Examining cognitive interference and adaptive safety behaviours in tactical vehicle control

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Concurrent mental workload degrades some aspects of driving performance, but drivers might be able to modify their behaviour adaptively to accommodate cognitive impairments. For example, they might maintain longer vehicle headway in dual-task conditions to compensate for slowed response times. Studies documenting such adaptive behaviours typically use steady-state driving scenarios such as car following. Yet, driving often involves tactical control situations in which drivers need to monitor multiple aspects of their traffic environment and to accommodate changing goals. In two simulator experiments, this study examined the impact of mental workload on safety margins (distances) that drivers keep when engaged in a tactical control task: passing other vehicles. Although drivers did increase their headway adaptively when engaged in steady-state car following (experiment 2), they did not adapt their behaviour to accommodate cognitive load when performing tactical control manoeuvres. Implications of this difference between steady-state and tactical control driving contexts, both for driving research and for driving safety, are discussed.

Keywords: Driver distraction; Mental workload; Tactical vehicle control; Adaptive safety behaviours

1. Introduction

Use of in-vehicle information systems, mobile phones and other ‘infotainment’ devices is growing exponentially (Ashley 2001) and with these changes the potential for driver distraction and inattention is becoming ubiquitous. An estimated 25–50% of motor vehicle crashes involve some form of driver inattention (Sussman et al. 1985, Wang et al. 1996, National Highway Traffic Safety Administration 1997, Ranney et al. 2000). A more recent estimate suggests that upwards of 78% of crashes and 65% of near-crashes are attributable to some form of driver inattention (Dingus et al. 2006). In-vehicle devices cause visual distraction, but they also cause cognitive impairments due to the need to focus on multiple tasks simultaneously. The now extensive literature on dual-task
performance while driving shows a substantial cost of cognitive distraction. For example, drivers engaged in concurrent mental tasks or conversations are slower to detect and respond to target stimuli (Alm and Nilsson 1995, Strayer and Johnston 2001, Consiglio et al. 2003, Patten et al. 2004, Horrey and Wickens 2006). Increased mental workload also reduces the breadth of visual scanning behaviour (Recarte and Nunes 2000, Hammel et al. 2002), implying that cognitive load impairs the ability to detect and respond to relevant visual information presented away from the centre of the roadway.

1.1. Adaptive safety behaviours

Although cognitive load consistently impairs driving performance, distracted drivers do sometimes adapt their behaviour in ways that might allow them to remain safe despite their delayed responses. For example, drivers engaged in a secondary task sometimes drive more slowly (e.g. Pohlman and Traenkle 1994, Dingus et al. 1997), which might compensate for the increased risk of delayed responses and detection of critical events. Similarly, drivers could adaptively increase the amount of space or buffer distance – the safety margin – around their vehicle to compensate for cognitive impairments. For example, drivers engaged in cognitively demanding mobile phone conversations or other in-vehicle tasks maintain longer headway distances in car-following situations than when driving without any form of distraction (Strayer et al. 2003, Strayer and Drews 2004, Ranney et al. 2005). To some extent, these drivers adaptively control their behaviours to maintain their target level of risk, keeping a relatively constant level of subjective risk and preserving the space and time needed to respond in an emergency (Wilde 1982, 1988, 1994, 2001).

Evidence for adaptive compensation for cognitive impairment comes primarily from steady-state driving tasks or scenarios that artificially constrain driving performance. The most commonly used task, car following, involves following a lead vehicle at a fixed distance and adjusting speed when the vehicle brakes or accelerates (e.g. Brookhuis et al. 1994). This task captures many aspects of vehicle control, such as maintaining headway, monitoring lane position and controlling speed. However, it does not capture more dynamic aspects of driving, those requiring more tactical control of a vehicle, such as planning and shifting among driving goals (e.g. executing a passing manoeuvre in traffic; Michon 1985). During tactical manoeuvres, drivers must maintain appropriate safety margins around themselves (and not just directly in front) in order to avoid collisions and they must adjust those margins according to changing task requirements. Yet, no studies have examined whether drivers adaptively adjust their safety margins to compensate for cognitive impairments under tactical driving conditions. Also, such situations are often those for which safety margins are most critical.

