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# Cyclists' predictions of what a car driver will do next at intersections

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## 1 INTRODUCTION

In the Netherlands, 30% of fatal crashes between 2010 and 2015 involved a cyclist [1], with a large portion of these crashes occurring at intersections in urban areas. Contributing factors to driver-cyclist collisions at intersections are not only inadequate visual search, but also incorrect expectations about the other's intentions [2]. Research also suggests that crashes between drivers and cyclists often happen even when the cyclist must have seen the approaching car [2].

The ability to anticipate future events is crucial for safe performance in traffic [3]. Recently, research has started on hazard anticipation in cycling. For example, an experiment using a hazard perception test has found that adult cyclists detect hazards earlier than children [4]. Furthermore, results from an eye-tracking experiment using animated video clips showed that cyclists are more likely to look at an approaching car (e.g., a car on a collision course) than to a car that has stopped before the intersection or a car that has passed the intersection [5]. However, it is unknown at which point in time and based on which visual cues a cyclist can predict that a perceived hazard becomes an actual hazard (i.e., that the car driver will not yield to a cyclist).

We developed a video-based survey with the aim to gain an understanding of cyclists' predictions in hazardous intersection situations. The following research questions were addressed herein:
(1) How do cyclists' predictions of the behavior of a car change in the moments prior to a crash or near miss with that car?
(2) Is there a difference in cyclists' predictions of the car's behavior between crash and near miss scenarios?

## 2 METHODS

### 2.1 Participants

A total of 1,344 participants from 65 countries were recruited through the crowdsourcing service CrowdFlower. 739 individuals (471 males, 267 females, and 1 unknown) who met eligibility and quality control criteria (i.e., older than 18 years, correct answers to the quality control items), and who indicated that they cycle at least 1–3 times per week in the summertime were included in the study. Data were collected between February 27 and March 7, 2017. The participants' mean age was 34.27 (*SD* = 10.63), ranging between 18 and 70 years.

### 2.2 Materials and procedure

Traffic video clips from a cyclist's point of view were collected from publically available YouTube postings. We selected intersection scenarios in which a car was crossing the cyclist's path and in which a hazardous car was visible for at least 2 s prior to this crossing. A total of nine hazardous and one nonhazardous scenarios were extracted from YouTube. The hazardous scenarios included an approaching car that was not giving right of way to the cyclist, resulting in a crash (five scenarios) or a near miss because the cyclist reacted promptly (four scenarios). The nonhazardous scenario was an approaching car that stopped in front of the bicycle path. The nonhazardous scenario was included with the aim to assess whether participants could discriminate between hazardous and non-hazardous scenarios. In addition, one extra nonhazardous scenario was extracted from YouTube and used as a practice clip to familiarize participants with the task.

All downloaded clips were stored at a frame rate of 29.97 fps. Using a video editing method proposed by [6], each clip started with a frozen frame containing a 3 s countdown in the right bottom of the screen, after which the clip was played. To examine how cyclists' predictions change over time prior to when a car crosses the cyclists' path, five freeze conditions of each clip were created using Adobe Premier Pro CC 2017. First, a *very late* freezing moment was created by removing 5 frames (= 0.17 s) from the moment the car either entered the bike path or the moment the car stopped in the nonhazardous scenario. From this point of each clip, eight additional frames were removed four times to create four additional versions of each clip: *late* (= 0.43 s), *intermediate* (= 0.70 s), *early* (= 0.97 s), *very early* (= 1.24 s) freezing moments (see Fig. 1). Thus, the very late freezing moment was temporally closest to the conflict (hazardous scenarios) or the car's stopping (nonhazardous scenario). The time between the *very late* freezing moment and the crash varied between clips from 0.23 to 0.70 s. After the video had played, the last frame was frozen. From the moment of the freeze, a 'relevant' hazardous car was encircled in the clips for 2 s, after which the same static image remained visible for another 2 s. The 10 clips with the very late freezing moments were between 13.75 and 21.42 s long (including the 7 s of frozen frames). In total, 50 experimental clips (10 intersection scenarios * 5 freeze conditions) were created. These 50 clips were divided into 5 different sets, and a participant was randomly allocated to 1 of 5 sets by CrowdFlower. Accordingly, each participant saw each of the 10 intersection scenarios only once and encountered each of the five freeze conditions twice during the survey. The order of the freeze conditions and the order of the intersection scenarios were counterbalanced across participants.

