

HUMAN RESPONSES TO LIGHT

**TO DO OR NOT TO DO?**

**THAT IS THE QUESTION**

What is Human Centric Lighting?

## WHAT IS HUMAN CENTRIC LIGHTING?

- Brings the **human** in to focus
- Adaptation of the lighting to individual needs
  - Age
  - Time of day
  - application

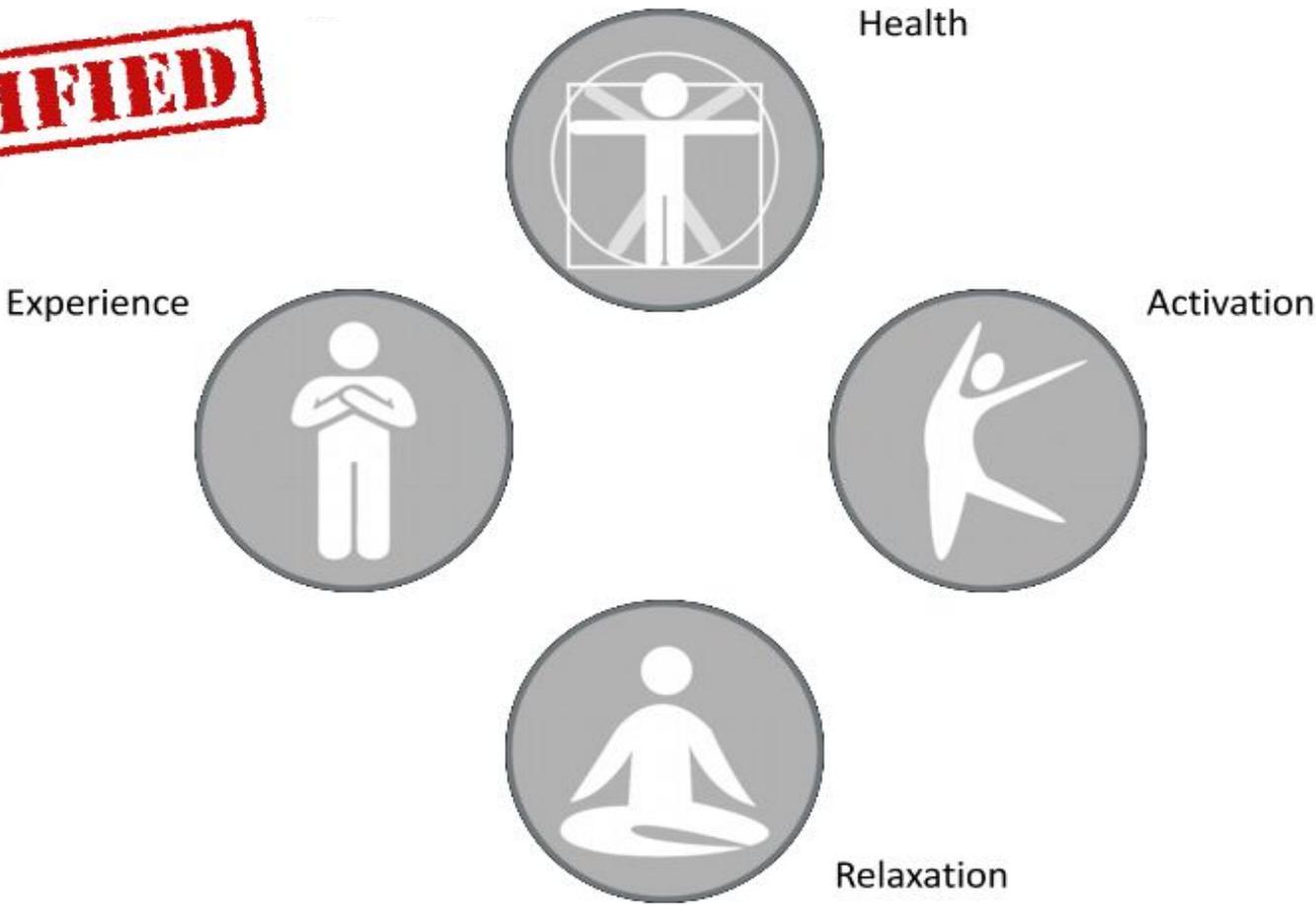


# Human Centric Lighting



# HUMAN CENTRIC LIGHTING

**SIMPLIFIED**



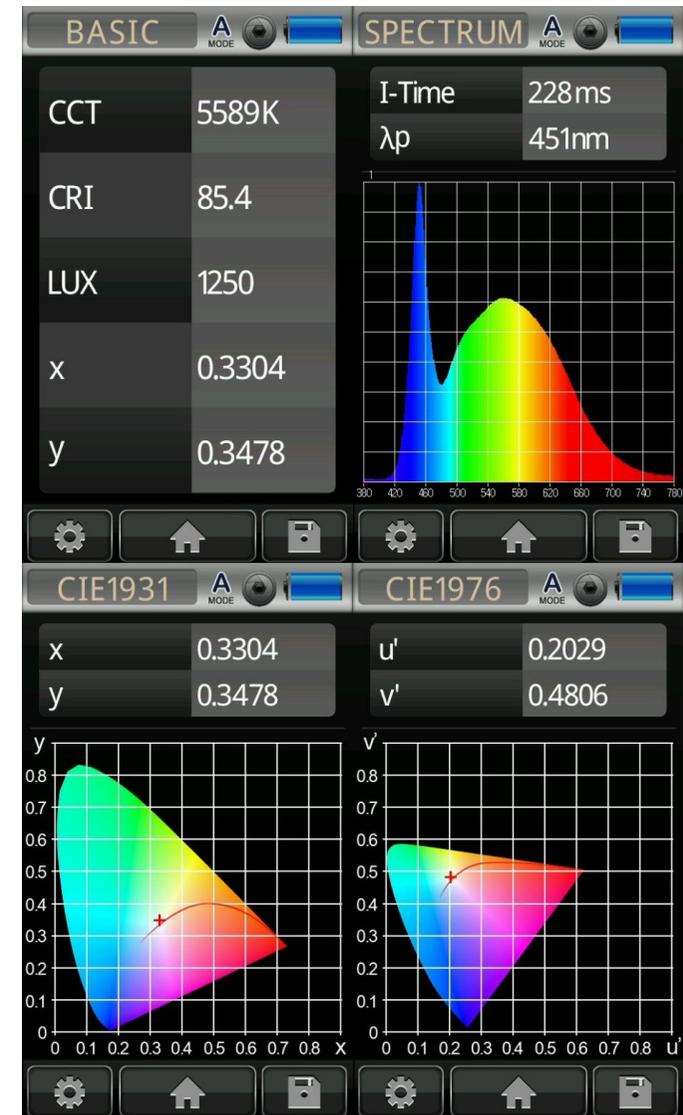
# DYNAMIC LIGHT

Natural light changes in intensity, colour temperature and direction...



