Using virtual reality in stakeholder engagement on autonomous vehicles

Lessons from experiments in Greece, Poland, and the Netherlands

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MOVE2CCAM

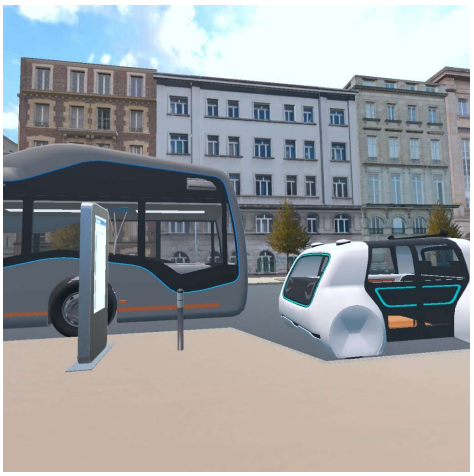
Why virtual reality?

Autonomous vehicles: a new type of passenger transport experience

Usual methods of engagement (surveys, workshops) are insufficient because most potential users have not yet used these vehicles and may find it hard to imagine using them

Virtual reality can provide experiences of autonomous vehicles

including future scenarios with radical changes in the transport system



..and experiences of different types of vehicles

The experience can be passive or interactive (as a game, with choices)

But autonomous vehicles already exist, we could invite people to use them, in a demonstration

We could, but…

- Virtual reality is cheaper and easier to organise
- Participants can experience a variety of different situations during the (virtual) trip that would not be possible in a demonstration

Examples of situations in the virtual car

Attribute	Stages								
	1	2	3	4	5	6	7	8	9
Landscape	City centre			Industrial	City centre	Industrial	City centre	Industrial	Residential
Time of day	Daytime		Gradually getting darker					Night-time	
Congestion	No	Gets progressively worse						Eases up	No

Examples of situations in the virtual bus

Attribute	Stages								
	1	2	3	4	5	6	7	8	9
Landscape	City centre			Industrial	City centre	Industrial	City centre	Industrial	Residential
Time of day	Daytime		Gradually getting darker					Night-time	
Passenger number	Few	Many		Few					None
Passenger behaviour	Mind their own business					Anti-social			No other passenger
Human assistant	Present				Absent				

But scenarios should be realistic…

It's difficult to represent speed, vibration, smells, weather conditions, activities while travelling, distractions

Aspects our participants said were unrealistic

- Movement was too smooth (no braking, overtaking, red signals)
- Roads was too straight, no intersections
- Buildings were monotonous
- No pedestrians or cyclists

Other considerations

Expensive (>€50,000/10 minutes)

- **Short** experiences (5-10 minutes) can be disappointing for participants and may not capture important aspects of a trip
- **Longer** ones are more expensive and require more time (or fewer participants)

Scenarios need **sound**: road traffic, bus doors opening/close, bus passengers chatting

Data that can be collected

Virtual reality can be used simply as a tool to provide people with an experience

But it can also be used to understand their perceptions, using questionnaires (before, after)

- Feelings about autonomous vehicles
- Intention to use one
- Comparison with conventional ones

Small group discussions

Show participants images of what they saw in virtual reality

Then they talk about them in small groups

Rich dataset: 95 participants= 8 hours of discussions, 50,000+ words, 1,000+ statements

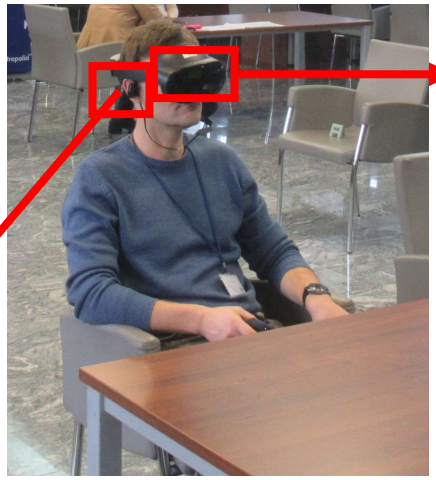
Example: how they felt when all the virtual passengers left the bus, and they were alone (also no driver)

alone anxiety around arouse attention autonomous board changed comfortable content driver effect emotion empty end final fine getting happen insecure life looked matter mind nothing ordinary paid particular passengers people point problem quiet react real reason regret ride self-driving sit situation someone stop strange surroundings switch unsafe unusual wonder worst

Data not only on what participants said they felt but also on what they really felt

Heart rates, skin conductance, brain electrical activity (EEG), can indicate stress, anxiety, arousal, etc

EEG device



Virtual reality headset

Who felt stressed and when?

