



MONASH University
Accident Research Centre

**MEASURES TO ACCELERATE AND ASSESS THE
DEVELOPMENT OF HAZARD PERCEPTION AND
RESPONDING SKILL IN NOVICE
MOTORCYCLISTS**

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Measures to accelerate and assess the development of hazard perception and responding skill in novice motorcyclists

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Abstract:

The overall aim of the research reported here was to identify options and to provide recommendations to VicRoads for the development and implementation of motorcycle-specific hazard perception and response measures in Victoria. Options for training and testing are considered. The research was carried out over two stages. Stage 1 involved several activities, including a review of recent research (since mid-2008) into hazard perception and responding, as well as a review of existing training and testing programs. The reviews considered recent research and current practice for novice drivers in addition to novice riders. Stage 2 involved discussion of testing and training measures with experts in the fields of rider safety, rider training and testing, skill development, and training systems design. The outputs of the workshop led directly to the specification of practical recommendations for the development and implementation of hazard perception and responding training and testing measures for novice riders in Victoria. A subsequent stage of the project, to be conducted by VicRoads, will involve an assessment of the technical and logistical feasibility of implementing the recommendations.

Key Words:

Hazard perception; Hazard perception and responding; novice riders; motorcycles

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Preface

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Ethics

Ethics approval was not required for this project.

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Chapter 1 Introduction

The overall aim of the research reported here was to identify options and to provide recommendations to VicRoads for the development and implementation of motorcycle-specific hazard perception and response measures in Victoria. Options for training and testing are considered. A subsequent stage of the project, to be conducted by VicRoads, will involve an assessment of the technical and logistical feasibility of implementing the recommendations.

The research was carried out over two stages. Stage 1 involved several activities, including a review of recent research (since mid-2008) into hazard perception and responding, as well as a review of existing training and testing programs. The reviews considered recent research and current practice for novice drivers in addition to novice riders. There are many critical differences between novice riders and novice drivers. For example, in Victoria at least, novice riders tend to be older than novice drivers and, in most cases, are already experienced drivers. Nonetheless, there are some similarities (e.g. nature of skill development) which means that there is opportunity, where appropriate, for considering lessons learnt in one domain and applying them to the other. This is in part necessary given that, relative to the situation for novice drivers, research into hazard perception and responding for novice riders is in its infancy.

Stage 2 involved discussion of testing and training measures with experts in the fields of rider safety, rider training and testing, skill development, and training systems design. The outputs of the workshop led directly to the specification of practical recommendations for the development and implementation of hazard perception and responding training and testing measures for novice riders in Victoria.

It is important to note that, in preparing this document, the assumption was made that the reader is aware of the earlier work in hazard perception and responding, both theoretical and applied, and is largely familiar with the terms that are common in this literature. For detailed discussion of the issues not covered here, the reader is referred to Haworth, Mulvihill and Symmons (2005) and Wallace, Haworth and Regan (2005).

1.1 Report structure

This report is structured as follows. Stage 1 activities are captured in Chapters 2 to 5. Chapter 2 presents the review of recent research into hazard perception and responding. Chapter 3 provides an overview of current approaches to training in hazard perception and responding, while in Chapter 4, the focus is on current approaches to testing. Finally, Chapter 5 presents the options for training and testing in the context of key issues, and discusses their strengths and weaknesses. Chapter 5 culminates in several broad recommendations for the development and implementation of motorcycle-specific hazard perception and response measures in Victoria. The options and recommendations formed the basis of the discussion at the workshop involving experts in motorcycle safety and skills training/testing from around Australia. Stage 2 activities are presented in Chapters 6 and 7. An overview of the workshop is given in Chapter 6. A detailed presentation of the recommendations deriving from this research are presented in Chapter 7.

Chapter 2 Recent research into hazard perception and responding

This section provides a review of the recent research (since mid-2008) into novice driver and rider hazard perception and responding. The review is organised around the key themes in the research. First, the research relating specifically to novice riders is considered. This is followed with a presentation of the research pertaining to novice drivers.

2.1 Riders

As anticipated, the bulk of the work into hazard perception since mid-2008 has concentrated on novice car drivers (see below). Nonetheless, several papers were uncovered with a focus on the hazard perception of novice riders. The discussion of these papers is organised around two general (although not independent) themes: the effectiveness of training in hazard perception using the “Honda Rider Trainer” (HRT), and the degree to which hazard perception skill in driving transfers to riding.

2.1.1 Training effectiveness using the Honda Rider Trainer

In partnership with Honda Motor Europe Ltd, researchers at the University of Padua in Italy carried out a program of research with the overall aim of evaluating the HRT to train effectively the hazard perception and responding skills of novice motorcycle riders (e.g. Alberti, Gamberini, Spagnoli, Varotto & Semenzato, Submitted; Spagnoli, et al., 2009; Vidotto, Bastianelli, Spoto & Sergeys, 2011; Vidotto, Bastianelli, Spoto, Torre & Sergeys, 2008). Also known as the SMART (Safe Motorcyclist Awareness and Recognition Trainer), the HRT has been “specifically designed to give riders a safe bridge between a typical beginning riding course (which often take place in a parking lot) and the real-world scenario of riding in traffic and on public roads” (www.motorcycle.com/how-to/honda-smartrainer-86756.html).

As described by Vidotto et al. (2011), the HRT is a simulator that is powered by PC technology. Visual images are displayed on a screen (e.g. 19 inch LCD monitor), which is positioned in front of the user. Interaction is achieved through typical motorcycle controls: handlebars fitted with active throttle, front brake and clutch and foot pegs with rear brake and shift lever. The HRT pre-programmed courses utilise several scenarios to cover a range of driving settings (e.g. city, urban, rural). Several features of the simulator are programmable, including engine size (small, medium, large), transmission type (automatic, manual), and lighting conditions (day, night, fog). Each course comprises either seven or eight hazardous events. Voice instructions guide users along the pre-programmed courses. In the case of a collision, the course is paused, and the events that led up to the crash are replayed. Each course is followed with a replay of the entire drive. This is coupled with commentary and feedback on the individual user’s performance.

Vidotto et al. (2011) report on a study involving 410 participants, aged 14 to 15 years. It is not stated whether participants had any prior driving or riding experience. The simulator was set up

with small engine size, automatic transmission, and daylight conditions. Participants were assigned to either a control group (CG) or an experimental group (EG). Over three sessions, EG participants completed 12 training courses of 10 minutes each (including replay). Three courses were completed at each session, with the first two courses of the first session and the last two courses of the third session providing measures of pre-training and post-training performance, respectively. CG participants were divided into four groups. All four groups completed two courses at their third session to obtain a measure of “post-training” performance. Two of these groups (CG1 and CG2) also completed two “pre-training” courses at their first session. At the second session, CG1 took part in a classroom lesson (“passive training”), which covered the topics of driving code, hazard perception and awareness. CG3 also took part in the passive training. Prior to their first session, all participants completed two practice courses to familiarise themselves with the simulator.

The results were largely positive, supporting the use of the HRT as an effective means for imparting training in hazard perception to novice riders. For Vidotto et al. (2011), the dependent variable of interest was the proportion of avoided hazards. Two findings are particularly noteworthy. First, EG participants showed an increase in the number of avoided hazards as a function of the number of courses completed. From the first to the twelfth course, participants in the EG experienced an overall improvement in hazard avoidance of approximately 16%. The mean proportion of avoided hazards for the twelfth course approximated 93%, leading the authors to speculate that this level of performance is “a good approximation of the maximum attainable performance level” for a HRT trainee. The second noteworthy finding is that, post-training, EG participants had a significantly higher proportion of avoided hazards than each of the control groups. Further, the control groups which undertook the passive training (CG1 and CG3) demonstrated, post-training, a higher proportion of avoided hazards than each of the two controls groups which did not undertake the passive training. Thus, while the full simulator training (12 courses) provided the most benefit, passive training coupled with a sub-set of courses (2 to 4) in the simulator led to greater improvement in hazard avoidance than completion of 2 to 4 simulator training courses alone. While it could be argued that the heightened post-training performance of the EG was simply a reflection of more simulator practice, Vidotto et al. (2011) report on anecdotal evidence that the advanced hazard avoidance performance of the EG was a reflection of improved strategies in hazard avoidance (e.g. slowing down earlier).

Alberti et al. (Submitted) provide complementary evidence in support of the HRT. In their study, 14 participants aged 20 to 25 years, with no riding experience, completed four training courses in an urban environment and under daylight conditions while having their eye movements recorded. Participants first completed a single practice course for familiarisation purposes. The HRT was programmed to simulate a motorcycle with a small engine size and automatic transmission. The critical dependent measure was first fixation latency – that is, elapsed time from when the hazard first appears to when the participant first fixates on the area containing the hazard. From the first to the fourth course there was a significant decrease in first fixation latency, implying that, as a result of the training, hazards are fixated earlier. This result was taken to support the hypothesis that riders trained on the HRT have heightened hazard anticipatory abilities, and that this is observed after as little as 16 to 24 minutes of training. Nonetheless, despite these positive results for the HRT as a training tool, the extent to which skills augmented as part of training using the HRT transfer to real-world riding, and persist for at least several weeks after training, remains to be explored.

2.1.2 Skill transfer from driving to riding

The second theme to emerge from the literature review into rider hazard perception and responding was the degree to which hazard perception skill in driving transfers to riding. This is an important issue when considering that, at least in Australia, the typical practice is for novice riders to be experienced car drivers. The extent to which novice riders can capitalise on skills developed (or in the process of being developed) as a car driver has important implications for determining how best to facilitate and design hazard perception training and testing for novice riders.

Liu, Hosking and Lenné (2009) compared the hazard perception and responding abilities of four groups of riders, who differed in their level of riding and driving experience. Of interest was to determine whether there is indeed a difference in the hazard perception and responding abilities of novice and experienced riders (with experienced riders showing greater skill), and also whether the hazard perception and responding abilities of novice riders who are also experienced drivers are heightened relative to those of novice riders who are also inexperienced drivers. The four groups of participants were as follows:

1. EM-FD (fully licensed, active motorcycle riders who are fully licensed drivers);
2. IM-FD (riders on their Learner's Permit who are fully licensed drivers);
3. NM-FD (riders with no riding experience who are fully licensed drivers); and
4. NM-PD (riders with no riding experience who are in the restricted licence phase of driving).

Following completion of a practice course in the simulator, participants completed three courses on the HRT, which was programmed to simulate a medium capacity motorcycle with manual transmission. Unlike in the training transfer studies described above, the assumption is that participants in the current study did not experience the HRT's replay and performance feedback facility.

For each course, the dependent measures of interest were: the proportion of crashes (that occurred in response to a hazard); HRT computed performance assessment for each hazard (grades from A to D); and motorcycle speed following hazard onset. In terms of crashes it was found for one course only that participants in the NM-PD group crashed the most frequently, with no differences between any of the three experienced driver groups. With regards to performance evaluations there was evidence from one course that the two groups of riders with at least some riding experience (EM-FD and IM-FD) outperformed those groups with no riding experience (NM-FD and NM-PD). Finally, with respect to approach speed (specifically, speed at one second after hazard onset), there was some evidence (based on two hazardous events in one course) that participants in the NM-PD group adopted a higher approach speed than any of the three experienced driver groups, although the only significant difference was with the EM-FD group. Thus, overall, there was some evidence in support of both questions of interest, although the authors cautioned that more research (e.g. under conditions of greater experimental control and where there is the opportunity to program scenarios and hazards) is necessary in order to draw more definitive conclusions about the relationship between driving and riding experience and skill transfer.

