SOUTH AFRICAN NOVICE DRIVER BEHAVIOUR: FINDINGS FROM A NATURALISTIC DRIVING STUDY

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ABSTRACT

Across the world novice drivers are over-represented in crashes. The first eighteen months after licensure appear to be the most dangerous as the newly licensed driver comes to terms with his or her newly acquired skills. With practice, skills such as scanning behaviour and handling of the vehicle improve significantly. This study used Naturalistic Driving Study (NDS) methodology to investigate novice driver behaviour in South Africa. Data acquisition systems were installed in two participant groups (pairs) vehicles. Participant groups were a combination of a parent and novice driver. Both participant pairs drove around with the data acquisition systems for approximately three months. A large amount of data was collected, not only from the drivers but from the vehicles and the environment as well. The paper provides an overview of the research process and methodology followed and will highlight key findings relating to the novice driver hazard perception skills. Although this study is not representative (as only four people participated), the findings indicate that this type of study, used on a larger scale, could provide important baseline data for novice drivers. This could, in turn, be used to tailor and improve current driver training practices in South Africa.

1 INTRODUCTION

1.1 A global problem

Worldwide, novice drivers are overrepresented in crash statistics (SafetyNet, 2006; World Health Organisation,2009). Several studies have documented the high level of crash involvement associated with newly licensed drivers (irrespective of the age at which drivers start to drive) in the first six to eighteen months of driving. This is the period over which novice drivers are at their most vulnerable.

This is attributed to a number of factors, the first two of which are age and gender (Mayhew and Simpson, 1995; Deery, 1999; Scott-Parker, Hyde, Watson and King, 2013). Younger drivers are predisposed to be involved in crashes due to personality aspects, social skills and cognitive functions that are still developing (Mäntyläa et al., 2009; Arnett, 2002). Novice drivers' elevated risk is a complex function of age, experience and misperception of risk on the road (Brown and Groeger, 2007). Developmental research has focused on the young drivers' need to experience sensation, cognitive egocentrism (the way in which one sees the world) as well as overrated confidence, resulting in feelings of invulnerability and invincibility.

Male drivers have been found to exhibit more risky driving practices that females (Bina et al., 2006; Ivers, et al., 2009). Attitudes and perceptions of safe driving influence safe driving behaviour (Ulleberg and Rundmo, 2003), and these differ markedly between genders. Personality characteristics such as sensation-seeking behaviour, lack of impulse control and aggression are also associated more with male drivers than with females. These are linked directly to risky driving behaviour (Engstrom et al., 2003).

Psychosocial and cognitive development issues highlight the fact that younger drivers have a reduced ability to recognise hazards or potential hazardous situations in complex traffic situations. Younger drivers lack the ability to anticipate unexpected situations and to appropriately react to these situations (Kinnear, 2009).

1.2 A South African problem

Research in South Africa confirms that novice driver deaths are also a matter of concern in South Africa. Chokotho et al. (2012) calculated age specific driver mortality rates, using Western Cape mortality data. The authors found that age specific mortality driver deaths were the highest in the youngest age groups (15-19 years). In 1988, Haddow defined young drivers as drivers between the age of 18 and 24 years. It is acknowledged that South African novice drivers will mostly fall in the 16-24 years age group. However, there may also be older South Africans who are learning to drive for the first time (also referred to as novice drivers) due to the fact that people in previously disadvantaged areas have not always had the means to pay for driver licence tests or might not have had access to a vehicle. Socio-economic changes in South Africa also brought about changes in car ownership, the opportunity to obtain a licence and improved mobility (Mokonyama and Venter, 2007). Thus while novice drivers in general exhibit high risks of crashing it would appear that the youngest of these face particularly high risks.

2 BACKGROUND TO THE PROJECT

This research focuses largely on the hazard perception skills of novice drivers. Research has shown that although novice drivers acquire skills to handle the vehicle fairly quickly, their ability to perceive and react to hazards on the road is slower to develop (Boufous et al., 2011). Novice drivers take longer to recognise and react to potential road and traffic hazards than experienced drivers (Pradhan et al., 2011). They experience hazard latency which refers to their inability to correctly recognise hazards in the traffic environment and to quickly and correctly react to the threat that hazards in the traffic environment pose (Scalfia, 2012). Underwood et al. (2003) found that novice drivers have limited capabilities in scanning the road (visual search) in comparison with more experienced drivers. Their research concluded that novice drivers did not have the scanning abilities due to limited mental resources to switch tasks (vehicle control *vs.* scanning of road). As novice drivers gain more experience they become more proficient in controlling the vehicle as well as scanning the road way for hazards.

