Investigation of the Effects of Driver Distraction

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Biography
John Brown is part of the Mobility Safety Team of NRMA Motoring & Services.

John has spent six years with NRMA in a variety of research, advocacy and program management roles.

John coordinates a number of community outreach programs including:
- The travelling road safety exhibition RoadZone
- 'Years Ahead'- Road Safety for Seniors ; and
- NRMA'S Road Safety Grants

John has conducted research into a variety of areas including:
- Driver Fatigue;
- Older Drivers;
- The Demerit Point System; and
- Repeat Serial Serious offenders.

Previous to his time at NRMA, John was an executive in the school system.

1. DRIVER DISTRACTION: A SIMULATOR EXPERIMENT

Any search of the literature will find a plethora of research, recommendations, claims and concerns raised about the issue of driver distraction. Such distraction might come from inside the vehicle (for example a driver interaction with a mobile phone or audio device) or from the highway environment (for example the driver visually attending to an advertisement or a pedestrian). As a general quantification of the size of the problem, Wang, Knipling and Goodman (1996), found that up to 25% of crashes involved some degree of driver distraction. As yet, however, little research has been undertaken to examine how distractions coming from within the vehicle and within the road environment might interact with each other.

In the current research, drivers were tested in the Monash University Accident Research Centre's advanced driving simulator, examining both within vehicle distraction, and possible distraction caused by visual clutter in the highway environment. The aim was to examine the effects of distraction upon driving performance and subjective responses. A hazard detection task was employed as the main experimental measure, whereby the effects of distraction were assessed in terms of drivers' reactions to pedestrian and other hazards in the roadway. Measures of perceived workload and overall driving performance measures were also analysed.

Overall, the experiment found that the in-car distraction tasks degraded overall driving performance, degraded responses to hazards and increased subjective workload. The performance decrements that occurred as a result of distraction were observed in both the simple and complex highway environments and for drivers in different age groups. The results will be fully discussed in the conference presentation.

Executive Summary

This report details research undertaken by the Monash University Accident Research Centre (MUARC) to investigate the issue of driver distraction. The MUARC advanced car driving simulator was used to undertake a study that examined the effects of distraction upon driving performance for drivers in three age groups. It examined the effect of within-vehicle distraction and possible distraction caused by visual clutter in the road traffic environment. There were two in-car distractors: operating the car audio system (tuning a radio and locating and inserting a music tape) and conducting a simulated hands-free mobile phone conversation. The effect of visual clutter was examined by requiring participants to drive in a simple and a complex road traffic environment. The study employed a hazard perception task, whereby the effects of distraction were assessed in terms of drivers' reactions to pedestrians and other hazards in the roadway.

Overall measures of driving performance were collected to assess driver distraction, together with responses to roadway hazards and subjective measures of driver perceived workload. The two in-car distraction tasks (especially the audio system task) degraded overall driving performance, degraded responses to hazards and increased subjective workload. The performance decrements that occurred as a result of distraction were observed in both the simple and complex highway environments and for drivers in different age groups. There was no difference found between the degree of performance degradation due to distraction in the simple and complex driving environments indicating that external visual clutter had no effect on driving performance.

Older drivers (over 60) drove more slowly when they were distracted by the audio system and in the complex driving environment. Younger people (18-25) maintained a more constant speed compared to middle aged (30-45) and older drivers (over 60). Fatigue caused by loss of sleep the night before the test, or by the driving task itself, did not affect driver performance.

The authors concluded that the in-vehicle tasks of interacting with the audio system and conducting a simulated hands-free mobile phone conversation do impair several aspects of driving performance. The audio system distractor had the greatest impact on performance. This finding fits in well with other previous research conducted on this topic around the world.

Introduction

Safely driving a vehicle on public roads requires a wide range of skills and abilities. Driving does not always take place in ideal road traffic conditions, in which a well-rested, well-trained and well behaving individual interacts with a simple, undemanding road environment. One issue that can make driving performance sub-optimal is distraction, both from within the vehicle and from within the highway environment.

3.1 Project Aims

As noted above, distraction is a significant road safety issue, and only recently has much research been devoted to it. Building on this previous research, this project aims to quantify the extent to which in-vehicle distraction and highway clutter influence driving performance and subjective responses (mental workload, sleepiness and related). In addition, the study aims to assess interactions between in-vehicle distraction and highway clutter and the extent to which these influence driving performance and subjective responses.

Method

4.1 Subjects

Participants were recruited from the MUARC subject database and general advertising around Monash University and the local community.

In total, 31 subjects were employed. The following age categories were used:

10 younger drivers (under 25 years);
11 mid-age drivers (30-45); and
10 older drivers (60-75 years).

