MONASH University
Accident Research Centre

HAZARD PERCEPTION AND RESPONDING BY MOTORCYCLISTS

SUMMARY OF BACKGROUND, LITERATURE REVIEW AND TRAINING METHODS

by

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Hazard perception and responding by motorcyclists – Summary of background, literature review and training methods

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Abstract:

This project is the first stage of a larger program of research into hazard perception training for motorcyclists. Future stages of the project will investigate what type of environment can be used to teach hazard perception and responding, for example a simulator environment or combination of off-road and simulator training.

This document summarises two reports that were prepared as part of this project. The first report (Haworth, Mulvihill & Symmons, 2005) reviews the research that has been conducted into hazard perception and responding, assesses what can be learnt from motorcycle crash data and describes current motorcycle simulators. The second report (Wallace, Haworth & Regan, 2005) examines the best methods for training riders in hazard perception and responding and examines the potential usefulness of simulation in motorcycle rider training.

Key Words:
Motorcycle, motorcyclist training, hazard perception, simulation, rider testing

Disclaimer

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Preface

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INTRODUCTION

This project is the first stage of a program of research into hazard perception training for motorcycle riders. Future stages of the program will investigate what type of learning environment can be used to teach hazard perception and responding, for example a motorcycle simulator or a combination of off-road and simulator training.

This document summarises two reports that were prepared as part of this project. The first report (Haworth, Mulvihill & Symmons, 2005) reviews the research that has been conducted into hazard perception and responding, assesses what can be learnt from motorcycle crash data and describes current motorcycle simulators. The second report (Wallace, Haworth & Regan, 2005) examines the best methods for training riders in hazard perception and responding skills.

DEFINITIONS AND THEORIES

We have defined a *hazard* as "any permanent or transitory, stationary or moving object in the road environment that has the potential to increase the risk of a crash. Hazards exclude characteristics of the rider or the vehicle, which are classed as modifying factors." *Hazard perception* is defined as "the process whereby a road user notices the presence of a hazard". As Figure 1 shows, hazard perception is one of the stages in responding to the presence of actual or potential hazards.

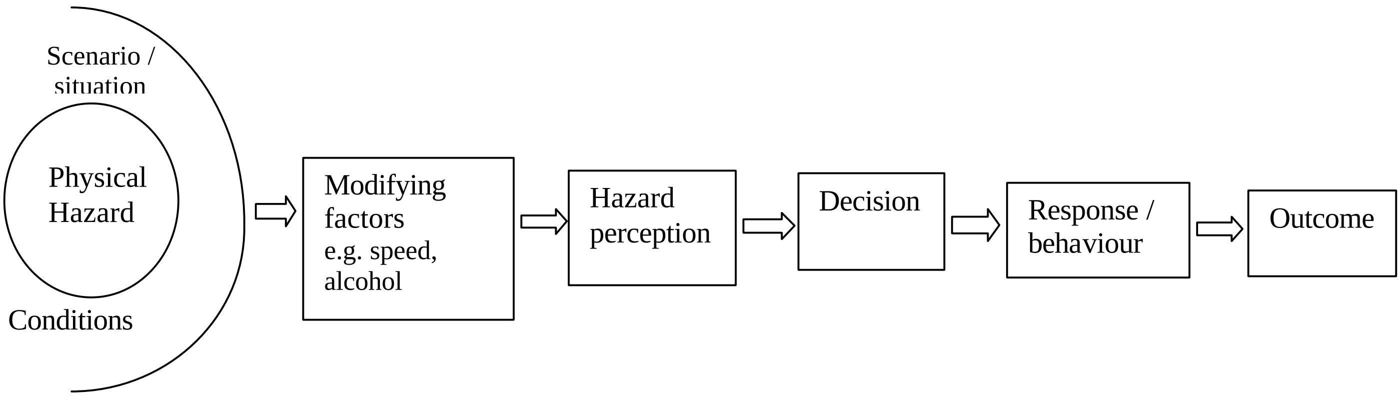

Figure 1 A model of the role of hazard perception in the chain of processes linking the existence of physical hazards and outcomes.

The concept of *defensive riding*, as described by riders, places more emphasis on the modifying factors and less on the perception of hazards.

A number of models of hazard perception have been developed for car driving. Probably the most useful model for motorcycling is the four-component model of responding to risk (Grayson, Maycock, Groeger, Hammond & Field, 2003) because it deals with both perceiving and responding to hazards.

