



Funded by the Horizon 2020 Framework
Programme of the European Union

Cycling through intersections: Patterns affecting safety

Mandy Dotzauer, Marek Junghans, Gina Schnücker

Background: Cycling trends


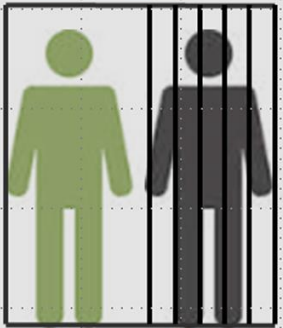
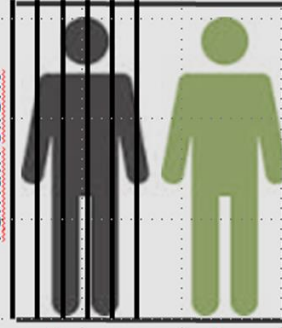
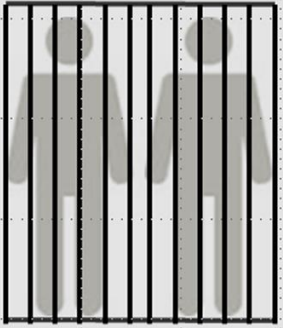
- Cycling cheap, convenient, healthy, environmental-friendly mode of transportation
- Gains more popularity, especially in urban areas
- Rate of fatalities increased over the past decade
- 51% of all fatalities occur at junctions → 85% in intersections
- Motorists and cyclists contribute to crashes equally
→ **Lack of cooperation**



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

Background: Cooperation

- Joint action (i.e. two or more parties work or act together for a common benefit/purpose)
- The degree of cooperation affects the outcome → Prisoner's dilemma
 - Acting on self-interest instead of seeing the bigger common good may lead to a worse outcome
- Construct applied to psychology
 - Understands a person's willingness to act for the common good and not for the individual
 - Requires trust and willingness to compromise
 - Is affected by individual gain (vs. loss) and distribution of power, past experience
- Cooperation in motorist- cyclist interaction
 - Adjusting behavior for the common good (e.g. driving a bit slower for a moment or leaving a little bit more room) may help to avoid conflicts/crashes and improves road traffic safety

	confess	remain silent
confess	 <p>2 years 2 years</p>	 <p>free 3 years</p>
remain silent	 <p>3 years free</p>	 <p>1 year 1 year</p>

Research goal and question

- Project goal: Investigating and developing new technical means (focusing on detection and networking technologies) in order to prevent crashes between VRUs and motorized traffic in urban areas
- Research goal: Online situation and risk assessment (predicting critical situations)
- Research questions:
 - How do encounters and critical situations differ for drivers and cyclists?
 - Where and when do conflicts emerge? Do they emerge abruptly or build up over time?
 - Is it possible to detect conflicts before they escalate?
 - Is it possible to quantify behavioral patterns (interaction/cooperation)?

