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The impact of eating at night on time on task impairments during simulated driving

Gupta, C., Dorrian, J., Grant, C., Pajcin, M., Coates, A., Kennaway, D., Wittert, G., Heilbronn, L., Della Vedova, C. & Banks, S.

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Shiftwork & Performance

- Simulated and on-road driving is impaired at night
  (De Valck et al., 2007; Hallvig et al., 2013)
- Attention impairments and sleepiness are highest during the circadian low
  (Åkerstedt, 2003)
- Shiftworkers alter eating patterns during nightshifts
  (Banks et al., 2015)
- Shiftworkers have more eating events and eat more high energy foods at night
  (de Assis et al., 2003)

Shiftwork & Diet

- Macronutrient consumption affects cognitive performance tested during the day (Hoyland et al., 2008)
  - *Reaction time* impaired after lunch vs no lunch (Smith & Miles, 1986)
  - *Reaction time* impaired after a high fat lunch compared to a low fat lunch (Lluch et al., 2000)
- Driving performance was impaired 1.5 hours after a high fat/high carbohydrate lunch meal (Reyner et al., 2012)

Research question

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How does eating at night impact performance?

Shiftwork & Time on Task

- Maintaining attention over time is challenging at night (van der Hulst et al., 2001)
- Driving performance becomes more impaired with time on task in sleep-deprived and non-sleep deprived drivers (Otmani et al., 2005)
- Sleepiness increases with time on task during simulated driving (Åkerstedt et al., 2010)

Research question

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How does eating at night impact time-on-task impairments?

Aim

To determine the impact of eating a meal during the nightshift on simulated driving performance, attention and subjective sleepiness

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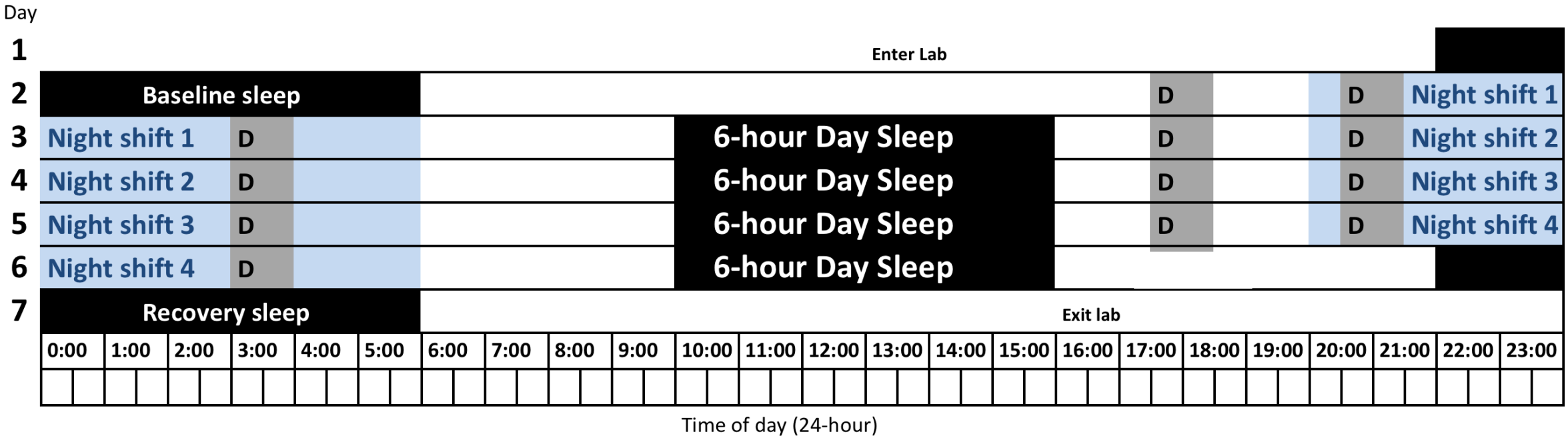
Method: Protocol



- Participants:
  - 10 healthy, non-shiftworking males
  - Age (M±SD): 24.7 ± 5.6 years
  - BMI (M±SD): 22.7 ± 1.3 kg/m^2
- 4 nightshifts 8pm to 6am
- Day sleep 10am to 4pm

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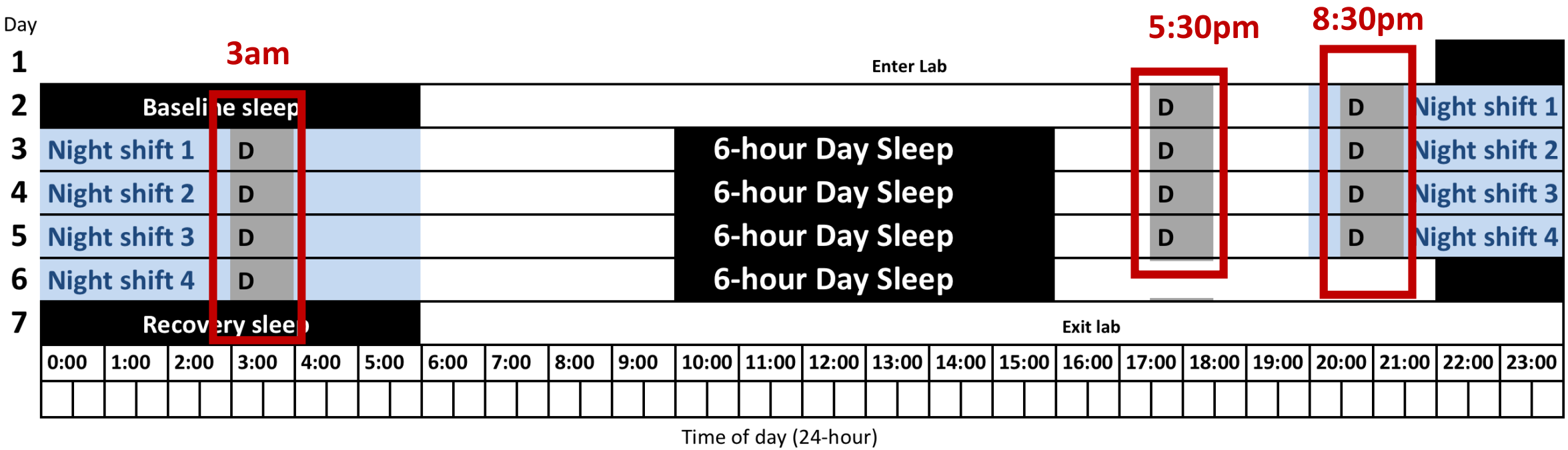
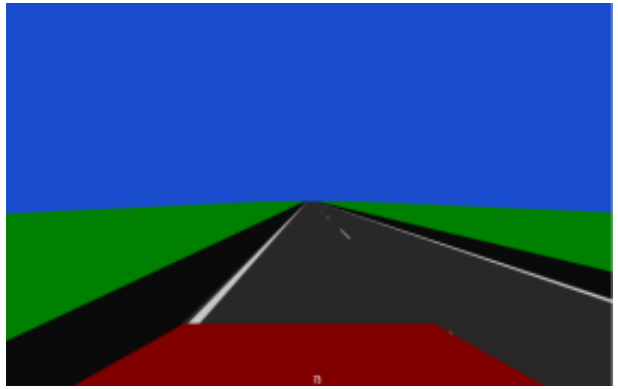
Method: Performance Testing



