Lane filtering and situation awareness in motorcyclists: An on-road proof of concept study

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Abstract

In Victoria, as in other jurisdictions, there is very little research on the potential risks and benefits of lane filtering by motorcyclists, particularly from a road safety perspective. This on-road proof of concept study aimed to investigate whether and how lane filtering influences motorcycle rider situation awareness at intersections and to address factors that need to be considered for the design of a larger study in this area. Situation awareness refers to road users' understanding of 'what is going on' around them and is a critical commodity for safe performance. Twenty-five experienced motorcyclists rode their own instrumented motorcycle around an urban test route in Melbourne whilst providing verbal protocols. Lane filtering occurred in 27% of 43 possible instances in which there were one or more vehicles in the traffic queue and the traffic lights were red on approach to the intersection. A network analysis procedure, based on the verbal protocols provided by motorcyclists, was used to identify differences in motorcyclist situation awareness between filtering and non-filtering events. Although similarities in situation awareness across filtering and non-filtering motorcyclists were found, the analysis revealed some differences. For example, filtering motorcyclists placed more emphasis on the timing of the traffic light sequence and on their own actions when moving to the front of the traffic queue, whilst non-filtering motorcyclists paid greater attention to traffic moving through the intersection and approaching from behind. Based on the results of this study, the paper discusses some methodological and theoretical issues to be addressed in a larger study comparing situation awareness between filtering and non-filtering motorcyclists.

Introduction

Lane filtering is a longstanding practice undertaken by motorcyclists but one that continues to stir controversy between them, other road users and the road safety community. Lane filtering involves using the space within a lane to overtake stationary or slow moving traffic (Sperley & Pietz, 2010) and is often performed by the motorcyclist to reach the front of the traffic queue at intersections. Lane filtering differs from lane splitting in which the space within one or more lanes is used to overtake traffic moving at high speed (FEMA, 2000). In Victoria, as in other jurisdictions, there is no single agreed definition of the practice, some confusion regarding its legal status, and almost no systematic research on its potential risks and benefits, particularly from a road safety perspective. This paper describes an on-road proof of concept study designed to investigate whether and how lane filtering influences motorcycle rider situation awareness (SA) at intersections and to address factors that need to be considered for the design of a larger study in this area. SA refers to road users' understanding of 'what is going on' around them and is a critical commodity for safe performance.

Definitions and legal status of lane filtering

Some definitions reserve the term 'filtering' for passing stationary traffic only, whilst others suggest it includes passing moving traffic up to a speed of 30 km/h or at a 'safe' speed (Road Safety Committee, 2012). In its 2011 review of the Australian Road Rules, the National Transport Commission (NTC) suggested that lane splitting occurred when the overtaking motorcycle involved speed, whereas lane filtering happened when the motorcycle was overtaking in slow or stationary traffic (NTC, 2011). However, the NTC did not specify a speed to distinguish between filtering and lane splitting, making it difficult to determine when lane filtering ends and lane splitting begins.

Lane filtering in Victoria is illegal, although there is some confusion over its legal status due to the explicit lack of an offence banning it (Road Safety Committee, 2012). If a motorcyclist filters, however, it can constitute a breach of other road rules such as overtaking on the left while a vehicle is moving, failing to signal, failing to keep a safe distance or failing to drive within a single marked lane. The 2012 Parliamentary Inquiry into Motorcycle Safety identified mixed reactions towards the legalisation of lane filtering. Proponents of the practice cited reduced commuting times, increased fuel efficiency and safety benefits, whilst opponents cited risks to rider safety as the key reasons against it (Road Safety Committee, 2012).