1.2. Present study

In two experiments, the present study examined whether drivers adaptively increase their safety margins when they perform a concurrent cognitive task while driving. Critically, changes are compared to safety margins under both steady-state conditions and under more tactical driving. In experiment 1, drivers were required to pass slower moving vehicles in the presence of faster moving vehicles in the adjacent lane. That is, they had to execute a tactical driving manoeuvre. In experiment 2, drivers freely navigated through a realistic, free-flowing traffic scenario, overtaking and changing lanes in response to changing traffic conditions. This flexible driving task made it possible to measure safety
margins, both when drivers performed a tactical manoeuvre (overtaking) and when they engaged in periods of steady-state car following, typical of other experiments. In both experiments, performance was compared when drivers performed only the driving task and when they performed a concurrent cognitive task. Assuming that drivers adjust their safety margins to compensate for cognitive load, it would be expected that they would maintain greater safety margins in the dual-task condition than when just performing the driving task. This should hold true for both steady-state and tactical control tasks.

2. Experiment 1

2.1. Methods

2.1.1. Participants. A total of 16 drivers from the University of Illinois participated in the study in exchange for course credit (mean age 20.8 years; eight males, eight females). Drivers averaged 4.7 years driving experience (SD 2.0) and an estimated average annual mileage of 11 360 km (SD 9060). All had self-reported normal or corrected-to-normal visual acuity.

2.1.2. Materials. This study was conducted in the Beckman Institute Driving Simulator, a fixed-base simulator consisting of a 1998 Saturn SL and a wrap-around environment with 135° forward and rear visual fields. Road and traffic information was visible through the windows and via interior and exterior rear-view mirrors (which had typical right and left blind spots). Epson Powerlight 703C projectors (Long Beach, CA) displayed the simulation that was created using DriveSafety’s HyperDrive Authoring Suite™ (version 1.6.1, Salt Lake City, UT) and controlled by DriveSafety’s Vection™ software (version 1.6.1).

Each environment consisted of a straight, four-lane divided freeway, with two lanes in either direction. Other vehicles were placed in the driver’s direction of travel, spaced between 140 and 180 m apart (the separation distances between vehicles were randomly selected from a uniform distribution between these two values). In order to control for vehicle size and the associated visual angle, all the vehicles were four-door sedans. All vehicles in the right-hand lane moved slower (64 kph) than did vehicles in the left-hand lane (112 kph). A cruise control mechanism maintained the driver’s car at a speed of 89 kph. Drivers could disengage the cruise control temporarily by pressing the brake or accelerator and the cruise-control re-engaged a few seconds after drivers ended their input. The cruise control system ensured that the approach speed for each vehicle to-be-passed was identical.

2.1.3. Procedure. At the start of the 45-min session, drivers completed a consent form and demographic and driver behaviour questionnaires. Drivers were then introduced to the simulator and given a few practice blocks in order to familiarize themselves with the vehicle control dynamics, traffic environments and cognitive task (described below).

The driver was instructed to keep the vehicle in the right-hand lane except when passing slower moving vehicles. Thus, drivers had to monitor traffic in both the fast- and slow-moving lanes in order to determine when it was safe to initiate the passing manoeuvre. During this manoeuvre, they were allowed to disengage the cruise control (either by braking or accelerating). Drivers were instructed to return their vehicle to the slow lane and to allow the cruise control to re-engage, once the passing manoeuvre was complete.
Each driver completed two experimental blocks, with the order of the blocks counterbalanced across participants. In one block, drivers performed only the passing task (single-task). In the other block (dual-task), drivers performed a concurrent mental arithmetic task (e.g. Brookhuis et al. 1991). At the start of the dual-task block, drivers heard a three-digit number (e.g. 967) and they then counted backwards by three aloud at a rate of one response every 2 s. An auditory metronome beeped every 2 s to help them keep pace in counting. In each block, drivers passed a total of 20 vehicles in the slow-moving lane over a period of approximately 9 min. Following the completion of both experimental blocks, drivers filled out some additional questionnaires and were debriefed.

