

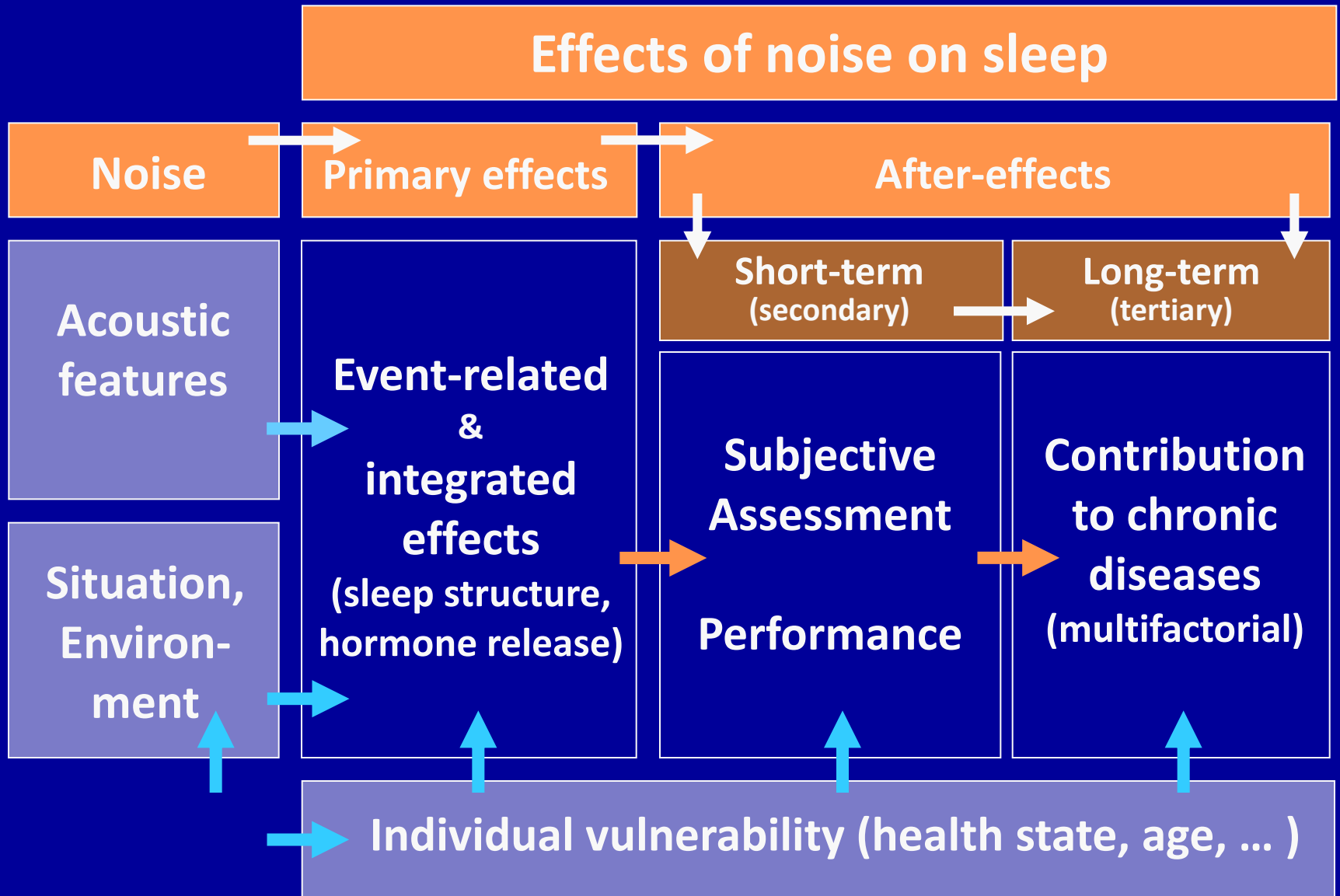
ENNAH

European Network
on Noise and Health

Priorities New directions for noise & sleep research

London, Feb 17-18 updated for FAA-workshop April 19, 2011

Noise-induced sleep disturbances



State of the art – further directions

State of the art

- types of reactions
- mechanisms
- correlations
- dose-response-curves

allows

- to identify gaps
- to design directed studies

Priorities depend on the development

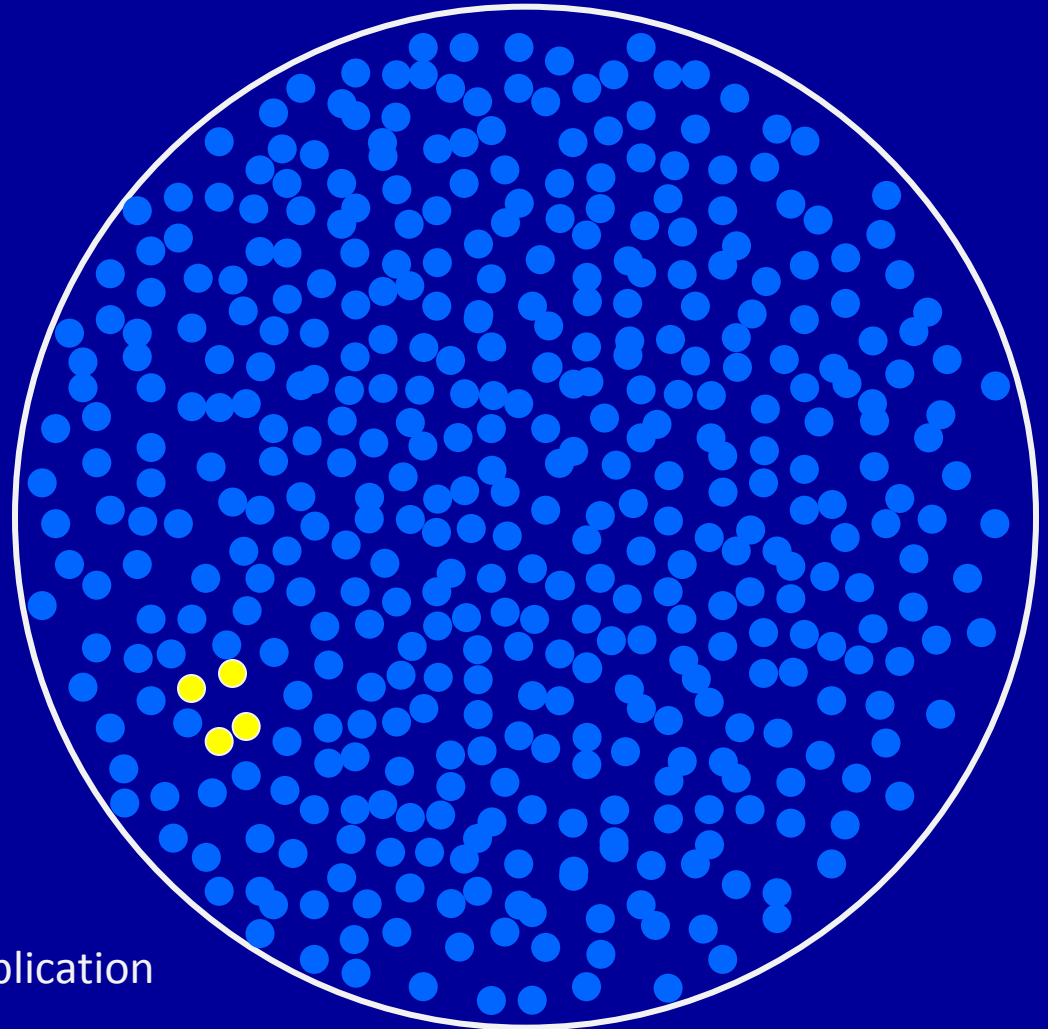
- of acoustic environment
- of the general environment

and concern (primarily)