# A DAY IN YOUR LIFE

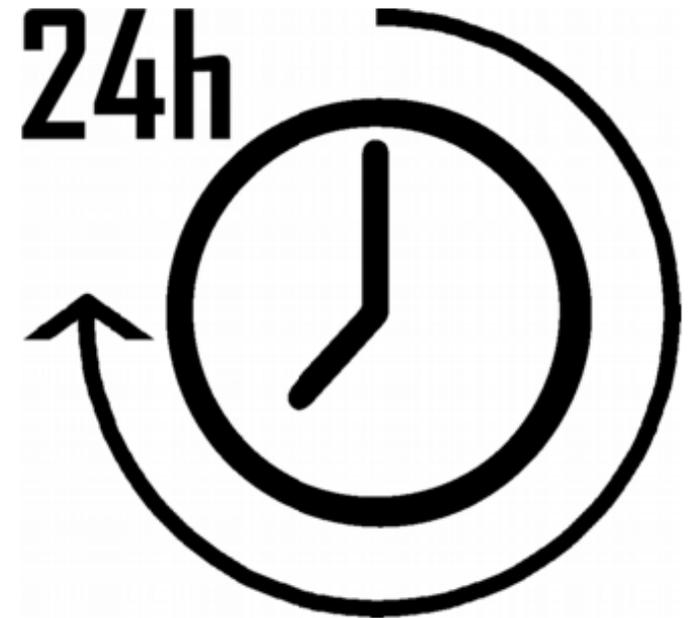
- See how much light you receive today
- Go outside at lunchtime
- Maybe try a bit of physical exercise
- Make a note if you feel sleepy



