Institute for Transport Studies
FACULTY OF ENVIRONMENT

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Needs of Pedestrians Interacting with Automated Vehicles

Ruth Madigan

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SEVENTH FRAMEWORK PROGRAMME

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No ‘Drivers’ in the Vehicle

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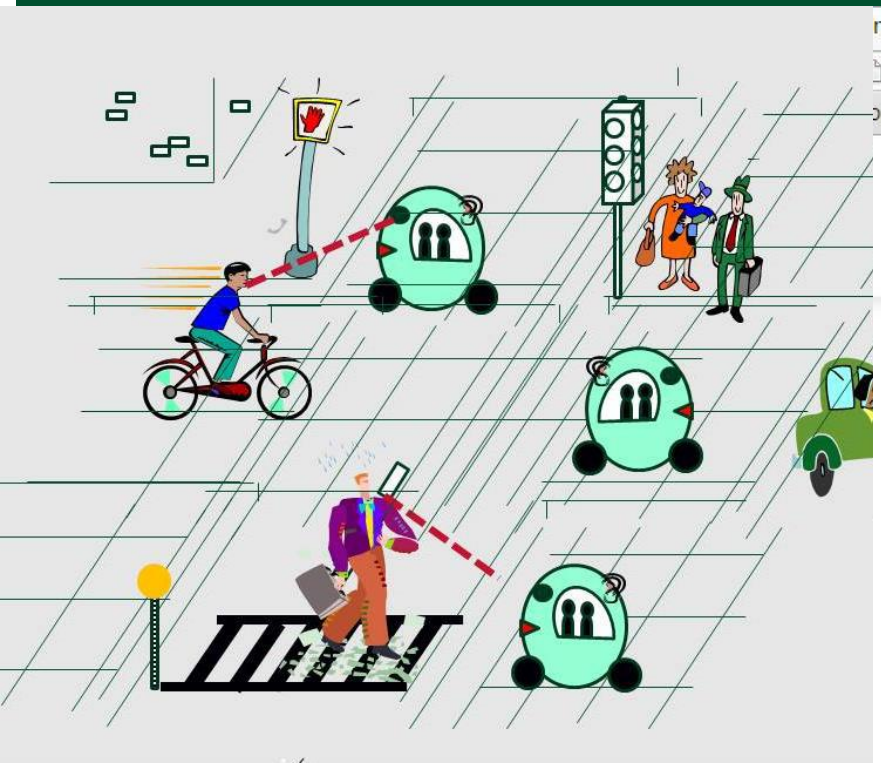

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clapway.com/2015/08/29/cyclist-standoff-google-self-driving-car-110/

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CLAPWAY

NEWS BLOG

SPACE EXPLORATION ECOLOGY TECHNO

News Technology

Cyclist Standoff With Google Self-Driving Car

By **Brandon Girod** - August 29, 2015

- No more eye-contact
- No more gestures
- Not about obstacle avoidance/detection, but about COMMUNICATION & <u>mutual</u> intention recognition

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Automated/Autonomous/ Driverless/Self-driving

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Human Machine Interface

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Nissan

Mercedes

Door opening indicator

Forward indicator

Reverse indicator

Mitsubishi

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Google Patents

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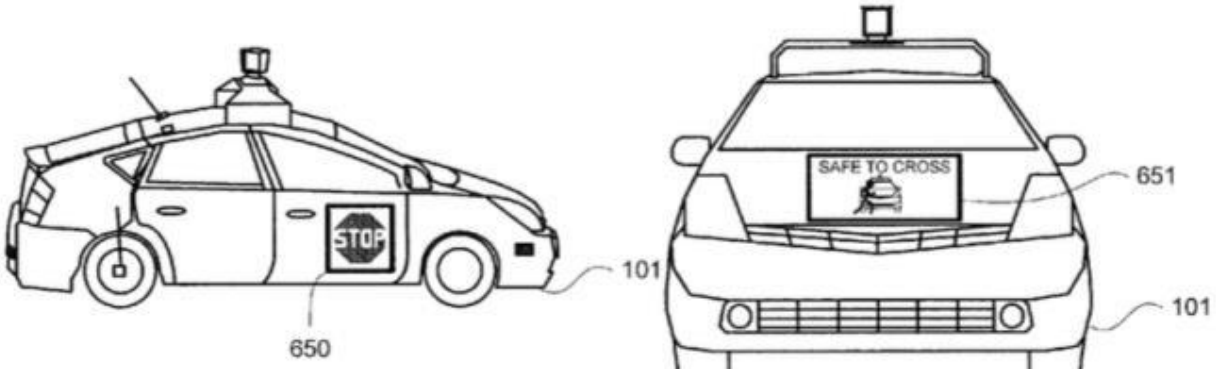

Urmson et al., 2015

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Clamann, Albert, & Cummings, 2016

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Lagström & Lundgren, 2016
Habibovic et al., 2016

