



The role of perceived competence and risk perception in cycling near misses

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ABSTRACT

Cyclists' crashes account for a relatively large proportion of road fatalities and this proportion is increasing. Research suggests that near misses can be used as surrogate measures of crashes, based on the assumption that they share common causes. Also, in the cycling domain, it has been suggested that near miss incidents may provide 'early warnings' of situations or behaviours that could lead to crashes. The aim of this study was to investigate the role played by perception of risk and control on the exposure to risky situations, such as the involvement in mixed traffic. We administered a questionnaire to 298 Italian cyclists measuring perceived competence (i.e. perceived control and overconfidence), risk perception of interactions with cars, bicycle use, avoidance of mixed traffic and recent experiences of near misses. Path analysis using Bayesian estimation showed that perceived control, mediated by overconfidence, had a positive indirect effect on bicycle use and a negative one on avoidance of mixed traffic, while it acted as a moderator in the relationship between risk perception of interaction with cars and avoidance of mixed traffic. Furthermore, the mediation paths revealed the indirect effects of perceived control on near misses through exposure. Results highlighted the importance of considering the role of individuals' perception of their ability to cycle with regard to near misses and provided new insight on how cyclists regulate their behaviour, as well as how such behaviour leads to different safety outcomes. Results have implications regarding theory, infrastructure and the application of new safety technologies.

1. Introduction

Risk perception has been found to reduce risky behaviours and the probability of safety outcomes by behavioural adaptation both theoretically and empirically (Ba et al., 2016; Koornstra, 2009). Moreover, perceived competence, in the meaning of the perceived capabilities that one possesses over one task, has been also proposed to be part of the behavioural adaptation process influencing the level of difficulty associated with a task (Rudin-Brown and Jamson, 2013). Both risk perception and perceived competence are cognitive constructs of utmost importance when modelling road users' behaviour due to their relationship with behavioural adaptation, nevertheless, there is lack of research addressing their influence on cyclists' safety outcomes (i.e. near misses). Thus, the present study aims to shed light on the interactions between perceived competence and risk perception and their effect on cyclists' involvement in risky situations and safety outcomes in cycling.

1.1. Crashes and near misses among cyclists

In the last decade, the amount of research investigating cycling safety has dramatically increased (e.g. Heydari et al., 2017; Jacobsen et al., 2016; Osama and Sayed, 2016; Prati et al., 2017). Several reasons might be the source of such interest. First, even though cyclists represent a small minority in comparison with motorised vehicles (Prati et al., 2017), they account for a relatively large proportion of fatalities (ERSO, 2016). In fact, in 2014 there were 2112 cyclists' fatalities in the EU countries, which correspond to the 8.1% of all the road deaths (ERSO, 2016) showing an increase of 0.3% compared to 2013. In addition to this, infrastructure is usually not designed to provide cyclists with safety conditions comparable to other road users (e.g. car drivers), therefore, their level of protection is considerably lower (Wegman et al., 2012).

Fatality trends and other safety outcomes (e.g. the number of non-fatal crashes) vary along different EU countries. In Italy, according to the Italian National Institute of Statistics (ACI-ISTAT, 2015), on a total

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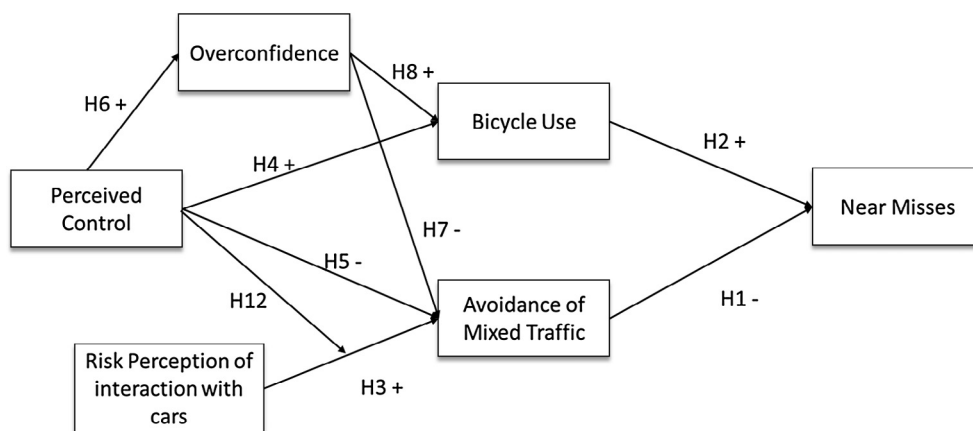


Fig. 1. Hypothesised path model. The characters next to each arrow point out the hypothesis and the sign of the expected association. Hypotheses 9–11 are not included since they foresaw mediation (i.e. involving more than one arrow).

of 17,437 crashes involving at least one cyclist in 2015, 16,827 cyclists were injured and 252 died within 30 days following the crash. These data show a decrease of 3.2% in the injuries and of 7.7% in the fatalities compared to the previous year. In Italy, the mortality index (deaths every 100 accidents) for cyclists is 1.44, which is higher in comparison with the mortality index of car users (0.88).