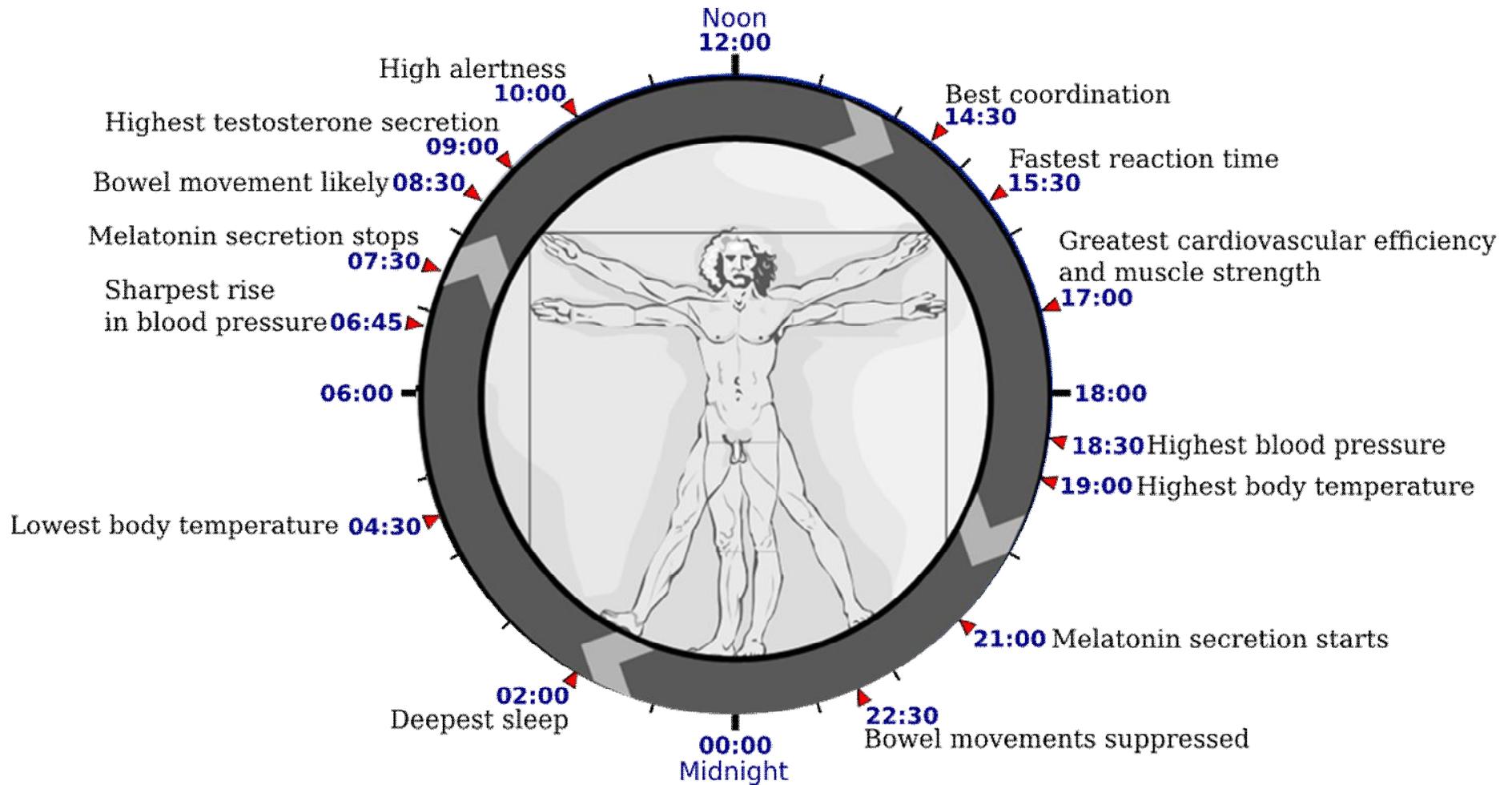
# Theoretical Background

## CIRCADIAN RHYTHMS

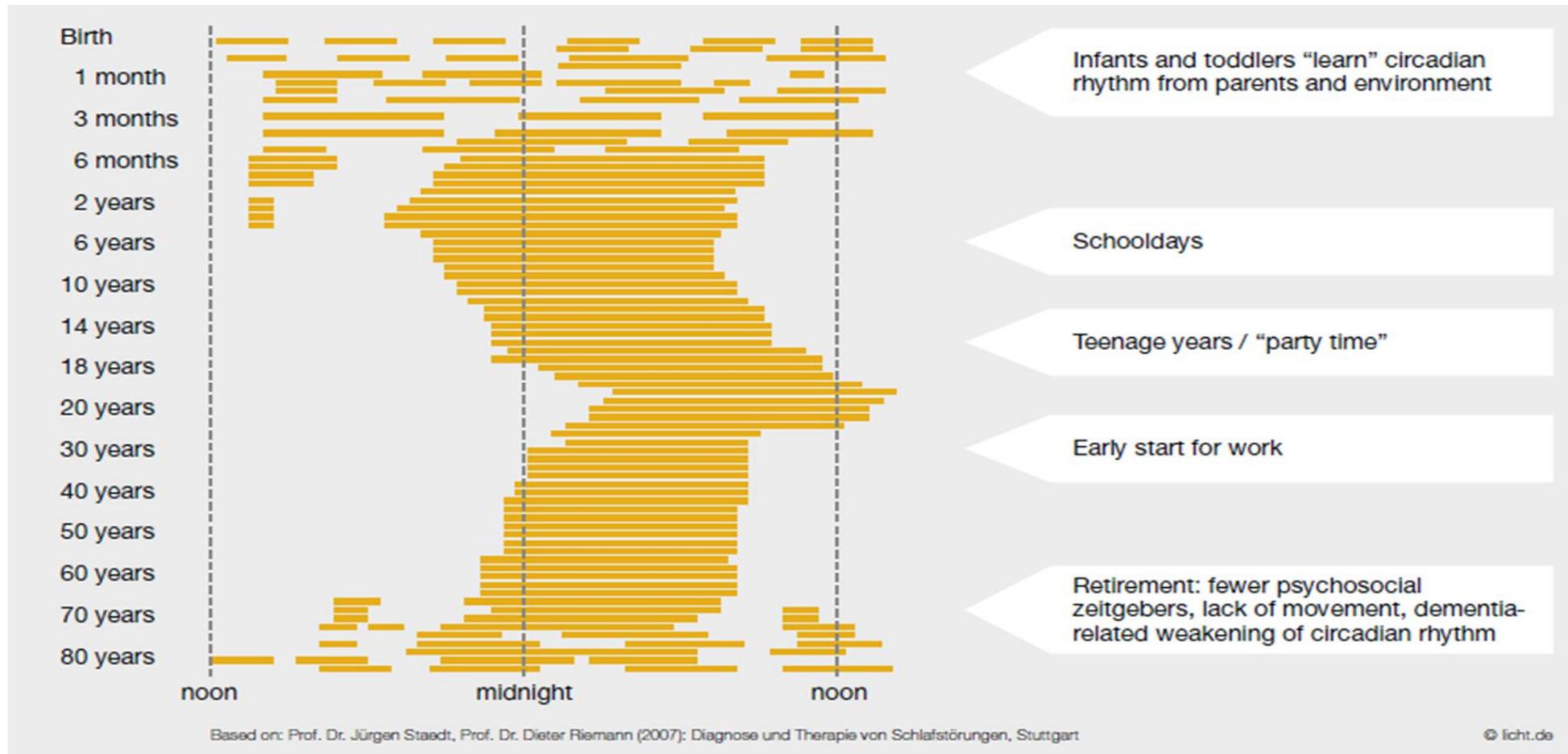
Time interval of  
**approx. one day**



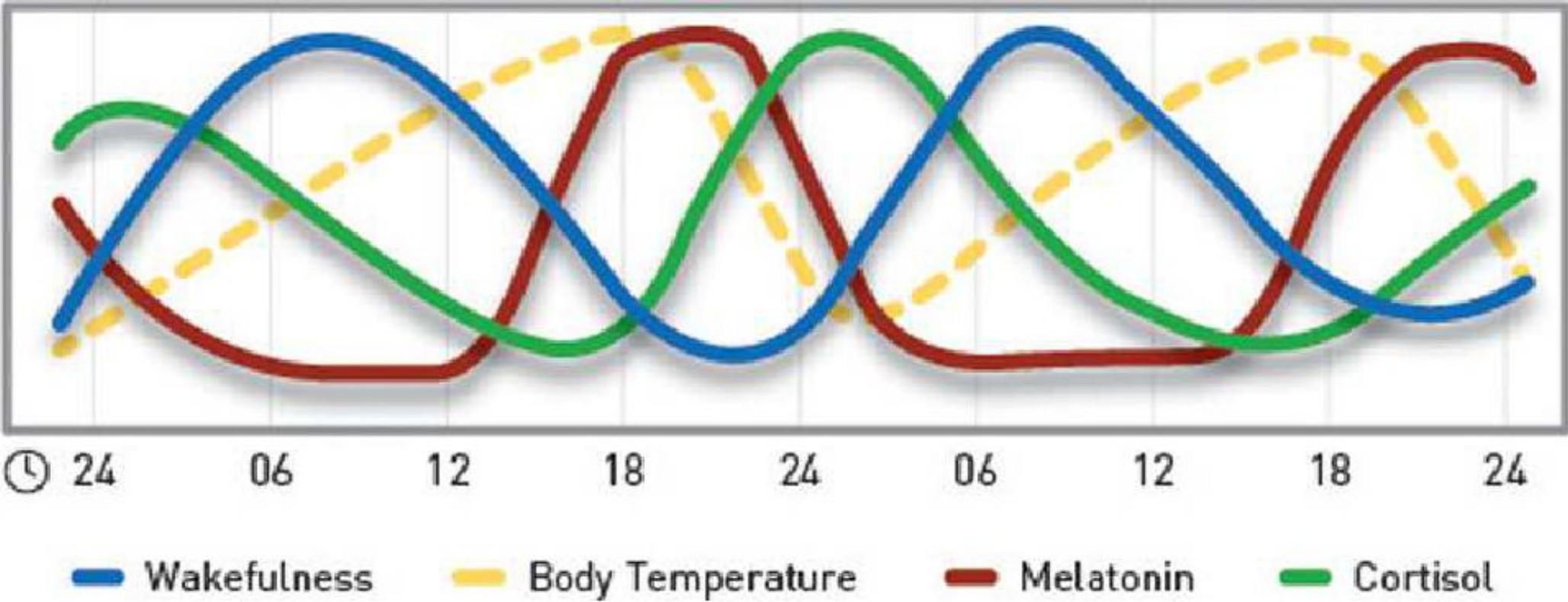
# CIRCADIAN RHYTHMS



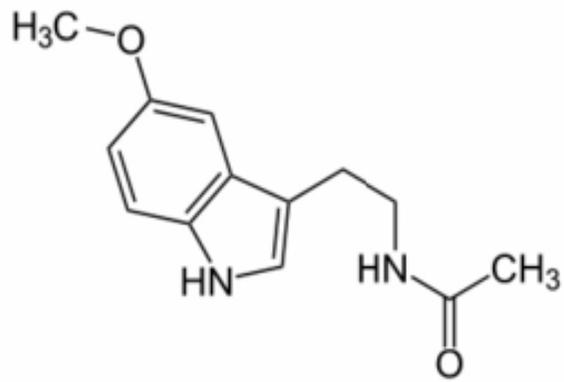
# DEVELOPMENT AND SYNCHRONISATION OF SLEEP



# CIRCADIAN RHYTHMS

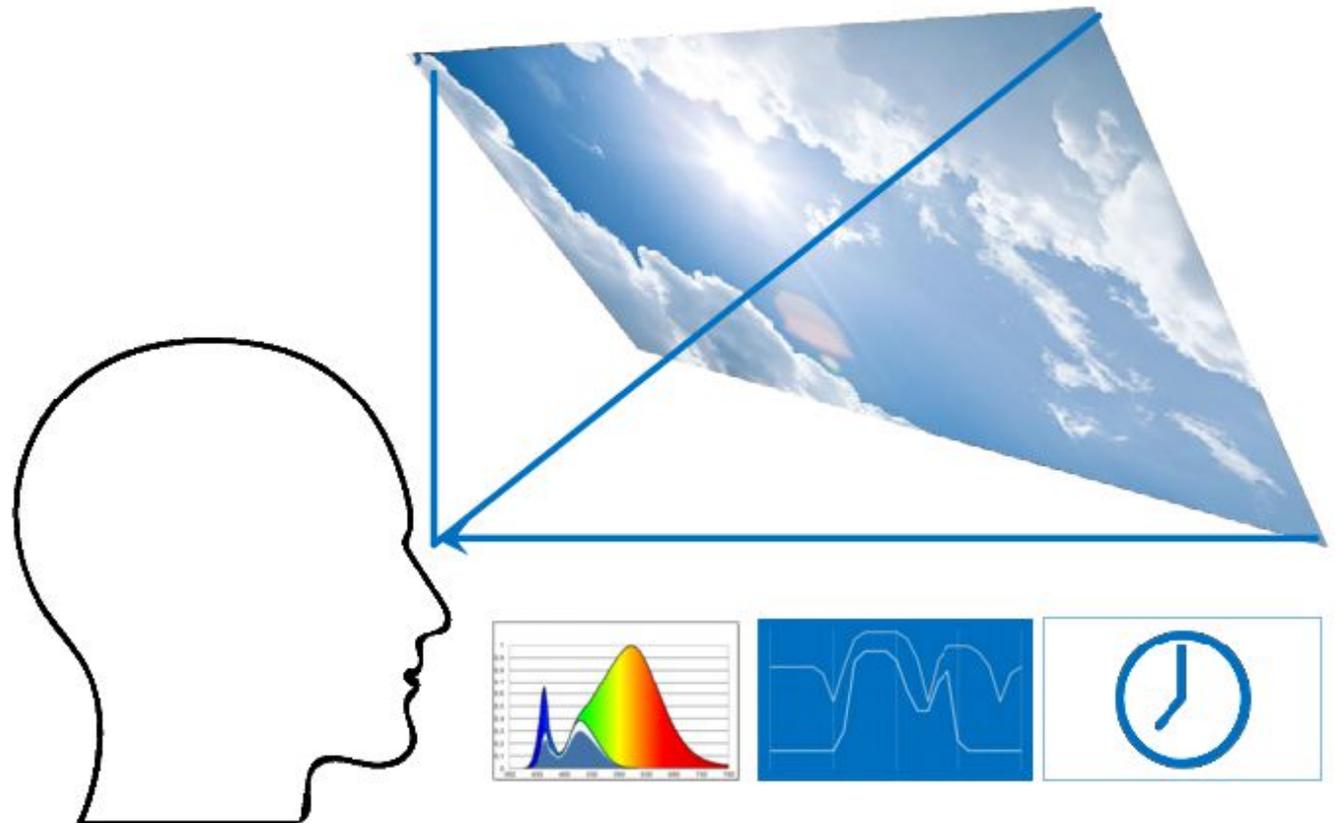


