Visual search in 3D-modelled rooms:

comparing results from the same protocol run in VR and on 2D screens

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Scene grammar lab, Frankfurt

Problematic

- VR headsets are great, they open new possibilities, but
  - Do we need the benefits of VR
    or do we want complex and high-quality scenes?
  - VR testing can be very time-consuming
  - Equipment can be costly for some labs

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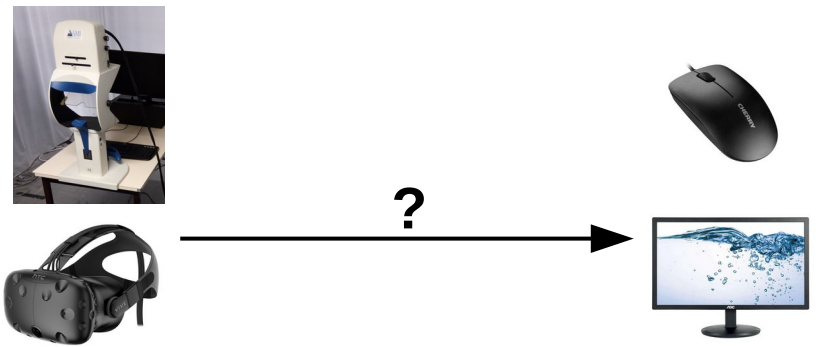
Problematic

- Can we use **mouse movement** controlling a **camera** in a 3D virtual environment on-screen as a **proxy for gaze in VR**?



- Can we push it further? To unsupervised online experiments, for mass testing.

Gaze tracking

Mouse-as-a-proxy

Computer screen

Computer screen

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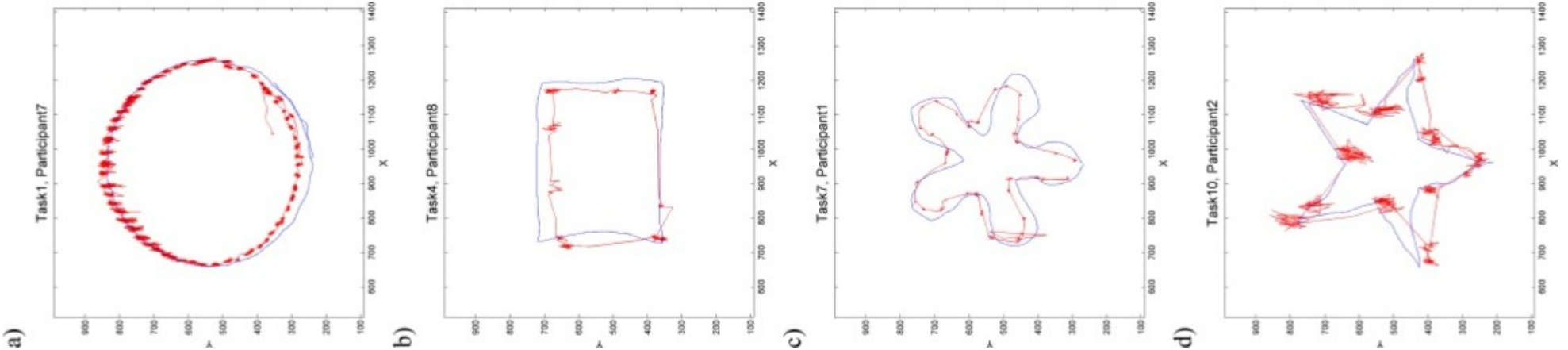
- Mouse as a proxy for gaze

Similar saliency maps obtained from gaze data and mouse data.

SALICON (Jiang et al., CVPR15)

- Mouse as a proxy for gaze



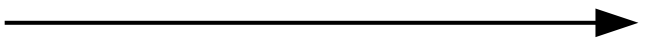
Very strong correlation between gaze and mouse position (and clicks).

