Visual attention in novice drivers: A lack of situational awareness

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Visual attention is an important skill in driving. Novice drivers have been shown to have significantly poorer visual attention skills in high demand situations. Two hypotheses, situation awareness and cognitive resource limitation, have been proposed to explain this attention deficit. Although support has been shown for both hypotheses, when tested directly situation awareness appears to best explain this deficit. This study aimed firstly to investigate the deficit in novices using a peripheral identification task to measure visual attention and secondly to improve on previous flawed methodology comparing the two hypotheses. 109 participants completed a driving simulation that varied in demand, as measured by drive difficulty, during which they had to identify peripherally presented stimuli. The results confirmed that novices display a visual attention deficit in high demand situations. To investigate what hypothesis best explained this deficit, 59 novice drivers completed an additional drive. Participants were allocated to one of four conditions that varied in amount of cognitive resources utilised. Even when cognitive resources were not being used for vehicle control, novice drivers still have poor visual attention. This finding supports the situation awareness hypothesis. Future research should focus on investigating the parameters of situation awareness in novice drivers to help them overcome this vulnerability.

1. Introduction

Over the past 35 years road crash casualties in Australia have gradually decreased (Department of Infrastructure, Transport, Regional Development and Local Government, 2008). Young drivers, ranging from 17 to 25 years old, however, are still over-represented in these statistics. They continue to have the highest risk of crashes regardless of the increasing amount of policies implemented to target this group, such as the graduate licensing scheme which imposes additional restrictions on provisional licence holders (Lam, 2003).

Inattention is commonly cited as the causative factor in novice crashes (Braitman, Kirley, McCartt, & Chaudry, 2008; McKnight & McKnight, 2003; Underwood, 2007). Attention to visual information whilst driving is crucial for extracting relevant information (Poggel, Strasburger, & MacKeben, 2007; Recarte & Nunes, 2000) and for safe driving, vehicle control and event detection (Jahn, Oehme, Krems, & Gelau, 2005; Simons-Morton, 2007).

Visual attention has a limited capacity, particularly in novice drivers (Crundall, Shenton, & Underwood, 2004; Harms & Patten, 2003; Underwood, 2007). In complex environments drivers need to allocate their limited attentional resources stringently to relevant information (Poggel et al., 2007; Underwood, 2007). It would appear that experienced drivers are able to do this adequately, however novice drivers struggle to cope in these situations (Crundall & Underwood, 1998; Simons-Morton, 2007). Crundall and Underwood (1998) assessed eye movements in novice drivers with two months experience and experienced drivers with nine years experience, under different demand levels. Substantial differences were found between novice and experienced drivers in the high demand dual carriageway section. This section was comprised of high density traffic with a lot of merging. In this situation, experienced drivers had shorter fixation durations and greater horizontal and vertical search variance than when driving along lower demand roads. This is suggestive of a compensatory strategy to accommodate the increasing demand of the road (Crundall & Underwood, 1998). Novice drivers however fail to show this pattern. Instead, novices had longer fixation durations and a limited horizontal search variance. This suggests greater attentional capture and slower information processing in high demand situations on the road (Crundall & Underwood, 1998). In low demand rural roads and medium demand suburban roads novice drivers did not differ from experienced drivers in their scanning patterns. Novice drivers appear to show a visual attention deficit, that is, novices fail to scan the driving scene adequately in high demand situations, where it would be most beneficial. This finding has since been confirmed by Falkmer and Gregerson (2001) comparing drivers with more than 100,000 kilometres driving experience to learner drivers, using eye movement data. As shown by eye movement studies, novice drivers demonstrate a visual attention deficit in high demand situations

2. Experiment One

2.1 Introduction

The current experiment explores this visual attention deficit in novices by investigating peripheral detection abilities. The standard peripheral detection task requires participants to detect peripherally presented stimuli whilst completing a central task (Martens & van Winsum, 2000). Detection performance, as measured by response accuracy and reaction time, is highly dependent on the level of cognitive and perceptual demand of the central task (Harms & Patten, 2003; Jahn et al., 2005; Martens & van Winsum, 2000). When applied in the driving situation the peripheral detection task provides information about the cognitive resources available to drivers and how they allocate their attention to the various aspects of the driving task (Crundall, Chapman, France, Underwood, & Phelps, 2005; Patten, Kircher, Ostlund, Nilsson, & Svenson, 2006). Peripheral detection has been found to improve with driving experience (Crundall, Underwood, & Chapman, 1999, 2002; Patten et al., 2006).

