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This is the author version of article published as:

Haworth, Narelle and Mulvihill, Christine (2006) A comparison of hazard perception and responding in car drivers and motorcyclists . In *Proceedings 2006 International Motorcycle Safety Conference: The Human Element*, Long Beach, California.

A comparison of hazard perception and responding in car drivers and motorcyclists

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9 January 2006

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This paper is based on the findings of the first stage of a project to investigate hazard perception training for motorcyclists that was funded from the Transport Accident Commission Motorcycle Safety Levy and managed by VicRoads.

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ABSTRACT

Poor hazard perception skills have been shown to contribute to novice driver crash involvement. Yet driving and riding differ in terms of hazards, responses and consequences and many novice motorcyclists are experienced drivers. Therefore the extent to which the findings of research into car driver hazard perception and responding are relevant to motorcyclists may be limited.

This paper presents results from the first stage of a program of research to develop hazard perception training for motorcyclists. The research began by examining the different theoretical frameworks that have been applied to hazard perception by car drivers. The four-component model of responding to risk (Grayson, Maycock, Groeger, Hammond & Field, 2003) was considered to be the most useful because it includes a response implementation phase, which appears to be more important in motorcycling than in car driving.

Analyses of motorcycle crash data from Victoria, Australia were undertaken in an attempt to identify those hazards and situations that pose a crash risk for motorcyclists of different levels of experience. However, road-based hazards were rarely recorded and the differences in crash situations appeared to largely reflect patterns of riding, rather than intrinsic risk.

The literature review identified very little research into 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.

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 accidents. Training in 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.

Most available hazard perception tests do not measure whether the correct response is chosen or implemented – the focus is on the detection of the hazard only. In addition, the 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. The methods needed to examine responding by riders may require a higher level of physical fidelity than those required for drivers because riding requires more complex vehicle control skills than driving.

These issues question the relevance of the results of car driver hazard perception research for novice motorcyclists and have led to our current research to assess the fundamental differences in hazard perception and responding between drivers and riders and between experienced and inexperienced riders.

INTRODUCTION

The two general approaches to improving the safety of road users are to prevent crashes and to reduce the severity of injury in the event of a crash. Crash prevention is relatively more important for vulnerable road users such as pedestrians, bicyclists and motorcyclists who are not protected by a vehicle body and related vehicle safety features. For bicyclists and motorcyclists, the ability to perceive and respond to hazards posed by other vehicles and by the road surface is crucially important.

Motorcycle riders are subject to specific hazards in addition to those that they have in common with car drivers. The rider's evaluation of level of risk also needs to take account of the different performance characteristics of a motorcycle compared with a car and the lower levels of injury protection afforded by the motorcycle.

This paper summarises the results of the first stage of a program of research to develop hazard perception and response training for motorcyclists. Based on a literature review and an analysis of motorcycle crash data, the paper examines differences in the age and car driving experience profiles of novice car drivers and motorcyclists in the state of Victoria, Australia and differences in their hazard perception and responding skills and requirements. It examines whether findings regarding hazard perception in car drivers are applicable to motorcycle hazard perception research and whether the content and delivery of training and testing that has been developed for car drivers is necessarily appropriate for motorcycle riders. An overview of how these issues are being addressed in Stage 2 of a program of research is presented and the extent to which the current research can be applied to motorcycle hazard perception research in other jurisdictions is considered in brief.

DEFINITIONS AND THEORIES

The term "hazard perception" is widely used, both in the scientific literature and by those interested in improving driver and rider safety. However, different people use the term to refer to different concepts and this can lead to misunderstanding and confusion (as noted by Evans and Macdonald, 2002). In addition, terms such as hazard and risk are often used interchangeably and definitions of hazards vary.

For the purposes of this research, the following definition was developed by the authors:

> *"A hazard is 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."*

This definition focuses on the hazard as an object whose presence could increase crash risk.

Modifying factors

Modifying factors are those characteristics of the rider or the motorcycle that modify the level of risk of a hazard. They can be long-term characteristics of the individual such as rider experience and (real or perceived) rider skill in executing responses or more transitory characteristics such as travel speed, type of protective clothing worn and mechanical condition of the motorcycle. Many of the transitory modifying factors may be affected by the longer-term modifying factors (e.g. travel speed may be higher in riders who perceive themselves as more skilled). The same object could be considered as a hazard in some situations but as a modifying factor in other situations (e.g., a wet road).