- effects/final outcomes
- causal relations
- vulnerable groups

and new methods

- development, validation & application



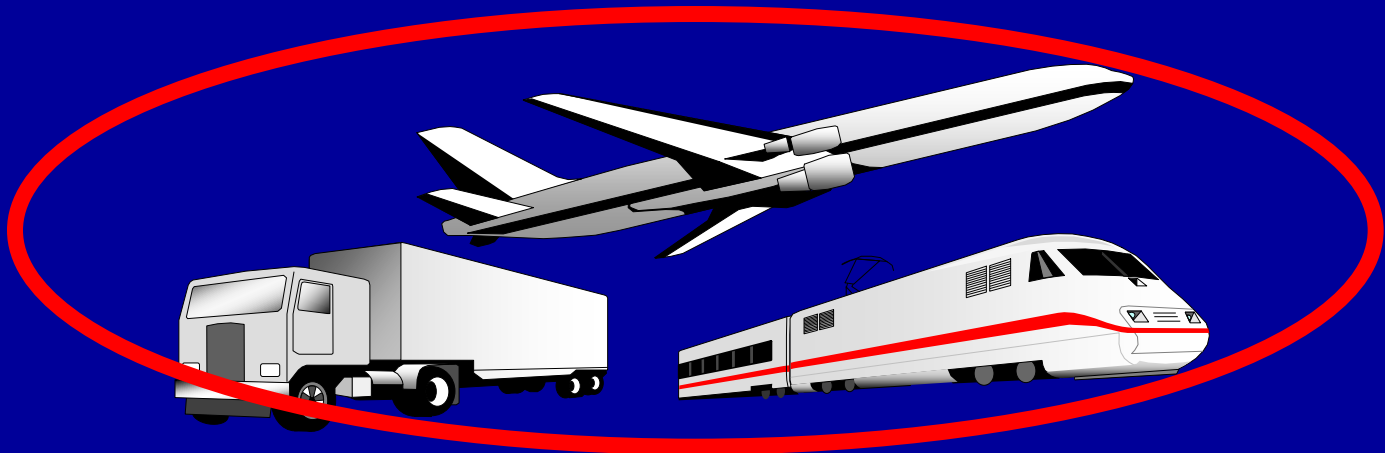
Acoustic situation

➤ Transportation noise

- number
- temporal distribution
- speed

- Road traffic: evasion into nights
- Railway: frequency and speed (rise time)
- Aircraft: nocturnal flights at few airports

Single and combined noise sources



Other noise sources

- **Wind turbines**
- Neighbourhood noises
- Industrial noises
- Leisure time noise

Environment – combined pollution

Physical – light pollution, global warming



Chemical – air pollution (toxic)



Psychosocial – stress, time pressure

**Increase of arousal level
overflow**



Arousal Degree

Effects/Indicators

Methods

Maximum Arousal

~1-5 per night

Wake periods (> 1 min),
with reoccurrence of consciousness

Push Button,
Actimetry,
Polysomnography

~23 per night

Micro-wakeings (> 15 s)
body movements

Actimetry,
Polysomnography

Evaluation:
'Macro' reactions

Micro-wakeings (> 15 s)
body movements

Polysomnography

~120 per night

'Nano' reactions

Micro-arousals
stage changes

Polysomnography

~100 per night

Micro-arousals
EEG accelerations (> 3s)
w/o sleep stage changes

Polysomnography

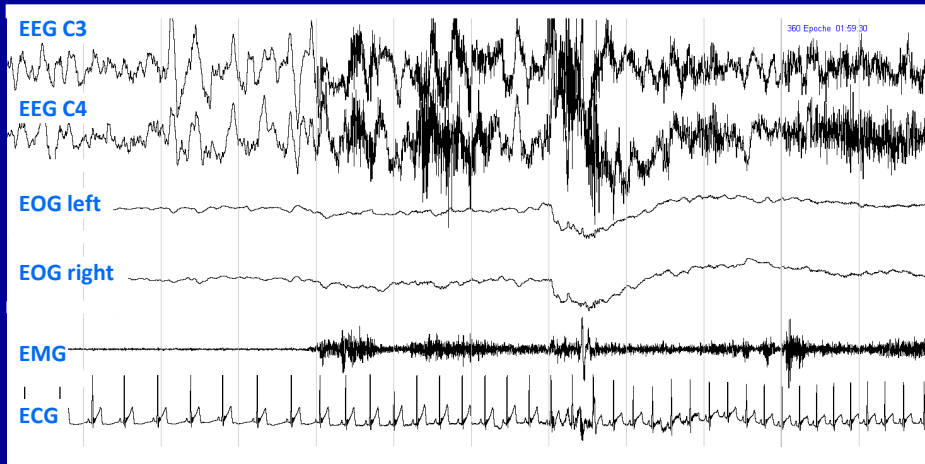
Minimum Arousal

Autonomic arousals

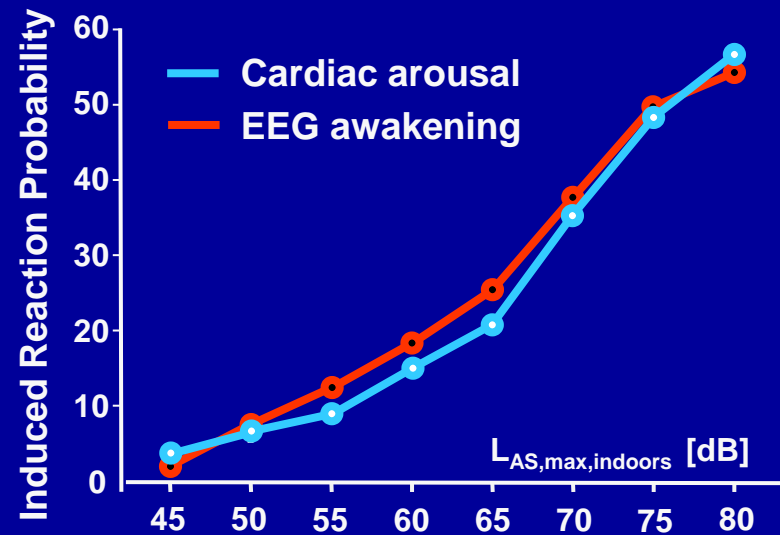
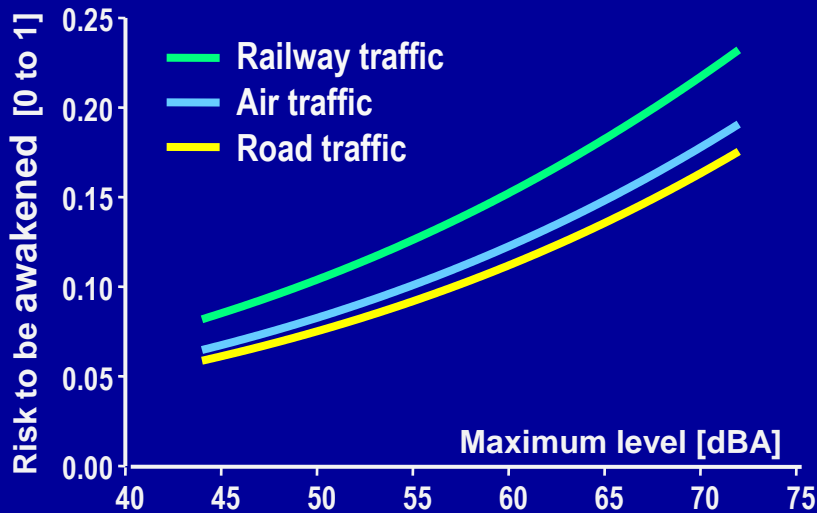
RR-measurements,
Pulse Transit Time, ECG

