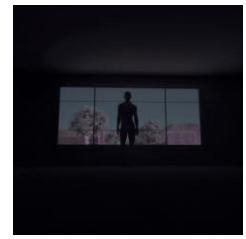
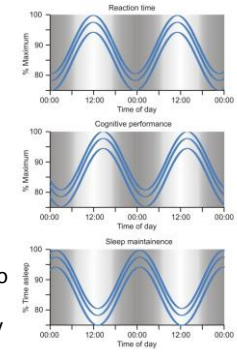
We are the cave men

or

the consequences of blurring the difference between day and night

Daily variations in physiology and behaviour are an integral part of life





The circadian clock is omnipresent. Organisms don't even need a brain to anticipate the earth daily rhythms. Humans, fruit-flies, plants, and many bacteria have circadian rhythms.

Animations by Zolloc for Endpoints.

Circadian Rhythms Everywhere!

actually more rare for a biological factor to *not* change throughout the 24 hour day

- Body temperature
- Hormones
- Proteins
- Genes
- **Behavior, Cognition, Mood**

all cycle throughout the day

Implications of circadian biology are transdisciplinary and unifying

Takahashi, 2017

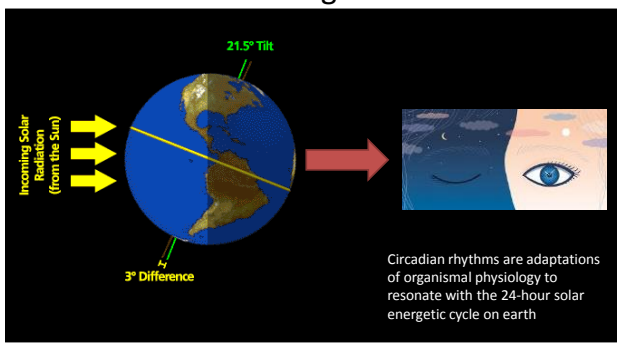
Our lives are controlled by three clocks

Internal clock

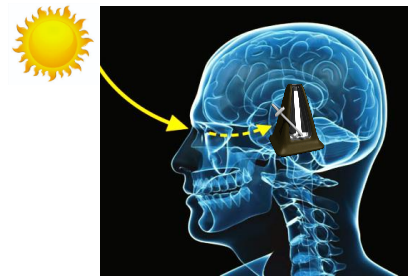
Astronomic clock

Social clock

The link between the astronomic clock to the biological clock



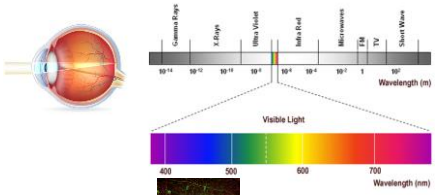
The internal clock is sensitive to light



Few thousand blue light sensing neurons in each eye tune our brain clock to light

Artificial vs Natural Light

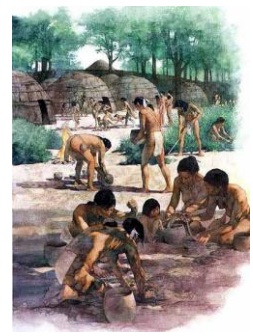
Light is the main environmental factor influencing the circadian system

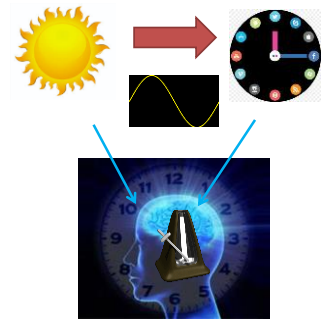


melanopsin is a blue light sensing protein

Roenneberg et al. 2007
LeGates, 2014

Evolutionally, the social clock was driven by the astronomical clock





Pre-Industrial Society

Biological Astronomical Social

Circadian alignment = Circadian consonance

Not any more

Now, the social clock is driven by technology

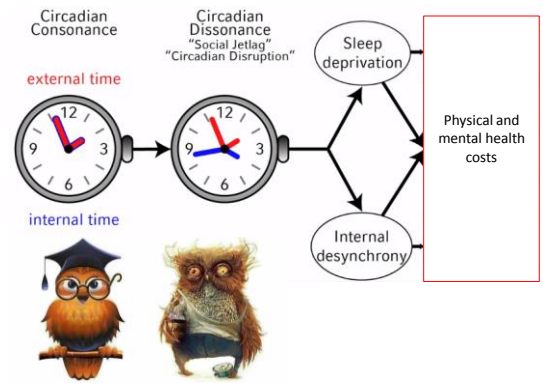
The border between day and night is blurred