Demšar & Çöltekin (PLoSOne,17), Egner et al. (JEMR18)

Gaze tracking

Mouse-as-a-proxy

Computer screen



Computer screen

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Gaze tracking

Virtual reality headset

Gaze tracking

Computer screen

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- On-screen to VR research
  - Demonstrated that behaviour is in general not different
    - In terms of fixational and saccadic biases
    - Search behaviour
    - Which parts of a scene are attended the most (saliency)

David, Beitner & Võ (MDPI-BS20, JoV21), David et al. (JoV22)

Gaze tracking

Virtual reality headset

Gaze tracking

Computer screen

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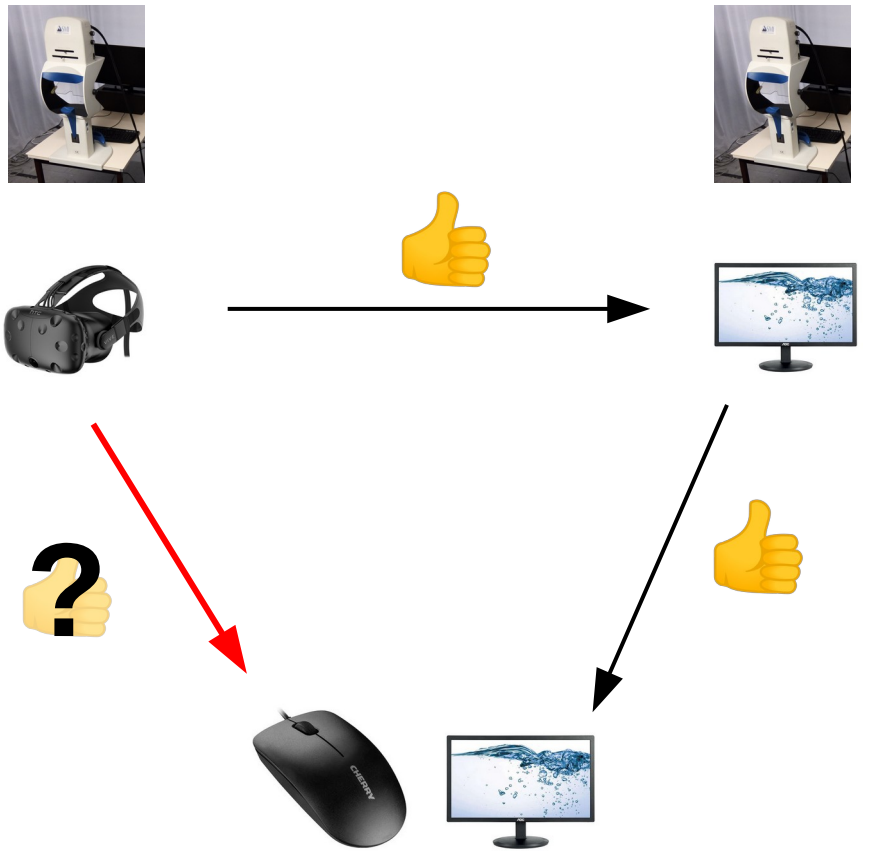