Lane filtering and safety

The purported safety benefits of lane filtering for motorcyclists include a reduction in the risk of rear-end collisions (ACEM, 2009), and improved visibility of hazards and traffic by permitting the rider to move away from traffic (Smith, 2011). To date, however, there has been almost no systematic research to support these claims, with much of the information derived from large crash investigation studies where lane filtering is not the primary focus (Sperley & Pietz, 2010). A purported key risk associated with lane filtering is that it violates driver expectation: drivers' limited perceptual exploration of the areas in which motorcyclists filter creates a conflict that increases the likelihood of collisions between the two (Salmon, Young & Cornelissen, 2013). UK research has identified some support for this finding, in which drivers were found to have turned across the path of filtering motorcyclists as a result of a failure to notice them in traffic (Clarke, Ward, Bartle & Truman, 2004; Crundall, Clarke, Ward & Bartle, 2008; Sexton, Fletcher & Hamilton, 2004).

Situation awareness and lane filtering by motorcycle riders

A notable feature of the literature on lane filtering is that the practice has not been examined from the motorcyclists' point of view under real world traffic conditions. Rather, research has examined only the motorcyclist's attitudes towards filtering based on anecdotal evidence, or driver behaviour, responses, and attitudes towards filtering. An important area of research relates to the effects of filtering on motorcyclist behaviour and cognition. If the risks and benefits of lane filtering outlined here are valid, then a front queue position at intersections would potentially provide a better view of the intersection for the rider and more protection from surrounding traffic that are approaching the intersection. However, the extent to which the process of lane filtering itself degrades motorcyclists' awareness of the surrounding traffic and hazards is not yet known.

One method for investigating how lane filtering might influence motorcyclists' perception of surrounding traffic and hazards is to assess their SA. Situation awareness refers to road users' understanding of 'what is going on' around them (Endsley, 1995). It is a critical commodity for safe system performance incorporating cognitive processes important for safe motorcycling including perception; (Kass, Herschler & Companion, 1991); attention and comprehension (Wickens & Hollands, 2000) and decision making (Endsley, 1995; Ma & Kaber, 2005). Of particular interest is whether filtering motorcycle riders focus more or less of their attention on the task of filtering than on surrounding hazards and traffic than motorcycle riders who do not filter. The present study set out to answer this question.. Intersections were chosen for investigation because they represent a component of the road network where stationary lines of traffic provide an opportunity for filtering. Intersections are also one of the most dangerous components of the road network, particularly for motorcyclists, where road users converge and can potentially conflict with each other (Haque, Chin & Huang, 2008; Young, Salmon & Lenné, 2011). In Victoria, for example, over a third of all motorcycle crashes occur at intersections where other vehicle drivers often do not see the motorcycle (VicRoads, 2012).

Method

Participants

Twenty-five motorcyclists (24 males, 1 female) aged 27 to 64 (mean = 43.7, SD = 12.5) took part in the study. All participants held a Full Victorian motorcycle licence. Participants had held their motorcycle licence for an average of 19.4 years (SD=16.4) and rode an average of 260 kms per week (SD = 156.1). Participants were recruited through the weekly on-line Monash University newsletter and were compensated $50 for their time and travel expenses. The study was approved by the Monash University Human Research Ethics Committee.

Materials

Motorcycle

Motorcyclists rode the route using their own motorcycle. Each motorcycle which was fitted with an Oregon Scientific ATC9K portable camera which, depending on motorcycle make and model was fitted to either the handle bars or the front headlight assembly. The ATC9K camera records the visual scene, speed and distance travelled (via GPS).

Verbal protocols

Verbal Protocol Analysis (VPA), or 'think aloud' protocol analysis, was used to elicit information regarding the cognitive and physical processes performed by motorcyclists while riding. Participants provided concurrent verbal protocols as they rode along the test route. They were asked to think aloud about what they were doing and seeing (e.g. "I am checking the lights in front and the traffic behind me") but not to explain or rationalize their behaviour in order to minimize any potential impact of the verbal protocols on riding performance. The verbal protocols were recorded using a digital Dictaphone fitted to the inside of the motorcyclist's helmet and transcribed verbatim post-trial.

