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On-site observation of driver-pedestrian interaction at zebra crossings in Urban settings

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4. Summary

1. Aims

The aim of this work was to describe pedestrian-driver encounters, communication, and decision strategies at marked crossings.

Including:

- Pedestrians' behavior before and while crossing the road at marked crossings (and when a car is approaching).

- Drivers' behavior while approaching a marked crossing when a pedestrian is on the sidewalk or about to cross the street.

- Pedestrian-driver communication (such as eye contact, gestures, verbal expressions, and signals, such as the flashing of lights) in situations before and while crossing at marked crossings.

2. Study design

Mixed-methods study design

1. Exploration of pedestrians' and drivers' needs and conflict situations that may arise from their interaction (identification of problems): focus groups with pedestrians and drivers.

2. Pilot study: sites, questionnaire, observation sheet, camera recordings.

3. Data collection: observation (data from cameras, on-site observations, speed measurements), interviews (short on-site interviews with pedestrians).

4. Exploration and generalization: expert workshop.

2. Study design

Field study design and data

1. Four observation sites – zebra crossings in the urban area of the city of Olomouc (approx. 100,000 inhabitants)

2. 3 activities at the same time: to observe drivers' behavior, to observe pedestrians' behavior, and to administer interviews to pedestrians (all data connected)

3. Observation situation: a car is approaching a crossing **where** a pedestrian is present (waiting), approaching, or crossing the road.

4. Focus of observation and interviews:
   1. Pedestrians – their behavior before and while crossing, awareness, crossing strategies (e.g., making the driver stop), communication with drivers
   2. Drivers – their strategies while approaching a crossing (when pedestrians are present – giving priority or not), communication with pedestrians
   3. Interviews with pedestrians – their needs, perceived safety and comfort, habits and strategies while crossing the road

2. Study design

Field study design and data

1. Field observations (observers & observation sheets): data collected during December 2013-March 2014, observation for one week, times: 7.00-9.00, 12.00-13.00, 16.00-17.00. No snow, ice or wet conditions.

2. Camera recordings – of selected sites; 24 hours; car and pedestrian densities were counted. Back up.

3. Speed measurement at selected sites during observation times.

4. Altogether **1584 observations** (situations observed at 4 sites).

2. Study design – data analysis methods

Qualitative analysis

The data was analysed systematically using a modified version of the **Editing Analysis Style** (Miller & Crabtree, 1992). Our study applied **thematic analysis** as a tool for pattern recognition across qualitative data. Two researchers performed the reading separately and then compared the key elements and concepts that had been elicited for consistency.

Quantitative analysis

We conducted **a logistic regression to model** the relationships between dichotomous dependent variables (e.g. the occurrence of conflict) and several independent variables covering the characteristics of drivers, pedestrians, and the environment. The practical effect of each independent variable is described with its odds ratio. The accuracy of model was described with **its chi-square statistics and p-value, as well as two effect size estimators** (Cox & Snell and Nagelkerke R squares).

2. Sites

Site 1: Billa supermarket
Single crossing, narrow street with turning vehicles, no traffic lights.

2. Sites

Site 2: Student cafeteria
Single crossing, narrow street, no traffic lights.

2. Sites

Site 3: Santovka shopping gallery
Crossing including a tram line and bicycle lane, narrow street, no traffic lights.

2. Sites

Site 4: Faculty of Natural Science
Crossing including a tram line and bicycle lane, narrow street, turning vehicles, no traffic lights.