The primary dependent measures (see figure 1) assess the space that drivers maintain around their vehicle (i.e. safety margins) when passing. Larger safety margins allow more room for error and increases in these margins under dual task conditions would reflect adaptive compensation for cognitive impairment. For example, adopting a longer vehicle headway would accommodate a slower than normal response to a potential braking event. At the point when drivers crossed the lane boundary (detected by the software and confirmed on video recordings of the drivers), indicating that a passing manoeuvre was in progress, the headway distance to the vehicle being passed ($H_D_A$), the headway distance to the closest vehicle ahead of the driver’s car in the target lane ($H_D_B$) and the tailway distance to a trailing vehicle in the target lane ($T_D_B$) were measured. When drivers completed the passing manoeuvre and crossed the lane boundary to return to the slow lane, the tailway distance to the passed vehicle ($T_D_A$) was assessed. Whenever drivers pressed the brakes prior to initiating a lane change (to disengage the cruise control), headway to the to-be-passed vehicle at that moment was also measured – a measure that reflected how close drivers were willing to get to a slow-moving vehicle before adjusting their speed. Such braking typically occurred when a vehicle in the fast lane temporarily prevented the driver from changing lanes to begin overtaking. The experimenter

![Figure 1. Pictorial illustration of the primary dependent measures. The driver’s vehicle is dark coloured. (1) Prior to the passing manoeuvre: $BD =$ the headway distance when the brakes are depressed (braking distance). (2) During the passing manoeuvre: $H_D_A =$ closest headway distance to the vehicle being passed; $H_D_B =$ initial headway distance to a vehicle in the target lane; $T_D_B =$ initial tailway distance to a trailing vehicle in the target lane. (3) End of passing manoeuvre: $T_D_A =$ tailway distance to the passed vehicle (grey), in the original lane.](image)
monitored performance of the cognitive task during runtime, but counting accuracy was not recorded.

2.2. Results and discussion

Planned pairwise comparisons were used to examine differences between the single- and dual-task conditions. Strikingly, no evidence for adaptive compensation for cognitive impairment was found (see table 1); headway distance was comparable for the single- and dual-task conditions both before \((HD_A)\) and after \((HD_B)\) a lane change. Tailway distances \((TD_A, TD_B)\) did not differ across conditions.

Although adaptive compensation for dual-task interference is evident in car-following tasks through increased headway distance (Strayer et al. 2003, Ranney et al. 2005), it does not appear to occur for tactical vehicle control, when a driver’s goals and intentions are in constant flux. That is, no evidence was found that distracted drivers increased their margins of safety when performing a tactical passing manoeuvre; they failed to compensate for the increased risk associated with a secondary task (i.e. they did not maintain their target level of risk). In fact, when drivers braked to disengage the cruise control \((BD)\), they were somewhat closer to the lead car in the dual-task than in the single-task condition (although the difference was only marginally significant). This finding suggests that drivers in the dual-task condition did not compensate as effectively for changing traffic conditions as they did when performing only the driving task. Dual-task interference might be more dangerous when drivers must actively decide how to interact with traffic than when their decisions are constrained by the driving context.

The passing task in experiment 1 incorporated more tactical aspects of vehicle control than car-following paradigms, where drivers are instructed to remain a fixed distance behind a lead vehicle over the course of a trial (e.g. Ranney et al. 2005). However, the driving situation was still constrained in some unrealistic ways. First, each group of vehicles (slow and fast) travelled at the same speed and none of the other vehicles changed lanes. This consistency might allow drivers to anticipate the flow of traffic, although the random inter-vehicle distances reduced the likelihood that drivers could rely on this regularity to reduce their monitoring of other vehicles. Second, reliance on a cruise control mechanism might limit how well these results generalize to more naturalistic passing situations. Experiment 1 also did not allow a direct comparison to steady-state driving, so it is also possible that the nature of the task or measures somehow limited the

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>HD_A</th>
<th>HD_B</th>
<th>TD_A</th>
<th>TD_B</th>
<th>BD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-task</td>
<td>25.2 (11.1)</td>
<td>26.5 (7.5)</td>
<td>39.8 (7.3)</td>
<td>76.7 (18.5)</td>
<td>42.3 (17.5)</td>
</tr>
<tr>
<td>Dual-task</td>
<td>23.9 (7.9)</td>
<td>24.3 (4.2)</td>
<td>39.7 (6.8)</td>
<td>79.3 (16.7)</td>
<td>38.8 (14.4)</td>
</tr>
<tr>
<td>T statistic (df = 15)</td>
<td>0.70</td>
<td>1.40</td>
<td>0.04</td>
<td>0.63</td>
<td>1.80</td>
</tr>
<tr>
<td>p value</td>
<td>0.50</td>
<td>0.19</td>
<td>0.97</td>
<td>0.54</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Statistics for pairwise comparisons described in the text are also provided. HD_A = closest headway distance to the vehicle being passed; HD_B = initial headway distance to a vehicle in the target lane; TD_A = tailway distance to the passed vehicle; TD_B = initial tailway distance to a trailing vehicle in the target lane; BD = headway distance when the brakes are depressed (braking distance); df = degrees of freedom.
ability to detect adaptive changes to safety margins. Experiment 2 addressed these concerns using a passing task that more closely approximated normal traffic, offering drivers full control over their vehicle. The experiment also measured safety margins during steady-state car following.

