Tenth International Conference on Managing Fatigue: Abstract for Review

Mitigating Drowsiness during Short Drives: Implications of Staged and Discrete Alerts

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Problem: Drowsy driving has been identified by the National Highway Safety Administration as a public health and safety risk. According to the National Sleep Foundation's 2009 annual Sleep in America survey, 28% of all respondents had driven drowsy at least once per month in the past year. A National Highway Traffic Safety Administration report of crash data from 2005 to 2009 attributed 83,000 crashes per year, and 886 fatal crashes per year, to drowsy, fatigued, or sleeping drivers. Methods are needed for identifying drowsy driving and preventing crashes.

Method: This research collected data from forty-eight participants, aged 21 to 34, with a valid driver's license that were assigned to either a discrete or staged drowsiness mitigation alerting condition. For each type of mitigation, participants were assigned to either an audio/visual, haptic or combined alert condition. Each completed a 35-minute drive through nighttime urban, interstate and rural driving environments on two separate nights separated by at least one week. During one visit they drove between 10 pm and 2 am, and on the other between 2 am and 6 am. This data was compared to data collected from twenty-four participants in the same age group who did not receive mitigation alerts. Participants wore actigraphs to monitor activity and sleep and on the day of the drive were required to wake by 7am, restrict caffeine intact and avoid naps. They were arrived at our facility by 7pm and were monitored in a dark room where they could engage in sedentary activities until their one hour before the drive. Prior to the drive participants were taken to a private secluded room to wait quietly without engaging in any activities. Stanford Sleepiness Scales were collected periodically throughout the visit including immediately before and after the drive. Additionally, a retrospective sleepiness assessment was completed after the drive to gauge sleepiness throughout the drive. Measures of lateral control including lane departures and lane position were recorded. Lane departures were coded using the Operator Rating of Drowsiness to identify drowsy lane departures for analysis.

Results: This analysis focused on the ability of the mitigation to reduced drowsiness related lane departures. The first analysis was to determine if there was an overall impact on the frequency of drowsiness related lane departures (per minute). As seen in Figure 1, the drowsiness mitigation resulted in a marginal reduction in lane departures per minute compared to the no-mitigation baseline during both the early and late drives. The main effect of mitigation was marginally significant, $F(1,68) = 3.76$, $p = 0.057$. The second analysis focused on the role of staged versus discrete alerts and the modality of the interface. This was assessed by examining the reduction compared to the baseline group. The analysis showed that there was a reduction in mean number of drowsy lane departures across all conditions, and an interaction between drive time and mitigation type indicating that during the late night drives, the staged mitigation reduced lane departures per minute relative to baseline more than the discrete mitigation, as shown in Figure 2. There were no significant effects for mitigation type, alert modality or their interaction.

Discussion: Results showed a marginally significant reduction in lane departures per minute for the mitigation compared to no-mitigation in both the early and late drives, suggesting that the drowsiness mitigation may have been effective over the parts of a short drive that are most prone to drowsy lane departures. Drivers' only choice was to continue, even if they would have pulled over to rest in actual driving.

Summary: This research provides valuable insights into the potential for mitigation to improve performance for drowsy drivers. Although this strategy may be effective for journeys of short duration, it is unknown the extent to which this type of mitigation can maintain its effect. Further study is needed to examine these systems over longer duration drives and under conditions where cessation of driving is an option.