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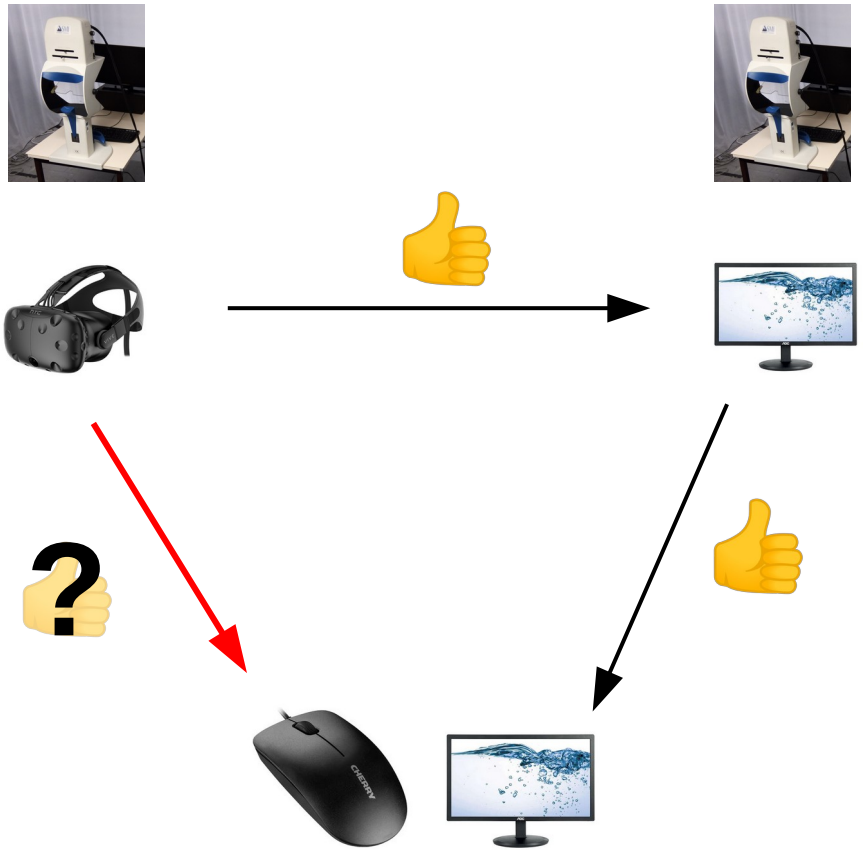

Can this shortcut work?

With complex tasks

(object search)

And complex scenes

(indoor rooms)

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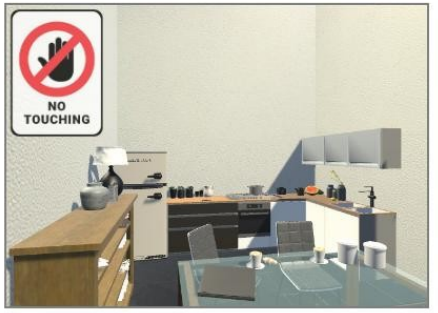
- Demo
  - Trial replays

[*Showed replays of VR trials, followed by replay of on-screen trial*]


Target presentation
Trophy
1s
Scene view
40s
Press trigger
or time-out
Next trial...



Targets: always outside		**Targets**: 50% outside/inside	
Training	Block 1	Training	Block 2
3 trials	27 trials	3 trials	51 trials

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- Analysis

“Gaze” on object
Gaze cone method (4°)

