HAZARDS OF SLEEPINESS

Pupillography detects daytime sleepiness

- Shortened version for EAGOSH Website -

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Sphere of Competence II
Autonomous Nervous System and Safety Studies
PST= Pupillographic Sleepiness Test
PUI= Pupillary Unrest Index
The Hazards of Sleepiness

... underestimated for a long period of time
The Hazards of Sleepiness

- little research about the problem
- difficult assessment
  - subjective scales
  - questionnaires
  - performance tests
Sleepiness at the Wheel

• about 25 % of all fatal highway accidents due to sleepiness at the wheel

• peaks of traffic accidents at times of chronobiological low performance level: early morning hours (predom. young drivers) and early afternoon (predom. elder drivers)

• 40 % of all fatal traffic accidents happen during the night from friday to sunday
Sleepiness at the Wheel

- many accidents are related to work: drivers of lorries, goods vehicles, company cars
- many sleepiness-related accidents happen during night shift work, driving home afterwards
- sleepiness does not occur spontaneously without warning
Sleepiness at work
- with fatal consequences like ...

- Exxon Valdez
- Harrisburg
- Bhopal
- Challenger
- Tschernobyl
Sleepiness at work - often has consequences

• subjects involved in work accidents report more sleep complaints than others

Why and how use the pupil?
PUPILLARY OSCILLATIONS IN DARKNESS

→ Reflect (tonic) central nervous activation

→ provide objective, quantitative assessment of daytime sleepiness
Pupillographic sleepiness test (PST)
The „Story“ of the PST

- first description of sleepiness-induced oscillations by Löwenstein & Lowenfeld 1963
- only anecdotal
The „Story“ of the PST

• Idea and start of development 1993
• Supported by fortüne and DFG
• Patent by UKT 1997
• Licensed by AMTech 1997
• Introduction into Sleep Research and Sleep Medicine since 1995
• New golden standard for the objective assessment of daytime sleepiness
Pupillographic sleepiness test (PST)

How does it work?
PST: Setting

PST see also http://www.amtech.de

- 11 minutes sitting
- head fixated on chin rest
- darkness
- quiet
- clinical conditions:
  - 4 h before
    - no caffeine, nicotine, alcohol
PST: Method of recording

- Infrared Video Pupillography
- Automated Analysis
- Parameter: Pupillary- Unrest-Index (PUI, mm/min)

![Graph showing alert and sleepy states](image)
Test quality criteria of the PST

✓ Standardization
✓ Validation
✓ Normal values
✓ Specificity/Sensitivity
✓ Objectivity
✓ Economy

Normal value range: Percentiles of normal subjects 20 - 60 years (n=349)

<table>
<thead>
<tr>
<th>Wertebereich</th>
<th>MW-2SD</th>
<th>MW-SD</th>
<th>MW</th>
<th>MW+SD</th>
<th>mean+2SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln PUI/ [mm/min]</td>
<td>0,73</td>
<td>1,11</td>
<td>1,50</td>
<td>1,89</td>
<td>2,28</td>
</tr>
<tr>
<td>Perzentile</td>
<td>2,3%</td>
<td>15,9%</td>
<td>50%</td>
<td>84,1%</td>
<td>97,7%</td>
</tr>
<tr>
<td>PUI/ [mm/min]</td>
<td>2,07</td>
<td>3,05</td>
<td>4,50</td>
<td>6,64</td>
<td>9,80</td>
</tr>
</tbody>
</table>
PUI does not depend on age or gender

(n=349)
PST
at present used in

• Sleep research and sleep medicine
  – objective assessment of daytime sleepiness in the diagnosis and therapy of sleep disorders

• Clinical pharmacology
  – drug-induced sleepiness

  • traffic medicine
  • industrial medicine
The PST Highway Project No 1 and 2
(Road house Gräfenhausen, A5)

• First objective studies investigating driver sleepiness in Germany

initiated by H-G Weeß
Sleep Lab Pfalzklinik
The PST Highway Projects

- Spring 2001
- Summer 2002
- three medical centers
- 24 hours
- supported by
  - AMTech
  - Praxis, ZDF
  - Stern TV, RTL
The PST Highway Projects: methods

- Recruiting drivers at the gas station / while parking
- Questionnaire
- PST-recording in four containers

Photography
The Highway Projects: Questionnaire

- Pittsburgh Sleep Quality Index
- Subjective alertness and subjective ability to drive
- Specific questions
  - Car type
  - Driving characteristics
  - Time at the wheel
  - Breaks
  - Planned route ahead

Photography
Results
Demographics No1

• n = 156 car- and truck-drivers:
  n = 39 truck-drivers
  n = 117 car-drivers
• Gender:
  n = 31 women
  n = 125 men
• Age range: 18 - 69 years
• Mean age: 40,78 (± 11,37) years
Results
Demographics No2

- n = 164 car- and truck-drivers:
  n = 27 truck-drivers
  n = 128 car-drivers
- Gender:
  n = 21 women
  n = 143 male
- Age range: 18 - 68 years
- Mean age: 39.93 (± 12.39) years
Pupillary Unrest-Index

classified according to normal value range

- normal \(<MW + 1 \text{ SD}\)
- suspicious \(MW + 1 \text{ SD to MW + 2 SD}\)
- pathological \(>MW + 2 \text{ SD}\)
PST at the Road House

- Both studies show considerable differences
- time of the year / temperature
- sample
  - both few truck drivers
  - No 2: many vacationists
  - *classical „start of vacation model“*...
PST at the Road House

• The classical „start of vacation model“
  – come home late from work
  – pack car late
  – go to bed much later than usual
  – go up much earlier than usual
    • reach destination early
    • avoid crowded roads

  partial sleep deprivation
Sleepiness at the wheel (No1)
PUI-values in car- and truck-drivers

PKW

- 79
- 15
- 6

LKW

- 61
- 16
- 23

Weeß, Binder and Steinberg 2002
Sleepiness at the wheel (No 2)
A comparison of shift workers vs others

Weß, Binder and Steinberg 2002
Sleepiness at the wheel (No2)
Vacationists vs others

Weeß, Binder and Steinberg 2002
Sleepiness at the wheel

Summary

- 25% - 42% of all drivers show significant daytime sleepiness
- In truck drivers, shift workers, holiday-makers the number of severely sleepy subjects is higher
- Sleep duration and sleep quality is not the major underlying reason of the detected sleepiness
Sleepiness at the wheel

Summary (2)

- main reason for sleepiness at the wheel are long hours of operation / long distances

- drivers recognize their own sleepiness but overestimate their ability to drive

- despite excessive sleepiness drivers do not draw the consequences (breaks, naps) but continue to drive for many more miles
Sleepy drivers - WHAT TO DO?

Only a nap helps to fight sleepiness!

... plus caffeine
Sleepy drivers - WHAT TO DO?

Sleepy drivers - WHAT TO DO?

- A) suspected PUI
  - power nap (10-15 Min)
  - caffeine (1-2 cups coffee / Energy drink)
- B) pathologic PUI
  - change driver
  - like A) and stop driving as soon as possible
Sleepiness on the roads

- the problem is obvious
- can now be measured objectively
- Studies for the optimization of working places in transportation are needed and feasible
- public information and prevention is needed in the interest of safety
Sleepiness not on the ground only

Sleepiness can fly

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http://www.dia.de/pupil
(further publications)