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A simulator study investigating how motorcyclists approach side-road hazards

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ABSTRACT

The most common form of motorcycle collision in the UK occurs when another road user fails to give way and pulls out from a side road in front of an oncoming motorcyclist. While research has considered these collisions from the car driver's perspective, no research to date has addressed how motorcyclists approach these potential hazards. This study conducted a detailed analysis of motorcyclist speed and road position on approach to side-roads in a simulated suburban setting. Novice, Experienced and Advanced riders rode two laps of a simulated route, encountering five side-roads on each lap. On the second lap, a car emerged from the first side-road in a typical 'looked but failed to see' accident scenario. Three Experienced riders and one Novice rider collided with the hazard. The Advanced rider group adopted the safest strategy when approaching side-roads, with a lane position closer to the centre of the road and slower speeds. In contrast, Experienced riders chose faster speeds, often over the speed limit, especially when approaching junctions with good visibility. Rider behaviour at non-hazard junctions was compared between laps, to investigate if riders modified their behaviour after experiencing the hazard. Whilst all riders were generally more cautious after the hazard, the Advanced riders modified their behaviour more than the other groups after the hazard vehicle had pulled out. The results suggest that advanced training can lead to safer riding styles that are not acquired by experience alone.

1. Introduction

Motorcycles account for a disproportionate number of road traffic accidents. As of June 2010, motorcycles constituted less than 1% of the total vehicle miles on UK roads, but accounted for 21% of all UK road fatalities (DfT, 2010 a,b,c). Research has shown that car driver failures to give way at T-junctions are one of the three main causes of accidents involving motorcycles in the UK (Clarke et al., 2007). In a recent report, 54.3% of motorcycle accidents took place at an intersection and in 60% of these cases, the motorcyclist collided with a passenger car (MAIDS, 2009). These accidents are characterized by other road users emerging from a side-road onto a main carriageway into the path of an approaching motorcycle. In such cases drivers often report failing to see the motorcycle, despite looking in the appropriate direction. This has been termed a 'look but fail to see' (LBFTS) error (Brown, 2002).

There has been much debate as to the cause of LBFTS errors (see Crundall et al., 2008b, for a review of potential causes). Crundall et al. (2008a) proposed three stages to a LBFTS error, with a failure in anyone of these stages potentially leading to a collision. First the driver must *look* at the approaching motorcycle, then process and *perceive* the motorcycle, before *appraising* the risk it poses and selecting an appropriate action. A mixture of bottom-up factors (e.g. luminance, contrast, spatial frequency, etc.) and top-down factors (expectancy, experience, perceptual biases, etc.) are likely to be responsible for any errors. Interestingly, while novice drivers are typically at greater risk of collision than more experienced drivers (e.g. Underwood, 2007), experienced drivers may actually have a more deep-seated expectancy to see an oncoming car rather than a motorcycle while waiting to exit a side-road and therefore be more prone to LBFTS errors. Indeed Crundall et al. (2012a) eye-tracked participants watching videos clips from the perspective of a driver waiting to pull out from a side road and found that experienced car drivers had inappropriately short gaze durations on approaching motorcycles. Such short gaze durations (compared to those on approaching cars) are linked with limited or inadequate processing, and are therefore symptomatic of a LBFTS error. More specific experience can be beneficial however, with some researchers reporting that car drivers who also ride motorcycles (or have at least ridden pillion) are less likely to collide with motorcycles while driving a car (Brooks and Guppy, 1990; Magazzù et al., 2006).

While the car-drivers' perspective has received considerable focus, it would appear that no research has looked at side-road collisions from the rider's perspective. Given the prevalence of accidents at these junctions, it is likely that many motorcyclists recognise

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them as a potential source of danger, therefore one might expect riders to slow down on approach to these junctions and to select a road position that improves their safety. Furthermore, one would expect that Experienced riders, who have probably witnessed more accidents or near-misses, should be more aware of potential side-road hazards than inexperienced riders, and may therefore display more pronounced precautionary behaviour when approaching side roads, especially when they contain another vehicle waiting to pull out.

Many studies have indicated that the hazard perception skill of car drivers is positively related to experience and training (e.g. Chapman et al., 2002; Crundall et al., 2010; Groeger and Chapman, 1996; Quimby et al., 1986; McKenna et al., 2006; McKenna and Crick, 1994; Pollatsek et al., 2006; Wallis and Horswill, 2007), thus one might also expect motorcycling experience and training to improve motorcycle-perspective hazard perception skills, such as identifying vehicles in side roads who may pose a threat.

More recently, simulator studies have begun to confirm that the positive effects of experience on hazard perception are also evident for motorcyclists (Liu et al., 2009; Hosking et al., 2010; Shahar et al., 2010; Vidotto et al., 2011). Generally, experienced motorcyclists are better at detecting hazards than novices and motorcycling experience appears to improve hazard perception over and above car driving experience (Hosking et al., 2010).