Stimulation of ARAS through internal or external stimuli

Effects/Indicators

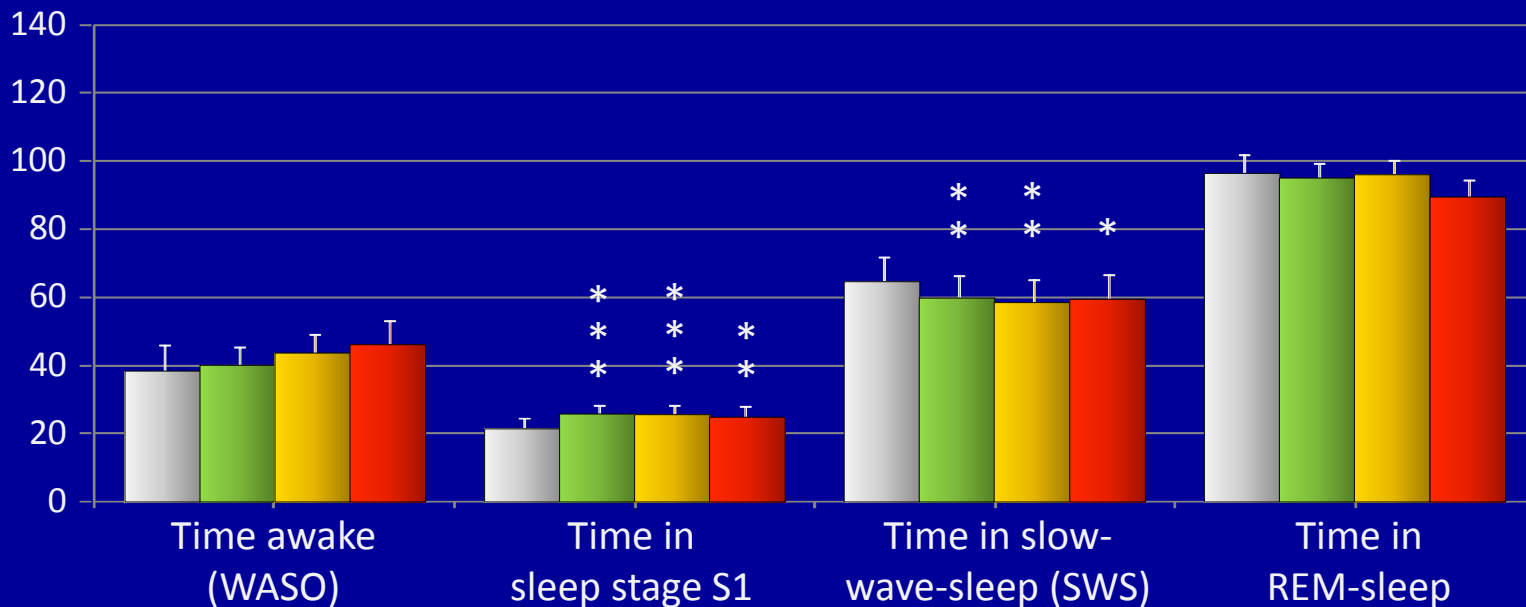
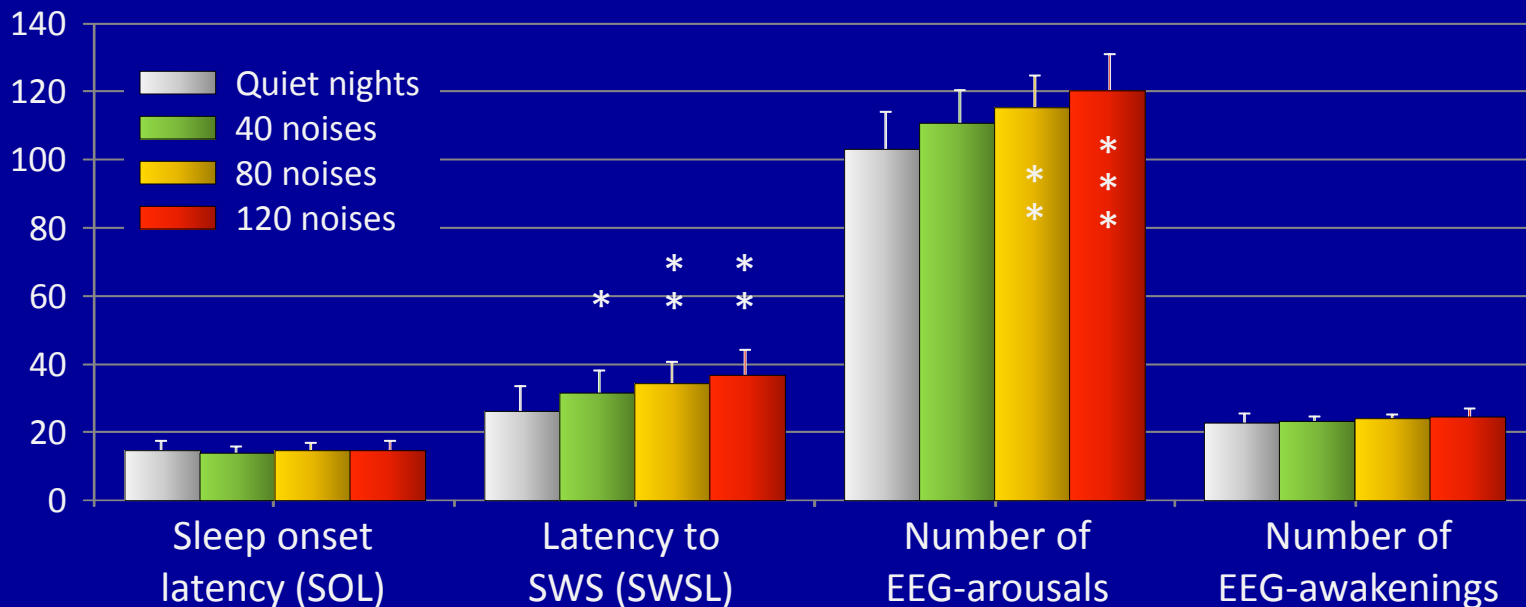


→ to develop reliable, valid & economic methods to record and evaluate autonomous arousals

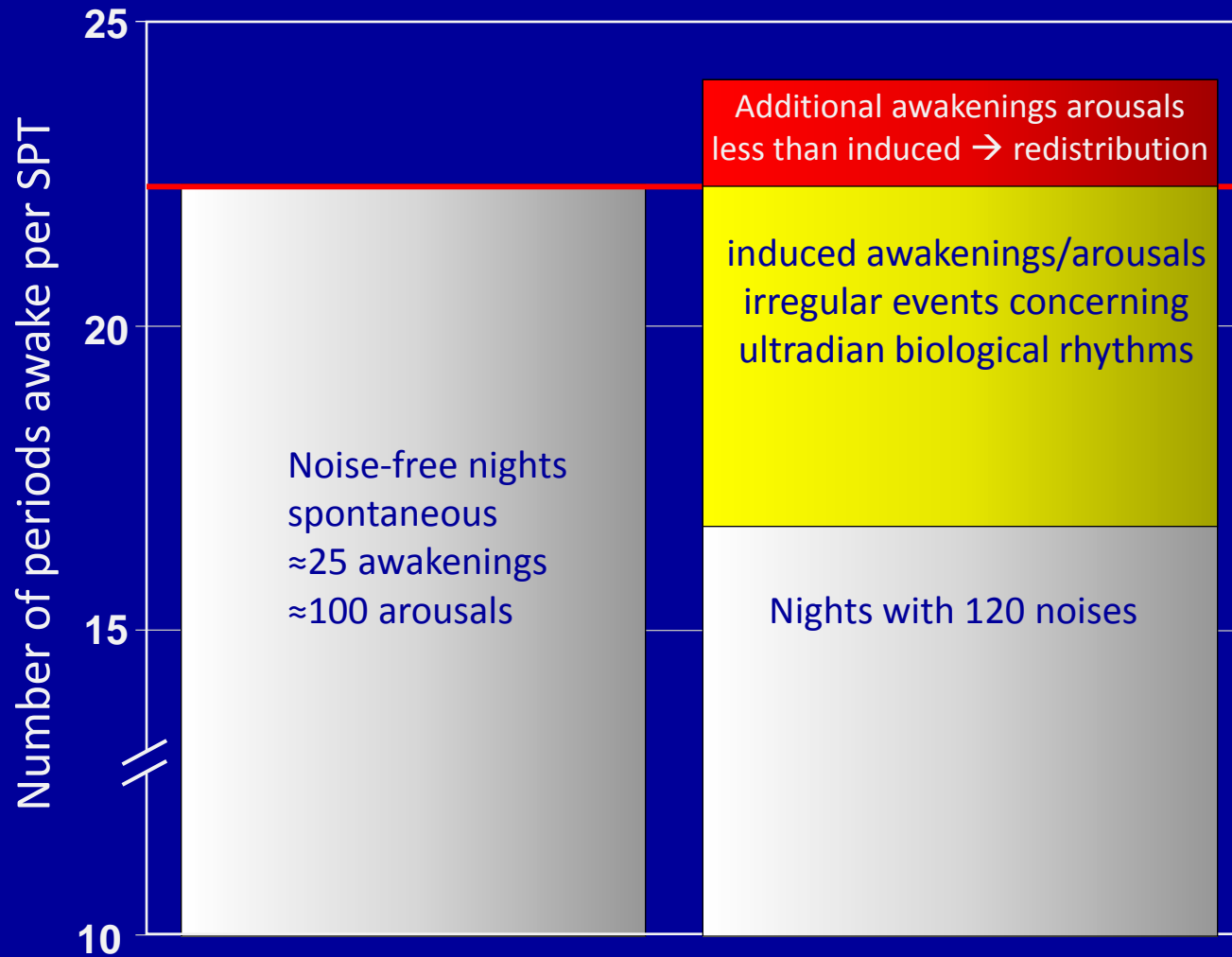


Effects on sleep structure

Minutes/number and 95% confidence intervals



Spontaneous and induced awakenings/arousals



Noise-free nights
spontaneous
≈ 25 awakenings
≈ 100 arousals

Additional awakenings arousals
less than induced → redistribution

induced awakenings/arousals
irregular events concerning
ultradian biological rhythms