However no definitive evidence of a visual attention deficit in novice drivers has been shown using peripheral detection. It has been found that in the presence of a hazard peripheral detection decreased for all drivers (Crundall et al., 1999, 2002). However experienced drivers recovered faster from the attentional capture of the hazard (Crundall et al., 2002). This definition of demand as a single hazard is different to the definition of high demand used in eye movement studies, where a high demand situation involved dense traffic with a lot of merging.

A more recent study found that novice drivers had poorer attention than experienced drivers across all levels of demand (Patten et al., 2006). Demand was defined similarly to the eye movement studies, however in this experiment experienced drivers were familiar with the test roads. It has been shown that after driving through the same route 24 times over four days scanning of the scene becomes so automatic that ten of twelve participants failed to notice that an important sign had changed (Martens & Fox, 2007). Therefore this has given the experienced drivers an advantage and may account for the poor performance in inexperienced drivers across all demand levels.

The findings from peripheral detection studies are inconclusive and fail to show evidence of a visual attention deficit in novice drivers in high demand situations. This is largely due to demand and experience being operationalised differently across the studies. The current study will operationalise demand and experience similarly to Crundall and Underwood (1998) and thus provide comparative data.

The task used in this experiment incorporates elements of the peripheral detection and divided attention tasks to measure visual attention in driving. Participants will need to identify the target by making a low level decision about its shape. This low level identification task has been established as harder than a simple detection task (Wilder, Kowler, Schnitzer, Gersch, & Dosher, 2009). It requires processing to identify and respond appropriately to the target (Nunes & Recarte, 2002). Therefore, this task should provide insight into not only how drivers distribute their attention to the road but also their ability to process and respond to peripheral objects during the driving task.

It is hypothesised that visual attention performance will vary depending on demand level as measured by drive difficulty. Furthermore, the relationship between visual attention and experience at different demand levels will differ, such that experience should lead to improved peripheral identification/attention in high demand situations, but experience will not have any effect in low demand situations.

2.2 Method

2.2.1 Participants

85 participants (57.6% female), ranging between 16 and 27 years of age (mean 20.16) were recruited for this experiment. 50 participants were first year psychology students at Macquarie University. The remaining participants were a convenience sample of family and friends of the experimenter. All participants had normal or corrected to normal vision and held at least a Learner’s Driving Permit.

2.2.2 Apparatus and Materials

The STISIM model 400 driving simulator was used to present drives to participants. The driving simulator system was run on three Dell DXP061 computers with 2394MHz processing speed, using an Altec Lansing model VS4121 Powered Audio System, consisting of three speakers, one subwoofer in the centre and two small speakers on the left and right.

A visual attention task was conducted during the presentation of a drive. This was a special function of the STISIM software. Triangles and horn shaped symbols were presented on the two outer screens. Participants responded via one of three possible buttons, one on either side of the metal dashboard and the horn. The desired response depended on the type of symbol presented.

A brief demographic survey on driving experience was administered.

2.2.3 Procedure

Prior to commencing it was checked that the participant held at least a Learner’s Driving Permit and that they did not experience motion sickness as the simulator is known to cause motion sickness in some people. They then completed the demographic survey.

Participants were then introduced to the driving simulator. Participants could adjust the seat to their liking, meaning that the viewing distance ranged from 61 to 86 cm from the middle screen. They were told that symbols would appear on the two outer screens, to which they needed to respond. Participants were instructed that when a triangle appears on the left screen they were to respond by pressing the black button on the left, that when a triangle appears on the right screen they were to respond by pressing the black button on the right and that when the horn symbol appeared in either screen they were to respond by pressing the horn. 72

symbols were presented in random positions on the two outer screens at random times throughout the drive. They appeared on screen for 2500ms or until a response was made. The symbols were 1.9cm high by 1.4cm wide at their largest extent. Participants were told to focus on driving, but if they notice the symbols they should respond appropriately to them. It was emphasised that they should not actively search for the symbols.