Each subject was given $20 for his or her participation. Those subjects who were unable to complete the experiment due to simulator sickness were also paid $20, but their data were not used in the analysis.

4.2 Study Design

Each subject performed in all combinations of experimental conditions. Formally, the study is a mixed factorial design consisting of 3 age ranges, 3 in-vehicle distraction levels and 2 environmental complexities. The in-vehicle distractions and environmental complexities are explained in more detail in the sub-sections below.

4.3 Distraction Conditions

The research was designed to assess both within-vehicle distraction and possible distraction caused by environmental complexity (visual clutter) in the highway environment.

1. Environmental Complexity
In terms of the environmental complexity factor, subjects were presented with a 'simple' and a 'complex' highway environment- complexity was altered by modifying factors in the highway that previous research (for example, Horberry, 1998) has found to be relevant.

The objects encountered in the simple conditions included trees, signs and the highway hazards. In the complex conditions buildings, signs, billboards and other vehicles were encountered as well as the highway hazards. In the simple conditions, on average, 28 objects per km were encountered and for the complex conditions, 484 per km.

2. In-vehicle Distraction
The in-vehicle distractors used in this experiment were chosen because they were representative of tasks commonly performed by drivers, performance of them could be accurately measured, and they would yield data that would build on research on in-vehicle distraction known to have been undertaken recently overseas. The following two in-vehicle distraction tasks were used:

- A hands-free mobile phone task. The MUARC simulator has a microphone and speakers in the vehicle, so a hands-free mobile phone conversation could be replicated. A conversation was conducted between the driver and the experimenter during which the experimenter asked the participant a series of questions. The questions were reasonably demanding and presented at a fast pace.

- A task of interacting with an in-vehicle audio system**.** Prior to commencing the experiment the participant was trained to use the functions of the vehicle's radio and cassette player. During the audio system distractor drives they were asked to tune

the radio to particular frequencies, adjust the bass and treble balance, adjust the speaker balance and insert, play and eject cassette tapes. The tasks involved general physical/motor control tasks while also having cognitive and perceptual demands.

Each subject participated in six experimental conditions, these were:

- Simple environment, with no in-vehicle distraction
- Simple environment, with a mobile phone conversation as the distractor
- Simple environment, with interacting with the audio system as the distractor
- Complex environment, with no in-vehicle distraction
- Complex environment, with a mobile phone conversation distraction task
- Complex environment, with interacting with the audio system as the distraction task.

The driving environments were approximately 6 km in length. The gradient was level, but several curves were contained within the drive. Speed limit signs were placed in all the scenes, with the posted speed limit randomly changing between 60,70, and 80 km/h every 1 km. The road was single carriageway in either direction.

4.4 Response measures

Within each drive there were four hazardous 'events'. These were as follows.
1. Event A: Pedestrian crosses the road in front of the car.
2. Event B: An oncoming vehicle turns right in front of the car
3. Event C: Pedestrian is standing one metre onto the roadway, but not moving.
4. Event D: A car reverses down a driveway towards the road but stops before reversing into the road.

In addition to these hazards, the experiment also recorded 'overall' measures of driving performance throughout each of the driving scenarios. These were: vehicle speed and roadway position of the vehicle. The hypotheses here were:

1. Speed Variability. Speed standard deviation (from the posted speed limit) would be higher for drivers in the distraction conditions.
2. Mean Speed. Mean speed will be lower for drivers in the distraction conditions.
3. Roadway position. Lateral lane position standard deviation (eg 'weaving' along the road) would be higher for drivers in the distraction conditions.

Finally, as well as these objective driving measures, subjective measures were also obtained to gauge participants' experiences of the different driving conditions. These were:

- Perceived workload with respect to the different conditions was measured using the well-known NASA Task Load Index (NASA-TLX) technique.
- Sleepiness/tiredness with respect to the different conditions was measured with the well-known Stanford Sleepiness Scale

Results

The negative effects of distraction were more pronounced for the audio system tasks than for the mobile phone tasks:

- When people were distracted by the audio system they slowed between 9 and 11 km/h less when there was a pedestrian crossing the road or standing in the roadway than when they encountered the same hazards without being distracted.

- When they were distracted by the mobile phone conversation they slowed between 5 and 7 km/h less than when there was no distraction.

- When distracted by the audio system, drivers' vehicle position on the road deviated up to 0.8 metres more than when they were not distracted. This means they wandered over the road more when they were distracted by the audio system than when they were not.

- Drivers were told to maintain a constant speed. When they were distracted by the audio system their speed varied from the target speed by 1.5-1.7 km/h more than when they were not distracted. This means they were less able to concentrate on maintaining a constant speed while operating the audio system.