Study Route

The test route was a 15 km urban route located in the south eastern suburbs of Melbourne. It comprised a mixture of arterial roads (50, 60, and 80 km/h speed limits), residential roads (50 km/h speed limit) and university campus private roads (40 km/h speed limit). Three fully signalized intersections (where the right turn phase was controlled with an arrow) were focussed on for the present analysis; two of which comprised two lanes for turning and the other comprised one lane.

Procedure

This study was conducted as part of a larger project investigating road user situation awareness ('Distributed situation awareness, road users' strategies and road safety: development of theory, measures, guidelines, and interventions'). Participants were informed that the aim of the study was to examine their SA in different types of urban environments, and that the results of the study would provide valuable insight into road user situation awareness in terms of how it is acquired, what it comprises, and how it can be enhanced through road and vehicle design, and training. Participants were not told that their behaviour was being observed for instances of lane filtering before or after the study, nor were they given any instructions on how they should ride along the route. They were advised to pull over if they had any concerns along the way.

In order to control for traffic conditions, all trials took place at the same pre-defined times on weekdays (9:30am or 1:00pm Monday to Friday). These times were subject to pilot testing prior to the study in order to confirm the presence of similar traffic conditions. A demographic (age, gender, riding experience and history) questionnaire was completed by participants after receipt of their informed consent. They were then given a short VPA training session in which they received a description of the VPA method and instructions on how to provide concurrent verbal protocols. Participants practiced providing verbal protocols in front of the experimenter who provided feedback and guidance. Following the VPA training, participants were shown the study route map which had been sent to them for familiarisation prior to the study. Whilst the motorcyclist was practicing his/her VPA method, a technician fitted the ATC9K camera to their motorcycle. Participants were then taken to their vehicle and given a demonstration of the video and audio recording equipment which was set to record at this point. Each motorcyclist was followed by an experimenter in a car to ensure they did not stray off the route.

Data analysis

Lane filtering cases

Four participants were excluded from the analysis due to technical problems with the video and audio-recording equipment. Video data was examined for each of the remaining 21 riders at each of the three intersections (21 riders x 3 intersections) to determine the number of instances in which lane filtering was possible and the number of instances in which lane filtering occurred. Any rider who approached an intersection at which the traffic lights on their approach side were green or at which there were no vehicles in the queue on their approach side was excluded from the analysis at that particular intersection. For the purposes of this study, lane filtering was defined as having occurred if the rider overtook at least one stationary or slow moving vehicle whilst queued up at the intersection. Seven riders filtered across the three intersections, with filtering occurring in 27% of 44 possible instances in which the traffic lights were red on the rider's approach side of the intersection and there was at least one vehicle in the traffic queue for the right turn lane/s.

Table 1. Number of and percentage of riders who filtered and percentage of cases in which filtering was possible at the three intersections

Intersection No.	No. of cases where filtering occurred and % of riders who filtered	Number and % of cases in which filtering was possible
1	1 (4.8%)	5 (20.0%)
2	6 (28.5%)	19 (31.6%)
3	5 (23.8%)	19 (26.3%)
Total	12 (57.1%)	43 (27.9%)

Leximancer analysis

A network analysis procedure was used to analyse and compare SA between filtering and non-filtering motorcyclists. Participants' verbal protocols were transcribed verbatim into Microsoft Word and then analysed by intersection using the text analysis software Leximancer. Leximancer extracts themes, concepts and links from the verbal transcripts in five steps: conversion of raw text data, concept identification, thesaurus learning, concept location, and mapping (i.e. visual representation of network). This process creates networks comprising concepts or information elements and the relationships between them (Walker et al., 2011), which represents an individual's

SA. For example, 'vehicle' *has* 'slowed' *its* 'speed'; 'traffic light' *is* 'red' (Young, Salmon & Cornelissen, 2013). Leximancer has been used previously in on-road studies to examine SA in different road user groups (Salmon, Young & Cornelissen, 2013; Walker, Stanton & Salmon, 2011) and in distracted and undistracted drivers (Young et al., 2013). For the current analysis, leximancer produced six SA networks; one filtering and one non-filtering network for each intersection.