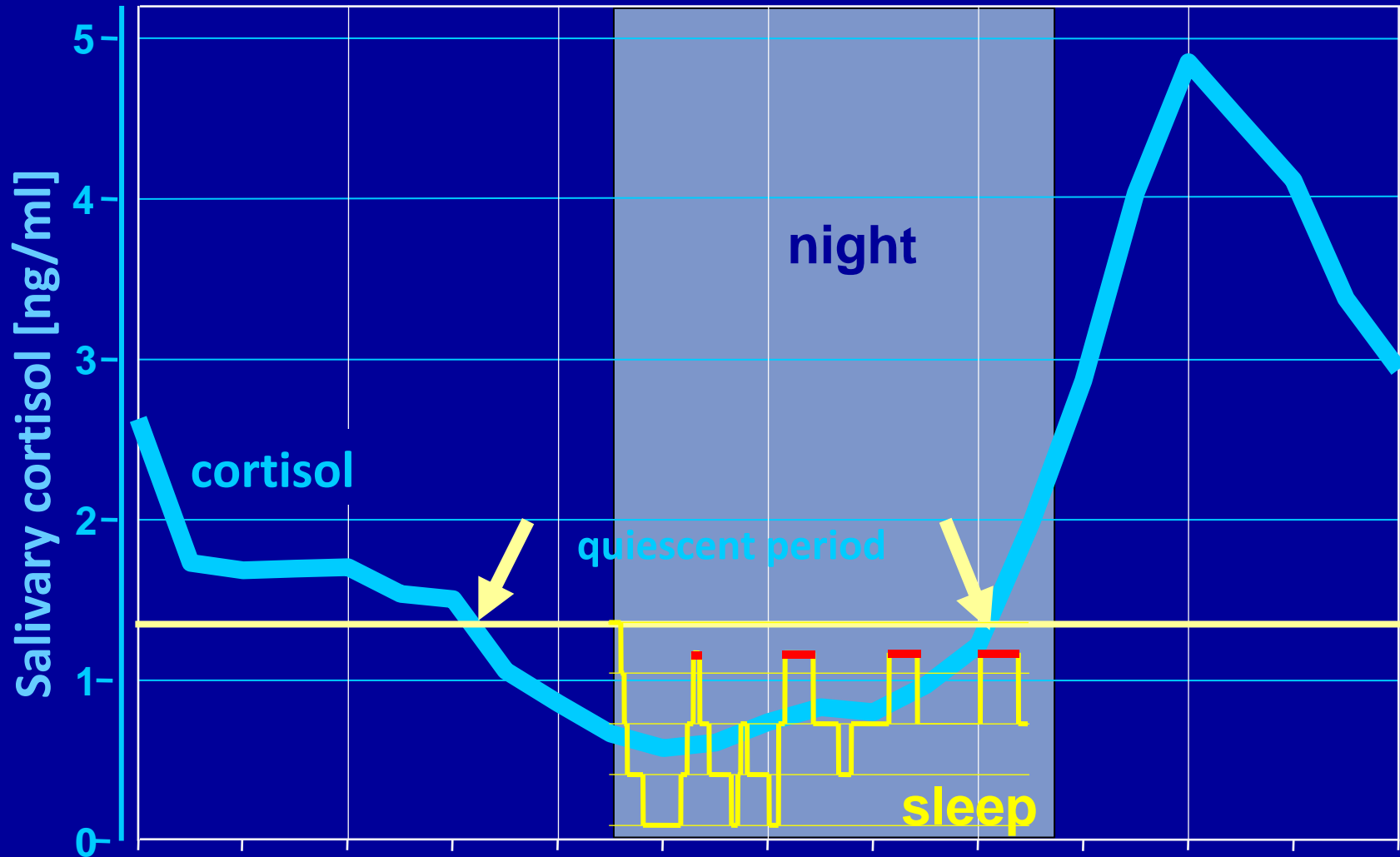
Nights with 120 noises

→ Clarify the significance of
additional/redistributed events

→ Clarify whether arousals/awakenings
indicate fragmentation/ultradian cycle

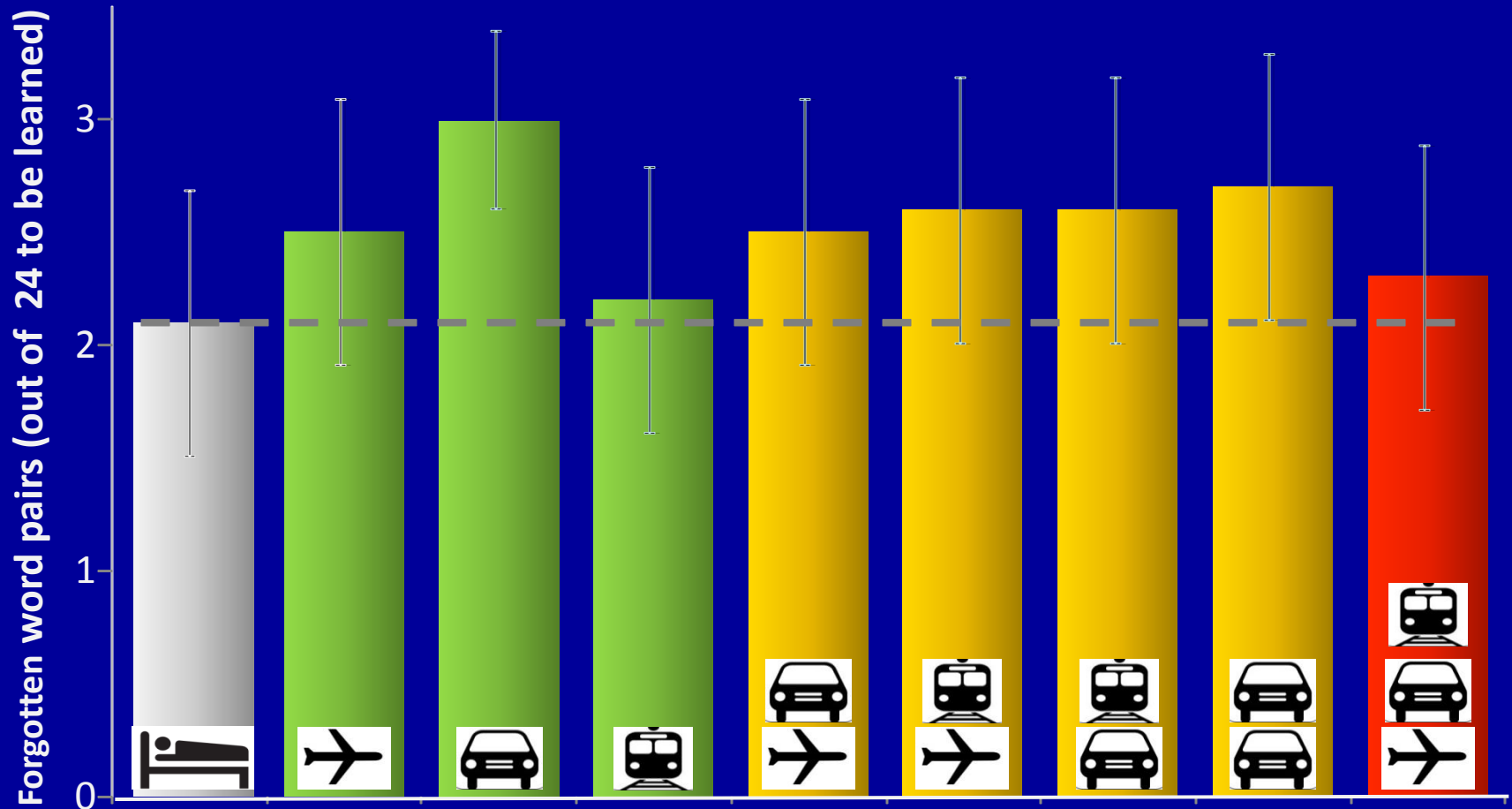
Effects: Performance clearly related to sleep