Hazard perception

Hazard perception was defined by Crick and McKenna (1992) as the ability to identify potentially dangerous traffic situations. Evans and Macdonald (2002) define hazard perception as "the process whereby a road user notices the presence of a hazard" (p.93). This definition fits well with the definition of a hazard that the authors have developed.

An outcome of the hazard perception and responding process might be to change the levels of the modifying variables – the response might be to slow down, which then changes the modifying variable of speed. Changes to the modifying variables might occur over a longer timeframe, and this may be what happens in gaining experience and learning to ride more safely.

Theoretical frameworks

Several different theoretical frameworks have been applied to hazard perception by car drivers including recognition-primed decision making (Klein, 1993), situational awareness theory (Endsley, 1995) and an evolutionary framework (Harrison, 2002).

The recent four component model of responding to risk (Grayson et al., 2003, see Figure 1) may be the most useful because it includes a response implementation phase, which appears to be more important in motorcycling than in car driving (Haworth, Symmons & Kowadlo, 2000). The model has four components:

- Hazard Detection – being aware that a hazard may be present
- Threat Appraisal – evaluating whether the hazard is sufficiently important to merit a response
- Action Selection – having to select a response from one's repertoire of skills
- Implementation – performing the necessary actions involved in the response that has been selected.

The four-component model focuses on the effects of stable personality traits, rather than states of the individual (e.g. sobriety). It is likely that modifying factors such as alcohol would affect several components of the model, including threat appraisal and implementation (e.g. by lengthening reaction time). However, the model does not specifically deal with transient modifying factors that influence the potential severity of the outcome such as speed.

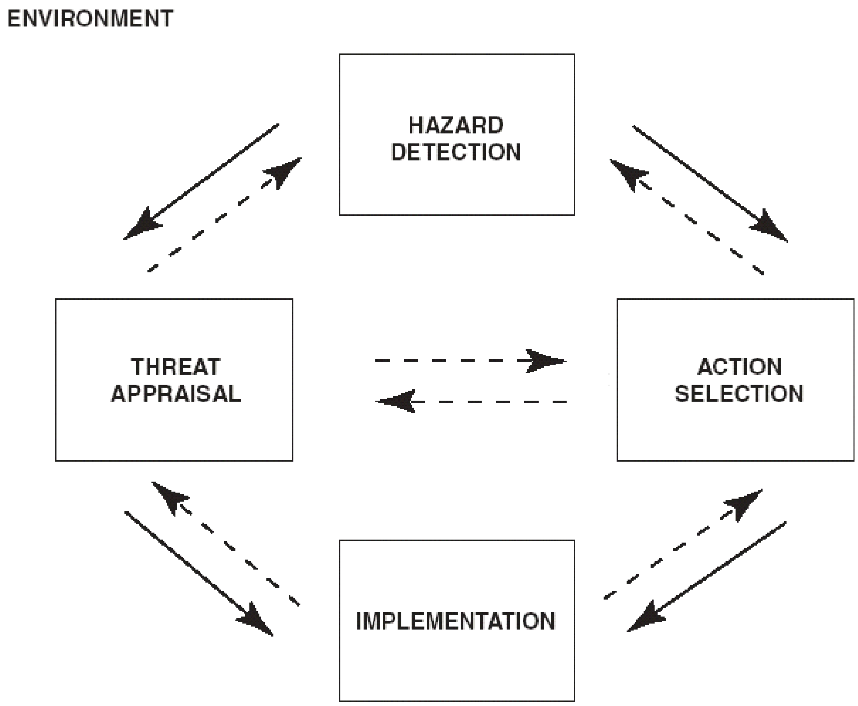

Figure 1. Processes involved in responding to risk (from Grayson et al., 2003). The bold arrows represent hypothetical forward links. The dashed arrows represent hypothetical feedback links.