If experience of hazards improves a motorcyclist's ability to spot them in the future, one might question what mechanism may be used to achieve this. Shinoda et al. (2001) suggest that car drivers perform an active search of the environment, influenced by a learnt probabilistic structure. Extrapolated to motorcyclists one can imagine that experience of a side-road hazard is likely to increase the perceived probability of future cars emerging from side-roads, resulting in a change in behaviour when the rider approaches subsequent side-roads. If riders are guided by a learned probabilistic structure, then experiencing a hazard could modify this via one of at least two ways.

First, one might expect that riders could assign a probability to the hazard occurring in subsequent situations on the basis of *similarity*. The higher the degree of similarity between the original hazard scenario and subsequent situations, the higher the perceived probability will be of the hazard recurring in the subsequent situation. This means that riders who have experienced a car emerging from a side-road will assign a higher probability to that hazard arising again at a subsequent side-road if they can see a car approaching or if the surroundings are similar to the original scenario.

Alternatively, riders could assign a probability of the hazard occurring in subsequent situations on the basis of *uncertainty*. In this case, riders who have experienced a car emerging from a side-road will still assign a higher probability to that hazard arising again at a subsequent side-road if they can see a car approaching, but also if they are uncertain that junction is empty (i.e. if their view of the junction is obscured).

Since similarity and uncertainty are both subjective, the probabilities assigned by different riders are likely to depend on what aspects of the situation the rider pays attention to.

1.1. Rationale

The primary aim of this study was to demonstrate whether riders of differing experience and training approach side roads differently, and whether this can be identified in a motorcycle simulator. On the basis of previous research suggesting experience leads to greater hazard awareness (Liu et al., 2009; Hosking et al., 2010; Shahar et al., 2010; Vidotto et al., 2011), more Experienced riders might be expected to approach side-roads at slower speeds than Novice riders and adopt a road position that is further from the potential source of danger. While this common-sense hypothesis appears well founded (i.e. if one notices a hazard then speed and position should be altered accordingly to reduce the possibility of collision), it is also possible that Experienced riders may choose to increase speed to pass the junction before the vehicle in the side road can pose a threat. Either way, one might predict a change in speed if Experienced riders predict a hazard ahead.

At least one study has however demonstrated that experienced car drivers do not necessarily outperform their novice counterparts on every measure. Duncan et al. (1991) found experienced drivers were outperformed by both novice and advanced drivers (the latter having had advanced driver training) in certain measures such as mirror checks. Duncan et al. suggested that this was because some poor behaviours are rarely punished (e.g. poor blind-spot checking) resulting in experienced drivers developing 'bad habits' that are only corrected when the driver has a collision (or near collision), or possibly through the advanced training that Duncan et al.'s third group had undertaken. Thus while a naïve view of the role of experience might argue for a linear improvement in behaviour related to a potential side-road hazard across novice to Experienced to Advanced riders, it is also possible that Experienced riders may show a dip in performance compared to the other two groups. The following study aims to establish whether the benefits of experience and advanced training are cumulative or different.

In addition to assessing differences between rider groups on approach to side roads, this study can assess how these riders respond when an actual hazard occurs (on one side road a vehicle fails to give way, causing a hazard). Riding measures can also be investigated to assess how exposure to the hazard influences approach behaviour to subsequent side-roads. Can a one-shot exposure change approach behaviour, and if so, does it work through scenario similarity or through uncertainty?

2. Method

2.1. Participants

Sixty-two participants were reimbursed for their time. Participants were filtered for excessive driving experience so that anyone with a typical annual mileage over 17,000 miles per annum or who held any other type of driving licence (e.g. large goods vehicle) was excluded from the study. One rider withdrew due to simulator sickness leaving 20 Novice riders, 21 Experienced riders and 20 Advanced riders. Novice riders (mean age = 26.5 years; SD = 8.2 years) were post-compulsory basic training (CBT; which allows them to ride with Learner plates) and either preparing to take the standard Driving Standards Agency (DSA) motorcycle test, or had passed it within the last 12 months. They averaged 7.7 h riding per week (SD = 5.3) and 3711 miles per year (SD = 2997). Experienced riders (mean age = 40.6 years; SD = 9.3 years) had over three years' riding experience since passing the standard DSA motorcycle test, but had no further training (7.3 h riding per week, SD = 5.8, and 4318 miles per year, SD = 3319). Advanced riders (mean age = 47.4 years; SD = 9.2 years) had passed their Institute for Advanced Motorists (IAM) advanced riding test in the last three years. Experienced and Advanced riders were matched on overall riding experience (mean = 16.1 years), although Advanced riders rode more (8.8 h per week, SD = 6.2), and had greater mileage (7400 miles per year, SD = 4357).

2.2. Apparatus

The MotorcycleSim facility consists of a full size Triumph Daytona 675 with standard user input controls. 'STISIM-Drive' simulation software takes throttle, gears and braking input along with