Memory consolidation depends on relation cortisol/SWS



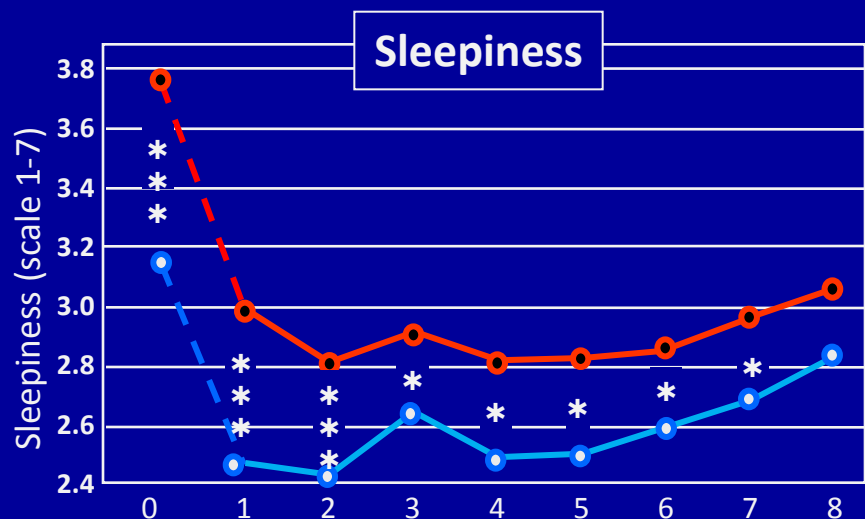
204 ss, 49f, 155m, 18-37 yrs)

Effects: Performance clearly related to sleep (Memory consolidation)

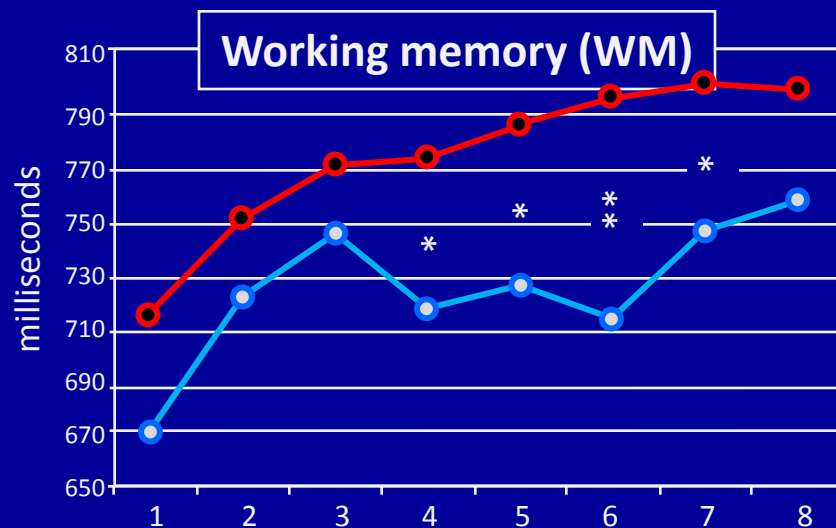
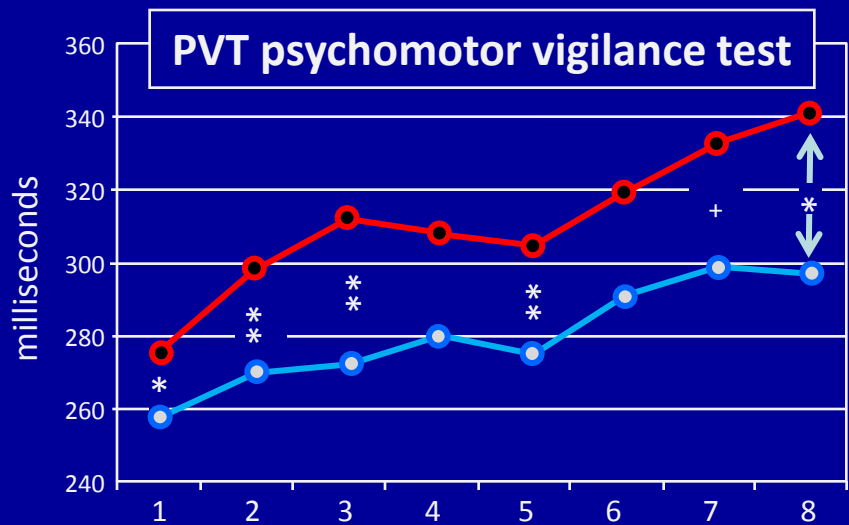


→ to increase the precision of suitable tests

Sleepiness & performance during work shifts



—●— after sleep in noise-free nights
 —●— after sleep in noisy nights

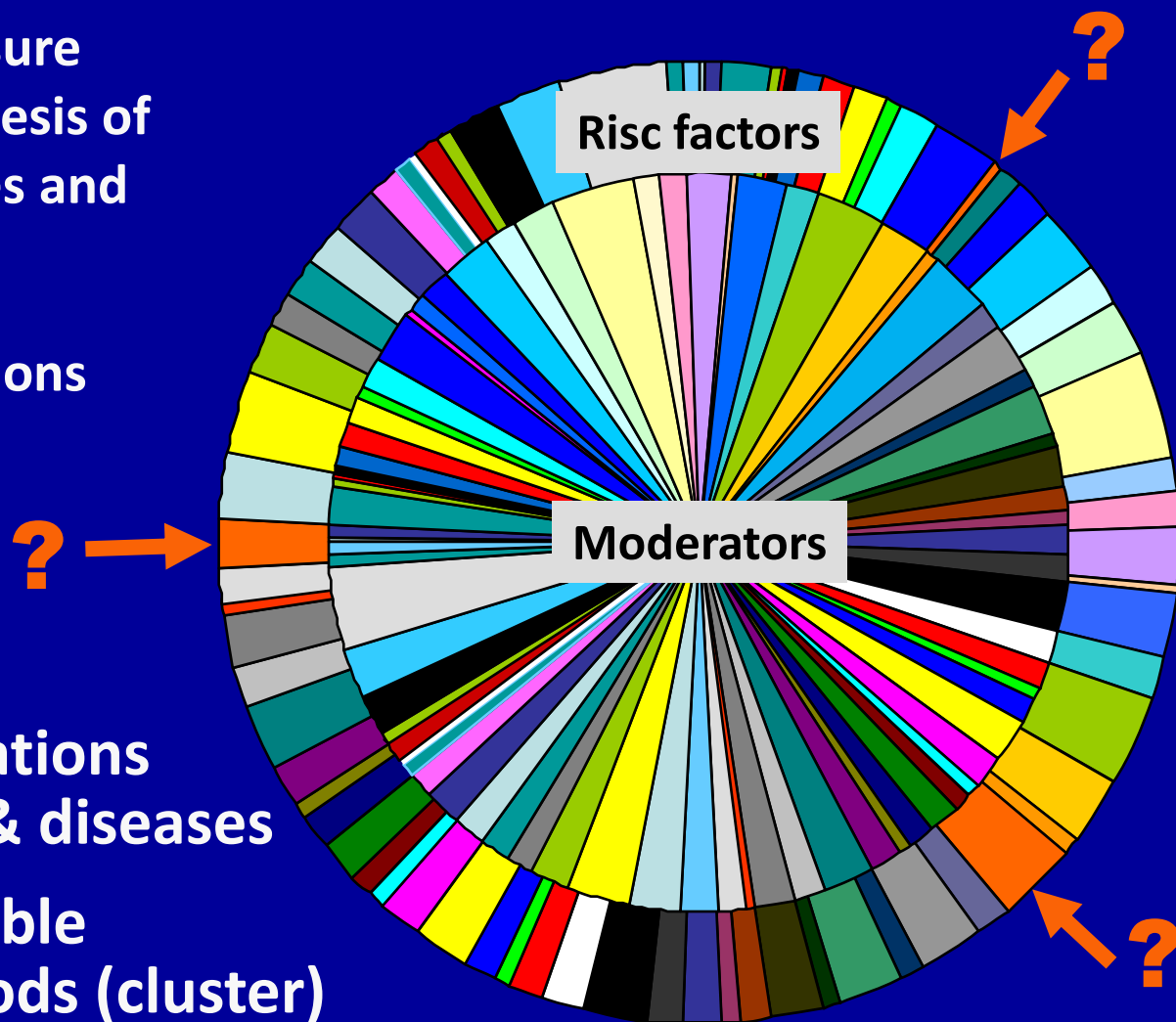


Final long-term outcome of nocturnal noise exposure appropriate approach: epidemiological studies

