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Factors influencing noncompliance with bicycle passing distance laws

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ABSTRACT

Many jurisdictions around the world have implemented laws to require a minimum distance when motor vehicles pass cyclists, but research into the factors influencing passing distances has produced inconsistent results, indicating the need for future research. This study examined the factors influencing motorists' compliance with a legislated bicycle passing distance rule in Queensland, Australia. Unlike the earlier studies, which used volunteer riders to record passing events, this study used a naturalistic study design to record passing events where none of the motorists or the cyclists were aware of being studied. As a result, this study captured the 'true' driving and riding behaviours during passing events. The likelihood of non-compliance was greater on higher (70–80 km/h speed limits) and lower (40 km/h) speed roads than 60 km/h roads, at curved road sections, and on roads with narrower traffic lanes. Rider characteristics (age, gender, helmet status, type of clothing, type of bicycle, and individual or group riding) had no statistically significant association with compliance status. The findings indicate that efforts to improve cyclist safety during overtaking events should focus on non-rider related factors, such as roadway infrastructure characteristics.

1. Introduction

Crashes involving a motor vehicle passing a cyclist are a key concern for cyclist safety. Many bicycle-motor vehicle crashes occur while travelling in the same direction and involve rear-end and sideswipe collisions (Stone and Broughton, 2003; Walker, 2007; Pai, 2011). In the UK, 13% of bicycle crashes involve motorists' overtaking cyclists (Walker and Jones, 2005). In Australia, side-swipe collisions between cyclists and motorists account for 14% of fatal bicycle crashes (BITRE, 2015). Motorists are at fault in the majority (57%) of bicycle-motor vehicle crashes (Haworth and Debnath, 2013), and passing too closely is the most common incident type (40.7%) (Johnson et al., 2010). Researchers (Parkin et al., 2007) have argued that close-passing events, even those events which do not result in crashes, make cyclists feel unsafe and discourage them from riding. In response, many jurisdictions around the world (e.g., 27 states and the District of Columbia in the USA, France, Portugal, Spain, several states of Australia) have implemented laws on the minimum lateral distance a motor vehicle driver should leave when overtaking a bicycle.

The distances left when motor vehicles pass bicycles and the factors influencing this distance have been the subject of considerable research. Some studies (e.g., Walker, 2007, Olivier and Walter, 2013, Walker et al., 2014, Llorca et al., 2017) examined the effects of rider and/or motorist characteristics on passing distances. Others (e.g., Parkin and Meyers, 2010, Love et al., 2012, Chapman and Noyce, 2014, Shackel and Parkin, 2014) focused on the effects of roadway geometric and/or traffic characteristics. Some researchers (e.g., Chuang et al., 2013) considered all or a selected set of these four types of characteristics.

Nevertheless, some key gaps exist in the literature. Firstly, bias might be present in the way earlier research measured passing distance. For example, the earlier studies involved volunteer cyclists or researchers themselves riding an instrumented bicycle. As these cyclists were aware of the study, their riding behaviour might have influenced the passing distance, resulting in biased measurements (Duthie et al., 2010). Measuring passing distances to actual cyclists, who are unaware of the study or the fact that their behaviour is being monitored or recorded, would remove this source of bias.

Secondly, studies of the factors influencing bicycle passing distances have produced inconsistent results. For example, Walker (2007) and Chuang et al. (2013) found differences according to rider appearance or perceived experience, while Walker et al. (2014) found that close passing events occurred regardless of rider appearance (although the word "POLICE witness.com" written in two separate lines on a vest with the word "POLICE" written in a larger font size seemed to increase passing

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distances). Walker (2007) established relationships between passing distance and helmet wearing, which was questioned in a re-analysis by Olivier and Walter (2013). Type of motor vehicle passing the cyclist was a significant predictor of passing distance in some studies (e.g., Walker, 2007, Parkin and Meyers, 2010; Pai, 2011; Chuang et al., 2013), but not others (Love et al., 2012). These inconsistent findings in the literature indicate that there is a need for further research on the factors affecting passing distance.

Thirdly, most of the earlier research focused on studying the effects of rider and roadway characteristics in isolation. While some efforts have been made to examine the combined effects of these factors (e.g., Chuang et al., 2013), there is a need to comprehensively examine the effects of rider, motorist, roadway, and traffic characteristics on passing distance. An understanding of these factors will allow for countermeasures for reducing close passing distances to be developed that focus on non-rider factors, such as infrastructural, educational, and legal countermeasures, as suggested by Walker et al. (2014).

This paper aims to address the above mentioned gaps by examining the factors influencing motorists' compliance with a legislated passing distance rule. Unlike the earlier studies which used volunteer riders to record passing events, this study used a naturalistic study design to record passing events where none of the motorists or the cyclists were aware of being studied. The findings of this study represent the 'true' driving and riding behaviours on roads. Use of this data collection approach in the literature concerning bicycle passing distances is a key strength of this study.