HAZARDS AND MOTORCYCLE RIDING

Hazards can be classified into those that are road based and those that arise from the behaviour of other road users. Motorcyclists are subject to the hazards faced by car drivers but are also at risk from situations not hazardous for car drivers, such as gaps in bridge decking wide enough to catch a motorcycle wheel but too narrow to affect a car tyre. The reactions required from riders also need to be different, as motorcycles handle differently to cars. The extent of potential harm associated with any given hazard is commonly greater for motorcyclists, given their comparative lack of protection.

The hazards associated with the behaviour of other road users can be thought of as arising from failures of hazard perception by other road users. The extent to which this can and should be addressed by improving the hazard perception and responding skills of motorcycle riders, compared with the corresponding skills of car drivers is a matter for debate.

Table 1 summarises the key issues relating to hazards and motorcycle riding that were identified and their implications for rider training.

Table 1 Key issues and their implications for rider training.

Key Issue	Implication for Motorcycle Rider Training
Motorcycle riders must deal with the same hazards as car drivers, as well as the additional hazards of failure by car drivers to give way and road surface hazards.	Approaches to hazard perception training that are known to be effective for car drivers may also be effective for motorcycle riders. Emphasis should be placed on anticipation of threats posed by car drivers.
The potential that the other road user may not have seen the motorcycle means that hazard perception and responding is more crucial for motorcyclists than car drivers.	As above.
The potential severity of crashes, regardless of the type of hazard, is greater for motorcyclists.	The risk of serious injury may make the approach of making riders aware of their own limitations (Moderating Illusory Beliefs) more effective.
The vehicle control skills involved in riding a motorcycle are more complex than driving a car and failure to correctly implement a response to a hazard may in itself be dangerous.	Vehicle control skills may be a more important aspect of hazard response for motorcycle riders than for car drivers.
Attention sharing between the vehicle control skills and hazard perception and responding may be problematic for novice riders.	Training in attention sharing (Attentional Control Training) may be an important aspect of hazard perception and responding training for novice riders.

HAZARDS AND HAZARDOUS SITUATIONS IN THE CRASH DATA

Motorcycle crashes reported to the Police provide limited information about the role of hazards and hazard perception and responding. Many crashes involving only the rider, in which road surface hazards may have played a role, are not reported to Police. For those motorcycle crashes that are reported to Police, there is little mention of hazards related to the road surface and hazards related to the behaviour of other road users are not always easy to identify. Despite these difficulties, the crash data provides some useful information about the riding environments (e.g. intersections, speed zones, weather conditions) in which (at least reported) crashes occurred. Knowing these riding environments and situations helps to identify what should be included in training in hazard perception and responding.

Overall, about half of the riders involved in reported casualty crashes in Victoria in 1997-2001 were involved in collisions with vehicles. In the majority of these crashes, it is likely that the other road user failed to give right of way to the rider.

The crash patterns differ according to the age and licence status of riders. Older fully-licensed riders had more crashes in higher speed zones outside of the metropolitan area (and perhaps in higher speed zones inside the metropolitan area), which may reflect their patterns of riding. Even within a given riding environment, age and licence status appear to affect the crash pattern. Older new riders (learner and probationary riders) were less likely to have collisions with vehicles and were more likely to have single vehicle crashes than other riders in low speed riding environments and in higher speed areas outside of the metropolitan area. This needs further investigation. It may be that older new riders are relatively better at perceiving and responding to hazards arising from the behaviour of other road users or relatively poorer at dealing with road-based hazards than other riders.

A set of high-risk motorcycle riding contexts was developed from the crash data analyses and broken down into scenarios to be incorporated in training. These are summarised in Table 2.

HAZARD PERCEPTION RESEARCH

There has been very little research into investigated hazard perception and responding by motorcycle riders. For car drivers, research has shown that experienced drivers are quicker to detect hazards and that slower responses to hazards are associated with higher self-reported crash involvement – but this has not been tested for motorcycle riders.

The small number of studies of hazard perception and responding by motorcycle riders has found that:

- Riders are more likely to nominate road-based hazards than car drivers
- In a simulator, experienced riders react faster to hazards when acting as car drivers than when acting as riders
- Responding is a relatively more crucial part of the process for riders than for drivers
- Most novice riders are experienced car drivers and are older than novice car drivers
- Riders and car drivers differ in where they look. One study found that riders spend more time looking at the road and less time looking further away but another study disagrees.

Table 2 High-Risk Motorcycle Riding Contexts.