DIFFERENCES BETWEEN NOVICE RIDERS AND DRIVERS

Much of the research in hazard perception and hazard perception training has focused on young novice car drivers. This group is generally both young and inexperienced. The research has demonstrated that their hazard perception skills are poorer than older, more experienced drivers. It has also shown that hazard perception training can improve their performance on hazard perception tests to a level similar to older, more experienced drivers. This type of research has not been conducted with motorcyclists.

It is important to consider the extent to which the findings of research into hazard perception and responding conducted with car drivers are relevant to motorcyclists. Novice motorcyclists differ to novice car drivers in terms of their age and car driving experience profiles and in terms of the additional and different types of hazards they encounter and the different vehicle control skills required for safe riding (see Haworth et al., 2000).

The extent to which the findings from car driver hazard perception research are applicable to motorcyclists may be limited because many novice motorcyclists are not young and many have more car driving experience than motorcycling experience.

The car-driving experience of novice riders

In terms of car driving experience, the main groups of applicants for a motorcycle permit or licence are

- Young non-drivers
- Young novice drivers
- Older, fully-licensed drivers.

In many Australian States, the number of novice riders who are young non-drivers (and thus lack car-driving experience) is very small. This is particularly the case in Victoria where applicants for a motorcycle learner permit must be a minimum of 18 years of age, while the minimum age for a car learner permit is 16 years of age. In 1995/96 to 1998/99, less than 3% of applicants for a motorcycle learner permit did not have a car driver learner permit and only 3% of applicants for a motorcycle licence did not have a car driver licence.

Most newly licensed motorcyclists have car licences. In 1998, 84% of riders obtaining a motorcycle licence in Victoria had a full car licence. This means that they had at least three years solo driving experience in addition to up to two years driving with a supervisor.

There is little in the hazard perception literature that addresses the issue of the extent to which experience as a car driver is expected to improve hazard perception and responding skills as a motorcycle rider. This is important, given that relatively few novice motorcyclists do not have experience as a car driver.

The extent of motorcycle riding experience

For car drivers, there is a reasonably reliable relationship between how long a licence has been held and the level of experience gained (in terms of distance driven). The relationship is not as clear for motorcyclists. Many riders have held a licence for an extended period but have little riding experience. For many who currently hold a licence, their riding experience occurred many years ago. In this way, some riders may no longer be novices in terms of the length of time they have been licensed, but still be inexperienced in that they have not accumulated many hours or kilometres of riding. Thus, it is possible that the need for improved hazard perception and responding skills is not limited to riders entering the licence process but may apply to many fully licensed riders. The groups of riders who may need improvement in their hazard perception and responding skills include:

- Older, fully-licensed drivers who hold motorcycle licences but are returning to motorcycling after a long break (returning riders)

- Older, fully-licensed drivers who hold motorcycle licences and have not ridden enough to gain sufficient experience and thus hazard perception and responding skills

Survey data suggests that returning riders comprise between 17% (Haworth & Mulvihill, 2005) and 27% (Haworth, Mulvihill & Symmons, 2002) of older riders. Haworth and Mulvihill (2005) found that about three-quarters of Australian riders aged over 25 rode less than 100 kilometres per week and thus had relatively little recent riding experience.

Given that the number of older motorcyclists killed or injured in crashes has increased in the last decade in many developed countries including the United States (Stutts, Foss & Svoboda, 2004), Great Britain (Sexton, Broughton, Elliot & Maycock, 2004) and Australia (Australian Transport Safety Bureau, 2002, 2005), an investigation of the hazard perception and responding skills of older riders is warranted.

Unlike novice car drivers, novice motorcyclists are a heterogeneous group in terms of their age profiles and their experience in riding and driving. Thus, 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.

HAZARDS FOR MOTORCYCLE RIDERS

Motorcyclists are subject to the hazards faced by car drivers but, because motorcycles have only two wheels, they are more susceptible to difficulties and hazards created by the design, construction, maintenance and surface condition of roads (ROSPA, 2001). For example, motorcyclists are at risk from situations 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.

Road based hazards

Road based hazards can be categorised as permanent characteristics of the road surface (e.g.roughness, being an unsealed or gravel road), temporary characteristics of the road surface (e.g., potholes, surface irregularities), visual obstructions (e.g., stationary vehicles, vegetation), and characteristics of the road alignment (e.g., horizontal and vertical curves).