Two studies have since aimed to further explore the issue of skill transfer. Briefly, Shahar, Poulter, Clarke and Crundall (2010) asked experienced drivers to complete three routes (two practice, one assessment) in the HRT, which was programmed to simulate a medium capacity motorcycle with manual transmission. Drivers were either experienced riders or had no riding experience. Riding performance was assessed in terms of objective (e.g. crashes, stalls) and subjective (skill, safety) measures. Subjective estimates of skill and safety were based on a set of pre-determined coding criteria and were provided by an observer who viewed a video recording of the assessment course after it had been completed. In general, the riders were found to stall on fewer occasions, and to score higher on safety and skill than the non-riders. However, contrary to expectations, there was no significant difference between groups in the number of crashes. While Shahar, Poulter et al. (2010) conclude that the HRT is effective in discriminating between riders and non-riders on some measures of performance, the absence of a difference in crashes (for which performance was equally poor across groups) may be, at least in part, due to the design of the hazardous events. Specifically, Shahar, Poulter et al. (2010) argue that there was limited foreshadowing of hazards, thus minimising participants' chances of early detection and subsequent avoidance of the upcoming hazard. Under these circumstances, the riders were not given the opportunity to demonstrate any advanced skill in hazard perception and responding.

Hosking, Liu and Bayly (2010) circumvented this issue by using an open-loop motorcycle simulator, which afforded greater experimental control in the presentation of hazards. In addition, the size of the display screen (subtending angles of 180 degrees horizontally and 40 degrees vertically) meant that hazards could be seen to approach from within a larger field-of-view. While seated on an actual motorcycle, participants viewed scenarios (two in total) as they unfolded that contained a range of hazards that had been identified in a focus group with experienced motorcyclists as critical to hazard perception as a rider. The hazards included both road-surface hazards (e.g. potholes) and hazards associated with the actions of other road users (e.g. car turning across the path of the motorcycle). Participants' had no control over the motorcycle simulator; their task was to press a response button positioned on the right-side of the handlebar as they detected hazards or hazardous events. Immediately following each scenario, the scenario was replayed and paused at each point corresponding with a button press. Participants' task was to name the hazard. Participants' eye movements were also recorded as they viewed the scenarios.

Participants in the study belonged to one of three groups: (1) experienced riders who were also experienced drivers (EM-ED); (2) inexperienced riders who were experienced car drivers (IM-ED); and (3) inexperienced riders who were also inexperienced car drivers (IM-ID). Experienced riders were active motorcycle riders with a full rider's licence, while inexperienced riders held a rider Learner's Permit. Experienced drivers held a full driver's licence, while inexperienced drivers were in the restricted phase of their driving licence. The expectations were two-fold. First, that experienced riders would respond to hazards more quickly and display more flexible visual search patterns compared with inexperienced riders. Second, that inexperienced riders who are experienced drivers would exhibit faster response times to hazards and would adopt different visual search strategies compared with inexperienced riders who are inexperienced drivers. Evidence in favour of the latter expectation would provide support for the transfer of hazard perception skill from driving to riding.

In general, it was found that response times (i.e. response times to detect hazards that were perceived correctly) decreased in a linear fashion as experience increased from IM-ID to IM-ED and, in turn, EM-ED. Further, analysis of the eye gaze data indicated that, relative to the

inexperienced drivers (IM-ID), the experienced drivers (EM-ED and IM-ED) showed more flexible visual search strategies. Thus, overall, there was support for both hypotheses, although it was concluded that inexperienced riders, regardless of their driving experience, would serve to benefit from riding specific hazard perception training. That is, while there was evidence of some skill transfer from driving to riding, the hazard perception performance of the IM-ED group was not as high as that of the EM-ED group, suggesting that there was opportunity for further improvement.

2.1.3 Summary

Recent research into novice rider hazard perception has sought to investigate three interrelated issues: whether training of novice riders in hazard perception and responding can be achieved through a custom-designed rider training simulator; whether experienced riders exhibit superior skill in hazard perception and responding relative to novice riders, and whether there is transfer of skill in hazard perception and responding from the driving to the riding domain. Responses to each of these issues has important implications for the design and implementation of rider dedicated hazard perception and responding training and testing.

Support for the HRT as an effective training tool was found; although, further consideration needs to be given to the extent to which positive effects in the simulator transfer to real-world settings, and also the extent to which skills imparted through training are retained post-training. These are important considerations in light of the research by Liu et al. (2009) and Shahar, Poulter et al. (2010), which brought into focus questions about the validity of the HRT as a testing tool to discriminate between the hazard perception and responding performance of different groups of riders. Nonetheless, there was evidence in support of more advanced skill among experienced relative to novice riders, and some degree of skill transfer from driving to riding. Of the studies reviewed, the strongest evidence comes from Hosking et al. (2010). However, in drawing conclusions from this study it is important to keep in mind that the focus of the study was on hazard perception specifically. Due to the open-loop testing environment, responding skill could not be investigated explicitly.

2.2 Drivers

As the focus of the review is on novice rider hazard perception and responding, only a brief overview of key themes in driver hazard perception and responding is given here, with an emphasis on those findings with implications for the design of hazard perception training and testing for novice riders. Further, in this section the focus is on novice drivers. This is important to highlight given that a current, active area of research concerns the hazard perception abilities of older drivers (e.g. Borowsky, Shinar & Oron-Gilad, 2010; Horswill, et al., 2008; Horswill, et al., 2009; Horswill, Kemala, Wetton, Scialfa & Pachana, 2010) and of drivers in certain clinical populations (e.g. Poulsen, Horswill, Wetton, Hill & Lim, 2010; Preece, Horswill & Geffen, In press; Sheppard, Ropar, Underwood & van Loon, 2010).

As was the case for novice rider hazard perception and responding, the discussion of recent research into novice driver hazard perception and responding is structured around the two general themes to have emerged from the literature review. The first theme relates generally to

hazard perception training and addresses such issues as training environment and methods for imparting training. The second theme is concerned with attempts to “unpack” hazard perception in order to identify the mechanisms or component skills which underlie the previously reported differences in hazard perception test performance between novice and experienced drivers. This latter theme is important as it has direct and clear implications for the design of hazard perception tests to ensure that the tests are sufficiently diagnostic to differentiate those individuals who have acquired the appropriate level of competence in hazard perception from those who have not.

2.2.1 Training issues

The discussion of training issues is divided into three sub-themes. The first sub-theme relates to the use of a computer-based program to impart training in hazard perception to young novice drivers. The second sub-theme concerns the effectiveness of training which utilises a technique known as “commentary driving”. The third sub-theme compares and contrasts two training techniques for hazard handling that are based on the premise of “error training”.

Computer-based training

A computer-based training (CBT) program that is akin to DriveSmart (see below), Risk Awareness and Perception Training (RAPT) was developed by researchers in the Human Performance Laboratory at the University of Massachusetts at Amherst, USA for the purposes of exploring the effects of imparting risk perception and risk awareness training to novice drivers (Pollatsek, Narayanaan, Pradhan & Fisher, 2006; Pradhan, Fisher & Pollatsek, 2005, 2006; Pradhan, Pollatsek, Knodler & Fisher, 2009). The program utilises as its main stimuli top-down, schematic, plan views of scenarios. As explained by Pollatsek, et al. (2006), schematic plan views were used because it was considered that such a view-point would encourage novice drivers to visualise and to reason spatially about a scenario more actively than they would if they saw perspective drawings or actual videos. It was argued further that, if novice drivers perform better on a driving simulator after PC-based training, it would be stronger evidence that the novices had learned those abstract elements of a given scenario that had made that scenario risky, rather than because the novices simply recognised the stimulus they had seen in the training when they were interacting with the driving simulator.

Initial evaluation of the RAPT program involved two groups of novice drivers (trained and untrained) undertaking a series of drives in a fixed-base driving simulator while having their eye movements recorded (Pollatsek et al., 2006; Pradhan et al., 2005, 2006). In general, the trained drivers were found to be almost twice as likely as the untrained drivers to fixate appropriately either on the regions where potential risks might appear or on signs that warned of potentially risky situations ahead, both for the scenarios they had encountered in the training (indicative of near-transfer of training) and for novel scenarios (reflecting far-transfer of training). These positive effects were observed approximately three to five days after training.

More recently, Pradhan et al. (2009) explored whether there is positive transfer of the RAPT program to the on-road environment. Drivers aged between 18 and 21 years, and who had held their driver’s licence for at least one year were assigned to either a treatment group or a control group. The treatment group completed the latest generation of the RAPT program, RAPT-3, on

PC. (For further detail on the RAPT-3 program, see Pradhan et al. (2009).) In turn, participants (treatment and control) drove along an open road course while having their eye movements recorded. In general, the training was found to be effective in modifying novice drivers' gaze strategies as intended, reflecting successful transfer of training to the open road environment. Participants in the trained group were significantly more likely to gaze at the critical, risky region of the scenario than participants in the control group. This pattern applied across both near- and far-transfer events.

Taken together, the results from the RAPT research program provide strong support for the use of CBT as a suitable and effective environment for imparting skill in hazard perception in novice drivers. This view is revisited below when discussing current approaches to hazard perception training.

Commentary training

Two recent studies have explored the use of commentary to train hazard perception in young novice drivers. The results of both studies were largely positive. Isler, Starkey and Williamson (2009) compared the hazard perception skills of a group of novice drivers (aged 18 to 19 years, licensed for an average of 1.5 years) with a group of experienced drivers (mean age of 36 years, licensed for an average of 16 years) both pre-and post-training. Hazard perception was assessed using a task which required participants to detect (as measured through a button press) and then identify (by saying out loud) hazards in video-based driving scenarios while also performing a secondary tracking task. The training involved participants watching a video-based driving scenario and providing a running verbal commentary of any hazards that were observed. Pre-training, the novice drivers identified fewer hazards and took longer to detect hazards than the experienced drivers. Post-training, the performance of the novice drivers improved to the level of the experienced drivers, and was significantly better than that of a novice group, who did not receive the commentary training. Critically, the pre-training performance of the trained novice group did not differ significantly from that of the untrained novice group.

Further support for commentary training comes from Crundall, Andrews, van Loon and Chapman (2010). Learner drivers (aged 17 to 25 years) completed a pre-training assessment route in a commercial driving simulator that included nine hazardous events. In turn, approximately half of the drivers received commentary training, while the remaining participants received no training. The training comprised two components. First, participants were given a classroom introduction in commentary driving. Second, participants completed a two-hour on-road training session with a driving instructor, who had previously been trained in the commentary protocol. The on-road training included example commentaries by the instructor, who in turn provided corrective feedback to participants as they produced their own commentaries. The aims were to train participants to identify hazards (including potential hazards), to prioritise the hazards, and to predict what might happen next. Participants were also encouraged to vocalise their intended actions. Two weeks after the pre-training assessment, all participants returned for a post-training assessment in the simulator. In general, trained participants' driving performance in the post-training assessment represented an improvement over their performance in the pre-training assessment. Further, it was found that, in the post-intervention assessment, the trained group experienced fewer crashes, and reduced their speed and applied their brakes sooner on approach to hazards than the untrained group. Crundall et al. (2010) concluded that the pattern of results are indicative of commentary training having a positive influence on novice drivers' abilities to

deal safely with hazardous situations. Although, it was also argued that, in further developing the training, more attention needs to be given to improving novices' awareness of those events where the cause of the hazard is initially hidden from view by the environment. Indeed, it is performance associated with these sorts of potential hazards that are considered most likely to distinguish novice from experienced drivers.

Error training

Not unrelated to commentary training, error training views trainees as active learners. Nonetheless, as explained by Wang, Zhang and Salvendy (2010), in error training, trainees are explicitly encouraged to make errors. The errors serve as feedback, informing trainees of limitations in their knowledge and skills and thus, highlighting areas in need of improvement. Wang et al. (2010) explored the relative effectiveness of two error training methods in augmenting novice drivers' ability to respond to hazards. The mechanism underlying one method was that trainees learn from their own errors, whereas the principal basis of the other method was that trainees learn from the mistakes of others. In the former method, called simulation-based error training (SET), participants made errors and experienced crashes while driving a desktop simulator. In the latter method, called video-based guided error training (VGET), a different group of participants viewed pre-recorded video of other drivers' driving errors and crashes. One week after receiving the training, participants completed a post-training assessment course in a "full cockpit" driving simulator. The course comprised events to enable assessment of both near- and far-transfer of training. In general, the findings were in favour of the SET method: the hazard handling performance (e.g. number of errors) and the response time to hazards in the post-training assessment course of SET participants was significantly more advanced than that of VGET participants. (It is not known, however, whether the pre-training performance of the two groups was equivalent.) Wang et al. (2010) interpreted the superior performance of the SET group in terms of heightened skill in metacognition and greater levels of intrinsic motivation to learn and to perform well.