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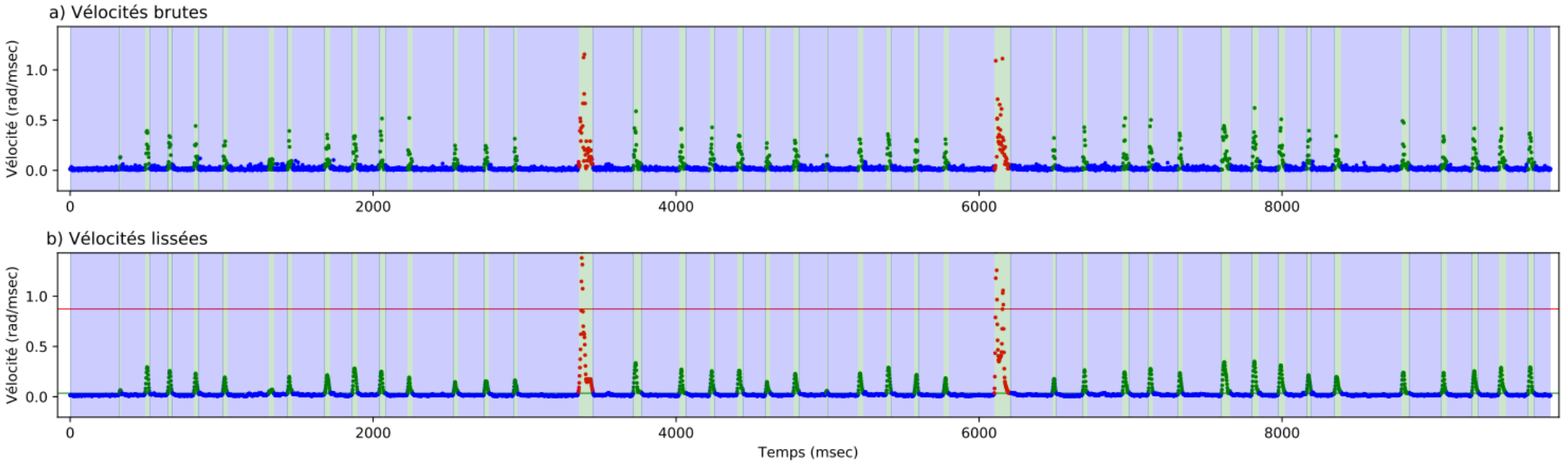
- Analysis
  - Gaze velocity signal **on-screen**