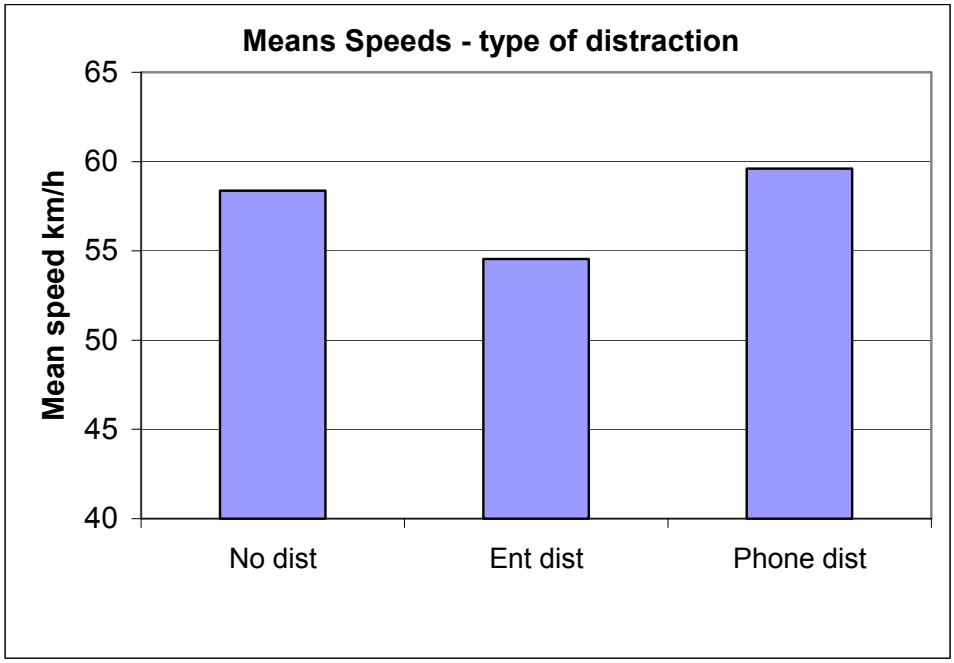
Overall, the results found:

- Reduced overall driving performance (e.g., poorer speed control; lane-keeping);
- Reduced drivers' ability to detect and respond safely to unexpected hazards; and
- Increased drivers' feelings that they were under pressure.

Results were relatively consistent across different age groups and environmental complexities.

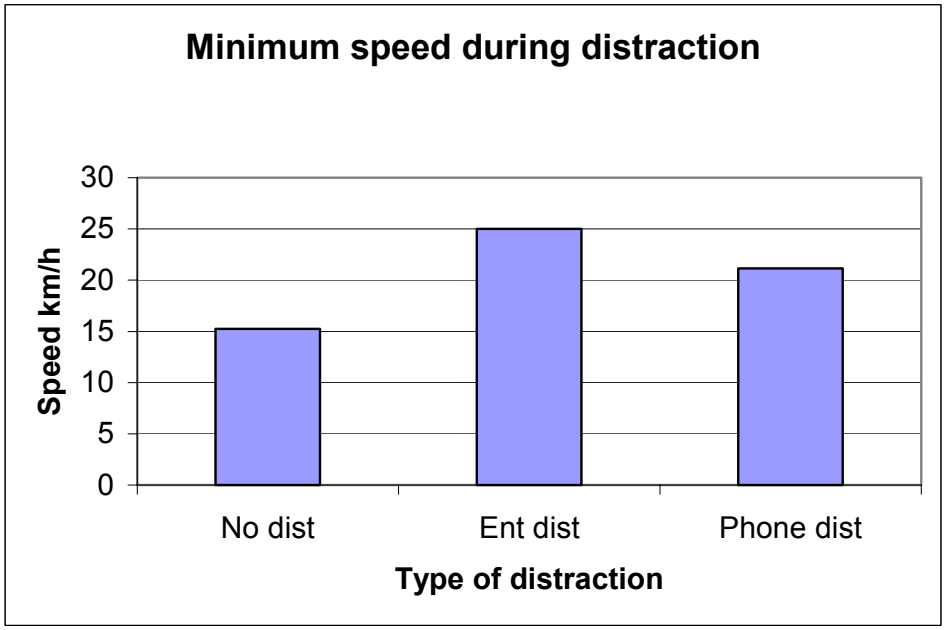
The negative effects of distraction were observed in both simple and complex highway environments - light traffic with fewer distractions versus situations with heavier traffic and more environmental distractions (pedestrians, signage etc).

It can be seen from the following graph that people drove more slowly when they were distracted by the audio system tasks. This indicates that they were finding it difficult to drive at a consistent speed as directed.