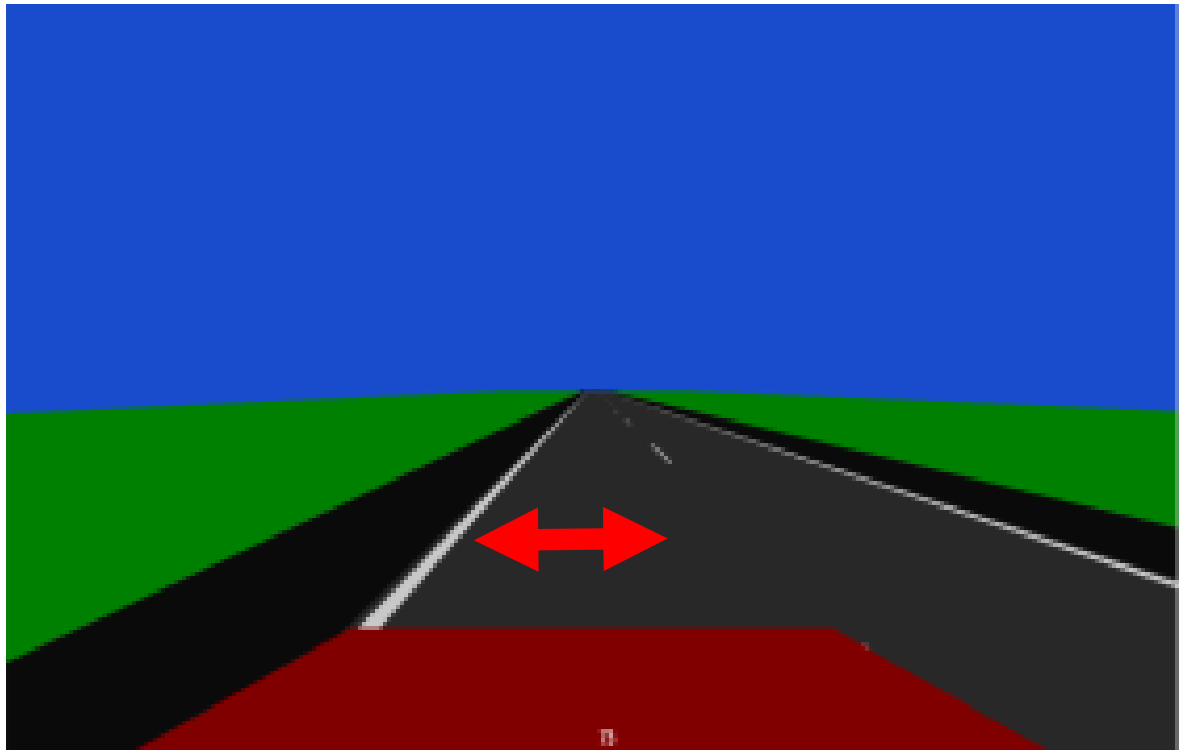
- Performance testing occurred at 5:30pm, 8:30pm, 3am
- A Subjective Sleepiness Scale, 3-minute Psychomotor Vigilance Task and a 40-minute simulated drive

Method: Driving simulator

- York Driving Simulator
- 40-minute computer-based simulation
- Sensitive to sleep deprivation, sleep restriction and time on task (Arnedt et al., 2000)
- Minimal practice effects (De Valck et al., 2003)
- Forward facing view of a 2-lane country highway
  - Standard road markings, road signs and occasional oncoming cars



Method: Driving simulator variables

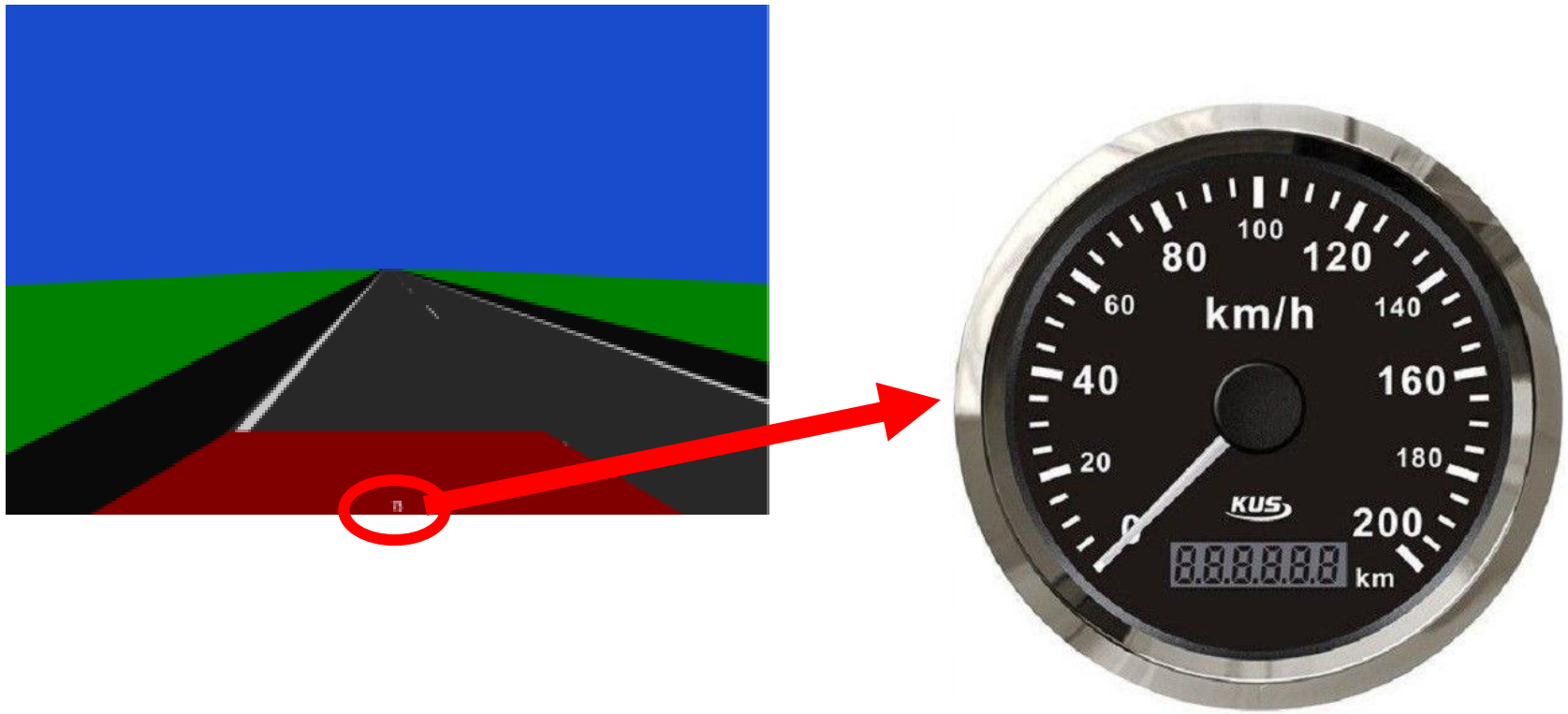


±10km/h

Time spent in the safe zone (%)

Percentage of time spent within 10km/h of the speed limit and within 0.8m of the lane centre

