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Lecture

Sleep in athletes

Foto: Reddit
https://www.reddit.com/r/comics/comments/h86zxz/a_comic_about_sleep_disorder_oc/

Trikala, 22.10.25

Patricia Frytz, MSc

PATRICIA FRYTZ

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- Applied sport psychologist (asp-Curriculum)
- Current research topics
  - The influence of elite sport on the sleep-wake behaviour of athletes
  - Protective psychological factors on athletes‘ sleep quality

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AGENDA

1. Basic sleep processes
    1. Two-process model of sleep regulation
    2. Functions of sleep
2. Sleep in athletes
3. Measuring sleep in athletes
    1. Objective measurements
    2. Self-assessment tools
4. Case example
    1. Strategies to improve sleep quality

Foto: Colourbox

BASIC SLEEP PROCESSES

SLEEP REGULATION – WHY ARE WE AWAKE DURING THE DAY AND TIRED IN THE EVENING?

Circadian Rhythm
(Process C)
Inner Clock

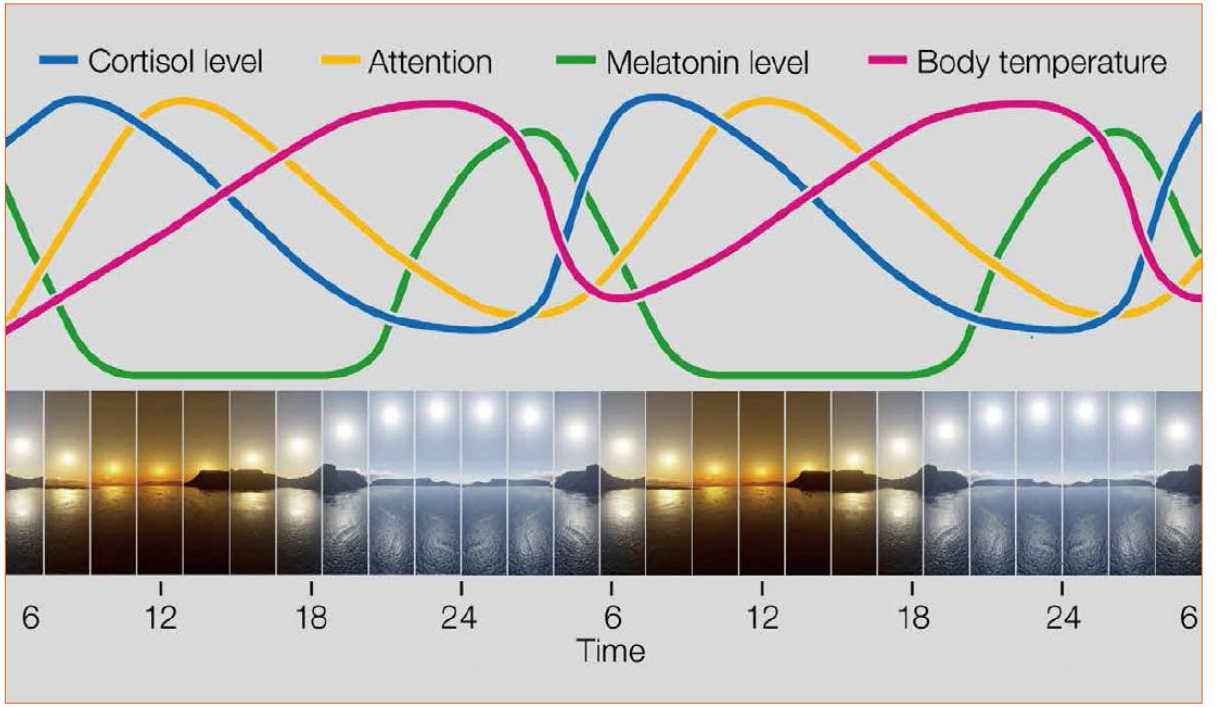
Sleep homeostasis
(Process S)
Sleep Pressure

BASIC SLEEP PROCESSES

CIRCADIAN RHYTHM

- Cycle duration: ca. 24 h
- Found in many living organisms
- Controls most of our
  - psychological,
  - physiological,
  - biochemical

  processes in our bodies

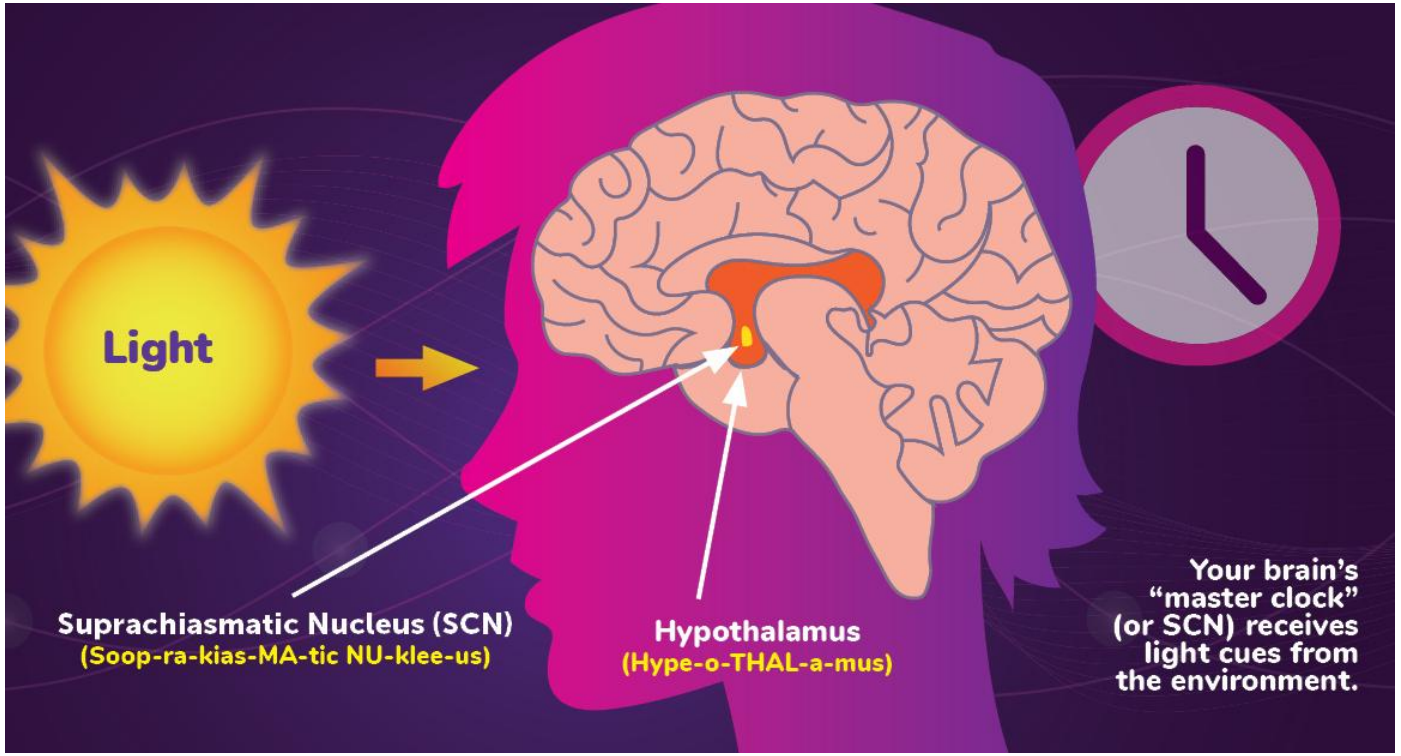


Cajochen, 2016 – Tech-Talks Bregenz
https://www.led-professional.com/resources-1/articles/tech-talks-bregenz-prof-christian-cajochen-univ-basel-head-of-center-of-chronobiology