## MELATONIN SUPPORTS GOOD SLEEP



# MANY ASPECTS OF LIGHT EFFECT OUR HORMONE PRODUCTION

- Spectral composition
- Illumination at eye level
- Exposure time
  
- Direction of light
- Surface size
- Light history



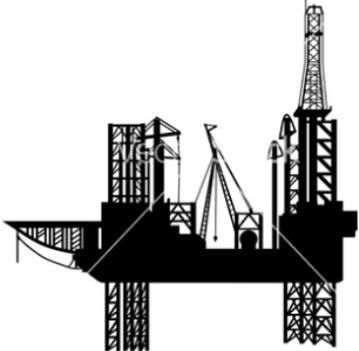
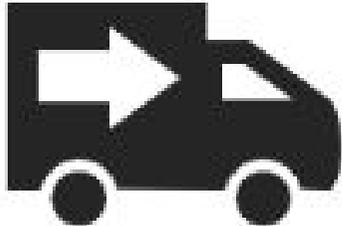
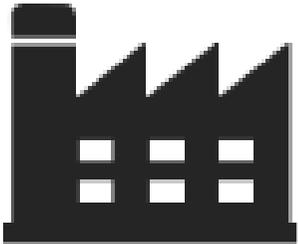
## CAN WE INFLUENCE THIS BIOLOGICAL EFFECT?

