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The implications of low quality bicycle paths on the gaze behaviour of young learner cyclists

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ABSTRACT

In a recent study, Vansteenkiste et al. (2014) described how low quality bicycle paths cause an apparent shift of visual attention from distant environmental regions to more proximate road properties. Surprisingly, this shift of visual attention was not accompanied by an adaptation in cycling speed. The current experiment investigated to what extent these findings are applicable for young learner bicyclists (aged 6–12 years). Since young learner bicyclists do not yet have mature visual and motor skills, it was expected that the implications of a poor road surface would be larger for them than for experienced adult bicyclists. In general, children looked less to the road and more to task irrelevant regions, but the magnitude of the shift of visual attention when cycling on a low quality bicycle track was similar to that of adults. Although children cycled slower than adults, they did not cycle slower on the low quality track compared to the high quality track. Overall, our results suggest that children displayed a different visual-motor strategy than adults, characterized by lower cycling speeds and a different visual behaviour, and that they responded in a similar way to a low quality bicycle path as adults.

1. Introduction

Recently, many studies have emphasized the benefits of a modal shift from car driving to bicycling as a healthy, sustainable and cheap way for short-distance displacements (De Hartog, Boogaard, Nijland, & Hoek, 2010; Rabl & de Nazelle, 2012). An increasing number of bicycle users leads to reduced health problems related to a lack of physical activity, reduces road congestion, and has been associated with an improved emotional well-being (Hamer & Chida, 2008; Oja et al., 2011; Pucher & Buehler, 2012). Therefore, many countries have recognized the potential benefits of promoting cycling as a mode of transportation. Unfortunately, with increasing numbers of bicyclists, also the number of bicycle accidents increase (Juhra et al., 2012). Even though the individual risk of accidents decreases with increasing numbers of bicyclists (Jacobsen, 2003), and the benefits of cycling far outweigh the risks (De Hartog et al., 2010), the actual and perceived risks of cycling in busy traffic is still a major drawback for many people (Horton, 2007). Although all bicyclists can be considered vulnerable road users, accident analyses show that especially children (<15 years of age) and older people (>65 years of age) are at risk (Carpentier & Nuyttens, 2013; DEKRA, 2011).

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Since human locomotion is primarily guided and controlled by visual information (Patla, 1997; Shinar, McDowell, Edward, & Rockwell, 1977; Wilkie, Kountouriotis, Merat, & Wann, 2010), identifying the differences in gaze behaviour between 'high risk groups' and less accident prone bicyclists could improve our understanding regarding the causes for their overrepresentation in accident statistics. Unfortunately, the visual behaviour of bicyclists is poorly documented, and to our knowledge, the visual behaviour of young learner bicyclists cycling on real cycling tracks has not yet been described.

In a recent study, Vansteenkiste, Zeuwts, Philippaerts, Cardon, and Lenoir (2014) showed that low quality cycling tracks affect the visual attention of adult bicyclists to a large extent. On a low quality cycling track, gaze was directed more than twice as much towards the proximate road properties as compared to on a high quality track (63% vs. 25%, respectively). This suggests that on low quality cycling tracks, cyclists have less spare time to anticipate to the upcoming trajectory compared to a high quality track, which may affect the alertness and responsiveness of bicyclists to environmental hazards. Unfortunately, this study only included experienced adult bicyclists. To investigate to what extent the visual behaviour of young learner bicyclists is different from that of adults, this experiment was repeated with 6–12 year old children.

Experiments in obstacle avoidance and road crossing behaviour have shown that children younger than ten years old adopt different visual-motor strategies than adults (Ampofo-Boateng & Thomson, 1991). Compared to adults, they rely less on peripheral vision (Franchak & Adolph, 2010), look more to irrelevant areas (Whitebread & Neilson, 2000), anticipate less on future actions (Berard & Vallis, 2006), and have more difficulties to synchronize their actions to other moving objects (Chihak et al., 2010; Connelly, Conaglen, Parsonson, & Isler, 1998). To compensate for this lack of mature perceptual-motor skills, children seem to adopt more cautious locomotor strategies, characterized by lower moving speeds and larger safety margins when an obstacle has to be avoided (Pryde, Roy, & Patla, 1997).

If these findings can be translated to cycling behaviour, children in the current experiment will probably cycle slower, spend more time watching irrelevant regions and spend less time watching the distant road. Since children adopt more cautious locomotor strategies in complex environments, it is also expected that the difference in both cycling speed and gaze behaviour between adults and children will be bigger on the low quality cycling track than on the high quality cycling track.

2. Methods

2.1. Participants

A convenience sample of eighteen adults (aged 26.50 ± 3.42 years; 10 females) and sixteen children (aged 9.25 ± 1.95 years; 10 females) took part in the study. However, the data of three adults and four children did not meet the inclusion criteria (see Section 2.4. Data analysis). Adults were recruited from Ghent University staff, children were recruited by spreading a request for volunteers via a school in the vicinity of the university campus. All children were accompanied by at least one of their parents and received a cinema ticket at the end of the experiment.

2.2. Apparatus

Gaze behaviour was recorded using the Eye Tracking Glasses 2.0 (ETG) of SensoMotoric Instruments (SMI; Teltow, Germany). The frame of these eye tracking glasses contains two small cameras to record eye movements of both eyes, and one scene camera to record the forward view of the participant. Using dark pupil position and corneal reflection, the system records eye movements at 30 Hz and with an accuracy of 0.5°. Eye movements and scene camera images were saved on a 'Smart Recorder', which was the size of a smartphone and was put in a waist bag (see Fig. 1). In contrast to the Head mounted Eye tracking Device (HED; SMI; Teltow, Germany), used in our previous experiment (Vansteenkiste et al., 2014), the ETG was capable of performing eye tracking in broad daylight.

2.3. Protocol and cycling route

On arrival the participant (and his/her accompanying parent) was briefed about the experiment, and asked to read and sign the informed consent. For the adults, the saddle of a standard city bicycle (women's model) was adapted to the participant's height. Children were asked to bring their own bicycle. When the participant was ready, the eye-tracking glasses were put on and the three-point calibration of the eye tracking device was performed indoors. Participants were accompanied by two experimenters (one cycling in front, one cycling behind) to the start of one of the two selected bicycle tracks, where a quick calibration check was performed. After this, the participant was instructed to cycle at a self selected pace in front of the experimenters until the next crossroad (±700 m). One of the experimenters stayed some metres behind and wore a sign on his/her back that informed other cyclists that an experiment was ongoing and that they therefore should not pass until the next crossroad. This way it was ensured that the participant did not cycle closely behind other cyclists during the experiment.

The two bicycle tracks selected for the current experiment were separated from the car road by trees on the one side, and neighboured by a bush and a river on the other side (see Fig. 2). One of the two tracks is a recently renewed cycling track of 2 m in width and has a smooth brick surface. This track will be referred to as the high quality track (HQ). The other track is