Underwood (2007) explained that hazard perception increases with experience. Experienced drivers learn to scan the road environment much more effectively and are more sensitive to complex road environments than novice drivers.

3 RESEARCH OBJECTIVES

Specific objectives included as research objectives are:

- Determining the level of skill that the sample of novice drivers possess when they start driving;
- Exploring a methodology that could potentially be useful for understanding novice driver behaviour in hazardous and dangerous driving situations;
- Comparing the sequence of decision making of the novice drivers with those of more experienced drivers in similar circumstances;
- Informing the development of approaches that could improve driver training methods and systems in South Africa.

4 METHODOLOGY

4.1 Naturalistic Driving Studies (NDS)

NDS is a fairly new methodology (Dingus et al., 2006; Sagberg et al. 2011; Eichorn and Van Schagen, 2011) that allows the investigation of driver behaviour in a natural environment. The driver is able to drive the way that he or she normally does - without any instructions or special interference from experimenters. From the 100-Car Study, Dingus et al. (2005) stated that the underlying assumption of this approach is that driver behaviour will not be significantly altered by being observed over the long term and that such studies therefore reflect natural driver behaviour over time. From these observations, researchers are able to make conclusions regarding driver behaviour, the vehicle and the driving environment. This research enables researchers to understand driving behaviour in a number of situations ranging from behaviour in different weather conditions, roadways and near collisions or actual collisions. Understanding these relationships can provide better insight into making traffic systems safer.

Use was made of a Data Acquisition System (DAS) which consisted of three cameras (one facing the driver and two facing the back and front of the vehicle). An on-board computer logged information related to the vehicle - including Global Positioning Coordinates, acceleration and deceleration information and speed.

4.2 Driver behaviour questionnaires

Two driver behaviour questionnaires were developed for use in the project. The questions included in the questionnaire measured general tendencies relating to skill and risk. The information derived from the questionnaires reflected pre- and post-information related to, among others:

- Perceived level of skill/acquired level of skill;
- Perception of risk while driving before and after acquiring a licence;
- Inclination to engage in risky driving behaviour before and after acquiring a licence;
- Travel behaviour before and after acquiring a licence.

4.3 Development of a hazard perception coding scheme

A coding scheme for hazard perception in novice drivers was developed using grounded theory. Grounded Theory (GT) was used to provide a platform for the in-vivo coding. This was introduced in the project when the coding commenced.

4.4 Selection of participants

Initially the aim was to recruit novice drivers whom had very recently obtained their licenses. The participants who were ultimately recruited had had their licences for between 4 and 6 months. The combination of participants for the first part of the study was a mother (41 years old) and son (21 years old). The second set of participants comprised a father (53 years old) and daughter (19 years old).

4.5 Period of research

Both experienced/novice driver combinations drove with the equipment for a period of three months. The novice drivers drove with the equipment in their vehicles for 51 days (novice driver 1) and 68 days (novice driver 2) respectively. Experienced Driver 1 drove around with the equipment for 66 days and experienced driver 2 for 53 days. Over 255 hours of video footage was recorded, including more than a million movements from the four vehicles. These movements include the date, time of day, acceleration and deceleration. Speed profiles can be linked precisely to the movements of the vehicle.

5 ANALYSIS OF THE DATA

5.1 Questionnaires

Because of the sample size the questionnaires could not be analysed statistically and the data was assessed on its qualitative content. This was deemed appropriate as the first questionnaire aimed to understand how the novice drivers felt about taking risks, and whether or not they would generally be inclined to sensation seeking behaviour such as speeding or reckless driving and how they felt about breaking road rules and regulations. The second questionnaire elicited information related to the participants' experience of the processes and how they believed their behaviour might have changed over the project period.

