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

Source: http://edition.cnn.com/2014/08/17/travel/best-cycling-cities/

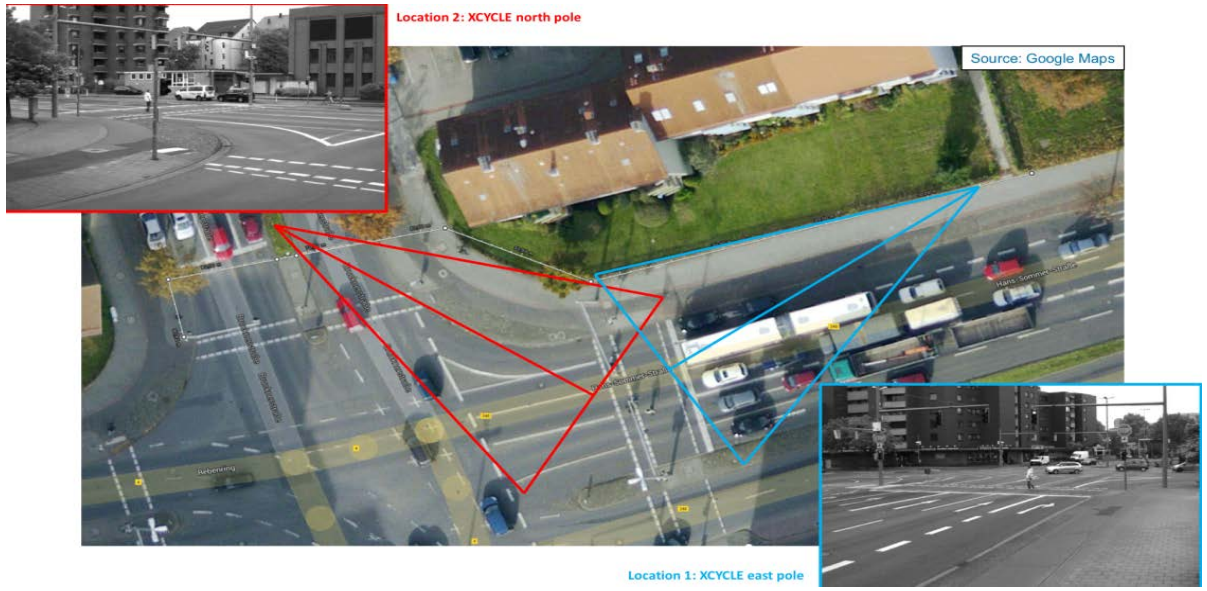
Background: Assistant systems

- 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

Status	Risk level	Definition
Off	0 &1	Road users are not on a collision or uncritical encounter
Illuminated	2 & 3	1st degree critical encounter (late, but controlled braking, accelerating, or swerving)
Flashing	4	2nd degree critical encounter (last second evasive manoeuvre)