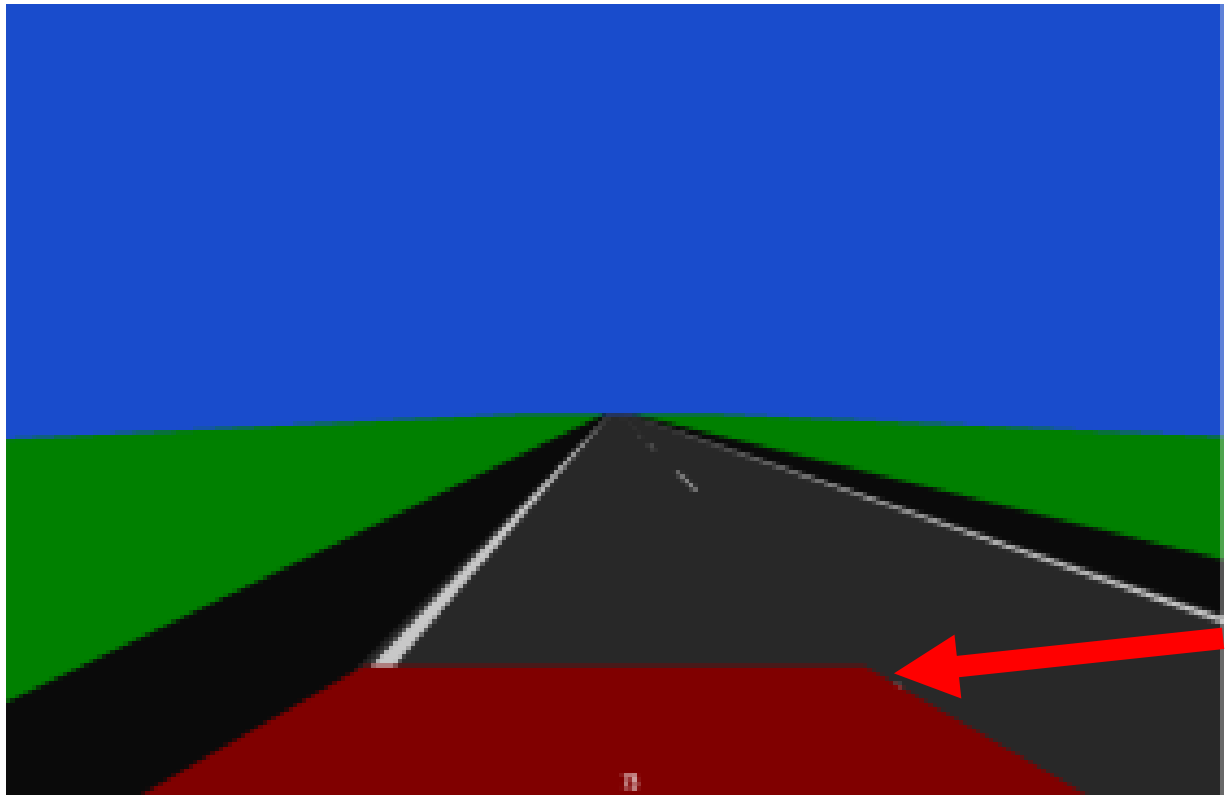
Method: Driving simulator variables



Speed variability (km/h)

Standard deviation of the deviation in speed from the speed limit

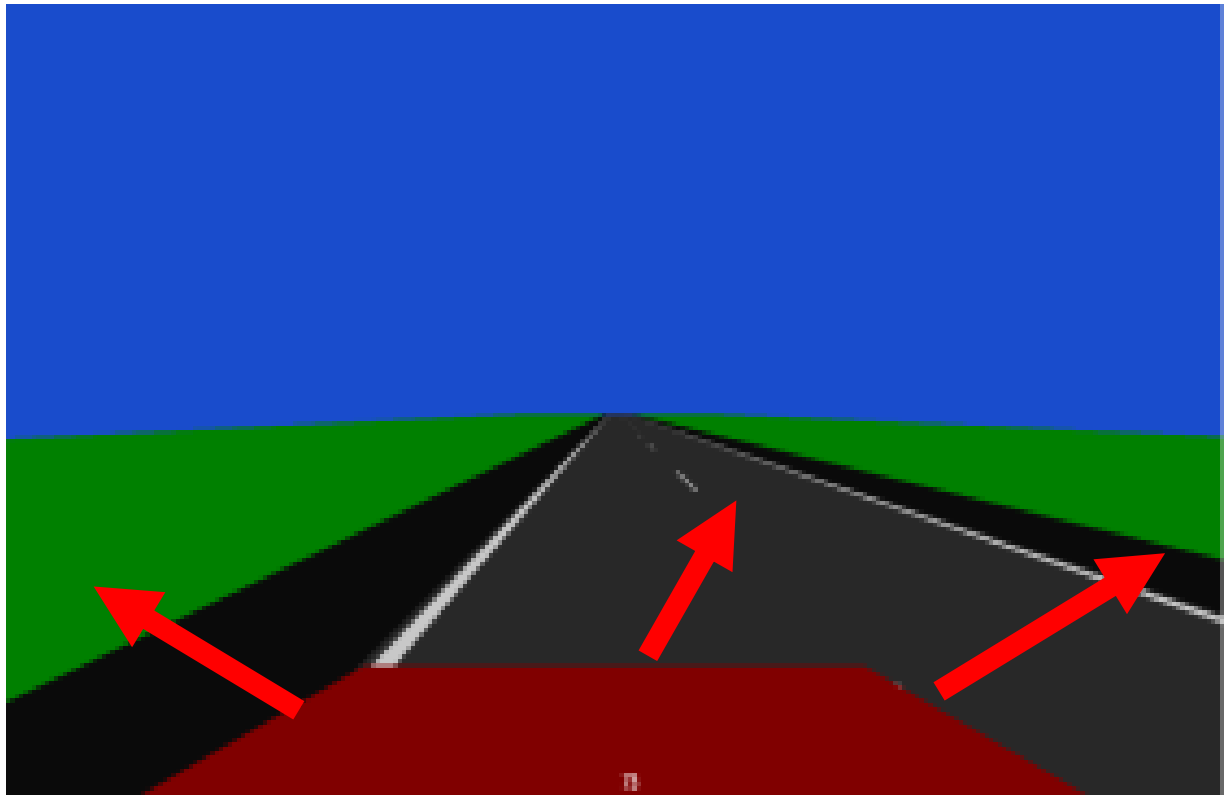
Method: Driving simulator variables



Lane variability (m)

Standard deviation of the road position from the right edge of the road

Method: Driving simulator variables



Crash count

A crash is recorded if the car drives off of the road to the left or right, or collides with an oncoming vehicle

Method: Attention and Sleepiness measures

Psychomotor Vigilance Task (PVT)

- Vigilant attention
- 3-minute task
- Variables:
  - Reciprocal of the mean response time (Mean RRT; ms)
  - Mean number of lapses (Lapse = RT>335ms)

Subjective sleepiness scale

- Self-reported sleepiness data
- Scale from 1 to 10

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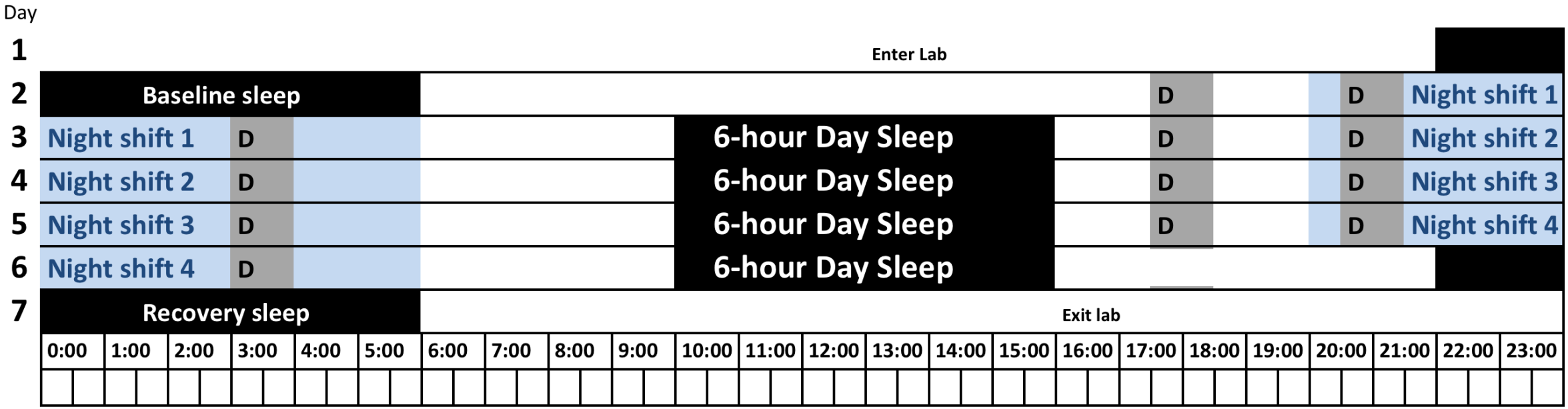
Method: Eating Condition



