

# eXtended reality and passengers of the future



University  
of Glasgow



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# Viajero

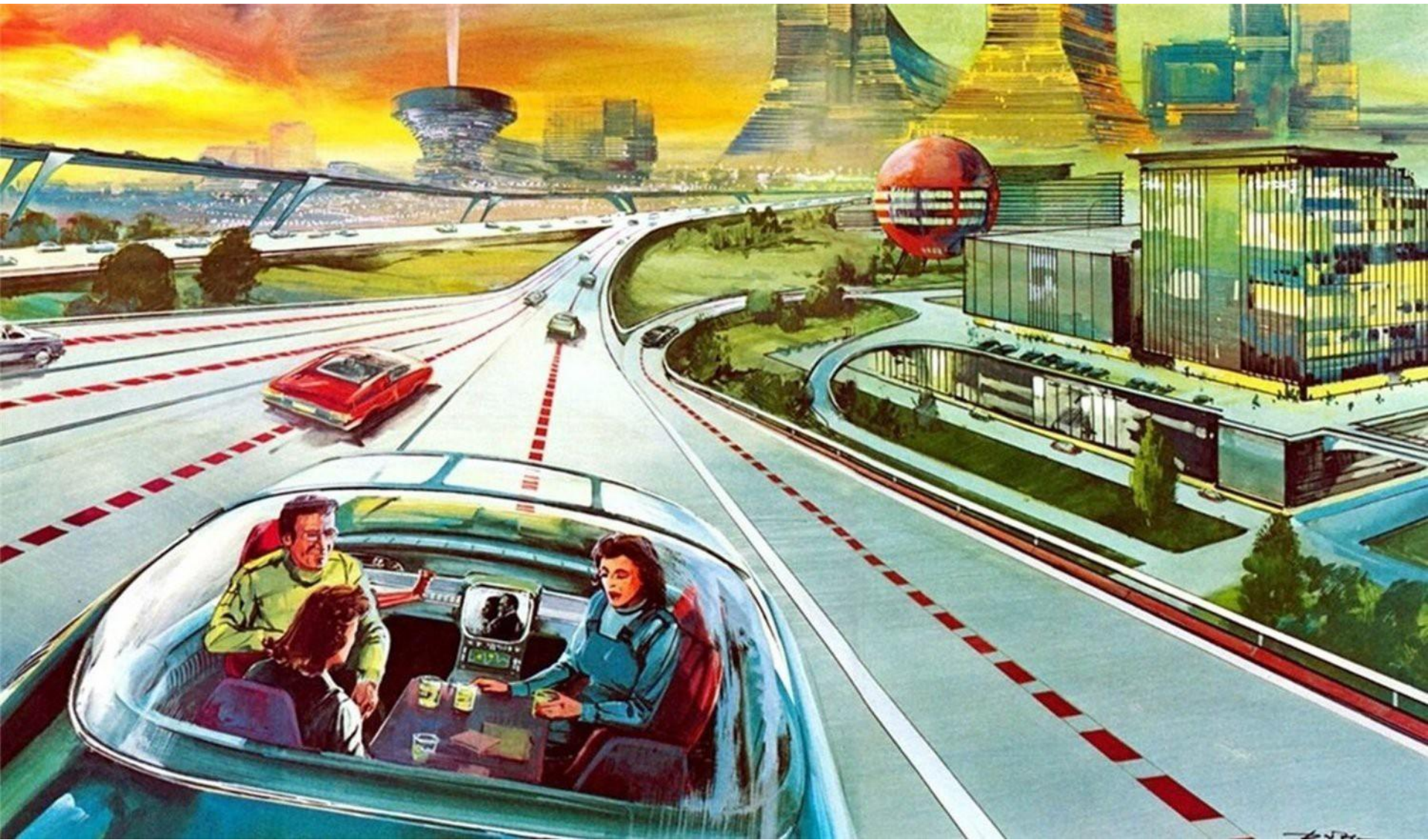
(Traveller)

The aim of *Viajero* is to radically improve all passenger journeys by facilitating the use of immersive Virtual and Augmented Reality to support entertainment, work and collaboration when on the move



European Research Council  
Established by the European Commission

[www.viajero-project.org](http://www.viajero-project.org)