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Rothenbücher et al., 2016

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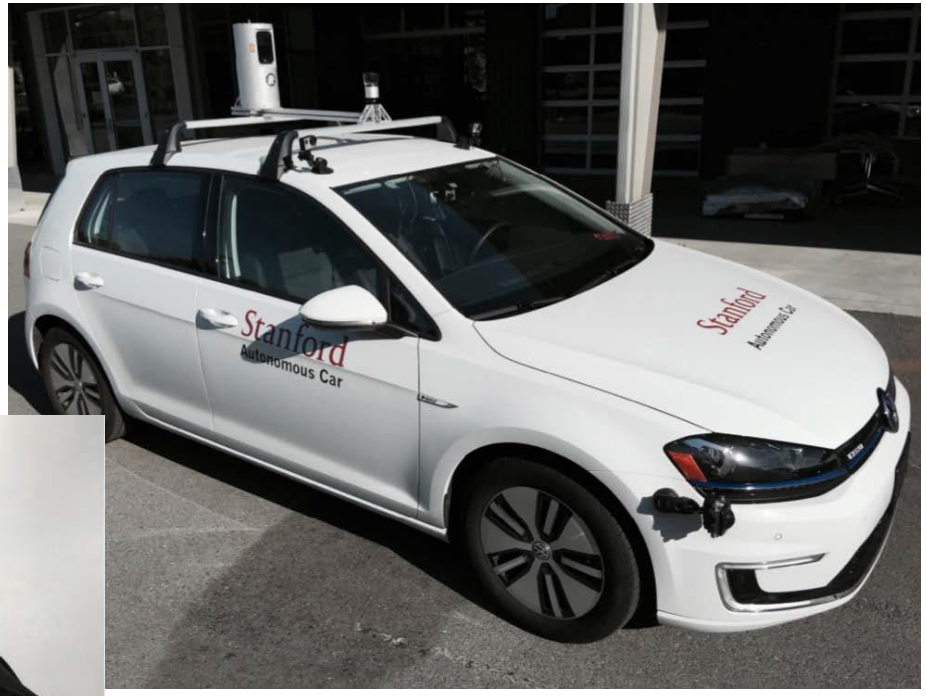

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- Large-scale demonstration of Automated Road Transport Systems (ARTS) in a number of cities across Europe
- Public transport
- No driver/operator
- Low speed (up to 45 km/h)
- Simultaneous Localisation and Mapping (SLAM)
- Shared space
- First mile/last mile solution to complement other public transport options

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Demo Vehicles

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Interviews, Focus Groups, on-site surveys & video analysis

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(N = 24)

(N = 20)

(N = 349)
La Rochelle = 204
Lausanne = 145

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Questionnaire Study

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- 42 questions
  - 8-10 minute completion time
- Demographics & travel patterns
- Interaction & communication requirements (Merat et al., 2017)
- Unified Theory of Acceptance and Use of Technology (Madigan et al., 2016)

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Trial Locations

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La Rochelle, France:

- November 2014 to April 2015
- Route 1.7km including 7 station stops
- Mainly operating in shared space
- 204 participants

Lausanne, Switzerland

- April to August 2015
- Route 1.6km including 6 station stops
- 145 participants
- Mainly operating on EPFL campus

Trikala, Greece

- September 2015 to February 2016
- Route 2.5km including 8 station stops
- 315 participants
- Mainly operating in dedicated lane

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Population Characteristics

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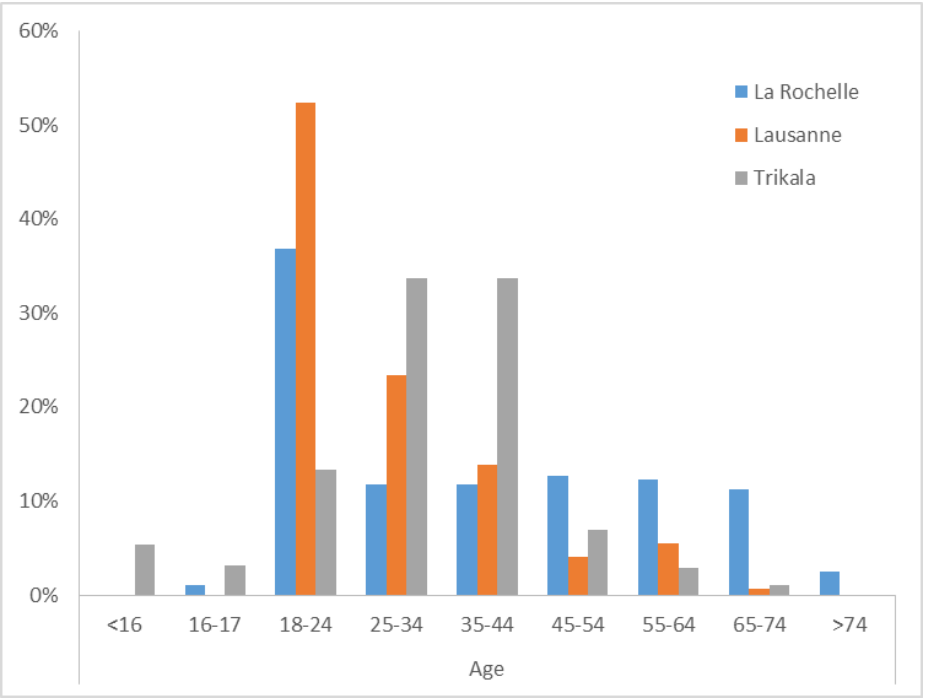

