Interactions of autonomous vehicles and cyclists:

Results from real-world and simulator trials

John Parkin
Professor of Transport Engineering
Centre for Transport and Society
University of the West of England, Bristol

John.parkin@uwe.ac.uk

Twitter @johnParkin28

http://www1.uwe.ac.uk/et/research/cts

John Parkin; Fiona Crawford; Jonathan Flower; Chris Alford; Graham Parkhurst

UWE Bristol | University of the West of England

Centre for Transport & Society

VENTURER

Objectives

- Develop AV technologies
- Consider public acceptance
- Consider insurance and legal implications

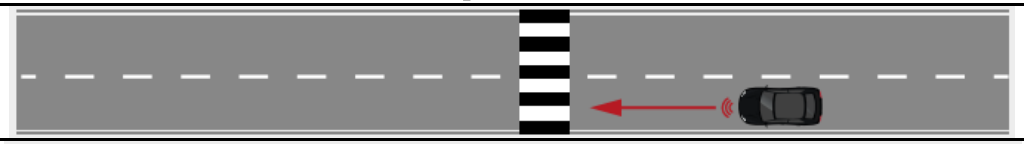
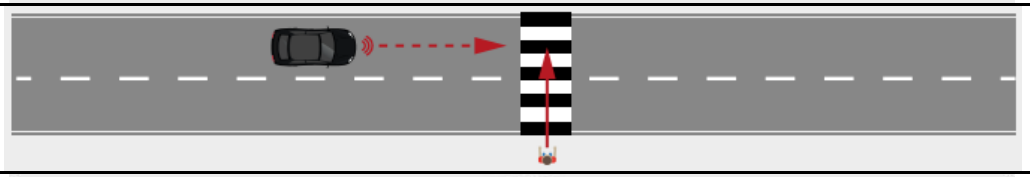
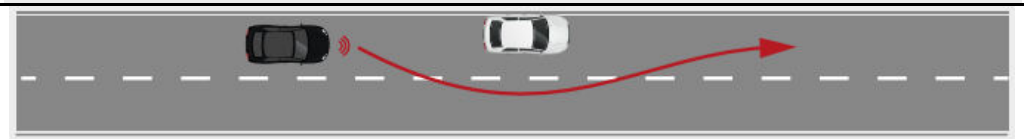
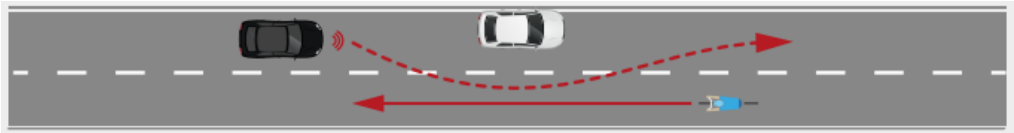
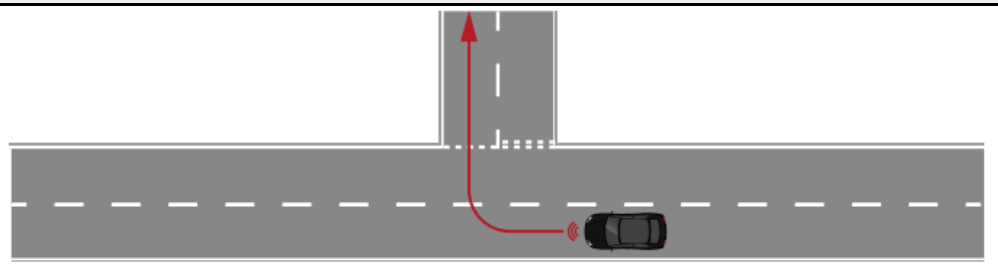
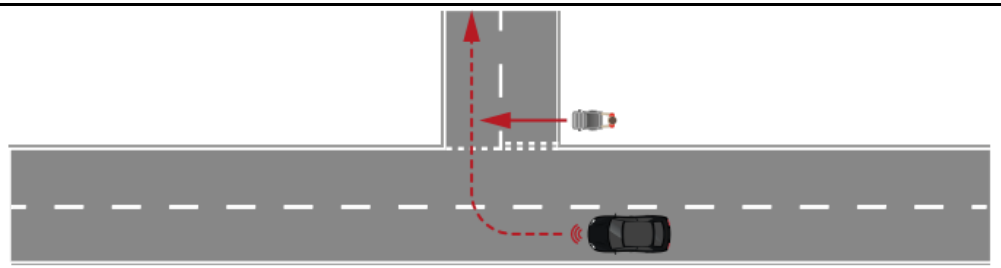
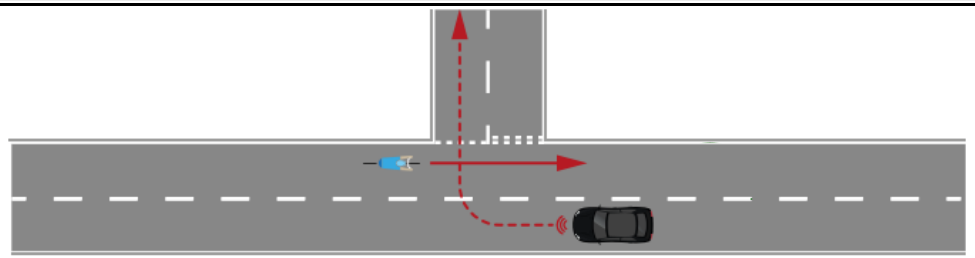
Trials

