

Assessing the combined effects of task factors and sleep need on driving

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Abstract

Driver fatigue has been attributed to both sleep need and to task-related factors, including time-on-task. The current simulator study examined the sleep-task interaction to determine their relative contributions to fatigue. Sixty participants were randomly assigned to two sleep conditions (shorter vs. longer) before a 2-hour drive. In addition to time-on-task, cognitive task load (higher vs. lower) was also manipulated as a task-related factor. Significant effects of sleep restriction and time-on-task were observed on performance (lane position variability - SDLP) and subjective ratings (sleepiness, alertness, effort). The implications for understanding driver fatigue are discussed.

Background

Much of the focus around driver fatigue has been on sleep-related contributors. The effect of task-related contributors (e.g., time-on-task, cognitive load) has received less attention. However, recent research suggests in-vehicle tasks that increase cognitive workload can reduce the effects of fatigue on driving performance. It is not clear whether such tasks also reduce the effects of fatigue due to sleep need, or how sleep and task factors combine to affect fatigue. Accordingly, the aim of the current study was to examine the interaction of time-on-task, task load and sleep need on driving performance and subjective fatigue.

Method

Design

A 2 (sleep restriction) by 2 (cognitive load) factorial experiment was conducted. Time-on-task varied within participants across the 2-hour drive. Each participant took part in one of the four conditions defined by shorter (≤ 5 hours in bed) or longer (8 hours in bed) sleep opportunity the night before the test drive and lower (reading posted speed limits) or higher (calculating speed limits) cognitive task load. Lane position variability (SDLP) and subjective ratings of sleepiness, mental alertness, and workload were measured.

Participants

Sixty participants (age $M=23.85$; $SD=3.85$; male=46.7%) with at least a probationary licence responded to study advertisements at UNSW and were randomly assigned to conditions.

Materials

A 2-hour (~200 km) monotonous drive was created on a Forum8 desktop simulator with straight, 'rural' road, no scenery or traffic and gentle curves every 5kms. The speed limit changed 18 times across the drive. Speed limit calculations were those used by Dunn and Williamson (2012). Participants verbally rated sleepiness and mental alertness on 9-point scales before, after, and every 300 seconds when prompted during the drive. Ratings were recorded via a desktop microphone. Cognitive workload was rated on the NASA-TLX. Sleep was confirmed with Phillips Actiwatch 2s.

Procedure

Participants attended a training session then, following their sleep manipulation night, they completed preliminary ratings and drove the 2-hour test scenario commencing at 9:30am. At the end of the drive, they completed final ratings including the NASA-TLX.

Results

Preliminary ANOVA analyses of performance and subjective sleepiness and alertness ratings over time showed significant effects of sleep condition and significant effects of time-on-task. Participants in the longer sleep condition had significantly greater lateral control (smaller SDLP), lower sleepiness ratings and greater alertness ratings than participants in the shorter sleep condition. Participants in the shorter sleep condition also rated the task as requiring significantly greater effort than those in the longer sleep condition. Lateral control deteriorated, alertness decreased and sleepiness increased over time. Significant overall effects of the cognitive load manipulation were not found. Further investigation of potential interactions is being undertaken.

Conclusions

Both sleep restriction and time-on-task reduced performance, increased subjective sleepiness and reduced mental alertness. The task load manipulation, however, was not effective. The implications of the pattern of performance and subjective findings will be discussed.

References

Dunn, N., & Williamson, A. (2012). Driving monotonous routes in a train simulator: the effect of task demand on driving performance and subjective experience. *Ergonomics*, 55(9), 997-1008. doi:10.1080/00140139.2012.691994