An early study of motorcycle accidents in Los Angeles (Hurt, Oullet & Thom, 1981), concluded that less than 5% of crashes were caused primarily by roadway defects or adverse weather conditions. However, the road surface was found to have contributed to the occurrence of the crash in 15% of inspected sites examined by Haworth, Smith, Brumen and Pronk (1997). A recent survey by the NSW Motorcycle Council (de Rome, Stanford & Wood, 2002) showed that 67% of the single vehicle crashes were considered by riders to be associated with loss of traction due to road surface conditions (although their sampling may not have been representative).

In their survey of older riders aged over 25 in Australia, Haworth and Mulvihill (2005) found that 21% of riders in crashes nominated slippery surface and 18% nominated loose gravel as contributing to their crashes. Younger, novice riders were more likely to report road surface factors as contributing to their crash than were older, more experienced riders. While most crashes were reported to occur on roads with a clean surface (66%), 22% of crashed riders stated that their crash occurred on roads with loose material and 11% reported oily surfaces.

Ouellet (1982) concluded that obstruction of the pre-crash line of sight between the motorcycle and the vehicles with which it collides is perhaps the most substantial environmental contribution to crash causation. It was found that one third of motorcycle crashes involve obstruction of the motorcyclist's and/or car driver's view of each other in the moments just prior to the collision.

While road based hazards can, in some cases, cause loss of control of the motorcycle, their role is more often contributory when the motorcycle is performing a complex manoeuvre such as turning or braking.

Hazards associated with the behaviour of other road users

Relatively more is known about the extent of involvement of hazards relating to the behaviour of other road users in motorcycle crashes because these hazards are easier to identify than road based hazards. Allardice's (2002) list of hazardous road configurations includes a number of situations that reflect the hazards associated with the behaviour of other road users:

- Roundabouts and intersections (other vehicles may fail to give way)
- Traffic lights (possible rear-end crashes and red-light runners)
- Motorways (high speeds close to "disinterested, inattentive, impatient, stressed and distracted vehicle drivers")
- Bridges (no escape route from potential head-on collisions).

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. Thus, many of the factors that interfere with hazard perception by car drivers (e.g. distraction associated with mobile phone use) contribute to those car drivers being hazardous to motorcyclists. 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.

Studies in the United States, Great Britain, Victoria and New South Wales have found that the other vehicle is at fault in about 55-75% of motorcycle multi-vehicle motorcycle crashes (Hurt et al., 1981; RTA, 2004; Booth, 1989, cited in ROSPA, 2001). Lynam, Broughton, Minton and Tunbridge (2001) found that this was true for serious and slight injury crashes, but that the reverse held for fatal crashes involving motorcycles. In this British study, 'Failed to give way' and 'poor turn/manoeuvre' were common in crashes for which the non-rider was largely responsible and were associated with failure to observe satisfactorily, careless, thoughtless or reckless behaviour, or failure to judge the rider's path or speed.

HAZARD PERCEPTION AND RESPONDING IN VICTORIAN MOTORCYCLE CRASH DATA

Previous published analyses of Victorian motorcycle data have found patterns indicative of the involvement of failures of hazard perception and responding. These include differences in the risk and severity of crashes of novice riders and fully licensed riders (Cameron, 1992; Carr, Dyte and Cameron, 1995), and differences in the crash rates per licence holder per year between novice riders and fully licensed riders (and between younger and older novices) (Haworth et al., 2002). Given that the profile of motorcycle crashes (and particularly of riders) has changed considerably in the last decade, analyses of recent (1997-2001) Victorian crash data were undertaken to validate these conclusions. The identification of the situations and conditions relevant to hazard perception and responding was hoped to provide information about what situations and conditions should be included in training programs.

However, 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-based 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.

Given these limitations, crashes involving young and older novices (defined as holders of learner, restricted or probationary licences) and fully licensed riders were compared. It was assumed that the older (over 25) novices also hold full car licences. This provides an indication of the hazards and situations that they encounter. It also provides a general indication of the extent to which their abilities in hazard perception and responding differ.