The drive consisted of three sections with varying difficulty. There was an easy (rural) section, which comprised of a one or two lane quiet road with very few cars; a medium (suburban) section, which comprised of a one lane road, with surrounding houses, parked cars and pedestrians; and a hard (city) section, which comprised of two or three lanes, with high density traffic and a lot of cars merging and pulling out. The order that these sections were presented to participants was counterbalanced. There were 24 symbols presented during each section.

Drivers were told that a crash would be recorded if they hit another vehicle or pedestrian, or if they drove more than 1.5 metres off the road. They were also asked to drive straight unless directed to turn by a recorded voice that would come through the speakers. They were told that it was important to drive through the simulated drive as they normally would on the road.

The experimenter left the room once the simulation began. Data recorded by the driving simulator included the number of crashes, pedestrians hit, percentage of time outside of the lane, and attention to the symbols. Data from the attention task was scored separately for each section of the drive. Data included correct responses, incorrect responses, misses and reaction times.

2.3 Results

To establish that the three difficulty levels differed in allocation of attentional resources, a one-way repeated measures ANOVA was used, with Drive Difficulty as a within subjects independent variable. There was a significant effect of Drive Difficulty when measured by Correct Responses [$F(2,168)=36.160$; $p<.0005$] and Reaction Times [$F(2,168)=20.626$; $p<.0005$]. A plot of means for Correct Responses and Reaction Times are presented in Figures 1 and 2, respectively. Using an alpha of .016 to investigate pairwise differences, it was found that all pair-wise comparisons were significant for Correct Responses. For Reaction Times all pair-wise comparisons were significant except for the difference between Easy and Medium sections ($p=.025$), although this was approaching significance. Overall this indicated that performance was best in the Easy section and worst in the Hard section.

[Figures 1 and 2 about here]

The effect of experience in the different demand levels was further investigated. In pilot studies a positive effect of experience and visual attention was found only for Reaction Times, so for this analysis only Reaction Times will be assessed. Pearson correlations were used to investigate the role of experience in the different difficulty levels. The correlation between the Reaction Times in the Easy section and Years Experience was not significant [$r(83)= -.199$; $p=.067$]. There was a significant, but low negative correlation between Medium section Reaction Times and Years Experience [$r(83)= -.237$; $p=.029$], as well as between Hard section Reaction Times and Years Experience [$r(83)= -.239$; $p=.027$].

2.4 Discussion

The findings from this experiment support the hypothesis that visual attention performance differs under varying demand levels, as measured by drive difficulty. As demand increased visual attention performance decreased. This is in accordance with past research showing that as the demand of driving increased peripheral detection decreased (Crundall et al., 1999, 2002; Jahn et al., 2005; Patten et al., 2006). This confirms that peripheral identification, like peripheral detection, is sensitive to cognitive workload (Chan & Courtney, 1993; Harms & Patten, 2003; Jahn et al., 2005). Visual attention suffers as the demand of the road increases.

In support of the hypothesis, the effect of experience differed depending on the demand level. It was shown that the effect of driving experience on performance in the low demand situation was not significant, suggesting that in this situation all drivers demonstrate sufficient visual attention skills. In high demand situations, however, there is a significant relationship between experience and performance, such that visual attention improves with more experience.

Novices have poorer visual attention in high demand situations where a wider search and efficient allocation of attention is necessary for safe driving (Jahn et al., 2005; Simons-Morton, 2007; Wikman et al., 1998). This confirmed the findings of both Crundall and Underwood (1998) and Falkmer and Gregerson (2001). The visual attention deficit novice drivers’ demonstrate in high demand situations is not just a result that appears in eye movement data. When operationalising experience and drive demand similarly to Crundall and Underwood (1998) the same results are obtained using peripheral identification as a measure of visual attention.