3. Experiment 2

3.1. Methods

3.1.1. Participants. A total of 18 drivers from the University of Illinois participated in this study in exchange for course credit (mean age 18.9 years; seven males, 11 females). They averaged 3.0 years of driving experience (SD 0.7) and an estimated average of 3375 km per year (SD 3662). All drivers had self-reported normal or corrected-to-normal visual acuity.

3.1.2. Materials. The simulator hardware was the same as in experiment 1 except as noted below. In experiment 2, the traffic environment consisted of a six-lane divided freeway with three lanes in both directions and a posted speed limit of 55 mph (89 kph). Other vehicles varied in speed (64 to 122 kph, randomly selected from a uniform distribution for each vehicle). Faster vehicles spontaneously passed slower moving vehicles by changing lanes, while maintaining safe headways. The variability in speed and spontaneous passing led to naturalistic traffic congestion, with some dense traffic regions and other regions with minimal traffic. Experiment 2 did not use a cruise control mechanism.

3.1.3. Procedure. At the start of the 45-min session, drivers completed an informed consent form and various demographic and driver behaviour questionnaires. They were then introduced to the simulator and allowed a few practice blocks for the driving and cognitive tasks. The cognitive task was identical to that used in experiment 1. Drivers completed one block of single-task driving and one block while performing the counting task, each lasting approximately 8 min. The order of the blocks was counterbalanced across drivers.

Drivers started each block on a freeway entry ramp and they were asked to merge onto the freeway and proceed to drive as they normally would, given the current traffic conditions. They were free to change lanes and pass vehicles as they saw fit. In order to elicit more naturalistic driving behaviour, drivers were given no specific instructions other than to avoid excessive speeding. Following completion of both experimental blocks, drivers filled out some additional questionnaires and were debriefed.

3.2. Results and discussion

As in experiment 1, headway and tailway distances were measured during all passing manoeuvres (see figure 1). Note that $TDA$ was not examined because not all passing manoeuvres were associated with a return to the original lane. Additionally, variability in lane-keeping performance, average speed, frequency of lane changes and frequency of braking responses were measured. To allow comparisons to other research on adaptive behaviour in dual-task contexts, performance when drivers were engaged in steady-state car following was also measured. Specifically, cases in which drivers approached and then followed a slower moving lead vehicle for some time before passing it were examined (see
figure 2). Steady-state periods were operationally defined as those in which the rate of increase or decrease in headway fell below 1.5 m/s for a minimum of 5 s. Thus, the experiment did not include intervals where the driver approached and passed a slower moving vehicle without any ‘following’ interval (i.e. no plateau; light coloured line in figure 2). Situations in which a lead vehicle was travelling faster than the driver so that headway continued to rise were also excluded.

Vehicle lane position was sampled at a rate of 10 Hz and cumulative samples for a given condition were used to derive the standard deviation in lane-keeping performance. A paired t-test revealed a significant difference between the single- (mean 0.39 m) and dual-task conditions (mean 0.33 m; $t(17) = 5.8, p < 0.001$), with greater lane-keeping precision (less variability) in the dual-task condition. Lane-keeping performance is minimally affected by mental workload (e.g. Horrey and Wickens 2006) and improved lane keeping under dual-task conditions is consistent with existing evidence (e.g. Brookhuis et al. 1991).

Drivers in the dual-task condition did not reduce their speed to compensate for slowed responses (dual: mean 26.3 m/s; single: mean 26.6 m/s; $t(17) = 0.5, p = 0.65$; cf. Pohlman and Traenkle 1994). They also made approximately the same number of lane changes across the two conditions (dual: mean 10.2; single: mean 11.1; $t(17) = 0.7, p = 0.51$). However, drivers did tend to brake more frequently while engaged cognitively (mean 9.8) than when performing the driving task alone (mean 6.6; $t(17) = 1.9, p = 0.07$). This marginally significant trend is consistent with delayed recognition of changes in traffic in the dual task condition (e.g. Strayer and Drews 2004).