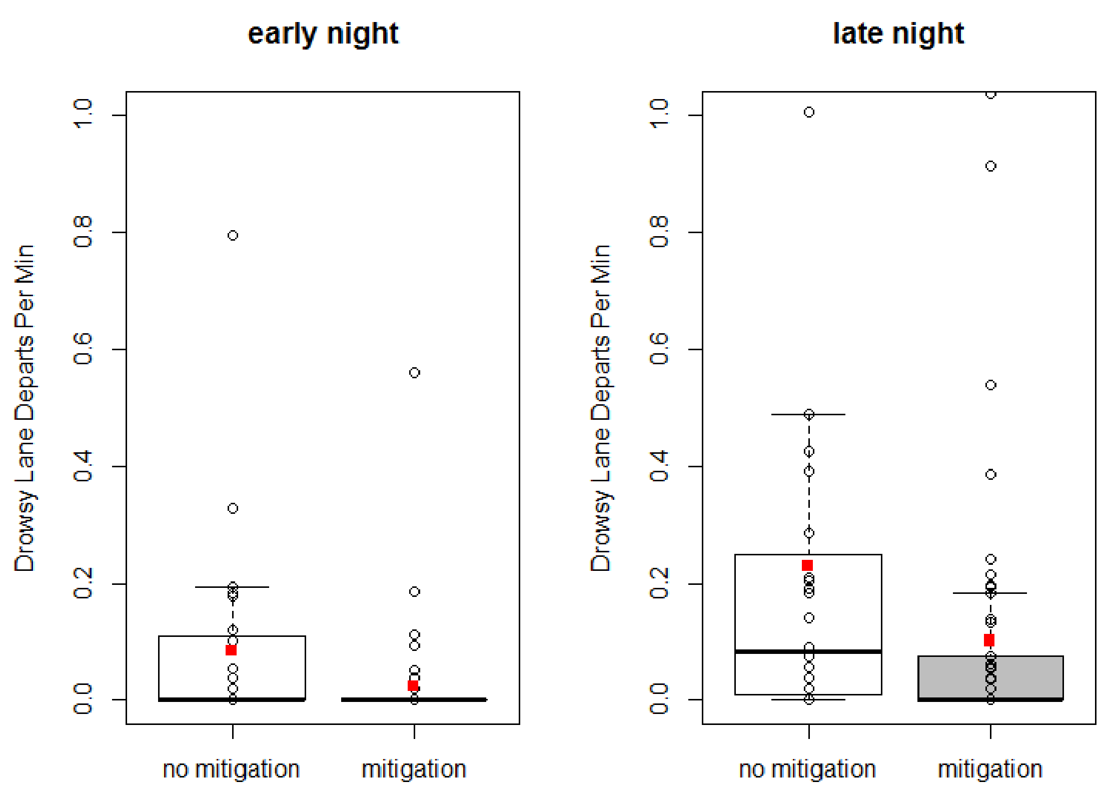

Figure 1. Boxplots of drowsy lane departures per minute in the early and late drives. Circles represent individual participant means. Red squares represent group means.

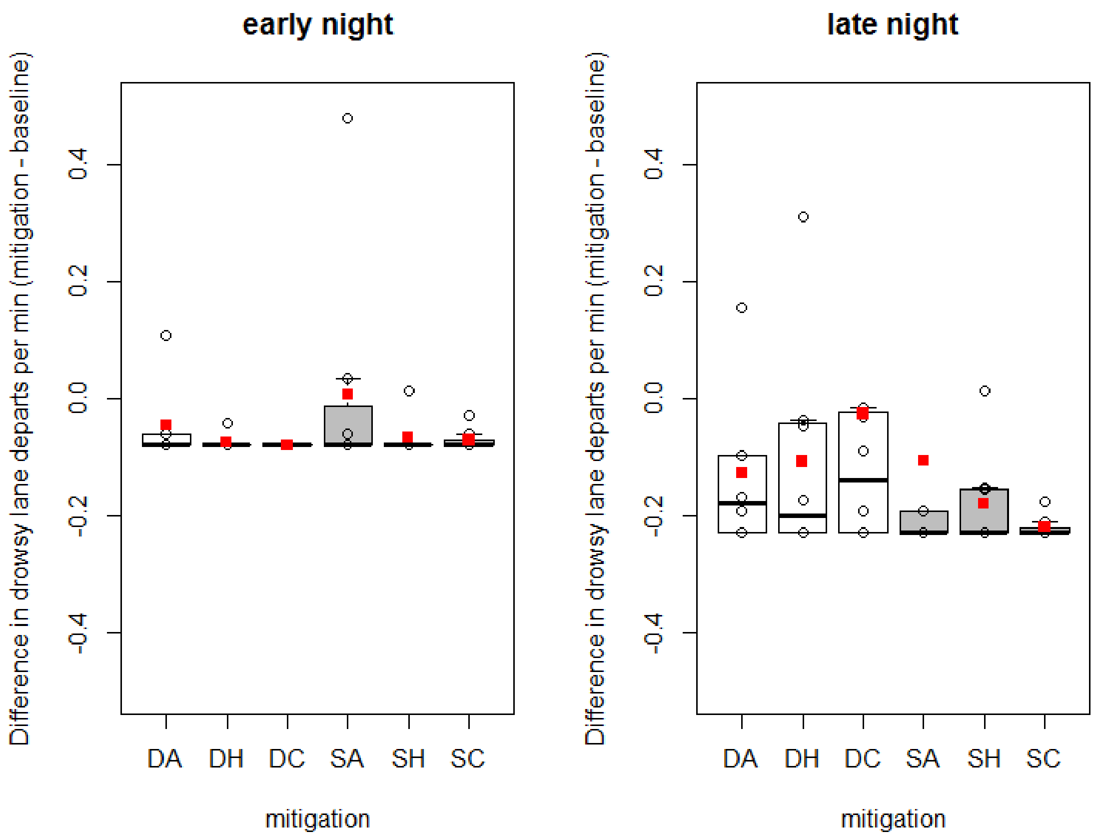

Figure 2. Boxplots of difference in drowsy lane departures per minute between each mitigation condition and baseline. Lower values reflect a lower rate of drowsy lane departures relative to the baseline no-mitigation group. DA = discrete audio/visual-manual, DH = discrete haptic, DC = discrete combined, SA = staged audio/visual-manual, SH = staged haptic, SC = staged combined. Circles represent individual participant means. Red squares represent group means.