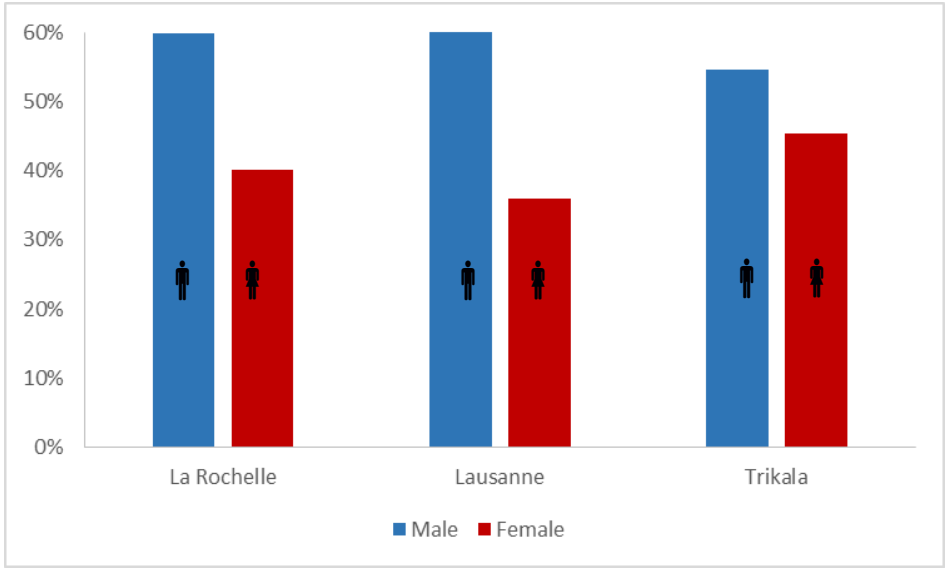

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Key Questions

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- How do cyclists and pedestrians feel (safety/priority) about the ARTS?

- What information do cyclists & pedestrians require from the ARTS?

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Safety and Priority?

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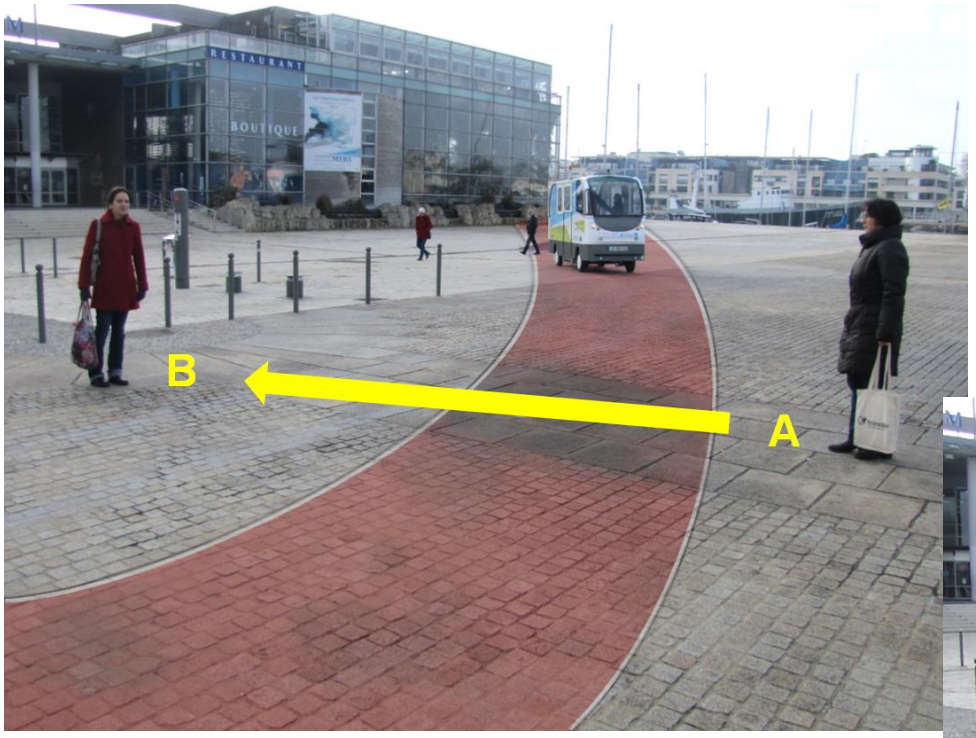