3.2.1. Safety margins. As in experiment 1, no difference was found between the single- and dual-task conditions in average headway distance ($H_{DA}$) when a lane change was initiated (see table 2). In addition to average headway distance, minimum headway distance that a driver adopted at some point during the task was also measured – drivers

![Figure 2. Examples of vehicle headway as a function of time during a typical approach to a leading vehicle. For the dark function, the driver approaches the lead vehicle from behind and then maintains a fixed distance (~62 m here) for several seconds (~20 s here) before renewing the approach and ultimately changing lanes and passing the vehicle. Car following is defined as the interval during which the headway distance plateaus (marked ‘Steady-State’). The light-coloured function depicts a situation for which there is no steady-state car following.](image-url)
might occasionally use too small a safety margin even if they tend to keep a reasonable safety margin on average. However, minimum headway distances did not differ across conditions. There was also no difference in mean tailway distance across conditions. Drivers in the dual-task condition did pull in closer behind lead vehicles in the target lane (HDB) than they did in single-task conditions. This decreased safety margin is inconsistent with the claim that drivers adaptively increase safety margins under dual-task conditions.

Although no evidence was found for increased safety margins under dual-task conditions when drivers were performing a tactical manoeuvre, evidence was found for such adaptive behaviour when they were engaged in steady-state car following. Headway distances were shorter in the single-task condition (mean 37.3 m) than in the dual-task condition (mean 43.5 m; t(17) = 1.7, p < 0.05) during car following. This result replicates earlier evidence from steady-state car following (Strayer et al. 2003, Strayer and Drews 2004, Ranney et al. 2005) using a less-constrained driving task.

Collectively, these results suggest that adaptive safety behaviours do not translate from car following to more tactical manoeuvring and that drivers may expose themselves to even greater risk when they must make decisions about how to approach a traffic situation. Safety margins in the dual-task condition were actually reduced with regard to vehicles in the adjacent lane and drivers engaged in a cognitive task were more likely to use their brakes in the traffic scenario than when performing the driving task alone (see Horrey and Wickens 2004 for evidence of increased variability in speed control under dual-task conditions). To the extent that braking reflects impairment either in the recognition of changing traffic patterns or in a driver’s ability to gradually adjust speed as a function of traffic, this finding suggests that cognitive interference leads to even riskier driving.

### 4. General discussion

Taken together, these experiments suggest that adaptive safety behaviours vary as a function of the driving task. Although drivers increase their headway under dual-task conditions when performing steady-state car following (Strayer et al. 2003, Ranney et al. 2005), they do not increase their safety margins during tactical manoeuvres, such as overtaking. In some cases, they even decrease their safety margin. While the previous findings of behavioural adaptation are consistent with the notion of maintaining target

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**Table 2. Primary dependent measures Standard Deviation (SD) averaged across drivers separately for each task condition.**

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<thead>
<tr>
<th></th>
<th>Distance (m)</th>
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<tbody>
<tr>
<td></td>
<td>Mean HD&lt;sub&gt;A&lt;/sub&gt;</td>
<td>Mean HD&lt;sub&gt;B&lt;/sub&gt;</td>
<td>Min. HD&lt;sub&gt;B&lt;/sub&gt;</td>
<td>Min. HD&lt;sub&gt;B&lt;/sub&gt;</td>
<td>Mean TD&lt;sub&gt;B&lt;/sub&gt;</td>
</tr>
<tr>
<td>Single-task</td>
<td>56.6 (14.1)</td>
<td>73.6 (11.3)</td>
<td>11.8 (4.2)</td>
<td>20.3 (18.0)</td>
<td>95.1 (32.0)</td>
</tr>
<tr>
<td>Dual-task</td>
<td>55.1 (19.0)</td>
<td>67.1 (11.0)</td>
<td>10.5 (6.5)</td>
<td>19.9 (13.7)</td>
<td>95.0 (32.0)</td>
</tr>
<tr>
<td>T statistic (df = 17)</td>
<td>0.30</td>
<td>2.10</td>
<td>0.90</td>
<td>0.08</td>
<td>0.01</td>
</tr>
<tr>
<td>p value</td>
<td>0.80</td>
<td>&lt;0.05</td>
<td>0.40</td>
<td>0.94</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Statistics for pairwise comparisons described in the text are also provided. Min = minimum; HD<sub>A</sub> = closest headway distance to the vehicle being passed; HD<sub>B</sub> = initial headway distance to a vehicle in the target lane; TD<sub>A</sub> = tailway distance to the passed vehicle; TD<sub>B</sub> = initial tailway distance to a trailing vehicle in the target lane; BD = headway distance when the brakes are depressed (braking distance); df = degrees of freedom.
levels of risk (Wilde 1982, 1988), the current results are somewhat contradictory –
this discrepancy might result from differences in the attentional demands of the two
tasks.