- Ideal conditions are daylight, preferably in the summer
- Artificial light can supplement this indoors
- We can deliberately increase alertness, concentration and delay sleep.
- Conversely we can improve wellbeing and improve sleep

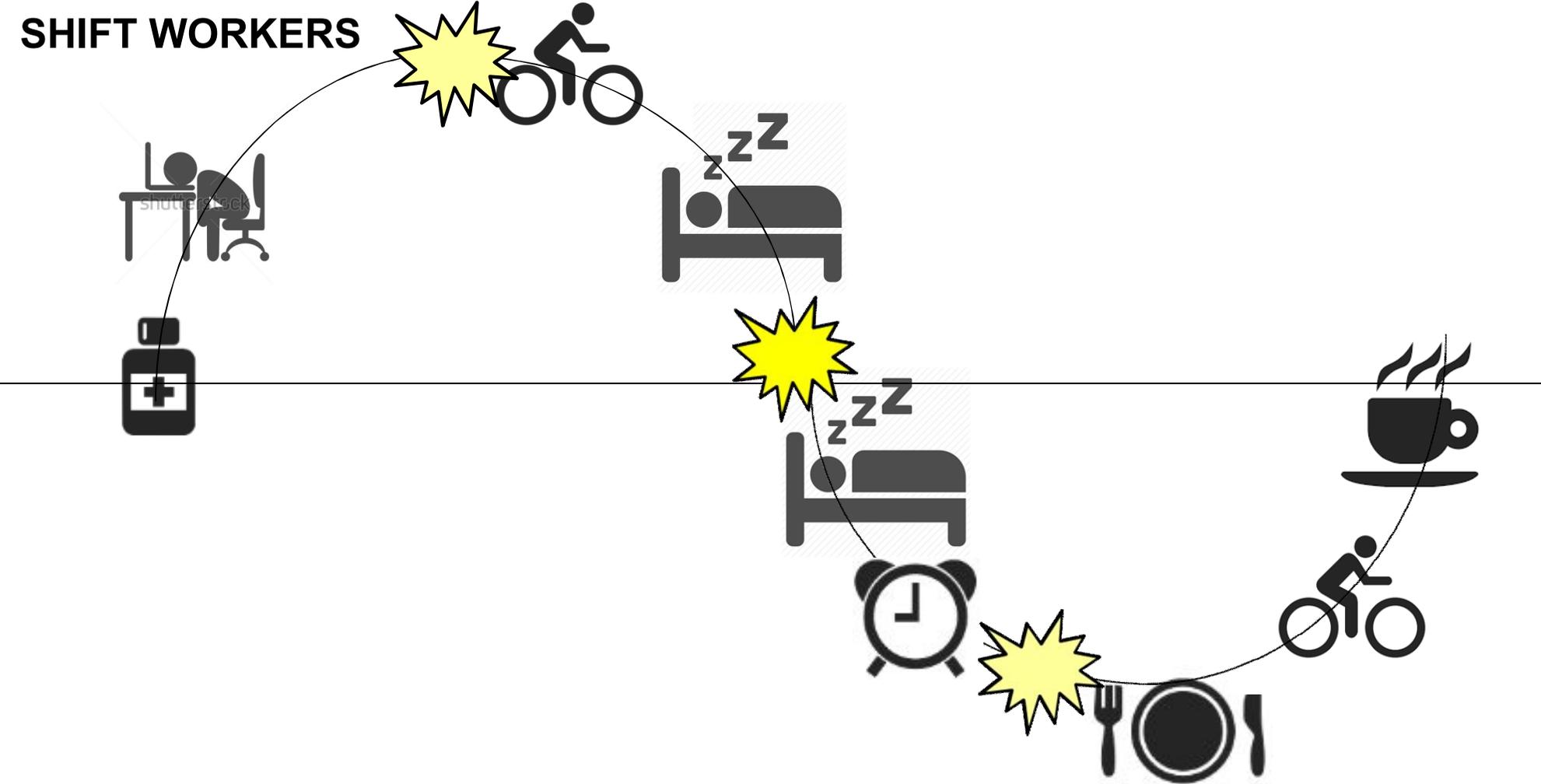
## THE MORAL QUESTION

- When is too much?
- Are we messing about with people's natural rhythms?
- Can we help the people we already ask to lead very unnatural lives?