BASIC SLEEP PROCESSES

CIRCADIAN RHYTHM

- **Pacemaker:**
  Suprachiasmatic Nuclei (SCN)
- **Influenced by:**
  - Light → Smartphone!
  - Social signals
  - Meal times
  - Physical activity

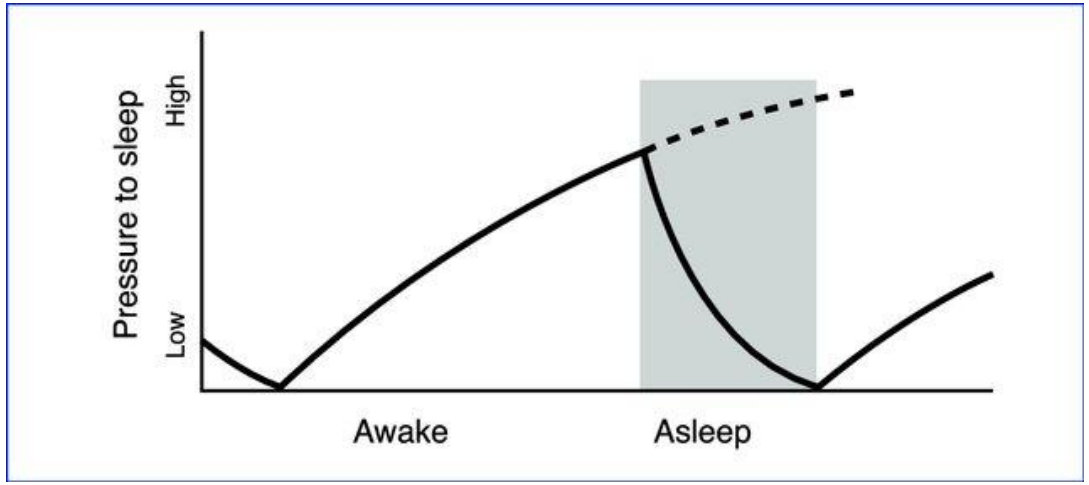


Circadian rhythms are physical, mental, and behavioral changes that follow a 24-hour cycle. Circadian rhythms are influenced by light and regulated by the brain's suprachiasmatic nucleus (SCN), sometimes referred to as a master clock.

BASIC SLEEP PROCESSES

SLEEP HOMEOSTASIS

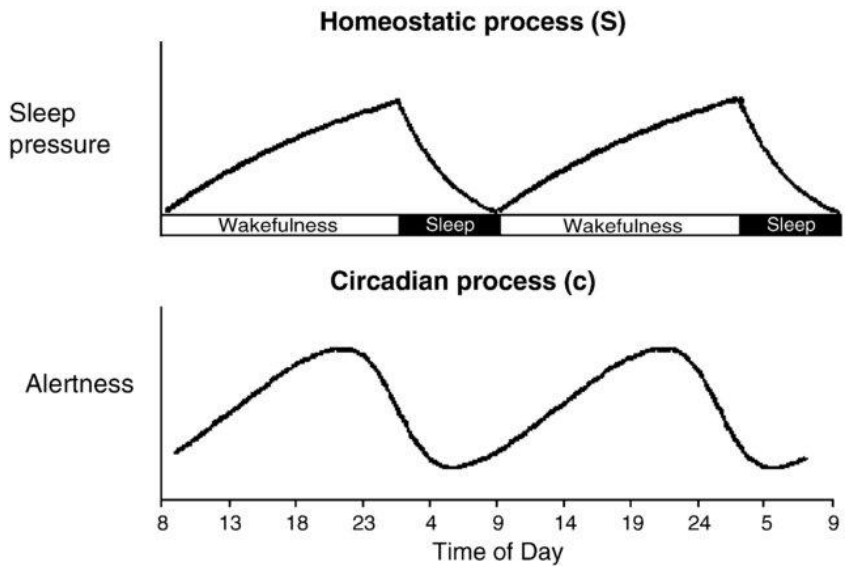
- Regulates the balance between wakefulness and sleepiness via adenosine
- **Sleep pressure**
  - increases with continuing wakefulness
  - decreases gradually after falling asleep



Amlaner, Greene, & Hanson, 2003

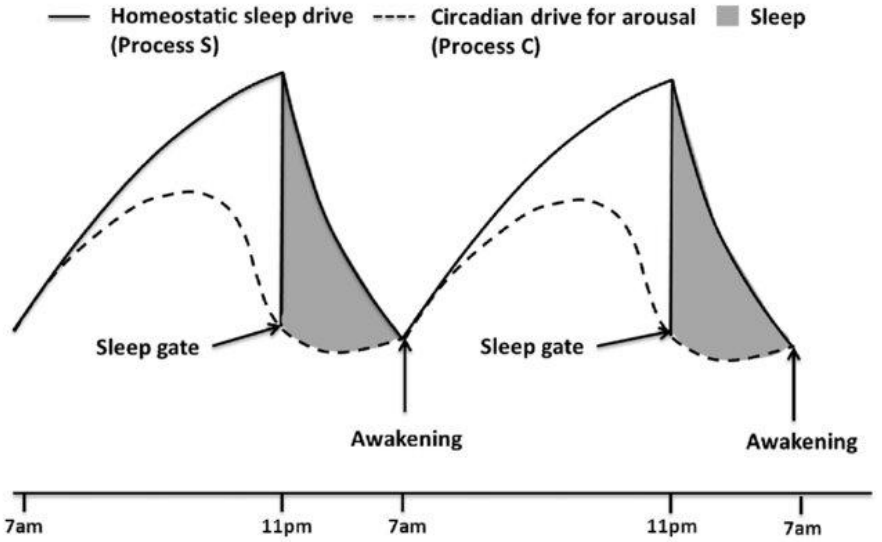
BASIC SLEEP PROCESSES

TWO-PROCESS-MODEL OF SLEEP REGULATION



Interaction of process S and process C. The homeostatic pressure for sleep builds up during wakefulness and dissipates rapidly during sleep. The circadian process is related to the time of day, is independent of the amount of previous sleep and opposes the homeostatic process