Nocturnal noise exposure contributes to the genesis of multi-factorial diseases and accelerated aging

- non-specific alterations
- no habituation

- ➔ to clarify associations between noise & diseases
- ➔ to develop suitable statistical methods (cluster)



Causal relations between noise and final outcome

The uncertainty about causal relations increases with the time until a reaction occurs



Causal relations between noise and final outcome



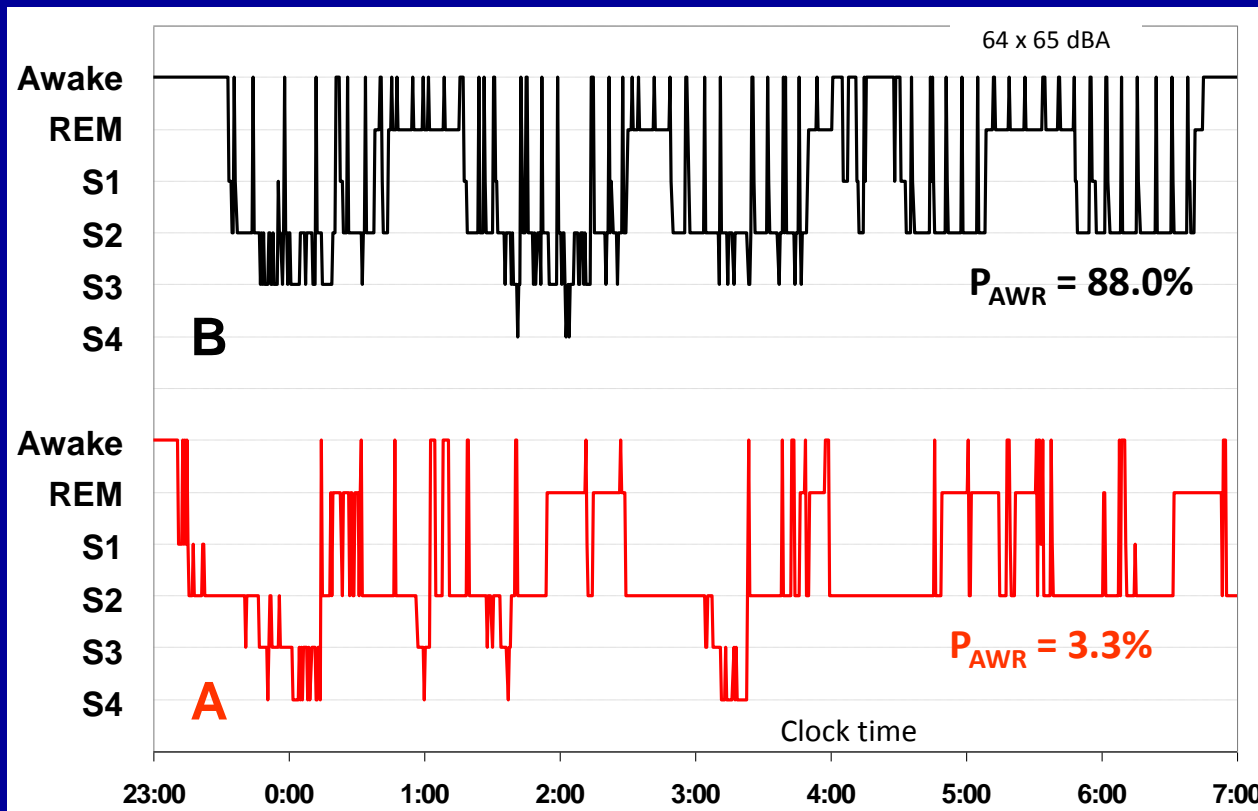
Why – scientific: to identify pathways/mechanisms
practical: to evaluate abatement measures

→ e.g. by recording defined effects in persons with exposure of different lengths (successive cross sectional studies)

Vulnerable groups

What is vulnerability ?

- an accelerated development of (supposed) final outcomes
- determined by lower thresholds and/or stronger reactions



➔ to clarify what vulnerability is

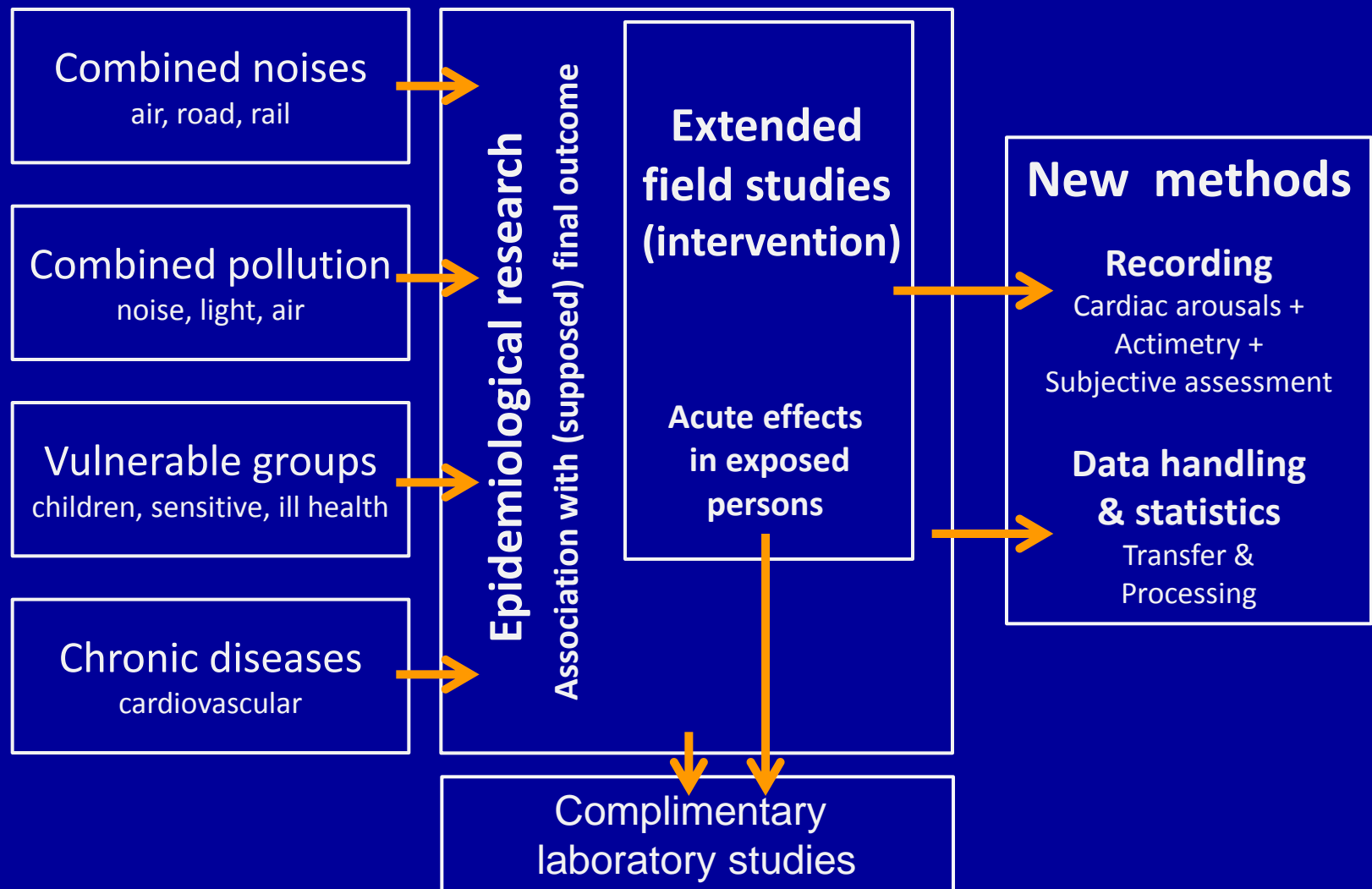
Vulnerable groups

Who is (supposed to be) vulnerable ?