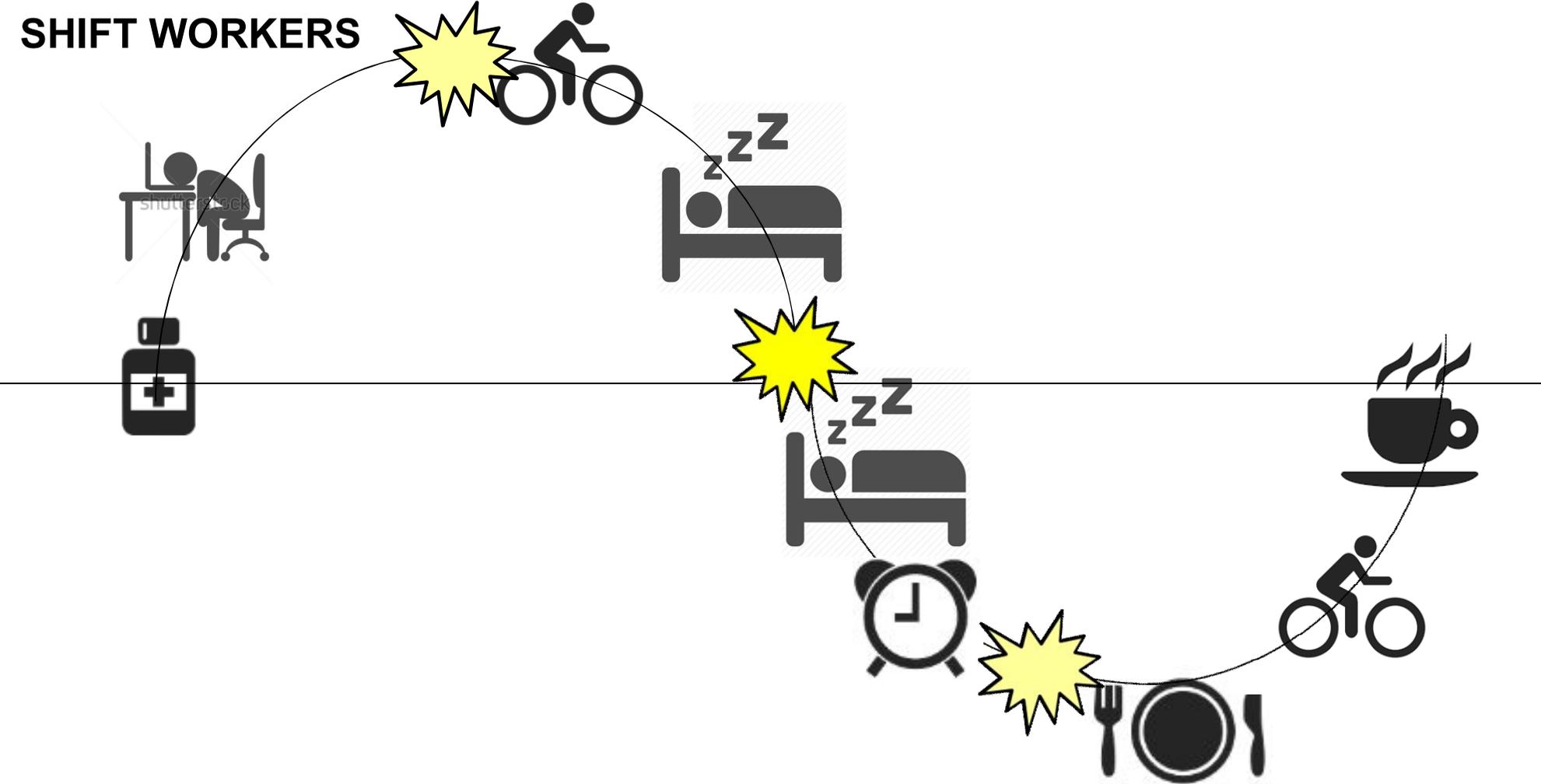
# SHIFT WORKERS



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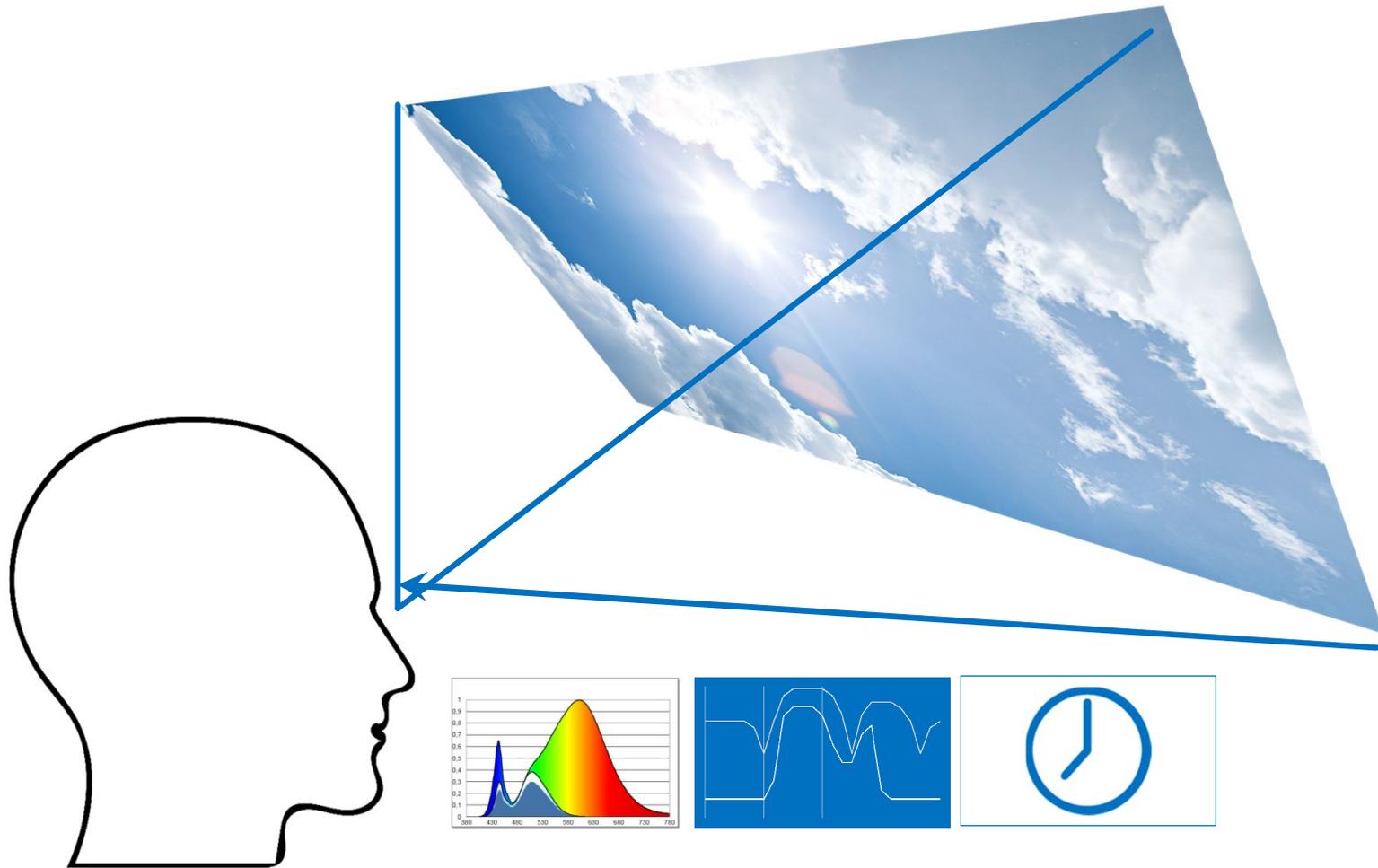
# SHIFT WORKERS