Figure by Stiller & Postolache, 2005



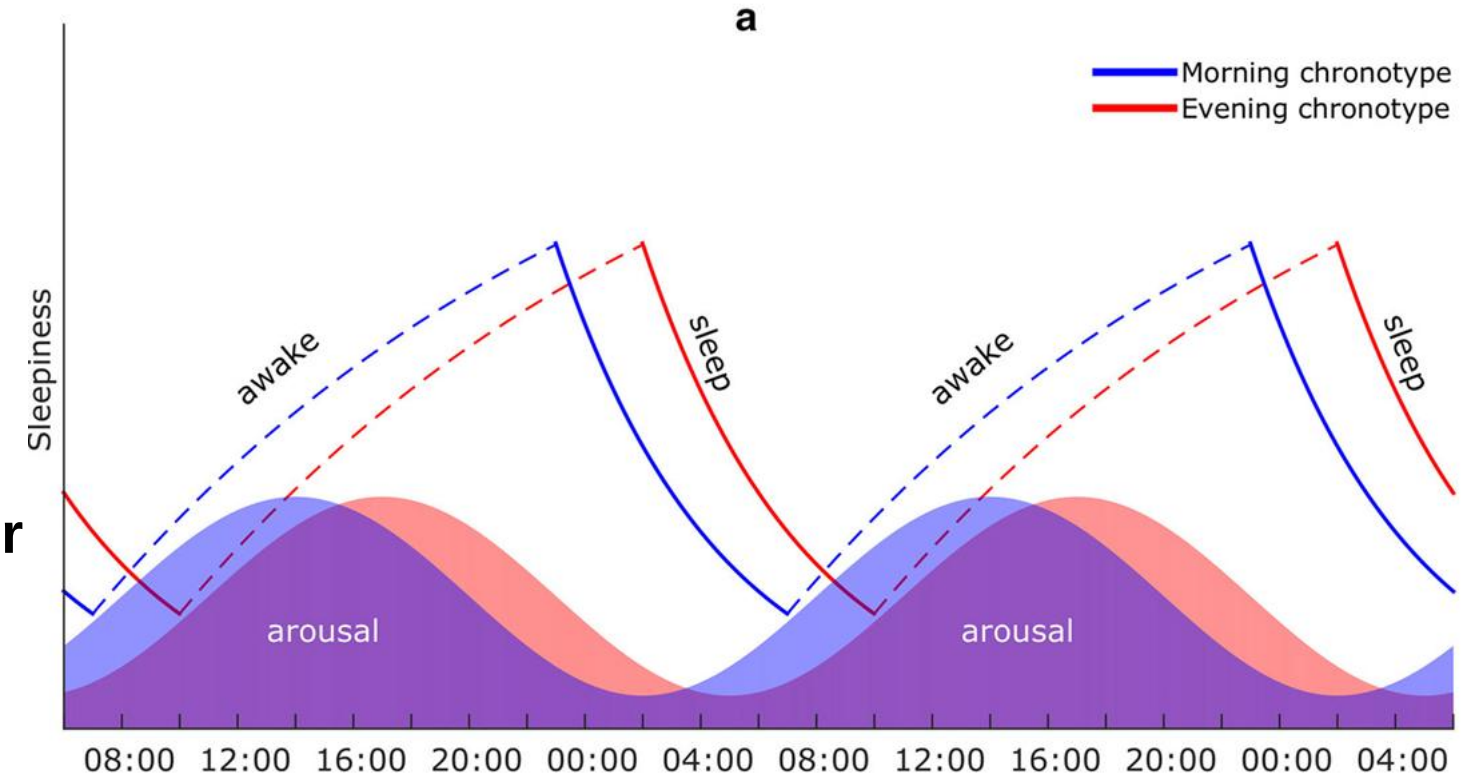
Two-process model of sleep regulation. Schematic representation of the two-process model of sleep regulation. Process S rises during waking and declines during sleep. Process C is like a sinusoid, the pressure to sleep is maximum when the difference between the two is highest (i.e. sleep gate). Modified from Achermann et al. (Achermann, 2004).

Figure by Yang (2013)

BASIC SLEEP PROCESSES

CHRONOTYPE

- Most people are **neutral types**
- Mainly determined by **genetics**
- Influenced by **age and gender** (Adan et al., 2012) **and habits**
- **Individual athletes** are predominantly early chronotypes (Lastella et al., 2016)



The theoretical effect of chronotype on sleepiness. Sleepiness of morning chronotypes (blue) and evening chronotypes (red) is moderated by arousal systems. In this example, on free days (a), the morning chronotype naturally wakes up (sleep offset) at 0700 hours, and the evening chronotype 3 h later. From this point onward, sleepiness steadily increases (dashed line). At some point of low circadian arousal (sleep onset) sleep is enabled to reduce sleepiness. Note the difference in sleepiness between chronotypes at any given time; this is due to the phase difference of the sleep–wake cycle

Figure by Reinke, Özbay, Dieperink & Tulleken, 2015

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Scan me!

Chronotype

BASIC SLEEP PROCESSES

Which chronotype do you belong to?

MEQ (Horne & Östberg, 1976)

https://qxmd.com/calculate/calculator_829/morningness-eveningness-questionnaire-meq

5 min

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Please discuss!

CHRONOTYPE

Which impact does your chronotype have on your learning/training performance?

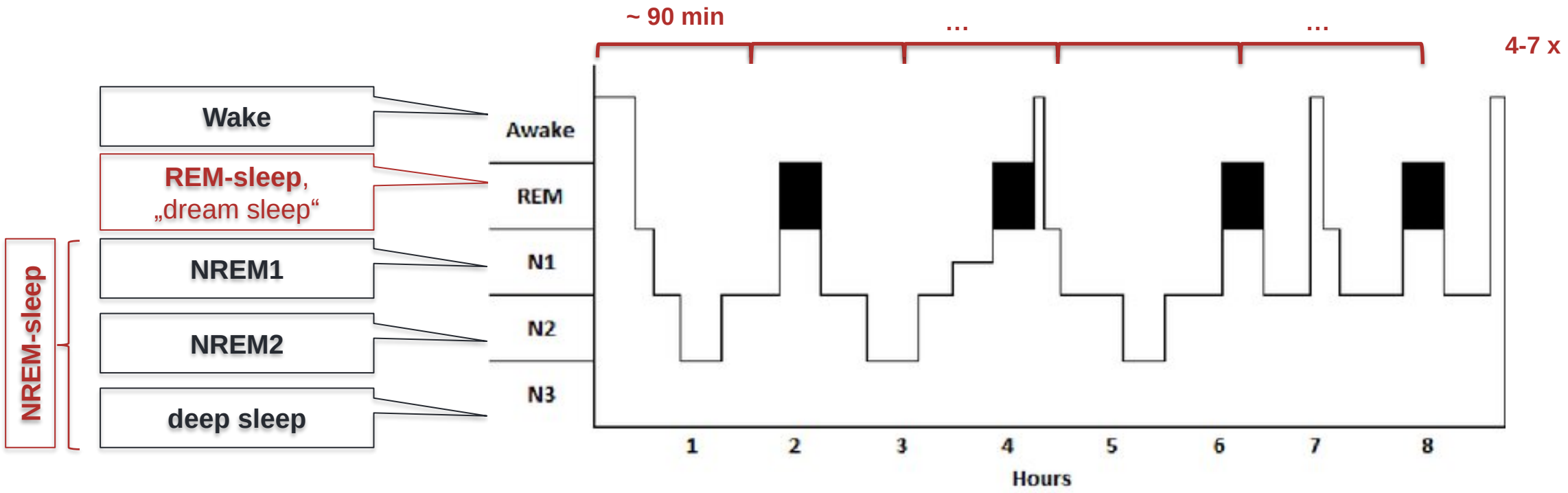
What implications does chronotype have for athletes (e.g., training and competition times, type of sports, travel)?