5.2 Image material and quantitative information from the vehicle

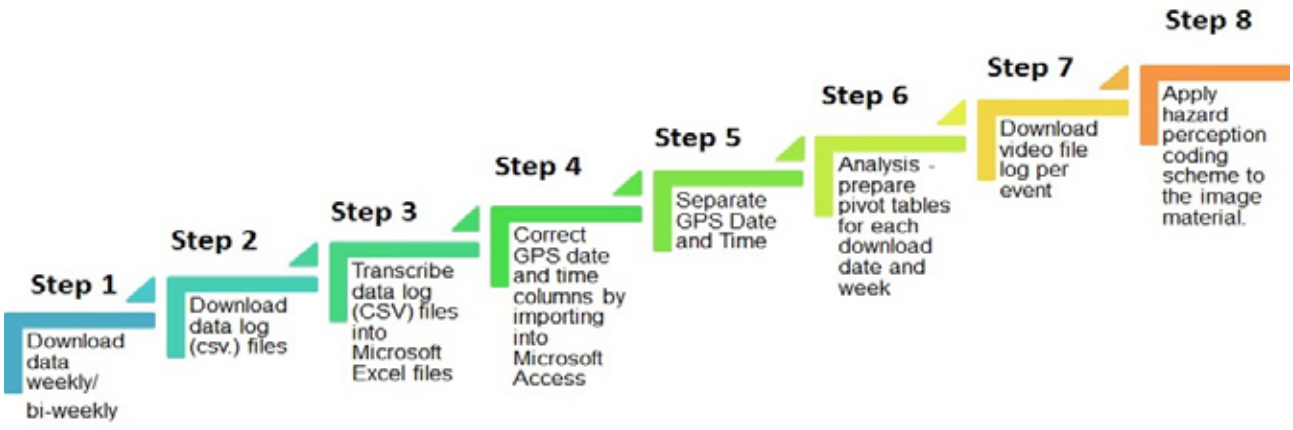

Figure 1: Steps in downloading and preparing data for analysis

Analysis of the collected quantitative data was carried out using Microsoft Excel and Access. Data relating to driver actions was analysed making use of video analysis software (MAXQDA©). A uniform approach was developed to ensure that data was analysed consistently and that the methodology will be replicable in further studies.
Four scenarios depicting situations (present in both novice driver image materials) were identified for analysis. These included:

- Behaviour at traffic lights
- Behaviour at traffic circles
- Behaviour at stop streets
- Turning behaviour at intersections.

The total number of videos generated over the past 7 months by the participants amounted to 1755 videos, totalling approximately 255 hours of footage.

Table 1 provides an overview of the hours of video data generated throughout the study.

Table 1: Hours of videos generated during the study period

Drivers	Hours
Novice Driver 1	35.7
Novice Driver 2	82.0
Experience Driver 1	113.9
Experience Driver 2	23.7
Total hours	**255.0**

Approximately two hours of videos with **selected** hazardous locations were used to compare novice and experienced drivers' behaviour Samples of the four situations were selected from both novice and experienced drivers and compared.
Summary statistics were compiled for each of the participant groups' in order to compare the means of the observed behaviours at the different hazardous locations with each other. P-values were calculated per scan behaviour using a t-test. A t-test was deemed the most appropriate statistical test as the sample sizes were relatively small.

6 SUMMARY OF KEY FINDINGS

6.1 Speed behaviour

Inappropriate and high speeds are recognised to be some of the most common errors that novice drivers tend to make, often associated with peer-pressure and loss of control crashes. In the analysis, average speeds on the approach to potential hazardous situations were used as a benchmark in order to assess the level of caution exhibited by both the novice and experienced drivers.

The speed analysis produced interesting results. The first was that neither novice nor experienced drivers had high average speeds on freeways. Both groups drove at levels below the speed limit. Novice drivers also had lower average speeds on 60 km/h, 70 km/h and 80 km/h roads, possibly evidence of their lack of confidence. In the urban (built-up) residential areas novice drivers drove at slightly higher average speeds than the experienced drivers. Figure 2 below provides an overview of average speeds per road type.

When considering speed on approaches to particular hazardous situations, novice drivers approaching intersections with intent to turn had lower average speeds than experienced drivers. The novice drivers however had higher average speeds on approach to traffic signals and intersections (Figure 3).

