CARRS

In the blink of an eye:

The circadian effects on ocular and subjective indices of driver sleepiness

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Introduction

- Approximately 1,300 fatalities occur from the trauma of road crashes each year
- Strongest evidence (case-control data) suggests that 19% of all fatal and severe crash are due to sleepiness
  - Younger drivers are over represented
- Crashes often have mutifactoral causes
- Self-awareness of sleepiness (i.e., subjective sleepiness) remains a critical component for mitigation of risk

Introduction (2)

- There is low correspondence between subjective and physiological measures

- Subjective sleepiness evaluations are effected by extraneous activities
  - E.g., Verbal interactions or physical movements

- Variability in the ability to predict sleep onset when highly sleepy

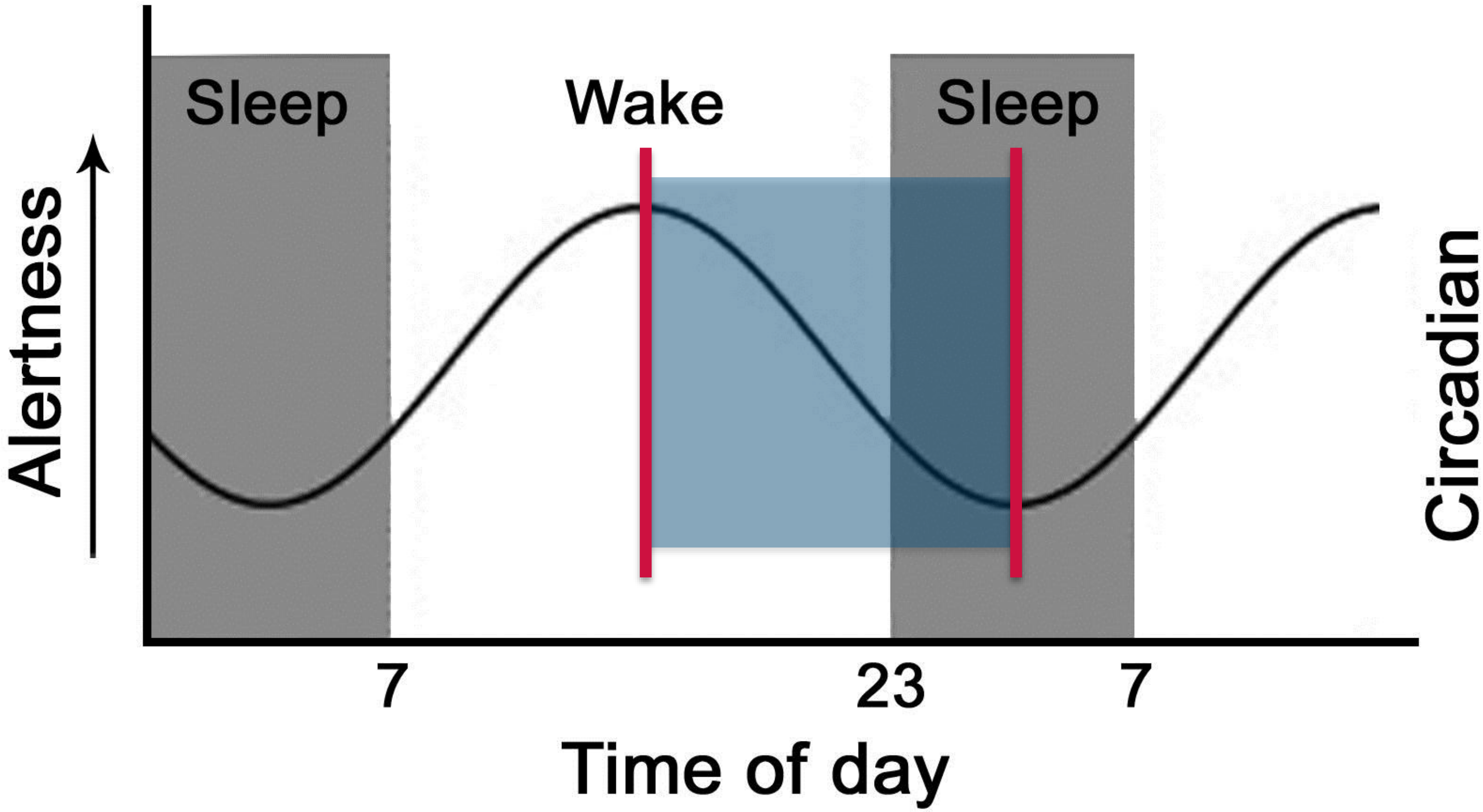
- Physiological measures appear to have potential as a reliable measure of sleepiness