5-7 min

BASIC SLEEP PROCESSES

American Academy of Sleep Medicine (AASM)

SLEEP ARCHITECTURE – WHAT IS HAPPENING DURING SLEEP?



Miller et al., 2015

FUNCTIONS OF SLEEP

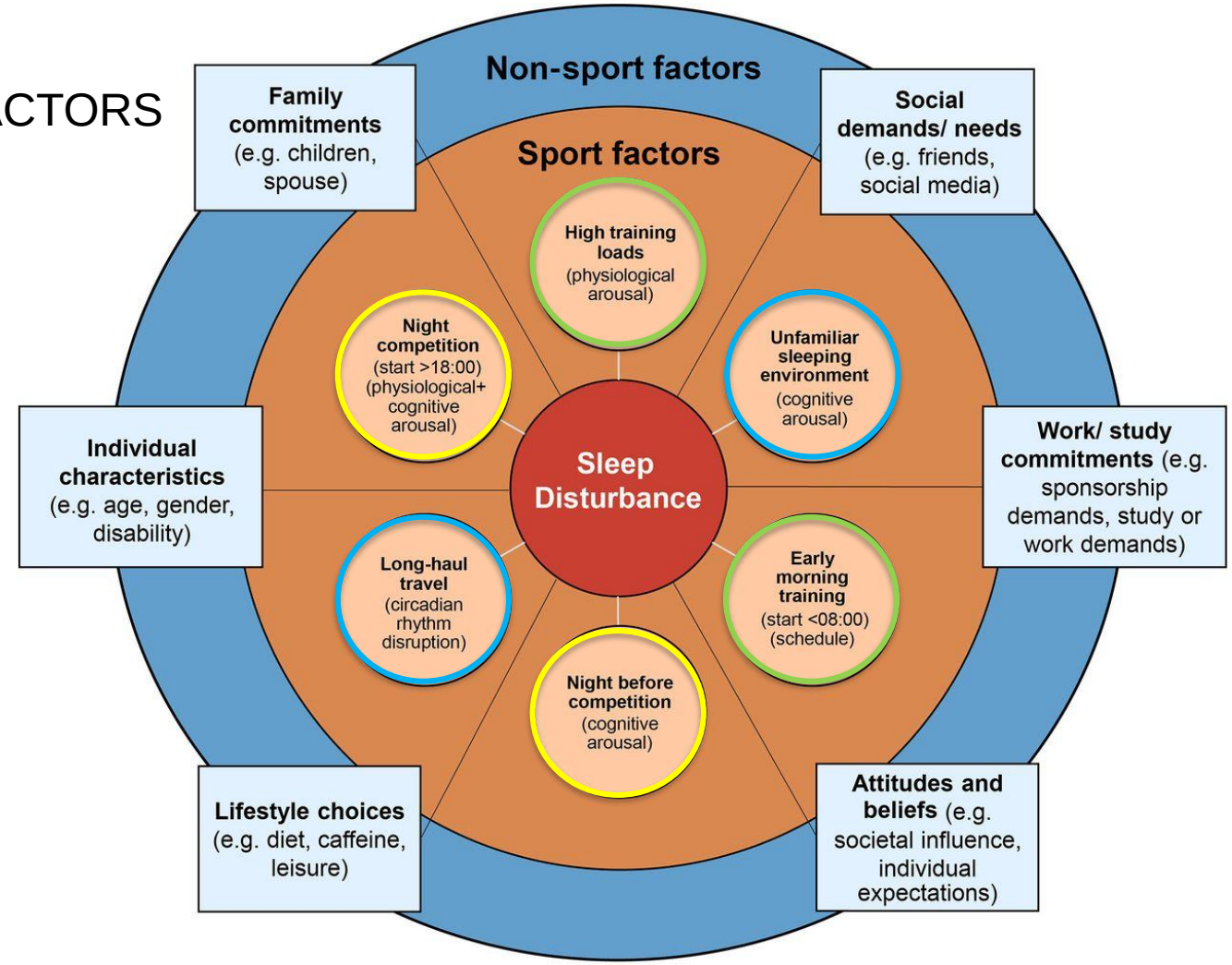
- Immune system
  - T-cell function
- Memory consolidation
  - Motor learning
- Regeneration
  - physical
  - mental
  - emotional
- Hormonal balance
  - Fat reduction
  - Muscle building
- Energy balance
- Thermoregulation

Foto: Colourbox

SLEEP DISTURBANCES IN COMPETITIVE SPORT

Foto: Jonathan Chng on Unsplash

INFLUENCING FACTORS



WHY SLEEP MONITORING IS IMPORTANT FOR ATHLETES

Foto: sleepcycle.com

- **Improvements in**
  - Athletic performance
  - Recovery (e. g. injury risk)
  - Mental health and cognitive function
- **Depict the „status quo“**
  - Identify suboptimal sleep patterns (Bonnar et al., 2018; Milewski et al., 2014)
  - Fulfilment of individual sleep needs (Sargent et al., 2021)
  - Uncover sports-related disturbances (Juliff et al., 2015; Sargent et al., 2014)
- **Personalized Sleep Interventions**
  - Adjusting sleep and training schedules (Halson, 2014; Nedelec et al., 2018)
  - Identify sleep hygiene strategies

