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journal homepage: [www.elsevier.com/locate/aap](http://www.elsevier.com/locate/aap)

Full length article

## The impact of environmental factors on cycling speed on shared paths

Soufiane Boufous<sup>a,\*</sup>, Julie Hatfield<sup>b</sup>, Raphael Grzebieta<sup>b</sup><sup>a</sup> School of Aviation, Transport and Road Safety (TARS) Research, The University of New South Wales, Sydney, Australia<sup>b</sup> Transport and Road Safety (TARS) Research, The University of New South Wales, Sydney, Australia

## ARTICLE INFO

## Keywords:

Shared path

Cycling

Speed

Safety

## ABSTRACT

**Background:** Despite the importance of cycling speed on shared paths to the amenity and safety of users, few studies have systematically measured it, nor examined circumstances surrounding it.

**Methods:** Speed was measured for 5421 riders who were observed cycling on shared paths across 12 metropolitan and regional locations in Sydney, Australia. Multivariate regression analysis was carried out to examine rider and environmental factors that contribute to riders cycling above the median speed.

**Results:** The study found that observed riders travelled at a median speed of 16 km/h (mean 18.4 km/h). Nearly 80% of riders travelled at 20 km/h or less and 7.8% at speeds of more than 30 km/h. Riders were significantly less likely to cycle above the median speed on shared paths that had an average volume of over 20 pedestrians/hour. Riders were significantly more likely to travel above the median speed on paths that had a centreline (OR: 1.71, 95% CI: 1.41–2.07), on wider paths (over 3.5 m) (OR: 1.34, 95% CI: 1.12–1.59) and on paths with visual segregation between cyclists and pedestrians. Visual segregation, where cycling and walking areas are differentiated by the type of material or by paint colour used, was the strongest predictor of travelling above median speed on shared paths (OR: 3.9, 95% CI: 3.1–4.8).

**Conclusions:** The findings suggest that riders adjust their speeds to accommodate pedestrians and path conditions. Path characteristics that support separation from pedestrians may allow relatively higher speeds, and associated amenity, without substantial loss of safety.

## 1. Introduction

Active transport is increasingly encouraged worldwide due the health, societal, environmental and economic benefits attributed to walking and cycling (Gordon-Larsen et al., 2009; Bassett et al., 2008; Maibacha et al., 2009). Broad public policies, including the provision of appropriate infrastructure, have been developed by governments to support these activities whilst maintaining the safety of pedestrians and cyclists. In various countries, shared paths are frequently used to meet demand for cycling facilities that are separate from motorised traffic when space or resources are deemed inadequate for a bicycle-only path.

However, there are increasing concerns about the safety offered by shared paths (Poulos et al., 2015; De Rome et al., 2015). About half of crashes experienced by bicycle riders on shared paths are due to falls off the bicycle mainly as result of loss of control or collision with an object, while a smaller proportion (1 in 6) are collisions with pedestrians (Chong et al., 2010; Poulos et al., 2015; De Rome et al., 2015). A considerable proportion of crashes associated with shared paths are bicycle–bicycle collisions or collisions with motor vehicles [MV] at intersections (Chong et al., 2010; Poulos et al., 2015; De Rome et al.,

2015). It is important to note that falls may be due to cyclist swerving to avoid pedestrians or other cyclists.

Cycling speed is likely to be a key factor in the likelihood and severity of crashes on shared paths. It is generally recognised in the road safety literature that crash likelihood and severity increase with vehicle speeds (Aarts and Van Schagen, 2006), and the same should apply to all types of bicycle crashes occurring on shared paths. For collisions between cyclists and pedestrians, the wide difference in speed may result in serious injuries to the pedestrian (Chong et al., 2010; Short et al., 2007).

While previous observational studies have examined conflicts between cyclists and pedestrians and between cyclists and motorised traffic (Haworth et al., 2014; Grzebieta et al., 2011), few studies have systematically measured cycling speed on shared paths, nor examined the different approaches to managing it. Moreover, little is known about the environmental, situational, and personal factors that may influence cycling speed, to assist with targeting interventions. This study aims to address these knowledge gaps by measuring cycling speeds on shared paths in Sydney metropolitan and regional areas and investigating the factors that contribute to variations in speed.

\* Corresponding author.

E-mail addresses: [Soufiane@unsw.edu.au](mailto:Soufiane@unsw.edu.au) (S. Boufous), [J.hatfield@unsw.edu](mailto:J.hatfield@unsw.edu) (J. Hatfield), [R.Grzebieta@unsw.edu.au](mailto:R.Grzebieta@unsw.edu.au) (R. Grzebieta).<http://dx.doi.org/10.1016/j.aap.2017.09.017>

Received 4 August 2017; Received in revised form 17 September 2017; Accepted 17 September 2017

0001-4575/© 2017 Published by Elsevier Ltd.

## 2. Materials and methods

### 2.1. Approach

This paper reports on one component of a larger study that examined various issues related to shared path safety including behaviour of, and interactions between, various shared path users. The paper focuses on cycling speed. Nonetheless, interactions played a central role in the methodology, as described below.