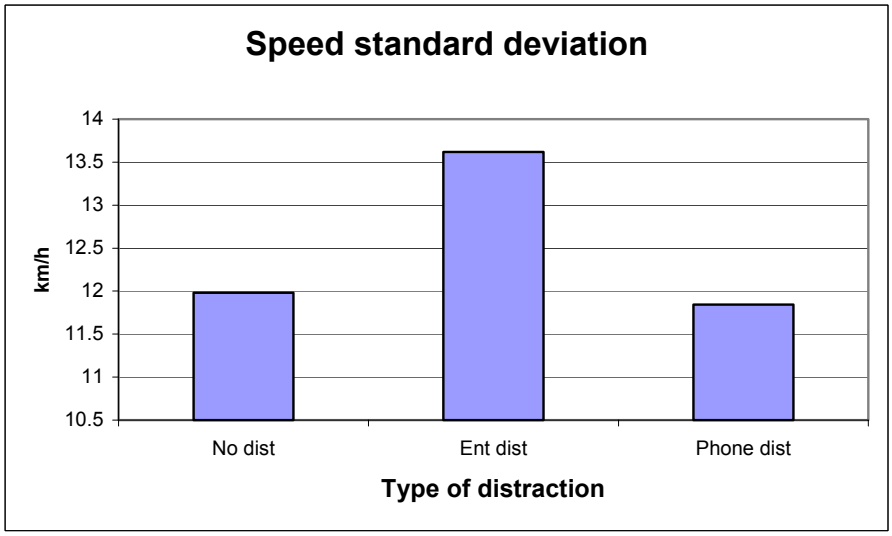


The graph below shows that when participants encountered a pedestrian crossing the road, drivers slowed down more when there was no distraction.

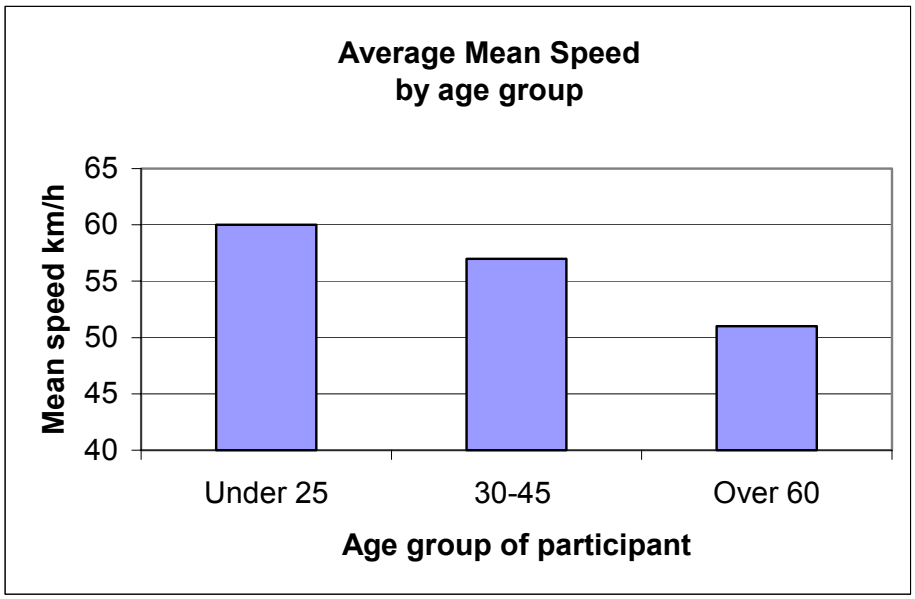
When participants were distracted by the audio system and the hands-free mobile phone conversation they did not slow down as much - 9 -11km/h less for audio system; 5 - 7km/h less during hands-free conversations.



The following graph shows that drivers' speeds deviated more when they were distracted by the audio system, compared to the phone distractor and when there was no distraction. This means they did not maintain a constant speed.



The following graph shows that the older age group drove more slowly when under the pressure of the phone conversation and interacting with the audio system. This appears to have been a compensatory response to give them more time to react. The fact that they drove more slowly even though the experimental instructions were to maintain a target speed (the posted speed limit) means they had difficulty performing when there was distraction and compensated by slowing their speed.



2. CONCLUSIONS

The study found that the audio system distractor had the greatest negative impact on performance, suggesting everyday activities such as tuning a radio or operating a CD player can be more distracting while driving than using a hands-free mobile phone.

While there has been much discussion and media activity in alerting the public to the dangers of using hand-held mobile phones while driving, this study suggests there is also a pressing need to inform motorists about the potential dangers of using in-car entertainment systems - particularly car stereos - and conducting hands-free mobile phone conversations.

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