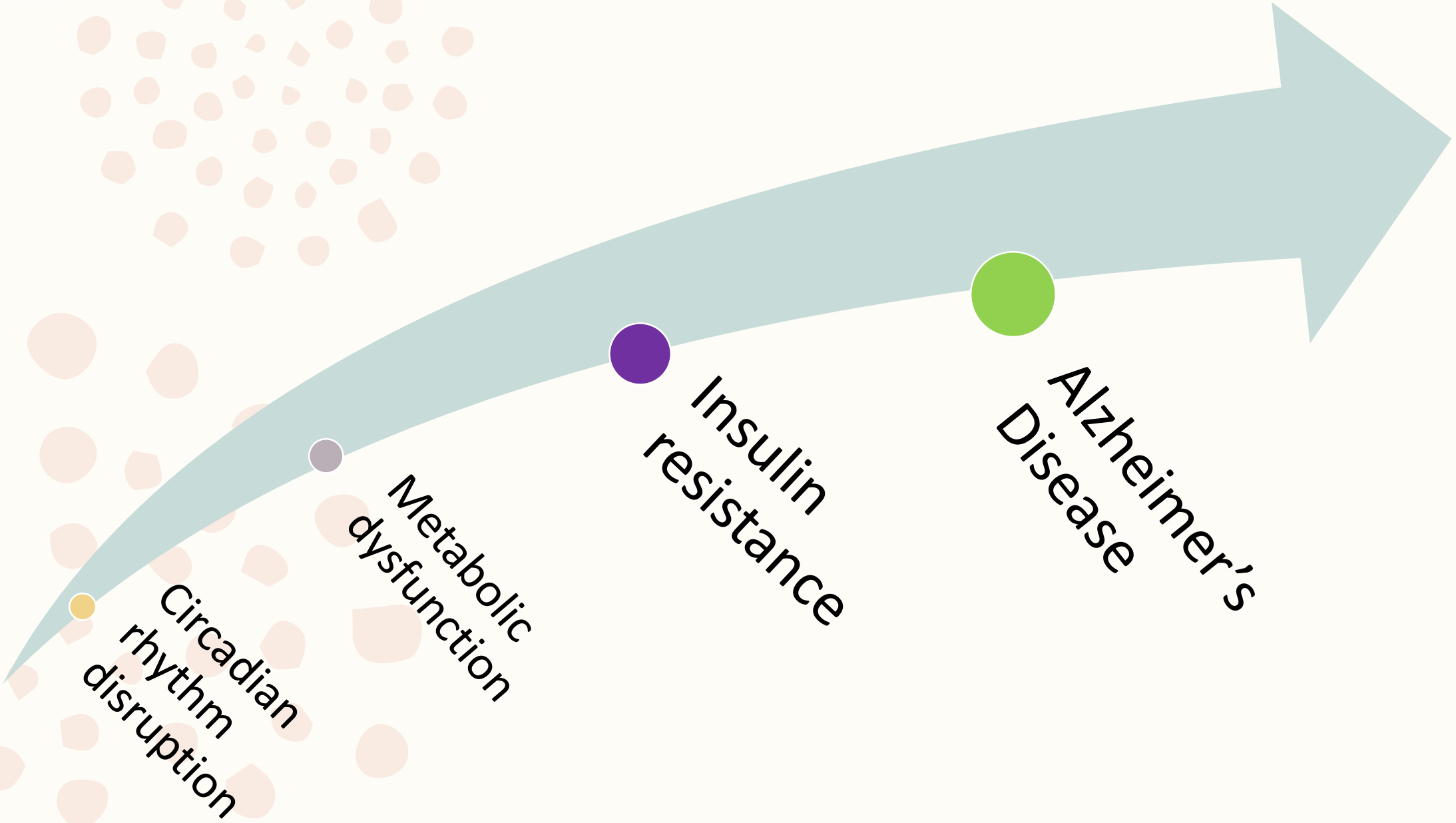
insulin receptors are found throughout the brain – cortex, midbrain and hypothalamus.

The risk of developing Alzheimer's disease is increased by 50 percent in people with diabetes.