2.2.2 Mechanisms/component skills of hazard perception and implications for testing

As will be discussed further below, hazard perception tests for novice car drivers are currently administered as part of the licensing process in most Australian states and in the UK. There is a high likelihood that the practice will soon be adopted in other Australian jurisdictions and internationally. For example, Scialfa, et al. (2011) conducted a study recently which sought to develop and evaluate a version of the test for future implementation in North American jurisdictions. The results were largely in support of the test as a means through which to differentiate drivers on the basis of their hazard perception skill.

In the traditional hazard perception test, drivers are presented with pre-recorded driving scenarios on video filmed from the driver's perspective. The driver's task is to watch the scenarios and, as the scenarios unfold, to respond (e.g. by pressing a button) as quickly as possible when he/she anticipates a potential hazard (Jackson, Chapman & Crundall, 2009; Wetton, et al., 2010). However, Jackson et al. (2009) caution that,

A major difficulty with the traditional hazard perception tests is that one cannot be sure what the participant is referring to when they press the button. An early response to a future hazard may actually be a response to something else on the road. Thus, a tight scoring window around the hazard is essential. Unfortunately, an experienced driver may have correctly anticipated the hazard before the scoring window; this pre-emptive button press would be disregarded effectively punishing expertise (p. 156).

In a similar vein, Wetton, et al. (2010) highlight that hazard perception is a complex skill, which is made up of multiple components (of which various classifications exist). Thus, it is not known whether one's hazard response time is a reflection of poor performance in one component of hazard perception or another. In essence, knowledge of which aspects of hazard perception are responsible for previously reported differences in novice and experienced drivers' hazard response times, would be instrumental in the design and development of more targeted (and therefore, cost-effective) training interventions and of tests with greater potential diagnosticity.

Herein is a list of the key characteristics and findings from recent novice driver hazard perception studies which have sought to explore hazard perception in greater depth and/or have implications for test design.

- *Impact of scenario processing time.* Jackson et al. (2010) presented video-taped driving scenarios to a group of novice and a group of experienced drivers. The scenarios were stopped just prior to hazard onset and either the screen went black or the final still image remained on the screen. In turn, participants were asked to predict what happens next. When the screen went black, the experienced drivers anticipated more correct hazardous outcomes than the novice drivers. However, when given more time to review the scenario the novices benefitted, with the novices correctly anticipating more hazards when the image remained on screen than when the screen went black. That is, it is only when processing time is limited that experiential differences in hazard perception accuracy appear. The implication is that a test which combines Jackson et al.'s (2010) approach with a response time measure would provide a more comprehensive and thus, diagnostic, assessment of hazard perception ability.
- *Hazard classification ability* (Borowsky, Oron-Gilad & Parmet, 2009). Novice and experienced drivers were asked to watch video-taped driving scenarios while pressing a response button each time they detected a hazard and, in turn, to classify the scenarios according to similarities in the hazards depicted. While the novice drivers classified the scenarios according to actual hazards, the experienced drivers drew on information about the traffic environment and so were more likely to consider potential hazards in their classification criteria. The implication for training is that programs should emphasise the link between hazards and the traffic environment (see Crundall et al. (2010) above for a complementary view). The implication for testing is that hazard classification should be an integral part of the assessment, and that the test involve systematic assessment of both actual and potential hazards.
- *Validity of a hazard change detection task and a hazard perception test* (Wetton, et al., 2010). A hazard change detection task was developed to assess drivers' efficiency in detecting

hazards in static images. A hazard perception test was developed as an overall assessment of drivers' ability to anticipate hazards quickly and accurately. In this test version, participants were required to touch that portion of the screen that contained the potential hazard. Contrary to expectations, novices responded more quickly than the experienced drivers on the change detection task. However, for the hazard perception test, performance was in the expected direction, with the novices requiring significantly more time than the experienced drivers to perceive the hazards. Thus, while support for the hazard perception test was found, support for the hazard change detection test, at least for assessing hazard perception in novice drivers, was not.

- *Role of visual orientation v hazard processing.* Huestegge, Skottke, Anders, Müsseler & Debus (2010) explored whether the previously reported faster response times of experienced drivers relative to novice drivers on hazard perception tests was due to more advanced skill in visual orientation and/or more efficient hazard processing. Novice and experienced drivers viewed static images, each for two seconds. Using eye movements, Huestegge et al. (2010) measured separately: the interval between the onset of a potential hazard and the first fixation (visual orientation), and the interval between the first fixation and the final response as provided through a button press (hazard processing). The overall response time was faster for the experienced drivers. Separate analysis of the two component measures revealed that the source of the overall effect was more efficient hazard processing (that is, greater efficiency in the latter phase of hazard perception). Time to initial fixation did not differ between the two driver groups.
- *Number of screens.* Shahar, Alberti, Clarke and Crundall (2010) compared two versions of a hazard perception test, where the participants' task was to press a button as soon as possible once they saw a hazard and then to name the hazard out loud. In one version of the test, participants viewed the driving scenarios on a single-screen (as in the standard test set-up), and in the second test version, participants watched the scenarios on a three-screen configuration, providing participants with a wider field-of-view. Results were in favour of the three-screen configuration. Shahar, Alberti et al. (2010) concluded that not only does the wider view provide a more immersive and realistic setting for assessing hazard perception skills, but it facilitates more reliable and valid assessments through the provision of additional environmental cues. In addressing Borowsky et al.'s (2009) recommendation, the use of a wider field-of-view may be instrumental in enabling the effective assessment of potential hazards.

2.2.3 Summary

In summary, recent research into novice driver hazard perception has served two complementary purposes: to explore effective means for imparting training in hazard perception to novice drivers; and also to better understand the component processes of hazard perception and how this might lead to improved testing practices.

As returned to below, there is mounting evidence in support of CBT programs for training hazard perception at least in young novice drivers. Moreover, as a training approach, commentary driving appears to offer much promise – although, more research is necessary to maximise the potential effectiveness of the approach and to understand more precisely the mechanisms underlying its

effectiveness as a training technique. As argued for error training, the relationship between commentary training and hazard perception may be mediated at least in part by superior skill in metacognition and/or intrinsic motivation. Examining whether the positive effects of the commentary training observed in the simulator translate to on-road driving as well as obtaining information on skill retention rates, will help to shed some light on this issue, in addition to providing a stronger case in support of the approach.

There is increasing evidence that, in general, hazard perception tests provide a valid means for measuring the hazard perception skill of novice drivers, and by implication, novices' readiness to progress to the next phase of licensing. Nonetheless, several complementary suggestions for test improvements have been made, including the use of three-screens instead of one, the inclusion of measures in addition to hazard response time, and the need to assess systematically individuals' appreciation of both actual and potential hazards.

Chapter 3 Current approaches to hazard perception training

This section provides an overview of current approaches for imparting training in hazard perception both in Australia and internationally. The purpose of this review is not to list every single training program that is available; rather “case studies” are presented to exemplify and illustrate the range of approaches that have either been implemented or are under development. The approaches available to drivers are considered first, followed by those approaches that have been developed for riders. Information on program/course effectiveness is also presented, to the extent that it is available.

3.1 Drivers

In general, two types of instructional environment have been used to train young novice drivers in hazard perception: driver training simulators, and CBT programs. While driver training simulators exist which utilise PC-based technology, the critical difference between these and CBT programs is that the former require additional components (e.g. steering wheel, pedals, additional monitors, gaming software) beyond what is required for a typical “home” PC.

Driver training simulators have been developed to supplement and complement the current training of young novice drivers. As a general rule, simulators that are used for driver training tend to be of lower fidelity than driving simulators which are used for research purposes. This is largely a function of the need for driver training simulators to be low cost, transportable, and easy-to-use with minimal or no specialist training. However, it is important to note that low fidelity does not necessarily imply low effectiveness (Park, Allen, Rosenthal & Fiorentino, 2005). The ultimate effectiveness of training simulators (and indeed, of other training modalities) can be attributed to several factors including training content, timing of training delivery (in terms of stage of skill development), amount of training, and logistical/pragmatic issues such as accessibility and affordability. Thus, while achieving a suitable level of fidelity is necessary, it is not sufficient.

Examples of driver training simulators include the simulators and associated tools developed as part of the European Union (EU) TRAINER project (Dols, Pardo, Falkmer & Forest, 2001; Falkmer & Gregersen, 2003; Nalmpantis, Naniopoulos, Bekiaris, Panou, Gregersen, Falkmer, Baten & Dols, 2005), the simulators developed and evaluated by Systems Technology Incorporated (STI) in the USA (Allen, Cook & Rosenthal, 2001; Allen, Park, Cook, Rosenthal, Fiorentino & Viirre, 2003; Allen, Rosenthal, Park, Cook, Fiorentino & Viirre, 2003; Allen, Park, Cook, Rosenthal & Aponso, 2004), and the ‘Dutch Driving Simulator’ developed by Green Dion Virtual Realities in The Netherlands and evaluated by de Winter, de Groot and colleagues (de Groot, de Winter, Mulder & Wieringa, 2007; de Winter, de Groot, Dankelman, Wieringa, van Paassen & Mulder, 2008).

CBT programs typically do not require any equipment other than the training software and the standard components of a “home” PC in order to be used. Thus, their low cost and easy

accessibility makes CBT programs an attractive option within the general community. The training software is typically distributed on CD-ROM, DVD or similar, or is available for download from the internet. Notable examples of currently available commercial CBT programs are DriveSmart (Transport Accident Commission; Regan, Triggs & Godley, 1999, 2000a, b; Regan, Triggs & Wallace, 1998; Triggs & Regan, 1998), and Driver ZED (AAA Foundation for Traffic Safety; Fisher, et al., 2002). Each of these programs has undergone systematic evaluation, with largely positive outcomes. Given their success and ease-of-use, DriveSmart and Driver ZED are each considered in further detail below.

3.1.1 DriveSmart (Transport Accident Commission, Victoria)

DriveSmart is a CD-ROM product for training risk perception and attentional control skills in young novice drivers. The program is targeted at those beginning drivers who are in the Learner phase of licensure and who have accrued at least some driving experience. DriveSmart is completed voluntarily. Moreover, it is not intended to provide the range and quality of stimuli encountered through actual driving and, as such, does not provide a substitute for actual driving experience. Rather, its purpose is to augment that experience by providing exposure to selected high risk circumstances through deliberate instructional methods which aim to establish effective perceptual and cognitive strategies for responding to risky situations in the real world (Regan et al., 2000b).

The content for DriveSmart was based on a review of the relevant literature and on the findings of an extensive driving simulator-based research program into young novice driver skill development carried out at MUARC (Triggs & Regan, 1998). The driving simulator experiments also investigated process issues. These issues were concerned with the techniques for training the critical skills in young novice drivers. It was found, for example, that methods utilising the mediated instruction approach were effective in training risk perception skills in novice drivers (Triggs & Regan, 1998). Mediated instruction is a cognitive approach to training where an external influence (such as an instructor) moderates the process of individual learning. The method of mediated instruction adopted in the MUARC research was based on the model of Incremental Transfer Learning (Wallace & Regan, 1998). This approach views skill acquisition as a process that extends over several definable stages. The model assumes that skill development involves the transfer of learning between increasingly complex contexts. Further, Incremental Transfer Learning places importance on the need to plan for both near- and far-transfer of skills (Regan, Triggs & Wallace, 1998). Incremental Transfer Learning was chosen as the underlying instructional strategy for DriveSmart.

DriveSmart incorporates two different types of learning environments. Only the environment relating directly to the training of risk perception is presented here. As described in Regan, Mitsopoulos, Triggs, Young, Duncan and Godley (2005), the first is digitised video footage, as seen from the driver's seat (including views of the forward scene and from the rear vision and side mirrors), of real world driving scenes in which potentially hazardous situations arise. These video clips are coupled with carefully scripted voice-overs. During these exercises, users are instructed to undertake several activities which include: scanning the driving environment for traffic hazards, predicting the actions of other drivers and pedestrians in the driving environment, and making safe driving decisions. The video clips are separated into several different modules which involve different risk perception skills and include activities of varying difficulty. The user's

response is always followed with appropriate feedback. DriveSmart also has an “Introduction” module, which contains a short tutorial for introducing the user to key terminology and concepts, and the “Concentration” module, which is targeted towards training skill in attentional control.