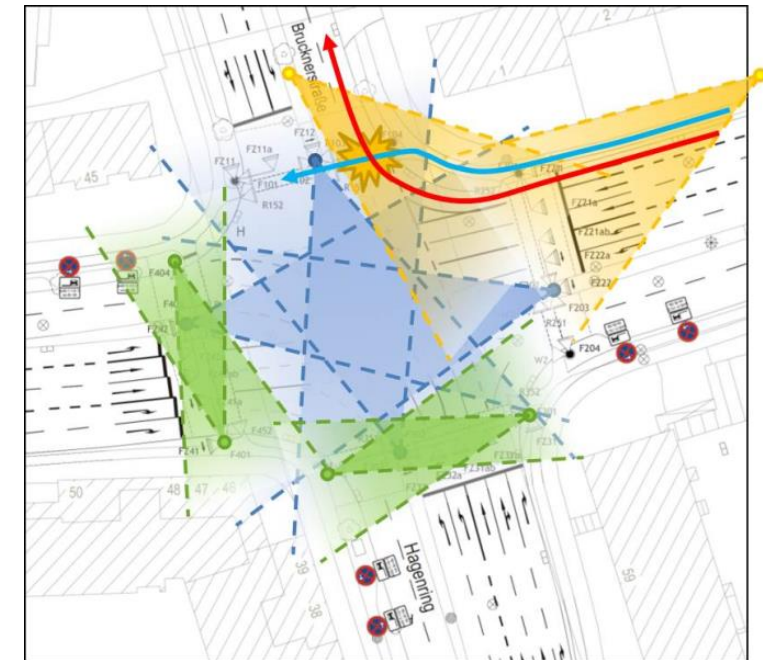
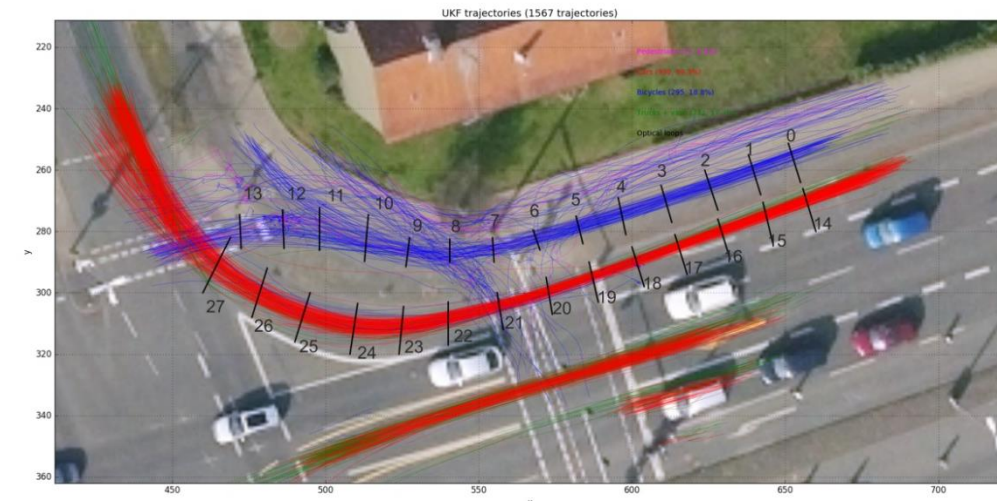
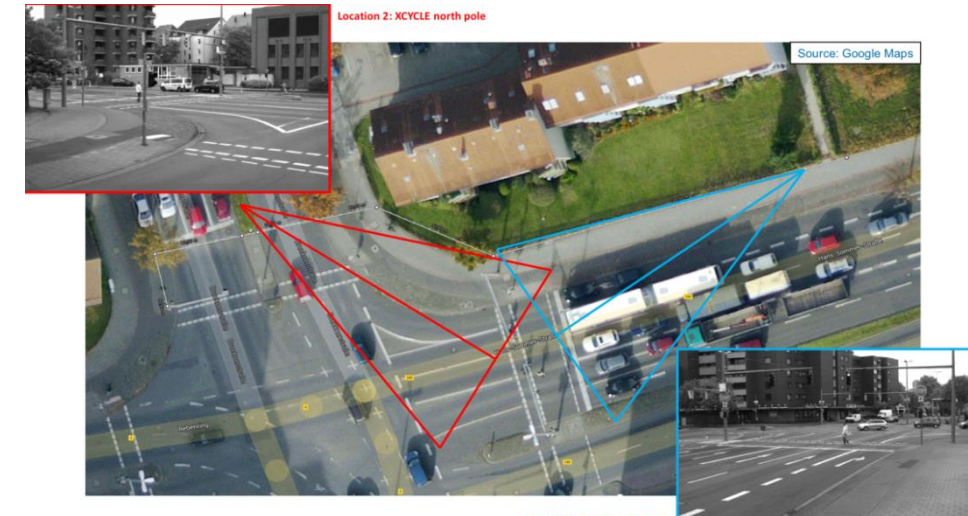