*Figure 1: Final frames from the five freeze conditions of Intersection scenario 1 (left = very early end point, right = very late end point).*

After each clip, participants were asked to indicate their responses to eight items: (1) perceived risk (indicated on a 7–point Likert scale), (2) potential cyclist's (own) behavior, (3) prediction of the driver's behavior, (4) certainty about the driver's behavior (7–point Likert scale), (5) factors that contributed to the prediction of the driver's behavior (multiple options), (6) priority rules, (7) number of times the video was replayed, (8) color of the encircled car (this was a quality control item). Items 2 and 3 had two response options based on game theory [7]: *Yes, I would slow down* vs. *No, I would continue cycling at this speed* and *Yes, the car driver will slow down and let the cyclist cross first* vs. *No*, respectively. It took on average 20 min to complete the survey.

## 3 RESULTS

Preliminary results of responses to Items 2 and 3 (Fig. 2) show that the percentage of participants who predicted that the car driver will *not* let the cyclist cross first (left panel) and that they themselves would slow down (right panel) increased over time in the hazardous scenarios (blue and black lines) and decreased over time in the nonhazardous control scenario (green line). Participants' predictions in the near miss scenarios appear to show earlier information pick-up about drivers not letting the cyclist cross first compared to the crash scenarios (left panel). Similarly, participants reported that they would slow down earlier in near miss scenarios compared to crash scenarios (right panel).

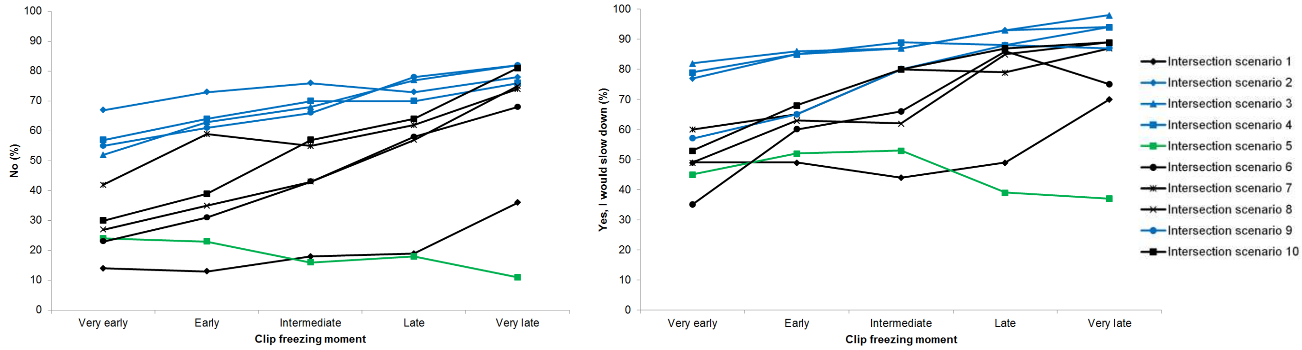


*Figure 2: Left panel = Percentage of respondents who reported 'No.' to the question 'Imagine that the cyclist in the video will continue cycling at this speed. Will the car driver let the cyclist cross first?' as a function of intersection scenario and clip freezing moment. Right panel = Percentage of respondents who reported 'Yes, I would slow down.' to the question 'Imagine that you are the cyclist in the video. Would you slow down?' as a function of intersection scenario and clip freezing moment. Intersection scenarios 1–5 were on Dutch roads, 6–8 were on American roads, and 9–10 were on Australian roads and their images were mirrored horizontally for this study. Blue lines correspond to scenarios that resulted in a near miss and black lines correspond to scenarios in which the outcome was a crash. The green line represents a nonhazardous scenario in which the car stopped and the cyclist could continue along his/her way.*

## 4 CONCLUSIONS

Our results suggest that cyclists' predictions of what a car driver will do in intersection scenarios develop over time, with the responses for the very late freezing moment (i.e., the videos where the freeze was temporally closest to the conflict) being the most accurate. Further, differences in accuracy of predicting driver behavior were observed between near miss and crash scenarios, which might be attributed to different visual cues present in the clips. In order to investigate which factors (e.g., speed/path of the car, line/markers on the road, traffic rules) contributed to cyclists' predictions and self-reported behavior, a follow-up analysis is planned. In addition, in the final paper we will report the results for the remaining survey items.

## 5 ACKNOWLEDGEMENTS

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