The instructional effectiveness of DriveSmart was evaluated through an experiment using the MUARC advanced driving simulator (Regan et al., 2000b). Learner drivers aged between 16 years 11 months and 17 years 10 months and with between 40 and 110 hours of driving experience participated in the study. Following a baseline drive in the simulator, participants assigned to the treatment group completed five sessions of DriveSmart training, while the participants assigned to the control group completed five sessions of training using the Microsoft Flight Simulator 98 CD ROM product. Performance on the baseline drive (i.e. mean speed) did not differ significantly between the two groups.

One week after training, and again four weeks later, all participants performed several drives in the simulator. Evidence of heightened risk perception skill was observed for the treatment group relative to the control group in approximately half of the traffic scenarios analysed. In the remaining scenarios, critically, no negative effects of the training (i.e. better risk perception skill among the controls relative to the treatment group) were observed. The positive training effects generalised to risky traffic situations which were not encountered during training (far-transfer) and persisted for at least four weeks after training. Further, comparison of mean speed on the baseline drive with that on an exit drive completed four weeks after training, revealed significantly lower speeds among participants who completed the DriveSmart training than among those who did not (Regan et al., 2000b). Since July 2000, DriveSmart has been distributed to all Learner drivers in Victoria.

3.1.2 Driver ZED (AAA Foundation for Traffic Safety, USA)

Driver ZED, which stands for Zero Errors Driving (www.driverzed.org/home/index.cfm), is a CBT program that focuses on training risk awareness and perception in beginning drivers. The program comprises 80 video clips of traffic scenarios filmed in city, urban and rural settings. The scenarios depict the forward road scene from the driver’s viewpoint, and contain views of the roadway as pictured in the side- and rear-view mirrors. For a given scenario, the user is required to take one of several actions, with the required action depending on the mode of presentation. The four presentation modes are: scan, spot, act, and drive. In the scan mode, the user is required, at the end of a given scenario, to answer questions that determine how well he/she attended to given features in the scenario. In the spot mode, the scenario pauses at the last frame and the user is asked to use the mouse to “click” on each risky element in the scenario. In the act mode, the user is asked what action he/she would take midway through a scenario. In the drive mode, the user is required to “click” the mouse at the point in the scenario when he/she would take an action that could potentially avoid a crash (Fisher, et al., 2002).

To evaluate the effectiveness of Driver ZED in imparting training in risk awareness, Fisher, et al. (2002) carried out an experiment using a fixed-base driving simulator. Two groups of young novice drivers were among the participants who took part in the study. These drivers were aged between 16 and 17 years and were currently participating in a driver education course through their high school. One of the young novice driver groups completed the training in risk awareness, while the other group completed no training. Approximately, one week after training

participants completed a series of drives in the simulator that were designed to test their risk awareness.

The training was found to have a positive effect on young drivers' awareness of hidden risks, and evidence of both near- and far-transfer of training was observed. Further, the driving patterns of the trained drivers were indicative of more cautious driving than those of the untrained drivers. For example, examination of individual travel speed profiles indicated that the participants in the trained group approached a crossing event at slower speeds, having reduced their speed sooner, than the participants in the untrained group.

3.2 Riders

Simulator and CBT programs for training hazard perception have also been developed for the novice rider. However, formal range-based and on-road opportunities also exist for imparting training in hazard perception and responding skills to novice riders. To illustrate the range of approaches, four "case-studies" are presented: two to illustrate local examples and two to exemplify existing or proposed approaches internationally (USA, Europe).

3.2.1 RideSmart (Transport Accident Commission, Victoria)

The positive evaluation results and public reception to DriveSmart led to the development of the RideSmart CD ROM – a cognitive skills training product for motorcycle riders. As is the case with DriveSmart, RideSmart is not a substitute for on-road experience and existing rider training; rather it is intended to supplement real-world riding experience. The instructional design philosophy which underpinned DriveSmart, Incremental Transfer Learning, also provided the instructional strategy for RideSmart.

RideSmart was launched in 2005 and is free to all Victorian motorcycle Learner's Permit and licence holders. As explained by Tierney and Cockfield (2005), the development of the product was overseen by motorcycle safety stakeholders, and the content itself was scripted by experienced rider trainers under the close guidance of an expert in instructional design, to ensure that the product is consistent with the intended learning outcomes.

The RideSmart modules and exercises make use of the real-world video sequences filmed initially for DriveSmart, and cover a variety of locations, including urban, rural and freeway settings. These sequences were modified digitally to include a range of motorcycle interfaces and to simulate various instrument and vehicle dynamics (Tierney & Cockfield, 2005).

RideSmart is comprised of four modules, commencing with the "Introduction" module. As users progress through the modules, they encounter more advanced exercises. In total, the product comprises 102 exercises, which test users' ability to observe, anticipate, and select an appropriate response strategy (Tierney & Cockfield, 2005). In general, a given exercise involves the user viewing the video sequence, and providing some sort of response. In turn, feedback is offered. Prior to its release, RideSmart underwent a systematic process evaluation. Since its launch, the product has been well received by the motorcycling community.

3.2.2 Honda Advanced Rider Training courses (Victoria, NSW, Queensland)

Currently, there exists no standard Australian curriculum for training novice riders in the critical competencies needed for safe riding. Moreover, in states such as Victoria, where rider training is currently not mandatory, there exists much variability (e.g. content, duration) across training providers in the training courses that are offered and the extent to which instruction in hazard perception and responding is available.

Among the training courses offered by Honda Advanced Rider Training (HART) in Victoria are those that aim to provide explicit training in hazard perception. Particularly noteworthy is the “Learners to Licence” course that is intended for novice riders who have already obtained their Learner’s Permit and are on the path to obtaining their licence. As described in the promotional brochure, which is available for download from the HART website (www.hondampe.com.au), “this course introduces skills and topics that go above and beyond the VicRoad’s Learner Permit requirements including more road-related riding exercises, and hazard perception training”. A four-hour course overall, the course is divided into three sequential components:

1. Hazard perception training session (1 hour) using the Honda Rider Trainer;
2. Practice session (1.5 hours) – range-based practical training; and
3. On-road session (1.5 hours) – on-road supervised training session to put into practice and to receive feedback on, the skills learnt as part of the hazard perception and range-based practical training sessions.

Stand-alone training sessions of one hour each using the Honda Rider Trainer are also available.

3.2.3 Initial Rider Training project (Europe)

The Initial Rider Training (IRT) project arose from the recommendation to develop a unified European approach to pre-licence rider training that aims to achieve a balance between training in vehicle control and training in hazard perception. The basis of the recommendation was the knowledge that pre-licence rider training varied widely in quality, availability, and cost across European Member States. Moreover, existing courses were found to overlook hazard perception, focussing exclusively on imparting training in vehicle control.

Concluded in 2007, the IRT aimed to determine the essential elements for pre-licence rider training. The result was a model program, which includes a modular approach to initial rider training, a method and approach to support initial rider training, and a comprehensive manual addressing the requirements of both the trainee rider and the instructor (Tomlins, 2007). The program structure is made up of three modular components:

1. *Theoretical* (road regulations, signs and markings, machine dynamics, hazard awareness, helmets and appropriate clothing, social responsibilities, impairment, attitude and behaviour),

2. *Machine control* (machine familiarity, first movements, gears, brakes and direction, steering and counter-steering, low speed manoeuvring, hazard management); and
3. *Traffic interface* (positioning in traffic, distance and speed, curves and bends, junctions, overtaking, motorways, anticipation, riding together, journey planning).

The companion resources and manual are critical in ensuring that the program is widely available, and not restricted to those individuals who have access to commercial initial rider training facilities. For example, as Tomlin (2007, p.19) explains “by following the IRT model program the family member or friend, who should be an experienced and competent motorcyclist, will be able to approach the range of skills and knowledge needing to be acquired by the rider, in a structured and logical way”.

As part of the IRT project, an additional component, e-Coaching, was explored for its potential to support and supplement initial rider training through the provision of virtual no-risk exposure to hazards.

e-Coaching

Ranta, Mäki and Huikkola (2007) conducted research into e-Coaching to explore the technical feasibility of the approach, and to provide recommendations on the required features of the program and the suitable implementation technologies for these features.

Ranta et al. (2007, p.4) indicated that, to be consistent with the aims of the IRT project, an e-Coaching program would need to meet the following goals:

- Offer a method for the trainees to experience hazardous riding scenarios, which they are likely to face in real traffic, in a no-risk context and receive advice and feedback on their performance;
- Enable learning of hazard preventing behaviour and attitude through understanding the consequences of incorrect actions, rather than reading or hearing a list of “do nots” of motorcycle riding;
- Enable an easy transference of the learned abilities to real-life situations;
- Be a self-learning process, rather than a replacement for the traditional instructor-based training;
- Be an affordable solution even for the young initial rider trainees (i.e. work on a regular PC or video-game console that trainees are already likely to have available);
- To reach both young initial riders and other riders, who for some reason may not receive hazard perception training from other sources; and
- Appeal to the “gaming generation”, while remaining accessible to the older, “non-gaming generation”.

As a result of their research, Ranta et al. (2007) concluded that e-Coaching is ideal for training hazard perception and avoidance, given the use of a virtual no-risk platform for imparting the training. It was also concluded that, because of its greater accessibility, PC hardware would be more suitable for the e-Coaching program than video-game consoles. Further, it was recommended that the e-Coaching software be distributed via a website to enable more widespread and efficient access, communal collaboration, and easy access to updated content (e.g. graphics and exercises) as it becomes available. A further recommendation was that the program comprise two modes. In the “level-based mode”, the trainee experiences events (“levels”) of randomly generated traffic situations with increasing difficulty. In the “exercise-based mode”, the trainee can select which aspect of riding they would like to practice. The trainee is then presented with an exercise that contains traffic situations related to this aspect. Briefings and debriefings accompany each level and exercise.

Recommendations arising from the IRT project

The IRT project culminated in a series of recommendations to the European Commission concerning the development and implementation of initial rider training in Europe (Tomlins, 2007). The recommendations included:

- Use of the IRT model program to assess the quality of existing national rider pre-licence training arrangements, with a view to influencing the development of effective arrangements where they are found to be lacking or non-existent;
- Support the development of an e-Coaching program; and
- Initiate and support an IRT dissemination project, the objectives of which would be to:
 - Undertake a technical review of the IRT model program;
 - Facilitate the translation of the IRT model program into an agreed number of European official languages;
 - Develop and produce a range of support materials for the IRT model program;
 - Establish a permanent IRT program website; and
 - Develop and produce e-Coaching packages to support the theoretical and machine control components of the IRT model program.

3.2.4 Motorcycle Safety Foundation courses (USA)

The Motorcycle Safety Foundation (MSF) develops and maintains research-based rider education and training curricula for the USA, establishes national certification standards, provides technical assistance for USA training and licensing programs, actively participates in government relations, research and public awareness, and works in partnership with other motorcycling and public organisations to improve and enhance the safety and enjoyment of motorcycling (Ochs & Buche, 2010). The core strategy underlying the MSF’s rider education and training system is “Search-Evaluate-Execute” (SEE). Riders are encouraged to adopt this strategy to reduce their crash risk.

As explained by Ochs and Buche (2010), the MSF has incorporated hazard perception training into its rider education and training system. Two programs have been designed specifically to address hazard perception directly: Street Smart – Rider Perception, and the Rider Perception Challenge. Indeed, central to the MSF’s approach is the importance of a safety mindset, and the role of “executive functions” in helping riders to identify and prioritise factors while riding. That is,

With the development of a comprehensive rider education and training system, the MSF has transcended simple skill-based training programs and has expanded into behavioural programs that target rider perception as a primary executive function that can lead to safe and enjoyable riding. Because MSF characterises the riding task as more a skill of the eyes and mind than of the hands and feet, using the eyes well and using the brain to sort, organise and prioritise factors in the traffic environment is of integral importance for training programs (p. 27).

Herein is a brief overview of each of the two dedicated hazard perception courses offered by the MSF.

