Online situation and risk assessment: Improving cyclists’ safety in intersections?

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Background: Cycling trends

- Cycling cheap, convenient, healthy, environmental-friendly mode of transportation
- Gains more popularity, especially in urban areas
- Germany
  - increase in bicycle owners from 67-72 million between 2005 and 2015
  - 30% of households in urban areas own only a bicycle for mobility purposes (increase of 8% compared to 2003)
  - first choice for distances of 5 km or less
- rate of fatalities increased over the past decade
- 51% of all fatalities occur at junctions → 85% in intersections
- motorists and cyclists contribute to crashes equally

Background: Assistant systems

• Effort has been put into improving cycling safety
• Innovations require on board units (in the vehicle or on the bike), so that messages/warnings can be received or vehicle can intervene automatically
• Resulting in low penetration rates
• Alternative
  • an infrastructural warning system not requiring any equipment in the vehicle or on the bike
• Amber light (AL)
  • warned right turning motorists depending on the calculated risk of a collision with a crossing cyclist
  • mobile, battery-operated single traffic light with a bicycle symbol
  • wireless communication with the DLR servers
  • received message about the calculated risk level
Infrastructural warning system and risk prediction

Infrastructural detection system

- consisting of two poles equipped with stereo cameras, lidar and radar
- connected with the DLR Server
- detecting and tracking traffic participants for approx. 35 m
- output: trajectory and video data
Infrastructural warning system and risk prediction

Online risk assessment

- based on the trajectory data, the probability of a collision (risk) between crossing cyclist and right turning motorist was calculated in real time

<table>
<thead>
<tr>
<th>Status</th>
<th>Risk level</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Off</td>
<td>0 &amp; 1</td>
<td>Road users are not on a collision or uncritical encounter</td>
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<tr>
<td>Illuminated</td>
<td>2 &amp; 3</td>
<td>1st degree critical encounter (late, but controlled braking, accelerating, or swerving)</td>
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<tr>
<td>Flashing</td>
<td>4</td>
<td>2nd degree critical encounter (last second evasive manoeuvre)</td>
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Study: Research goal

• Installation of the Amber light may lead to behavioural adaptation:
  ...Therefore...

• Investigating the effects of the Amber light on road traffic safety, namely changes in the behaviour of right turning motorists:
  1. Differences in the distribution of maximum risk levels
  2. Differences in post encroachment time (PET)
  3. Differences in approach speed
Study: Setup and data

Scenario

- motorists and cyclists approached intersection from East → motorists headed North, cyclists crossed
- motorists and cyclists had green at the same time

Data

- 2161 encounters within 5 weeks
- week 1: no Amber light installed
- week 2-5 Amber light installed and active

- IV: risk level and weeks
- DV: No. risk levels, mean PET, and mean speed
Results: Distribution of maximum risk levels

- Relative frequency of risk levels 3 and 4 decrease
- Increase in the proportion of risk levels 1 and 2
Results: PET

**Maximum risk level:**
F(3, 2142) = 58.7, p < .001

- PET decreased as risk level increased
- Differences between risk levels 1 & 2 not significant

**Week:**
F(4, 2142) = 1.9, p = .1

- Increase in PET from baseline to first week with AL
Results: Approach speed

Maximum risk level x Week:
F(11, 2142) = 5.3, p < .001

- Significant differences in speed from baseline to first week with Amber light, most prominent for risk level 2
- Increase in speed observable for risk level 4
Discussion

1. Results indicate a positive effect on safety
   - Decrease in maximum risk levels 3 and 4
   - Increase in PET

2. Changes in approach speed may suggest some behavioural adaptation
   - Risk level 2: increase in speed, increase in PET by 0.3s
   - Risk level 4: increase in speed, no effect on PET

3. Further analyses needed to assess the effects of the Amber light on safety
   - Analysis of the minimum gap time and the resulting PET
   - Analysis of the temporal distribution of risk levels
   - Analysis of the data of the post week
Thank you for your attention!

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We thank the European Commission for funding the project XCYCLE under grant number 635975.