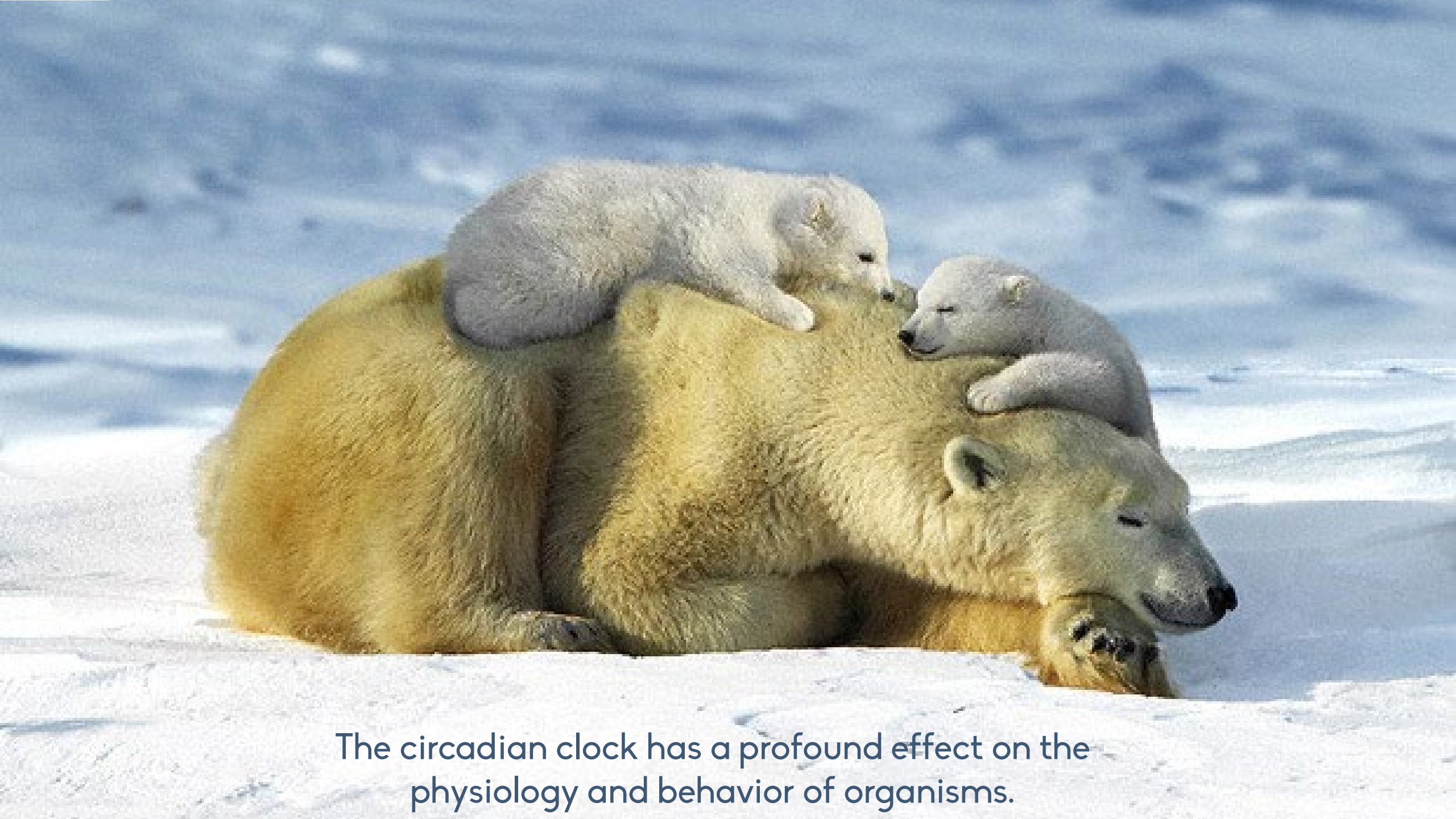
Craft, S. Nat. Rev. Neurol. 8, 360–362 (2012);

