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Where do people direct their attention while cycling? A comparison of adults and children

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ABSTRACT

Cycling in urban environments requires the ability to distinguish between relevant and irrelevant targets quickly and reliably, so that potential hazards can be anticipated and avoided. In two experiments, we investigated where adults and children direct their attention when viewing videos filmed from a cyclist's perspective. We wanted to see if there were any differences in the responses given by experienced adult cyclists, inexperienced adult cyclists, and child cyclists.

In Experiment 1, 16 adults (19–33 years) were asked to watch ten videos and to point out things they would pay attention to by tapping a touchscreen (pointed out locations). Afterwards, they were asked to explain their answers. In Experiment 2, 17 adults (19–34 years) and 17 children (11–12 years) performed the same task with the same ten videos, but they were not asked to explain their answers afterwards. The data sets from these two experiments were pooled, creating three groups: ten experienced adult cyclists, 23 inexperienced adult cyclists and 17 children. A total of 23 clearly visible, traffic-relevant targets (pre-specified targets) had previously been identified in the videos. We investigated whether the participants' pointed-out locations matched these targets (and if so, how fast they responded in pointing them out). We also investigated the number and vertical/horizontal dispersion of these pointed-out locations on the touchscreen.

Adults pointed out more locations than children, especially pedestrians and cyclists. This result suggests that, while children focussed as well as adults on cars (arguably the most salient hazard), they were less able to identify other hazards (such as pedestrians or other cyclists). The children had also a larger vertical dispersion and a larger between-participant variation than the adults. Adults were faster at tapping the pre-specified targets and they missed them less often. Overall, the results suggest that 11–12 year old-cyclists have worse situation awareness in traffic than adults.

1. Introduction

Cycling has been linked to longer and healthier lives due to the physical activity it entails (Celis-Morales et al., 2017; Oja et al., 2011). However, cycling-related injuries incur substantial costs for the individual and society (Scholten, Polinder, Panneman, Van Beeck, & Haagsma, 2015). Measures to improve cycling safety are sorely needed. While helmet use has been

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demonstrated to be an effective countermeasure for head injuries (Olivier & Creighton, 2016), it is important to understand why crashes occur in the first place in order to further reduce the risks to cyclists. Crashes and injuries may decrease the popularity of cycling if cycling is perceived as dangerous (Backer-Grøndahl, Fyhri, Ulleberg, & Amundsen, 2009; Noland, 1995). Specifically, parents' conception of the safety of cycling may affect their decision to let children cycle to school (Panter, Jones, van Sluijs, Simon, & Griffin, 2010).

In Finland between 2012 and 2014 there were on average 860 cycling injuries and 19 fatalities every year, constituting 12% of all traffic accidents and 7% of all accident-related deaths (Liikenneturva, 2015). Among 10–14 year olds, the risk of a cycling injury was twice that of the overall population (Liikenneturva, 2015).

Children's bicycle crashes most often happen when they are entering the roadway or crossing it mid-block (Ellis, 2014). This suggests they may have failed to anticipate and look for approaching cars. Appropriate expectations in this situation help predict what will happen next and thus focus the visual search (Räsänen & Summala, 1998; Underwood, 2007). The ability to accurately assess visual cues that indicate a situation with a high probability of leading to a crash is called hazard perception (e.g. Crundall et al., 2012).

Typical hazard perception tests measure reaction times to a set of hazards which have been predefined to discriminate between novice drivers and safer, more experienced ones (Horswill & McKenna, 2004). However, hazard perception can be conceptualized more generally as situation awareness in hazardous situations (Endsley, 1995; Horswill & Mckenna, 2004). With this perspective, hazard perception tests have been expanded to probe for participants' awareness of relevant elements, their interpretation of the situations, and their predictions for what will happen next (Crundall, 2016; Jackson, Chapman, & Crundall, 2009; Lehtonen, Airaksinen, et al., 2017). Significantly, hazard prediction appears to be robust against variation in the participant's response criteria; that is, it is not affected by the person's assessment of the level of hazard/risk (Lim, Sheppard, & Crundall, 2014).

Hazard perception studies among car drivers suggest that more experienced drivers scan relevant areas in the traffic environment for potential hazards more extensively than novices do, and they identify hazards earlier (Borowsky, Shinar, & Oron-Gilad, 2010; Crundall et al., 2012; Pradhan et al., 2005). However, few comparable studies have been done among cyclists. Lehtonen, Havia, Kovanen, Leminen, and Saure (2016) asked adults to assess how much 'caution' the situation required when they viewed videos from the cyclist's perspective. More experienced cyclists reported increased caution more often than less experienced cyclists, a result which can be interpreted to mean that they detected more potential hazards. On the other hand, another study with similar video material and criteria for cycling experience failed to find a difference as a function of cycling experience among adults (Lehtonen, Airaksinen, et al., 2017). However, that study probed for the presence of hazards in a predefined set of locations, instead of asking the participants to point out all the locations, as in the current study. We were interested to see if experienced cyclists would point out more locations than inexperienced ones and if their locations would be more spread out horizontally, suggesting wider scanning for potential hazards.

Studies comparing children and adults have often found that children identify fewer hazards than adults and react to them more slowly (Lehtonen, Airaksinen, et al., 2017; Lehtonen, Sahlberg, Rovamo, & Summala, 2017; Meir, Parmet, & Oron-Gilad, 2013; Meyer, Sagberg, & Torquato, 2014; Zeuwts, Vansteenkiste, Deconinck, Cardon, & Lenoir, 2016). Typically, it is more challenging for children to detect covert hazards, where the road users causing the hazards are occluded (e.g. a pedestrian stepping behind a parked van) than overt hazards (e.g. a clearly visible approaching car) (Meir et al. 2013; Zeuwts et al., 2016; Lehtonen, Sahlberg, et al., 2017 but see Lehtonen, Airaksinen, et al., 2017). Consequently, we expected that adults would point out more hazards, especially covert hazards, than children.

The purpose of the current study was to explore what cycling-relevant locations the adult and child cyclists would direct attention to when watching videos recorded from a cyclist's perspective. The research questions were the following:

Q1: What elements did the participants point out in the videos (pointed-out locations)? The reported locations, at least, were part of their situation awareness—even though we would not suggest that these were the only elements that made up the participants' situation awareness.
Q2: Are there differences in the number or horizontal and vertical dispersion of the pointed-out locations for the different groups (children, inexperienced adult cyclists, and experienced adult cyclists)?
Q3: How do the pointed-out locations match against the set of targets previously classified as potential hazards (pre-specified targets)? How fast did participants respond to them and how many of the latter did they miss?

2. Methods

2.1. Task

For this paper, we performed two different experiments (Experiment 1 and Experiment 2). The first task was similar in both experiments. All participants were asked to imagine being the cyclist in a video played on a touchscreen and tap any locations in the videos that they felt they should pay attention to if they were in traffic. The location was then highlighted with a red circle. These pointed-out locations on the screen were not prespecified.

The second task was presented only in Experiment 1: participants were shown the videos again and this time they were able to see what they had tapped. At the moment of each tap, the video stopped and the target they had tapped was once again highlighted with a red circle, for 250 ms. After that the video stopped and the screen went blank. The participant was