Persons that are (supposed to be) vulnerable

- children (sleep when traffic density is high)
- ill health (generally elevated arousal levels)
- insomniacs (elevated arousal levels)
- older persons (advanced circadian phase, reduced SWS)

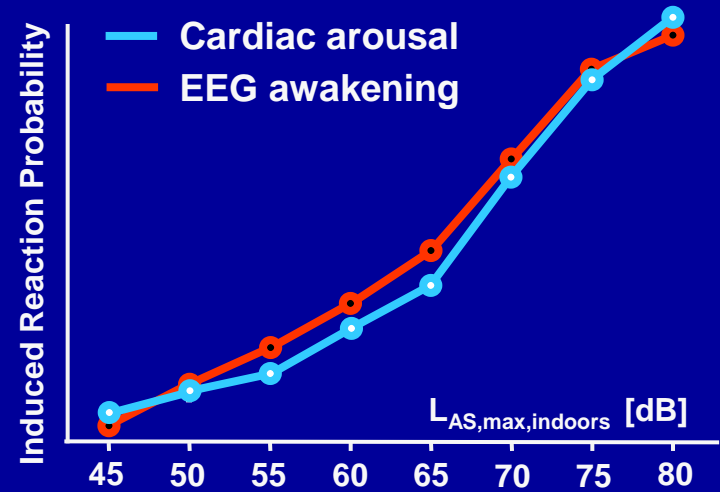
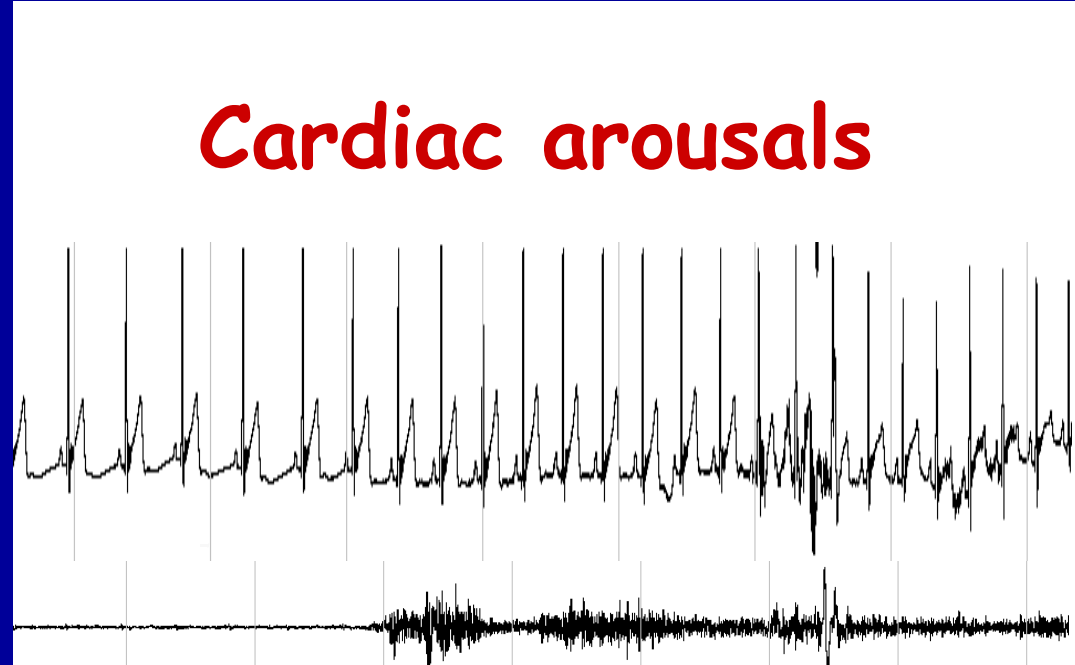
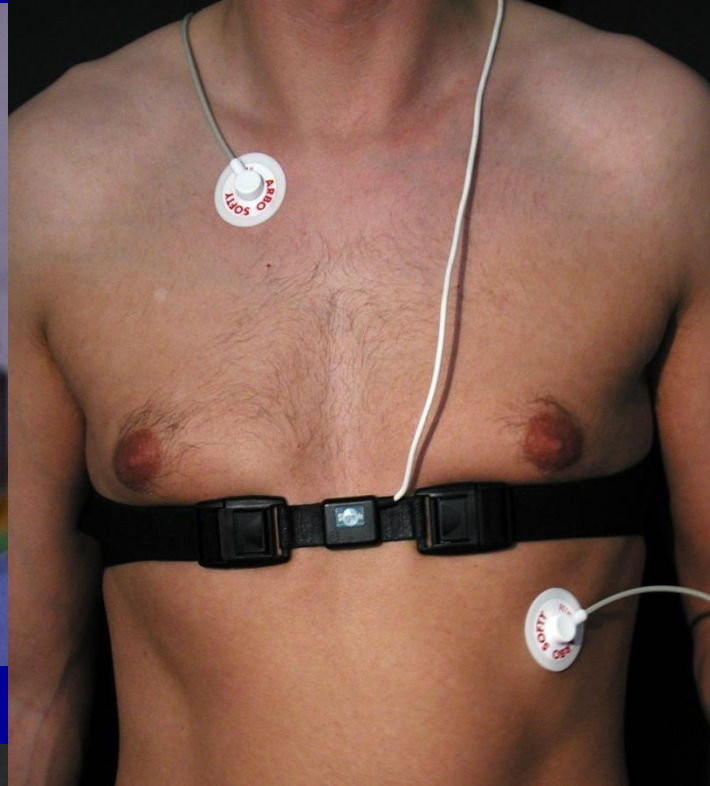
Approaches for the most important topics