1. Eating at night (*n*=5)
2. No eating at night (*n*=5)
   - Macronutrient content constant across conditions
   - Total 24-hour energy intake for individuals constant
   - Different meal times

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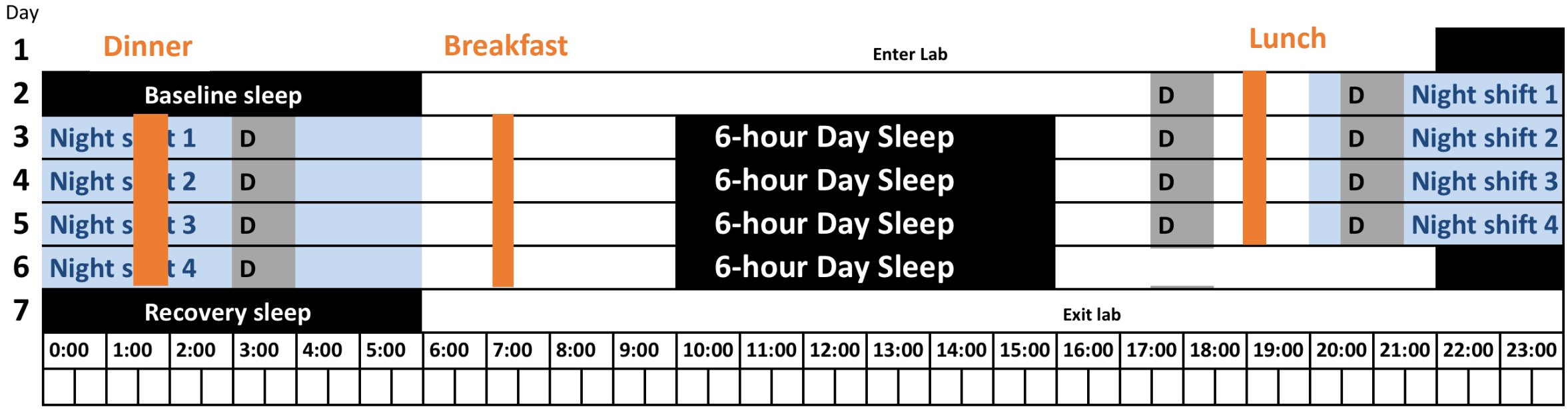
Method: Eating Condition



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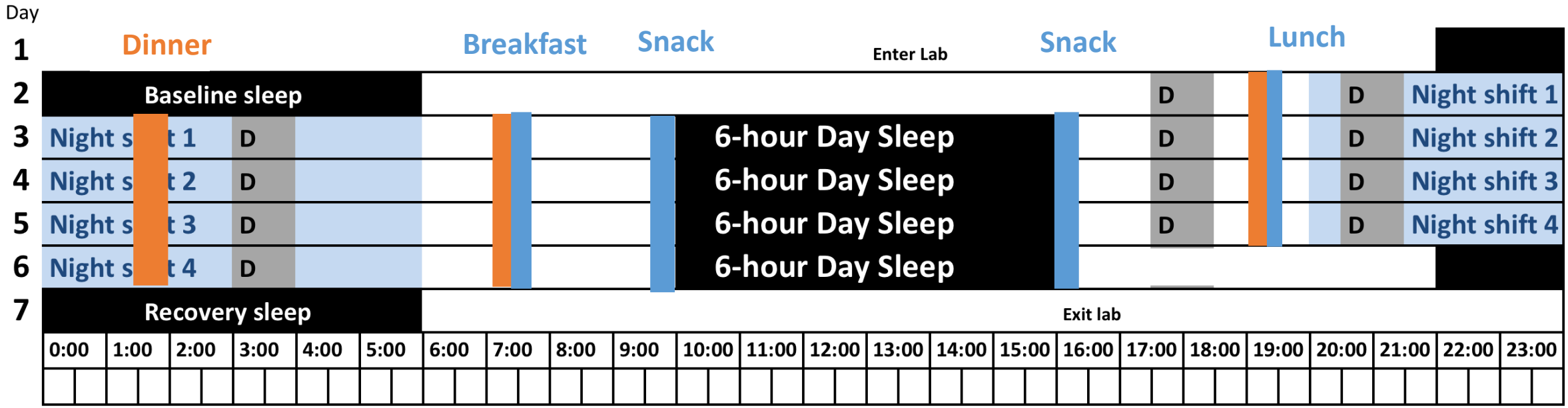

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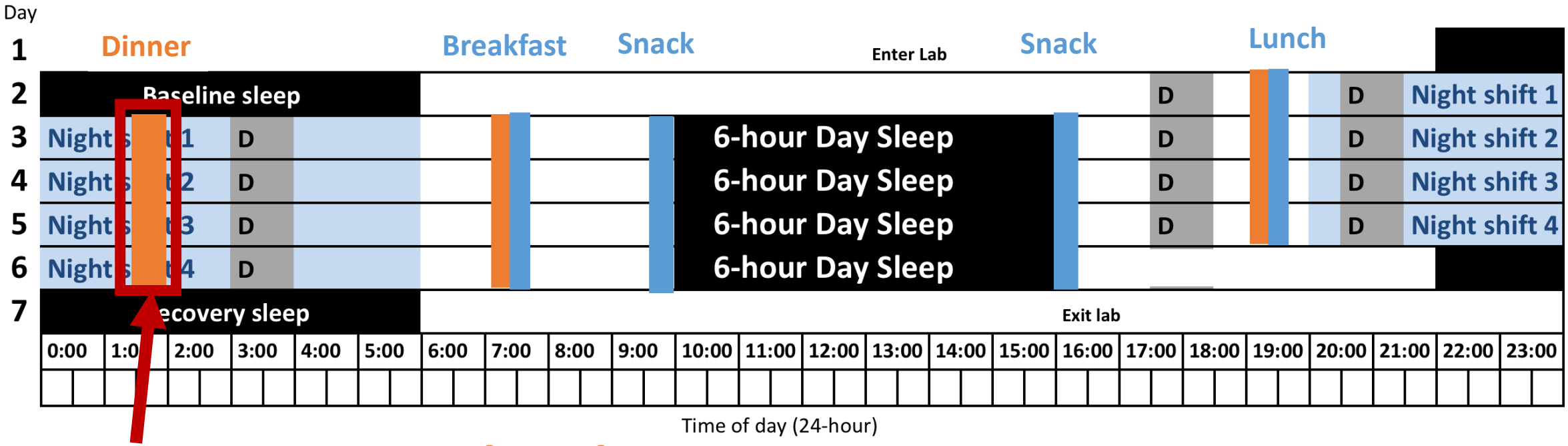
Method: Eating Condition