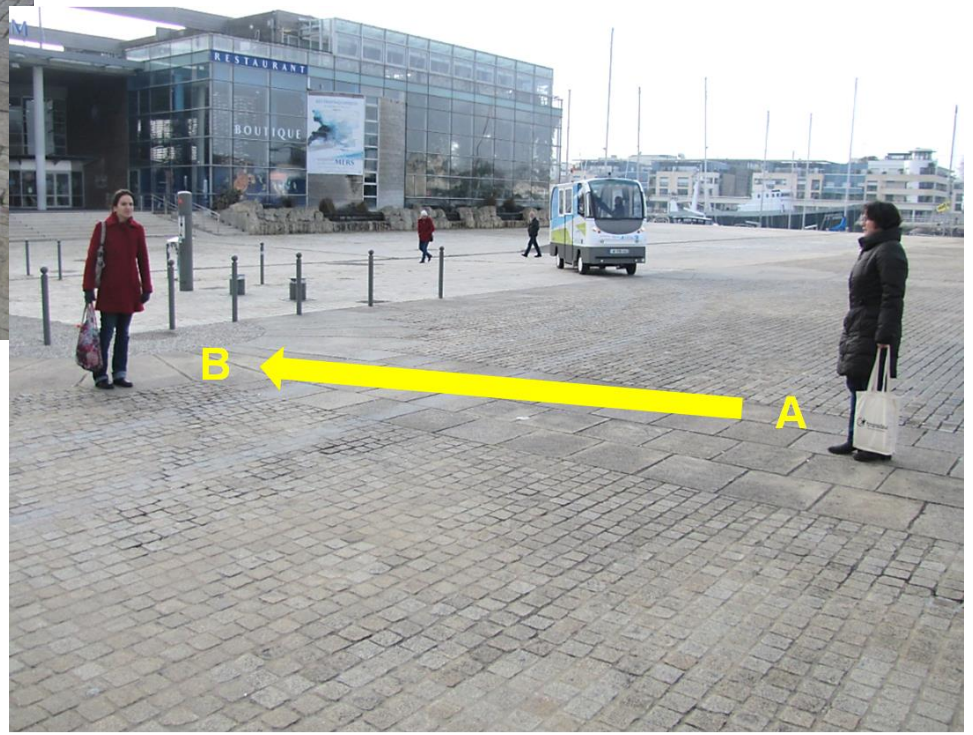

Images from La Rochelle

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Do you feel more safe?

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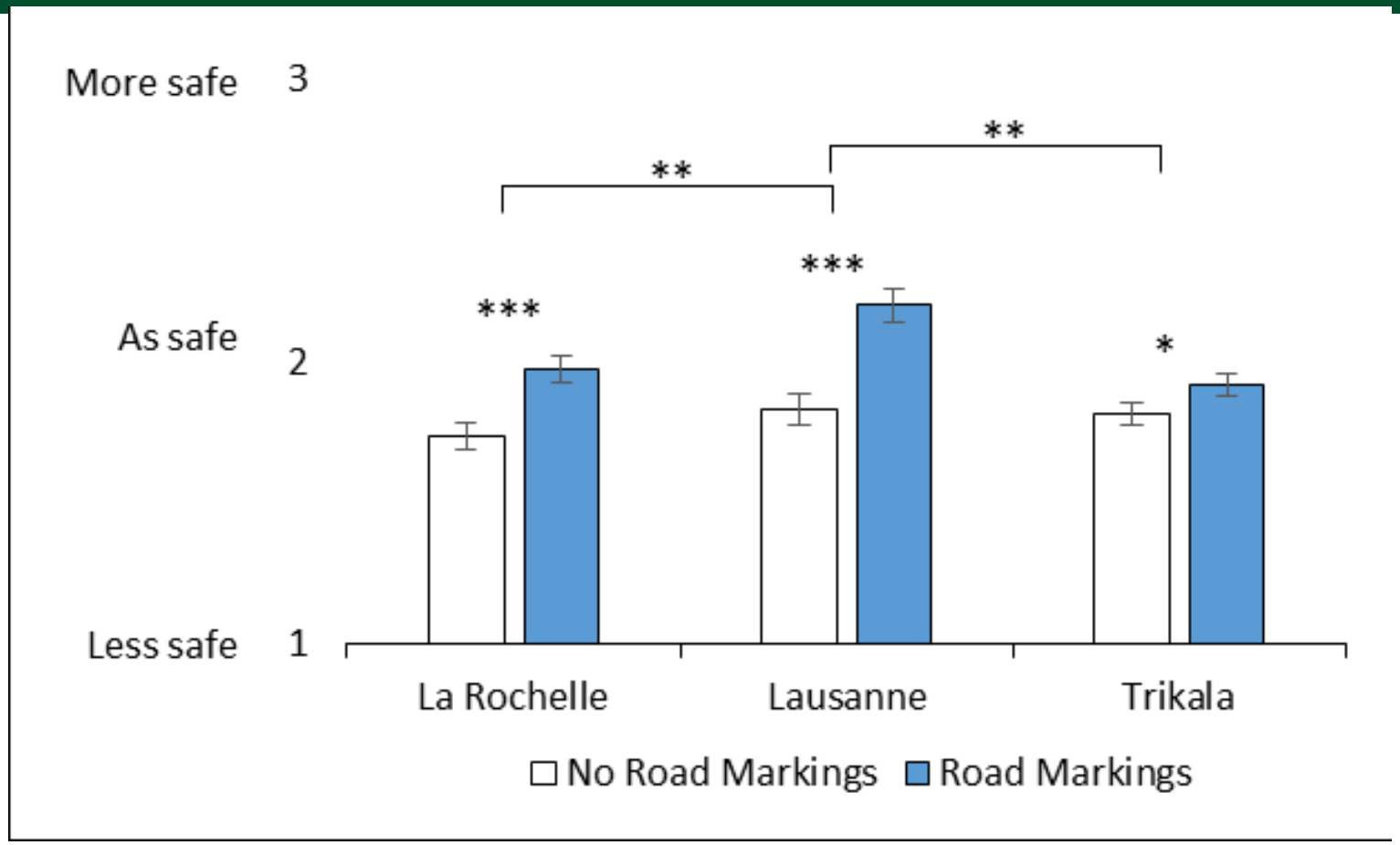

- Road Marking ($F(1,659) = 5.26$, $p<0.05$, $\eta p^2 = 0.08$
- Location ($F(2,659) = 2.493$, $p<0.05$, $\eta p^2 = 0.01$)
- Road Markings & Location ($F(2,659) = 6.27$, $p<0.01$, $\eta p^2 = 0.02$)

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Who has priority?