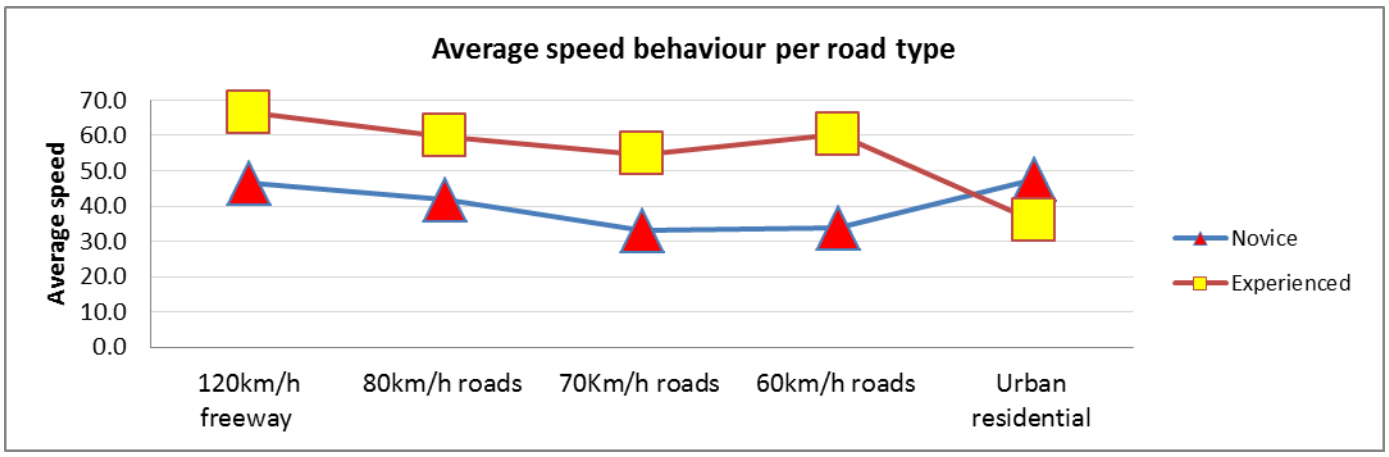

Figure 2: Average speed according to road type

Similar average speeds were found for approaches to traffic circles and stop streets. In the two events where novice drivers did run a red light it was at a much lower average speed than that of experienced drivers.

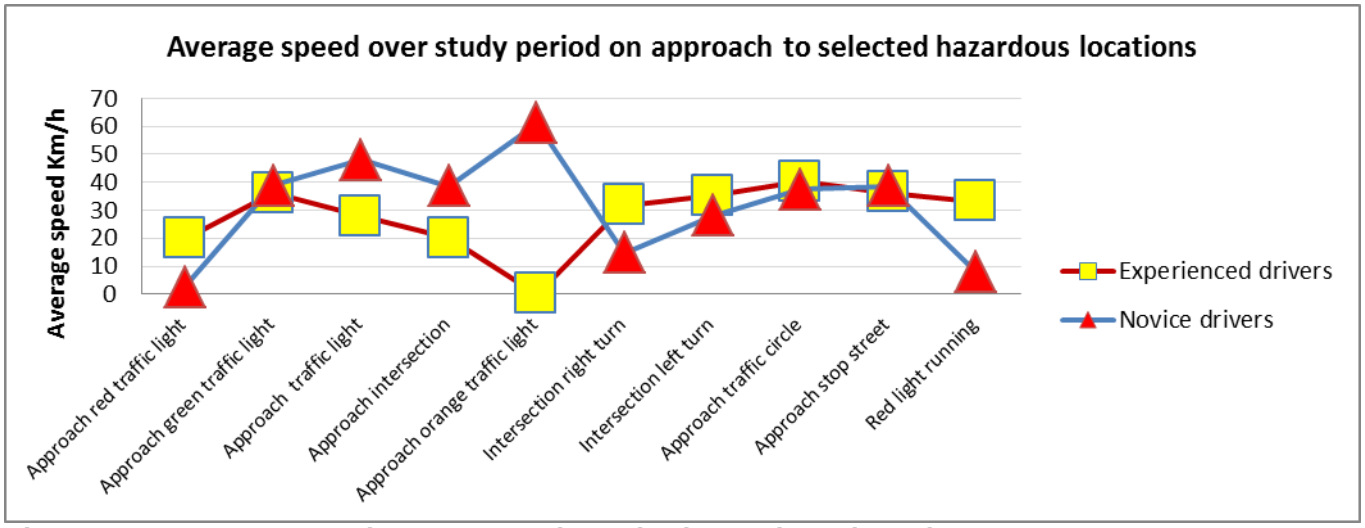

Figure 3: Average speed on approach to the hazardous location

6.2 Hazard perception at selected locations

6.2.1 Stop streets

When approaching an intersection and stop sign, a driver is required by law to come to a complete stop. Hazards within and around intersections and stop signs may include pedestrians crossing, other vehicles approaching and not stopping in the intersection and so forth. It is therefore important that novice drivers should be able to not only obey the law, but should be able to recognise hazards associated with stop streets. Scan behaviour especially to the left and the right is considered important to cross and clear the intersection safely.