Figure: AIM Research Intersection

Method: Dataset

- Video recordings and trajectory data from August, 22nd to September, 18th (4 weeks)
- Altogether approx. 1800 potential interactions of cyclists and motorists extracted (300 discarded)
- 55 critical situations + 110 encounters (interactions between motorists and cyclists) identified
- Approach to the intersection (approx. 35 m) divided into 13 sections
- Mean speed (and SD) calculated for each interaction partner per section



Method: Variables and analysis

Independent variable:

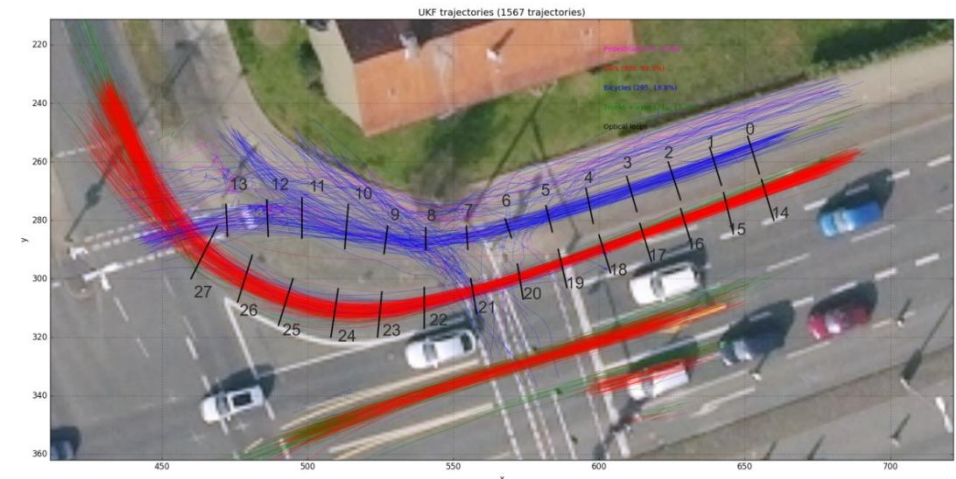
Type of interaction

Dependent variables:

- Mean speed (v in m/s)
- Distance in speed=
 $(vehicle_{v2} - vehicle_{v1}) - (bike_{v2} - bike_{v1})$

Analysis:

- ANOVA with repeated measures (Greenhouse-Geisser correction)
- Post hoc tests (one-sample independent t-test; $\alpha = 0.004$)
- Repeated contrast analysis for significant interaction effects