A slight difference between Crundall and Underwood (1998) and the current finding is the effect of experience in the medium demand situation. In the current study, more experience lead to better visual attention in the medium demand level, whereas Crundall and Underwood

(1998) found no difference. It is possible that the medium demand section in our drive was slightly harder than the medium demand section used in Crundall and Underwood (1998).

3. Experiment Two

3.1 Introduction

Since a visual attention deficit was shown in Experiment 1, investigation of the cause of this deficit is justified. Two hypotheses have been proposed to explain the visual attention deficit in novice drivers. These hypotheses are situation awareness and cognitive resource limitations (Pollatsek, Fisher, & Pradhan, 2006; Underwood, 2007).

The situation awareness hypothesis suggests that novices fail to scan the scene adequately in high demand situations because they aren't aware that the situation requires more scanning (Pollatsek et al., 2006; Underwood et al., 2002; Underwood, 2007). More experience with a task leads to more efficient allocation of attention through the use of schemas about common problems and their solutions (Simons-Morton, 2007). Schemas are acquired with experience (Underwood et al., 2002). Novice drivers don't have sufficient schemas about road situations to inform them of the situations that are more dangerous and that require more attentional resources. Therefore, novices do not employ different strategies to deal with the varying demand levels.

A model of situation awareness explains there are three levels of situational awareness (Endsley, 1995). The levels range from having perception of the environment and its elements to anticipating and predicting how the situation will unfold (Endsley, 1995). These levels can be applied to the driving task (Evans & MacDonald, 2002; Underwood, 2007). It has been suggested that novices struggle with the highest level of situational awareness, involving anticipation of road events (Groeger, Whelan, Senserrick, & Triggs, 2002;

Underwood, 2007). In support of this Groeger et al. (2002) found that novice drivers were worse at both remembering and predicting car positions after a brief pause. This high level of situational awareness is necessary for drivers to be able to make an informed decision about the road situation and adjust their attentional resources accordingly (Evans & MacDonald, 2002; Underwood, 2007).

Support for this hypothesis comes from studies that successfully train novices to scan for hazards and potentially dangerous situations (Chapman, Underwood, & Roberts, 2002; Fisher, Pollatsek, & Pradhan, 2006; Pollatsek et al., 2006). Chapman et al. (2002) found that in all situations scanning increased significantly, however drivers still failed to alter their search strategy to suit the various situations. This was taken as evidence that novice drivers *do* have the cognitive resources to scan the scene sufficiently but they still have not developed awareness of the different situations.

The cognitive resource limitation hypothesis proposes that novice drivers fail to scan adequately in high demand situations because they do not have the cognitive resources available to allow a more thorough scan that is necessary in this situation (Pollatsek et al., 2006; Underwood, Chapman, Bowden, & Crundall, 2002; Underwood, 2007). Cognitive resources are taken up by vehicle control and basic monitoring of the scene (Summala, 1988; Underwood et al., 2002). Thus, when a situation is more demanding and requires more attention, novices do not have the cognitive resources available to meet this need. With experience, driving becomes easier and requires fewer resources (Harms & Patten, 2003; Jahn et al., 2005; Lansdown, 2002; Simons-Morton, 2007; Wikman, Nieminen, & Summala, 1998). In turn, this leaves drivers with more resources available to allocate to other tasks involved in driving.

Evidence for this hypothesis comes from studies using secondary tasks during driving. The addition of a secondary task leads to poorer visual attention in all drivers (Harbluk, Noy, Trbovich, & Eizenman, 2007; Recarte & Nunes, 2003). The effect of a secondary task is more detrimental to novice drivers (Horberry, Anderson, Regan, Triggs, & Brown, 2006; Lansdown, 2002; Wikman et al., 1998). When the cognitive load increases, novices struggle to allocate their attention adequately because of a lack of cognitive resources (Wikman et al., 1998). Furthermore, with more experience, drivers learn to rely on peripheral vision for lane maintenance (Land & Horwood, 1995; Summala, Nieminen, & Punto, 1996). Novice drivers have not yet learnt to do this, and therefore it is still utilising cognitive resources that could be allocated to other tasks.