Novice drivers in the study had an average scanning time of approximately 8.1 seconds compared with experienced drivers' 4.3 seconds. This shows that on approach to the stop street, novice drivers took longer to scan their environment. Novice and experienced drivers spent exactly the same proportion of time scanning the environment directly ahead of them as well as to the left of the stop street. However, novice drivers took more time to scan their environment to the right and their left side mirror (whereas experienced drivers did not make use of any of their mirrors).

6.2.2 Intersections

Behaviour at intersections was divided into behaviour where the novice driver approached and continued through the intersection, and where the novice driver turned either left or right at the intersection. The first section considers scanning behaviour where the novice driver was approaching the intersection and then traveling straight through the intersection. The second part considers scanning behaviour when turning at intersections. Intersections are typically areas where traffic conflicts can occur. Voster et al. (2008) and Nel (1989) indicated that in SA, possible hazardous locations included intersections.

According to Tshwane Municipality crash data - out of the 85% usable crash data it was found that 65% of crashes occurred at intersections and 50% of the these crashes occurred at traffic signals (Vorster et al., 2008).

T-tests applied to determine differences in straight, left and right scanning behaviour indicated that there are no significant differences in left and right scanning behaviour between the two groups but that there were significant differences in straight scanning behaviour (means significantly different at 95% confidence interval). Scanning left was neglected most of the time. The exception was on approach to stop streets where novice drivers did scan left and right possibly in anticipation of other vehicles that do not stop at the stop streets).

In terms of turning at intersections, novice drivers scanned the right side for longer than experienced drivers. In this context experienced drivers made more use of their rear-view mirror - possibly to determine if there were vehicles approaching from the rear. Again a significance difference in behaviour (means significantly different at a 90% confidence interval) was found for right turns at intersections.

6.2.3 Traffic signals

Traffic signals regulate traffic at busy intersections. Different types of traffic behaviour are regulated, from through traffic to turning behaviours either left or right over intersections. Signalised intersections are potentially dangerous as there are many competing stimuli to which the driver needs to pay attention.

Novice drivers mainly scanned the road in front of them while approaching a traffic signal. Right scan behaviour (looking at something directly next to the vehicle) was evident only 1% of the time. Experienced drivers spent time scanning right, the right side mirror and looking down at controls. No time was spent on scanning the left side of the vehicle or the left side mirror. Experienced drivers tended to use approaches to or waiting at the red traffic signal to look down, search for things under seat and so forth. A similar amount of time was allocated by both novice and experienced drivers to scanning straight in front of them on approach to green traffic signals. Novice drivers tended to scan the environment right of the vehicle, neglecting the left. However novice drivers made much more use of the rear-view mirror. No significant differences were found in behaviour on approach to traffic signals, neither green nor red nor produced any significant differences in terms of straight, left or right scanning behaviour.

6.2.4 Traffic circles

A traffic circle assists with the flow of traffic and although a complete stop is not required this traffic situation does require special vigilance from a driver as vehicles might be entering and exiting the circle at various points (legs). The novice driver should therefore be able to recognise potential hazards such as these and should adapt their behaviour accordingly. Both novice and experienced drivers scanned their right side and rear-view mirrors briefly, but only experienced drivers scanned their left side mirrors in this context. Experienced drivers also spent much longer scanning the environment to their right for oncoming traffic than the novice drivers. No significant differences were found in scanning behaviour between the groups on approach to the traffic circle.

7 DISCUSSION

Very little information about novice driver behaviour is available in South Africa. This study showed that there were differences in the scanning behaviour of the novice and experienced drivers participating in this study. Although both novice drivers had had some experience prior to the study there were still elements of their scanning behaviour that had not yet been fully developed.

In none of the behaviour or situations that were coded was there evidence of immediate danger, near-collisions or actual crashes. The locations selected were deemed important as it is these traffic contexts that have the greatest potential to develop into serious traffic conflict situations.

