Accident Analysis and Prevention 108 (2017) 112–121

Contents lists available at ScienceDirect

Accident Analysis and Prevention

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

Full length article

Hazard perception training in young bicyclists improves early detection of risk: A cluster-randomized controlled trial

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

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

A R T I C L E I N F O

Keywords:
Bicycling
Hazard anticipation
Intervention
Safety
Education

A B S T R A C T

Introduction: Since child bicyclists are more likely to get involved in a traffic crash, there is a stringent need to provide child bicyclists with tailored interventions in order to enhance their capabilities to deal with the complexity of traffic situations. The current study therefore aimed to test the effectiveness of a hazard anticipation training in young bicyclists by means of eye tracking technology.

Methods: A cluster-randomized controlled design was used in which participating schools were randomly assigned to the intervention or the control group. At first, a baseline hazard anticipation test was carried out in the intervention group (78 children; 9.56 ± 0.38 years of age) and the control group (46 children; 9.58 ± 0.41 years of age). Child bicyclists who participated in the intervention followed the training that consisted of two classroom sessions. In each session children were presented with video clips from the perspective of a bicyclist encountering various (potentially) dangerous traffic situations. Following the intervention, a post-test directly after the training and a retention test three weeks later were completed. The control group received the intervention after the retention test.

Results: Trained child bicyclists were found to detect more hazards and reacted quicker compared to the control group that did not receive the training. However, the training did not result in improvements in anticipatory visual search behaviour.

Conclusion: Trained child bicyclists seemed to have developed a better processing regarding potential dangerous situations but were not able to 'see' the hazard sooner. The potential of a brief hazard anticipation training is discussed.

1. Introduction

Cycling is often promoted as a cheap and healthy way of transportation (Chillón et al., 2012; Davison et al., 2008). The increasing number of bicyclists in Europe (DEKRA Automobil GmbH, 2011) has strongly been associated with many positive effects for both the bicyclist and the environment (de Hartog et al., 2010; Oja et al., 2011). This increase in bicycle share however, also resulted in more bicycle accidents in Germany (Juhra et al., 2012). Furthermore, Carpentier and Nuyttens (2013) and Maring and van Schagen (1990) reported that mainly children (under the age of 14) and older cyclists (above the age of 65) are at risk. Indeed, bicycle accidents in Europe represent 7.8% of all road fatalities (European CARE report, 2015), whereas in Flanders 9- to 14-year-old children represent 10% and 14- to 19-year-old children almost 11% of all bicycle accidents (Carpentier and Nuyttens, 2013). Therefore, there is a stringent need to provide child cyclists with means for enhancing their abilities to safely deal with the complexity of dynamic traffic settings (Hill et al., 2000).

Cycling safely can be considered as a function of both motor (Ducheyne et al., 2013b; Zeuwts et al., 2015, 2016) and cognitive abilities (Briem et al., 2004). With respect to the motor abilities, previous research has shown that training of specific cycling skills has a long term effect on young children's general cycling ability (Ducheyne et al., 2013a). For the cognitive abilities, it is known that skills such as perception, anticipation, and decision-making (Briem et al., 2004) continue to improve with experience until late childhood (Plumert et al., 2011; te Velde et al., 2005; Chihak et al., 2010). Accordingly, children's perceptual and cognitive skills in a variety of different complex traffic situations might benefit from tailored interventions or practice too (Connelly et al., 1998; Thomson et al., 1996).

Visual search strategies and perceptual-cognitive abilities in children have been reported to be inadequate in obstacle avoidance and

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

http://dx.doi.org/10.1016/j.aap.2017.08.024
Received 25 May 2016; Received in revised form 17 August 2017; Accepted 19 August 2017

road-crossing tasks (Franchak and Adolph, 2010; Whitebread and Neilson, 2000). Children were shown to adopt simpler strategies when confronted with more complex traffic situations (Pryde et al., 1997), have difficulties with synchronizing their actions to moving objects (Grechkin et al., 2013), make less use of their peripheral vision (Franchak and Adolph, 2010), and focus more on irrelevant stimuli compared to adults (Berard and Vallis, 2006; Day, 1975; Whitebread and Neilson, 2000). Moreover, they pay less attention to task-relevant information (Ampofo-Boateng and Thomson, 1991), have difficulties with integrating information into a holistic perspective of the situation (Underwood et al., 2007) and have a tendency to focus on the most salient factor in the environment (Ampofo-Boateng and Thomson, 1991; Thomson et al., 2005). This inadequate behaviour is likely to result in unsafe interactions with the traffic environment.

In support of this, Zeuwts et al. (2017) found that young children's (about 10 years of age) hazard perception skills are poorer developed compared to adults. Hazard perception is the ability to read the road ahead and anticipate upon the developing situations. Hazard perception is therefore closely related to Endsley's (1995) concept of situation awareness consisting of perception, comprehension and projection of future events. Zeuwts et al. (2017) showed that young cyclists did not actively search for other road users who are hidden from view (covert hazards), which resulted in delayed reaction times with respect to the hazardous situation. Children are therefore suggested to lack the capacity to efficiently decide whether or not a situation might contain risk (comprehension) and to make predictions regarding the future events (projection) (Meir et al., 2015a, 2013; Rosenbloom et al., 2015).

