Accident Analysis and Prevention xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

The efficacy of a brief hazard perception interventional program for child bicyclists to improve perceptive standards

Linus H.R.H. Zeuwts*, Greet Cardon, Frederik J.A. Deconinck, Matthieu Lenoir

Department of Movement and Sport Sciences, Ghent University, Watersportlaan 2, 9000 Ghent, Belgium

ARTICLE INFO

Keywords:
Hazard perception
Bicyclists
Children
Intervention
Situation awareness

ABSTRACT

Introduction: Even though child bicyclists are highly vulnerable in traffic only few studies focused on providing child bicyclists with means to enhance their abilities to deal with the complexity of dynamic traffic situations. The current study therefore evaluated whether a brief hazard perception intervention might be effective to improve hazard perception skills in child bicyclists towards a level more comparable to adult bicyclists.

Methods: Eighty children of the fourth grade (9.03 ± 0.43 years; 34 girls) and forty-six adults (34.67 ± 14.25 years age; 24 woman) first performed a Hazard Perception test for bicyclists. Response rate, reaction times, first fixation, duration of the first fixation, dwell time and total number of fixations on the events were measured. Next, the children took part in the HP intervention in which video clips of dangerous traffic situations were presented. The intervention comprised two classroom sessions of one hour (1/week). A post-test was performed one day after and the retention-test three weeks after the intervention.

Results: Children responded to more covert hazards immediately after the intervention ($p < 0.05$), but did not improve their response rate for overt hazards. Reaction times for the covert hazards improved on the post-test ($p < 0.001$) compared to the pre-test but this effect was reduced on the retention test. There was no effect of the intervention for entry time of the first fixation but the duration of the first fixation increased for the covert hazards ($p < 0.05$). Children made fewer fixations on the event compared to adults ($p < 0.001$), except for the covert hazards on the retention-test. The training also increased the number of fixations for the overt hazards on the post-test ($p < 0.001$) and the retention-test ($p < 0.001$) but only increased on the retention test for the covert hazards ($p < 0.001$).

Conclusion: The results demonstrated that a brief intervention for training hazard perception skills in child bicyclists is able to improve children's situation awareness and hazard perception for potential dangerous situations. The training, however, was too short to improve children to higher adult levels.

1. Introduction

As the number of bicyclists in Europe is increasing (DEKRA Automobil GmbH, 2011), resulting in both positive health-related and environmental benefits (de Hartog et al. 2010; Oja et al., 2011), there is also a downside attached to this fortunate trend. Growing levels of bicycle use have led to an increase in the number of bicycle accidents in which mainly children (under the age of 14) and older cyclists (above the age of 65) are involved (Carpentier and Nuyttens, 2013; Maring and van Schagen, 1990). Bicycle accidents in Europe represent 7.8% of all road fatalities indeed (European Commission, 2015). Moreover, in Flanders (Belgium) 9- to 14-year-old children represent 10% and 14- to 19-year-old-children up to 11% of all bicycle casualties (Carpentier and Nuyttens, 2013). Despite this unenviable trend only few studies focused on providing child bicyclists with means to enhance their abilities to deal with the complexity of dynamic traffic situations (Hill et al., 2000). In the context of lifelong traffic education, the current study therefore aims to improve the ability of young bicyclists to negotiate complex traffic situations through a brief hazard perception training.

1.1. Review of the literature

Bicycling in traffic occurs at higher speeds compared to walking or lower speeds compared to driving, requiring a more complex interaction between perceptual and motor skills such as simultaneously coordinating control over the bicycle in relation to other faster moving objects in the environment (cars) e.g. checking the shoulder for traffic from behind. Bicycling safely through traffic therefore largely depends on the child's ability to simultaneously combine motor bicycling skills (e.g. steering, pedalling or signalling), as well as perceptual-motor skills

* Corresponding author.
E-mail address: Linus.Zeuwts@Ugent.be (L.H.R.H. Zeuwts).

https://doi.org/10.1016/j.aap.2018.02.006
Received 21 December 2017; Received in revised form 2 February 2018; Accepted 6 February 2018

(e.g. hazard perception and anticipation) which have been demonstrated to improve through deliberate practice (Briem et al., 2004; Ducheyne et al., 2013a,b; Ellis, 2014; Zeuwts et al., 2017a,b). Given that young children are physically and mentally not mature yet, they are limited in their capabilities to sufficiently cope with dynamic traffic situations. Children place motor over cognitive task when they have to perform both at the same time (Schaefer et al., 2008). Accordingly, children have difficulties detecting the presence of traffic, distinguishing safe from dangerous locations, making time-to-contact judgments, coordinating and processing visual information, and integrating the relevant information into a holistic appreciation of the situation (Ellis, 2014; Foot et al., 1999; Meyer et al., 2014; Plumert et al., 2011; Thomson et al., 2005). In support of these findings young children have been suggested to primarily focus on the most salient factor in the environment (Meir et al., 2015a; Zeuwts et al., 2017a). For example a car in front of the bicyclist is attended while the intersecting street from the right goes unnoticed. It can therefore be suggested that young bicyclists display poorer situation awareness compared to adults which hampers them to attend to the relevant visual information (perception; SA1), decide whether or not a situation might contain risk (comprehension; SA2) and to make predictions regarding the future development of the situation (projection; SA3) (Endsley, 1995; Meir et al., 2015a, 2013; Rosenbloom et al., 2015). Situation awareness is considered to be closely related to hazard perception (Wetton et al., 2011). Hazard perception refers to the ability to "read" the road and anticipate upon the forthcoming situation. Since novice drivers have been shown to overlook more traffic conflicts and displayed more difficulties with detecting the elements that might have predicted the dangerous situations (Borowsky et al., 2010; Huestegge et al., 2010; Wetton et al., 2011) it can be suggested that hazard perception skills are not utterly dependent on maturation but on experience too. A number of studies therefore aimed to improve young learner drivers' and children pedestrians' hazard perception skills.