SLEEP HEALTH DIMENSIONS

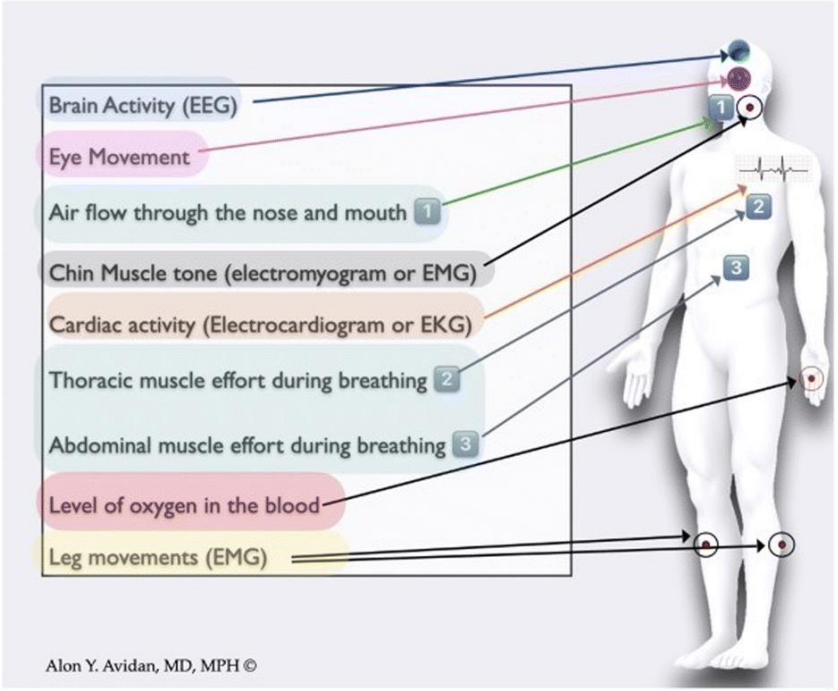
HOLISTIC FRAMEWORK

1. **Sleep duration**
   The amount of sleep in 24 hours
2. **Sleep efficiency/continuity**
   Ability to fall and stay asleep
3. **Sleep timing**
   Bed times, daytime naps
4. **Alertness / sleepiness**
   How well one can remain awake
5. **Satisfaction with sleep**
   Perception of sleep quality

OBJECTIVE METHODS

Foto: Apotheken Umschau

Polysomnography
(PSG)
„The Gold Standard“



OBJECTIVE METHODS

Foto: Apotheken Umschau

Polysomnography
(PSG)
„The Gold Standard“

- **Most accurate measurements**
- **Sleep stage detection** through
  - EEG (brain activity)
  - EOG (eye movements)
  - EMG (muscle tone)
- **Standardized** measurement conditions
- **clinical** examinations,
  sleep disorders, e. g. sleep apnea

- **Expensive**
- **Complex and time-consuming**
- No **long term** measurements
- **Unfamiliar** sleeping environment
- **No external factors**
  - E. g. sports-related factors

Moore et al., 2024; Walsh et al., 2021

OBJECTIVE METHODS

Foto: Apotheken Umschau

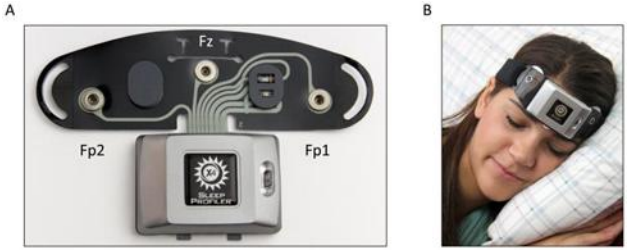
Alternatives:

Polysomnography (PSG)
„The Gold Standard“

Portable PSG

Foto: neurosoft.com

Single-channel EEG



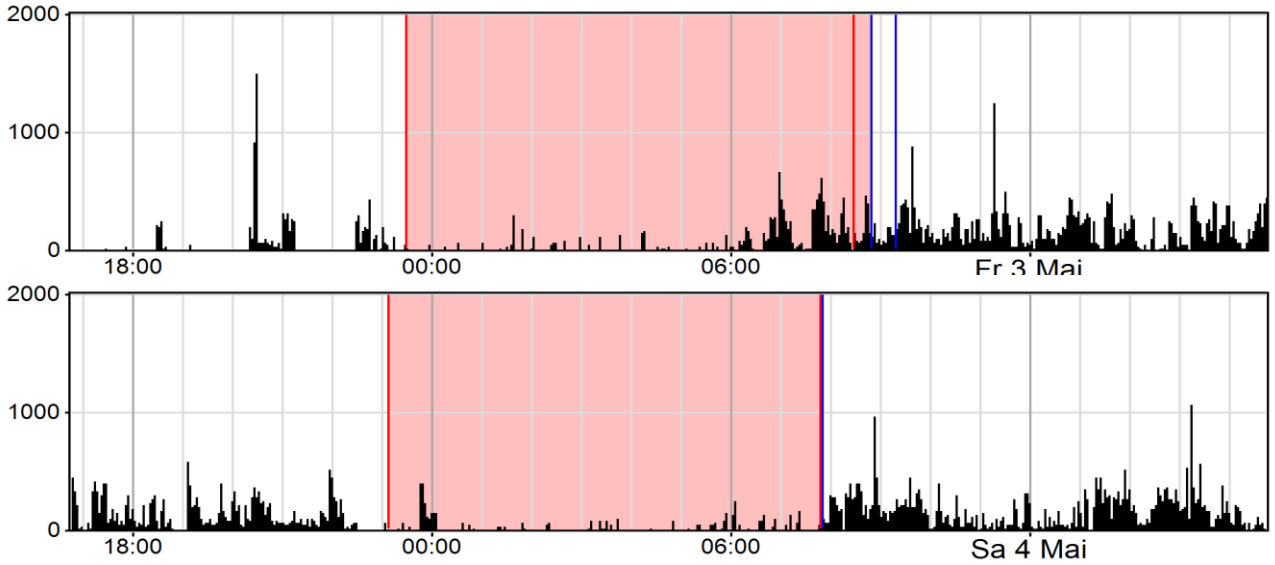
Figures by Lucey et al., 2016

OBJECTIVE METHODS

Foto: Medical Expo

Actigraphy
Accelerometer

Foto: camntech.com



OBJECTIVE METHODS

Actigraphy
Accelerometer

Foto: Medical Expo

- **familiar sleeping environment**
- **Long-term** measurement possible
  - **24 hour**
  - **Several weeks**
- **Response** to external and internal variances
  - **Sleep-wake habits**
- Most commonly used in **sport psychology**

- **Expensive** software
- Not every instrument is **validated** against PSG
- **No substitute** for PSG
  - Sleep disorders
- **Measurement errors:**
  - Overestimation of sleep duration
  - Underestimation of wake phases and sleep onset latency

OBJECTIVE METHODS

Foto: Forbes.com

Consumer Wearables

Wrist/ring worn, nearables

Foto: nationalgeographic.com

OBJECTIVE METHODS

Postdoc & Data Scientist
https://www.robterhorst.com/

Foto: Forbes.com

Consumer Wearables

Wrist/ring worn, nearables

- **familiar sleeping environment**
- **Long-term** measurement possible
  - Sleep-wake habits
- **No expert** needed for the setup
- **Commercially** available