The impact of dual tasks on dynamic, tactical situations, such as overtaking, might be
even more significant than in steady-state tasks because tactical driving requires the
timely allocation of additional attention resources under increased time pressure.
Constant monitoring for changes in relative vehicle positions requires distributed
attention across multiple areas and vehicle locations (e.g. rear-view mirror, blind spot,
lead vehicles, trailing vehicles) and a concurrent task reduces resources available for
continuous updating of speed, lane position and headway necessary to maintain safe
driving distances in varied traffic. The updating of relevant information is subject to
increased time pressure during tactical manoeuvres compared to steady-state car
following, where time constraints are less severe. Furthermore, cognitive capacity is
needed for the decision processes involved in tactical driving to a greater extent than in
steady-state driving. Failure to increase safety margins to compensate for impaired
performance suggests that cognitive load is more detrimental to tactical driving than to
steady-state driving and that drivers lack the resources to adjust their safety margin
appropriately to maintain their target level of risk. Given this lack of adaptive
compensation for cognitive impairments and the fact that real-world driving involves
many tactical decisions and varied traffic situations, such impairments lead to increased
risk in driving.

Moreover, the task explored the impact of a dual task under conditions that were
largely predictable – other vehicles typically maintained speed without braking
unexpectedly. The impact of a concurrent cognitive task would be even greater in the
face of unexpected traffic changes, as cognitive load can lead to failures to notice
otherwise visible objects (Simons and Chabris 1999). Future research can examine
whether performing a cognitive task during tactical manoeuvres leads to even greater
disruptions in detecting and avoiding such unexpected hazards.

Although this study has attempted to create scenarios that rely on more tactical aspects
of vehicle control, the method has several limitations. First, both studies use a simulator
instead of an actual vehicle on the road. Second, in allowing drivers more freedom in the
driving task (in experiment 2), some control over vehicle interactions was necessarily
sacrificed. For example, some drivers did not initiate lane changes as often as others,
although all drivers initiated at least some lane changes. (Variations in passing rate could
also serve as a risk compensation mechanism. Note, however, that the frequency of
passing manoeuvres did not differ between the single- and dual-task conditions. As an
exploratory analysis, the safety margins for high and low frequency passers were
examined and some group differences were found. For example, drivers who passed
frequently tended to pull in closer behind another vehicle than did low-frequency passers;
however, this difference was constant across the single and dual task conditions.
Additional measures of behavioural compensation should be considered in future work,
ideally with larger sample sizes needed to definitively test for individual differences.) More
generally, it was not possible to assess secondary task performance. Although
experimenters actively monitored secondary task performance online to ensure that
drivers continued to perform it, there may have been subtle speed–accuracy trade-offs.
Despite these limitations, these studies suggest that drivers do not increase their safety
margins to compensate for cognitive impairments during tactical driving manoeuvres.
Thus, cognitive interference could have even greater consequences for driving safety
under these conditions.
Acknowledgements

Data were collected at the Beckman Institute for Advanced Science and Technology at the University of Illinois, Urbana-Champaign. The authors are grateful to Evan Buschmann, Kevin Zinter and Eamon Caddigan for their assistance in data collection, reduction and analysis. We also thank Hank Kaczmarski, Camille Goudeseune, Kyle Consalus of the Integrated Systems Laboratory for technical assistance and continued maintenance of the simulator facility and Mary Lesch, William Shaw, Yueng-hsiang Huang and two anonymous reviewers for helpful comments and suggestions on earlier drafts of this manuscript. A subset of data from the current manuscript was presented at the 2006 annual meeting of the Human Factors and Ergonomics Society.

References