1. *Street Smart – Rider Perception (“Host-An-Event program”)*. This classroom-based program is designed to help riders improve their hazard perception. It uses highly interactive individual and group activities. The program’s kit contains a Leader’s Guide with a core lesson plan, student workbooks, oversized playing cards and floor mats for highlighting central and peripheral vision, and a CD with PowerPoint program and interactive scenarios that consist of traffic signs and traffic situations. The PowerPoint contains the visual components of the program for classroom presentation and is divided into four parts: (1) Introduction to Perception, (2) Improving Perception, (3) Analysis of Collision Traps, and (4) Road Sign and Collision Trap Practice.
2. *Rider Perception Challenge!* This companion program is available online and is accessible at any time from the MSF website (www.msf-usa.org). It contains a series of exercises designed to challenge and develop users’ hazard perception abilities.

The Street Smart – Rider Perception program is included in the MSF’s recommended core of courses. The MSF recommends a core set of courses to give beginning riders complete preparation in developing and maintaining safe and responsible riding performance and behaviour (Ochs & Buche, 2010). The MSF Director of Training Systems, Ray Ochs (2010, personal communication), advises that, to date, the Street Smart – Rider Perception and the Rider Perception Challenge have been well-received, with some elements having been incorporated into MSF’s newer rider courses, such as their “Advanced RiderCourse” and “Street RiderCourse”.

Finally, it is noteworthy that the MSF encourages and supports the use of the Honda Rider Trainer to enhance rider’s risk awareness and management skills. Currently, the MSF uses the Honda Rider Trainer as a standalone tool. Although the option exists, to date, the Honda Rider

Trainer has not been incorporated into any MSF rider courses (Ray Ochs, 2010, personal communication).

Chapter 4 Current approaches to hazard perception testing

A principal objective of hazard perception testing is to ensure that the novice has achieved the necessary level of competence to progress to the next phase of licensing. This section provides an overview of the current practice in Australia, the UK, and New Zealand for testing competency in hazard perception. Both Australia and the UK utilise computer-based testing, while testing in New Zealand is conducted on-road. It is important to highlight at the outset that there exists currently no dedicated computer-based hazard perception test for novice riders. Where novice riders are required to take a computer-based hazard perception test to progress to the next phase of licensure, the typical requirement is that they pass the hazard perception test designed initially for novice drivers.

4.1 Australia

Hazard perception testing for novice drivers is currently practised in five Australian jurisdictions: Victoria, NSW, Queensland, South Australia and Western Australia. Table 1 provides an overview of current practice in each of these five states. Further detail is given in Appendix A.

In every case, the hazard perception test is completed on PC. With the exception of Queensland (where the test is completed online, at home), the test is completed at customer service centres. The argument for online testing is that it ensures that the test is available at any time. It is advised that the best preparation for the test is driving practice during the preceding licence phase(s). However, each state offers additional resources, which in several cases include practice exercises.

In Victoria and Western Australia, drivers must pass the hazard perception test in order to progress from the Learner phase to the Probationary (P1) phase. In every other case, the hazard perception test is a requirement for progressing from the first to the second phase of the Probationary licence. The rationale for the former timing relates to the knowledge that the first six months of solo driving are the riskiest, and so testing for hazard perception skills at the end of the Learner phase ensures that drivers have obtained sufficient competency before being able to progress to the next, solo driving phase. The argument for the latter approach relates to the knowledge that driving is a cognitively demanding task, and even more so for the Learner driver whose vehicle control skills are yet to be fully automatised. Thus, delaying the test until after a period of solo driving ensures that the novice driver is cognitively ready to undertake the hazard perception test (Palamara, 2005). While there is no direct evidence in favour of one approach over another, the requirement in several states for drivers to practice driving during the Learner period for a certain minimum number of hours, means that, depending on the number of hours, sufficient mastery of vehicle control may have already been achieved at some point during the Learner phase. While speculative, such a view would support the former approach of testing hazard perception skill at the end of the Learner period.

Table 1. Hazard perception testing for novice drivers in five Australian states

State	Medium & Location	Resources	Timing
Victoria	PC; VicRoads Customer Service Centre	Website	To progress from L to P1 phase
New South Wales	PC; RTA Motor Registry	Website; Handbook	To progress from P1 to P2 phase To progress from P2 to Full licence
Queensland	PC – online; Home	Website; Handbook (information only)	To progress from P1 to P2 phase
South Australia	PC; SA Customer Service Centre	Website; Handbook	To progress from P1 to P2 phase
Western Australia	PC; WA Licensing Centre	Website; CD; Handbook (information only)	To progress from L2 to P1 phase

Further, it is noteworthy that NSW also requires successful completion of a computer-based exit test in advanced hazard perception in order for novice drivers to be granted a full, unrestricted licence. The logic behind exit tests, in general, is sound as these ensure that the novices have achieved a certain level of mastery before being permitted to drive unrestricted.

Across states there are also some differences in the test itself. While in every case, the test comprises a series of driving sequences filmed from the driver's viewpoint, participants' task may vary. In the Queensland test, participants are required to identify (by clicking the mouse on the appropriate portion of the screen) a potential traffic conflict that would require the driver to take some action, such as to slow down or change lanes. In the other states' tests, participants' task is to indicate (mouse click or screen touch) when they would perform a pre-specified action (e.g. slow down) in order to avoid a potential hazard.

In Victoria and Western Australia at least, novice riders must also pass the hazard perception test in order to progress from learner to licensed rider. However, this is only a requirement if the novice rider does not already have a car driver's licence. A major issue in administering the driver hazard perception test to novice riders is that the test does not include an assessment of hazards that are specific to riders. This has led to the recommendation that a rider-specific hazard perception test be developed and implemented.

4.2 United Kingdom

In the UK, the hazard perception test forms part of the theory test. (See Appendix A for additional detail.) The same hazard perception test is used for both novice drivers and novice riders. Learner drivers/riders must pass the theory test in order to apply to take their practical licence test. Individuals with a licence in one category (e.g. car) who wish to obtain a licence for another category (e.g. motorcycle) also need to take the theory test. The theory test is available at theory test centres.

As explained on the Directgov website (www.direct.gov.uk), the hazard perception test is administered on PC and involves participants watching a series of filmed video clips which feature typical road scenes. Participants' task is to respond by pressing the mouse button as soon as they see a hazard developing that would result in the driver having to take some action (e.g. slow down).

There is recent evidence in support of the UK hazard perception test, at least for novice drivers. As part of a six-year cohort study, which sought to provide insight into how cohorts of learner drivers in the UK learn to drive and of their subsequent experiences as new drivers, it was found that the introduction of the hazard perception test (in 2002) was associated with a decrease in subsequent crash liability for some types of crash in the first year of driving. Specifically, for reported non-low-speed crashes on a public road where the driver accepted some blame, the crash liability of those who had taken the hazard perception test was significantly lower than those who had not (Wells, Tong, Sexton, Grayson & Jones, 2008).

4.3 New Zealand

To graduate from a restricted driver's licence to a full driver's licence in New Zealand, individuals are required to pass a practical, on-road exit test. The same also applies for riders wishing to graduate from a restricted rider's licence to a full rider's licence. There are many similarities between the test for drivers and the test for riders – for example, in terms of rationale and structure. Thus, only the test for riders is described in detail below. Further detail is given in Appendix A.

As described on the NZ Transport Agency website (www.nzta.govt.nz/resources/roadcode), the full licence practical test for motorcycle riders is “designed to test whether the skills of the motorcyclist are at a level where they can safely ride without the conditions of the restricted licence”. The test is conducted on a motorcycle provided by the testee, and takes approximately one hour. During the test, the tester (a trained rider testing officer) observes and assesses the testee's riding. To achieve this, the tester travels behind the testee in another vehicle. Applicants are advised that, to pass the test, they will need to have obtained sufficient experience to have achieved a level of skill which enables them to ride competently on all types of roads and in all traffic conditions. This includes the ability to perceive and respond adequately to hazards.

The full licence test comprises three parts.

- *Part 1 - Test of basic riding* - is intended to confirm that the testee can ride without breaking the road rules, and that the testee has the basic skills needed to deal with the four

road and traffic situations which have shown to be the most hazardous for newly licensed riders (riding straight, riding through intersections, turning left at 90 degree intersections, turning right at 90 degree intersections). Testees are asked to ride on laned and unlaned roads, in speed zones ranging up to 60 km/h, in all types of traffic, and through controlled and uncontrolled intersections.

- *Part 2 – Detecting and responding to riding hazards in built-up areas* – requires that applicants perform a number of tasks (e.g. making a U-turn, turning right at an uncontrolled intersection) and to observe and remember the hazards that they see as they carry out certain tasks. After a given task, applicants are required to recall the hazards. The tasks are carried out in busy, built-up areas, where the speed zone ranges up to 60 km/h.
- *Part 3 – Riding in higher-speed zones* – involves testees performing tasks, such as riding straight, riding around curves, and merging and changing lanes, on highways and motorways, where the speed limit ranges between 70 and 100 km/h.

Performance in each part is assessed against set criteria. Each task is scored as either “yes” (meets the required standard) or “no” (does not meet the required standard). Testees must achieve a score of at least 80% in part 1 in order to be eligible to progress to parts 2 and 3. To pass the test, successful completion of part 1 must be followed with a score of at least 80% across parts 2 and 3.

In general, practical tests have the advantage over computer-based tests in that they enable more definitive and direct assessment of riders’ hazard perception and responding skills across a range of scenarios. Nonetheless, to our knowledge, the New Zealand full licence practical test has, to date, not been assessed for its effectiveness by relating test performance to post-test crash incidence. It is noteworthy, however, that a process evaluation (with only 4% motorcycle licence holders) conducted in the late 1990s as part of the test’s development, revealed that the test was received favourably among participants and that the test was easy to administer and to comprehend (Christie, et al., 1998). The evaluation also highlighted a need to promote the test early during licensure in order to encourage restricted licence holders to accrue on-road practice and experience in order to maximise their likelihood of passing the test. Ensuring that the test was available to individuals from minority and non-English speaking backgrounds was also identified as an area in need of further consideration as part of test implementation.

Chapter 5 Discussion

To reiterate, the aim of this research is to identify options and provide recommendations for the development and implementation of motorcycle-specific hazard perception and responding measures (training and testing) in Victoria. While it is recognised that the options and recommendations presented here may have implications for the training and testing of “returning riders”, the focus here is on the training and testing of novice riders as part of the initial licensing process.

To assist in this endeavour a review of the recent research into novice driver and rider hazard perception and responding was undertaken, along with a review of a sample of current training and testing programs. This chapter presents a consolidated list of key conclusions that can be drawn from previous research (including, but not limited to that presented here) into novice driver and rider hazard perception and responding, training and testing, and skill development in general. This incorporates a presentation of candidate modality options for hazard perception and responding training and testing, and leads to a discussion of the key issues that need to be considered and resolved in developing such training and testing. The preliminary recommendations deriving from this research are summarised at the end.

5.1 Key conclusions

- Critical differences exist between riders and drivers, and the types of hazards encountered.
 - In Victoria at least, novice riders are typically older than novice drivers.
 - In Victoria at least, novice riders tend to be experienced drivers (with at least 10 years of driving experience).
 - Riders are prone to hazards that are additional to those encountered by drivers.
 - Rider hazards can be categorised into two types: road-based hazards, and hazards associated with the behaviour of other road users.
- Well-developed skill in hazard perception and responding, in general, is critical to safe driving and riding. However, the size of the vehicle notwithstanding, due to the relatively greater complexity of controlling a motorcycle than a car, the ability to execute an appropriate response successfully following perception of a hazard and selection of an appropriate response is considered to be more critical for riders than it is for drivers.
 - It is well-established that experienced drivers have superior skills in hazard perception than novice drivers.
 - There is mounting evidence that experienced riders have more advanced skill in hazard perception and responding than novice riders.
 - For drivers at least, there exists an established relationship between hazard perception test performance and crash likelihood in the first years of licensure. This relationship

has yet to be examined for novice riders, although it is reasonable to assume a priori that participants' scores on a reliable and valid measure of rider hazard perception and responding would also correlate negatively with crash likelihood during the early years of solo riding. This relationship may be even stronger than it is for drivers given the greater risk of riding and riders' vulnerability as road users, in general.