# Overview

Support new passenger experiences with XR

Journeys often repetitive and wasted time

Autonomous cars could make this worse

Limited access to technology

Phone, tablet, laptop, seatback display

Entertainment, productivity, collaboration

Research challenges

Interaction, sensing, social acceptability, motion sickness



# *What could we do with XR?*

## *Entertainment*

IMAX cinema in the back of a car

Playing immersive games

## *Work*

Multi-monitor desktop setup when on the move and out of the office

## *Collaboration*

Work together with remote collaborators

Meet with friends and family

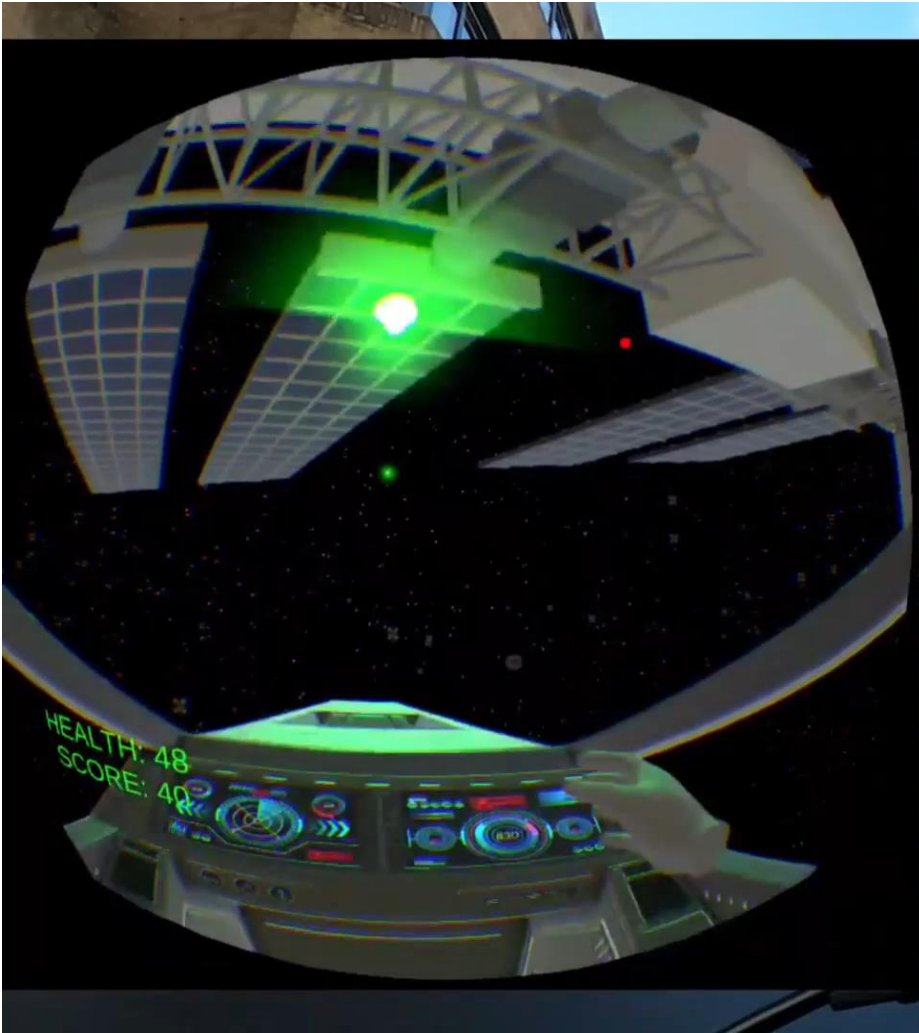


## 4: VR Cinema at-a-distance



\* such content can induce motion sickness