In the safety domain, using Heinrich's Safety Triangle model, accidents are on the pinnacle of the pyramid, whereas near misses are found below them being more frequent and less severe (e.g. Hamann and Peek-Asa, 2017). A near miss can be defined as an event that did not cause any harm and therefore has limited immediate impact. Near misses have been used as surrogate measures of crashes since they both have been found to share common causation (Wright and Van der Schaaf, 2004). Moreover, safety outcomes with lower severity (i.e. near misses) are more frequent, thus, more susceptible of being studied (Laureshyn et al., 2017). At a theoretical level, Güttinger (1982) proposed a model in which a conflict is defined as a set of initial conditions that, depending on the successfulness of the evasive action, either develop further into a collision or resolve without any consequences. This definition implies the existence of a continuum in which conflicts always precede crashes and with the possibility for the conflicts to develop either in a crash or in an avoided crash – near miss. In other words, this model can be interpreted in a way that a conflict is a set of circumstances that either results in a crash or not.

In the cycling domain, the relationship between near misses and crashes is yet to be understood. In accordance with Güttinger's (1982) model, Aldred (2016) suggests that near miss incidents may provide 'early warnings' of situations or behaviour that could lead to crashes. Moreover, Aldred (2016) compared percentages of attribution of near misses and crashes in the study of Knowles' et al. (2009) and found that they were very similar, giving support to the shared causation.

Despite these early studies, cycling near misses remain under-researched, regardless of their likely contribution to injury crashes (Aldred, 2016). Nevertheless, more and more innovative solutions and methodologies attempted to address such matter (i.e. Aldred and Croweller, 2015; Westerhuis and De Waard, 2016). Some studies, such as Aldred and Croweller (2015), and Joshi et al. (2001) in the UK, and Sanders (2015) in the San Francisco Bay Area, have also shown that near misses are a very common experience for cyclists. For example, using an online diary methodology, Aldred and Croweller (2015) found that the 75% of participants experienced at least .75 incidents per cycled hour, with a median of 1.71 per hour. Similarly, using a self-reported questionnaire, Sanders (2015) showed that 86% of those who bicycle at least annually in this sample had experienced some type of near miss.

1.2. Cycling levels and avoidance of mixed traffic as exposure

Exposure is of utmost importance when it comes to studying cycling safety. Research suggests that studies that intend to estimate the importance of factors other than exposure in crashes and injuries must control for exposure given to its overall effect on cycling safety and risk of crash and injury (Vanparijs et al., 2015). Moreover, its effect on crash and injury risk has been consolidated over the years by research (Carlin et al., 1995; Bacchieri et al., 2010).

In the present study, we consider exposure at two different levels: (1) exposure to cycling in general, that is to say, use of the bicycle; and (2) cycling in mixed traffic situations. The latter type of exposure allows for more opportunities for cyclists to interact with cars, which is of especial importance when considering risk. Evidence shows countries and cities with extensive bicycling facilities have the highest cycling modal split shares and the lowest fatality rates (Pucher, 2001; Pucher and Dijkstra, 2000). Those countries and cities without separate facilities have low modal split shares and much higher fatality rates (Buehler and Dill, 2016; Pucher and Dijkstra, 2000). However, in emerging cycling regions where cyclists are rapidly growing in number, cyclists are forced to share the road with motorised vehicles due to the underdevelopment of cycling infrastructure (e.g. Pucher et al., 2011). Cyclists in urban area may have to choose between (1) cycle within mixed traffic situations with shorter travel time, (2) cycle on bike lanes or segregated paths with a longer travel time, and (3) use other means of transport. The two latter options would imply avoiding mixed traffic and, therefore, the risk of conflicts with road users in it.

For this reason, in our model (Fig. 1) we hypothesise that, on the one hand, avoidance of cycling in mixed traffic will be negatively associated with the occurrence of near misses (Hypothesis 1). In other words, the more cyclists avoid mixed traffic situations, the lower the probability of being involved in a conflict (i.e. near miss), especially with vehicles generally involved in mixed traffic. On the other hand, concerning exposure to cycling in general and according to the aforementioned, we hypothesise a positive association between bicycle use and near misses (Hypothesis 2).

1.3. Risk perception of interaction with cars

Risk-adaptation theory proposes that road traffic risk perception depends on fear and arousal (Koornstra, 2009). Cyclists feel most secure on road with cycle tracks and most at risk on roads with mixed traffic, while cycle lanes can be considered half way: less secure than cycle tracks, but considerably more secure than mixed traffic roads (Jensen et al., 2007). In particular, it has been shown that the presence and the size of motor vehicles (Aldred, 2016) increase cyclists' feeling of being at risk. Moreover, previous experiences set up the adaptation level

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