1. Eating at night (*n*=5)
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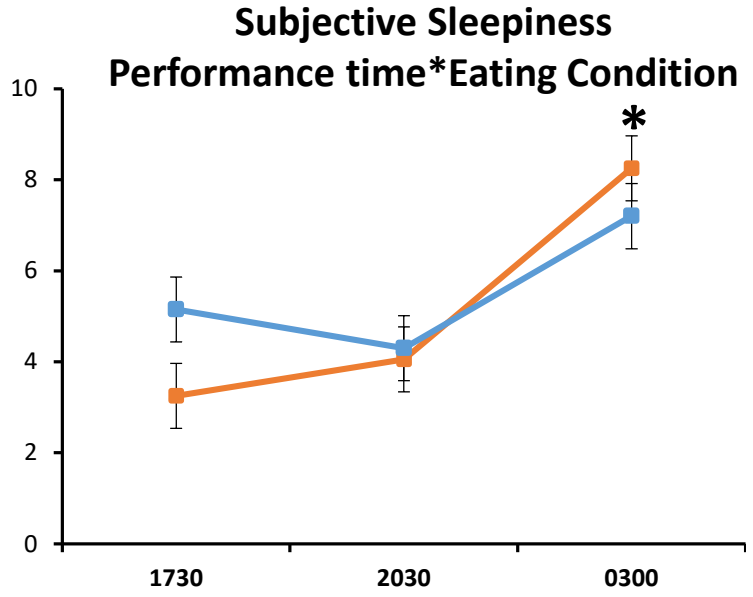
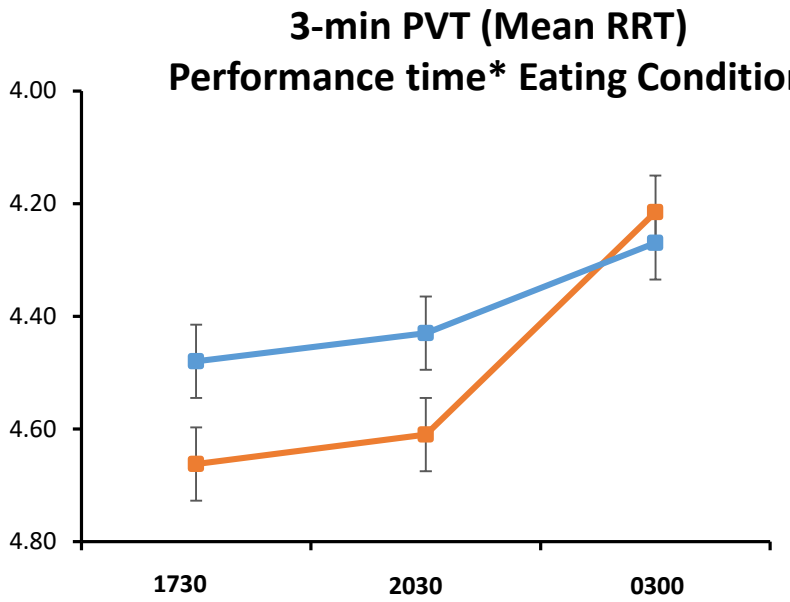
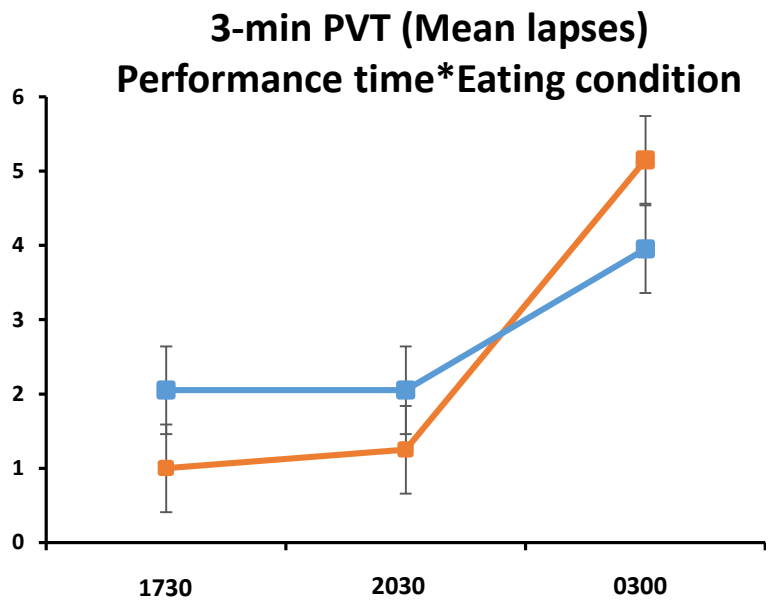
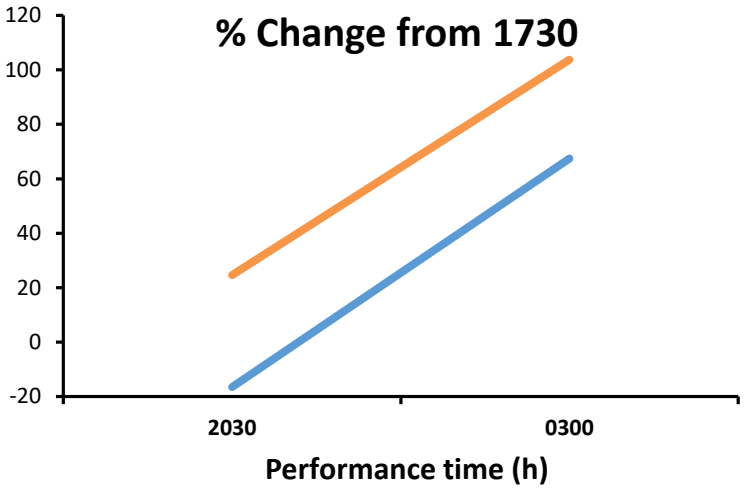
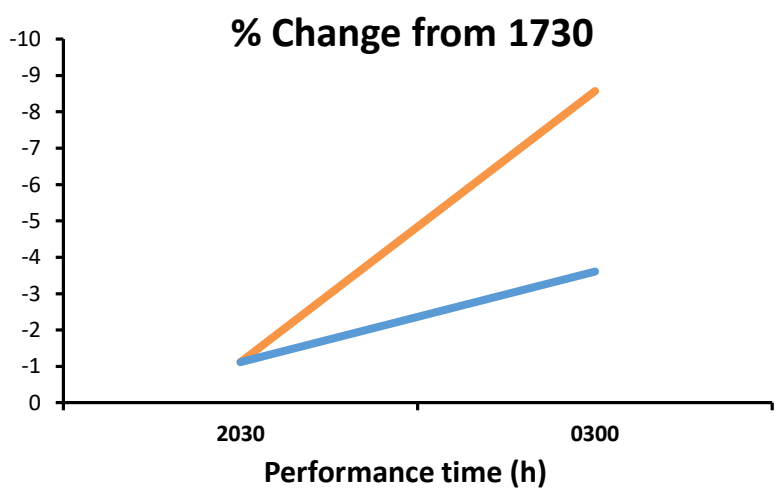
Increased sleepiness after eating at 3am