- For novice riders, there is at least some transfer of hazard perception skill from driving to riding.

- In general, skills develop in a sequential fashion, with some skills developing sooner than others.
 - In the context of driving and riding, more rudimentary skills in vehicle control start to develop earlier than higher-order perceptual and cognitive skills, such as hazard perception and attentional control.
 - Models of skill development exist (e.g. Incremental Transfer Learning) that relate the stage of learning to the fidelity of the training modality.

- Training offers a means through which to accelerate the development of certain skills.
 - In the driving context, driving simulators and CBT programs have been shown to be an effective means for imparting training in certain higher-order perceptual and cognitive skills, including hazard perception. Effective transfer of training has typically been observed in the simulated environment, although evidence of training transfer to real-world scenarios has also been observed.
 - There is mounting evidence that simulators at least, offer an effective means for imparting training in hazard perception and responding to novice riders.
 - Several modalities exist for imparting training in hazard perception and responding to novice drivers and riders. These can be categorised as follows: written materials in hardcopy, recorded real-world video footage, computer-based programs, simulators, range-based courses, and on-road courses. Each modality has its strengths and weaknesses, as summarised in Table 2 below.
 - In discussing the merits of various training modalities it is important to note that while achieving a suitable level of fidelity (e.g. physical and functional) is necessary, it is not sufficient. Other factors including training content, timing of training delivery (in terms of stage of skill development), amount of training, and logistical/pragmatic issues such as accessibility and affordability are also critical.
 - Nonetheless, at the highest level, the merits of a given training modality are determined on the following three grounds: the training time that is required in order to reach criterion performance; the level of transfer to the real-world environment; and the length of skill retention.
 - At least in the driving context, commentary driving provides an effective means for training hazard perception in novice drivers. However, the caveat is that the approach may not be a viable option for certain minority groups (e.g. non-English speakers),

and may add unduly to the novice driver's workload. Although currently not known, this effect may be greater for the novice rider given the added demands associated with riding a motorcycle.

- The provision of appropriate feedback and self-evaluation play critical roles in effective learning. Metacognition and intrinsic motivation may play an important role here.
- Testing offers a means through which to assess one's competence and whether the novice has acquired a sufficient level of skill to progress to the next stage of licensing.
 - Testing serves other purposes as well. It aims to encourage practice and the accumulation of experience in order to maximise one's chances of passing the test. Testing also aims to encourage novices to undertake formal training courses (which are often not mandatory as part of licensing) with the intention of increasing one's likelihood of passing the test. Although widely recognised, this latter objective is potentially problematic as it could actually act to subvert the intention of the test. That is, by emphasising its relationship with testing, the focus of training becomes learning all that is needed to pass the test rather than on skill development with adequate retention for successful application in the real-world.
 - Several modalities exist for assessing hazard perception and responding skill in novice drivers and riders. These can be categorised as follows: computer-based, simulators, range-based, and on-road. Each modality has its strengths and weaknesses, as summarised in Table 2 below.
 - While examples of on-road hazard perception tests exist for both drivers and riders, computer-based tests currently exist as the most popular option where formal testing is required as part of licensing. However, currently, where novice riders must take a computer-based test, the test that is used is that which was developed initially for drivers.
 - While sufficiently valid for assessing competency in hazard perception for novice drivers, existing computer-based hazard perception tests may not be completely appropriate for novice riders. There are two critical issues here: the extent to which rider-specific hazards are considered, and the extent to which responding skill is assessed. The general consensus is that existing computer-based tests do not sufficiently cater for riders in either regard.
 - In the case of novice drivers at least, several complementary suggestions for improvements to computer-based hazard perception tests have been offered. These include the use of three-screens instead of one, the inclusion of measures in addition to hazard response time, and the need to assess systematically individuals' appreciation of both actual and potential hazards.

5.2 Key issues

In developing and implementing hazard perception and responding training and testing for novice riders in Victoria, several issues require due attention as these could impact on the measures' ultimate utility, including their reliability and validity. The following issues are each considered briefly here: modality, timing, duration, content, assessment of competence, and location. While considered separately below, as will become clear, these issues are not necessarily independent and need to be considered in unison when proposing and developing measures, and exploring their feasibility.

- *Modality:* The strengths and weaknesses of various training and testing modalities have already been considered (see Table 2). It is important to reiterate that the provision of training and/or testing through one modality only may not provide a sufficient coverage of skills. Thus, to be sufficiently comprehensive, it is recommended that training and testing programs in rider hazard perception and responding adopt a suite of modalities. Moreover, the choice of modality or suite of modalities may depend on the stage of skill development. For example, classroom-based, theoretical training may be more appropriate during early skill development where the emphasis is on knowledge acquisition.
- *Timing:* The timing of training delivery and testing is closely related to the stage of skill development and, as already noted, the use of certain modalities might be better suited to certain stages of skill development than others. For the most part, timing of training delivery and testing is an issue that, to date, has received little systematic attention in the research into hazard perception and responding. However, timing is of great importance. For example, the delivery of practical training or testing for competency of certain skills too early may be futile as the novice may not be ready developmentally and thus, easily overloaded. It is worthwhile noting that timing of training delivery was a key consideration in the development of the CBT program, DriveSmart. It is recommended that learners have accrued at least 40 to 50 hours of supervised on-road driving experience before attempting the program.
- *Duration:* This issue relates to the quantity of training and testing. How much training is required in order for sufficient skill transfer to occur? How long should the test be in order to ensure that sufficient competency has been demonstrated? The answers to these questions vary across case studies, and the issue is often reduced to one where the solution is determined on pragmatic grounds so as to make the measure acceptable to potential users. Training and testing sessions that are too long may induce fatigue and boredom and, under circumstances where training and testing are voluntary, may lead to low rates of uptake and completion. The ideal solution is to make training and testing sessions as long as they need to be in order to maximise their potential effectiveness. Dividing training over several sessions may be useful in this regard, and may offer the added advantage of encouraging novices to reflect on their preceding performance and consolidate the knowledge imparted in the previous session in preparation for the next session.

Table 2. Strengths and weaknesses of different modalities for rider hazard perception and responding training and testing

Modality	Use		Strengths	Weaknesses
	Training	Testing		
Written materials in hardcopy	✓	✗	Easy-to-use; Widely accessible*; Relatively inexpensive; Useful for independent study and/or can form syllabus for classroom-based instruction; Safe; Can be studied over several sittings and reviewed on multiple occasions.	Largely passive; Limited practice and performance feedback opportunities; Limited application beyond imparting knowledge.
Recorded real-world video	✓	✗	Easy-to-use; Widely accessible; Can be distributed on a range of media and/or through the internet; Can be used as a resource for classroom-based instruction or independent study; Provides the basis for one-on-one commentary training; Safe.	Unless used as part of one-on-one commentary training, largely passive, with limited practice and performance feedback opportunities.
Computer-based	✓	✓	Easy-to-use; Widely accessible; Can be distributed on a range of media and/or through the internet; Can incorporate a range of environments (e.g. digitised real video footage, virtual reality) and tasks/exercises, with performance feedback, to maximise learning opportunities; Some interactive opportunities; Safe; Collection of range of performance measures.	The technical requirement may not appeal to all potential users; Limited opportunity to seek assistance as queries arise; Constraints on available technology may limit the range of scenarios or events that can be studied/tested; Extent to which responding skills are addressed may vary.
Simulators	✓	✓	Safe, with opportunity to experience range of scenarios and hazardous events in a controlled and supervised environment; Interactive, with performance feedback from the simulator and/or instructor; Collection of range of performance measures; Enables training/testing of both hazard perception and responding skills.	Limited availability and accessibility; Relatively expensive; Constraints on available technology may limit the range of scenarios or events that can be studied/tested.
Training-range	✓	✓	Reasonably safe, with opportunity for expert instruction/supervision, practice and assessment in a controlled environment; Fully interactive; Enables training/testing of both hazard perception and responding skills.	Constraints on range of scenarios or events that can be studied/tested; Largely contrived scenarios.
On-road	✓	✓	Opportunity for expert instruction/supervision, practice and assessment under real-world conditions; Fully interactive; Enables training/testing of both hazard perception and responding skills.	Least safe (particularly if it involves commentary training) and least controlled option for training and testing.

* The assumption here is that written materials are available for download from a website or similar and available for collection from customer service providers and training providers at least.

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- *Content:* The quality of training and testing is also critical. This point concerns the range of scenarios and hazardous events that are covered as part of the training and testing. Due consideration needs to be given to the full repertoire of scenarios and hazardous events that pose the greatest risk to novice riders. Inadequate treatment of certain scenarios and events over others may not distinguish sufficiently in testing those novices who are at greatest risk of a crash due to errors in hazard perception and/or responding (and therefore, in need of additional training and practice in preparation for further testing) from those who are not.
 - *Assessment of competence:* This issue is closely related to duration and content of both training and testing. What performance criteria and what level of performance should be used to ascertain whether a user has satisfied the requirements of one training module before being permitted access to the next? Similarly, in the testing scenario, what performance criteria and what level of performance should be used to determine that the user has demonstrated sufficient competency? Premature acceleration through training modules as performance thresholds are set too low may not lead to effective training transfer. In testing, pass thresholds that are set too low may lead to riders being permitted to ride on fewer restrictions (and therefore, under conditions of higher-risk) before they are ready developmentally to do so. Further, to maximise training and test effectiveness and to ensure that both hazard perception and responding are adequately addressed, competence should be based, to the extent possible given the modality and other considerations, on a range of suitable performance measures.
 - *Location:* Where training and testing is conducted is firstly dependent on modality. Classroom-based, simulator, range-based and on-road training courses are best provided by qualified instructors/training providers with access to the appropriate facilities. The same also applies to testing that is conducted in a simulator, on a riding-range or on-road. Nonetheless, ensuring that such training courses and testing programs are available on weekdays and weekends and at a range of times makes them more accessible and attractive to users. Computer-based training courses and testing programs that can be completed at home offer users greater flexibility than courses and programs that must be completed at customer service centres, which typically have restricted hours of operation and for which access to facilities must be booked in advance. Nonetheless, completion of programs at customer service centres may minimise the likelihood of potential cheating in testing, and offer users access to staff who may be able to assist should technical problems arise.

A final point relates to the issue of evaluation. Evaluating a training course or test as part of its development is critical for maximising the measure's utility, including its reliability and validity. Ideally, a comprehensive evaluation of hazard perception and responding measures should consider both process and outcome aspects. Process evaluations can help to uncover important barriers to training and testing effectiveness for resolution prior to the measure's implementation. Appropriate process evaluation tools include focus groups, observation, and questionnaires. Outcome evaluations provide an indication of the training and testing's effectiveness – that is, an indication of the extent to which the training course and/or test does what it was designed to do. Ideally, outcome evaluations should be based on the analysis of objective performance data, which are collected on a simulator and also preferably, on-road. In the case of training, to assess skill retention, performance could be assessed at several time points post-training. Ultimately, the

effectiveness of a training or testing measure comes from relating performance on the measure against crash likelihood. Objective crash estimates may take some years to collect, and so self-reported information on crash experiences may provide a useful surrogate in the interim.

5.3 Preliminary recommendations

At the broadest level, there are two options for rider hazard perception and responding training and testing in Victoria. One option is to maintain the status quo, while the second option is to pursue the development and widespread implementation of rider-dedicated hazard perception and responding measures. The research presented here provides strong justification and clear support for the latter option. On this basis, the following preliminary, and deliberately broad, recommendations are offered. The intent is that, where appropriate given the aims of the current research, the recommendations be discussed, expanded, and fine-tuned as part of the expert workshop.