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

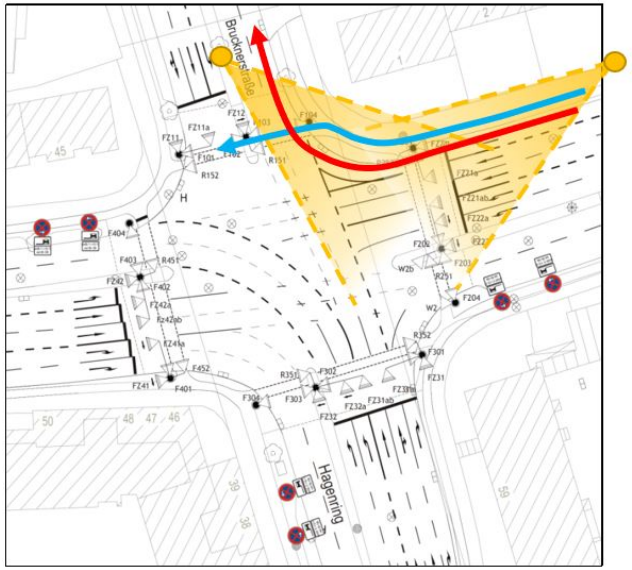
Scenario

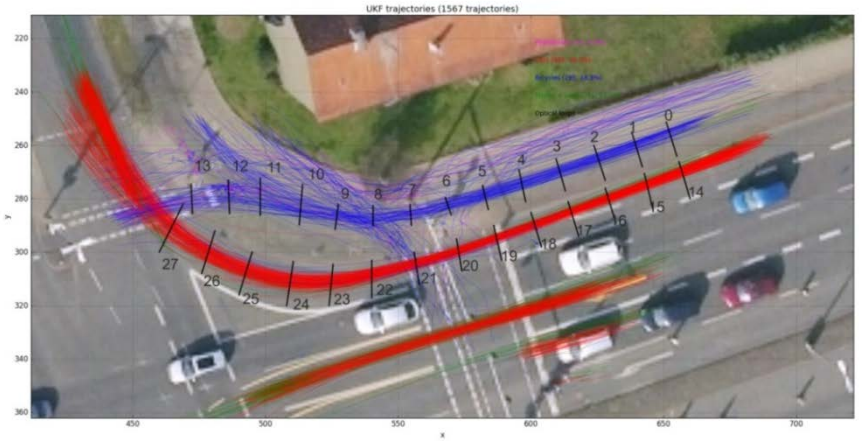
- motorists and cyclists approached intersection from East → motorists headed North, cyclists crossed
- motorists and cyclists had green at the same time

Data

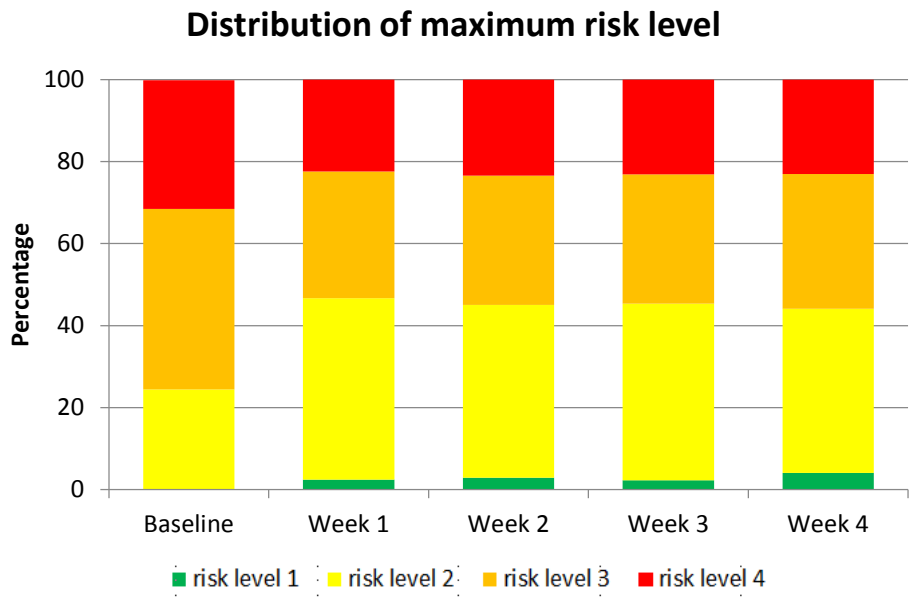
- 2161 encounters within 5 weeks
- week 1: no Amber light installed
- week 2-5 Amber light installed and active

- IV: risk level and weeks
- DV: No. risk levels, mean PET, and mean speed





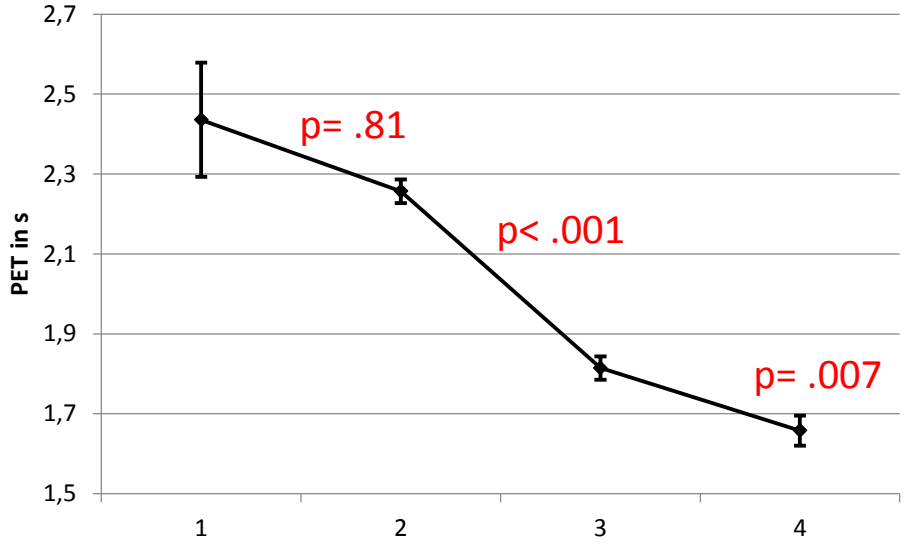
Results: Distribution of maximum risk levels