Process	Segment	Task
Riding in low speed zones	Un-signalised intersections	Approach Cross Turn
	Roundabouts	Approach Cross Turn
	Residential streets	Transit Join
	Pedestrians	Approach
City riding in high speed zones	Signalised intersections	Approach Cross Turn
	Un-signalised intersections	Approach Cross Turn
	Arterial roads	Overtaking
Country riding in high speed zones	Un-signalised intersections	Approach Cross Turn
	Single lane roads	Transit Overtaking
	Multi-lane roads	Transit Join
	Animals	Approach Pass
	Curves	Approach Transit Exit

HAZARD PERCEPTION TRAINING AND TESTING

Improving hazard perception skills can potentially lower the crash risk for all road users. However, teaching how to respond appropriately may be more critical for riders than for drivers because failures in responding may result in a failure to avoid the initial hazard or a different type of crash. If hazard perception and appropriate responding skills are necessary for safe riding, then an important question is whether their development can be accelerated by training. While research has shown that hazard perception training in novice drivers leads to improved performance on hazard perception tests, it is not yet known whether these drivers go on to be safer drivers and have fewer crashes.

Most approaches to hazard perception training for car drivers require only perception of the hazard and responding by pressing a button. They do not train improved responding to hazards, which is of greater importance to riders than drivers.

Given the reported links between crash involvement and poor hazard perception ability, some jurisdictions have developed tests to measure hazard perception skills among novice drivers at the probationary stage of licensing. Having to pass a test of hazard perception in order to obtain a licence helps to ensure that training in hazard perception occurs on a voluntary basis. However, most of the available tests do not measure whether the correct response is chosen or implemented – the focus is on the perception of the hazard only. In addition, the hazard perception tests may not give sufficient emphasis to hazards specific to riding, particularly road surface hazards. This may limit the extent to which such tests are able to predict the crash risk for riders.

No rider-specific hazard perception test has been developed or introduced anywhere in the world. At present, it appears that there are no plans to introduce a separate version of the test designed specifically for riders in any jurisdiction.

In the United Kingdom, candidates for a motorcycle licence are required to pass the car Hazard Perception Test (HPT), but this is not the case in Victoria, Western Australia and New South Wales. Most of the Victorian applicants for a motorcycle licence are not required to sit the car Hazard Perception Test because they already hold a car licence and it is assumed that they would have passed the Test (those who obtained their car licence after 1996) or would have developed hazard perception skills from years of driving cars. One study suggests riders are disadvantaged by the current UK licensing system that requires learners applying for their motorcycle licence to pass the HPT designed for car drivers. The authors recommend that a separate HPT for riders with associated training should be developed and introduced into licensing systems.

A FRAMEWORK FOR LEARNING HAZARD PERCEPTION AND RESPONDING SKILLS

In this project, the model of incremental transfer learning is used as a framework for learning hazard perception and responding skills. In this model, learners (not just holders of motorcycle Learner Permits, who we refer to as LEARNERS) transfer the skills that they have acquired in relatively simple environments to more complex environments. This learning model was the basis for DriveSmart, the training product developed by MUARC for the TAC for novice car drivers.

All methods of training are simulations of the real world. They differ in terms of how much they look and feel like the realworld task (physical fidelity) and in terms of how much they share the same functions and responses as the realworld task (functional fidelity). For example, a PC-based training program has less physical fidelity than a set of on-road training exercises for teaching effective braking.

It is assumed that skills are learned in stages, with improving performance as the learner moves from *knowledgeable*, to *prepared*, to *trained*, to *skilled*, to *expert*. Which method of training is best depends on the stage in skill learning. There is generally less need for physical resemblance (physical fidelity) or functional similarity (functional fidelity) in the early stages of learning than in later stages. However, when the expert stage is reached, the wealth of experience means that the need for physical fidelity is reduced.

Table 3 classifies rider training methods in terms of their levels of physical and functional fidelity. Those methods listed toward the lower-right corner of the table would typically be employed early in training, while those listed toward the upper-left corner would be employed in later stages of training. Methods in the upper-right corner would typically be used for skills that have strong cognitive (thinking and decision making) aspects, while the lower-left corner would be used for skills that have strong psychomotor (perceiving and responding) aspects.

Table 3 The levels of fidelity of motorcycle rider training methods.