- **Questionable accuracy**
  - Barely validated against PSG
  - No athlete populations
  - Limitations for complex cases & irregular sleep patterns
  - Limited algorithmic transparency
- **Data privacy concerns**
  - Cloud-based storage

NEW METHODS

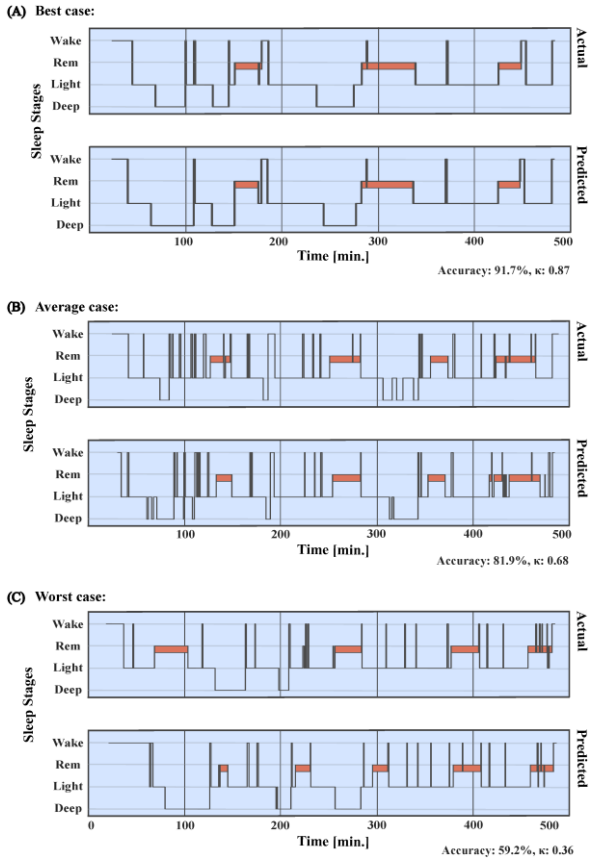
Foto: Polar

The Virtual Sleep Lab—A Novel Method for Accurate Four-Class Sleep Staging Using Heart-Rate Variability from Low-Cost Wearables

by Pavlos Topalidis [1], Dominik P. J. Heib [1,2], Sebastian Baron [3,4], Esther-Sevil Eigl [1], Alexandra Hinterberger [1] and Manuel Schabus [1,*]

COMBINING **LOW-COST WEARABLES** AND **ACCURATE 4-CLASS- SLEEP STAGING**

- Low-cost consumer wearables:
  - **POLAR® optical heart rate sensor, breast belt**
- Based on
  - **inter-beat-interval data (IBI)**
- Method
  - **Multi-resolution convolutional neural network (MCNN)**
- Outcome
  - **epoch-by-epoch four-class sleep staging approach**
  - **Wake, Light [N1 + N2], Deep, REM**



Topalidis et al., 2023

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COMBINING **LOW-COST WEARABLES** AND **ACCURATE 4-CLASS- SLEEP STAGING**

Soccer, Sleep, Repeat: Effects of Training Characteristics on Sleep Quantity and Sleep Architecture

by Patricia Frytz [1,2,3,*], Dominik P. J. Heib [1,2,4] and Kerstin Hoedlmoser [1,2,*]

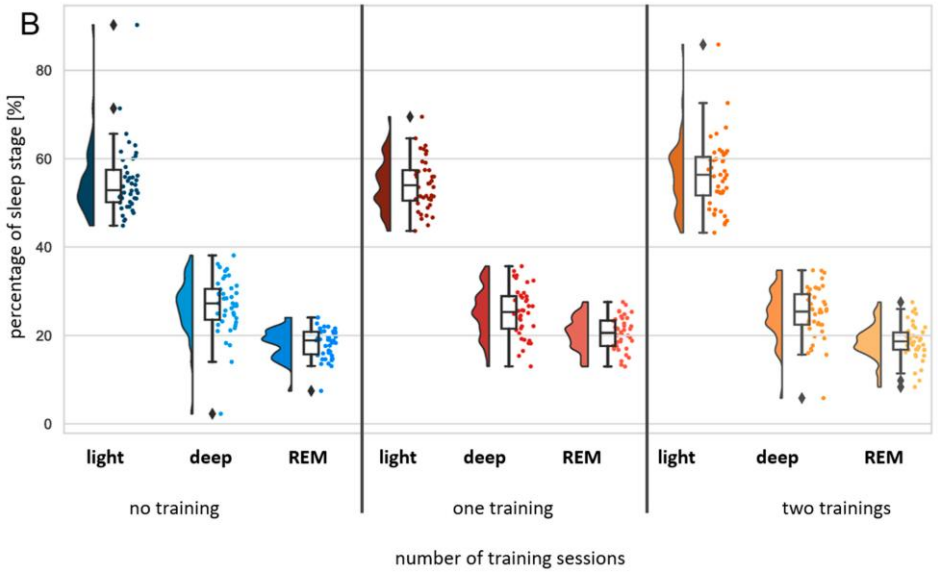


Foto: VivoScout

sleep²

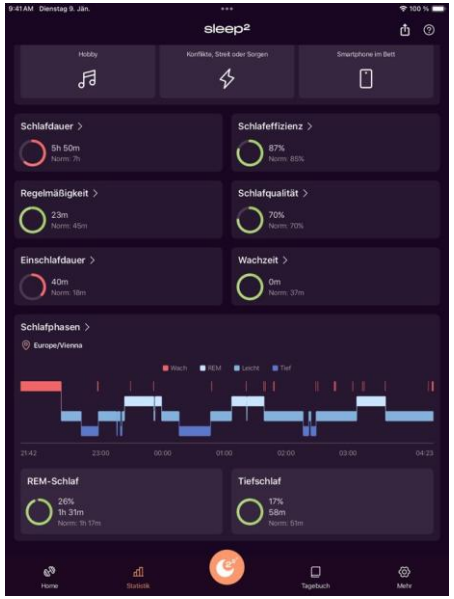
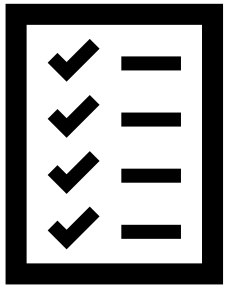


Foto: apple.com

SUBJECTIVE METHODS



Questionnaires

Screening - general

- Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989)
- Epworth Sleepiness Scale (ESS; Johns, 1991)