Industrialized Society

Biological Technological 24/7 Social

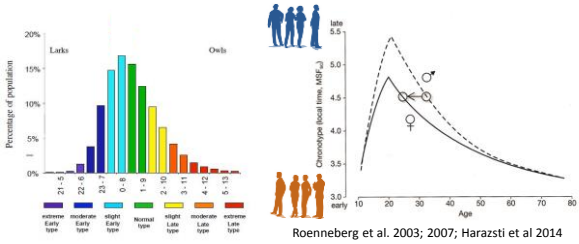
Circadian Dissonance = Misalignment = Social Jetlag

The consequences of living against the clock



Biology: 'Morningness' vs. 'eveningness'

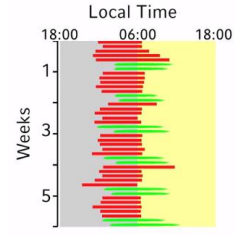
- There is considerable inter-individual variability in the circadian phase, as well as variation in the peak periods of key behavioral, neuro-hormonal and body temperature elements.
- This variability, largely under genetic control, can be measured by self-report along a dimension of chronotype: 'morning' vs. 'evening' in the preferred timing for regular sleep schedules and other daily activities.



Roenneberg et al. 2003; 2007; Harazsti et al 2014

Chronotype and social jetlag

- In late chronotypes, sleep occurs in later hours, particularly on free days
- During workdays, the rising time in most people is constrained by social duties (work, school, etc.).
- This results in **shortened sleep** duration in late individuals during workdays; they try to recover during free days by prolonging sleep and **social jetlag**

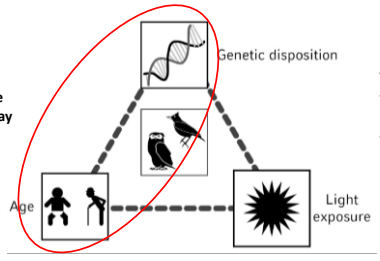


- Note this person's wake-up times on work days. They show absolutely no biological scatter and are so regular that one has to assume an alarm clock.
- The most apparent quality of this sleep log is, however, the enormous displacement of sleep timing between work- and free days. It is as if this person flew many times zones to the west each Friday evening and flew back on Monday morning.
- Since this virtual travelling is similar to a jetlag situation without the people ever leaving their location, Roenneberg and colleagues called this phenomenon "social jetlag".

Roenneberg, 2013, 2015
Zavada 2005; Korczak 2008

Linking chronotype and light entrainment

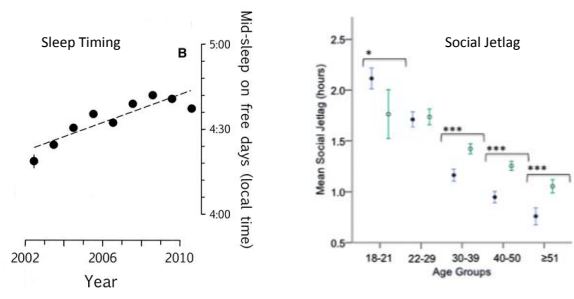
How entrainment by light is related to for different chronotypes? It is responsible for it!!



Define the internal day length

The challenge is to adjust the non-24 clock to the 24h cycle

We are an increasingly evening-oriented society



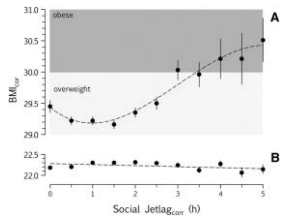
Social jetlag varies with age and sex, women (open circles) have on an average more social jetlag than men during adulthood.
Late chronotype is related to higher magnitude of the social jetlag.

Allebrandt 2014
Roenneberg, 2013,

Living against the clock

Evening-oriented people

- drink more alcohol
- smoke more tobacco
- keep more often irregular or unhealthy diets less often engaged in physical activity
- sleep less or have poorer sleep quality than others



Partonen, 2015

Health-related hazards related to Evening Type

Physiology	Condition
Brain	Alcohol misuse
	Smoking
	Irregular or unhealthy diet
	Low physical activity
	Irregular or deprived sleep
	Sleeping difficulties
	Overweight
	Sleep disturbances
	Depressive symptoms
	Depression, hypomania, or mania
	Anxiety
Heart and blood vessels	
Lungs and respiratory tract	Wheezy breathing
	Allergic respiratory symptoms
Endocrine organs	Reduced insulin sensitivity, reduced glucose tolerance, poorer glycemic control
	Difficulties in getting pregnant

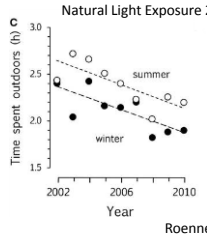
Alarmingly, the relative risk of all-cause mortality is on average 1.3-fold higher for "night owls" as compared with "early birds," these premature deaths starting to emerge after the age of 55 years (Broms, 2014)

Partonen, 2015

What is normal and why?