2. General characteristics of the crossings

	Site 1	Site 2	Site 3	Site 4
Average car speed	28.4	30.0	29.7	31.2
SD	4.2	7.7	3.5	10.6
Car density	3358.0	3477.0	4672.0	4609.0
Pedestrian density	1903.0	791.0	546.0	930.0
Car/pedestrian ratio	1.8	4.4	8.6	5.0
Accidents (last 3 years)	3.0	0.0	0.0	1.0
Conflicts observed	4.0	1.0	12.0	17.0
Waiting time (No. of cases of waiting for more than 5 sec.)	35.0	74.0	121.0	81.0
Driver not yielding to pedestrian (No. of cases observed)	34.0	110.0	146.0	121.0
Subjective safety (feeling safe vs. not feeling safe)	**3.9**	**3.6**	**0.7**	**1.1**
Crossing width (m)	10.0	7.5	18.0	17.0

4. Results
a. Pedestrian interviews – perceived safety

Do you find it safe to cross the road here? (N= 473)
The majority of the pedestrians (287, i.e., 60%) who were interviewed found it **rather safe** to use the given crossings to traverse the road, while 186 respondents (40%) did not find it safe to cross the road at the crossing under study.

The most common reasons for the pedestrians finding it unsafe to cross included a **poor view, heavy traffic, the speed of the passing cars, the absence of traffic lights, the absence of a traffic island on a long crossing, and experience of drivers not stopping before the crossing**.

4. Results, b. On-site observations

1. **What influences drivers' yield/go behavior? What is the role of explicit communication between drivers and pedestrians in wait/go behavior?**

Independent variable	B	Wald	Sig	Exp(B)
Car speed	-0,30	17,82	**0,00**	0,74
Road traffic density	-0,15	4,52	**0,03**	0,86
Pedestrian traffic density	0,12	2,13	0,14	1,12
The car was less than 10 metres away	-0,71	25,45	**0,00**	0,49
A line of cars was approaching (driving in platoon)	0,50	16,37	**0,00**	1,65
Child (0-12)	0,35	0,68	0,41	1,42
Male (13-25)	0,11	0,24	0,62	1,12
Female (13-25)	0,22	1,28	0,26	1,24
Female (13-25)	-0,04	0,03	0,85	0,96
Senior citizen (65+)	0,98	2,26	0,13	2,67
Group of pedestrians	1,04	24,49	**0,00**	2,82
The pedestrian stood waiting more than 0.5 m away from the curb	-1,06	6,64	**0,01**	0,35
The pedestrian used at least eye contact to give the driver a sign.	0,87	2,04	0,15	2,39
The pedestrian waited less than 5 seconds.	0,73	3,60	0,06	2,08
The pedestrian waited more than 5 seconds.	-1,04	55,33	**0,00**	0,35
The driver engaged in other activities while driving.	0,59	0,95	0,33	1,81
The pedestrian engaged in other activities while crossing the road.	-0,39	5,24	**0,02**	0,68
Invariable	0,00	0,00	0,99	1,00