A study by Underwood et al. (2002) was designed to differentiate between these two hypotheses. Experienced and novice drivers in this experiment watched videos of a drive that varied in demand level. Participants were required to search for hazards in an attempt to ensure participants were processing the scene as though they were driving. Scanning patterns were assessed in both groups on the pretence that by removing the cognitive task of vehicle control they would be able to conclude what hypothesis explains any observable deficit. They found that novice drivers' scanning was still worse than experienced drivers in the high demand situations, even when they do not have the cognitive task of controlling the vehicle. That is, even with spare cognitive resources available, novice drivers still do not scan high demand scenes efficiently. Underwood et al. (2002) therefore concluded that the deficit must occur because of a lack of a situational awareness of the demands of the scene. This conclusion is slightly problematic, however, as scanning patterns in the presence of hazards have been found to be different than when in a highly demanding scene (Chapman &

Underwood, 1998). This means the task may not be eliciting scanning patterns that are typical of high demand situations.

The current experiment builds on the method used by Underwood et al. (2002) to test between the two hypotheses. To overcome the possibility that participants were not scanning the scene as though they were driving, the present study will employ a condition where participants are required to verbalise what they would be doing if they were driving (verbalising/driving). This should ensure participants are really processing and thinking about the drive as though they were actually driving. The possibility that verbalising places a demand on cognitive resources will be controlled for in a condition where participants are required to recite the alphabet while they watch the video of the drive (verbalising only).

Only novice drivers will be used to test between the two hypotheses. Novices are defined in this study as Learner or Provisional One licence holders. The risk of crashes in new drivers decreases substantially after one year of driving (Simons-Morton, 2007; Mayhew, Simpson, & Pak, 2003). Since Provisional One licence holders are required to be on this level of licence for a minimum of one year, this division proved to be suitable. Learners are generally safer drivers (Lam, 2003; McKnight, Peck, & Foss, 2002), however they provide important information about patterns of visual attention very early in the process of driving skill acquisition.

It is hypothesised that the situation awareness hypothesis will provide a better explanation for novice drivers' visual attention deficit in high demand situations.

3.2 Method

3.2.1 Participants

Participants from Experiment 1 completed this experiment if they met the criteria of holding a Learners or Provisional One licence driver. There were 59 participants (63.8% female), ranging between 16 and 25 years of age. Of this sample 45 participants were first year psychology students.

3.2.2 Apparatus

In some conditions in this experiment pre-recorded drives were presented to participants. The experimenter had driven through the drives on the driving simulator in a sensible, consistent and predictable manner. They were presented to participants using the playback function on the STISIM software. The presentation therefore was from the driver's perspective and was identical to the view the participants would see if they were driving.

The visual attention task was also presented whilst participants viewed a pre-recorded drive. Although symbols could be presented on screen as mentioned above, due to limitations in the STISIM software, responses made whilst viewing a pre-recorded drive were not recognised. To record data from the pre-recorded drive conditions the responses were made and recorded via another program. The reaction time program DirectRT version 2004, operated on a Toshiba MTOS010AOM01 notebook with processing speed 1.93GHz, was run simultaneously with the pre-recorded drive to collect data on the responses. Two numerical keypads attached to the edge of the metal frame were used to record responses. The participants did not view the notebook screen at any time.

3.2.3 Procedure

Participants were identified as novice drivers prior to commencing the experiments. For novice drivers the order of completing Experiments 1 and 2 was counterbalanced.

The format of the drive and the attention task requirements were identical to the drive from Experiment 1, however it was a different route. Participants were randomly allocated to one of four conditions to complete the drive. The conditions were driving, where participants were required to drive as per normal; verbalising/driving (labelled Talk-R), where participants watched a pre-recorded drive and were required to verbalise what they would be doing if they were driving; verbalising, (labelled Talk-I), where participants were required to recite the alphabet whilst watching the pre-recorded drive; and watching, where participants were simply watching the pre-recorded drive. These conditions allowed the level of cognitive resources required for the driving task to be manipulated.