Introduction (3)

- Ocular indices have some potential as a reliable measure of physiological sleepiness
  - blink rate, blink duration, blink amplitude, percentage of eyelid closure, eyelid closing/opening speed
- An advantage of ocular indices is that they can be recorded via non-contact methods
- Blink rate and blink duration have been associated with increases in sleepiness
- Increases in blink rate and blink duration also correlate with poorer driver performance indices

Circadian Rhythm Influences

- The circadian rhythm promotes alertness during the daytime and sleepiness during the night time



Circadian Rhythm Influences

- The circadian rhythm promotes alertness during the daytime and sleepiness during the night time
- A higher proportion of sleep-related crashes during the descending phase
- Subjective measures have been found sensitive to the afternoon descending phase
- Extensive evaluations of the circadian effects on blink rate and blink duration are lacking

The Current Study

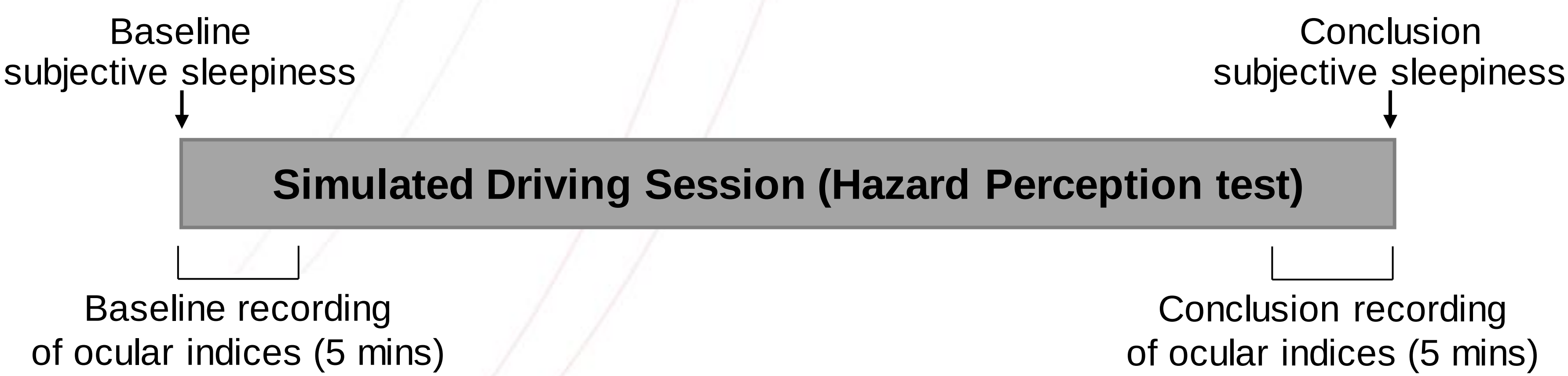
- Awareness of sleepiness is a safety critical aspect for sleep-related crashes
- Contradictory evidence regarding the relationship with subjective and physiological measures
- Extensive evaluations of blink rate and blink duration during the descending circadian phase are lacking
- **This study aimed to examine the circadian effects on blink rate, blink duration and subjective sleepiness levels**

Method

- Participants
  - In total, 26 participants (19 females and 7 males)
  - Mean age of 24 yrs (*SD* = 2.46; range = 20-28)
- Materials
  - Sleepiness Questionnaire
    - Assessed levels of sleep quality, daytime sleepiness, and awareness of sleepiness signs
  - Karolinska Sleepiness Scale (KSS)
    - Assess current levels of sleepiness
  - Ocular Indices of Sleepiness via EOG
    - Blink rate and blink duration
  - Driving stimulus: Hazard Perception task

Method (2)

- Procedure
  - On testing days participants woke at 05:00
  - No caffeine or alcohol until completion of testing
  - Instructed to **"Stop when you think you *would be* too sleepy to drive safely on the road"**
- Design
  - Participants randomly assigned to the morning (09:00) or afternoon (14:00) start time