1. Planned hand-back of control to a driver
2. Exploring interactions with other motor vehicles
3. **Investigating trust in AVs during interactions with other road users, such as cyclists and pedestrians.**

UWE Bristol University of the West of England

Innovate UK

Trial 3 events

Event	Depiction
Crossing zebra	
Crossing zebra with pedestrian	
Overtaking a parked car	
Overtaking parked car with oncoming cyclist	
Turning right into side road	
Turning right into side road with pedestrian	
Turning right into side road with cyclist	

UWE Bristol | University of the West of England


S409 EAF
EG12 PNU

Participants and overall scores

49 in driver role
45 in cyclist role and
40 in pedestrian role

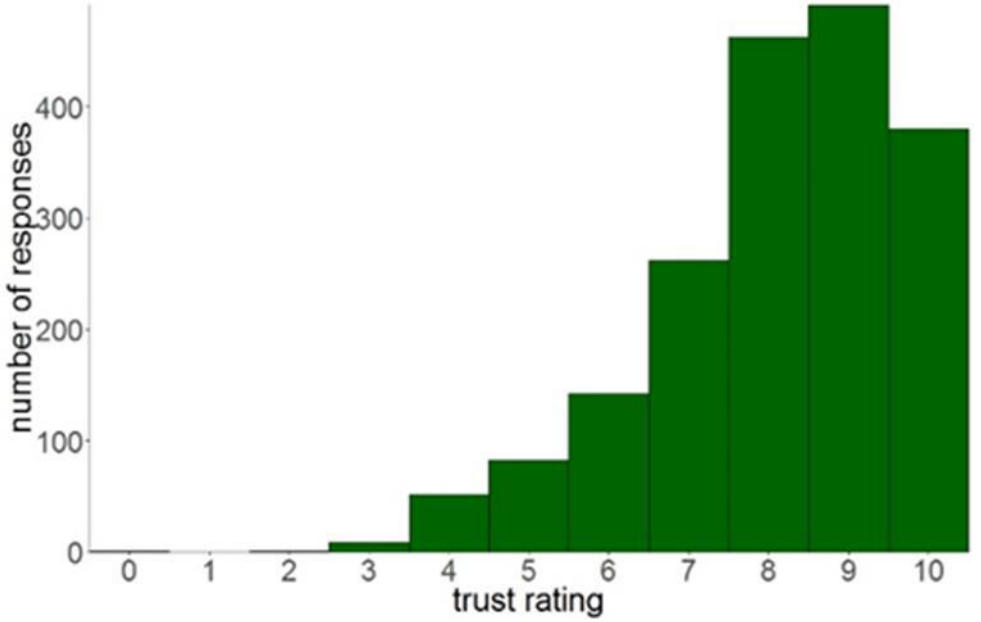
134 people

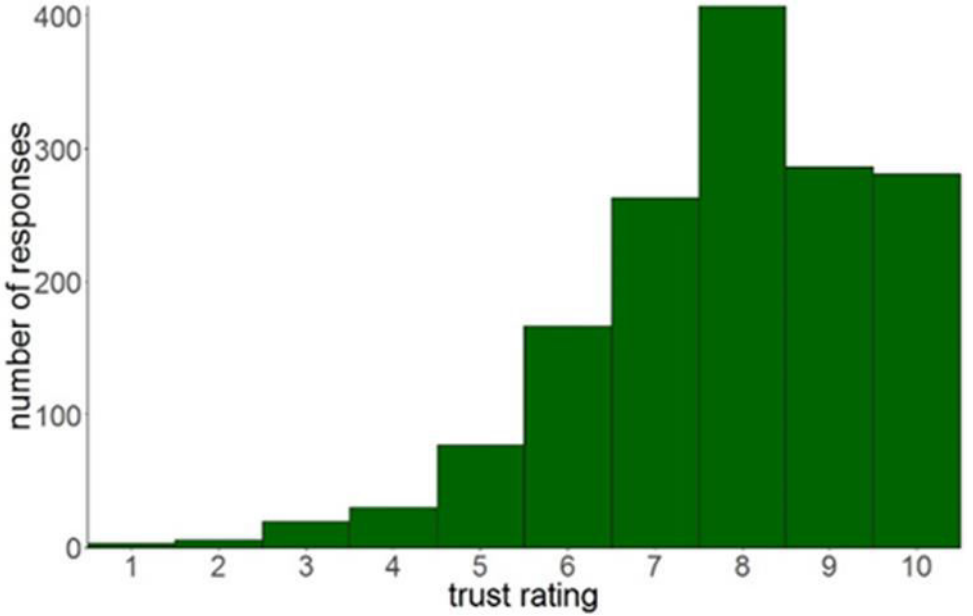
48 female
86 male

Ages 18 to 79
(mean 50)

132 have passed a driving test

10 months to 49 years driving experience





UWE Bristol University of the West of England

Centre for Transport & Society