Participants in the driving condition were given the same instructions used for Experiment 1. Participants in the three other conditions were told they would be watching a pre-recorded drive rather than driving themselves. Participants were told they would still be completing the attention task, but they would now be responding using two numerical keypads that were attached to the edge of the driving simulator. Participants were told to respond by pressing the Enter button on the left numerical keypad to triangles presented in either screen, and to respond by pressing the Minus button on the right numerical keypad to horn symbols presented in either screen. The symbols remained on screen for 2500ms, even after the participant responded. Participants were made aware of this. They were also asked to keep their hands in their laps for the entire drive unless responding. They were instructed to view the drive like they would if they were driving. This instruction was emphasised.

Participants were given specific instructions about the task depending on the condition to which they were allocated. Participants in the Talk-R condition were told that in order to help them scan the scene as though they were driving they had to verbalise what they would be doing if they were driving. Participants were given the example of approaching an intersection and saying that they would start to brake, put the indicator on, and look for oncoming traffic. Participants in the Talk-I condition were asked to recite the alphabet out loud, continuously for the duration of the pre-recorded drive. Participants in the watching condition were not given any further instructions.

The researcher left the room for the driving condition, but stayed in the room for the three non-driving conditions. This was to ensure participants completed the task appropriately and that they kept their hands in their lap. For the driving condition the data recorded was identical to Experiment 1. For the non-driving conditions only data from the attention task was recorded.

3.3 Results

To investigate whether combining these licence groups was sensible, independent t-tests were run to test whether Learners and Provisional One licence drivers differed. No significant differences were found between the two groups on the variables used in this study. Therefore it was suitable for the licence groups to be combined and used as novice drivers for this analysis.

The effect of cognitive resources was only of interest in sections where there was a significant effect of experience. Therefore, for this analysis, data from the medium and hard sections were averaged. Significant positive correlations were found between Medium and Hard sections for Correct Responses [$r(59)=.802$; $p<.0005$] and for Reaction Times [r(59)=.500; p<.0005]. Three extreme cases were identified on the correct response variable and were excluded from this analysis. The distributions for the new averaged variables were normal.

The means for Correct Responses in each Condition are shown in Figure 3. With Correct Responses as the dependent variable, a one-way ANOVA with Condition as a four level between subjects independent variable was conducted. A significant effect of Condition was found [F(3,52)=3.348; p=.026]. To further investigate these differences, orthogonal contrasts were performed with alpha set at .05 decision-wise (Bird, 2004). It was found that Driving and Talk-R averaged together, had significantly lower correct responses than Talk-I and Watching, averaged together [F(1,52)=9.65; p=.003]. No significant difference was found between Driving and Talk-R [F(1,52)=.76; p=.387]. There was also no significant difference between Talk-I and Watching [F(1,52)=.000036; p=.954].

[Figures 3 and 4 about here]

The means for Reaction Times in each condition are shown in Figure 4. Reaction time differences were assessed using a one-way ANOVA with Condition as the independent variable. There was no significant effect of Condition [F(3,55)=1.864; p=.146].

3.4 Discussion

This study has found evidence that suggests that the situation awareness hypothesis explains the visual attention deficit in novices, thus confirming the hypothesis. Poorer performance was shown in the conditions where participants were required to process the scene as the driver. This suggests that processing the scene as the driver, either by driving or verbalising the drive, is more difficult and requires more resources than simply watching the scene.

The finding that performance was similar in the driving and driving/verbalising conditions supports Underwood et al.'s (2002) claim of a situation awareness hypothesis. Removing the task of vehicle control does not lead to improved visual attention skills. Even with more cognitive resources available, novice drivers fail to allocate attention and monitor the scene adequately. This therefore points to a situation awareness problem, as it eliminates the possibility that cognitive resources are too limited to allow a thorough scan in high demand situations (Underwood et al., 2002). Novice drivers lack the situational awareness to anticipate the demand and danger of the driving situation. This suggests that novice drivers have not built up schemas of road situations that would enable them to allocate their attentional resources depending on the demand of the situation. Therefore in high demand situations novices fail to compensate and adjust their resources for the increased hazard potential, thus increasing their vulnerability on the road. This conclusion also supports findings from training interventions (Chapman et al., 2002; Fisher et al., 2006; Pollatsek et al., 2006).