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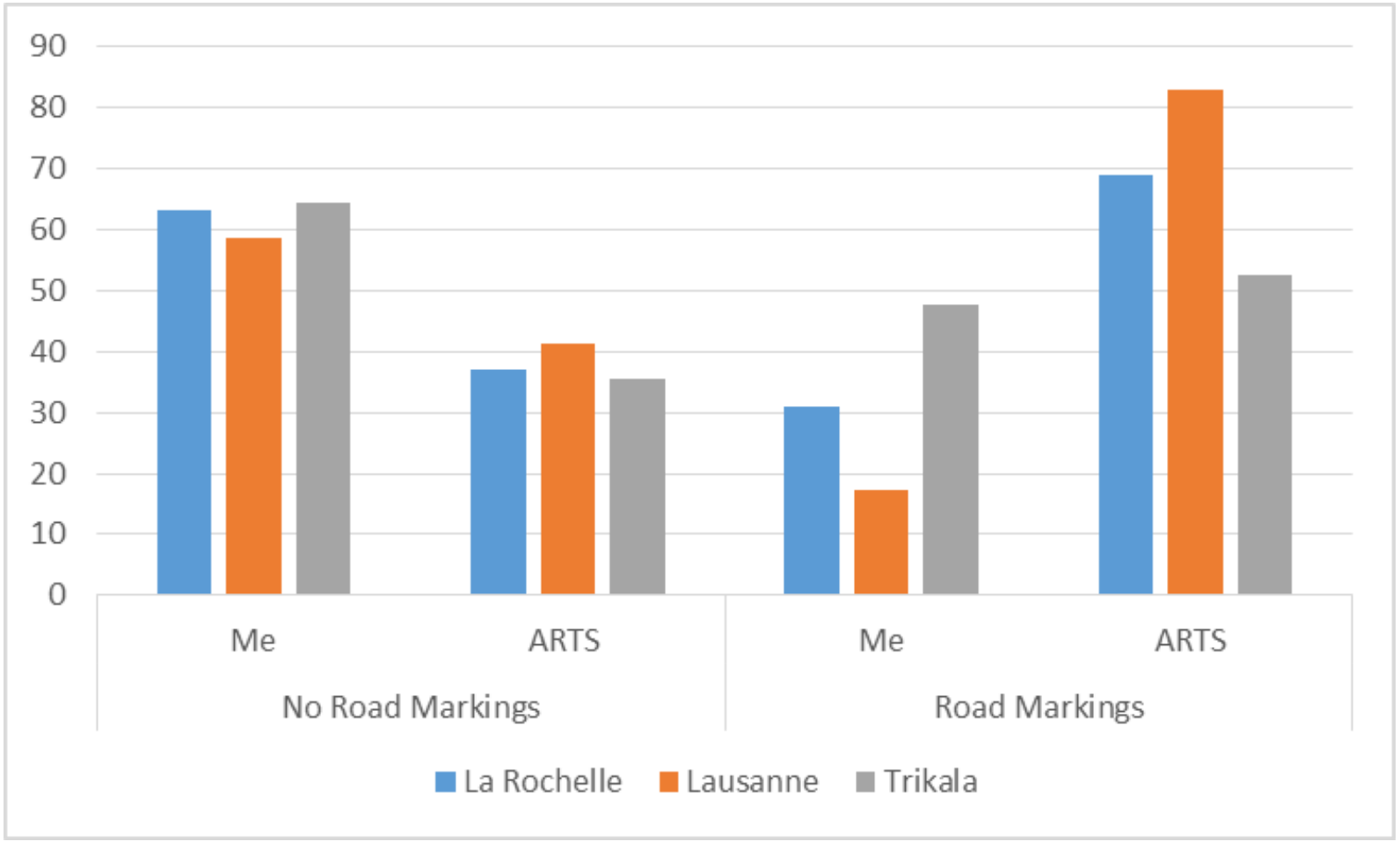

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What information?

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ARTS Behaviour (5 point likert scale)

- Whether it is stopping?
- Whether it is turning?
- How fast is it going?
- Whether it is going to start moving?
- Whether it has detected me?

Overall Results

- Most important: **has it detected me?**
- Least important: speed of travel
- No effects of Road Markings

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How would you like to receive this information?

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- Visual (lights)
- Visual (words)
- Auditory (tones/signals)
- Auditory (words)