4. Results, b. On-site observations

1. What influences drivers' yield/go behavior? What is the role of explicit communication between drivers and pedestrians in wait/go behavior?
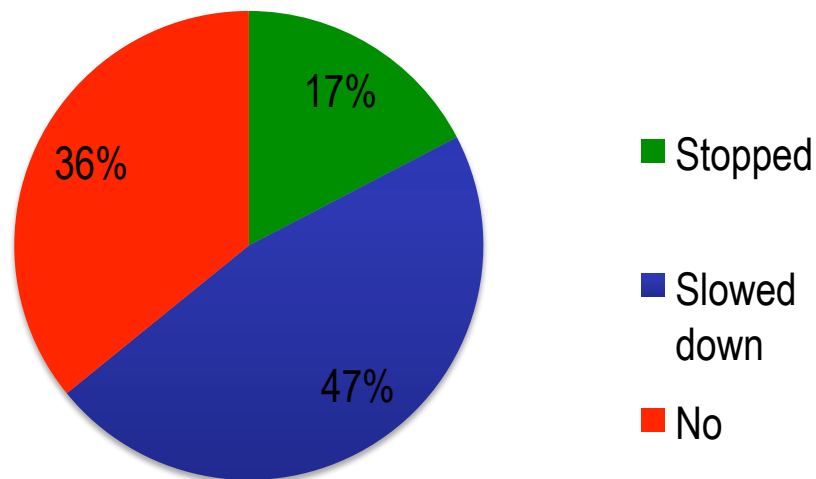
- The probability of a driver yielding to a pedestrian declines as the speed increases
- The probability of a driver yielding to a pedestrian declines as the traffic density increases
-A driver is less likely to yield if a pedestrian stands waiting more than half a meter away from the curb
- A driver is less likely to yield to a pedestrian if the latter is engaged in a different activity (such as writing a text message)
- A driver is more likely to yield to a pedestrian when there is a platoon of cars
- A driver is more likely to yield when a group of pedestrians is waiting/crossing
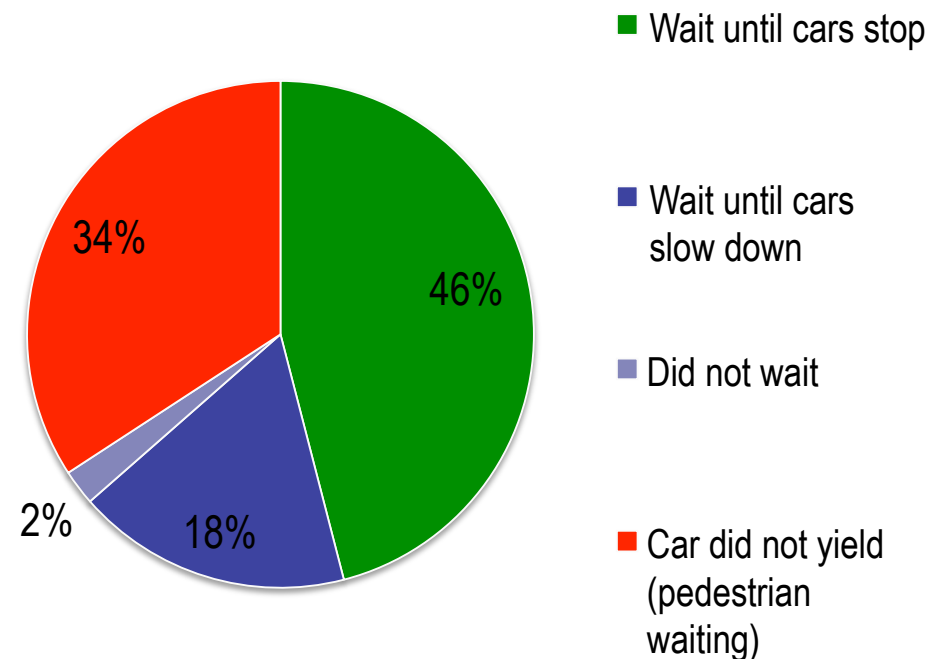
*significant

4. Results, c. On-site observations

Did the driver yield to the pedestrian?

Did the pedestrian wait before crossing the road?

- 🟩 Stopped
- 🟦 Slowed down
- 🟥 No

- 🟩 Wait until cars stop
- 🟦 Wait until cars slow down
- 🟪 Did not wait
- 🟥 Car did not yield (pedestrian waiting)

4. Results, c. On-site observations

2. What influences pedestrians' wait/go behavior? What is the role of explicit communication between drivers and pedestrians in wait/go behavior?

Observations:
- *Pedestrians waited until the car came to a complete standstill (rather than slowed down) when the traffic density rates were low*
- *Pedestrians waited for more than 5 seconds to cross when the traffic density rate was high*
- *Pedestrians find it safer to cross the road when the traffic density is low (not confirmed for speed)*