PC-based hazard perception training interventions in young drivers have been reported to effectively improve learner drivers' ability to detect hazardous situations up to the level of more experienced drivers (Isler et al., 2009; Pradhan et al., 2009, 2005; Taylor et al., 2014). In an attempt to accelerate the development of perceptual-motor skills in children, computer-based learning strategies have been effectively adopted to drive educational interventions (Meir et al., 2015b; Schwebel et al., 2016; Thomson et al., 2005). In the simulation intervention of Thomson et al (2005), children had to help an avatar to cross several intersections when 'walking to the park'. Each time a child chose an unsafe gap, the image froze and screeching brakes were heard, followed by the avatars' ghost departing from its body. This was used to open discussion and provide the participant with feedback. In addition, Meir et al. (2015b) presented children with 11 traffic scenarios from the perspective of a child pedestrian. Children were required to press the response button every time they detected a dangerous situation. Then, the scenarios were replayed from a higher point of view to improve children's perception regarding the situations. In the second part of the intervention, children were presented with three pairs of traffic scenes. Each pair represented the same environment but from a different perspective to improve their situation awareness. More recently, Schwebel et al. (2016) aimed to improve children's road crossing skills when presented with a virtual reality training. Children stood on a simulated curb in front of the monitors on which the virtual road was presented. Whenever they felt safe to cross the street, they stepped of the curb onto a pressure plate. First person view then changed to third person view which allowed children to view their own crossing. A cartoon appeared after each crossing to provide children with feedback. In general, trained child pedestrians (7–11 years old) significantly improved their road crossing behaviour (e.g. quicker road crossing, better aligned road crossing, and fewer missed opportunities), conceptual understanding and awareness to potential hazardous situations compared to the controls. With respect to cycling, Zeuwts et al. (2017a) reported that child bicyclists' performance on a tailored hazard perception test was poorer compared to the performance of experienced adult bicyclists, but a brief hazard perception training for child bicyclists resulted in lower response latencies, higher response rates and better cognitive processing of the potential dangerous situations compared to a control group (Zeuwts et al., 2017b).

1.2. Objectives

Even though the beneficial effects of hazard perception interventions in learner drivers and child pedestrians have been extensively described in the literature, there is only limited evidence available with respect to bicycling. It is therefore unknown whether there is a carry-over effect to cycling, especially given that bicycling requires a more complex coordination between perception and action and experience is often task specific (e.g. cycling between traffic at lower and higher speeds while controlling a bicycle and looking for hazards) (Briem et al., 2004; Plumert et al., 2011; Zeuwts, 2016). Furthermore, to measure the effectiveness of the intervention, studies often compare learner drivers or child pedestrians to more expert drivers or adult pedestrians, who are considered the standard for comparison. Also adult bicyclists can be considered more expert bicyclists as they, should have mastered their bicycle handling skills and traffic skills through repetitive practice, the current study aims to address whether a brief hazard perception intervention is effective to improve hazard perception skills in child bicyclists towards the level of more experienced adult bicyclists. Given that access to the visual information is essential for evaluating the first level of situation awareness and precedes anticipation, visual behaviour of the participants will be documented by means of eye tracking methodology.

2. Methods

2.1. Participants

2.1.1. Child bicyclists

In total, 30 elementary schools received an invitation to participate in this study. However, only four schools were willing to cooperate in the hazard perception test and the intervention. Given that higher cognitive training should take place when basic bicycling skills have been obtained (Deery, 1999; Meir et al. 2014), 80 fourth graders (9.03 ± 0.43 years of age; 34 girls) with at least two years of bicycling experience were included since Ducheyne et al. (2013a,b) and Briem et al. (2004) reported that children should be able to control their bicycle around the age of nine and start to bicycle more independently. Children were given an informed consent which their parents read and signed for approval.

2.1.2. Adult bicyclists

In addition, 46 adults (34.67 ± 14.25 years of age; 24 women) performed the hazard perception test to compare hazard anticipation skills between children and adults. Adults were recruited from the department of Movement and Sport Sciences. Adults were allowed to participate if they used their bicycle on a regular basis (four times a week), and used their bicycle to bicycle to school when being a kid. Adults read and signed the informed consent prior to the testing. The study protocol was approved by the Ghent University ethical committee.

2.2. Apparatus and protocol

2.2.1. The hazard perception test

The Hazard Perception test (Hptest) consisted of fourteen video clips (± 30 s) which were videoed with a GoPro Hero2 camera (30 Hz, full HD and 170° field of view) mounted on the handlebar of a bicycle. Each film clip from the perspective of the bicyclist included a variety of