Network analysis

Network analysis metrics are used to examine the content and structure of SA networks (e.g. Salmon et al, 2013; Walker et al, 2011). The Agna network analysis software was used to analyse the content and structure of each of the six networks to enable comparisons between SA when filtering versus when not filtering. Both quantitative and qualitative methods were used. The quantitative analysis used two metrics: density, and sociometric status, whilst the qualitative analysis involved identifying concepts that were common (i.e. used by both filtering and non-filtering riders) and unique (i.e. used by one group and not the other) across networks for each intersection as well as key concepts within each network.

Network structure: density

Density is a measure of the level of interconnectivity of the network in terms of the number of links between information elements. The formula for calculating network density is:

Network density =

$$\frac{2L}{g(g-1)}$$

Where L is the number of links in the network and g is the number of concepts or information elements. Network density values range from 0 (no concepts are connected) to 1 (every concept is connected to every other concept). Higher density values indicate a richer set of links between concepts and thus, more efficient SA than lower density networks.

Network content: common, unique and key concepts

For each intersection, common concepts (present in both 'filtering' and 'non-filtering' networks) were compared as well as unique concepts (present in only one of the networks). In addition, the sociometric status metric was used to identify the key concepts underpinning SA, and the relative importance of common concepts between the filtering and non-filtering networks. Sociometric status provides a measure of how 'busy' a concept is relative to the total number of concepts within the network being examined (Houghton, Baber, McMaster, Stanton, Salmon, Stewart & Walker, 2006). It is calculated using the formula:

Sociometric status =

$$\frac{1}{g-1}\sum_{j-1}^{g}(Xji + Xij)$$

Where g is the total number of nodes in the network, i and j are individual nodes and are the edge values from node i to node j. Concepts with a high sociometric status represent key concepts because they are highly connected to other concepts in the network. Key concepts are quantitatively defined as those with a sociometric status value of one standard deviation above the mean value for the network.

Results

Network content

Figure 1 presents an example of a conceptual map demonstrating the concepts and links underpinning filtering motorcyclists' SA at Intersection 2.

Figure 1. Concept map of filtering motorcyclists' SA – Intersection 2

Figure 1 shows that there were nine key concepts representing filtering motorcyclists' SA at Intersection 2, with concepts more closely linked representing higher levels of connectivity within the network. Further details of the content analysis for each intersection network are given in Table 3.

Network structure: density

Table 2 presents the mean density values for each of the six networks.

Table 2. Network density and diameter across lane filtering and non-lane filtering motorcyclists by intersection

Intersection	**Network**	**Density**
Intersection 1	Filtering	0.357
	Non-filtering	0.638
Intersection 2	Filtering	0.289
	Non-filtering	0.437
Intersection 3	Filtering	0.533
	Non-filtering	0.394

The mean density values were higher at intersections one and two for non-filtering than filtering motorcyclists. This suggests that, at intersections one and two, non-filtering motorcyclists had more connected SA networks, whereas filtering motorcyclists had SA networks with few connections between concepts. However, the reverse was true at Intersection 3 where the filtering rider networks were more dense in terms of connectedness.

Network content: shared and unique concepts

Table 3 presents the common and unique concepts within lane filtering and non-lane filtering networks for each of the three intersections.