Diabetes is a risk factor for dementia

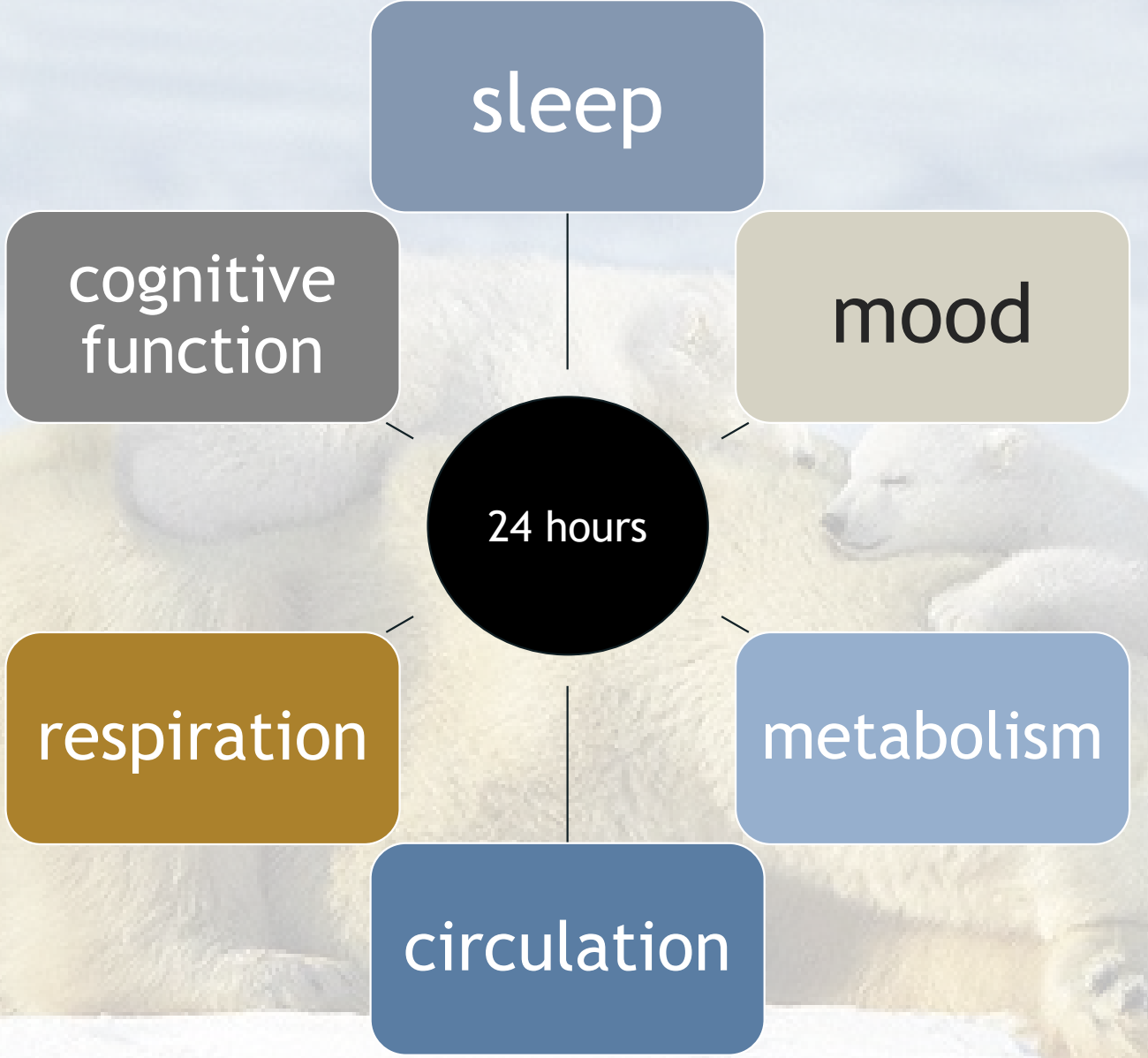
PRIVATE COLLECTION/JAMES GOODMAN GALLERY, NEW YORK/BRIDGEMAN ART LIBRARY



Talbot, K. et al. J. Clin. Invest. 122, 1316–1338 (2012).



The circadian clock has a profound effect on the physiology and behavior of organisms.