# *Activities*

## *Entertainment*

IMAX cinema in the back of a car

Playing immersive games

## *Work*

Multi-monitor desktop setup when on the move and out of the office

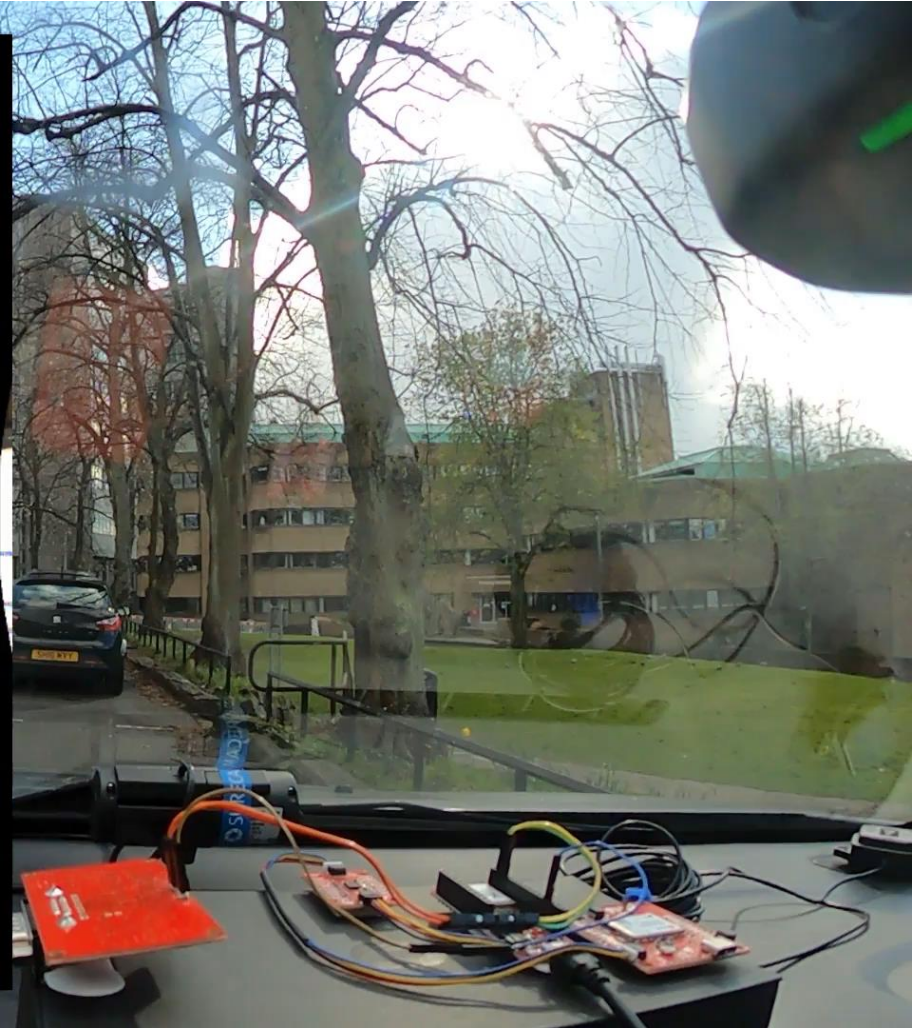
## *Collaboration*

Work together with remote collaborators

Meet with friends and family







# *Activities*

## *Entertainment*

IMAX cinema in the back of a car

Playing immersive games

## *Work*

Multi-monitor desktop setup when on the move and out of the office

## *Collaboration*

Work together with remote collaborators

Meet with friends and family







# *Interaction challenges*



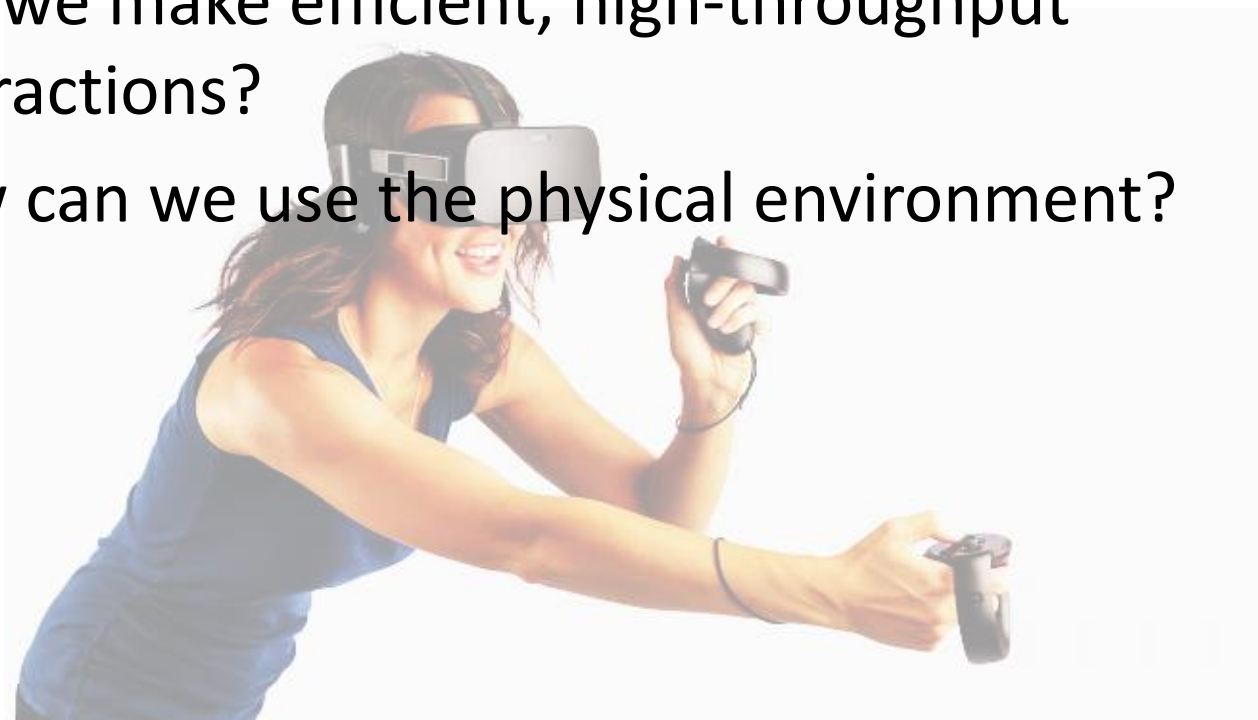
# *Confined spaces*

No room for 'big' interactions typical of XR

Can smaller movements be mapped into larger space?