Screening – athlete-specific

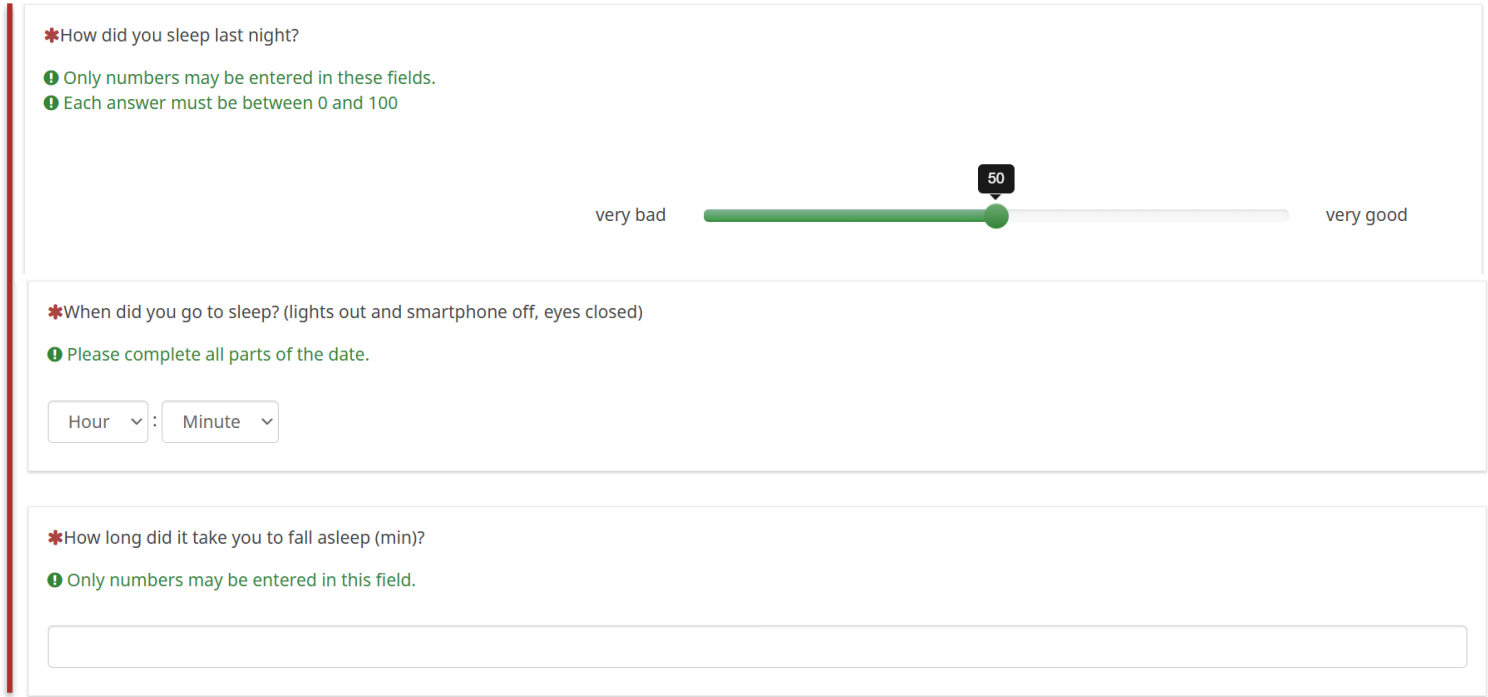
- Athlete Sleep Screening Questionnaire (ASSQ; Samuels et al., 2016)
- Athlete Sleep Behavior Questionnaire (ASBQ; Driller et al., 2018)
- Competitive Sports, Sleep, and Dreams (Erlacher et al., 2011)

No	In recent times（over the last month）…	Never	Rarely	Sometimes	Frequently	Always
1	I take afternoon naps lasting two or more hours					
2	I use stimulants when I train/compete（e.g caffeine）					
3	I exercise (train or compete) late at night (after 7pm)					
4	I consume alcohol within 4 hours of going to bed					
5	I go to bed at different times each night (more than ±1 hour variation)					
6	I go to bed feeling thirsty					
7	I go to bed with sore muscles					
8	I use light-emitting technology in the hour leading up to bedtime (e.g laptop, phone, television, video games)					
9	I think, plan and worry about my sporting performance when I am in bed					
10	I think, plan and worry about issues not related to my sport when I am in bed					
11	I use sleeping pills/tablets to help me sleep					

SUBJECTIVE METHODS

Sleep diaries

- **Evening sleep logs:**
  - Training & competition schedules
  - Daytime Naps
  - Smartphone Use
- **Morning sleep logs:**
  - Subjective sleep parameters
  - Bed times
  - (Morning) fatigue



CASE EXAMPLE: ADOLESCENT ELITE SWIMMER

Information needs

- Which additional information (biography, anamnesis, sleep behaviour, daily routines, habits, etc.) would you need to better understand Alex's sleep situation?
- How would you collect/measure this information (subjective, objective methods)?

Recommendations

- Which interventions or strategies would you recommend Alex to improve his sleep quality while balancing both school and sport?
- Base your ideas on the lecture content – but feel free to include your own perspectives or practical experiences.

Please discuss in groups & summarize your results briefly!

RECOMMENDATIONS FOR MEASURING ATHLETES' SLEEP

BY MOORE ET AL., 2024

- ✓ **Baseline sleep profile**
  - ✓ Best: offseason, limited obligations for athletes, desired sleep schedule
- ✓ **Track sleep changes during the season**
  - ✓ interim sleep assessments through different training/competition phases
- ✓ **Combine subjective & objective measures**
  - ✓ Seek for validated tools, compare low-cost wearables
- ✓ **Minimum of 7 days measurement**
- ✓ **Work together with a sleep medicine professional**
  - ✓ Interpretation of sleep measurements

STRATEGIES TO IMPROVE SLEEP QUALITY

Sleep before, during and after the Olympic Games: an important determinant of sports performance

› written by **Kerstin Hoedlmoser**, **Patricia Frytz**, **Daniel Erlacher**, **Michele Lastella**, **Jacopo Vitale** & **Mathieu Nedelec**

https://www.in-mind.org/article/sleep-before-during-and-after-the-olympic-games-an-important-determinant-of-sports

#1 **Determine your individual sleep duration and phase** (chronotype)

#2 **Maintain a regular time to get up and go to bed every day** (including weekends) and treat your sleep schedule as part of your training schedule.

#3 **No caffeinated drinks after 2 p.m.** and **no heavy meals before bedtime**.

#4 **No physically or mentally strenuous activity** for 60 minutes before bedtime.

#5 Create a **cozy and adequate sleeping environment**.

#6 Think about your **personal 30-45min sleep ritual**

#7 If you take a **nap**, make sure it is between **1 and 4 p.m.** and lasts between **20-90 min.**

#8 **The bed is only for sleeping** (exception: sexual activity)

#9 If you wake up during the night right before a competition, **do not panic and remind yourself that you banked your extra sleep beforehand**.

#10 **Bright light is a wake-up call**. If you feel exhausted in the morning or during the day, **go out into the daylight** or use a daylight lamp.