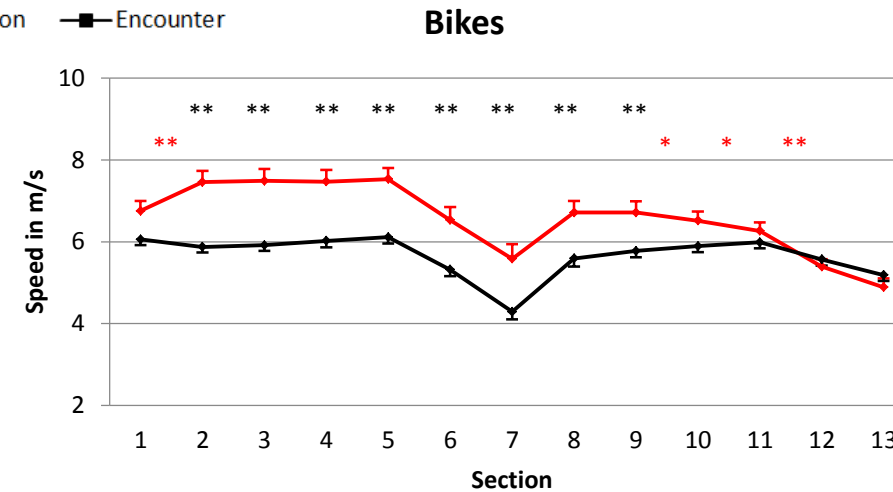
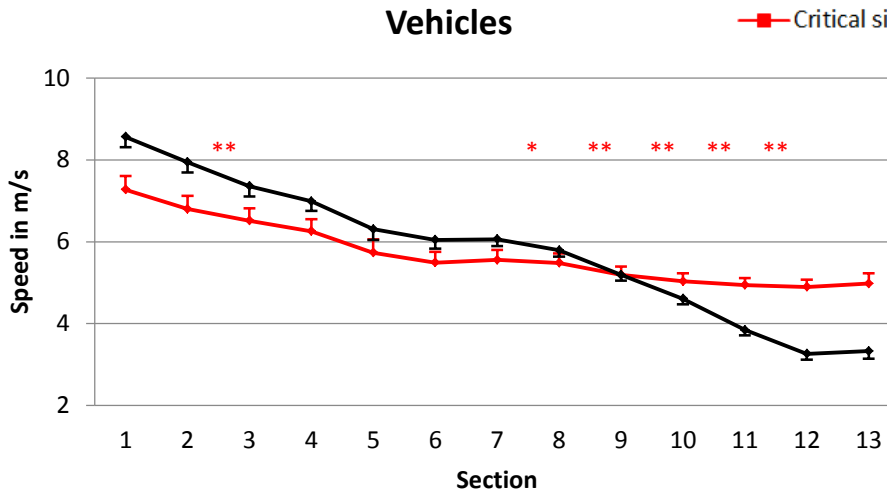
Results: Descriptive analysis

- 51 critical situations and 107 encounters

Gender	male	female	total
Encounter	64 (~60%)	43 (~40%)	107
Critical situation	35 (~ 69%)	16 (~31%)	51

Vehicle type	Car	Van	Truck	Total
Encounter	99 (~92.5%)	7 (~6.5%)	1 (~1%)	107
Critical situation	40 (~78%)	10 (~20%)	1 (~2%)	51