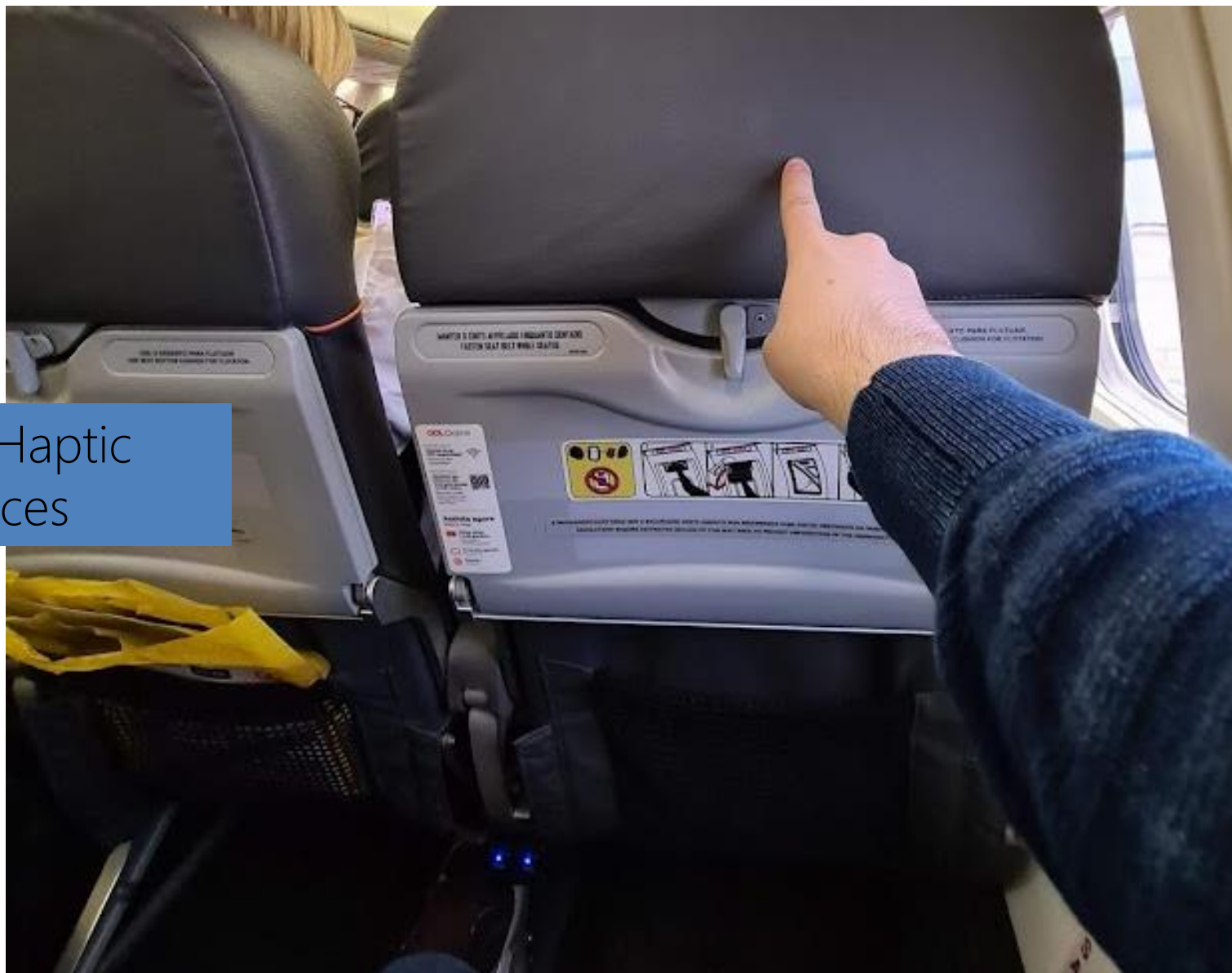
Can we make efficient, high-throughput interactions?

How can we use the physical environment?