		All respondents		Cyclists		Drivers		Pedestrians	
Location	Encounter	Mean n=95	St. Dev.	Mean n=33	St. Dev.	Mean n=35	St. Dev.	Mean n=27	St. Dev.
Autonomous vehicle									
Zebra crossing	None	8.4	1.35	8.2	1.12	8.6	1.33	8.5	1.62
	Pedestrian	8.1	1.52	8.2	1.35	7.9	1.76	8.2	1.40
Parked car	None	7.7	1.52	7.5	1.52	8.0	1.61	7.6	1.38
	Cyclist	8.2	1.40	8.1	1.47	8.3	1.42	8.2	1.34
Junction	None	8.1	1.31	8.0	1.18	8.1	1.38	8.2	1.41
	Pedestrian	8.0	1.42	7.7	1.42	8.0	1.40	8.3	1.44
	Cyclist	8.2	1.32	8.2	1.17	8.3	1.39	8.2	1.42
Simulator		n=110		n=37		n=41		n=32	
Zebra crossing	None	7.3	1.84	6.9	2.06	7.4	1.66	7.7	1.75
	Pedestrian	8.1	1.43	7.8	1.47	8.2	1.52	8.3	1.27
Parked car	None	7.9	1.51	7.6	1.35	8.0	1.75	8.0	1.34
	Cyclist	7.8	1.54	7.7	1.36	7.7	1.82	8.2	1.34
Junction	None	7.8	1.64	7.5	1.47	7.8	1.81	8.0	1.60
	Pedestrian	7.9	1.47	7.5	1.52	8.0	1.48	8.1	1.37
	Cyclist	8.1	1.38	7.8	1.34	8.2	1.50	8.3	1.22

UWE Bristol University of the West of England

The red 7.3: first event, and responses suggest participants slightly taken aback