Results: Mean speed

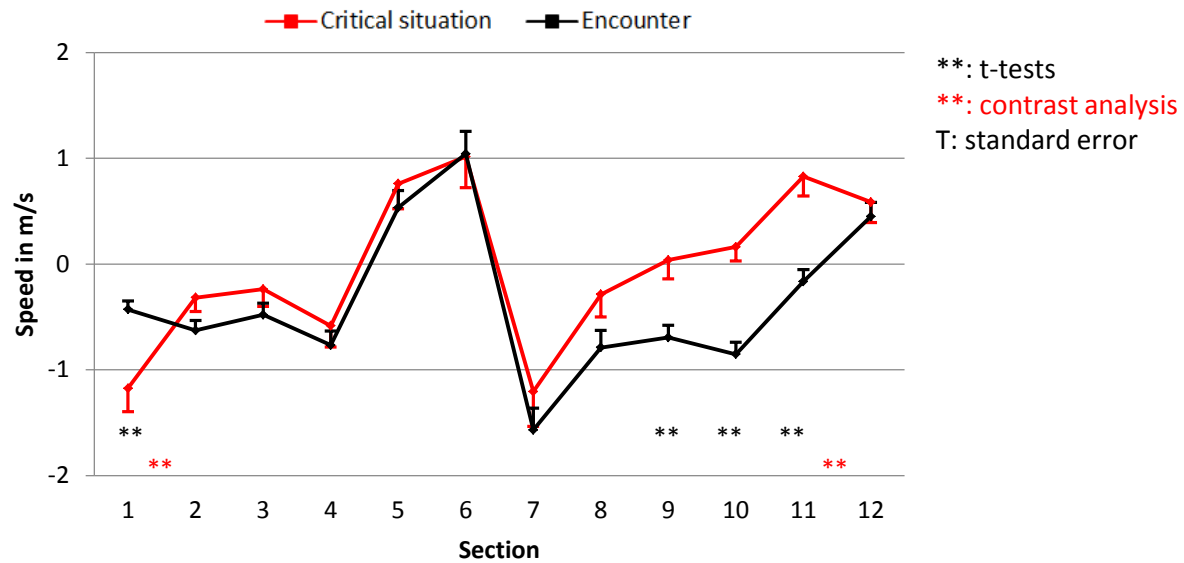


** : t-tests
 **: contrast analysis
 T: standard error

	Df	F	p
Section	2.56	125.73	< .001
Type of interaction	1	.105	ns
Section x Type of interaction	2.56	20.75	< .001

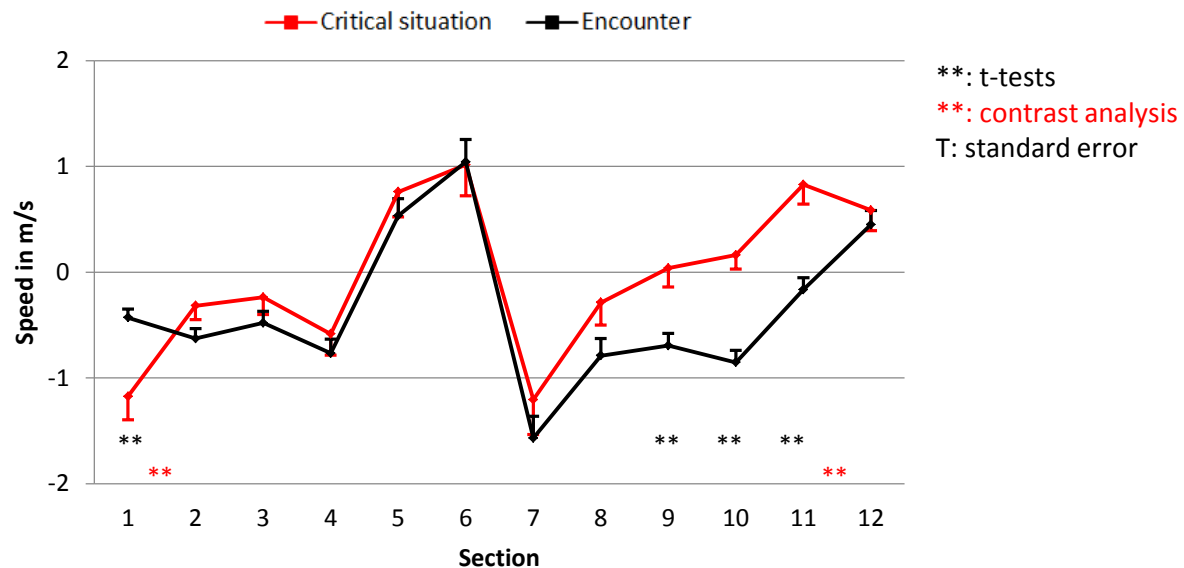
	Df	F	p
Section	5.95	40.39	< .001
Type of interaction	1	16.24	< .001
Section x Type of interaction	5.95	10.63	< .001

Results: Distance in speed (DiS)



	Df	F	p
Section	7.10	28.29	< .001
Type of interaction	1	51.26	< .001
Section x Type of interaction	7.10	3.31	.002

Results: Distance in speed (DiS)



Testvalue= 0	Critical situation (n= 51)	Encounter (n= 107)
Section 1	< .001	< .001
Section 2	.02	< .001
Section 3	.150	< .001
Section 4	.005	< .001
Section 5	.002	.001
Section 6	.001	< .001
Section 7	.001	< .001
Section 8	ns	< .001
Section 9	ns	< .001
Section 10	ns	< .001
Section 11	<.001	.148
Section 12	.004	.001