Overall, about half of the motorcycle riders involved in casualty crashes in Victoria in 1997-2001 were involved in collisions with vehicles. These collisions comprised 64% of crashes in low speed areas (60 km/h or less), 54% of crashes in higher speed (over 60 km/h) metropolitan areas and 23% of crashes in higher speed (over 60 km/h) areas in the Rest of Victoria. The most common types of collisions with vehicles were:

- turning right through, not at intersection (note: Australia drives on the left-hand side of the road)
- adjacent directions: right near (at intersection)
- head-on, not overtaking
- rear-end impact
- U-turn.

The research reported in the previous section suggests that it is likely that the other road user failed to give right of way to the motorcyclist in the majority of these crashes.

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 a pattern of recreational riding (see Table 1). 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.

Table 1 Distribution of crashes among riding environments for young and older novice and fully licensed riders. Victoria 1997-2001

Riding environment	Under 25 L or P	25 + L or P	Under 25 Full	25+ Full	Total
60- metro & rural	932	384	557	3187	5060
	66.5%	62.7%	63.4%	56.9%	59.6%
>60 metro	256	133	165	1124	1678
	18.3%	21.7%	18.8%	20.1%	19.7%
>60 rural	214	95	157	1293	1759
	15.3%	15.5%	17.9%	23.1%	20.7%
Total	1402	612	879	5604	8497
	100.0%	100.0%	100.0%	100.0%	100.0%

The interpretation of these crash data in terms of hazard perception and responding is difficult for the reasons outlined earlier. While the crash data suggest that hazards associated with the behaviour of other road users are most important, the crash data system provides little scope for identifying the presence or role of road based hazards in crashes. The crash data does suggest that riding patterns vary with rider age and experience and that training scenarios need to encompass these patterns.

RESEARCH INTO HAZARD PERCEPTION AND RESPONDING BY MOTORCYCLISTS

While there has been extensive research into hazard perception by car drivers since about 1990, relatively few studies have measured hazard perception and responding by motorcyclists. For car drivers, research has shown that experienced drivers are quicker to detect hazards and that slower responses are associated with higher self-reported crash involvement - but this has not been tested for motorcycle riders.

Types of hazards reported by motorcyclists

Armsby, Boyle & Wright (1989) reported a study that sought to compare the effectiveness of different techniques for assessing drivers' perceptions of hazards using three types of interview methods, the Q-sort technique and several variants of the repertory grid method. All participants held a full driving licence. Regardless of whether nondirective, focussed or critical incident interviews were conducted, over 70% of the hazards mentioned by car drivers with no motorcycle riding experience arose from the behaviour of other road users, rather than features of the road environment. Car drivers who also rode (or had ridden) motorcycles, however, were able to identify specific features of the road, and specific actions of other road users, as hazards to motorcyclists. They conclude that "this might be expected, given that motorcyclists are more at risk from physical deficiencies in the road environment, such as a road surface with low skid resistance, and more vulnerable to injury if they are involved in an accident" (p.56).

Rider performance on car driver hazard perception test

In the United Kingdom, Horswill and Helman (2001) conducted a series of studies that attempted to assess the relative contributions of rider behaviour and car driver behaviour towards motorcycles and the physical vulnerability of motorcycles to the increased crash and injury rates of motorcycles compared to cars. Their first study compared the performance of three groups:

- Car drivers who had no (or almost no) riding experience
- Motorcycle riders who were asked to respond as if they were riding their normal motorcycle
- Motorcycle riders who were asked to respond as if they were driving their usual car.

The three groups were matched in terms of age, gender, total distance travelled per year and the proportion having undergone advanced training. The average age was 40 years, there were more males than females and about 45 percent had undertaken advanced training.

The participants completed a battery of video-based tests of driving behaviour and performance in the Reading University driving simulator. Those participants who were asked to respond as if they were driving their usual car sat in a car mock-up (with seat, steering wheel, and pedals mounted on a platform). Those participants who were asked to respond as if they were riding their usual motorcycle sat on a Suzuki B120 motorcycle mounted in a stabilising frame. Digital video stimuli were presented on the back projection screen and, where appropriate, participants responded to events on the video with a hand-held button (which allowed reaction times to events to be measured). In the terms used in this paper, the study measured hazard perception, but not the response selection or execution components of hazard perception and responding.

