Awareness of sleepiness – on the road, in the air, and the link to safety, physiology and other factors

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In collaboration with Anna Anund, Christer Ahlström, and Carina Fors of the Swedish Road and Transport Research Institute, and many others
First some points about the studies
Sleepiness ratings
Karolinska Sleepiness Scale - KSS

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>extremely alert</td>
</tr>
<tr>
<td>2</td>
<td>very alert</td>
</tr>
<tr>
<td>3</td>
<td>alert</td>
</tr>
<tr>
<td>4</td>
<td>rather alert</td>
</tr>
<tr>
<td>5</td>
<td>neither alert nor sleepy</td>
</tr>
<tr>
<td>6</td>
<td>some signs of sleepiness</td>
</tr>
<tr>
<td>7</td>
<td>sleepy, but no effort to keep awake</td>
</tr>
<tr>
<td>8</td>
<td>sleepy, some effort to keep awake</td>
</tr>
<tr>
<td>9</td>
<td>very sleepy, great effort to keep awake, fighting sleep</td>
</tr>
</tbody>
</table>
The driving studies

The simulator

The instrumented vehicle

Comparison: day drive vs night drive (01-05h)
The key variables

EEG – Alpha/theta activity

EOG Blink duration

Sleepiness ratings /5 min

Lateral variability
Speed
Steering wheel movement
Line crossings
A detailed example
What comes before being taken off the road because of dangerous sleepiness

Sleepiness KSS

Motorway, 42% are taken off the road for dangerous sleepiness. 01:00-04:30
Blink duration

Level at termination
EEG alpha/theta activity

Value at termination
Unintentional line crossings
So, dangerous sleepiness is very common in late night driving on the motorway
Is there a link to other sleepiness symptoms, physiology or driving performance?
KSS vs line crossings and blink duration – night drive in simulator

Ingre et al 2006
KSS and the probability of a line crossing within 5 minutes – real driving

Night drive

Hallvig et al 2014
Probability of being taken off the road and immediately preceding KSS – real driving

Night drive

Akerstedt et al 2013
KSS and blink duration & theta power – night drive in simulator

Ahlström et al. in prep

N=30
Between groups sleepiness in three groups differing in rumble strip hits during a drive (simulator)

N=45
Morning drive after night shift

Anund et al 2007
So, there is a steep rise in risky driving at KSS 8&9 – within and across individuals
Consistency
KSS consistency across driving studies
Consistency across individuals
- KSS at 08:00h after a night shift – simulator

Åkerstedt et al 2014
The relentless nature of sleepiness
Hitting a rumble strip while driving the simulator home after a night shift

N=45; 90min

Blink duration

SDlat

Alpha/theta

KSS
But, the hits keep occurring

Watling et al 2014
So, sleepiness is relentless
(Work) schedules
Night work in occupational groups

Time of day

Sleepiness - KSS

very sleepy

effort/fight

SHIFT W

TRUCK D

AIR CREW

sleepy-

no effort

neither

alert

evening

early

night

late

out

return

1 2 3 4 5 6 7 8 9

12 24 06 18 24 12 24 12 24
3-shift workers – different studies

Åkerstedt et al 2014
Long-haul flights (8-11h), pilots
Is 4 hours of sleep enough? Or 8 hours?

N=15
Simulator

Åkerstedt et al 2010
So, late night work is very conducive to sleepiness
Other influences
Work or not?

N=500
1 week
Different occupations

Åkerstedt et al 2017
A break? – truck drivers during the night on the highway

N=10 (truck drivers)
Duration of drive (real road) and sleepiness – the only study controlling for time of day, time awake and prior sleep

Sagaspe et al 2008
The simulator vs real driving (stimulation?)

N=10

Hallvig et al, 2011
Age and KSS during night driving in simulator

N=20
21 and 59 years

KSS

Minutes of drive

Lowden et al 2009
Sick listed?

N = 37 (of 800) 1 week with 3-hourly ratings
Experimentally sick?

Lipopoly-sacharide injection

placebo

Sleepiness

IL-6 (pg/mL)

Andreasson et al., in prep
So, more than sleep/wake timing affect sleepiness
Summary pattern

- Burnout
- Patients
- Night
- Shift
- Work
- Insomniacs
- 5d 4h sleep
- Ill
- Work
- Weekend
- Late
- Night
- Driving
- Night
- Shift

Time BO

kss BO
Conclusions

- Individuals are quite aware of their sleepiness level
- High sleepiness is closely related to risk behavior and sleep related physiology
- A key risk situation is late night work/activity
- But, time on task, boredom, being ill, being young, and others will exacerbate
- 8h of prior night sleep will not prevent late night sleepiness risk