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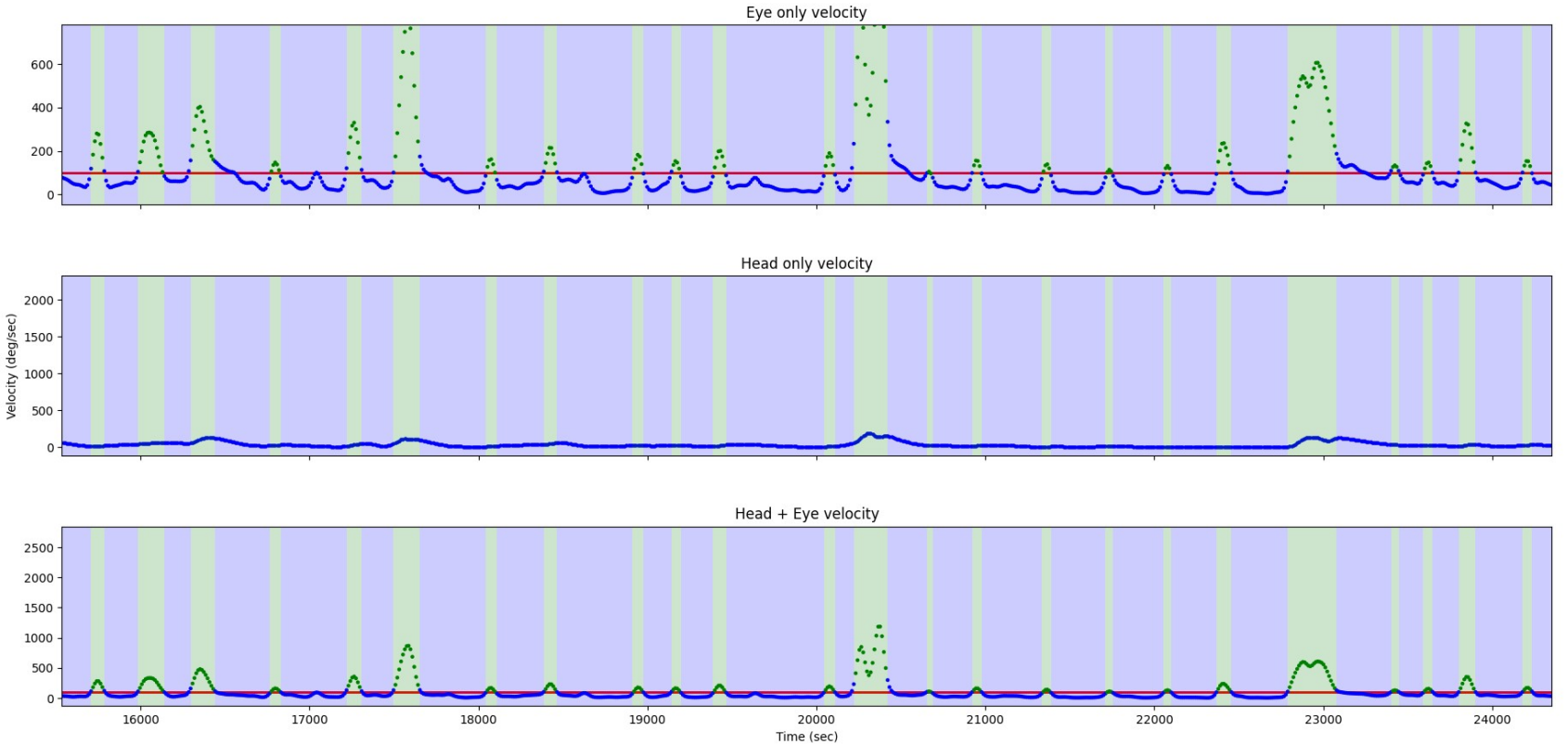
- Analysis
  - Gaze velocity signal **in VR**