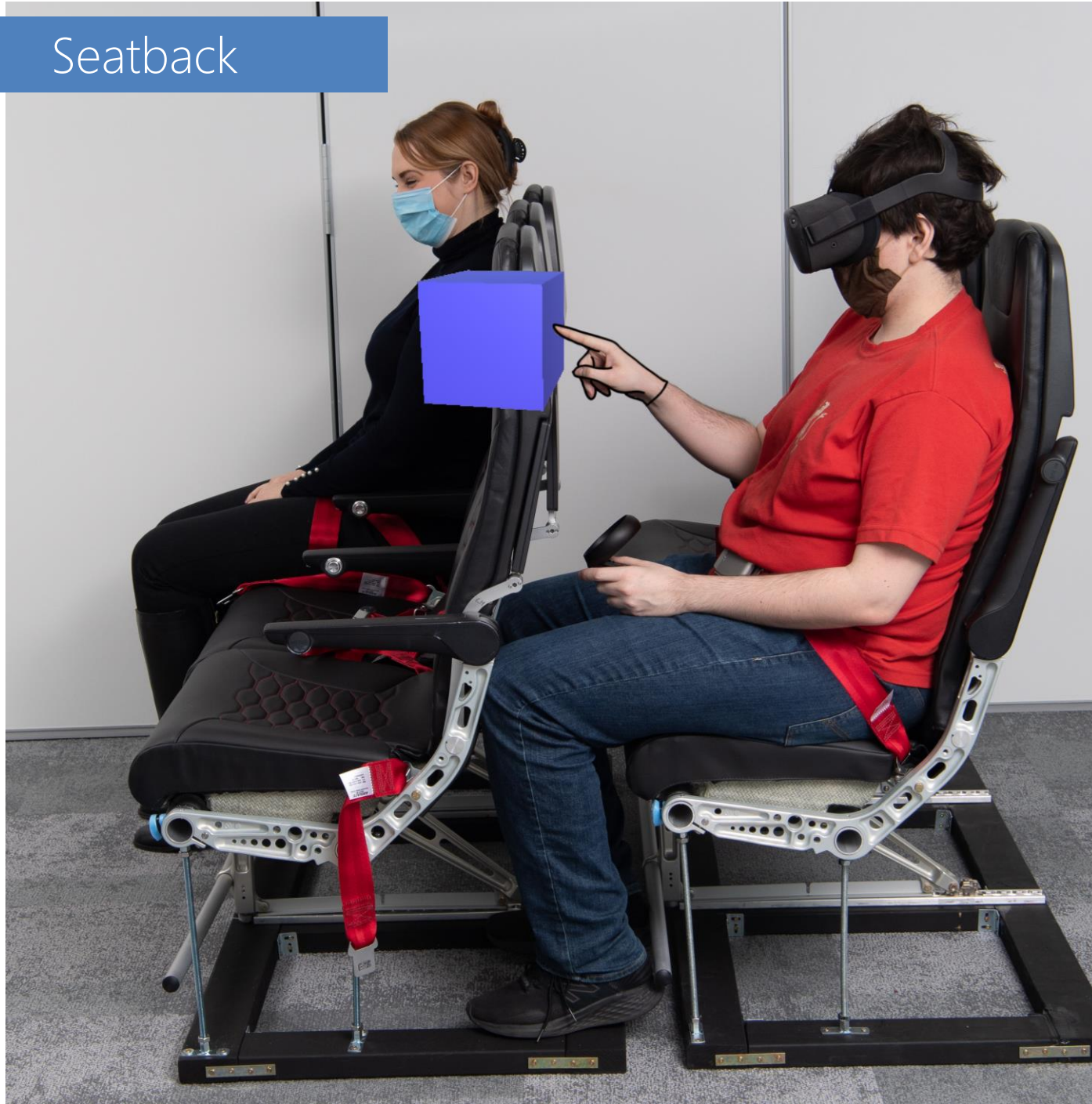




# Passive Haptic Surfaces



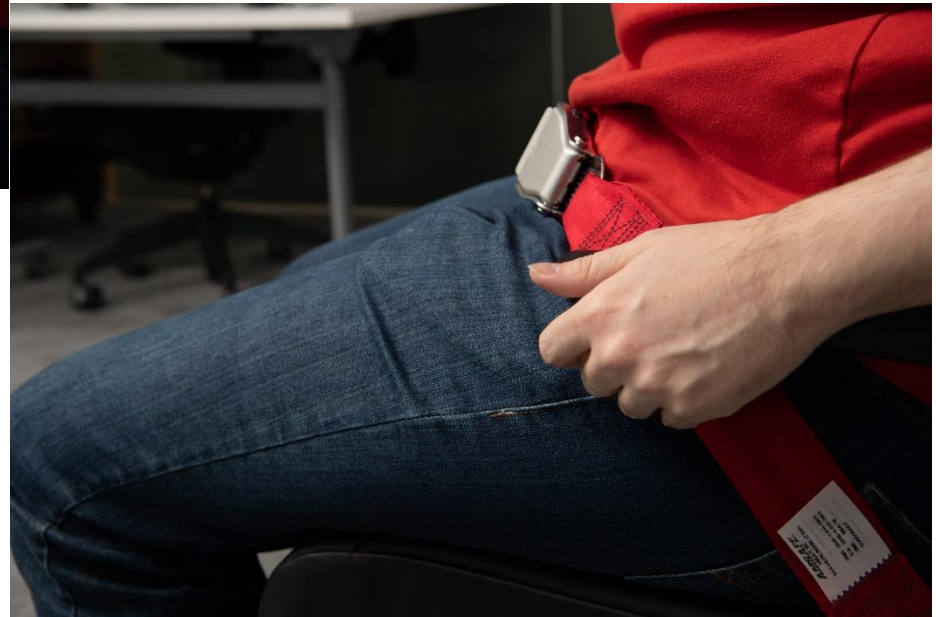
# Seatback



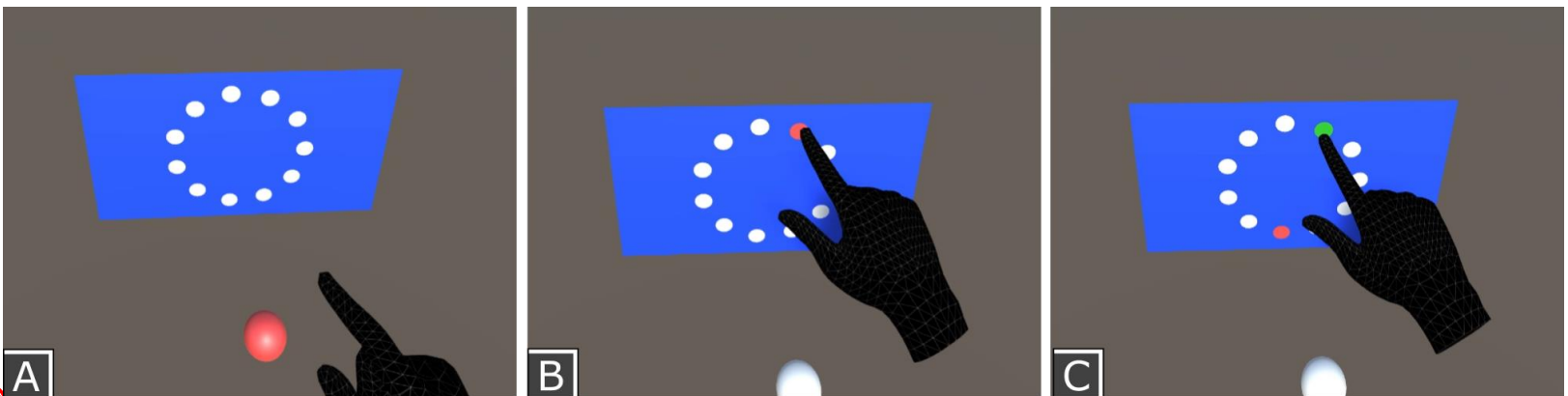
# Tray Table



# Armrest



# Passive haptics



# *Results*

Passive haptics significantly improves reaching and dragging input performance in all orientations