Within observation zones at twelve shared paths in metropolitan Sydney and regional New South Wales (NSW), interactions between randomly selected bicycle riders and other path users (pedestrians, bicycle riders, or others) were observed, and details associated with these interactions recorded. Cycling speed was measured by video-recording cyclists passing through a 4 m “speed-measurement stretch” at one end of each observation zone.

### 2.2. Site selection

Ten shared path locations in metropolitan Sydney and two shared path locations in Wollongong (a regional centre 90 km south of Sydney) were selected with the aim of examining key path characteristics. Three Sydney sites were narrow (less than 2.5 m), four were of medium width (2.5–3.5 m), and three were wide (more than 3.5 m). One Wollongong site was narrow and the other was wide. Eight Sydney locations and one Wollongong location had a centreline. Seven locations (all in Sydney) were judged a priori to serve primarily commuting purposes at their peak time of usage. Table 1 summarises the sites and their characteristics.

Two Sydney locations involved “visual segregation” of bicycle riders and pedestrians. That is, cycling and walking areas were differentiated by the type of material or by paint colour. These paths are distinct from “separated” paths where cycling and walking areas are physically separated by a barrier such as a grass median strip, railings, kerbs, or walls. It is noted that the terms “segregated” and “separated” are used inconsistently in the literature.

### 2.3. Site set-up and equipment

At each location, an “observation zone” of approximately 30 m was selected – to allow good visibility for observers and for videoing. At one end of each observation zone a 4 m “speed measurement stretch” (SMS) was marked out by drawing lines in chalk on the path. Video equipment (GoPro Hero 3 Black Edition camera) was set up centred on the SMS and at a minimum of 1.5 m back from the path-edge to capture the view of bicycle tyres crossing the lines in the SMS for speed measurement. A second camera was positioned at the same end of the observation zone to capture the entire observation zone. A pair of observers stood beside the video equipment to make observations of interactions between randomly selected bicycle riders and the other path users. The standard

observation zone set-up is depicted in Fig. 1.

### 2.4. Procedures

Ethical approval for the study was obtained from the UNSW Human Research Ethics Committee. Anyone who approached the observers was offered a Participant Information Statement and given an explanation of the research.

Observations were conducted from 16 October 2013 to 21 December 2013. Observations were conducted on three weekdays (on Wednesdays, Thursdays and Fridays) and one weekend day (Saturday) at each site (except for one location, where only 2 weekday sessions were conducted due to inclement weather). On weekdays sessions were during the morning peak (07:30–09:30) and the afternoon peak (16:30–18:30), while Saturday sessions were from 10:00–12:00 and from 13:00–16:00.

The first cyclist to enter the observation zone from either end (Fig. 1) when the previous set of observations was complete was the “trigger cyclist” participant. If the trigger cyclists would not interact with another path user in the observation zone, then only the trigger cyclist was observed. If the trigger cyclist interacted with one or more other path users in the observation zone then an interaction partner was selected for observation in the following priority order:

- 1 The first pedestrian passed or met by the trigger cyclist.
- 2 The first other cyclist passed or met by the trigger cyclist (if no pedestrian would be passed or met).
- 3 The first user other than a pedestrian or cyclist passed or met by the trigger cyclist (if no pedestrian or cyclist passed or met).

### 2.5. Analysis

The time taken to cover the 4 m speed measurement stretch was employed to calculate speed. Information about the frame rate of the cameras allowed calculation of the time taken to cover this 4 m interval. The observation zone video was used to obtain counts of each user type passing through the observation zone for 2.5 h at each site (30 mins during a morning peak and 30 min during an evening peak on each of 2 weekdays, and 30 mins during a Saturday). This is to measure the general level of path use (Atkins, 2012).

In addition to relevant descriptive analysis, particularly of cyclists’ speed on shared paths (mean with 95% confidence intervals, median, minimum and maximum speeds), multivariate regression analysis was carried out to examine factors that contribute to riders cycling above the median speed. Independent factors examined at the univariate level include path characteristics (primary path use, path width, path centreline, visual segregation and pedestrian traffic volume), environmental factors (Weekday vs Weekend, Am vs Pm and interaction with a pedestrian) as well as characteristics and behaviours of the rider (age, gender, rider companions and use of potential distractor, such as mobile

**Table 1**  
Locations for field observations showing key characteristics.

	Location	Width	Centreline	Visual segregation	Primary commuter use
1	Spit Bridge	Narrow	No	No	Yes
2	St Leonards Park, North Sydney	Narrow	No	No	Yes
3	Marine Parade, Manly	Narrow	Yes	No	No
4	Grand Pacific Drive, Wollongong	Narrow	Yes	No	No
5	Naremburn Cycleway, Naremburn	Medium	Yes	No	Yes
6	Victoria Road, Rozelle	Medium	Yes	No	Yes
7	Wansey Road, Randwick	Medium	Yes	No	Yes
8	Anzac Parade, Moore Park	Medium	Yes	No	No
9	Naremburn cycleway, Artarmon	Wide	Yes	Yes	Yes
10	Anzac Bridge, Pyrmont	Wide	Yes	No	Yes
11	Prince Alfred Park, Surry Hills	Wide	Yes	Yes	No
12	Cliff Road, Wollongong	Wide	No	No	No

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