Despite the overrepresentation of children in accident statistics, training interventions to improve hazard perception are to our knowledge non-existent. Just like bicycling skills may be learned Ducheyne et al. (2013a), it can be assumed that specific training programs could aid the development of hazard perception skills and situation awareness among young inexperienced bicyclists

In driving, video-based road commentary training in young drivers (18–19 years of age) resulted in a similar hazard detection rate compared to more experienced drivers (mean age of 35.5 years; Isler et al., 2009). Consistent with this, Pradhan et al. (2005, 2009) found positive effects on drivers (16–21 years of age) gaze behaviour after a PC-based Risk Awareness and Perception Training. Trained drivers were reported to gaze more to relevant dangerous areas. This behaviour was also observed in situations substantially different from the training scenarios.

With respect to children, Thomson et al. (2005) reported that in an attempt to accelerate the development of 7-, 9- and 11-year-old child pedestrian skills, interactive learning was effectively adopted to drive educational interventions. The computer-based intervention consisted of four sessions, each lasting between 30 and 40 min with increasing complexity. Within each training session, children were presented with nine road crossing simulations, which were embedded into a real-life scenario, e.g. a walk to the park. The instruction was to help the character on display with crossing several junctions. Each time the participant selected an unsafe gap in between the passing cars, the sound of screeching brakes was heard, the image froze and the child character's ghost departed from its body. This feedback was used to initiate a discussion with the participant. Children who were trained with a computer-simulated environment showed safer crossing behaviour – quicker crossing, better aligned crossing, missed fewer opportunities – and improved conceptual understanding. In another study, Meir et al. (2015b) evaluated the effect of a 40-min simulator hazard perception training (the Child-pedestrians Anticipate and Act Hazard Perception Test) among 7–9-year-old child pedestrians which consisted of two individual parts. In the first part, participants were presented with 11 traffic scenarios from the perspective of a child pedestrian and had to press a button each time they encountered a dangerous situation. Then, the scenarios were replayed from a different point of view (POV). Participants were encouraged to identify and describe the hazard instigators. In the second part, children were presented with three pairs of traffic scenarios. Each pair represented the same scenario but from a different perspective. They were asked to compare between them. Trained children displayed improved awareness with respect to potential hazardous situations due to restricted field of view.

In summary, despite the evidence of positive effects of hazard perception training in young novice drivers (Crundall et al., 2010; Isler et al., 2009; Meir et al., 2014; Pradhan et al., 2009) and child pedestrians (Meir et al., 2015b), research with respect to hazard anticipation and hazard perception training amongst young cyclists is limited. Since limited complex higher order perceptual and cognitive skills in children, in particular hazard perception, situation awareness and visual search (Meyer et al., 2014; Meir et al., 2015a,b; Rosenbloom et al., 2015; Zeuwts et al., 2017) are suggested to be associated with higher crash risk, training interventions to improve these abilities are of interest. Therefore, the aim of the current study was to test whether hazard perception training in young bicyclists will improve child bicyclists' response rates, reaction times and result in a more efficient visual search pattern. Visual search patterns of children will be documented by means of eye tracking methodology since access to the visual information is a prerequisite for evaluating the first level of situational awareness. It is expected that the trained children will fixate the hazards sooner. However, no clear hypothesis is formulated regarding the number of fixations and dwell time.

2. Methods

2.1. Participants

In the first stage, a total number of 30 randomly selected elementary schools have been sent an invitation to participate in the study. Ultimately, only four elementary schools gave permission to conduct the hazard perception training, of which two were located in an urban and two in a suburban area. Schools were randomly assigned to the intervention (one urban and one suburban) or the control group (one urban and one suburban) which resulted in a cluster-randomized control study design. Only children with at least two years of cycling experience on the road were included for further testing since Deery (1999) and Meir et al. (2014) suggested that higher cognitive training should take place after the basic manipulation skills are obtained. According to Ducheyne et al. (2013a,b) and Briem et al. (2004) children should be able to control their bicycle around the age of nine. Therefore, 127 fourth graders (56 girls) were recruited, of which 80 children, divided over four classes (34 girls), were allocated to the training group (minimum age: 8.91 years old, maximum age: 11.49 years old) and 47 children, divided over three classes (24 girls), were allocated to the control group (minimum age: 8.57 years old, maximum age: 10.62 years old). The children of the control group received the training after the retention test. Children were given an informed consent which their parents read and signed for approval. The study protocol was approved by the Ghent University ethical committee. Table 1 provides more

Table 1
Demographics regarding the intervention and control group.

	Intervention n = 78	Control n = 46
Age	9.56 ± 0.38	9.58 ± 0.41
Age at onset of cycling	4.32 ± 0.87	4.32 ± 0.87
Transportation to school		
Distance to school (km)	2.81 ± 3.00	5.80 ± 11.77
Minutes cycling to school	9.65 ± 5.48	12.09 ± 17.88
#Days to school by bicycle per week	0.97 ± 1.53	0.72 ± 1.28
#Days to school by foot per week	1.16 ± 1.96	0.68 ± 1.57
#Days to school by car per week[aa]	2.59 ± 2.20	3.59 ± 1.89
Minutes cycling per week	36.9 ± 62.64	39.4 ± 63.48

[a] $p < 0.05$, [aa] $p < 0.01$, [aaa] $p < 0.001$.