Results

- Examination of the between groups **demographic and traffic-related demographic**
  - No significant differences were found between the morning and afternoon groups for:
    - Age; $t(12) = 1.38$, $p = .18$
    - Gender; $\chi^2(1) = 0.19$, $p = .67$
    - Years licenced; $t(12) = 1.56$, $p = .13$
    - Km/year driven; $t(12) = -1.69$, $p = .10$
    - Driving duration; $t(12) = -0.44$, $p = .66$
  - The morning and afternoon groups were deemed to have similar demographic and traffic-related demographic characteristics

Results (2)

- Examination of the between groups **sleep variables**
  - No significant differences were found between the morning and afternoon groups for:
    - Pittsburgh Sleep Quality Index; $t(12) = 1.14$, $p = .27$
    - Epworth Sleepiness Scale; $t(12) = -0.10$, $p = .93$
    - Sleep Timing stability score; $t(12) = -0.25$, $p = .81$
    - Signs of sleepiness; $t(12) = 1.48$, $p = .15$
    - Baseline KSS; $t(12) = -0.85$, $p = .41$
  - The morning and afternoon groups were deemed to have similar levels of sleep quality, daytime sleepiness, and awareness of the signs of sleepiness

Results (3)

- The morning and afternoon groups were deemed to have similar levels of sleep quality, daytime sleepiness, and awareness of the signs of sleepiness

- The morning and afternoon groups were deemed to have similar demographic and traffic-related demographic characteristics

- The analyses can proceed without having to control for these variables

Results (4)

	Time of Day of Testing					
	Morning (n = 13)			Afternoon (n = 13)		
	Baseline	Conclusion	Significance test	Baseline	Conclusion	Significance test
Data Source	**Mean (*SD*)**	**Mean (*SD*)**	**Mean Diff (*p*)**	**Mean (*SD*)**	**Mean (*SD*)**	**Mean Diff (*p*)**
Mean blink duration	96.80 (10.02)	117.11 (29.62)	**-20.31 (.01)**	108.98 (13.44)	117.49 (20.63)	-8.51 (.20)
Mean blink rate	129.15 (38.59)	138.46 (49.77)	9.31 (.32)	111.00 (54.54)	104.23 (62.99)	6.77 (.47)
Subjective sleepiness	6.54 (0.77)	8.00 (0.41)	**1.46 (<.001)**	6.77 (0.60)	8.31 (0.48)	**1.54 (<.001)**

- Blink duration increased in the morning only
- Blink rate showed no change whatsoever
- Subjective sleepiness increased in the morning and afternoon sessions

Discussion

- All participants were able to choose to stop driving before any unwanted sleep occurred
- Both morning and afternoon groups stopped driving (on average) before 40 minutes had elapsed
  - Well within the commonly promoted 2 hours of driving duration before stopping driving
  - Only relatively moderate levels of sleep restriction
- Simulated driving environment could have been a factor
  - Laboratory condition can invoke lower arousal levels

Subjective Sleepiness

- The subjective measure was sensitive to changes of sleepiness during the morning and afternoon sessions
- Subjective perceptions of sleepiness might be less reliable when at extreme levels of sleepiness or when "fighting" sleep onset
  - Potentially an effect of cognitive impairment or limited awareness of the signs of sleepiness
- When participants are not "fighting" sleep onset their self-awareness of sleepiness might be more precise

Blink rate

- No changes were found for blink rate during morning or afternoon testing sessions
  - Inconsistent findings in the literature
- An effect from the perceptual demand of Hazard Perception test?
  - Successful Hazard Perception requires a high level of visual scanning of the road environment
- Increases in blink rate might only dramatically occur during high levels of sleepiness?

Blink duration

- A significant increase was found during the morning session, but not for the afternoon session testing
- Potentially due to baseline blink durations in the afternoon already affected by increased sleepiness
- However, baseline subjective sleepiness levels did not significantly differ between morning and afternoon sessions
  - An issue between the correspondence of subjective sleepiness and those of physiological measures?

Next steps

- Address limitations of current study
  - No driver performance measure
  - Young adult sample; what about more mature drivers?
  - Laboratory conditions

- Future research
  - Blink characteristics of mature drivers
  - The utility of other ocular indices (e.g., blink amplitude, eyelid closing speed, etc)

Conclusion

- Driver sleepiness contributes substantially to fatal and severe crashes
- Subjective sleepiness measures were able to detect increasing sleepiness during morning and afternoon testing sessions
- Blink duration was only sensitive to increasing sleepiness during morning testing sessions
- Further examinations of the utility of ocular indices seem warranted to determine its suitability as a physiological measure of driver sleepiness

Thank you for listening!

Comments

or

Questions?

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