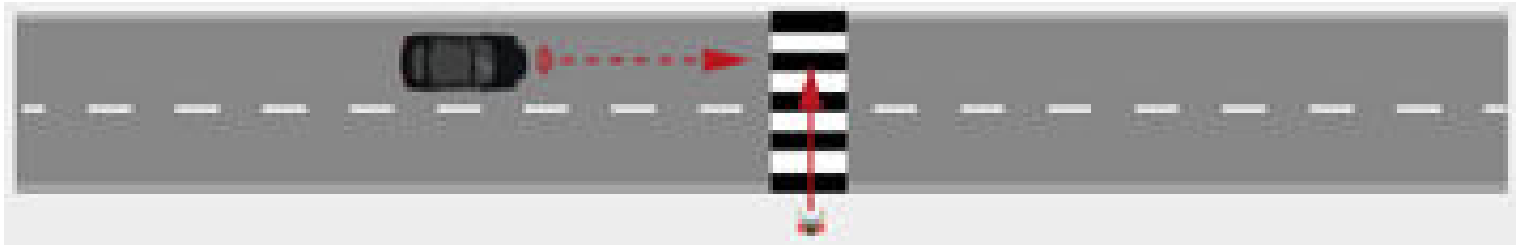
Centre for Transport & Society

1 Effect of pedestrian/cyclist presence: AV

Only significant differences in scores in the AV:

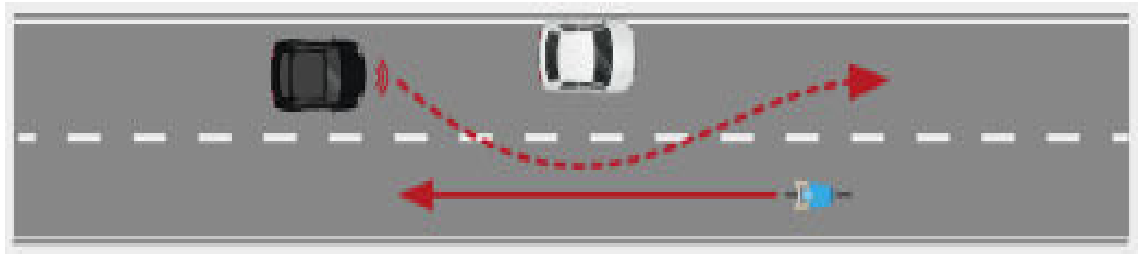
Pedestrian presence decreased the trust score at the zebra crossing (8.4 to 8.1)