Table 3. Shared and unique concepts across lane filtering and non-lane filtering motorcyclists by intersection

	Filtering motorcyclists				
Common Intersection 1	**Unique Intersection 1**	**Common Intersection 2**	**Unique Intersection 2**	**Common Intersection 3**	**Unique Intersection 3**
Lights (F)	Watch	Straight (N)	Lane	Lights (F)	Whole
Cars (N)	Wait	Green (F)	Bike	Cars (F)	Cycle
	Opportunity	Look (N)	Pull	Front (F)	Filter
	Keeping	Indicate (N)	Cautious	Intersection (N)	
	Eye	Front (N)		Traffic (N)	
		Cars (N)		Lane (N)	
				Hand (N)	
	Non-filtering motorcyclists				
Common Intersection 1	**Unique Intersection 1**	**Common Intersection 2**	**Unique Intersection 2**	**Common Intersection 3**	**Unique Intersection 3**
Lights	Lane	Straight	Road	Lights	Turning
Cars	Road	Green	Car	Cars	Red
	Arrow	Look	Coming	Front	Arrow
	Green	Indicate	Traffic	Intersection	Car
	Traffic	Front	Turning	Traffic	Crossing
	Intersection	Cars	Behind	Lane	One’s
	Light		Waiting	Hand	Stick
	Car		Sure		Lanes
	Slow		Arrow		Behind
			Stay		Merging
			Confusing		Coming
			Moving		Aware
			Intersection		Road
			Highway		Moving
					Quick
					Sure

Table 3 demonstrates that the content of motorcyclist SA was substantially different between filtering and non-filtering motorcyclists, with a large proportion of filtering riders’ SA being shared with riders who did not filter. Both filtering and non-filtering motorcyclists shared concepts relating to the intersection itself and its rules (i.e., 'lights', 'green', 'straight', and 'intersection') as well as concepts relating to other road users (i.e., 'cars', 'traffic') and to their own actions ('indicate', 'look', 'hand').

The sociometric status metric was then examined to identify the relative importance of shared concepts between the filtering and non-filtering networks. Shared concepts that obtained a higher sociometric status (indicating more prominence in the network), are indicated in Table 3 with an 'F' where the concept was more important for filtering riders and an 'N' where the concept was more important for non-filtering riders. Overall, concepts associated with the timing of the traffic light sequence (i.e. 'lights', 'green') and moving to the front of the traffic queue (i.e. 'front') featured more prominently in the SA of filtering motorcyclists, whereas concepts associated with the actions of other road users (i.e., 'cars' , 'intersection' and 'traffic') were more important for motorcyclists who did not filter. There were two exceptions to this. At Intersection 3 'cars' featured more prominently in the networks of filtering riders. However, inspection of the motorcyclists' verbal protocols revealed that this concept was used more frequently in the context of the rider moving past cars whilst filtering (i.e. 'I'm just going to filter through these *cars'*; and 'I'm just filtering here, up to the front...drivers get mad if you scrape their *cars* on the way up'). At Intersection 2, non-filtering riders used the term 'front' to refer to the actions of other road users (e.g., 'I've got cars to my right that are turning right as well, but they're aware I'm here; I've had eye contact with the driver in *front'*).

Important differences between filtering and non-filtering rider SA are revealed through the unique concepts. Filtering motorcyclists focussed on their own actions relating to the task of filtering and moving to the front of the traffic queue (i.e., 'watch', 'wait', 'opportunity', 'lane', 'bike', 'pull', 'whole cycle' and 'filter'). This is perhaps not surprising, but the unique concepts found in the non-filtering networks suggest that the orientation of filtering riders' SA toward the filtering task may be causing a degradation of SA in which important elements of the intersection situation are ignored. For example, the non-filtering riders had a range of unique concepts relating to important features of the intersection situation, including the nature of the intersection itself (e.g. 'intersection' concept), the behaviour of surrounding traffic (e.g. 'turning', 'coming', 'behind', 'waiting', 'crossing', 'merging').

Overall, the analysis of shared and unique concepts suggests that motorcycle riders who filter tend to shed their focus on perception of surrounding hazards and traffic moving through or approaching the intersection to tasks associated with their own actions whilst moving to the front of the traffic queue.

