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A hazard-perception test for cycling children: An exploratory study

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ABSTRACT

In car driving, hazard perception tests have revealed important differences in perceptual-cognitive skills between novice and experienced drivers. Although these insights have led to new educational programs for learner drivers, similar research has not yet been done for other road users such as bicyclists. In the current investigation, a first hazard perception test for bicyclists has been developed and tested on both adults and children of ±eight year old. The test consisted of three sections in which visual behaviour, environmental awareness, and risk perception were evaluated respectively. Although only few differences in visual behaviour and environmental awareness were found, adults were found to react earlier on hazards than children. These results suggest that children have difficulties to interpret the necessary information to react timely to hazardous traffic situations. Alternatively, the current set-up of the hazard perception test might not have been suitable to detect differences in visual behaviour between children and adults in traffic situations. Therefore the development and use of future hazard perception tests for bicyclists is discussed.

1. Introduction

Cycling is often promoted as a cheap and healthy way of transportation. The increasing number of bicyclists (DEKRA, 2011) has been associated with many positive effects for both the cyclists and the environment (de Hartog, Boogaard, Nijland, & Hoek, 2010; Oja et al., 2011). Unfortunately, it also led to more bicycle accidents. Accident statistics show that especially children and older cyclists are at risk (Carpentier & Nuyttens, 2013; Juhra et al., 2012; Maring & van Schagen, 1990). Therefore, many studies have investigated possible safety measures. Most of these studies focussed on limiting extrinsic risk factors such as road design (Thomas & DeRobertis, 2013), and secondary prevention measures such as bicycle helmet usage (De Jong, 2012; Karkhaneh, Rowe, Saunders, Voaklander, & Hagel, 2013). In contrast, few studies have investigated the importance of intrinsic factors such as cycling skills and cognitive skills, and how they relate to bicycle safety.

Safe cycling can be seen as a joint function of cognitive and motor capacities (Briem, Radeborg, Salo, & Bengtsson, 2004). Learning to master cycling skills is an essential first step to independent traffic participation by bike (Ducheyne, De Bourdeaudhuij, Lenoir, Spittaels, & Cardon, 2013a), but safe traffic participation also requires cognitive skills such as perception, anticipation, and decision-making (Briem et al., 2004). Since the coupling between perception and action undergoes changes until late childhood (Chihak et al., 2010; Plumert, Kearney, Cremer, Recker, & Strutt, 2011; Te Velde, van der

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Kamp, Barela, & Savelsbergh, 2005), children are limited in what they can learn and how they can behave in traffic environments (Connelly, Conaglen, Parsonson, & Isler, 1998). In obstacle avoidance and road crossing tasks while walking, the perceptual-cognitive abilities of children have been reported to be insufficient to use adult-like locomotor strategies (Franchak & Adolph, 2010; Whitebread & Neilson, 2000). Therefore, they often adopt simpler strategies when confronted with complex situations (Ampofo-Boateng & Thomson, 1991; Berard & Vallis, 2006; Day, 1975; Pryde, Roy, & Patla, 1997). Although the lack of mature perceptual-cognitive skills might be a contributing factor to the overrepresentation of children in accident statistics, the development of these skills in function of safe traffic participation is still poorly documented.

In car driving, learner and newly qualified car drivers have been identified as a higher risk group for traffic accidents (Pradhan, Pollatsek, Knodler, & Fisher, 2009; Fisher, Pollatsek, & Pradhan, 2006). In contrast to cycling, the perceptual-cognitive skills of learner drivers have been thoroughly studied using hazard perception tests (Borowsky, Shinar, & Oron-Gilad, 2010; Sagberg & Bjørnskau, 2006; Vlakveld, 2011; Wetton, Hill, & Horswill, 2011). Hazard perception is the ability to detect and interpret hazardous situations, unfolding on the road ahead, which enable early anticipation (Wetton et al., 2011). During a typical hazard perception test, video clips of real traffic situations are presented to the participants and they are asked to press a button when they perceive a hazardous situation. Alternatively, some hazard perception tests use a driving simulator instead of video clips, or pose questions about the traffic scenarios instead of asking to press a button when a hazard is perceived (Hosking, Liu, & Bayly, 2010; Liu, Hosking, & Lenné, 2009).