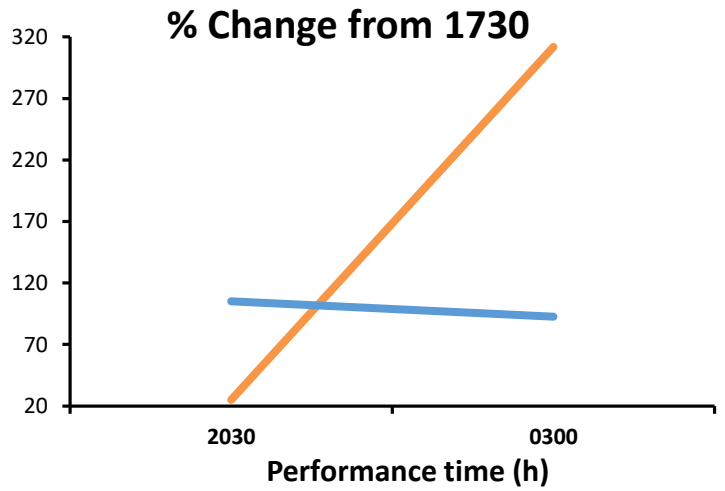












Eating at night No eating at night * *P*<.05

Gupta et al. (2016), *Chronobiology int.*

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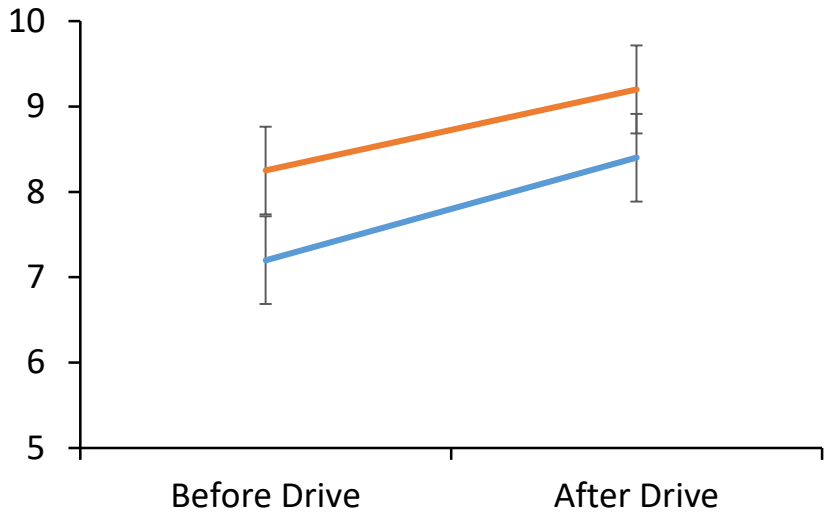
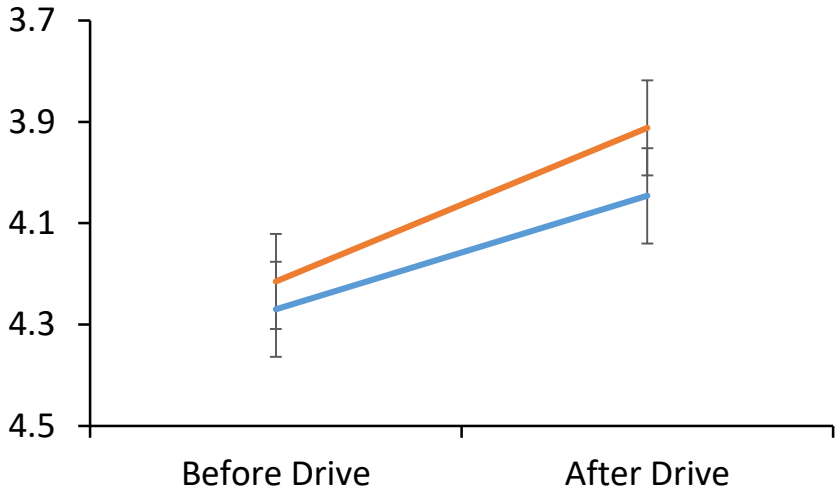
Sleepiness and PVT impairments at 3am increase over time

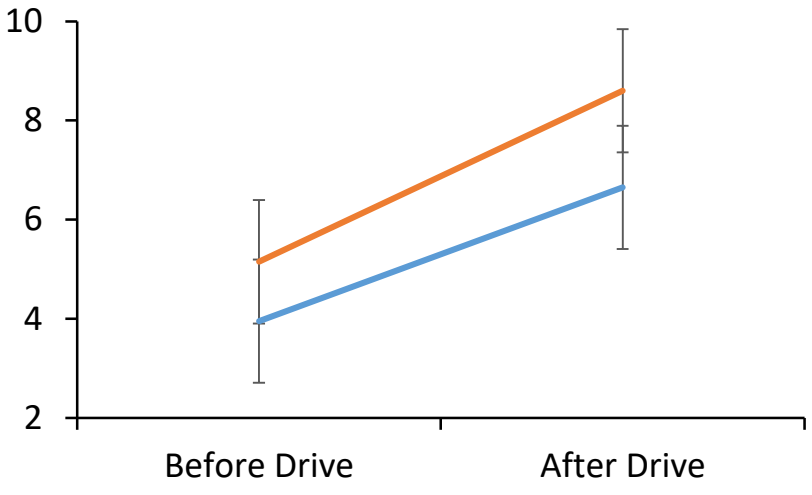
Subjective sleepiness Time*condition



3-min PVT (Mean RRT) Time*condition



3-min PVT (Mean Lapses) Time*condition



Eating at night No eating at night

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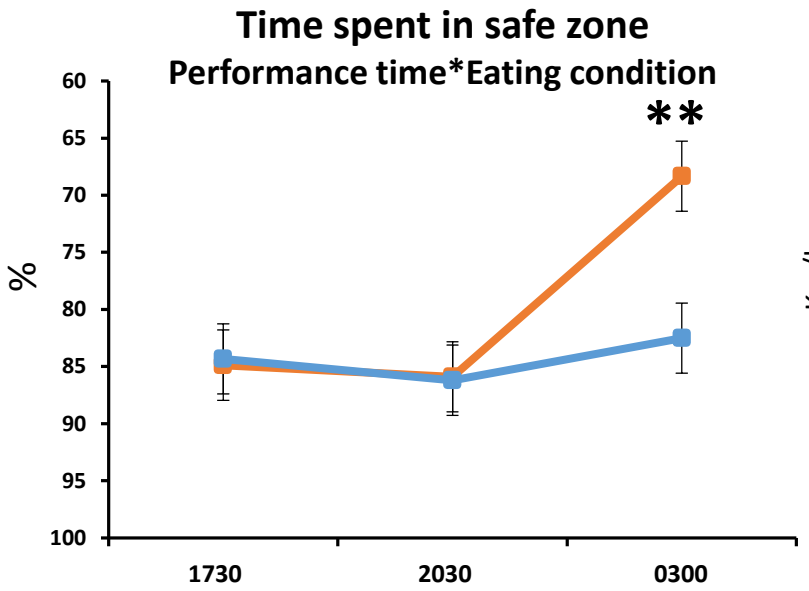
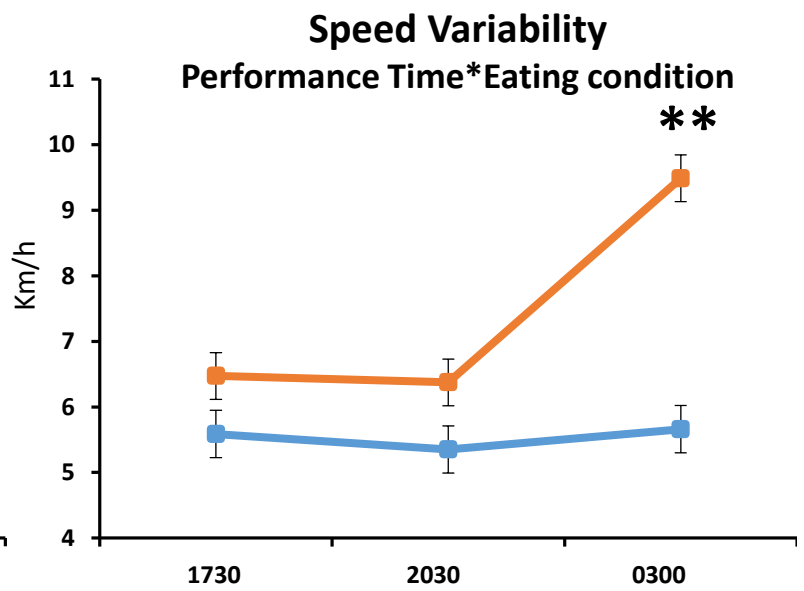
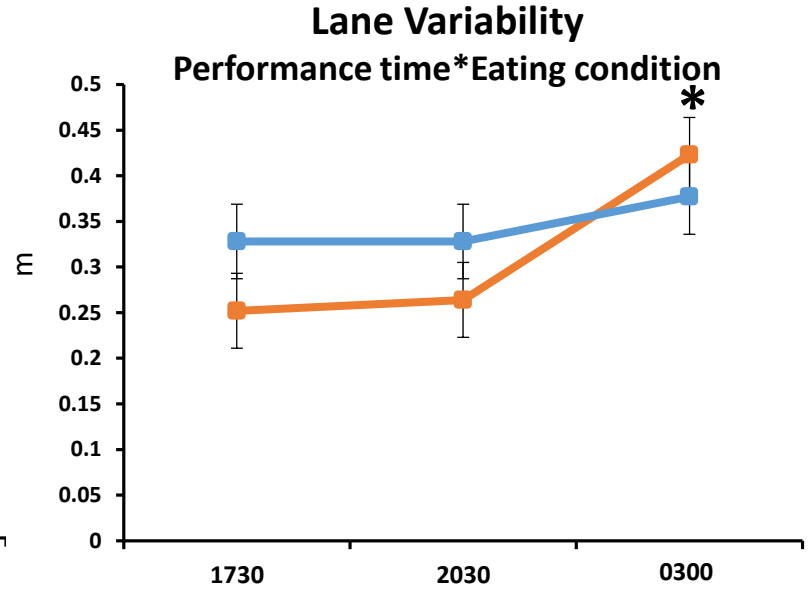
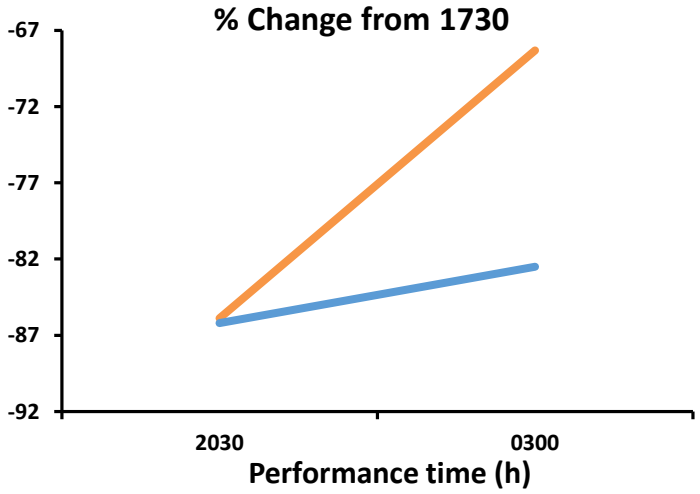
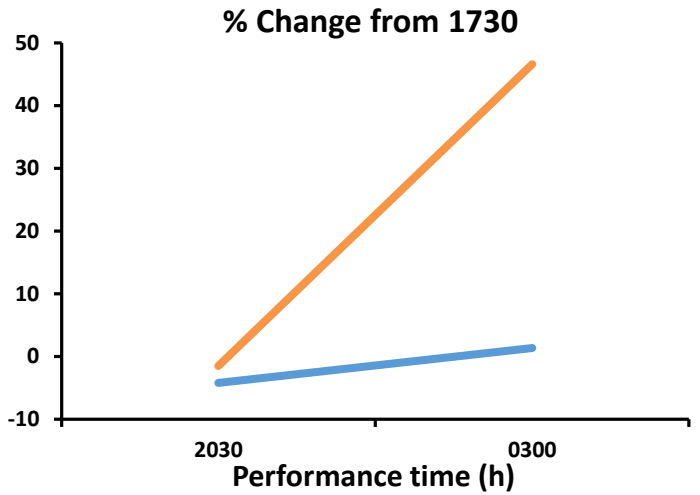
Driving performance was worse after eating during the nightshift

