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Safety perceptions and reported behavior related to cycling in mixed traffic: A comparison between Brisbane and Copenhagen

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ABSTRACT

This study explores the differences in safety perceptions and reported behavior of cyclists in mixed traffic between an emerging cycling city (Brisbane, Australia) and an established cycling city (Copenhagen, Denmark). Perceptions and reported behavior were retrieved from a custom-designed web-based survey administered among cyclists in the two cities. Elicited items concerned perceived risk of infrastructure layouts, fear of traffic, cycling while distracted, use of safety gear, cycling avoidance due to feeling unsafe, and avoidance to cycle in mixed traffic conditions. The data were analyzed with structural equation models. Results show that, in comparison with cyclists in Copenhagen, cyclists in Brisbane perceive mixed traffic infrastructure layouts as less safe, feel more fear of traffic, and are more likely to adopt cycling avoidance as a coping strategy. Results also show that cyclists in Copenhagen tend to use less helmets and to cycle more while being distracted.

1. Introduction

Over the last two decades, the number of cyclists has been rising dramatically in North American, Australian, South American and European major cities with car-oriented street design and marginal cycling mode shares (e.g., Buehler & Pucher, 2012; Pucher, Buehler, & Seinen, 2011; Pucher, Dill, & Handy, 2010; Pucher, Garrard, & Greaves, 2011). Authorities in these cities have implemented a wide range of bicycle-friendly policies such as the development of bicycle infrastructure, the design of bicycle sharing schemes, and the promotion of training and educational programs (e.g., Pucher et al., 2010). The rapid growth in the number of cyclists and the transformation of the city landscape characterizes these cities as emerging cycling cities (see Copenhagenize, 2013). Nevertheless, when the development of bicycle infrastructure is lagging behind in terms of length, continuity, and design (e.g., Krizek & Roland, 2005; Pucher et al., 2011b), emerging cycling cities still experience cyclists being forced to share the road with motorized vehicles. This constitutes a challenge that hampers the transition towards higher bicycle mode shares and becoming established cycling cities such as Amsterdam, Copenhagen and Utrecht (see Copenhagenize, 2013), as the road sharing experience is associated with a sense of threat and high emotional stress among cyclists (e.g., Heesch, Sahlqvist, & Garrard, 2011; Kaplan & Prato, 2013; O'Connor & Brown, 2010).

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Comparing cities has proved useful for analyzing the association between pro-cycling policy measures and cycling growth rates (e.g., Pucher & Buehler, 2006, 2008; Pucher et al., 2010; Pucher et al., 2011a), uncovering the "safety in numbers" phenomenon that relates an increase in the number of cyclists to a decrease in the crash risk of cyclists (e.g., Elvik, 2009; Jacobsen, 2003), and understanding the role of legislation in the usage rate of helmets and bicycle lights (Osberg, Stiles, & Asare, 1998). These comparisons have focused on policy measures and their effect on bicycle mode shares, calculated risk and rates of cyclists wearing safety gears. Therefore, these studies focused only on implemented policies and overt behavior, while differences and similarities across cities with respect to attitudes and perceptions remained unexplored. Attitudes and perceptions serve as important mediators between policy implementation and behavior, because they are important factors in gaining public acceptability of transport policy measures (Di Ciommo, Monzón, & Fernandez-Heredia, 2013) on the one hand, and they are fundamental factors affecting transport intentions and decisions (Heinen, Maat, & van Wee, 2011; Sigurdardottir, Møller, Kaplan, & Teasdale, 2013) on the other hand. So far, only one study has benchmarked perceptions and attitudes of cyclists in two cities for gaining insights regarding the differences in social norms and beliefs about health, environmental, and safety effects of cycling (Heinen & Handy, 2012). Heinen and Handy (2012) based their study on exploratory open-ended interviews of a small sample of cyclists (15 respondents per city) and showed the usefulness of benchmarking perceptions and attitudes in cities with different cyclist shares for revealing potential encouraging and impeding factors to the decision to cycle. Nevertheless, a systematic large-scale analysis is required for a statistically significant comparison.