In this experiment the null result, showing no significant difference between driving and verbalising/driving, is meaningful as it provides evidence for the situation awareness hypothesis. However when interpreting null results as meaningful the question arises as to whether this result occurred because of a lack of power. A lack of power is clearly not the case since comparison of the two driving-like conditions and the two non-driving conditions reached significance.

The condition requiring participants to recite the alphabet was employed to control for the cognitive demands of verbalising. Performance when reciting the alphabet was no different to when participants were merely watching the scene. Thus the addition of a verbalising task does not increase cognitive load.

4. General Discussion

The effect of experience and its role under varying levels of driving demand was explored. In support of two studies using eye scanning data, it was shown that visual attention in low demand scenes was similar for all drivers, however in high demand scenes visual attention improves with driving experience. This has been identified as a deficit in novices' driving ability, such that they struggle to deploy attention and monitor the peripheral field adequately in situations where this is of utmost importance. This highlights a potentially dangerous behaviour of novice drivers that may contribute to their disproportionally high crash rate.

The current findings support the numerous studies that have shown that novices fail to search high demand scenes adequately because they lack situational awareness. Situational awareness improves with experience as schemas are built up of different types of road situations encountered. In this period when schemas, and thus situational awareness, are being acquired, novices are more vulnerable on the roads, especially in difficult situations. The situational awareness problem in novice drivers has been identified as a lack of anticipation about road events (Evans & MacDonald, 2002; Groeger et al., 2002). Without having the experience and schemas of road situations, novices are unable to form expectations about road situations. Training programs try to improve this ability in novice drivers. One training intervention appeared to have successfully trained participants to scan the scene efficiently, but failed to improve situational awareness (Chapman et al., 2002). Trained novices still did not vary their scanning patterns according to the demand of the situation (Chapman et al., 2002). The skill of anticipation and awareness of road situations can not be easily taught and is only acquired with a great deal of practice and experience. Although situation awareness is hard to measure (Jones & Endsley, 2004), further research is necessary to explore the parameters and foundations of this problem in novices and to employ training programs and strategies to help novice drivers overcome this deficit.

The situation awareness and cognitive resource limitation hypotheses may not be mutually exclusive (Underwood et al., 2002). Although the majority of evidence suggests that the situation awareness hypothesis is the best explanation, it is possible that limited cognitive resources contribute to the issue (Evans & MacDonald, 2002). Novice drivers may lack the cognitive resources to assess and make a judgement about the level of visual attention the scene requires (Evans & MacDonald, 2002). This is related to the fact that with experience and adequate schema, information about the scene is processed faster (Rensick, O'Regan, & Clark, 1997; Simons-Morton, 2007), thus requiring fewer cognitive resources. However in the early stages of driving, schemas aren't readily available and any sort of situation assessment requires too many cognitive resources. This may explain the finding by Chapman et al. (2002) that training improves scanning abilities but not situational awareness, as novice drivers still may not have the cognitive resources available to assess the situation. Whether or not situation awareness is dependent on having the cognitive resources available to assess and judge the scene requires further research.

This study extended the Underwood et al. (2002) methodology of removing the vehicle control component of driving. The current study used a new and effective technique to ensure that participants were processing the scene as though they were driving. Measuring eye movement data whilst employing this methodology would further substantiate the findings and the methodology used. Another benefit of the current experiment is that it allowed direct comparison between novices who were verbalising/driving and novices who were merely watching under the instruction to scan the scene as though they were driving. Underwood et al. (2002) did not make this comparison, so therefore can not firmly claim that they induced driving-like processing that would differ from processing if merely watching the drive. In the current study the difference found between these two conditions clearly display that verbalising/driving successfully induces processing of the scene as though they were driving, whereas the watching condition does not produce such an effect. This study, therefore contributes to the situation awareness literature by using a more valid methodology.