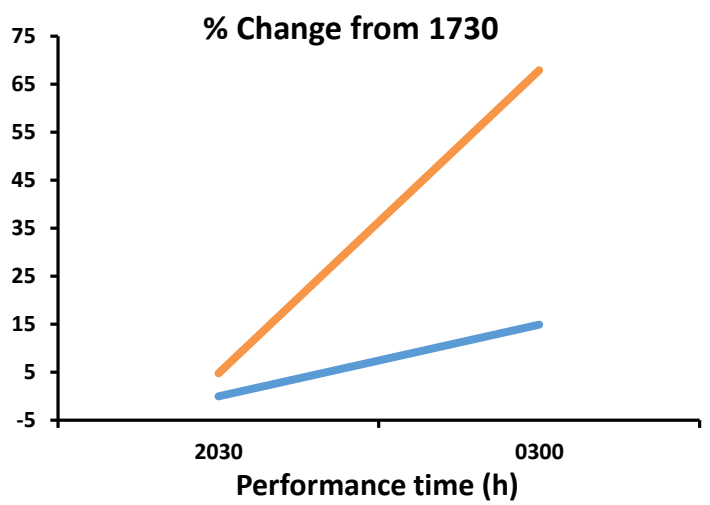












Eating at night No eating at night * $p<.01$ ** $p<.001$

Gupta et al. (2016), *Chronobiology int.*

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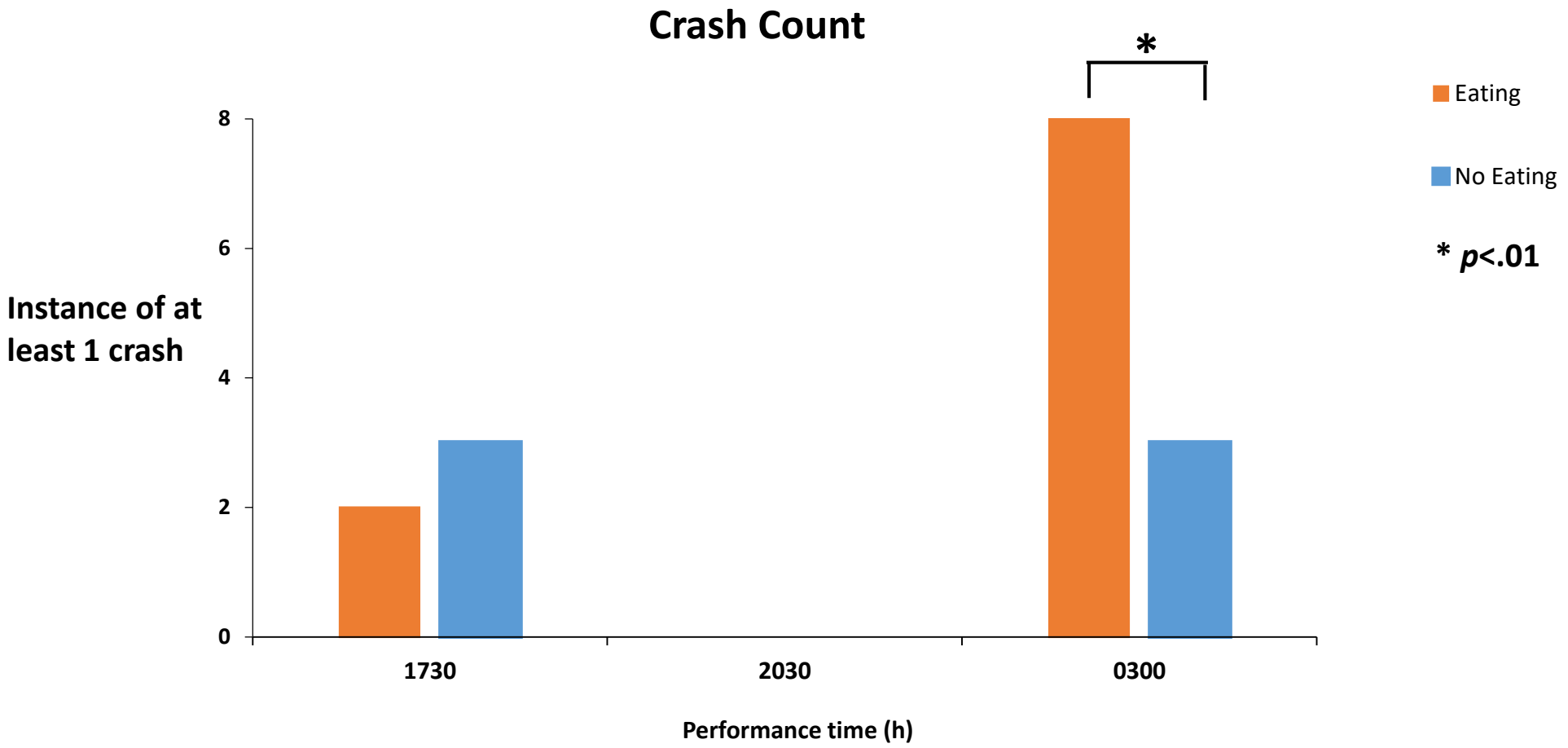
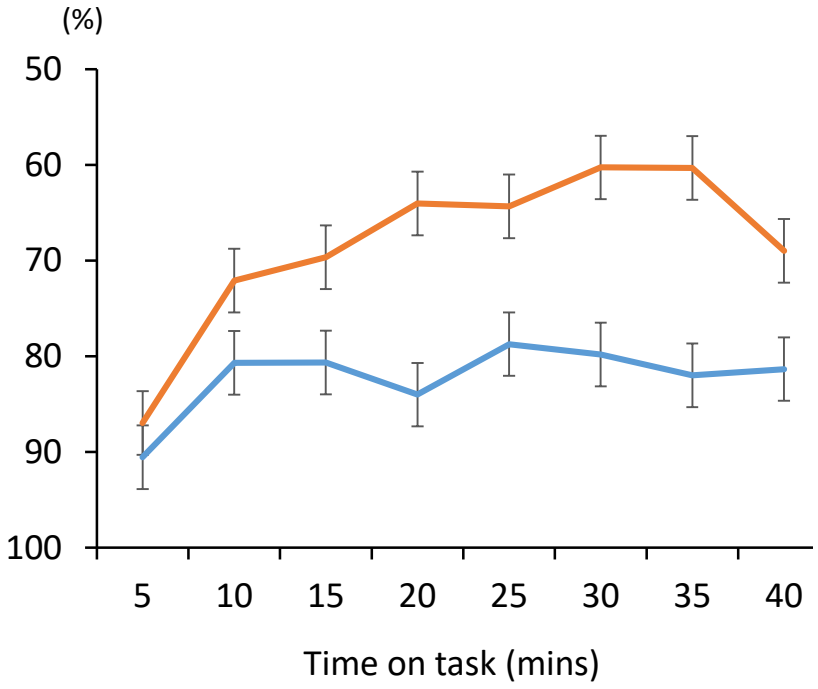
Significantly more crashes at 3am after eating