Less stress — More stress

Car

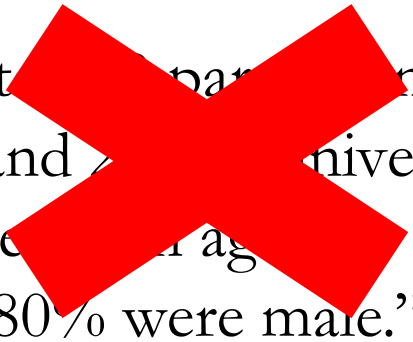
	Start of trip → End								
Landscape	City centre		Industrial	City centre	Industrial	City centre	Industrial	Residential	
Time of day	Daytime		Getting darker				Night-time		
Congestion	No	Getting worse					Eases up	No	
Stress levels									
Men									
Women									
18-34									
35-64									
65+									

Bus

	Start of trip → End								
Landscape	City centre			Industrial	City centre	Industrial	City centre	Industrial	Residential
Time of day	Daytime			Getting darker				Night-time	
Passengers	A few	Many		A few					None
Behaviour	Passengers are minding their own business					Some passengers are annoying			No passengers
Assistant	Present				Absent				
Stress levels									
Men									
Women									
18-34									
35-64									
65+									

Participants

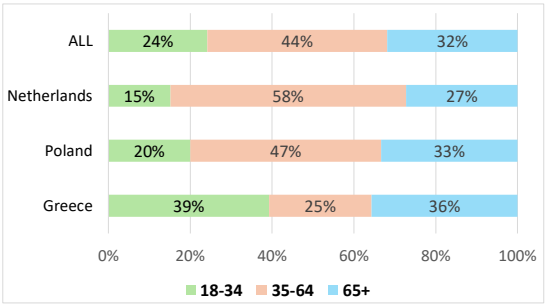
Not ideal!



"We recruit[illegible] par[illegible]nts. 18 were students and [illegible] niversity staff. The[illegible] ag[illegible] 25. 80% were male."

We need more representative samples

Including groups usually underrepresented in citizen engagement (e.g., rural residents, ethnic minorities, people with disabilities, those not aware of autonomous vehicles)



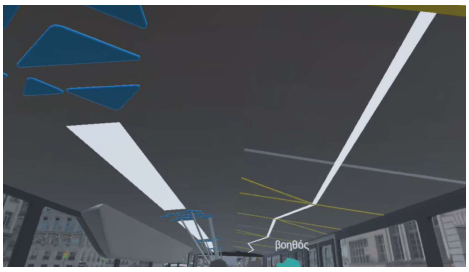
…and larger samples

- More participants=more data. We recruited 95 people
- Recruitment by market research companies is costly but by social media may not reach some groups

Technical and organisational issues

Technical issues – they will happen

The scenarios may not display correctly, or participants may use commands in the wrong way



Solution: cast the experience onto a tablet computer so researchers can see what is wrong

(but this may not work due to poor wi-fi connectivity…)

Some participants will need help wearing the devices and using the commands

Researchers helping a participant

One researcher per participant, if help is needed

Equipment

- If we measure physiological data and we also cast the virtual reality experience onto a tablet, **3 types of devices** will be needed per participant (↑ cost and complexity)
- If we buy **4 sets** of each (=12 devices), ~30 participants can join the experience in 8 hours
- All this equipment needs to be **charged** during the day!

Space is needed for all this equipment

… and to increase participants' enjoyment, reduce sound leaking, and help researchers to help participants

More space

Less space

Ethical issues

"We obtained ethical approval from our institution. Participants gave informed consent"

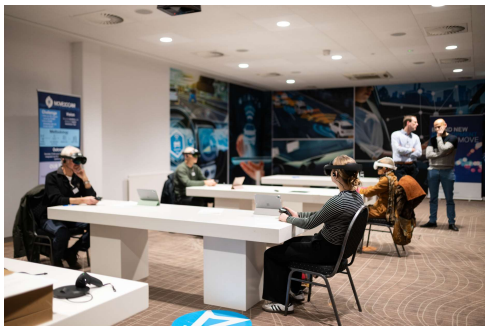
We need more than that

Ethics should be embedded in the design and implementation of the experiment

This requires time and effort but ensures a better experience for participants and increases data quality

Concerns about the equipment

Equipment is intimidating – use standard equipment, tell (and show) equipment in advance to participants, explain how to use equipment, do experiment in small groups



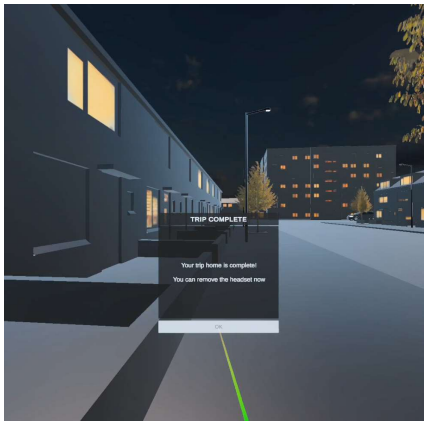
Motion sickness, skin irritation, marks, hygiene – short and simple experience, procedures to address possible cases, clean equipment before each use, inform all this to participants

Epilepsy, implanted medical devices, etc – should not take part

Concerns about the scenarios

Scenarios should be not too threatening

End on a positive note, with all problems solved



Tell (and show) participants in advance what they will see

Concerns about data

ID number 42

- Event organisers know ID and name/email but have no access to experiment data
- Researchers know ID and have data but do not know name/email

Tell participants in advance all data that is going to be collected

(including photos such as this one!)

Thank you!

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