- Reduces time taken and error rates

- Improves agency, self-location and workload

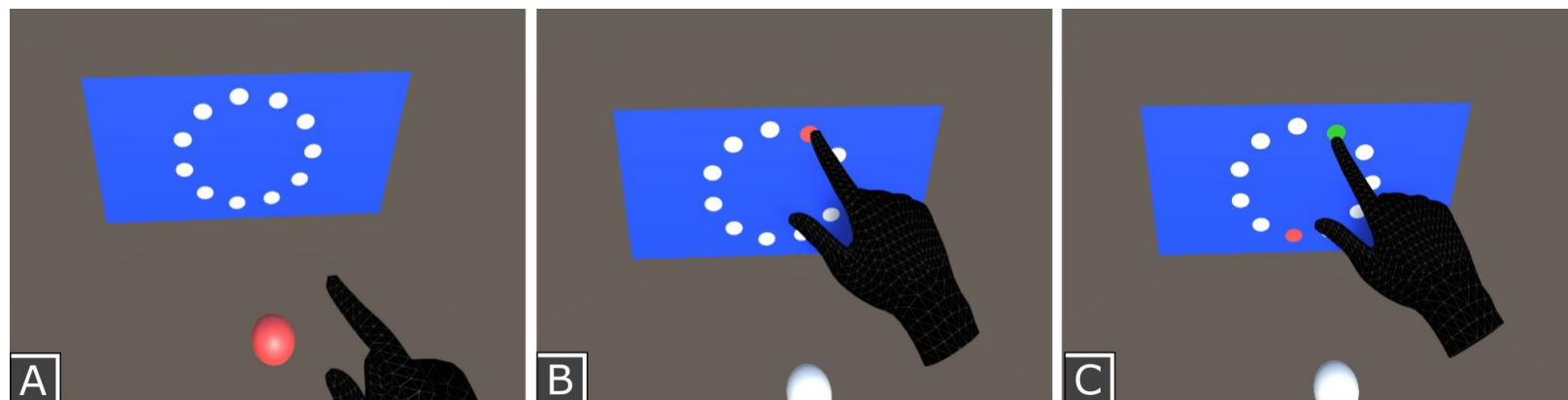
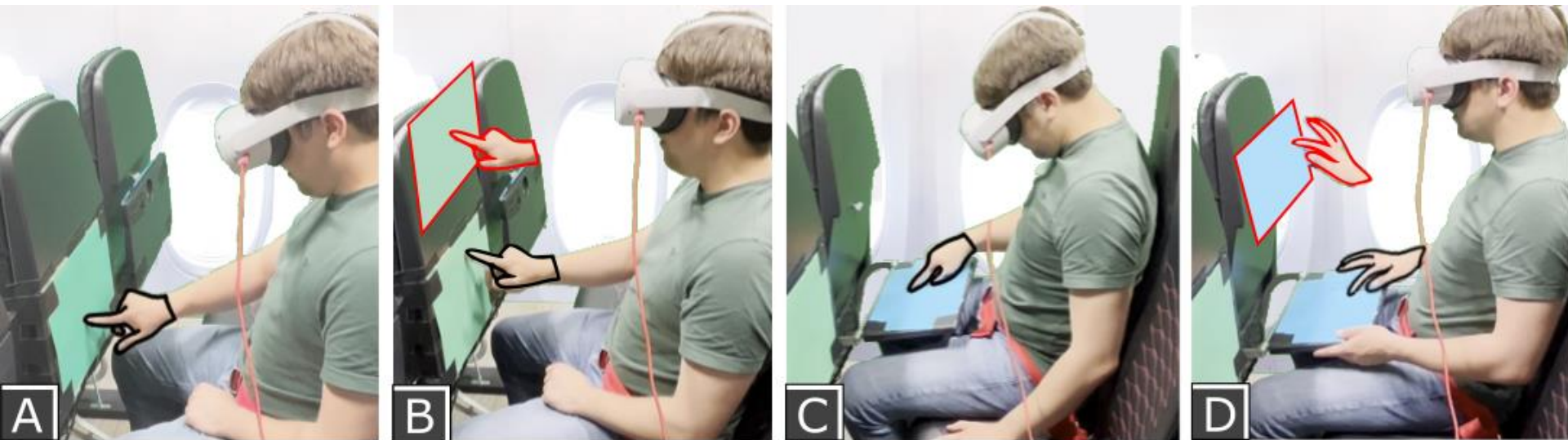
Horizontal performance on tray table best

- Neck issues made it uncomfortable

CHI 2023 paper 😊



# Perceptual retargeting



# *Results*

Perceptual retargeting / movement remapping of  
45° - 60° good for user comfort and good  
performance

No neck issues

Greater mappings very confusing!





# *Sensing challenges*



# *In-car sensing challenges*

Maintaining the forward bearing of IMU-based headsets in vehicles

Need to separate head movements and car movements

Conflicts between optical and inertial tracking of inside-out headsets

Obtaining vehicle telemetry

PassengXR: Low-latency sensing platform to separate car and headset motion



# *PassengXR platform*



# *Social acceptability challenges*



# *Social acceptability*

Headset use in social settings

We may be alone in vehicle car or sharing

With people we know / With people we don't know

Where should displays be located?

What kinds of interactions are socially acceptable?