- *Women feel less safe*

*significant

4. Results, c. pedestrian interviews

2. What influences pedestrians' wait/go behavior? What is the role of explicit communication between drivers and pedestrians in wait/go behavior?
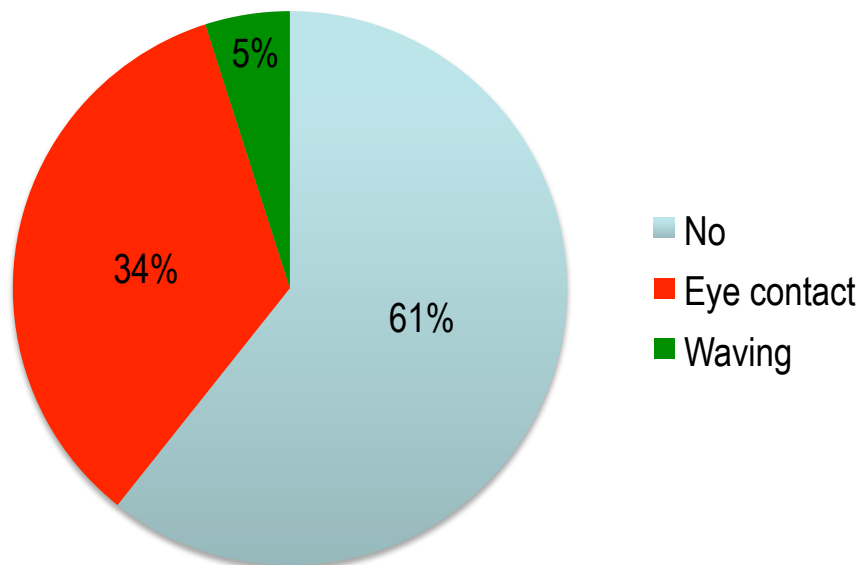
Interviews:

What options do you consider when crossing a road? (whether to wait and "yield to the car" or step onto the road/crossing?) **(N= 290)**

- **speed of the approaching car** (197 answers)
- **distance of the car from the crossing** (164 answers)
- **traffic density** (101 answers)
- **whether there are cars approaching from both directions** (90 answers)
- **various signs given by the drivers** (waving a hand, flashing their lights, etc.) (67 answers)
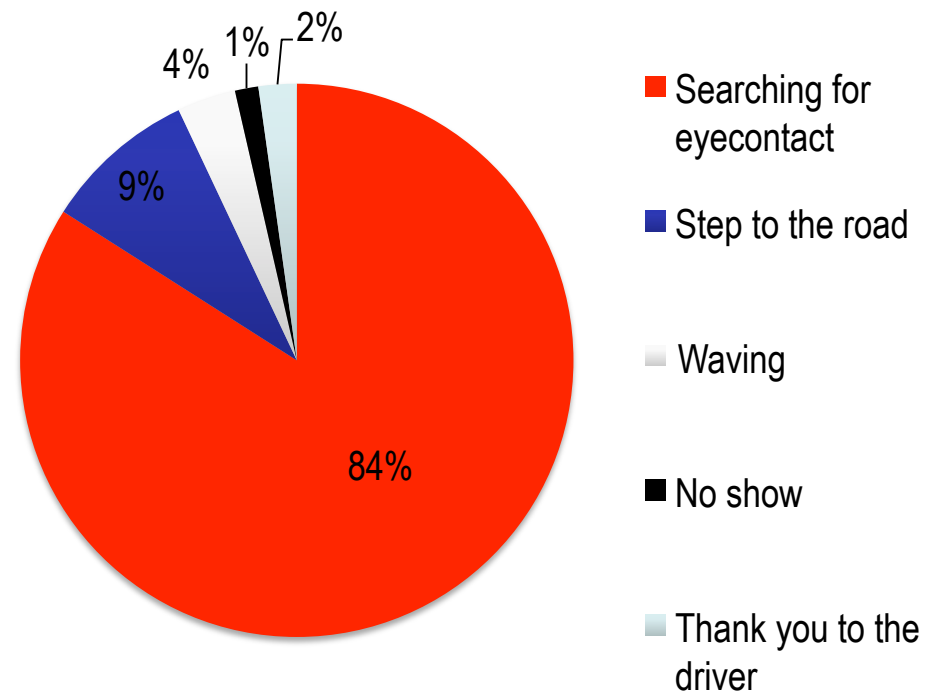- **presence of other pedestrians** (58 answers)

4. Results, c. On-site observations

Did the driver explicitly communicate with the pedestrian?