Discussion

Situation awareness is a critical commodity for safe system performance, incorporating cognitive processes important for safe motorcycling including perception; (Kass et al. 1991); attention and comprehension (Wickens & Hollands, 2000) and decision making (Endsley, 1995; Ma & Kaber, 2005). This paper described an on-road proof of concept study designed to investigate whether and how lane filtering by motorcyclists influences their SA at intersections. Of particular interest was whether filtering motorcyclists focus more or less of their attention on perception of surrounding hazards and traffic than motorcyclists who do not filter. This question was addressed by comparing the content and structure of SA in the two groups.

The content analysis revealed that motorcyclists who filtered tended to focus less of their attention on perception of surrounding hazards and traffic behaviour than motorcyclists who did not filter. The analysis of common and unique concepts across the three intersections revealed that the content of SA was different among non-filtering motorcyclists. Most of the common concepts comprised elements of SA associated with predicting the actions of other road users, such as ‘cars’, ‘intersection’, ‘traffic’, and ‘look’. However, these concepts featured more prominently in the SA networks of non-filtering motorcyclists. This is supported by the analysis of unique concepts in which filtering motorcyclists’ SA was focussed primarily on information associated with the rider’s own actions when moving to the front of the traffic queue (e.g. ‘watch’, ‘wait’, ‘opportunity’, ‘lane’, ‘bike’, ‘pull’, ‘whole cycle’, and ‘filter’). In contrast, non-filtering motorcyclists were generally aware of a more diverse range of concepts, particularly those pertaining to surrounding hazards and traffic moving through or approaching the intersection from behind (e.g. ‘turning’, ‘behind’, ‘waiting’, ‘crossing’, ‘merging’, ‘coming’ and ‘moving’), in addition to the rules of the intersection (e.g., ‘arrow’, ‘red’, ‘green’, ‘road’). These results suggest that the task of filtering influences motorcyclist SA in terms of the types of concepts from the road situation they are aware of. The findings also suggest that lane filtering altered the structure of motorcyclists’ SA at the three intersections. The structural analysis provides a measure of the level of interconnectivity of the network, with higher values indicating a richer set of links between concepts. At intersections 1 and 2, non-filtering motorcyclists were able to integrate concepts more effectively than filtering motorcyclists, which is indicative of more efficient SA. Interestingly, the reverse was found at intersection 3; non-filtering motorcyclists’ SA was less connected than that for the filtering motorcyclists despite their awareness of a more diverse range of concepts. It is possible that these results were influenced by the design of the intersection. The intersection is one of the largest in Melbourne and set on a forty-five degree angle. As such, it is possible that a higher level of uncertainty at this intersection resulted in non-filtering motorcyclists sampling a wider range of information from the environment but less efficiently than the filtering motorcyclists. In contrast, filtering motorcyclists focussed only on the task of moving to the front of the traffic queue and so the process of ‘shedding’ information pertaining to non-filtering tasks potentially enhanced the overall level of connectivity between information elements sampled from the environment.

The number of lane filtering opportunities and occurrences in this study was too small to enable firm conclusions to be drawn about SA in filtering and non-filtering motorcyclists, particularly from a road safety perspective. However, this proof of concept study has demonstrated a method worthy of further exploration in a larger program of research on lane filtering, and raises some important methodological and theoretical issues that should be addressed as part of that research.

With respect to methodological issues, several points can be made. The frequency of lane filtering is likely to be influenced by the time of day. The study was conducted during the early afternoon to avoid potential safety incidents that might occur more frequently during morning and evening peak periods. The disadvantage of this approach, however, was that traffic queues and waiting times were relatively short, potentially limiting the frequency with which motorcyclists were inclined to filter. Intersection crossings at which there were no vehicles in the traffic queue or where the traffic lights were green on approach to the intersection were necessarily excluded from the study since lane filtering was obviously not possible in these situations. Therefore, the larger study would need to include a sufficient number of crossings in which lane filtering was possible, and could include riders traversing the route several times. Such an investigation would enable more reliable conclusions to be drawn about motorcyclist SA, ruling out any differences that may be attributable to individual rider characteristics such as age; risk taking propensity; experience; and attitudes towards safety.