On the behavioral level there are two sorts of living against the clock:
1. One is associated with demands of the social external clock that force us to live against our biological internal clock.
2. The other concerns people who are already ill or suffer from a pathology that appears to be associated with circadian qualities that differ from those of most healthy people.

Natural Light Exposure 2002-2010



Roenneberg, 2013,

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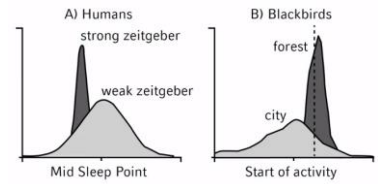
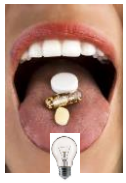
Colorado camping experiment:
students who lived a normal urban life were taken camping far away from towns or settlements.

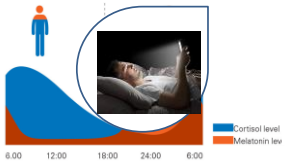


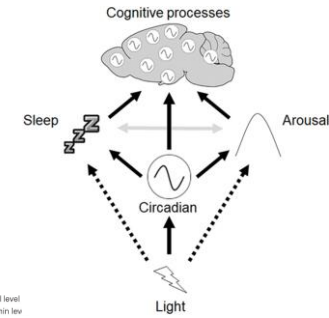
Wright, 2013; Dominioni 2013



Light is a potent drug: can help and can harm

Depending on:
Type of light
Intensity of light
Timing of light





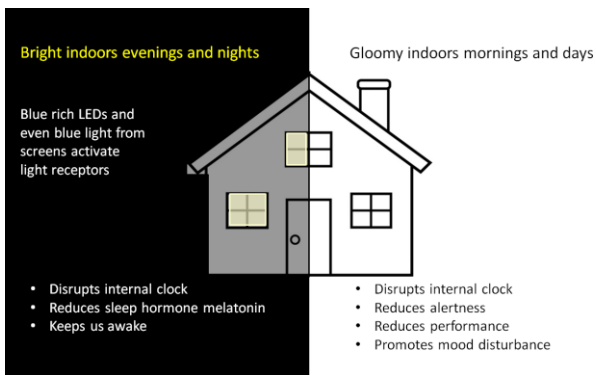
Fisk et al, 2018

Light at home and at work

- Natural light is the single most important attribute in a home, with over 60% of respondents ranking it as important
- WHO's report that residents with inadequate natural light in their homes have greater risk for depression and falls
- The access to the naturally lit environment through daylight and operable windows bring to individual (up to an 18% increase) and organizational productivity (such as increased retail sales)

Loftness et al, 2003, Brown & Jacobs 2011

Light-for-vision is not Light-for-health



A quick list of the ways chronobiology affects us

- Development
- Social Jet
- [illegible]
- [illegible]alth – Depression, Stress, [illegible]xiety
- Physical health - Cancer, Heart diseases, ADHD, Autism, Diabetes, Alzheimers …

We need to get out from the caves… or use technology to simulate it

New Enlightenment Era

Four D's of healthy lighting around the clock

Daylight - morning and noon

Dim light – afternoon and evening

Digital diet - evening

Darkness - night

Getting Your Circadian Rhythm Back on Track

First, do no harm

Blue Light at Night affects your brain, body, sleep, mood, hormones & health

Getting **Your** Circadian Rhythm Back on Track

Before you do anything, you need to determine whether you're a morning person or a night person

Technology:
- dim light melatonin onset test (saliva)
- questionnaires

Next, determine how much sleep you need on average per night.

Technology:
- a sleep tracker app on your phone
- smart watch
- bio behavioral tests for attention, response inhibition, memory

Proper sleep cycle habits that feel natural and are long lasting, require small changes over a long period of time

Getting **Your** Circadian Rhythm Back on Track

- Manipulate Lighting

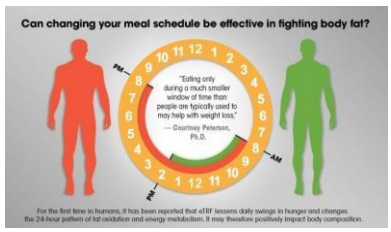
Blue Light Blocking Computer Glasses

green-blue light therapy

white light without the harmful blue light

Getting **Your** Circadian Rhythm Back on Track

- Manipulate Lighting
- Fast 12h a day, normalize Meal Times



Getting **Your** Circadian Rhythm Back on Track

- Manipulate Lighting
- Fast,
- Go Nature

- **Sunlight is a resource!!!**
- **Dynamic properties of daylight may be simulated**

Example: Chrono lighting in hospitals

https://chromaviso.com/en/

Pharmacological solutions currently are limited or untested, but the non-pharmacological components solutions are simple and logical interventions of relatively low cost, including lighting, meals and physical activity regiments.