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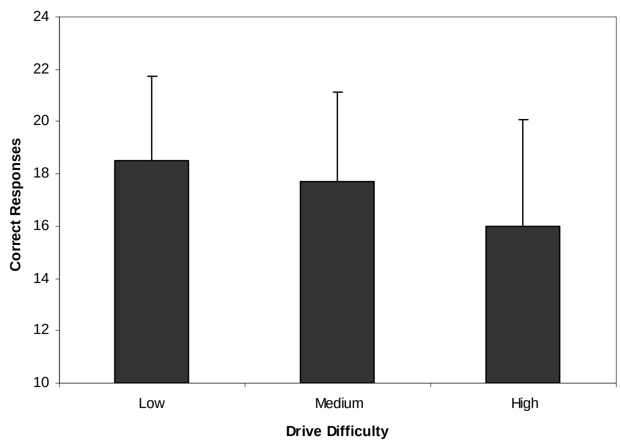

***Figure 1*. Mean correct responses for each level of drive difficulty.**

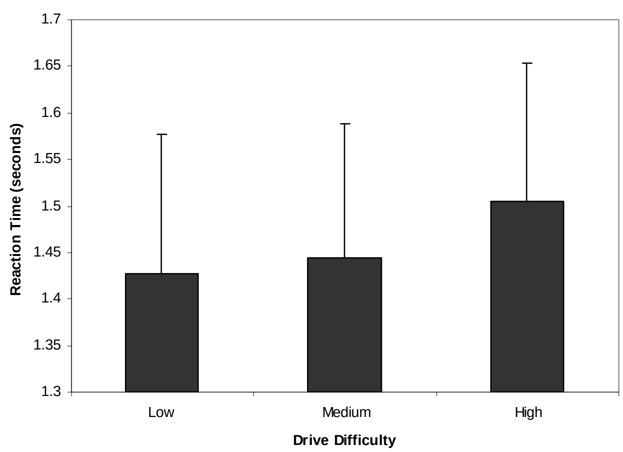

***Figure 2*. Mean reaction times for each level of drive difficulty.**

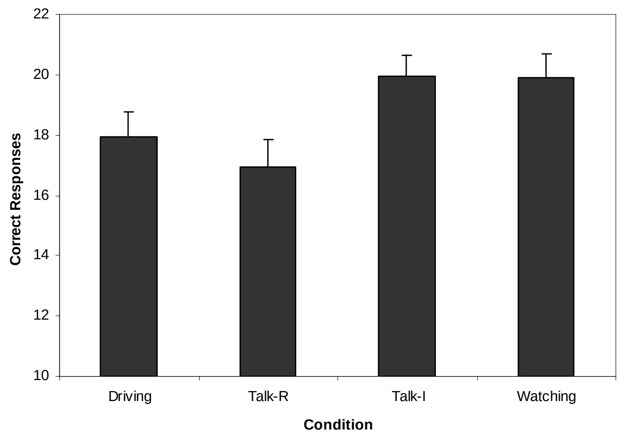

***Figure 3*. Mean correct responses for each condition. Bars show standard errors of means.**

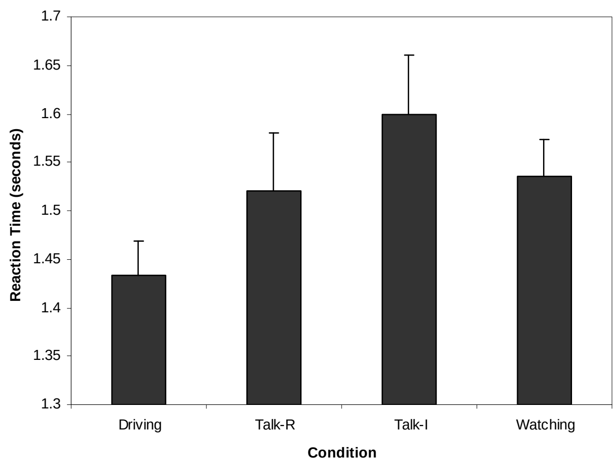

***Figure 4*. Mean reaction times for each condition. Bars show standard errors of means.**