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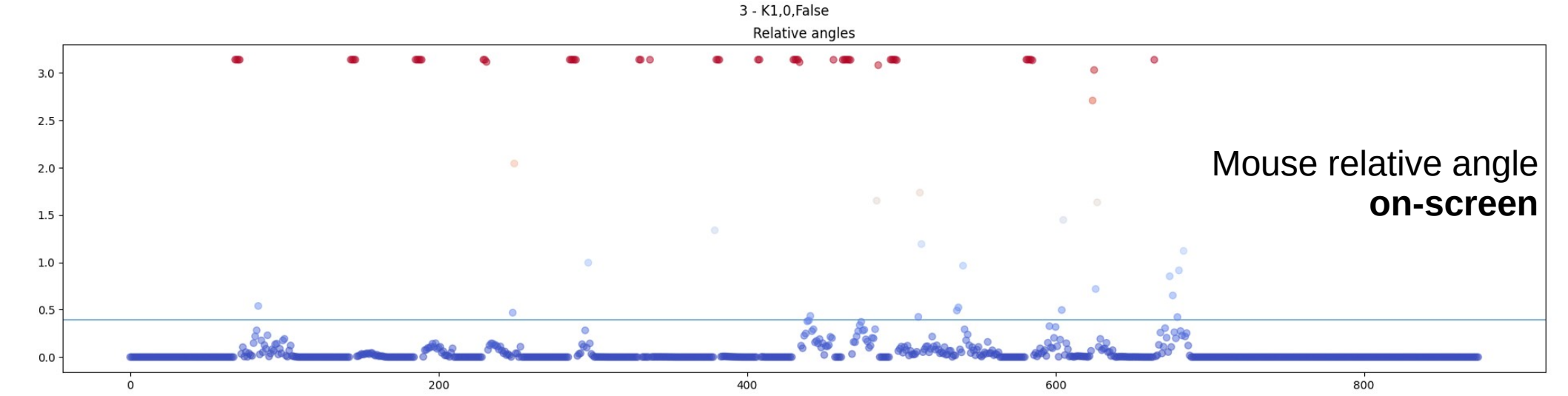