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La Rochelle

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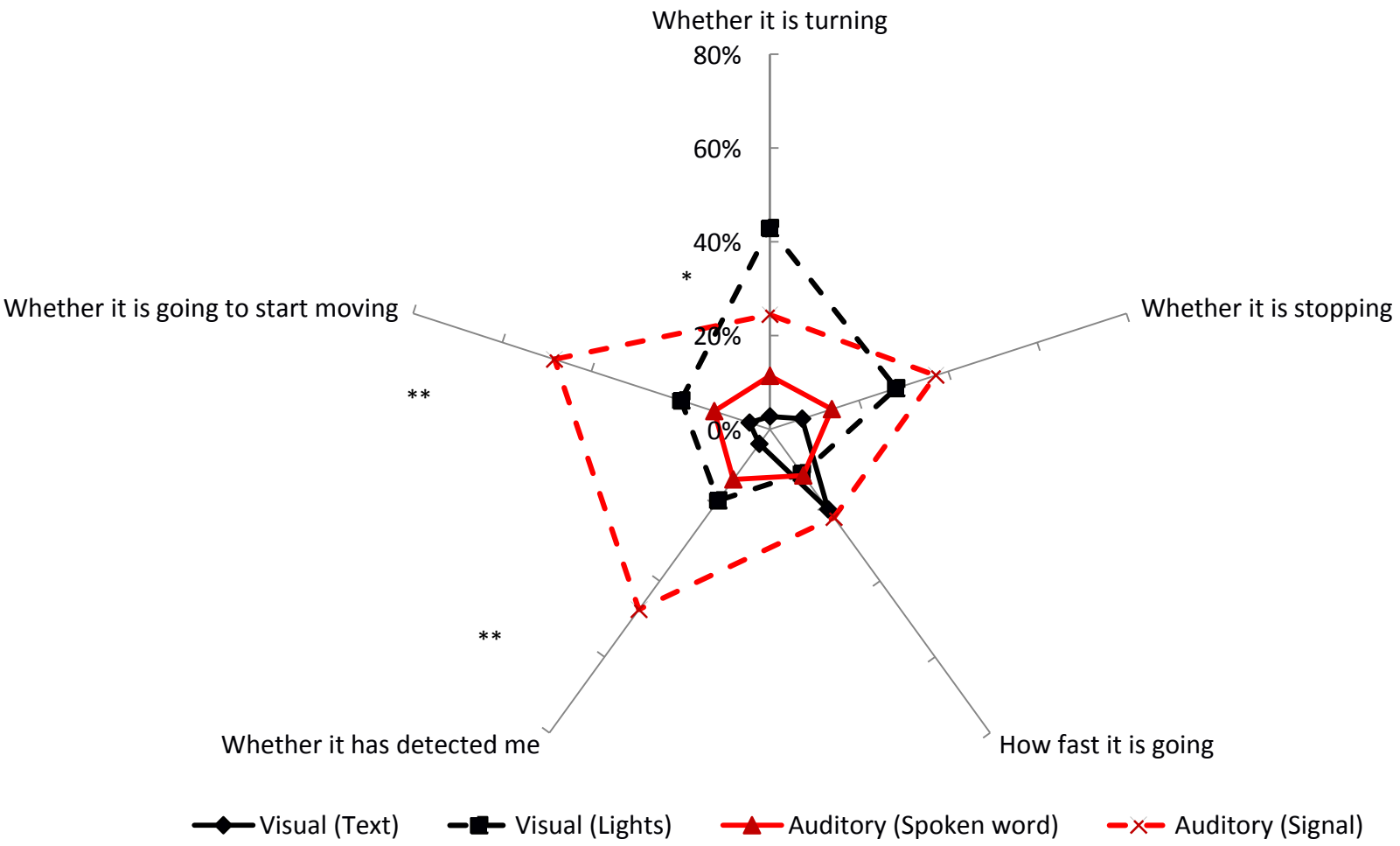

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Lausanne

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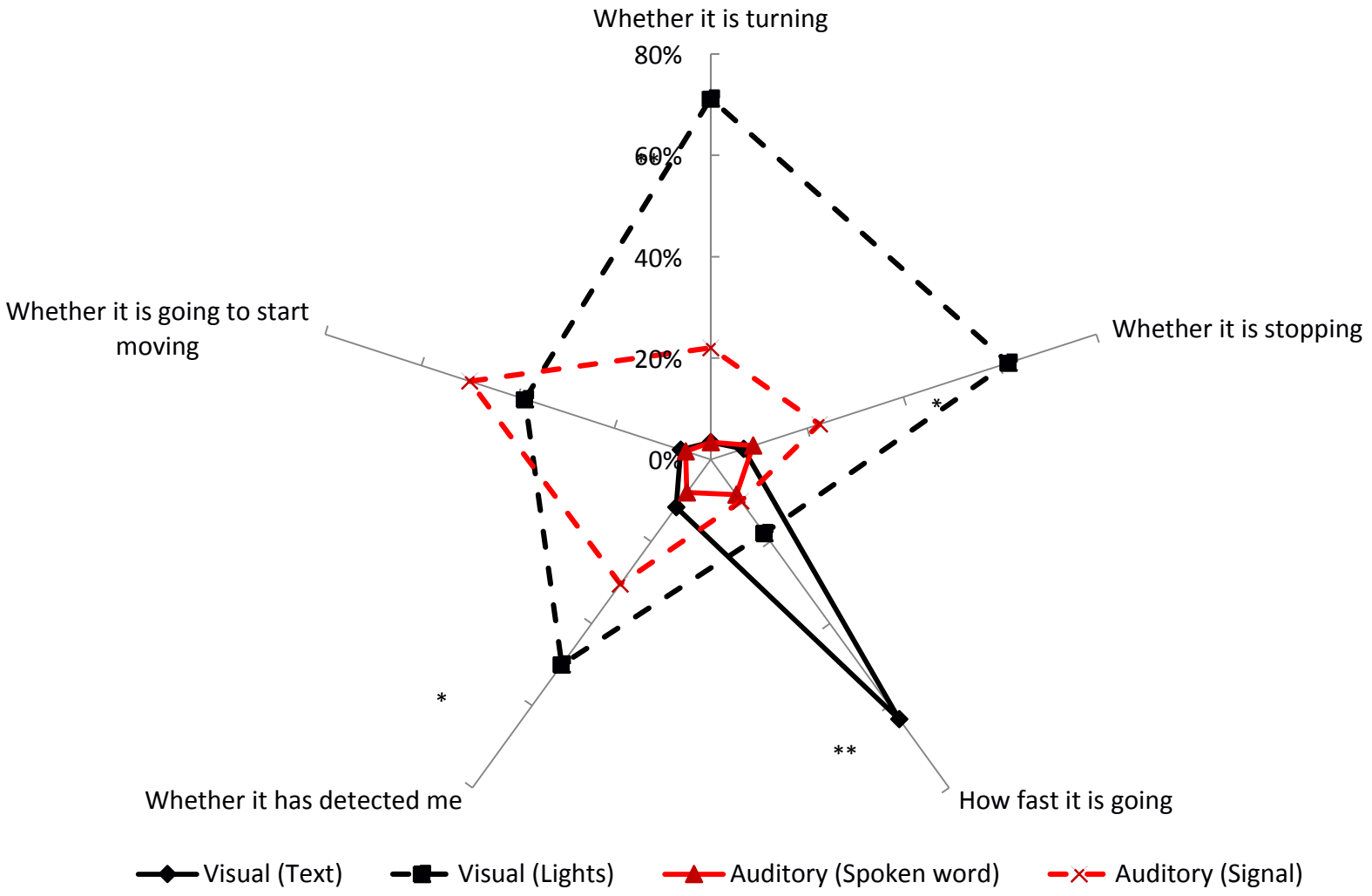