The current study is in continuum to the line of research proposed by Heinen and Handy (2012), and extends the existing knowledge with a statistically rigorous comparative analysis of cyclists' safety perceptions across cities. Specifically, the objective of the current study is to provide a systematic comparison of safety perceptions and reported behavior of cyclists related to cycling in mixed traffic in an emerging cycling city (Brisbane, Australia) and an established cycling city (Copenhagen, Denmark). The current study focuses on perceptions and reported behavior related to safety because of the wide agreement among researchers that safety perceptions form an important barrier to the societal transition towards higher bicycle mode shares, in particular in emerging cycling cities (e.g., Gatersleben & Appleton, 2007; Heesch et al., 2011; Joshi, Senior, & Smith, 2001; Kaplan & Prato, 2013; Lawson, Pakrashi, Ghosh, & Szeto, 2012; O'Connor & Brown, 2010; Parkin, Wardman, & Page, 2007; Rondinella, Fernández-Heredia, & Monzón, 2012). Previous studies on safety perceptions and reported behavior have focused on a single geographical region by exploring the effects of infrastructure layouts (e.g., Krizek & Roland, 2005; Møller & Hels, 2008; Parkin et al., 2007), cyclist-motorist interactions (e.g., Chaurand & Delhomme, 2013; Kaplan & Prato, 2013; King, Wood, Lacherez, & Marszalek, 2012; O'Connor & Brown, 2010; Wood, Lacherez, Marszalek, & King, 2009), and their combination (Lawson et al., 2012). Instead, the empirical results of the current study show a statistically significant difference in cyclists' safety perceptions between an established cycling city with a vast infrastructure of segregated cycling paths and where a cycling culture is established, versus an emerging cycling city with an infrastructure of on-road narrow and discontinuous cycling lanes and where cycling culture is emerging but not yet formed.

The analyzed data set consisted of a large sample of cyclists in Brisbane (Australia) as an emerging cycling city, and Copenhagen (Denmark) as an established cycling city (see Copenhagenize, 2013). The investigated safety perceptions were perceived safety of infrastructure and fear of traffic, while the reported behaviors were safety gear use, distracted cycling, cycling avoidance due to feeling unsafe, and cycling avoidance on the road in mixed traffic conditions. A closed-form questionnaire allowed a systematic analysis of safety perceptions and reported behavior across the two cities. The differences in cyclists' safety perceptions and reported behavior in Brisbane and Copenhagen were investigated while controlling for demographics and experience of cyclists and accounting for interdependencies across perceptions and reported behaviors. The analysis was conducted by means of a structural equations model (SEM) because of its suitability for accommodating the latent nature of perceptions and the observed nature of the cyclists' characteristics and behavior.

The remainder of the paper is structured as follows. Section 2 introduces the behavioral framework and the model formulation. Section 3 presents the study context and the data source. Section 4 details the estimation results and shows the differences between the two cycling populations. Sections 5 and 6 propose discussion of the results and conclusions of the study.

2. Methods

2.1. Behavioral framework

The current study focuses on perceptions and reported behavior of cyclists in mixed traffic on the basis of the literature concerning objective and subjective safety of cyclists. Six recurring constructs were identified in the literature: perceived safety of infrastructure layouts, fear of traffic, use of safety gear, distracted cycling, avoidance of cycling when feeling unsafe and avoidance of cycling in mixed traffic.

The *perceived safety of infrastructure layouts* has been extensively studied in recent years. The lack of bicycle infrastructure is one of the main barriers to cycling because of the consequent lack of perceived safety (e.g., Daley, Rissel, & Lloyd, 2007; Kaplan & Prato, 2013). The presence of cycle lanes is associated with reduced cyclist injury severity (Kaplan, Vavatsoulas, & Prato, 2013) and their use is related to a higher perceived safety of cyclists and a mitigation of the perception of risk on busy roads (Lawson et al., 2012; Parkin et al., 2007). Crashes involving a cyclist hit by a vehicle turning right form a significant portion of cyclist-motorist crashes (e.g., Kaplan et al., 2013; Schepers & den Brinker, 2011) and the presence of vehicles