A second methodological issue concerns the number and types of intersections chosen for investigation. The route was designed to incorporate three large and relatively complex intersections within the vicinity of the university, all of which were fully signalized. However, two of the intersections comprised two lanes for turning and were separated from the oncoming traffic lanes by a median strip. The third intersection comprised only one lane for turning and was not separated by a median strip. It is possible that differences in the design of the intersections impacted on riders’ decisions to filter. For example, riders were less likely to filter at the intersection with no median strip – a finding that may be attributed to a perceived lack of protection between the rider and traffic entering the intersection from the opposing lanes. In addition, as described above, the structural analysis revealed that motorcyclist SA was quite different at one of the two right turning lane intersections compared to the other two intersections, a finding that may be due, in part, to the relatively larger size and greater complexity of the intersection. Due to the small number of cases of lane filtering in this study, however, it was not possible to determine whether these factors were influential in any decisions about lane filtering and how they impacted motorcyclist SA. The larger study should include multiple different types of intersections to address these issues.

The ecological validity of the study was likely constrained by having the experimenter follow the rider along the route, potentially discouraging some riders from filtering. For example, the verbal protocol analyses revealed that three of the participants would have filtered at some intersections if they had not been a part of the study. The larger scale study should include a pilot test of the planned route with the rider and the experimenter, and then allow riders to undertake the study without the experimenter following.

An important theoretical issue is the extent to which any differences in SA reflect differences in safety. One of the purported key safety benefits of lane filtering is that it improves visibility of hazards and traffic by permitting the rider to move away from traffic to the front of the queue (Smith, 2011). However, this presents a conundrum for the motorcyclist who must interact with traffic *more* closely en route to the front of the queue in order to achieve better visibility. Recent research suggests that lane filtering potentially violates drivers' expectation because motorcycles are allowed in spaces not designed for such traffic and where movement is not expected (Salmon et al., 2013; Sperley & Pietz, 2010; Sexton et al., 2004; Crundall et al., 2008). This incompatibility between driver and motorcycle rider SA identified in previous studies on lane filtering may create a conflict for the motorcyclist which increases the likelihood of a collision. This is particularly pertinent at intersections where over one third of all motorcycle crashes in Victoria occur, most commonly as a result of a failure of the other road user to notice the motorcycle. The results reported here suggest that some potentially important features of intersection negotiation were absent from filtering motorcyclists' SA – filtering riders tended to focus less of their attention on perception of surrounding hazards and traffic behaviour than riders who did not filter. However, there were no unsafe outcomes associated with any of the riders' actions in this study. Accordingly, the results cannot be taken to infer that the SA of filtering riders was any less safe than that of the non-filtering motorcyclists, or vice-versa. Nevertheless, this finding applies to most short-term research studies in which the likelihood of unsafe events including near misses and collisions, in particular, are rare.

Currently in Victoria, as in other jurisdictions, the incidence of near misses or crashes resulting from lane filtering is unknown due to a lack of definitive research in the area. A long term naturalistic study is required to assess the safety implications of lane filtering by motorcyclists at intersections. Such an investigation would provide the backdrop for a more definitive exploration of potential SA differences between filtering and non-filtering motorcyclists in a larger study on this topic.

Lastly, situation awareness is likely to be different in novice compared to experienced motorcyclists, as has been found in novice compared to experienced car drivers (e.g. Salmon, Lenné, Young and Walker, 2011). However, this study was too small to examine the impact of age or experience on SA, given the very small number of lane filtering cases. Anecdotal evidence suggests that lane filtering is not encouraged in very novice motorcyclists who are still mastering basic riding skills (Road Safety Committee, 2012). However, due to a lack of research in the area, there is no evidence that novices are more likely to filter or more likely to encounter traffic conflicts whilst filtering. Differences in SA between novice and experienced motorcyclists could be explored as a secondary aim in the larger program of research on lane filtering and SA in motorcyclists.

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