		Physical Fidelity		
		High	Moderate	Low
Functional Fidelity	High	On Road	High-End Motorcycle Training Simulator	High-End Desktop PC Simulator
	Moderate	Training Range	Low-End Motorcycle Training Simulator	Low-End Desktop PC Simulator
	Low	Static Motorcycle	Arcade Motorcycle Simulator	Written Materials, Multimedia, Classroom

ASSESSMENT OF TRAINING METHODS

The following general categories of training methods were assessed in terms of the extent to which they could provide the required outcomes in a cost-effective manner:

- Training Range Rider Training,
- On Road Rider Training,
- Training Range Licence Testing,
- On Road Licence Testing,
- Motorcycle Simulators,
- PC-Based Part-Task Training,
- PC-Based Interactive Recorded Media,
- Recorded Video, and
- Written Materials.

While more research is needed regarding hazard perception and responding by motorcycle riders, specific deficiencies in current training methods were identified and potential remedies suggested. In particular, there is potential to improve existing Training Range rider training through provision of written materials. PC-based part-task training appears to offer a cost-effective means of addressing hazard perception and responding training in the near term. PC-based part-task training could also be used to develop hazard perception tests for the Learner and Licence Tests. This would encourage voluntary use of PC-based part-task training.

MOTORCYCLE SIMULATORS

Motorcycle simulators allow a rider to experience a wide range of hazards in a safe, and instructor-supervised environment. In addition to the circumstances that can be presented, simulators provide instructors with access to detailed information about student performance that can assist with the diagnosis of rider errors.

Only in Japan have simulators been used widely in motorcycle rider training. In the Japanese licensing system, learning to drive or learning to ride must occur off-road and training sessions with simulators are a compulsory part of training for a motorcycle licence. However, very little description of these programs and evaluations is available in English.

Riding simulators have been developed by the Honda Motor Company, by Kawasaki (a head mounted display unit) and by some European companies. In Britain, TRL Limited may possibly develop a motorcycle simulator in the future. The Honda simulator appears to be the most relevant to hazard perception and responding, although little information was available regarding the Kawasaki simulator. A description and assessment of the first generation Honda driving simulator located in Melbourne is provided as an appendix to the second report.

The research suggests that simulators should be used as part of a comprehensive rider education system that includes classroom training and skills practice using real vehicles, with simulators being used to train riders in situations that are too dangerous to practice using a real vehicle.

Currently and in the near future, simulator technology does not allow perfect replication of the motions and other stimuli present in realworld riding. Consequently, simulation must be viewed as no more than an activity leading in to, and augmenting, instruction on an actual motorcycle. Furthermore, the cost of sufficient access to simulators may prevent this approach from being applied to the general motorcycle rider LEARNER population. However, simulators may be cost-effective for training particular groups, such as individuals with high accident rates or professional riders. In the short-term, simulators may provide a useful tool for conducting research into hazard perception and responding by riders.

RECOMMENDATIONS

The following recommendations are made:

1. Research should be undertaken to investigate whether experienced riders are faster at perceiving hazards than novice riders and whether this depends on the type of hazard (vehicle-based or road-based) and the level of car driving experience of the rider.

2. The results of the research outlined in 1. should be used to determine the relative emphasis given in training to the two types of hazards and who the training should target (novice car and motorcycle operators, novice motorcycle riders who are experienced car drivers etc.).

3. Hazard perception training products (or a hazard perception test) for motorcycle riders cannot be developed until more is known about what affects hazard

perception, how this varies among the different classes of hazards, and the extent to which hazard perception can be trained.

4. Research should be undertaken to resolve whether training should focus on addressing hazard perception or responding or the modifying factors. It may be that addressing the modifying factors could be more useful than improving hazard perception or responding.

5. Any hazard perception training that is developed should fit the needs of the Victorian riders. Different approaches may be needed for younger and older novices. There is a need to assess for which categories of motorcycle riders – younger, older, novice, experienced, returning – hazard perception and responding needs to be improved and how this could be done.

6. The approach of providing strategies to support long-term skill development is sound and should be a cornerstone of any future program. The current initiative to develop the publication 'Bike Right' is strongly supported.

7. PC-based part-task training is considered to be a cost-effect method to provide structured experience of a comprehensive range of hazardous contexts. This type of training is likely to be useful for LEARNERS.

8. PC-based part-task training could also be used to develop hazard perception tests for the Learner and Licence Tests. This would encourage voluntary use of PC-based part-task training.

9. A detailed description of the concept for Victorian motorcycle rider training should be documented. This concept should explain the training process and underpinning theories of learning and instruction. The concept should extend beyond acquisition of a licence and consider how ongoing learning can be facilitated.

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