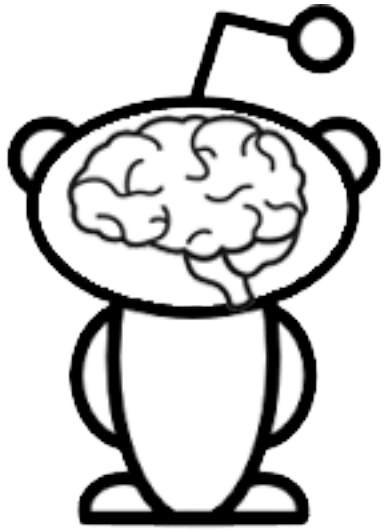


The circadian clock has a profound effect on the physiology and behavior of organisms.

A Single Night of Partial Sleep Deprivation Induces Insulin Resistance in Multiple Metabolic Pathways in Healthy Subjects

Esther Donga, Marieke van Dijk, J. Gert van Dijk, Nienke R. Biermasz, Gert-Jan Lammers, Klaas W. van Kralingen, Eleonara P. M. Corssmit, and Johannes A. Romijn

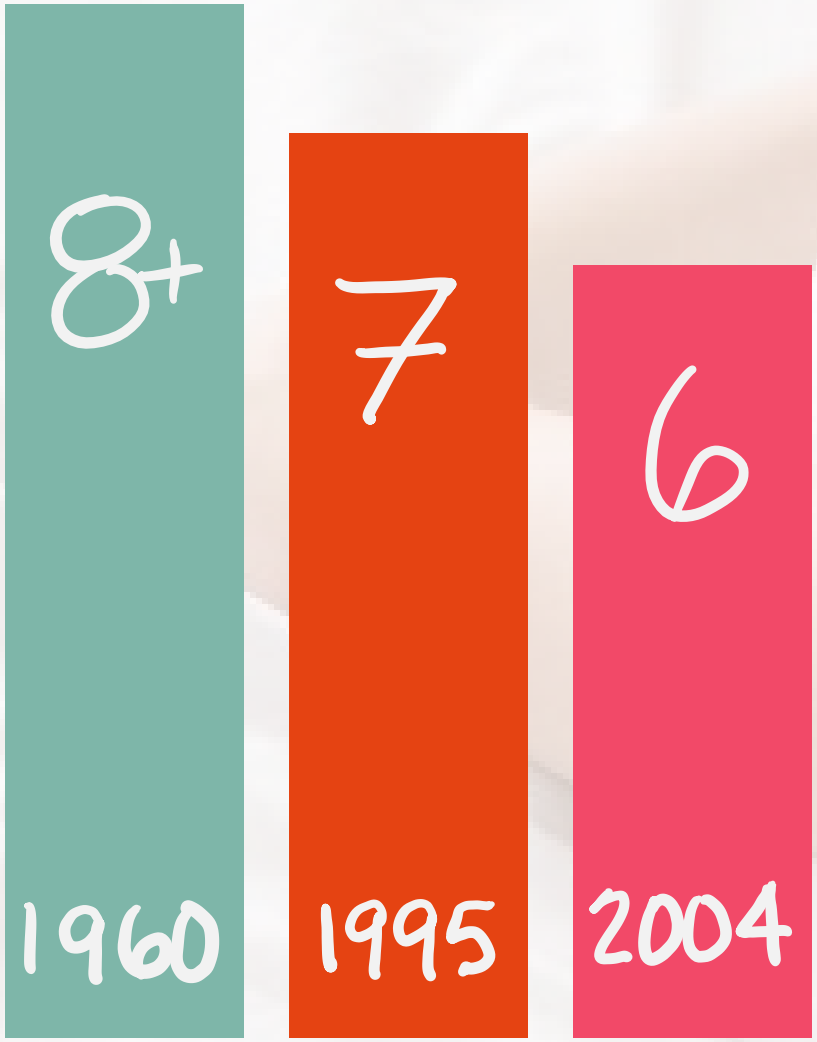
Departments of Endocrinology and Metabolic Diseases (E.D., M.v.D., N.R.B., E.P.M.C., J.A.R.), Neurology (J.G.v.D., G.-J.L.), and Pulmonology (K.W.v.K.), Leiden University Medical Center, 2300 RC Leiden, The Netherlands