Smaller horizontal scans (Scalfia et al., 2012) were evident as the novice drivers did not scan their environment 360 degrees and most of the time neglected to scan the environment to the left of them. The only selected hazardous location where novice drivers did scan to the left was at traffic circles. Both experienced drivers scanned their environments much more frequently and effectively than the novice drivers. In spite of this, the experienced drivers scanned the left side of their environment less than expected. This is an interesting finding as the drivers drove separate routes but still exhibited the same behaviour. On enquiry, during the last interview, both experienced drivers indicated that they are not aware that they did not scan the road on the left-hand side. Both novice drivers looked closely in front of the vehicle. They tended to scan the area directly in front of them for long periods of time (directly in front fixating on objects in front of them as described by Chapman et al., 1998).

The two novice drivers also scanned the area on the left which might suggest that driving habits such as neglecting to scan the environment quickly before crossing the stop street might not yet have been developed. Thus the novice drivers might still perceive traffic from the left as hazardous situations.

Novice drivers checked their mirrors much more infrequently than experienced drivers. Experienced drivers also made more frequent use of left and right mirrors as well as rear-view mirrors.

No significant differences between novice and experienced drivers were found at stop streets. The time that both allocated to scanning their environment was very similar. An interesting finding was that experienced drivers tended to acknowledge other vehicles from either side - by looking in the direction from where the vehicles were coming - whereas novice drivers gave no such indication.

In contrast, behaviour at intersections yielded different results. The difference was particularly noticeable in novice and experienced drivers' approach to intersections and in instances where they had to turn right over intersections. In both of these instances experienced drivers allocated much more time to scanning their environment effectively in all directions (including the rear-view mirror) whereas novice drivers tended to scan the environment to the right but not necessarily to the left. In terms of the differences in skill that were observed, it seems likely that experienced drivers have a better perception of the relativity of dangers associated with intersections such as oncoming traffic from the rear, while waiting to turn (rear-view mirror use), possible traffic from either side of the intersection and oncoming traffic which could potentially cause conflict if a turning driver should cross their path.

In terms of traffic signals, no significant differences were found between novice and experienced drivers behaviour. However experienced drivers spent much more time scanning the environment around them in all directions whereas novice drivers only made use of their rear-view mirrors. No left scanning behaviour was observed for novice drivers.

Traffic circles were the only hazardous location scenario where novice drivers were observed scanning the left of the vehicle. No significant difference was found between novice and experienced drivers' behaviours.

In terms of speed, Wagener et al. (2011) stated that the target zone for safe driving is in the middle range or the conservative neutral range. Wagener et al also indicated that behaviour such as speeding that is either too slow such as driving well below the speed limit or driving too fast could be equally dangerous. In the novice speed profiles, the average speed for most type of roads was well below the speed limit which could potentially be just as hazardous as driving too fast for prevailing conditions. On 80 km/h roads novice drivers had an average speed of 41km/h, on 70 km/h and on 60 km/h roads an average speed of 33 km/h. The effect of variable levels of congestion and spacing of intersections has not been taken into account in these averages. These effects and impacts should be considered in future research.

CONCLUSION

Although the sample size in this study was too small to make generalisations, notable differences between experienced and novice drivers were observed. The findings from this project provide a business case for the design and execution of a larger and more representative Naturalistic Driving Study which incorporates novice and experienced drivers in terms of different backgrounds, income groups, gender and possibly race. The issue of gender difference could be further explored as the literature indicates that male drivers in general have a more risky approach to driving than their female counter parts. This difference was not clear in this study and it could be interesting to explore this further within a South African context.

The video material collected for this project has potential for further analysis and could well provide the basis for a larger study where all videos are coded and behaviour over the three month period can be better interpreted. Such a study would provide a clearer indication of how behaviour changes over time. A longitudinal study, investigating behaviours of the two novice drivers over the whole three months would provide valuable insight into information regarding gender differences, choices as well as progression. GPS coordinates could provide insight into travel patterns and behaviours. Additional research

into automating the behavioural recognition processes is another potential avenue for exhilarating the process.
These preliminary findings clearly indicate some differences between novice and experienced drivers hazard perception skills as specific locations. More observations, better selection criteria and a larger sample could potentially contribute to better insight into the differences in skill between novice and experience drivers. Calls have been made to introduce a hazard perception test into the driver licensing process in SA. This study provides some evidence that the introduction of such a test might be useful in a South African context.

By conducting a larger and more representative study it would be possible to pinpoint specific problematic novice driver behaviours that could be addressed in driver training. By understanding the problems and proactively addressing them in the initial stages of driving, more skilful, confident and safer drivers could be produced from early on.

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