- No: 61%
- Eye contact: 34%
- Waving: 5%

Did the pedestrian show his/her intention to cross (and how)?

- Searching for eyecontact: 84%
- Step to the road: 9%
- Waving: 4%
- No show: 1%
- Thank you to the driver: 2%

4. Results, c. On-site observations / Conflict situations

Independent variable – Did a conflict situation occur?	B	Wald	Sig	Exp(B)
Average road traffic speed	0.45	4.72	**0.03**	1.57
Road traffic density	0.42	3.81	**0.05**	1.52
Pedestrian traffic density	0.26	1.08	0.30	1.30
The car was less than 10 metres away	-0.02	0.00	0.96	0.98
A line of cars was approaching	0.17	0.20	0.65	1.18
Demographic group; reference group = men (26-65)		13.27	0.04	
Child (0-12)	-0.53	0.23	0.63	0.59
Male (13-25)	-1.82	5.37	0.02	0.16
Female (13-25)	-1.31	6.13	0.01	0.27
Female (26-65)	-1.21	4.74	0.03	0.30
Senior citizen (65+)	-18.59	0.00	1.00	0.00
Group of pedestrians	-1.63	8.66	0.00	0.20
Driver-pedestrian communication; reference group = no communication		1.51	0.47	
Eye contact	0.43	1.31	0.25	1.54
Other forms of active communication	0.53	0.46	0.50	1.69
The pedestrian looked out for any approaching cars before entering the carriageway.	1.60	3.81	0.05	4.94
The pedestrian did not stop before the crossing.	0.59	1.45	0.23	1.81
The driver engaged in other activities while driving.	-17.43	0.00	1.00	0.00
The pedestrian engaged in other activities while crossing the road.	0.84	3.24	0.07	2.32
Invariable	-5.02	26.67	**0.00**	0.01

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5. Summary

1. Generally, the most relevant predictors of pedestrians' and drivers' behavior are:

- densities of car traffic and pedestrian flows
- car speed

2. Pedestrians – wait/go behavior and perceived safety and comfort

The majority of the pedestrians who were interviewed found it rather safe to use the marked crossings under study (60%), while 40% of the respondents do not find it safe to traverse the road at the given crossings.

46% of the pedestrians require drivers to stop before the crossing (not only slow down) for them to feel safe to cross. On the other hand, only 17% of the drivers did so (and 47% slowed down). 36% of the drivers did not yield.

5. Summary

2. Pedestrians – wait/go behavior, perceived safety and comfort, explicit communication

Women feel less safe.

Factors influencing pedestrians' wait/go behavior:

- car speed
- distance of the car from the crossing
- traffic density

The majority of the pedestrians (84%) were searching for eye contact with drivers, while only 34% of the drivers did so.

5. Summary

3. Drivers' yield/go behavior

Factors influencing drivers' yield/go behavior:

- speed (higher speed = lower willingness to yield)
- traffic density (higher density = lower willingness to yield)
- driving in a platoon = greater willingness to yield
- driver's willingness to yield increases where there is a group of pedestrians
- pedestrian being distracted = lower willingness to yield

4. Conflict situations

The probability of conflict situations increases with:
- cars travelling at higher speeds
- higher traffic density
- pedestrians being distracted by a different activity while crossing.
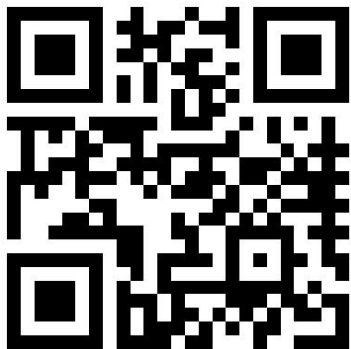
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Thank you for listening!

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