the effect of a single night of partial sleep on insulin sensitivity

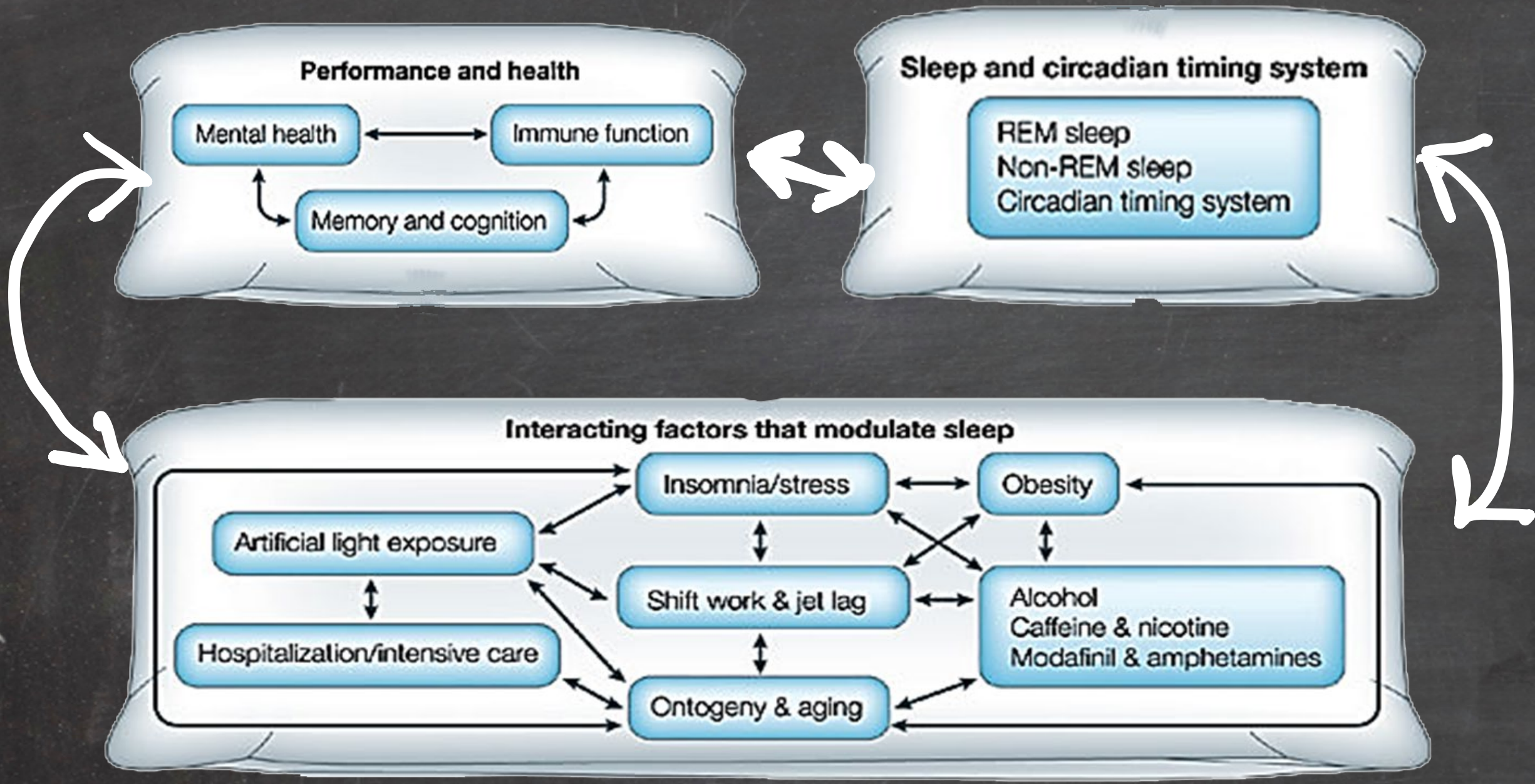
Donga, E., et al. (2010) J Clin Endocrinol Metab 95: 2963-2968

Average Number of Hours of Sleep per Night



Are you getting enough sleep?

Kripke, D et al (1979) Arch Gen Psychiatry;
Gallup Organization (1995), Sleep in America;
National Center for Health Statistics (1984 & 2004) Morb Mortal Wkly Rep 2005



Adapted from: Nature Neuroscience Reviews

Imagine the benefits that would await you if you got one more hour of sleep?