Trikala

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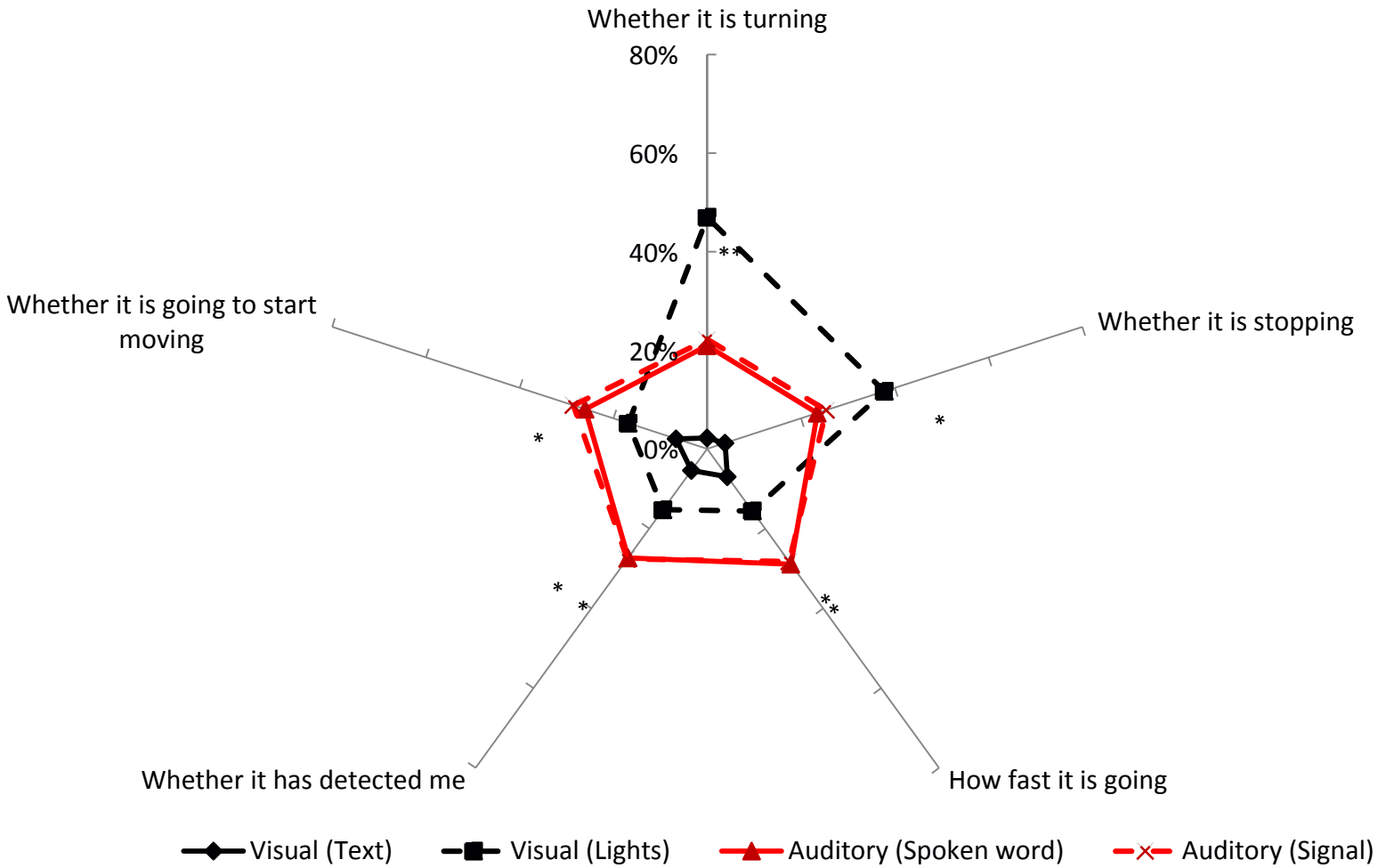

