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Evaluation of user behavior and acceptance of an on-bike system

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A B S T R A C T

In this study, users' acceptance of an on-bike system that warns about potential collisions with motorized vehicles as well as its influence on cyclists' behavior was evaluated. Twenty-five participants took part in a field study that consisted of three different experimental tasks. All participants also completed a follow-up questionnaire at the completion of the three-task series to elicit information about the acceptance of the on-bike system. In the experiment phase, participants were asked to ride the bicycle throughout a circuit and to interact with a car at an intersection. Participants completed three laps of the circuit. The first lap involved no interaction with the car and served the purpose of habituation. In the second and third laps participants experienced a conflict with an incoming car at an intersection. In the second lap, the on-bike device was not activated, while in the third lap, participants received a warning message signaling the imminent conflict with the car. We compared the difference in user's behavior between the second lap (conflict with a car without the warning of the on-bike system) and the third lap (conflict with a car with the warning of the on-bike system). Results showed that, when entering the crossroad, participants were more likely to decrease their speed in case of warning of the on-bike system. Further, the on-bike system was relatively well accepted by the participants. In particular, participants did not report negative emotions when using the system, while they trusted it and believed that using such technology would be free from effort. Participants were willing to spend on average 57.83 € for the system. This study highlights the potential of the on-bike system for promoting bicycle safety.

1. Introduction

Bicycle use is an alternative and complementary mode of transportation and is recognized to have individual health benefits (Götschi, Garrard, & Giles-Corti, 2016; Kelly et al., 2014) as well as societal benefits such as reduction in traffic congestion, air and noise pollution, and fossil fuel consumption (de Nazelle et al., 2011; Macmillan et al., 2014; Xia, Zhang, Crabb, & Shah, 2013). However, the adoption of cycling for transportation has been slowed due to safety concerns and because bicyclists are considered vulnerable road users (Wegman, Zhang, & Dijkstra, 2012), or better, minority road users (Prati, Marín Puchades, & Pietrantoni, 2017).

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Collisions involving motor vehicles account for the majority of the recorded bicyclists' crashes resulting in serious injuries and fatalities in police and hospital records (Chong, Poulos, Olivier, Watson, & Grzebieta, 2010; Nicaj et al., 2009; Prati, De Angelis, Marín Puchades, Fraboni, & Pietrantoni, 2017; Rosenkranz & Sheridan, 2003; Rowe, Rowe, & Bota, 1995; Sze, Tsui, So, & Wong, 2011). Although different factors account for bicycle–motorized vehicle collisions, the central role played by the behavior both of the cyclist and the driver of the opponent vehicle involved in the collision has been ascertained (Prati, Marín Puchades, De Angelis, Fraboni, & Pietrantoni, 2017). Based on that, it has been suggested the adoption of an on-bike system that informs cyclists about potential collisions with approaching vehicles (Prati, Pietrantoni, & Fraboni, 2017). However, to our knowledge, bicyclist's behavior and acceptance of an on-bike system that warns about potential collisions have not been yet evaluated. This paper aims to address this gap in knowledge by examining bicyclist's behavior and acceptance of an on-bike system.

The acceptance of intelligent transport systems has been conceptualized and operationalized in different ways (Huth & Gelau, 2013; Payre, Cestac, & Delhomme, 2014; Van der Laan, Heino, & De Waard, 1997; Vlassenroot, Brookhuis, Marchau, & Witlox, 2010; Wolf & Seebauer, 2014). Van der Laan et al. (1997) proposed a standardized checklist to assess drivers' acceptance of new technology. The Van der Laan scale comprises two dimensions, one denoting the usefulness of the system, and the other one designating satisfaction associated with the system. Among the theories and models of user acceptance of information technology, Venkatesh, Morris, Davis, and Davis (2003) described and analyzed different underlying basic concepts in behavioral models, such as the Theory of Planned Behavior (TPB; Ajzen, 1991), the motivational model (Vallerand, 1997), the Technology Acceptance Model (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989), and the Social Cognitive Theory (Bandura, 1986), that can be applied to the acceptance of technology. Based on these acceptance models, Venkatesh et al. (2003) developed a unified model named the Unified Theory of Acceptance and Use of Technology (UTAUT). In the UTAUT, four core determinants of intention to use the technology are conceptualized: (1) performance expectancy (e.g., perceived usefulness and trust from the TAM); (2) effort expectancy (e.g., perceived ease of use from the TAM); (3) social influence (e.g., subjective norm from TPB); and (4) facilitating conditions (e.g., perceived behavioral control from the TPB). Osswald, Wurhofer, Trösterer, Beck, and Tscheligi (2012) developed and extended the UTAUT with the Car Technology Acceptance Model (CTAM) that unifies several models of technology acceptance. Specifically, they added four further direct determinants of intention to use the technology besides those included in the UTAUT: perceived safety (e.g., users' beliefs about the degree to which the system can affect the safety), anxiety (e.g., anxious or emotional reactions when it comes to use the technology), self-efficacy (e.g., belief in users' ability and competence to use a technology), and attitude toward using technology (e.g., overall affective reaction upon using a system). While the Van der Laan scale is focused on users' perception, the target variable of CTAM and UTAUT is the intention to use/usage behavior. User-acceptance may also include an assessment of the price people are willing to pay or sell the technology (Huth & Gelau, 2013; Payre et al., 2014; Son, Park, & Park, 2015; Vlassenroot et al., 2010; Wolf & Seebauer, 2014). Based on the above description of the approaches to investigate the acceptance of a new technology, the first aim of this work was to investigate potential users' acceptance of an on-bike system that warns about potential collisions with motorized vehicles. Information about users' acceptance of an on-bike system was collected using the Van der Laan scale as well as measures of intention to use the technology, perceived usefulness, perceived ease of use, attitude toward technology, facilitating conditions, anxiety, perceived safety, trust, social influence, willingness to pay (WTP) and willingness to accept (WTA). We did not collect information about self-efficacy because the system does not require any ability and competence to be used.

In addition to users' acceptance, device assessment in road safety also requires an evaluation of the technological solution effectiveness in terms of users' behavior (Bordel et al., 2014; Son et al., 2015). For instance, in the field of advanced driver assistance systems, the effectiveness of forward collision warning system as well as lane departure warning system was investigated in terms of improvements in driving safety behavior (Ben-Yaacov, Maltz, & Shinar, 2002; Blaschke, Breyer, Färber, Freyer, & Limbacher, 2009). To this end, the second aim of the study was to investigate cyclists' behavior in response to the triggering of the device.

2. Method

2.1. Ethical considerations

The data collection procedure complied with the Research Ethical Code of the Italian Association of Psychology. All participants were asked to provide written informed consent prior to their inclusion in the study. Specifically, we informed participants about (1) the purpose of the study and its characteristics (e.g., duration and procedures); (2) their right to decline to participate, and to withdraw participation at any time without penalty; (3) potential risks, discomfort or adverse effects associated with the study (e.g., the risks associated with this research are the same as what they face every day while riding a bicycle); (4) any potential research benefits; (5) any data collected during the study that personally identifies them would have been treated with confidentiality; (6) incentives for participation; and (7) an explanation of the proper person to contact for questions about the research, its findings, and research participants' rights.