On McKenna and Crick's (1994) hazard perception test, motorcyclists responding as if they were driving their normal cars reacted faster to hazardous situations than either car drivers or motorcyclists responding as if they were riding their normal motorcycles. This would suggest that motorcyclists had better hazard perception skills than car drivers. Given that the hazard perception test was intended for car drivers, the researchers argue that some of the hazards might be less relevant for motorcyclists and that this might explain why this group did not perform as well on motorcycles as they did in cars.

Visual scanning patterns of riders and drivers

Few studies have compared the visual scanning patterns of riders and drivers. Nagayama et al. (1980) found that, compared to car drivers, motorcyclists had a wider vertical distribution of fixations and looked frequently at both near and far road surfaces. Whereas motorcyclists' fixations were more frequently on the road surface, car drivers looked relatively far ahead at objects such as traffic lights, and seldom at the road surface.

The differences in visual scanning patterns between motorcyclists and car drivers seem to be consistent with the types of crashes they have and with the nature of the riding/driving task itself. For example, given that hazards such as uneven, rough or slippery road surfaces are potentially more dangerous for motorcyclists than for car drivers, comparatively more of a rider's attention is directed towards the road surface. This leaves little time to scan the distant foreground.

Tofield and Wann (2001) compared the scanning patterns of a group of 12 car drivers and a group of 12 motorcyclists. In contrast to Nagayama et al (1980), they found that motorcyclists looked significantly further down the road than car drivers. Tofield and Wann suggested that motorcyclists exhibited a pattern of scanning that is consistent with safe driving, whereas the pattern by car drivers could potentially lead to hazardous outcomes.

The inconsistency in the findings of these studies may reflect differences in the types of methodologies used and suggests that further research is needed to clarify any differences in scanning patterns between motorcyclists and car drivers.

MOTORCYCLIST 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. 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 accidents.

Most approaches to hazard perception training for car drivers require only detection 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.

Most available car driver hazard perception tests do not measure whether the correct response is chosen or implemented – the focus is on the detection of the hazard only. This is largely due to difficulties in developing a valid measure of hazard perception response. The implications for motorcycle hazard perception research are problematic as the methods needed to examine responding by riders may require a higher level of physical fidelity than those required for drivers because riding requires more complex vehicle control skills than driving.

In addition, the 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 HPT 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. Horswill and Helman (2001) argue that 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. They recommend that a separate HPT for riders with associated training should be developed and introduced into licensing systems.

WHERE TO FROM HERE? WHAT HAS BEEN LEARNT FROM THE STAGE 1 RESEARCH?

The literature review conducted for the Stage 1 research identified very little research into hazard perception and responding by motorcycle riders. For car drivers, research has shown that experienced drivers are quicker to detect hazards (e.g., Quimby & Watts, 1981; Egberink, Lourens & van der Molen, 1986; McKenna & Crick, 1994; Quimby, Maycock, Carter, Dixon & Wall, 1986) and that slower responses to hazards are associated with higher self-reported crash involvement (e.g., Catchpole, Cairney & Macdonald, 1994; Catchpole, 1998, cited in Catchpole & Leadbeatter, 2000) – but this has not been tested for motorcycle riders. The research also showed that hazard perception training in novice drivers leads to improved performance on hazard perception tests (e.g., McKenna & Crick, 1992; 1997; Mills et al., 1998) but it is not yet known whether these drivers go on to be safer drivers and have fewer crashes.

It is not yet known whether these results would also be obtained with motorcycle riders, because there has been very little research into motorcycle hazard perception and responding by motorcyclists. Unlike novice car drivers, novice motorcyclists are a heterogeneous group – many of them are not young and most have extensive car driving experience. It is not known to what extent experience as a car driver is expected to improve hazard perception and responding as a motorcycle rider.

In previous studies of car driver hazard perception, the methods of presenting hazard scenarios have varied from methods with little physical fidelity (text descriptions, photographs or slides) to moderate physical fidelity (videos or computer-generated sequences) to the high fidelity (but potentially dangerous) approach of presenting actual hazards in a real-world drive. McKenna and Crick (1994) have shown that relatively simple methods can be used to demonstrate differences in novice and experienced car driver hazard perception skills and have argued that high fidelity visual simulation of the road environment (i.e., video presentation of a visual scene) is the key to providing a valid measure of hazard perception.