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Focus Group: La Rochelle

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Priority

- **Direction of travel** not obvious
- Not sure who had priority
- Would prefer **demarcations**
- Not sure if the vehicle can **identify hazards**?
- Suggested use of horns and lights for **detection and communication**

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Other Focus Group comments

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- **Visibility**: Colour maybe too discrete, brighter colour to make it easy to see. In La Rochelle yellow would be more suitable to fit in with other public transport modes

- **Sound**: Lack of engine noise a problem for its localisation, especially for the visually impaired

- **Speed:** Too slow, but probably ok in shared space

- Better for **tourists** than commuters

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Summary & Conclusions

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- As the deployment of automated vehicles become commonplace, the views of other road users should be sought
- In particular, understanding how VRUs (and other vehicles) interact and communicate with a ‘driverless’ vehicle is important
- This study shows that VRUs definitely want some information and (at the moment) prefer the ARTS to be in a dedicated space.
- They assume they have priority in a shared space

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Issues to consider…

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- Ability to see/hear/understand messages & stimuli
- Global understanding (international standards) of messages used
- Two-way communication vs. uni-directional
- Role/responsibility of the ‘driver’

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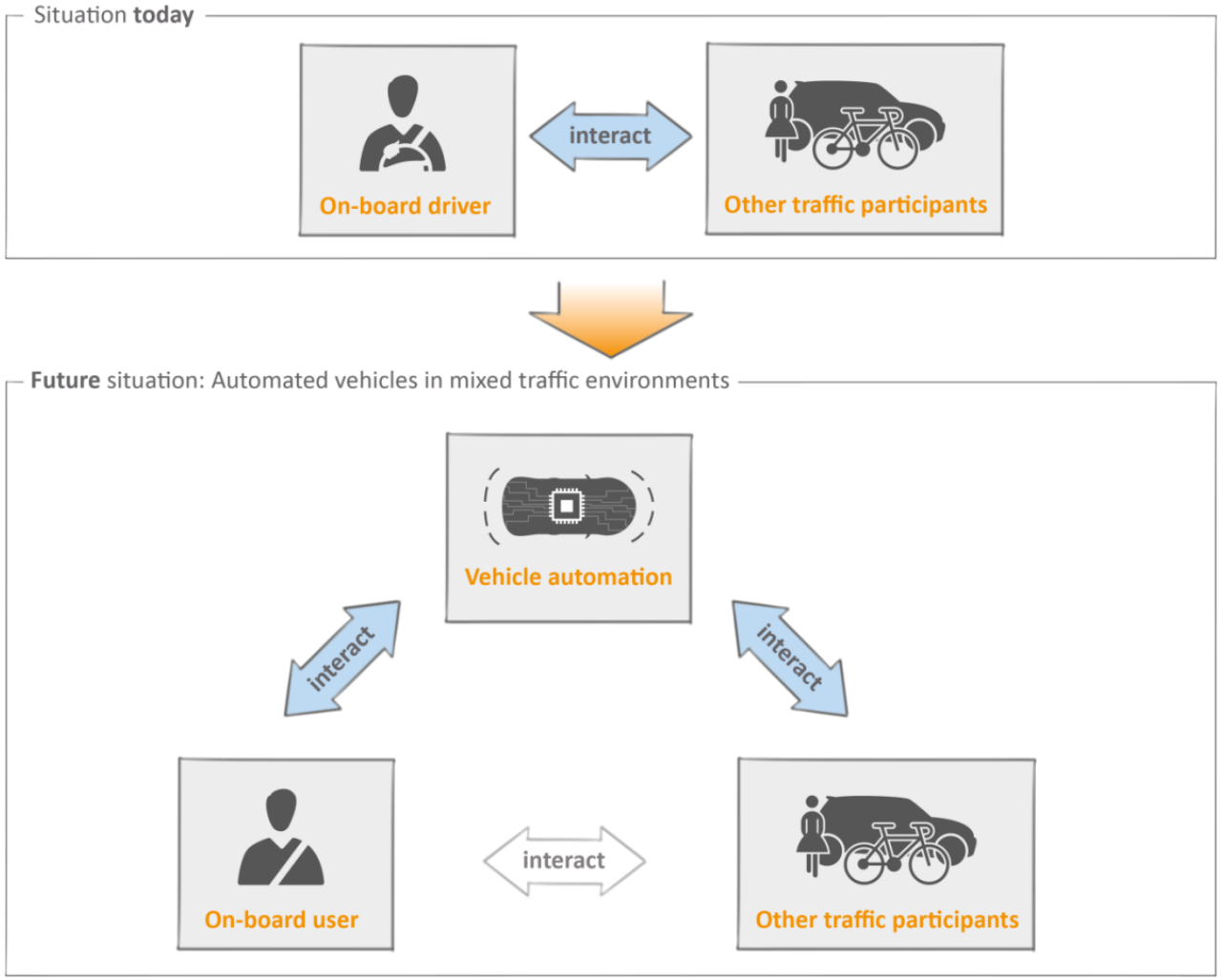
Next Steps……..

interACT

Designing cooperative interaction of automated vehicles with other road users in mixed traffic environments

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723395.


Situation today
On-board driver
interact
Other traffic participants
Future situation: Automated vehicles in mixed traffic environments
Vehicle automation
interact
interact
On-board user
interact
Other traffic participants

interACT

Questions?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