- **Recommendation 1:** Develop and implement rider-specific measures for the mandatory assessment of hazard perception and responding as part of licensing. Including,
 - *Recommendation 1.1:* Determine the optimal suite of testing modalities, as testing using one modality may not be sufficient to provide a comprehensive assessment of competence. Optimise the choice of testing modalities for the stage of skill development.
 - *Recommendation 1.2:* Determine the timing of testing and the potential to test for competency in hazard perception and responding on more than one occasion during the licensing process (e.g. to progress from learner to restricted licence, and also to progress from restricted to full licence).
- **Recommendation 2:** Further develop and promote rider-dedicated hazard perception and responding training as part of licensing. Including,
 - *Recommendation 2.1:* Design a comprehensive training program that offers both theoretical and practical training in hazard perception and responding, and that is endorsed across the State by key stakeholders (e.g. training providers).
 - *Recommendation 2.2:* Select the suite of modalities to be utilised for both theoretical training and practical training in order to optimise training effectiveness. Choose modalities that are appropriate for the purpose of the training and the stage of skill development.
- **Recommendation 3:** In the context of Recommendations 1 and 2 above, address the key issues and set a research agenda in order to address any outstanding key issues. Including,
 - *Recommendation 3.1:* Determine the range of hazards for training and testing.

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- *Recommendation 3.2:* Determine the key dependent variables for assessing competence.
 - *Recommendation 3.3:* Determine the appropriate allocation of time across theoretical and practical training modules.
 - *Recommendation 3.4:* Where simulators are to be used for training and/or testing, determine the appropriate level and form of fidelity given the intended use.
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- ***Recommendation 4:*** Develop and implement an evaluation plan to assess the proposed measures against process and outcome objectives.

Chapter 6 Expert workshop

A day-long workshop hosted by VicRoads and facilitated by MUARC was held on Thursday 18 November 2010 at the VicRoads offices in Kew. The report presenting Stage 1 activities served as pre-reading material. The primary objective of the workshop was to brainstorm options for hazard perception and responding training and testing, and to derive specific, practical recommendations for the development and implementation of training and testing measures for novice riders in Victoria.

A list of experts to invite to the workshop was prepared by the MUARC research team in consultation with VicRoads. Included in the list were individuals whose collective expertise covered the areas of novice rider safety, licensing, skill development, training systems design, and rider training and testing. Nominated experts were in turn invited by VicRoads to take part in the workshop.

The following experts participated in the workshop: Ms Samantha Cockfield (TAC); Mr Mark Collins (HART); Prof Narelle Haworth (CARRS-Q); and Mr Phil Wallace (LSA). Participants from VicRoads were: Ms Nicola Fotheringham, Ms Linda Ivett, and Mr Hammad Zaidi. Mr Chris Brennan joined the workshop briefly during the morning session to update the group on preliminary feedback following the recent public consultation of VicRoads' *Graduated licensing for motorcyclists discussion paper*. Workshop attendees from MUARC were Prof Tom Triggs, and Dr Eve Mitsopoulos-Rubens. Prof Triggs was the workshop Chair. Dr Mark Horswill (University of Queensland) was invited to the workshop, but was unable to attend. To supplement the workshop pre-reading material, Dr Horswill prepared a document summarizing the driver hazard perception training research being carried out currently at the University of Queensland.

As intended, much of the workshop discussion led directly to the specification of recommendations. Thus, key discussion points are presented in the context of the recommendations. The recommendations are detailed in Chapter 7.

Chapter 7 Recommendations

The overall objective of the current research was to provide specific, practical recommendations for the development and implementation of hazard perception and responding training and testing measures for novice motorcyclists in Victoria. The recommendations are presented below. For each measure, consideration is given to the modality of the proposed measure (e.g. computer-based), in addition to mechanism (e.g. compulsory), location (e.g. training provider), format (e.g. on-line), media (e.g. real-video), timing (e.g. Pre-Learner phase), duration (e.g. 10 minutes) and type (e.g. practical).

While it is recognised that training and testing have the potential to work “hand-in-hand” in order to maximise their effectiveness, for current purposes, recommendations that relate directly to training are presented separately from those that relate directly to testing. In each case, training and testing recommendations are organised according to phase of licensure. For current purposes, two phases are delineated: Pre-Learner and Learner/Pre-Licence. In general, the recommendations support a multi-modal approach to the training and testing of hazard perception and responding skills in novice motorcycle riders. The choice and range of modalities, from written materials to on-road, is intended to best support the skill development needs of new riders. Moreover, in general, it is felt that the potential key strengths of a given proposed approach outweigh the potential weaknesses. Although, a more formal, systematic analysis will need to be undertaken to explore this issue more definitively.

It is important to highlight that description of the recommendations and supporting material assumes some prior knowledge of current training and testing requirements, within the context of existing and proposed elements of the graduated licensing system for motorcyclists in Victoria.

Recommendation 1: Training, Pre-Learner

Recommendation 1.1. It is recommended that materials and exercises for training hazard perception comprehension be developed and made available on-line for completion during the Pre-Learner phase prior to attempting the formal assessment requirements for a rider Learner’s Permit.

- *Justification:*

Well-developed hazard perception skill is deemed critical for safe riding. Initial stages of skill development focus on increasing knowledge and developing mental models of what constitutes a hazard, and where and under what circumstances hazards are likely to occur. While many riders come to riding as experienced drivers, they may not yet have an understanding of the hazards that are specific to riding a motorcycle and therefore, that are most relevant to riders, particularly new riders. The primary purpose of the training is to raise and develop this awareness.

- *Recommended options:*

- *Modality:* Computer-based
- *Mechanism:* Voluntary
- *Location:* At home
- *Format:* On-line
- *Media:* Written and cartoon schematics
- *Timing:* Pre-Learner in the weeks leading up to attempting the formal training and testing requirements for a Learner's Permit
- *Duration:* Variable, determined by the trainee (approximately 1 to 2 hours)
- *Type:* Theoretical

- *Key strengths of proposed approach (and reasons for selection):*

The proposed approach is intended to satisfy the developmental and training needs of individuals who are preparing to become Learner riders. For convenience, the training can be completed at home, in one's own time, and at one's own pace. By utilizing simple cartoon schematics, the training is intended to provide, in principle, a relatively low-cost alternative to the use of real-video, without compromising face validity and possible effectiveness. The on-line nature of the training means that it can be updated as required (to incorporate new exercises, etc) by those administering the training.

- *Key weaknesses of proposed approach:*

Not all beginning riders will have easy access to a computer. Nonetheless, it is anticipated that the proportion to whom this applies will be relatively small, given that computers are available for public use in locations such as libraries. The voluntary nature of the training suggests that not all beginning riders will opt to complete it. However, the intention is that completion of the training be perceived as a necessary precursor to the comprehension test (see Recommendation 2.1), maximizing the likelihood of passing the test.

- *Assumptions underlying recommendation and proposed approach:*

The main assumption is that beginning riders will have access to a computer with on-line capabilities, and that on-line training is an acceptable approach to learning among this group. Alternatives may need to be considered if not – for example, having computer stations available at Customer Service Centres and/or training providers, and/or providing any non-dynamic materials and exercises in hardcopy format. Given the direct relationship between the Pre-Learner hazard comprehension training and testing, it is assumed that uptake of the training and motivation to complete it will be high. Further consideration will need to be given to the types and range of hazards to be addressed through the training, and the nature and extent of automated feedback to be provided.

Recommendation 1.2. It is recommended that a dedicated hazard perception and responding training component be developed for successful completion at the conclusion of the Pre-Learner phase immediately prior to attempting the formal assessment requirements for a rider Learner's Permit.

- *Justification:*

As for Recommendation 1.1.

- *Recommended options:*

- *Modality:* Classroom and some range-based
- *Mechanism:* Compulsory
- *Location:* At training provider
- *Format:* Off-line
- *Media:* Classroom modules will make use of dynamic real-world video and/or filmed simulator sequences with instructor commentary
- *Timing:* Pre-Learner, as an immediate precursor to attempting the formal test requirements for the Learner's Permit
- *Duration:* Approximately 1 day (may include completion of complementary testing requirements)
- *Type:* Theoretical and practical

- *Key strengths of proposed approach (and reasons for selection):*

The proposed approach is intended to meet the developmental and training needs of riders who are about to embark on solo riding for the first time, as prescribed under the regulations for the rider Learner's Permit. The majority of beginning riders already travel to training providers to undertake training in preparation for the Learner's Permit. Thus, it is not anticipated that the proposed approach will constitute an onerous request. The choice of modalities means that the beginning riders can be introduced to hazardous situations in dynamic circumstances, and given instruction and some practice in hazard anticipation and controlled responding in relatively benign conditions. Opportunities for self-evaluation and reflection can be created, and the presence of a skilled instructor will enable the presentation of more targeted and tailored feedback. Further, in principle, compulsory training helps to ensure greater consistency across training providers in the content and standard of the training that is delivered. Implicit in this argument is that training content and standard be monitored periodically.

- *Key weaknesses of proposed approach:*

There will be some impact on training providers, including those groups who govern training provision, with the degree and nature of the impact to be determined. The duration of the training may be perceived as problematic by those individuals for whom time to undertake training is limited. To the extent that it is possible, the intent is to incorporate the proposed hazard perception training into the time-frame (or slightly longer time-frame) adopted by existing Pre-Learner courses, without unduly sacrificing current skills training. As part of this process, consideration will need to be given to possible trade-offs in the time spent on hazard perception as opposed to current skills training. While it has the advantage of being controllable, there are inherent limitations in the extent to which certain scenarios can be adequately mimicked on a training range. For this reason, it is not intended that range-based training form a dominant or sole component of hazard perception and responding training. Also, with compulsory training comes potential concern about the overall cost of the training.

- *Assumptions underlying recommendation and proposed approach:*

The main assumption is that Pre-Learner training of the type that is currently delivered through training providers will be made compulsory (and therefore, more consistent across training providers) in the future as part of proposed reforms to the rider graduated licensing system in Victoria. The implication is that all new riders who wish to obtain a Learner's Permit will be required to complete successfully a standard, Pre-Learner training course that includes a core hazard perception component as proposed above.

Recommendation 2: Testing, Pre-Learner

Recommendation 2.1. It is recommended that a hazard perception comprehension test be developed for completion in the Pre-learner phase as part of the requirements to gain a rider Learner's Permit.

- *Justification:*

As for Recommendation 1.1. The primary purpose of the testing is to assess one's comprehension of the hazards that affect riders and, in the process, to raise, further develop, and reinforce knowledge of those hazards.

- *Recommended options:*

- *Modality:* Computer-based
- *Mechanism:* Compulsory
- *Location:* At training provider
- *Format:* Off-line

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- *Media:* Cartoon schematics, with multiple-choice response options
 - *Timing:* To obtain a Learner's Permit (to be undertaken in conjunction with existing knowledge test)
 - *Duration:* Up to 10 minutes
 - *Type:* Theoretical

- *Key strengths of proposed approach (and reasons for selection):*

The proposed approach is intended to constitute an easy-to-use and accessible option for those individuals who are seeking to obtain a rider Learner's Permit. A computer-based test also offers a more efficient and reliable option than written, paper-based tests. Applicants must already travel to a training provider to complete any Pre-Learner training and the existing test requirements for a rider Learner's Permit, and so completion of the test at the training provider presents the most logical and convenient option, and is more likely to guarantee that the test be completed under supervision. Currently, there exists no requirement for testees to attend a Customer Service Centre. Also, a requirement to complete the test at home would create the opportunity for potential breaches of test item security and for cheating. Administering the hazard comprehension test questions as part of a package with the existing rider knowledge test should help to streamline the test process, thus not appearing to add onerously to the total time allocated to testing. Also, by utilizing simple cartoon schematics, the testing is intended to provide, in principle, a relatively low-cost alternative to the use of real-video or computer-generated graphics, without compromising face validity and possible effectiveness.

- *Key weaknesses of proposed approach:*

There will be some impact on training providers, with the degree and nature of the impact to be determined. Individuals who are not "computer-literate" may encounter some difficulties in interacting with the test environment. As such, care will need to be taken in designing the test to ensure that test items are easy-to-understand, and that interaction with the computer in order to progress through the test and complete test items is intuitive, requiring minimal training. Nonetheless, the intention is that instructors will be on hand should problems or difficulties arise.