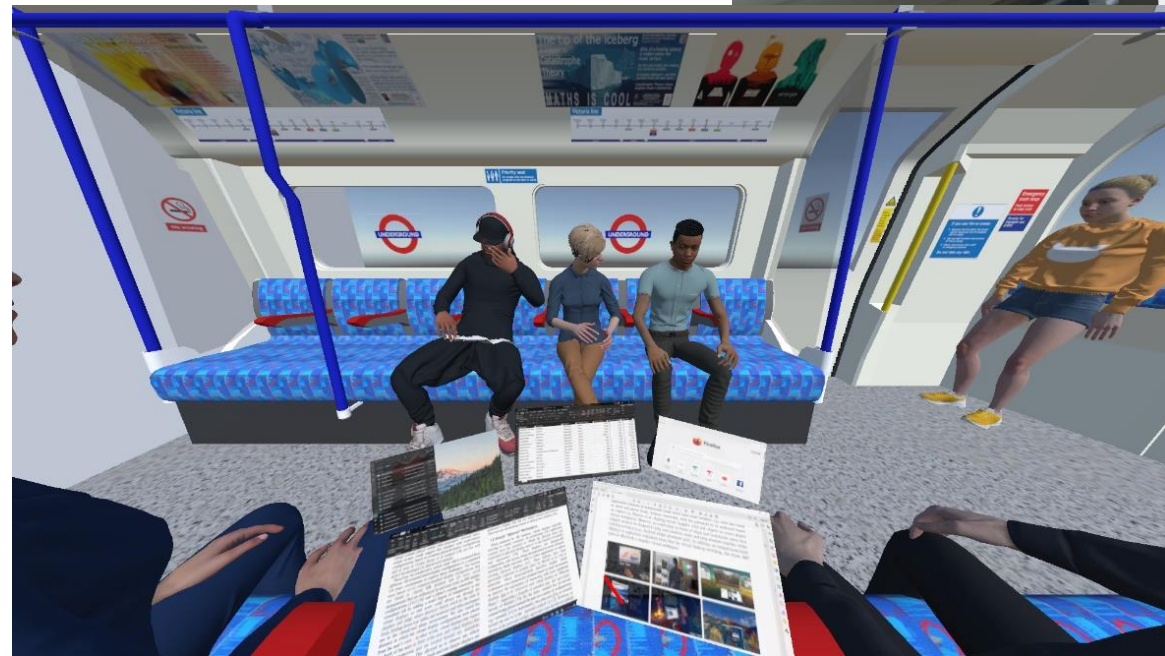
What information from the real world is needed?



# *Display layouts in vehicles*

Investigated how people want to layout content in different scenarios and for different tasks





# *Input techniques*

Surveying the  
Social Comfort of  
Body, Device, and  
Environment-Based  
Augmented Reality  
Interactions in  
Confined  
Passenger Spaces





# Results

Environment has a strong effect on social acceptance of interactions!

Face-to-face seating layouts affect acceptability



Mid-air interactions less acceptable



# *Motion sickness challenges*



# *Motion sickness*

Many people suffer from motion sickness

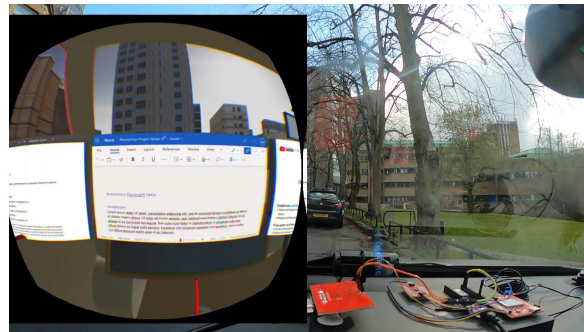
Reading, phone/tablet

Can't use travel time

Visual / vestibular mismatch

Immersive content can make this worse

Exocentric head-locked content most useful but causes most motion sickness



# *Motion sickness*

How to reduce motion sickness so that we can use immersive displays in cars?

Two parts:

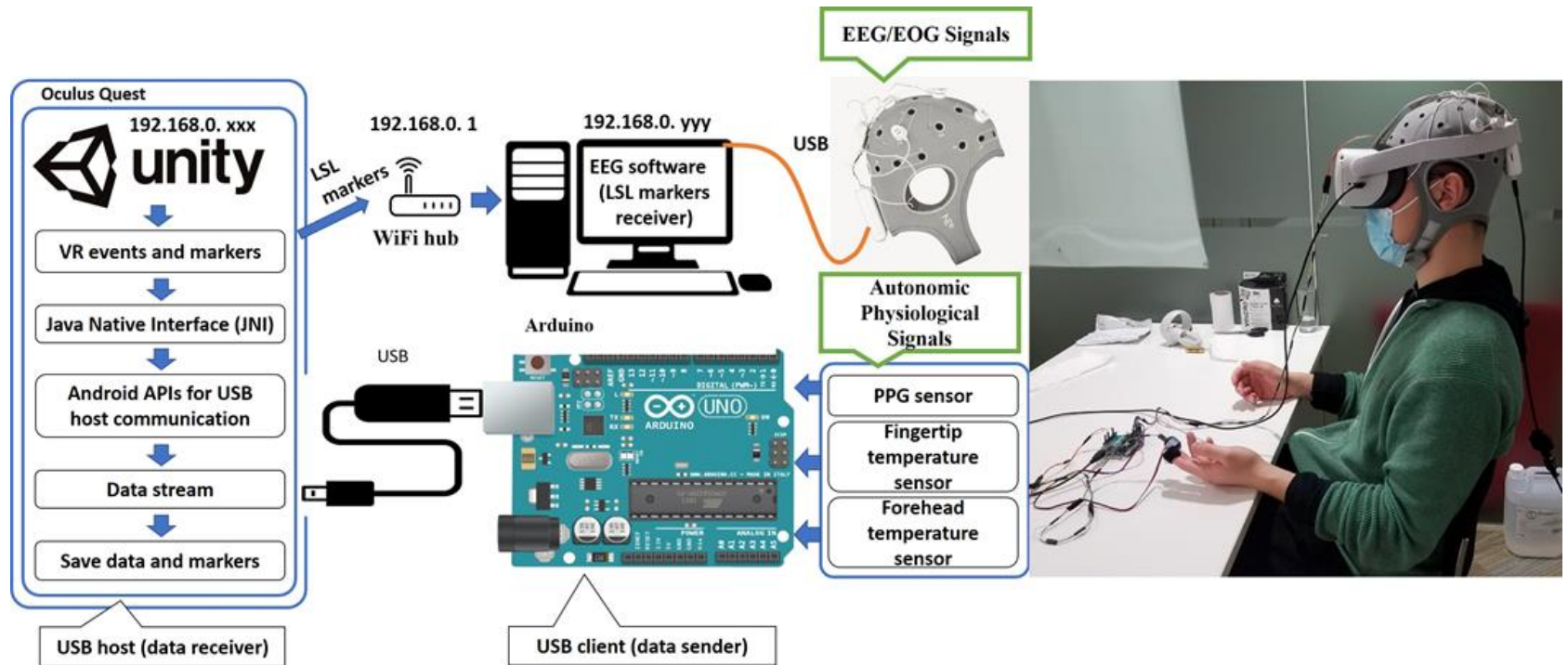
Reliable detection of onset

Effective mitigation



# Motion Sickness Detection

Highly-integrated Biosensing Platform for VR study (including EEG, PPG and skin temperature sensors)



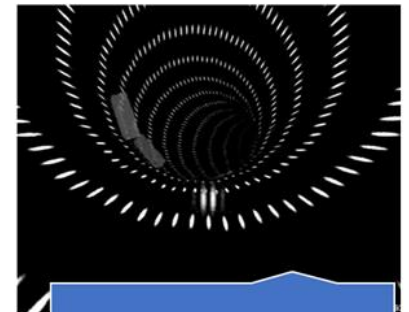
# *Multimodal Biosensing for Motion Sickness Detection*

Paradigms:

To induce moderate motion sickness, we used 3 stimuli: from a mild stimulus (attention task) to a more 'spicy' stimulus (rollercoaster)



(a) Attention task



(b) Tunnel travel



(c) Rollercoaster

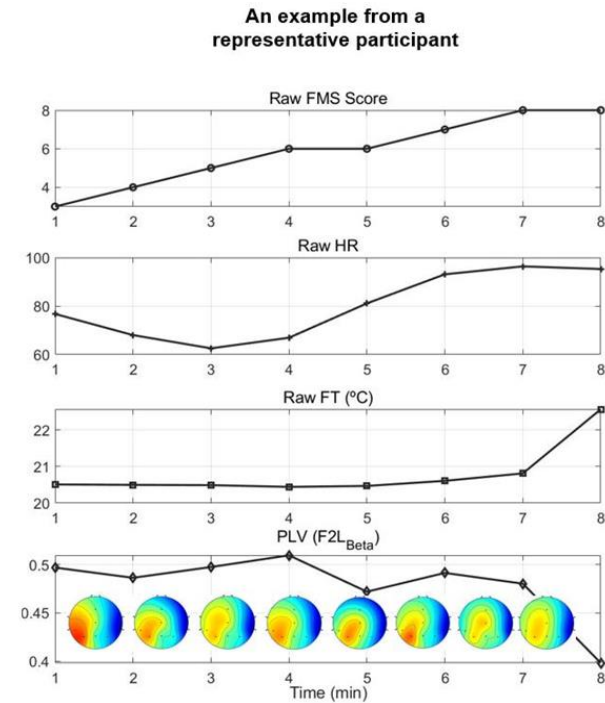
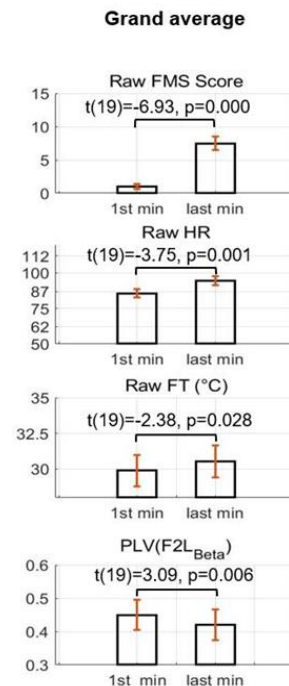


# Motion Sickness Detection

Brain frontoparietal connectivity decreases with the increase of sickness ratings

New brain biomarker for motion sickness detection, validated by proxy references, such as increased heart rate and fingertip temperature

New brain biomarker opens a door for brain stimulation-based motion sickness mitigations



# *Motion Sickness Mitigation Solutions*

How to reduce motion sickness so that we can use immersive displays in cars?

Two solutions

Brain stimulation

Visual displays





# *Brain stimulation for motion sickness mitigation*



# *Peripheral visual display for mitigation*

Motion environment tightly coupled to car motion  
Presented in peripheral vision





# *Results*

Neurostimulation experiments are on-going

Initial significant results for neurostimulation

Peripheral visual cues can reduce motion sickness

Peripheral multimodal displays: Audio and haptics can help

Multimodal cues



# *Conclusions*



# *Conclusions*

We spend a lot of time as passengers

Can we use time more effectively?

Entertainment/work/collaboration

Research challenges

Interaction in confined spaces

Social acceptability

Motion sickness

Sensing an issue across all of these

Unlock the potential of travel time in future vehicles



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