## WHAT CAN WE DO?

- We can advance the circadian rhythms by an hour fairly easily
- It is harder to delay them
- For people with an erratic shift pattern we might be able to provide melanopic supporting lighting

# IS LIGHT THE SAVIOUR?



## RESEARCH

- Assessment of a new dynamic light regimen in a nuclear power control room without windows on quickly rotating shift workers -- effects on health, wakefulness, and circadian alignment; A pilot study by ARNE LOWDEN, Stress Research Institute, Stockholm University
- Prevention of fatigue and insomnia in shift workers-a review of non-pharmacological measures RICHTER K, ACKER J, ADAM S, NIKLEWSKI G
- Improving wellbeing with blue enriched light in rotating shiftworkers. MIDDLETON B, VANDENBOSSCHE E, MORGAN PL, ROUSSEAU A, KANTERMANN T, HAUBRUGE D, SCHLANGEN LJM, KERKHOFS M, SKENE DJ.
- Returning from night shift to day life: Beneficial effects of light on sleep. THORNE CH, HAMPTON SM, MORGAN LM, SKENE DJ, ARENDT J.

## RESEARCH

- Shift work: health, performance and safety problems, traditional countermeasures, and innovative management strategies to reduce circadian misalignment.

**By Mark R. Smith, PhD & Charmane Eastman, PhD, Nature & Science of Sleep, 2012**

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# RESEARCH - SLEEP AND LIGHT SCHEDULE TO REDUCE CIRCADIAN MISALIGNMENT IN NIGHT WORKERS