Results of hazard perception tests showed that experienced drivers detect hazardous situations faster and show shorter reaction times to these hazards (Huestegge, Skottke, Anders, Müsseler, & Debus, 2010). Furthermore, inexperienced drivers are less likely to detect foreshadowing cues, recognize them and therefore often miss the chance to anticipate on developing hazards (Vlakveld, 2011; Wetton et al., 2011). The ability to perceive and predict the development of hazardous situations is closely related to the concept of situation awareness (SA) which describes how individuals create understanding of what is going on around them (Endsley, 1995; Salmon & Stanton, 2013; Vlakveld, 2011). According to Endsley (1995), three interrelated levels of situation awareness can be defined. Level one would be the perception of elements in the current situation or the ability to perceive possible hazards. The cyclist actively searches the environment for stimuli which could intervene with his goals. Level two is the comprehension of the current situation. The cyclist relies on long-term memory knowledge to interpret the stimuli in the environment. Long term knowledge offers a more coherent and organized framework for information processing that develops from experience. The last level describes the ability to predict the future actions of the elements in the current situation. Level three is based on knowledge of the declarative memory and assessment of the elements which lead to the decision-making process and action guidance. For example, a novice cyclist might achieve the same level one SA as a more experienced cyclist, but may not be able to integrate all the essential elements to comprehend the situation to its full extent and therefore show inferior hazard perception because of less developed schemata. Since poor hazard perception skill in novice drivers was associated with elevated crash risk, a hazard perception test was incorporated in the theory exam for learner drivers in some countries (Hosking et al., 2010; Wetton et al., 2011).

Although the use of hazard perception tests has led to a better insight in the visual search behaviour of car drivers and to adapted educational programs, it is surprising that similar research has not yet been done for other road users such as cyclists. Especially since recent evidence suggests that different road users interpret the same situations different because of differences in cognitive and physical task demands (Salmon, Young, & Cornelissen, 2013; Walker, Stanton, & Salmon, 2011). Learner cyclists might benefit even more from a hazard perception training than learner car drivers since children have few to no experience with complex traffic situations to rely on. In addition, the perceptual-cognitive skills of children are still developing, which also might have an effect on their ability to interpret and react to traffic situations (Ampofo-Boateng & Thomson, 1991; Chihak et al., 2010; Plumert, Kearney, & Cremer, 2004). A hazard perception test for cyclists could provide more insights in the development of traffic skills from learner to experienced bicyclists. In turn, these insights could lead to primary prevention measures such as adapted traffic education for children and better design of road infrastructure.

In the current study, an exploratory hazard perception test for cyclists was developed in which multiple aspects of traffic related cognitive skills were investigated. Risk perception, visual attention and reaction times to the hazards were analysed and the usability of the hazard perception test was evaluated.

2. Methods

2.1. Development of the hazard perception test

Film clips for the Hazard Perception Test (HP-test) were collected by cycling in real life traffic environments, while frontal images were captured using a GoPro Hero2 (30 Hz, full HD and 170° FOV). In addition, some hazardous traffic scenarios were staged and filmed on a calm street using volunteers as 'traffic'. All video footage was analysed by the authors and based on video quality and the type of traffic situation that was filmed 33 fragments of 20–30 s were selected for the hazard perception test (see Fig. 1 for an example of three clips, and Appendix A for a description of all clips). Only three clips did not contain a (potential) hazard. The videos were corrected for vibrations using the video stabilising software 'Mercalli V2' (ProDad) and were provided with a 3-2-1 countdown before the start of the clip. Then, all clips were uploaded into the eye-tracking experiment designing software 'Experiment center 3.4' (SensoMotoric Instruments, Teltow, GER).

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