- *Assumptions underlying recommendation and proposed approach:*

The key assumption is that the existing knowledge test will be computerized to facilitate and streamline its completion immediately prior to administration of the proposed hazard perception comprehension test, with the two tests presented as a package. (The current knowledge test is in the form of a paper-and-pencil test.) As a consequence, there is the assumption that training providers will be supplied with the required hardware and software to administer the test package, and that training providers will be able to ensure secure access to the hardware and software. In addition to other requirements, the assumption is that individuals will need to pass both the knowledge test and the hazard comprehension test in

order to qualify for a rider Learner's Permit. Further consideration will need to be given to the types and range of hazards to be addressed through the testing. Also, due to the proposed formative nature of the test, consideration will need to be given to the nature and extent of any automated, corrective feedback to be provided.

Recommendation 3: Training, Learner/Pre-Licence

Recommendation 3.1. It is recommended that a computer-based hazard perception training program, such as "RideSmart", be offered for completion in the Learner/Pre-Licence phase prior to attempting the formal assessment requirements for a rider Restricted Licence.

- *Justification:*

Skill development in the intermediate to later stages involves applying and further developing the knowledge learnt previously, and developing strategies for hazard anticipation, decision-making, and response selection. The purpose of the proposed training is to augment and challenge these skills through the provision of developmentally appropriate practical exercises with feedback.

- *Recommended options:*

- *Modality:* Computer-based
- *Mechanism:* Voluntary
- *Location:* At home
- *Format:* On-line
- *Media:* Digitised real-world video
- *Timing:* Learner, in the weeks leading up to attempting the formal training and testing requirements for a Restricted Licence; Approximately 3 to 4 months into the Learner's Permit period
- *Duration:* Approximately 5 hours, over 4 to 6 weeks
- *Type:* Practical

- *Key strengths of proposed approach (and reasons for selection):*

The proposed approach is intended to meet the developmental and training needs of Learner riders who are preparing to progress to the next stage of licensure. Computer-based training presents an easy-to-use, cost-effective option for training hazard perception and other higher-order skills in a controlled environment. To some extent, "RideSmart" has already been developed for this purpose and so, as it stands, provides an existing and readily available resource for Learner riders. RideSmart is intended for completion in one's home, over a

number of sittings, and at one's own pace. This provides the opportunity for reflection and consolidation of the training imparted in the previous sitting in preparation for the next. The proposed on-line administration of the training program means that it can be readily updated as required (to incorporate new exercises, revised video sequences, etc) by those administering the training. It also provides the opportunity for greater control in the rate of administration of given program modules.

- *Key weaknesses of proposed approach:*

The anticipated weaknesses of this approach are similar to those outlined above under Recommendation 1.1. Specifically, not all beginning riders will have easy access to a computer. However, it is anticipated that the proportion to whom this applies will be relatively small, given that computers are available for public use in locations such as libraries. The voluntary nature of the training suggests that not all Learner riders will opt to complete it. The intention is that completion of the training be marketed as beneficial in one's preparation for the proposed hazard perception test (see Recommendation 4.1). However, there exist currently a number of potential additional barriers to completion, such as the length of time required to complete the program. Current efforts to revise the program (e.g. incorporation of new, more rider-relevant traffic scenarios) may help to address these barriers through improved face validity.

- *Assumptions underlying recommendation and proposed approach:*

A key assumption is that individuals will be motivated, not only to start the program, but to complete it. The perceived relevance of the training to performance on subsequent tests, as well as its face validity, and the provision of routine incentives, may offer some level of assistance in this regard. The ideal situation is to make a computer-based program, such as RideSmart, compulsory for all Learner riders. However, this rests on the assumption that RideSmart first undergoes some systematic evaluation and revision to ensure that it meets training objectives. Finally, it is assumed that prior to undertaking RideSmart, Learner riders will have already gained some practical on-road riding experience. In the case of DriveSmart, it is advised that Learner drivers have obtained at least 40 to 50 hours of driving experience before attempting the training. A similar rule-of-thumb could extend to RideSmart.

Recommendation 3.2. It is recommended that a dedicated hazard perception and responding training component be developed for successful completion at the conclusion of the Learner phase prior to attempting the formal assessment requirements for a rider Restricted Licence.

- *Justification:*

As for Recommendation 3.1.

- *Recommended options:*

- *Modality:* Simulator and/or on-road
- *Mechanism:* Compulsory
- *Location:* At training provider
- *Format:* Off-line
- *Media:* Simulator scenarios and/or real-world scenarios encountered on an opportunity basis as part of planned/supervised on-road rides
- *Timing:* To obtain a Restricted Licence
- *Duration:* Approximately half day (may include completion of complementary testing requirements)
- *Type:* Practical

- *Key strengths of proposed approach (and reasons for selection):*

The proposed approach is intended to meet the developmental and training needs of Learner riders who are preparing to progress to the next stage of licensure. The majority of Learner riders already travel to training providers to undertake training in preparation for the Restricted Licence. Thus, it is not anticipated that the proposed approach will constitute an onerous request. Simulators can expose trainees to a range of scenarios (including unpredictable events) in a controlled and risk-free environment. On-road training enables riders to experience, under supervision, riding under real-world conditions, providing the opportunity for interaction with real traffic and for travel at more realistic speeds (than is possible on a training range). Opportunities for self-evaluation and reflection can be created, and the presence of a skilled instructor will enable the presentation of more targeted and tailored feedback. Further, in principle, compulsory training helps to ensure greater consistency across training providers in the content and standard of the training that is delivered.

- *Key weaknesses of proposed approach:*

The duration of the training may be perceived as problematic by those individuals for whom time to undertake training is limited. To the extent that it is possible, the intent is to incorporate the proposed hazard perception training into the time-frame (or slightly longer time-frame) adopted by existing Pre-Licence courses, without unduly sacrificing current skills training. As part of this process, consideration will need to be given to possible trade-offs in the time spent on hazard perception as opposed to current skills training. Nonetheless, with compulsory training comes potential concern about the overall cost of the training. The main weaknesses of the proposed approach, however, are two-fold. The first relates to the lack of simulators across training providers, and the likelihood that a number of training providers will not have the resources to purchase a simulator. For these training providers, a greater emphasis and reliance will need to be placed on the on-road training component. The second

issue relates specifically to on-road training and that exposure to certain situations may only happen on an opportunity basis. While it can be argued that a skilled instructor will turn even the simplest of situations into opportunities for learning, the implication overall is that such training would not be entirely standard.

- *Assumptions underlying recommendation and proposed approach:*

The main assumption is that Pre-Licence training of the type that is currently delivered through training providers will be made compulsory (and therefore, more consistent across training providers) in the future as part of proposed reforms to the rider graduated licensing system in Victoria.. The implication is that all Learner riders who wish to obtain a Restricted Licence will be required to complete successfully a standard, Pre-Licence training course that includes a core hazard perception component as proposed above. Moreover, it is assumed that prior to undertaking the proposed training, Learner riders will have already gained some practical on-road riding experience. Finally, where simulators are to be used, consideration will need to be given to the sophistication (essentially, fidelity) of the simulator, and where both simulation and on-road training are to be used, the proportion of time allocated to each component.

Recommendation 4: Testing, Learner/Pre-Licence

Recommendation 4.1. It is recommended that a rider-focused hazard perception test be developed for completion in the Learner phase as part of the requirements to gain a rider Restricted Licence.

- *Justification:*

As for Recommendation 3.1. The primary purpose of the testing is to assess one's hazard perception and responding skill and, in the process, to further develop that skill.

- *Recommended options:*

- *Modality:* Computer-based
- *Mechanism:* Compulsory
- *Location:* At training provider
- *Format:* Off-line
- *Media:* Real-world video
- *Timing:* To obtain a Restricted Licence (to be completed in conjunction with the training proposed under Recommendation 3.2)
- *Duration:* Approximately 20 minutes

- *Type: Practical*
- *Key strengths of proposed approach (and reasons for selection):*

While a computer-based hazard perception test already exists in Victoria, this test is driver-centric. Much of the research evidence and expert opinion points to the need for a rider-dedicated hazard perception test as this should enable a more direct, focused and valid assessment of rider's perception of those hazards, which are of primary relevance to riders as opposed to drivers, than the current test. The computer-based approach has intuitive appeal as it allows for ease-of-administration of test items, including the scoring of responses. Also, the standard PC environment offers a more affordable option than a more sophisticated motorcycle simulator. Regarding "location", the same strengths and considerations apply as described above for Recommendation 2.1.

- *Key weaknesses of proposed approach:*

As for Recommendation 2.1. In addition, issues with face validity may arise. This would not be due to the choice of media (real-world video), but because the test environment would underemphasise the cognitive load that riders experience when riding in the on-road environment. A potential option is to ask testees to undertake an additional task (e.g. tracking task) in conjunction with the hazard perception task. The purpose of this additional task is to recreate a dual-task situation, thus mimicking to a greater extent the demands of the riding task.

- *Assumptions underlying recommendation and proposed approach:*

A main assumption is that training providers will be supplied with the required hardware and software to administer and score the test, and that training providers will be able to ensure secure access to the hardware and software. In principle, the same hardware used for the test proposed under Recommendation 2.1 could also be used for the test proposed as part of this recommendation. A further assumption is that individuals will have completed some practice exercises and have familiarised themselves with the test format prior to attempting the test at the training provider. The intention here is to ensure that test time is kept to a minimum. In developing the test, consideration will need to be given to the scope of the test – that is, whether it be restricted to assessing perception skills or both perception and responding skills. Given their importance for riders, ideally, both perception and responding skills would need to be covered, recognizing that a responding component will add a layer of complexity to the test and may be more resource intensive to develop and implement in practice than a test which focuses on perception alone. Indeed, in general terms, the scope of the test represents an important consideration as the ultimate choice will have implications for the type of task to be performed, as well as response options (e.g. simple v choice reaction time¹), and scoring.

¹ Simple reaction time is the time interval between presentation of a stimulus and detection of a response. No differentiation is made in the type of response. Choice reaction time is a measure of processing speed when the subject has to choose between one of several responses following presentation of a stimulus.

Also, due to the proposed formative nature of the test, consideration will need to be given to the nature and extent of any automated, corrective feedback to be provided.

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Appendix A Testing overview

Source	Target group	Timing	Look and feel	Duration
Victoria	Novice drivers, min. age 17 yrs 11 mo	End L period (min. 1 yr) to progress to P1	PC-based; Completed at Customer-Service Centre; Stimuli: dynamic driving scenes (30 s) utilising real-video footage	45 mins (includes 28 test items)
NSW	Novice riders (no driver's licence) Novice drivers, with P1 licence for at least 1 yr	End L period (min. 3 mo) to progress to P End P1 period (1 yr) to progress to P2	PC-based, with touch-sensitive monitor; Completed at Customer-Service Centre; Stimuli: dynamic driving scenes utilising real-video footage	15 test items (overall duration?)
Queensland	Novice drivers, with P1 licence for at least 10.5 months	Towards end P1 period to progress to P2 after 1 yr on P1	PC-based, delivered on-line; Stimuli: dynamic driving scenes utilising real-video footage	Average of 13-15 mins to complete test to component; 45 mins overall (includes practice, instructions, etc)
South Australia	Novice drivers, with P1 licence for at least 1 yr	End P1 period (1 yr) to progress to P2	PC-based, with touch-sensitive monitor; Completed at Customer-Service Centre; Stimuli: dynamic driving scenes utilising real-video footage	15 test items (overall duration?)
Western Australia	Novice drivers, 6 mo since passing the practical driving assessment (required to progress from L1 to L2) & 25 hrs logged supervised driving practice	End L2 period (6 mo) to progress to P1 (Note: L1 period also 6 mo)	PC-based; Completed at Customer Service Centre; Stimuli: dynamic driving scenes utilising real-video footage	45 mins (includes 28 test items)
United Kingdom	Novice drivers and riders	To progress from learner/provisional licence status (min. age 17 yrs) to full licence status. (Must pass the theory test in order to apply for the practical test. A pass on both tests is required to achieve full licence status.)	PC-based; Completed at Customer Service Centre; Stimuli: dynamic driving scenes utilising real-video footage	14 clips (administered after 57 min multiple-choice test, which with the HPT makes up the theory test)
New Zealand	Novice drivers and riders, with restricted licence for at least 18 mo (<25 yrs of age)	To progress from restricted licence to full licence	On-road practical test	1 hour (divided into three parts)