5,000 Lux



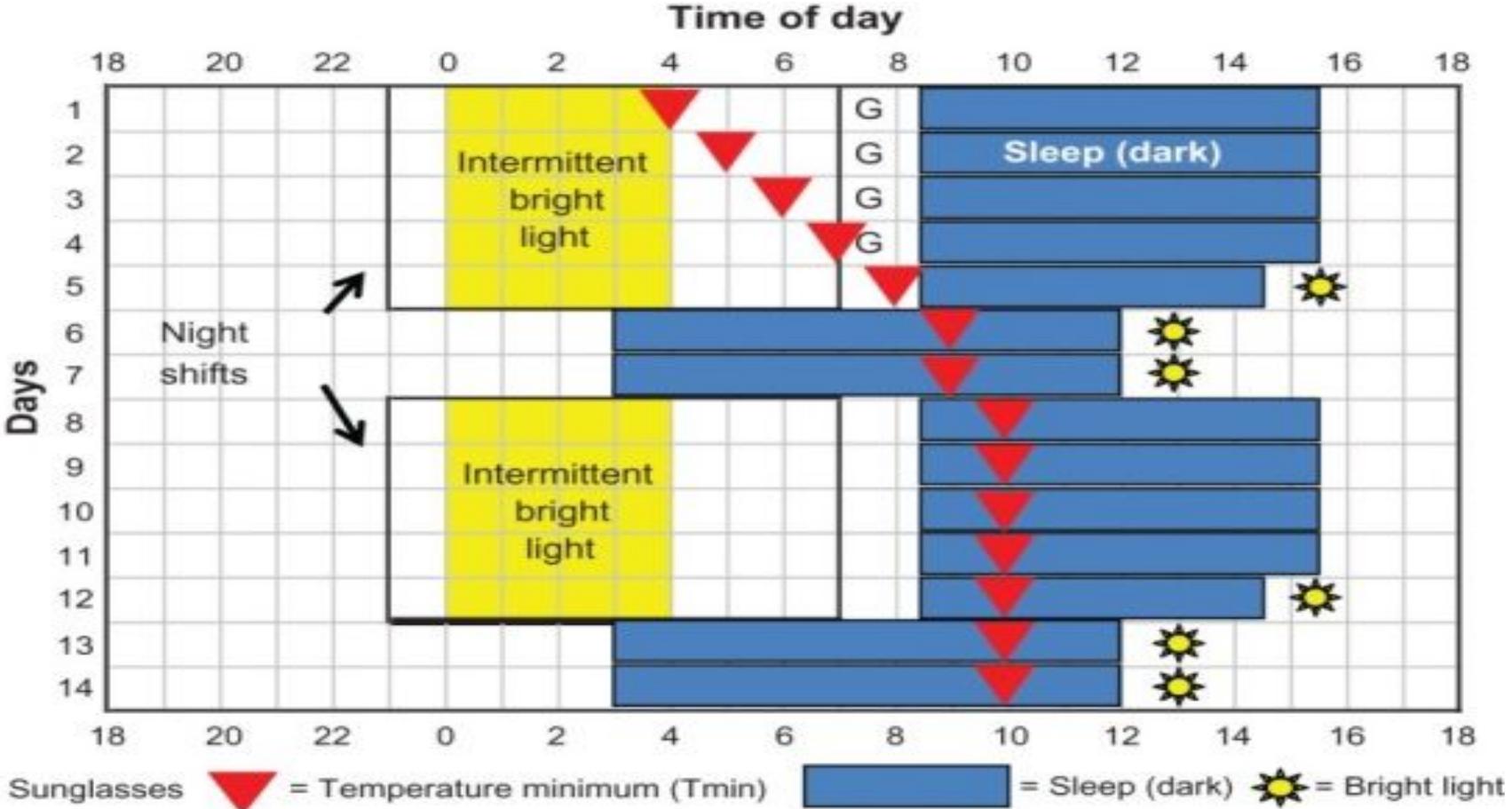
1,200 Lux



250 Lux

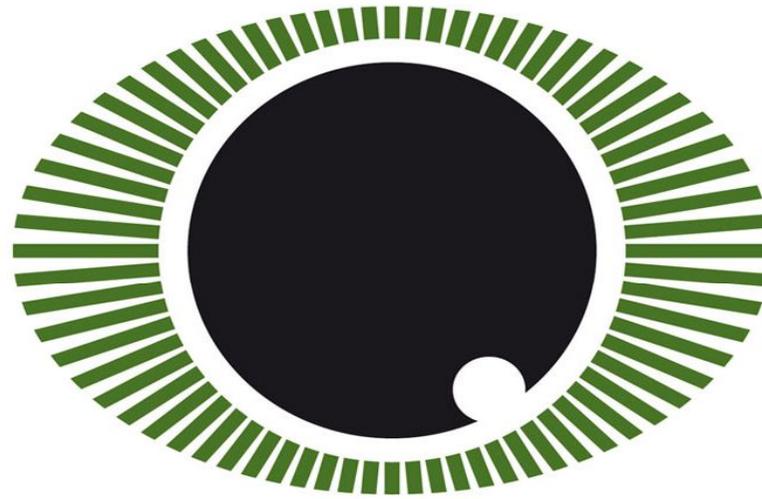


# RESEARCH - SLEEP AND LIGHT SCHEDULE TO REDUCE CIRCADIAN MISALIGNMENT IN NIGHT WORKERS





IAO Stuttgart, Fraunhofer Institute ZVE



**OLIVE**

Olive Research Project in conjunction with German Federal Ministry for Education and Research (BMBF)

# "OLIVE" RESEARCH PROJECT

## WHO THE PARTICIPANTS?

- Highly efficient modules, ECGs and luminaires for dynamic light
- Measurements on LEDs, modules, ECGs and luminaires
- Software and hardware for a sensor network system
- Norms and standards, coordination and publicity work

- Chronobiological parameters from a single blood test determine
- This principle is reliable in most light situations



**TRILUX GROUP**



- User requirements, behaviour and acceptance for house installations
- Market-compliant living room luminaires for dynamic light

- Develop process for determining the non-visual effect of light across the day
- Characterising key figures for biologically optimised light
- Energy savings via biologically optimised light



- Systematic recording of user requirements for professional applications
- Spatial and gesture-controlled technologies for light control
- Algorithms for context-specific dynamic light

- Calculation of light distribution in a room based on sensor data
- Light simulation with manual user input (gestures)



Hochschule  
Bonn-Rhein-Sieg  
University of Applied Sciences

**OLIVE**



- LED modules with static emission spectra
- LED modules with dynamic emission spectra

# OUR OWN RESEARCH

Energy efficiency can be measured in lumens. And in design, we work.

The most pleasing factor of energy efficiency, the light which it delivers.

## MEASURABILITY

- Actiwatches 24 hours per day
- Sleep diaries
- Mood/alertness VAS
- KSS –Karolinska sleepiness scales



# PROFESSOR DEBRA J. SKENE

***Chronobiology***  
**Faculty of Health and Medical Sciences**  
**University of Surrey, Guildford, UK**

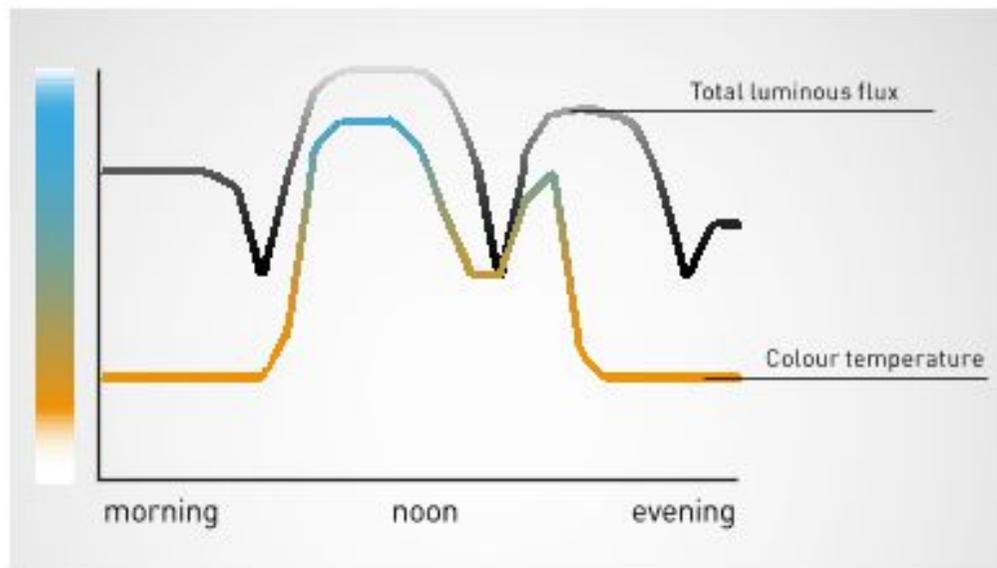


# OUR OWN RESEARCH



## AN EXAMPLE

### Light profile



### Explanation

In the morning at the beginning of the early shift, the daylight-synchronous, activating sequence starts.

Noon – decreasing activation at the end of the early shift. Activation for the late shift starts during the afternoon. The melanopic effectiveness is reduced during evening-time. Modifying the light colour to warm white with increased illuminance leads to higher alertness levels and less impact on the suppression of melatonin.

Decreasing activation with the late shift in late evening.

Start of the night shift, increase in alertness only by modifying lighting intensity.

## CONCLUSIONS

- There are several possibilities for the use of light in the workplace, depending on the time schedules.
- There is still a lack of standardised recommendations for light use, however research has shown that light in the workplace mitigates sleepiness, lifts the mood, and improves the mental status in general.
- Effective use of light may lead to an adaptation to the extended night work period and facilitate the subsequent re-adaptation to daytime life.
- Much research is still needed but should also canvass the genetic predisposition for maladaptive circadian phase in night shift workers.



**ARE YOU STILL FEELING AWAKE?**