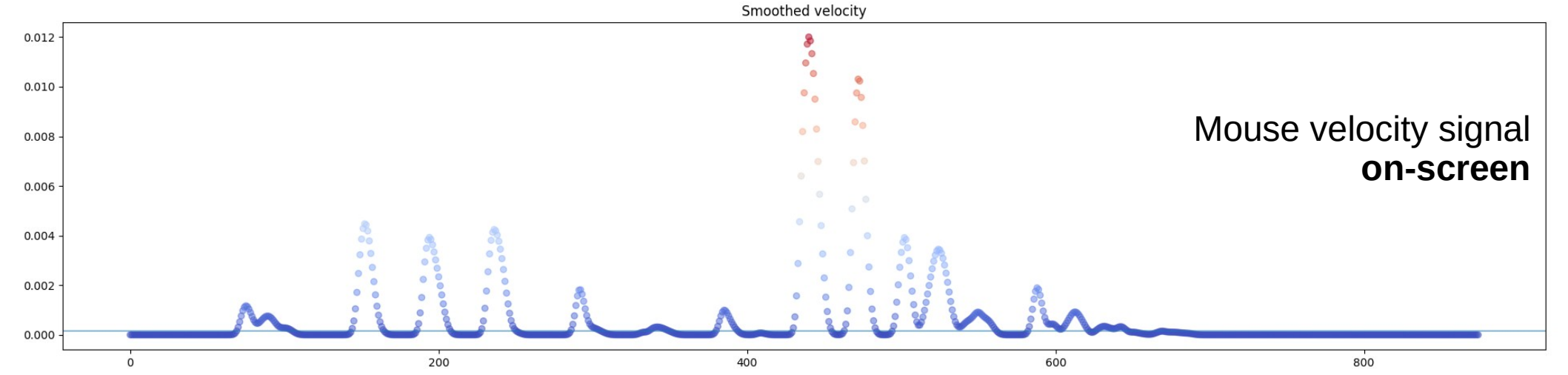
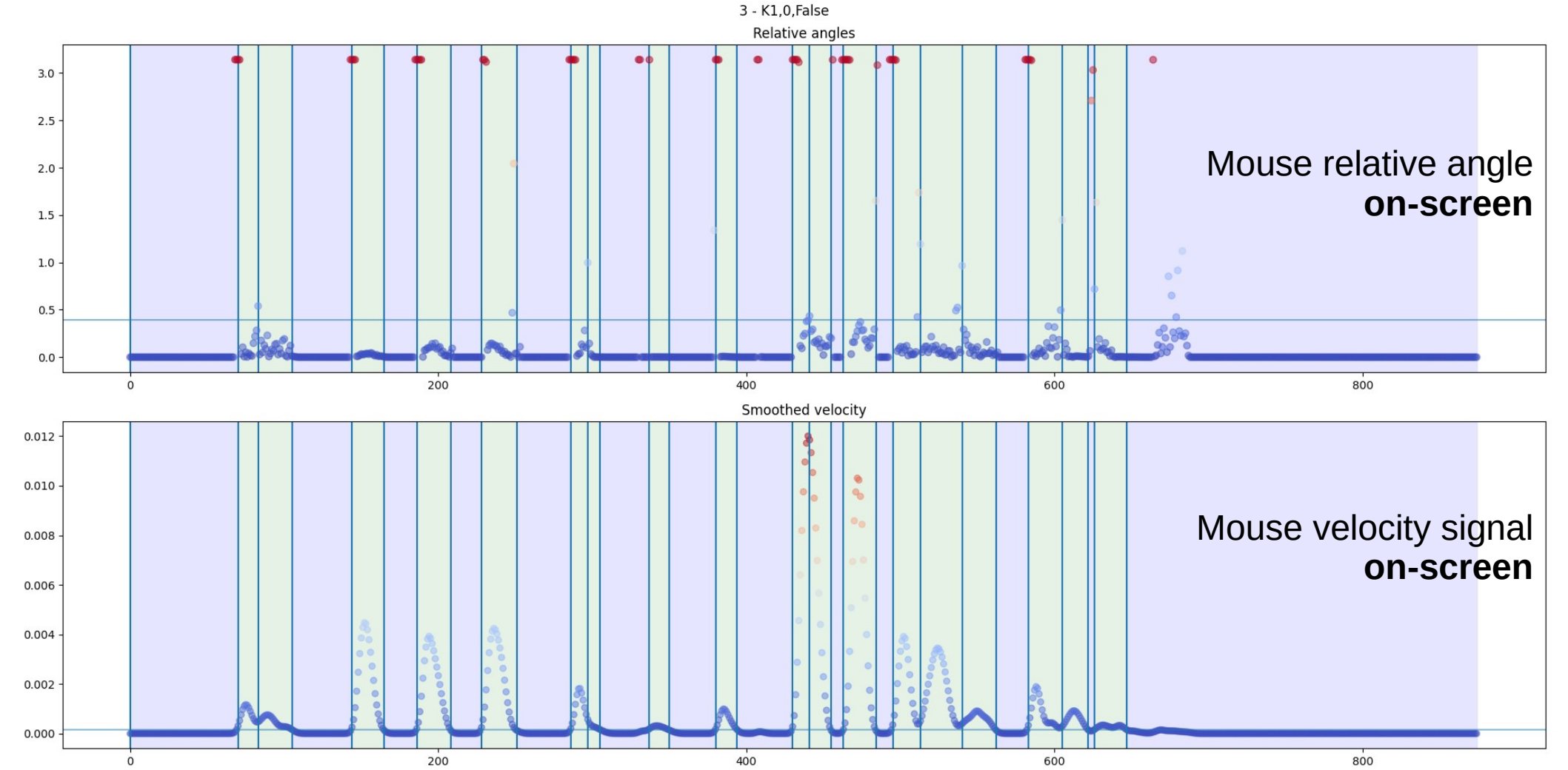