Most of the methods used to examine car driver hazard perception have measured only detection of the hazard and not whether the correct response is chosen or implemented. This is largely due to difficulties in developing a valid measure of hazard perception response. However, responding is more critical for motorcycle riders than for car drivers because of their greater potential for injury in the event of a crash. The implications for motorcycle hazard perception research are problematic as the methods needed to examine responding by riders may require a higher level of physical fidelity than those required for drivers because riding requires more complex vehicle control skills than driving.

Research has shown that the hazard perception and responding skills of novices are fundamentally deficient compared to experienced drivers and that the differences are not the result of the additional demands of vehicle control which can be difficult for very inexperienced drivers. However, it is unclear whether this finding would generalise to motorcycle riding. It is expected that, in novice riders, the demands of controlling the vehicle might have an impact on their hazard perception abilities because handling a motorcycle is more complex than handling a car. Thus, there is a need to separate out the effects of deficiencies in hazard perception from vehicle control deficiencies on any impaired hazard perception and responding performance found in novices compared to experts.

These issues question the relevance of the results of car driver hazard perception research for novice motorcyclists. The outcomes of the Stage 1 research have shown that 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. These questions have led to Stage 2 of a program of research to assess the fundamental deficiencies in hazard perception and responding between drivers and riders.

The outputs for Stage 2 will provide a platform of empirical knowledge in hazard perception and responding by motorcyclists that will identify targeted hazard perception and response training measures and develop appropriate simulation based hazard behaviour training program materials.

APPLICABILITY OF OUR RESEARCH TO OTHER JURISDICTIONS

Given that motorcyclists are over-represented in traffic crashes in all jurisdictions, it is useful to consider the extent to which the findings discussed in this paper are applicable to motorcycle riders outside of Victoria, Australia. This is important for researchers in other countries who may be considering the best approach to improve motorcycle safety. It is likely that motorcyclists in other jurisdictions, as in Victoria, differ to car drivers in terms of the types of hazards they face, the types of responses required, and in the consequences of not perceiving and responding to hazards. Therefore, similar issues need to be considered when developing the best training programs. However, licensing systems vary in terms of the minimum age of licensure, whether a motorcycle licence can be obtained prior to a car licence, and in the stringency of restrictions on novices. For example, motorcyclists in some jurisdictions may be younger than those in others and possibly have less (or no) car driving experience, and there may be fewer restrictions on novices such as maximum blood alcohol concentration (BAC) levels, carriage of pillion passengers, and in the requirement to wear protective clothing, including a helmet. These issues need to be taken into account by researchers when tailoring training programs to motorcycle riders in different jurisdictions.

CONCLUSIONS

Little is known about the relationship between age and experience and ability in hazard perception and responding for motorcyclists. It is not known to what extent experience as a car driver is expected to improve hazard perception and responding skills as a motorcycle rider. This is important given that most motorcyclists in Victoria (at least) are experienced car drivers. It is possible that the need for improved hazard perception and responding skills is not limited to riders entering the licence process but may apply to many fully licensed riders (particularly returning riders). Thus, 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.

Analysis of Police-reported mass crash data appears to provide little insight into hazard perception by motorcyclists. While the crash data suggest that hazards associated with the behaviour of other road users are most important, it has little scope for identifying the presence or role of road based hazards in crashes. The crash data does suggest that riding patterns vary with rider age and experience and that training scenarios need to encompass these patterns.

The small number of studies of hazard perception and responding by motorcyclists have supported the concept that road-based hazards are relatively more salient to motorcyclists and have suggested that motorcyclists may not perform as well on some of the hazards portrayed in hazard perception tests because they are less relevant for motorcyclists. The two studies reported thus far disagree on whether motorcyclists look more at the road surface and less at the road further ahead, which could result in relatively poorer hazard perception ability. Other research suggests that many of the difficulties for motorcyclists lie in responding, rather than hazard perception, per se. Given that current hazard perception tests (and training approaches) for car drivers require only detection of the hazard and responding by pressing a button, the extent to which such tests are able to predict the crash risk for riders may be limited.

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