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

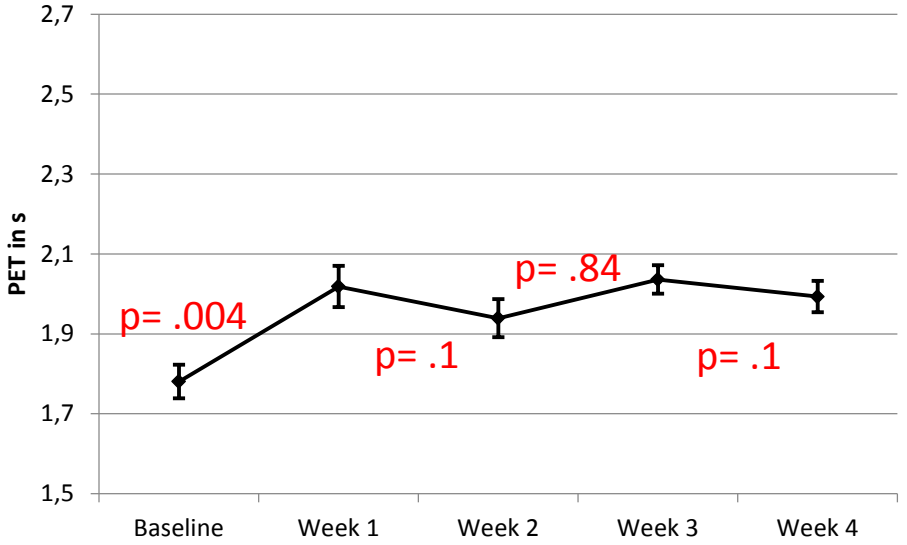
Results: PET

Maximum risk level:
F(3, 2142)= 58,7 p < .001



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

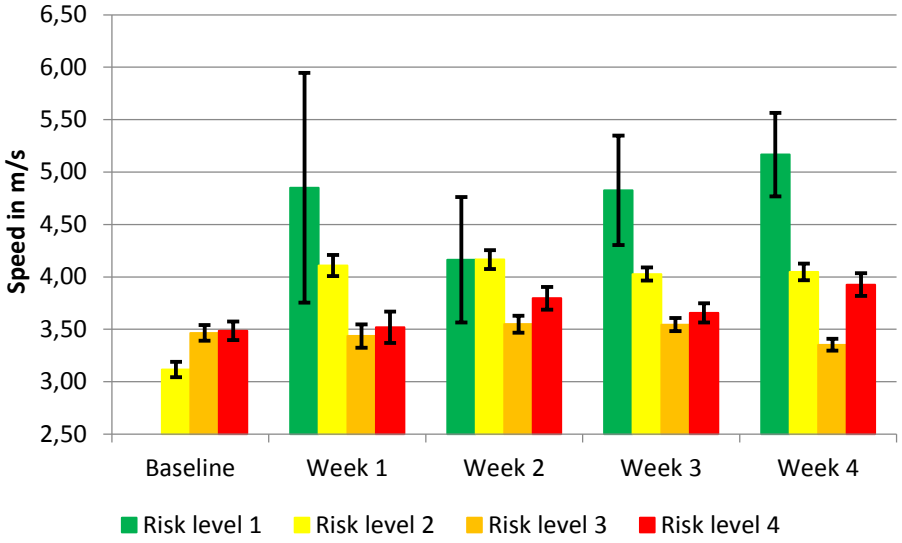
Week:
F(4, 2142)= 1,9, p = .1



- 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



Mean and standard error of speed

		Weeks											
		BL		1		2		3		4		Total	
		M	SE	M	SE	M	SE	M	SE	M	SE	M	SE
Max. risk level	1			4.85	1.10	4.16	0.60	4.83	0.52	5.17	0.40	**4.8**	**.27**
	2	3.12	0.07	4.11	0.10	4.17	0.09	4.03	0.06	4.05	0.08	**3.9**	**.03**
	3	3.47	0.07	3.44	0.11	3.55	0.08	3.54	0.06	3.35	0.06	**3.4**	**.03**
	4	3.49	0.09	3.52	0.15	3.80	0.11	3.66	0.09	3.93	0.11	**3.7**	**.04**
Total		**3.38**	**.04**	**3.78**	**.07**	**3.88**	**.05**	**3.8**	**.04**	**3.8**	**.05**		

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