2. Method

2.1. Study setting

This research was conducted in the State of Queensland, Australia. Queensland has 4.7 million inhabitants, of which 2.3 million live in the capital city, Brisbane (ABS, 2017). The climate varies from sub-tropical to tropical, which allows year-round cycling. A recent national survey estimated that about 17% and 35% of the Queensland population rode a bicycle in the previous week and the previous year, respectively (Austroads, 2017). Of those who cycled in the last month, 75% rode for recreation and 40% rode for transport. Most urban roads in Queensland have signed 60 km/h speed limits. Vehicles drive on the left side of the road, and cycling on the footpath is legal for riders of all ages unless there are signs prohibiting riding.

Queensland implemented a Minimum Passing Distance (MPD) rule in April 2016 after a 2-year trial. The stated purpose of the rule is to clarify any ambiguity about safe passing distances and to encourage motorists to provide a suitable amount of space between cyclists and their vehicle (TMR, 2015). The rule requires motorists to maintain a minimum lateral passing distance of 1 m (3 feet) when overtaking cyclists in a speed zone of 60 km/h (37 mph) or less, and 1.5 m (5 feet) when the speed limit is greater than 60 km/h (37 mph). In order to comply with the law, drivers overtaking cyclists are exempt (where it is safe to do so) from the general prohibitions on driving over centre lines (including double unbroken centre lines) on 2-way roads, straddling or crossing a lane line (including a continuous lane line) on a multi-lane road, and driving on a painted island. Motorists who breach the law receive a fine of three penalty units and AU$378 fine (in July, 2017) and incur three demerit points. A maximum fine of AU$5000 (in July, 2017) can apply if the matter goes to court.

2.2. Data collection

Video observations of cyclists were made at 15 sites that included urban and suburban locations in South East Queensland, regional Queensland, and tourist areas. The sites were selected to maximise the likelihood of observing sufficient cyclists (and therefore passing events) to allow robust data analysis, and the availability of roadside infrastructure to mount video cameras for data collection. At these sites, the number of cyclists over four days ranged from 46 to 5968. Very few passing events (4–15 observations per site) were observed at five of these sites, and so they were excluded from the current analysis. Table 1 summarises the characteristics of the 10 remaining sites. Among the 10 sites, 7 had posted speed limits of 60 km/h or less (minimum passing distance of 1 m in the MPD rule) and the other 3 sites had speed limits of 70 km/h or more (minimum passing distance of 1.5 m in the MPD rule). Examination of passing distances and cyclist volumes at these sites did not show meaningful relationship between cyclist volume and passing distance ($r = -0.17$). The video-based observation method meant that accurate demographic information about cyclists and motorists (e.g., age, education, income) could not be collected, and therefore, it was not possible to conduct statistical tests of the sample's representativeness.

Table 1
Data collection sites for observation of passing events.

Road name	Suburb	Region	Speed limit (km/h)
Breakfast Creek Rd	Newstead	Brisbane	60
Annerley Rd	Dutton Park	Brisbane	60
Jacaranda Av	Logan	Brisbane	60
Grey St	South Brisbane	Brisbane	40
Montague Rd	West End	Brisbane	60
Sandgate Rd	Bracken Ridge	Brisbane	70
Cooroy-Noosa Rd	Tewantin	Sunshine Coast	80
Dean St	North Rockhampton	Rockhampton	60
The Esplanade	Surfers Paradise	Gold Coast	40
Hope Island Rd	Hope Island	Gold Coast	70

Video data were collected using cameras attached to roadside poles or sign posts and equipped with infrared filters to enable both day and night recordings. Data were collected on 16–19 April and 7–10 May 2015 (Thursday to Sunday inclusive) after the Minimum Passing Distance rule had been in effect for more than 12 months (the trial of the rule started on 7 April 2014). Surveys conducted among cyclists and motorists at about the same time (Schramm et al., 2016) showed that 98.5% of cyclists and 94.8% of motorists were aware of the MPD rule.

Passing events were recorded using a camera (Eazzy Digital Video Technology Company model DC-910i) of image resolution 640 × 480 pixels mounted 3–4 m above ground level. Video data were recorded at 12 frames per second, and therefore, most passing events were captured in more than one frame of video. The passing events were first identified manually by a research assistant, and then the video images were processed, in order to measure passing distances. A point-and-click custom Python script was developed to measure the distances by manually selecting the edges of the cyclists and the overtaking vehicles, from the video image when a motorist was overtaking a cyclist. The script calibrated a distance measured on the pixel-scale of the video images (the width of the traffic lane visible within the video images) by transforming it to a real-world distance (i.e., scaling with the real-world width of the traffic lane). Therefore, the measured passing distance on the video images could easily be converted to the real-world distances.

Depending on the distance between the camera and the passing event, the number of pixels on the video image filled by vehicles and cyclists – and by the passing distance - varied. On average, vehicles were 100–150 pixels wide and cyclists were 30–50 pixels wide when a passing event occurred near the camera, and about half this when a passing event occurred at mid-distance from the camera. Close to the camera, each pixel represented about 0.015–0.021 m, whereas in the mid-distance each pixel represented about 0.029-0.048 m. The maximum errors in passing distance measurement were estimated to be 0.045–0.064 m for events near the camera and 0.080–0.132 m for events in the mid-distance. To minimise estimation errors, only those passing events that were not obscured by other vehicles or vegetation and were sufficiently close to the camera to allow the edges of the