Methods indicating sleep disturbances

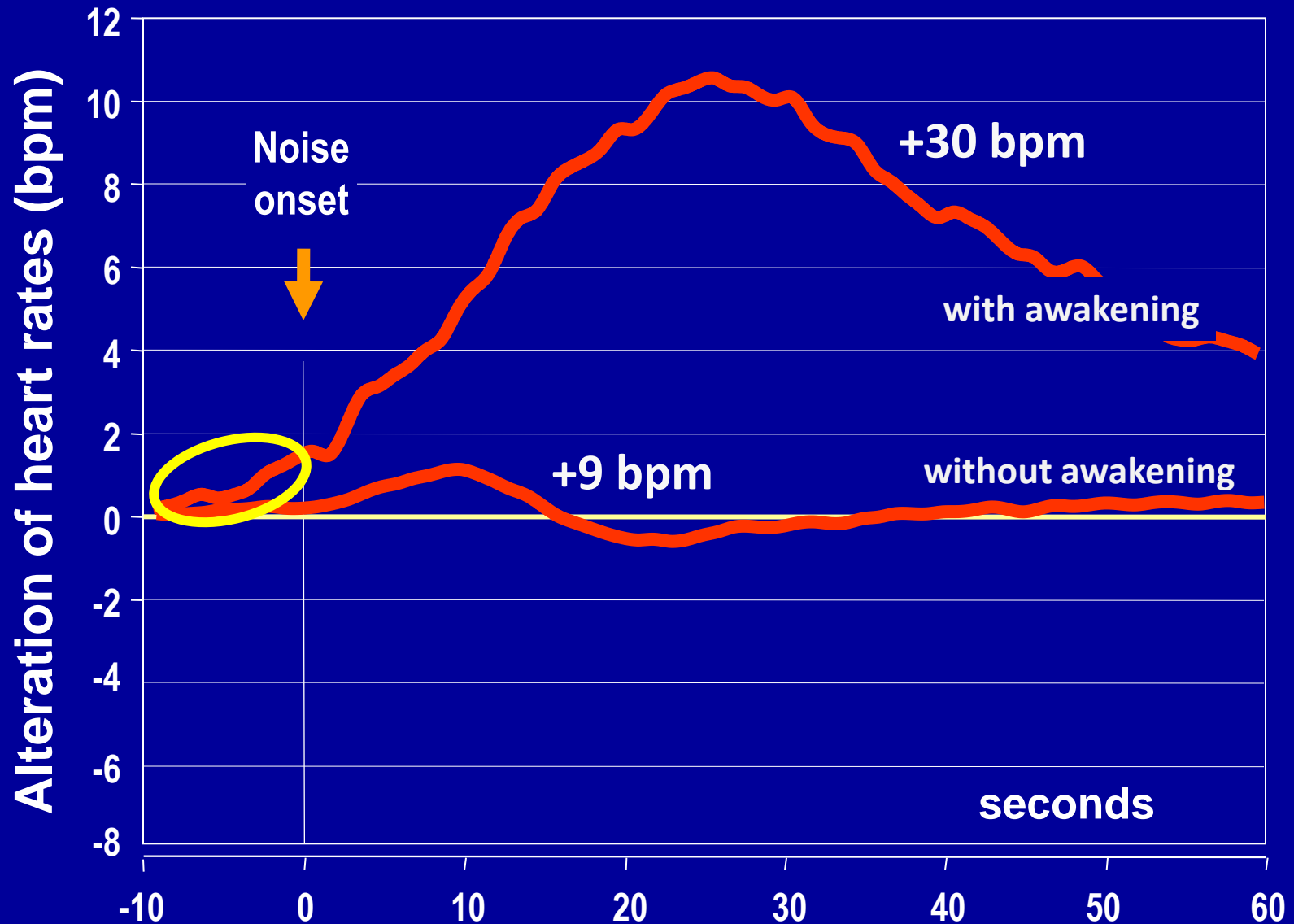
	pro	contra
Polysomno- graphy (PSG)	<ul style="list-style-type: none"> ➤ Gold standard for evaluation of sleep structure & sleep fragmentation ➤ Well standardized ➤ Very sensitive (detection of subtle physiological changes) 	<ul style="list-style-type: none"> ➤ Electrodes somewhat invasive → influence sleep ➤ Trained personnel to attach electrodes & analyse data → expensive ➤ Inter-rater variability in sleep staging
Actimetry	<ul style="list-style-type: none"> ➤ Easy to use → inexpensive ➤ Less invasive than PSG ➤ Detects moderate body movements 	<ul style="list-style-type: none"> ➤ Low degree of standardization (hardware, algorithms for analysis) ➤ Misclassifications (wake → sleep → wake)
<u>Signalled awakening</u>	<ul style="list-style-type: none"> ➤ Easy to use → very inexpensive ➤ Non-invasive ➤ High specificity (i.e. few spontaneous signaled awakenings) 	<ul style="list-style-type: none"> ➤ Not standardized (instructions) ➤ Low sensitivity ➤ Sleep may be altered by demanding active cooperation ➤ Motivation influences results
<u>Question- naire</u>	<ul style="list-style-type: none"> ➤ Easy to use → very inexpensive ➤ Non-invasive ➤ Good self-rated sleep is a primary goal of noise mitigation policy 	<ul style="list-style-type: none"> ➤ Subjects unaware of their surroundings during sleep → assessment related to periods awake ➤ Substantial discrepancies between subjective and objective evaluation of sleep possible
<u>Electro- cardiogram</u>	<ul style="list-style-type: none"> ➤ Easy to use → inexpensive ➤ Less invasive than polysomnography ➤ Automatic algorithm for data analysis → objective and not time consuming ➤ Good agreement with EEG awakenings ➤ Repeated autonomic arousals may be reason for long-term health effects 	<ul style="list-style-type: none"> ➤ Not yet standardized ➤ Further validation needed

Polysomnography vs cardiac arousals



Event-related cardiac arousals during sleep

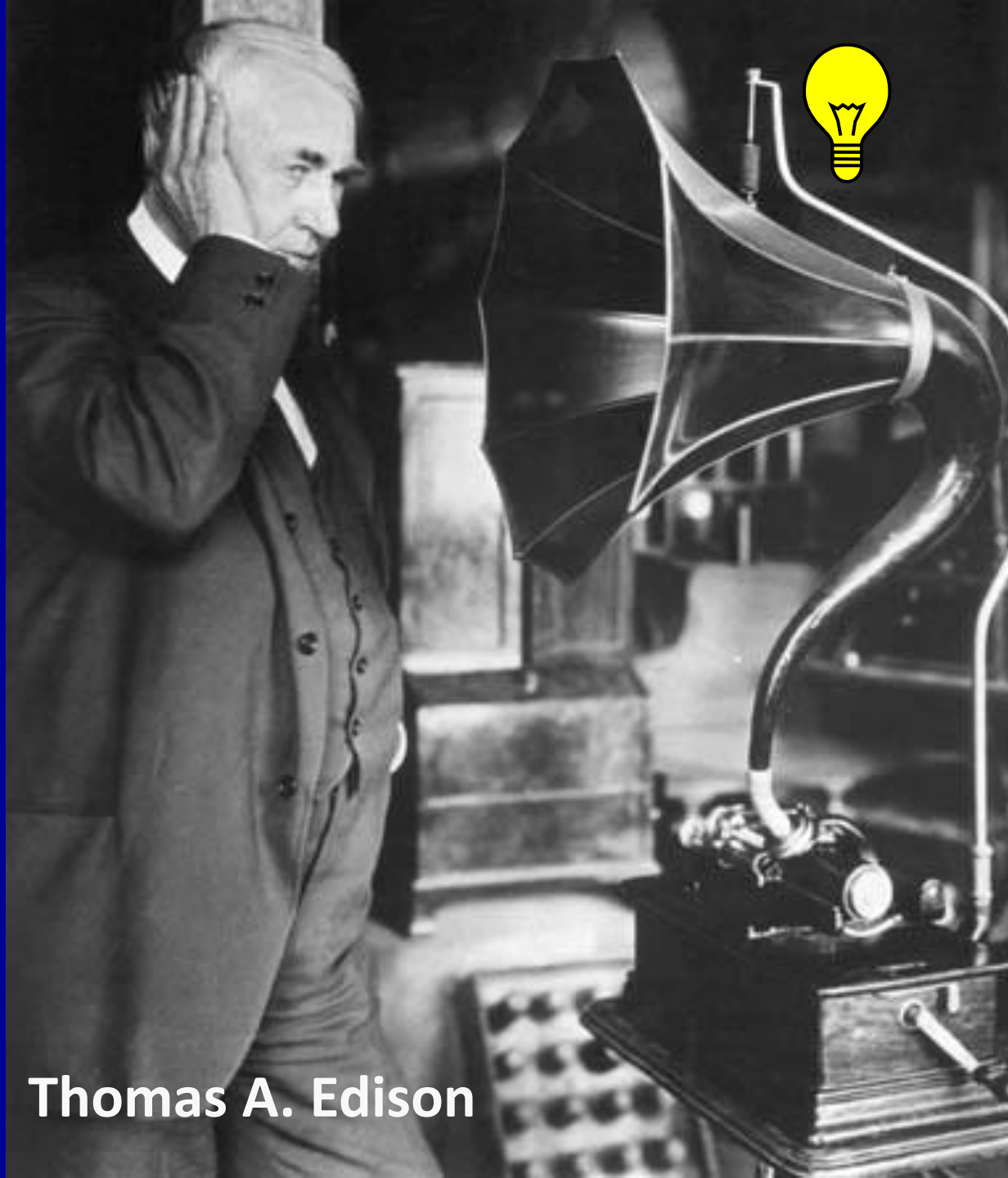
quantitative and qualitative differences with/without awakening





Thanks for listening

Barbara Griefahn, Mathias Basner, Ken Hume



Thomas A. Edison