Revisiting research questions

1. How do encounters and critical situations differ for drivers and cyclists?
 - Cyclists in critical situations approach the intersection with higher speeds
 - Drivers in critical situations do not show differences in speed during the last 10-12 meters before the crossing point, while drivers in encounters decelerate
2. Where and when do conflicts emerge? Do they emerge abruptly or build up over time?
 - Last 10 meters before meeting appear to make a difference
 - Encounters: 10 m before the crossing point, mean speed of cars drops from 4.6 to 3.3m/s, cyclists from 5.9 to 5.2m/s
 - Critical situations: 10 m before crossing point, mean of speed cars constant, while cyclists drop from 6.5 to 5.2m/s
3. Is it possible to detect conflicts before they escalate?
 - Results indicate differences between encounters and critical situations before they occur
 - Last 10 meters before the crossing point appear to make a difference
4. Is it possible to quantify behavioral patterns (interaction/cooperation)?
 - Variable 'distance in speed' may be promising → encounter interactions less coherent than critical interactions



Discussion/Conclusion

- Discussion

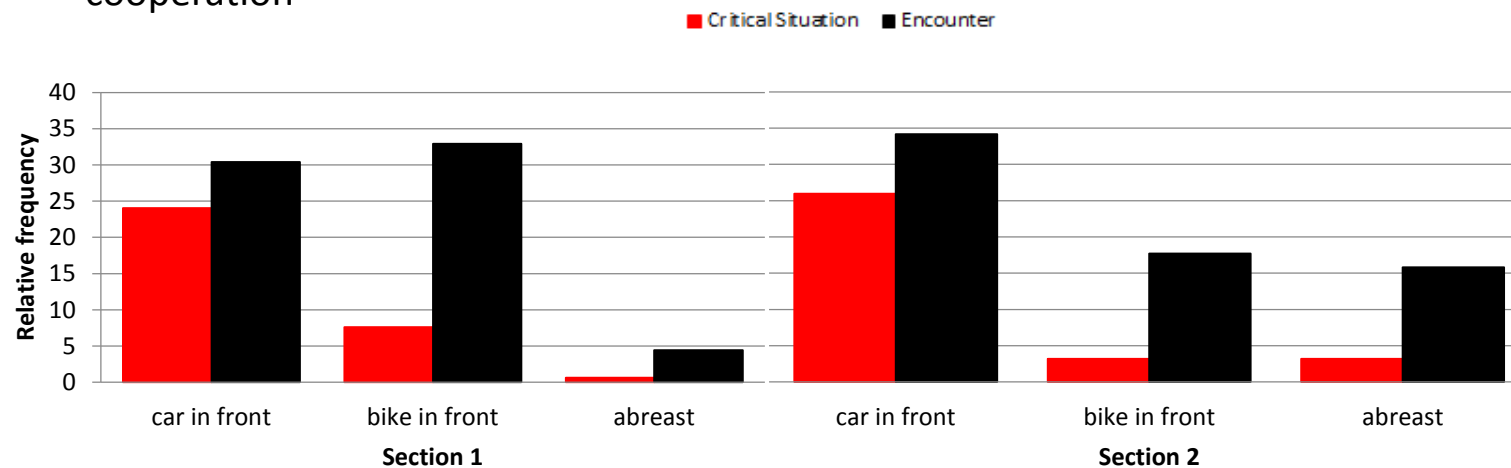
- Analyzing speed patterns first approach to finding a method to quantify cooperation
- Calculating 'distance in speed' was done independent of:
 - Relative position to each other
 - Distance between interaction partners
 - Differences in time crossing a section
- What we know:
 - Interaction partners hardly ever cross through a section at the same time

Discussion/Conclusion

- Discussion

- What we know:

- Interaction/cooperation requires proximity
 - Seeing the cyclist while approaching the intersection may affect the outcome of the interaction/ the level of cooperation



- How can spatial and temporal information be factored into the speed information?



Thank you for your attention!

Dr. Mandy Dotzauer

Mandy.dotzauer@dlr.de

Visit: <http://www.xcycle-h2020.eu/>

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