- *Does the presence of a pedestrian acts as a reminder of the risk involved?*



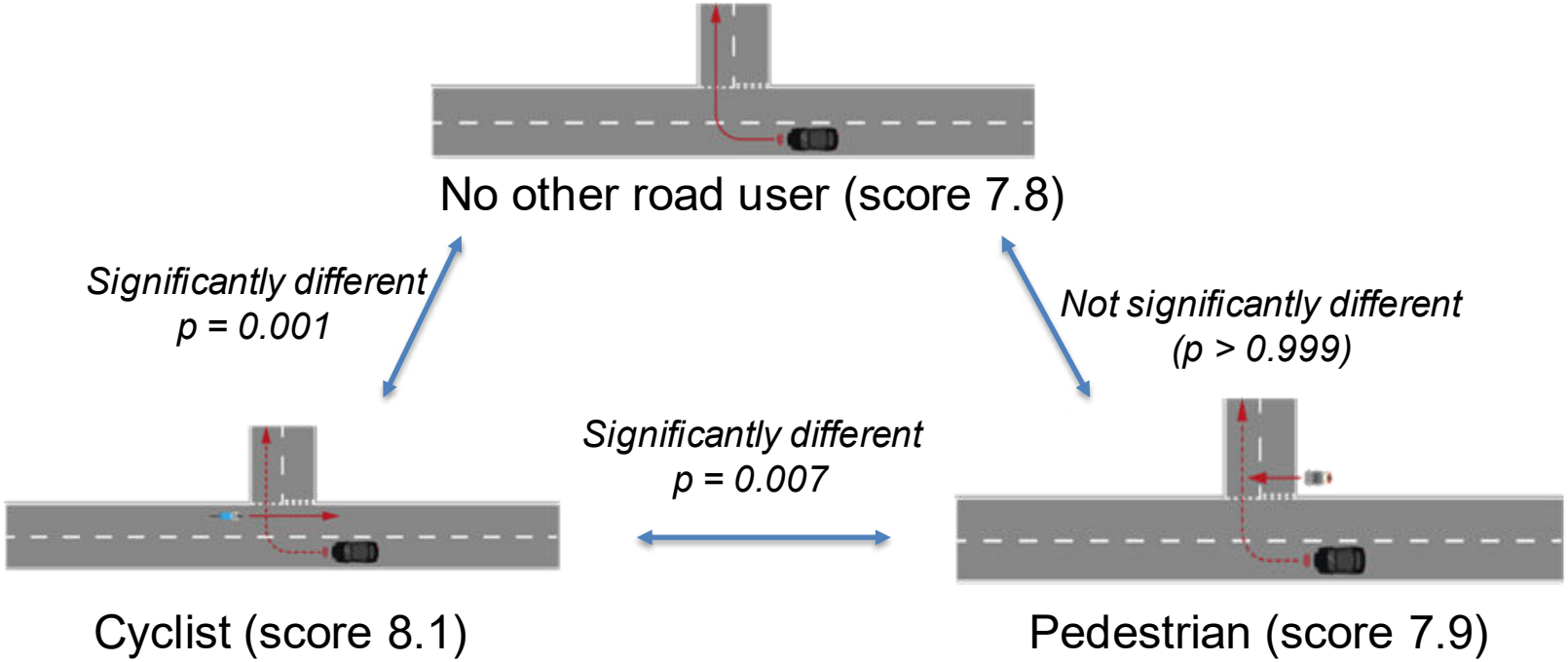
Cyclist's presence increased the trust score when overtaking a parked car (7.7 to 8.2)

- *Did participants wonder at the AV's intentions with an on-coming vehicle when it is absent?*



1 Effect of pedestrian/cyclist presence: Simulator

Only significant difference in scores in the Simulator



- *Does the presence of other traffic give confidence that the AV is behaving properly?*
- *Was the AV too cautious?*

2 Effect of respondent role

No statistically significant differences in trust ratings given by cyclist, driver and pedestrian participants

3 Effect of platform

Only significant differences in trust scores:

Junction: The significance of only the events (not the platform or the interactions) suggests the platform has no effect.

Parked car: With and without on-coming cyclist are not the same for each platform (the interaction was significant), i.e. the platform is moderating the response.

4 Effect of driver vs autonomy

Only significant differences in trust scores:

Parked car: trust higher when manually driven

- *Is there still progress to be made with very complex manoeuvres?*

Right turn with cyclists: trust highest anyway, but higher when manually driven (8.5 versus 8.2).

- *Does this reflect the AV was apparently too cautious?*

5 Correlation with psychometric tests

- Psychometric tests included: driving experience questionnaire; Faith and Trust Stance in General Technology; Trust in Automation; Impulsivity; Self-control; Risk taking; Distractibility; Personality; Sleep; Mood; Cognitive workload.

- There were no associations with age, years since driving test or annual mileage

- Low to medium strength positive association between the trust scores for all events, bar overtaking a parked car with oncoming cyclist in the AV.

Summary and implications

1 Effect of presence of pedestrians and cyclists

- Trust ratings were high, but no overarching pattern in the scores that were statistically significantly different
- Trust higher with a cyclist present: is the vehicle apparently too cautious, or are people re-assured?

2 Effect of participant role (pedestrian/cyclist/driver)

- Neither role nor their viewpoint impact trust: *no need to differentiate messaging for different audiences*

3 Platform

- Research in simulation prior to real world appears to be useful

4 Effect of manual driving versus autonomy

- Higher trust in manually driving for four out of the seven scenarios (but order effect?)

5 Personality type

- No correlations with age or driving experience, but correlations between trust in autonomy and reported trust scores: *do we need to guard against being too trusting?*