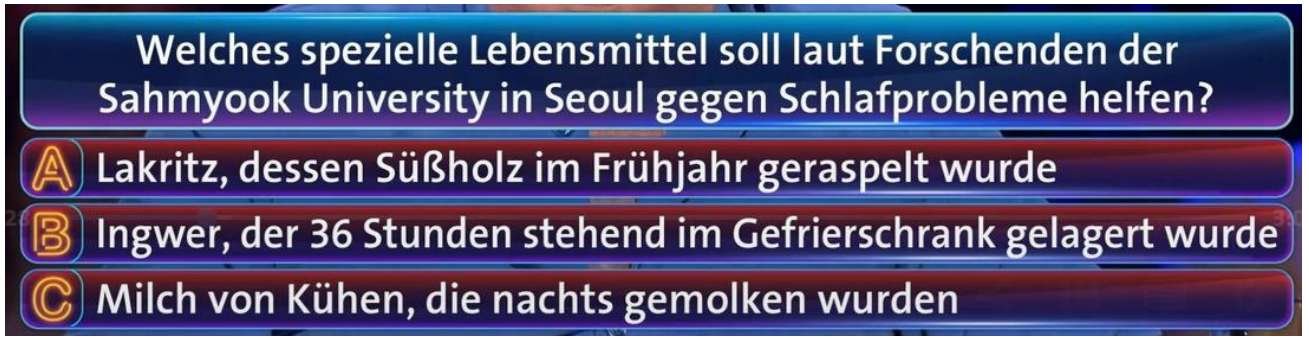
#11 **Do not go to bed with your smartphone, tablet or other light-emitting electronic devices.** If so, use "Night Mode" (blue light filter).

#12 On stressful, training-intensive or competition days, **plan in phases of regeneration** (relaxation exercises, listening to music, etc.) during the day.

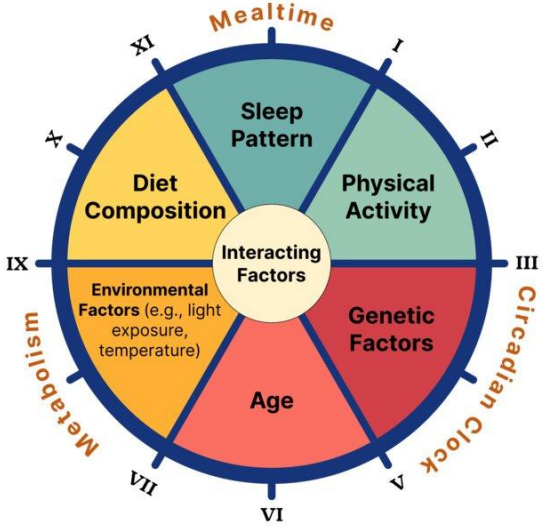
NUTRITION

„CHRONONUTRITION“

Foto: ard



- **Tryptophan** for regulating the sleep-wake cycle
  → e.g., soybeans, cashews, edam cheese, peanuts
- After intense exercise: **high glycemic index**
- Better sleep quality: **proteins during the evening**
- **Foods with high melatonin content:** milk, pistachios, cranberries, (sour) cherries, oatmeal, walnuts
- **Others:** fatty fish, kiwis



Bahammam & Pirzada, 2023

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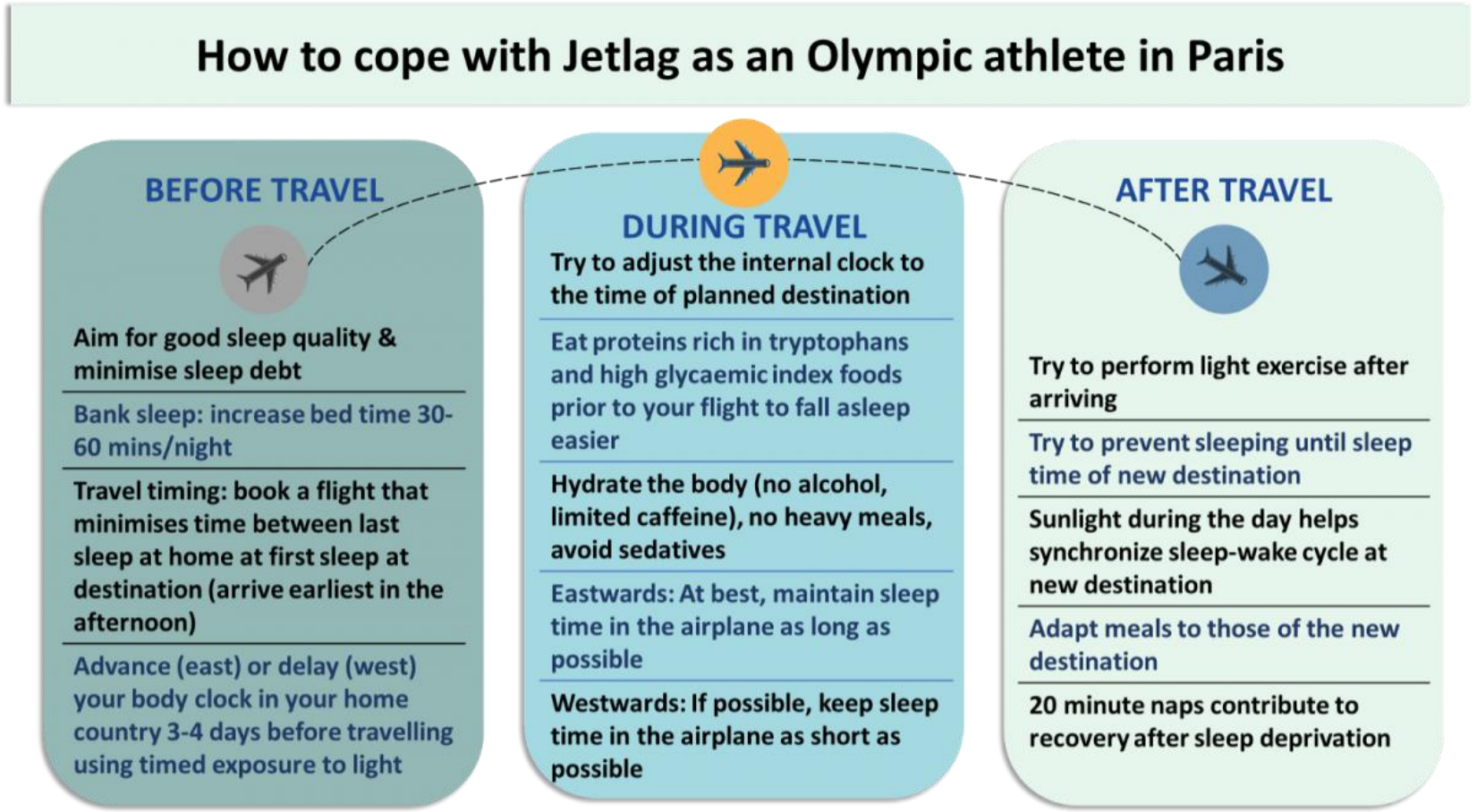

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THANK YOU!

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Credit: Nathan W. Pyle