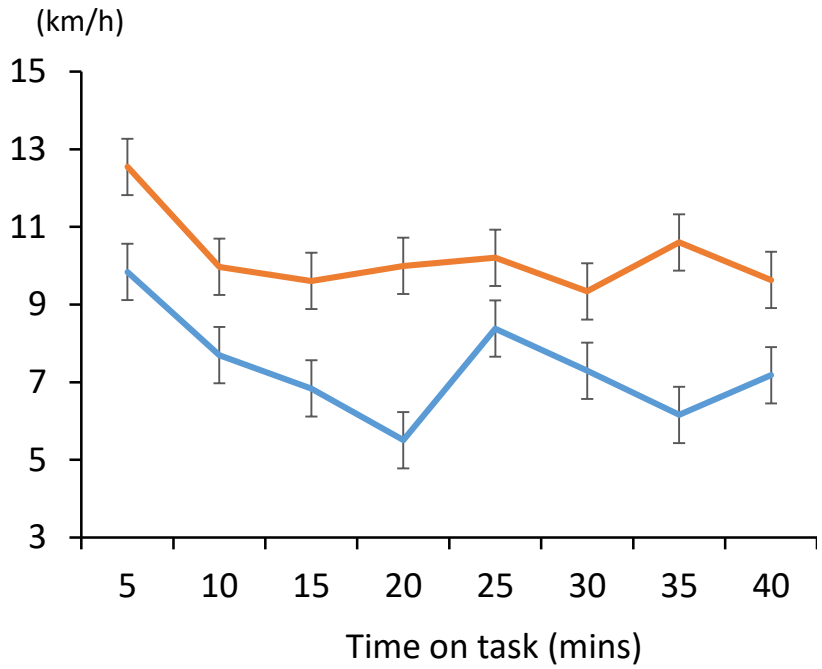
Gupta et al. (2016), *Chronobiology intl.*

Driving performance at 3am is worse over time

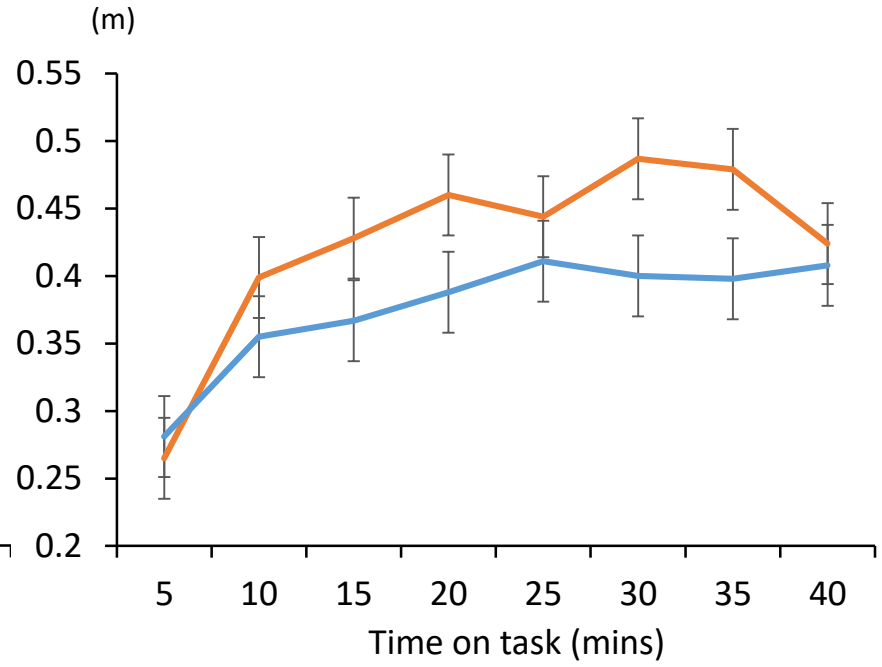
Time spent in the safe zone
Time on task*Eating Condition



Speed Variability
Time on task*Eating Condition



Lane Variability
Time on task*Eating Condition



Eating at night
No eating at night

Conclusion

- Driving performance at 3am is impaired with time-on-task
- Driving performance and sleepiness at 3am were significantly worse after eating at 1:30am
- Possible mechanisms
  - Impaired glucose metabolism at night
  - Stress response (body temperature and cortisol)
  - Changes in sensations (hunger, nausea)
  - Changes in blood distribution
  - Reduced rates of gastric emptying

Conclusion

- Timing of meals may be a modifiable factor affecting the performance of shiftworkers
- Advisable to avoid large meals during the nightshift
  - Could you work a nightshift without eating?

    "I would struggle to remain productive and focused"

    "Incredibly difficult, performance would suffer greatly."

    - Study participants who ate during the nightshift
- Future research
  - <u>Lab:</u> Meal size, macronutrient profile
  - <u>Field:</u> On-road driving, industry specific implications

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Thankyou

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Assoc. Prof Alison Coates

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Maja Pajcin (PhD Candidate)

Prof David Kennaway

Prof Gary Wittert

Assoc. Prof Leonie Heilbronn

Dr. Chris Della Vedova

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Emily Watson

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Alex Agostini

Alex Chatburn

Nursing staff Katja Morsky

Kenji Sison (Honours student)

Thankyou to the participants

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