Mouse relative angle
on-screen



Mouse velocity signal
on-screen


3 - K1,0,False
Relative angles
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
200
400
600
800
Mouse relative angle
on-screen
Smoothed velocity
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0
200
400
600
800
Mouse velocity signal
on-screen

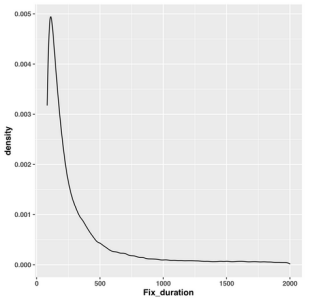
- Results

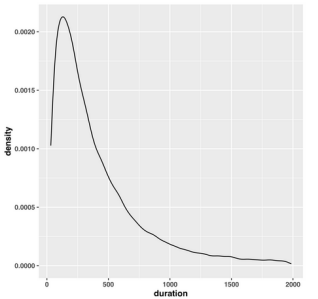
Density distributions:
same shapes at different scales

VR HMD

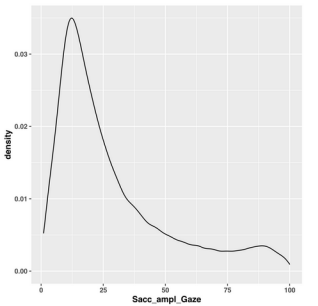
Mouse

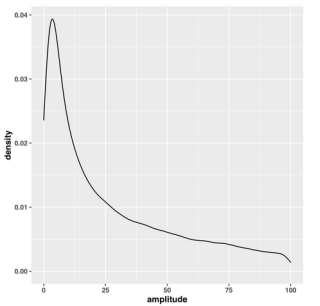
Fixation duration





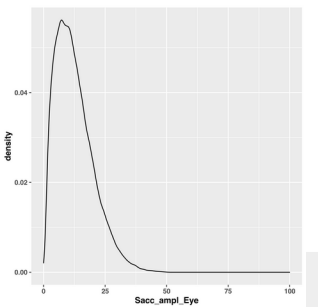
Gaze





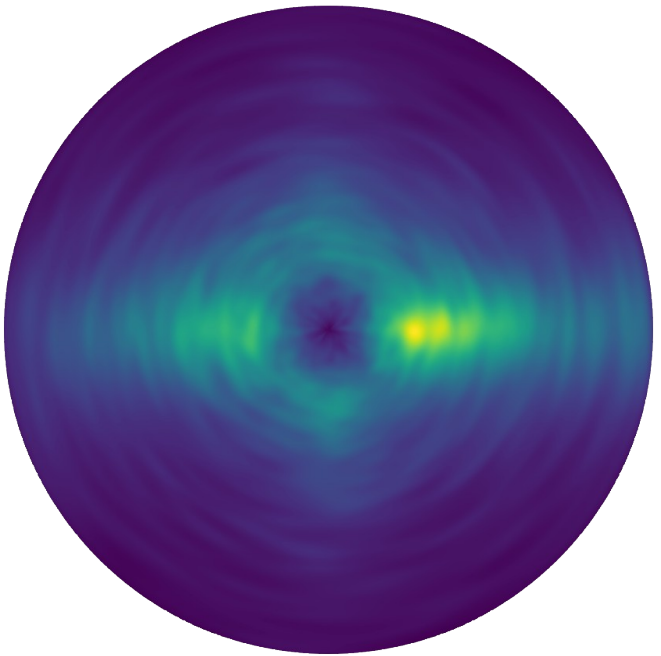
Saccade Amplitude

Eyes

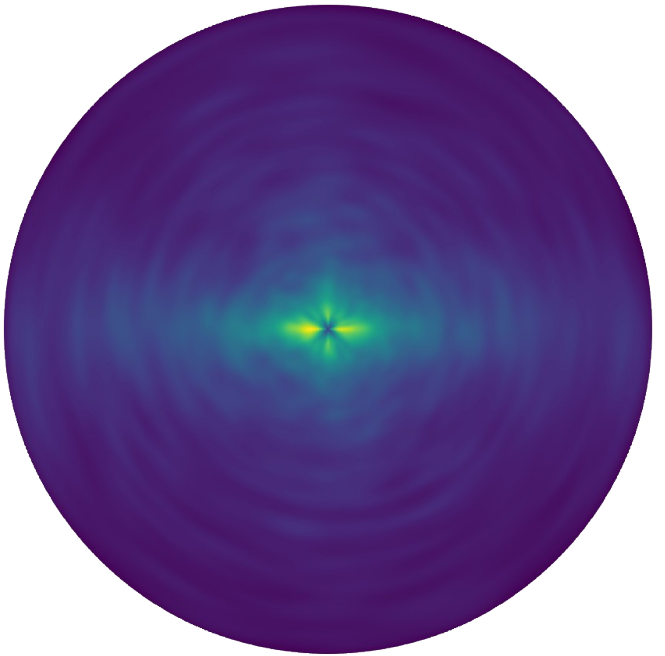


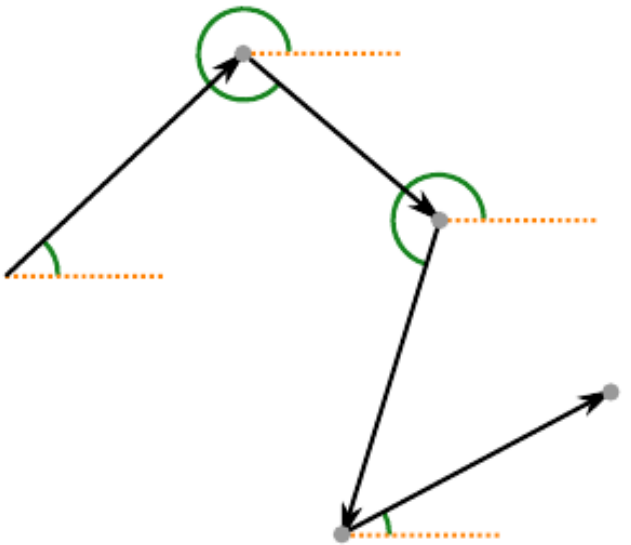
Absolute angles

VR HMD



Mouse





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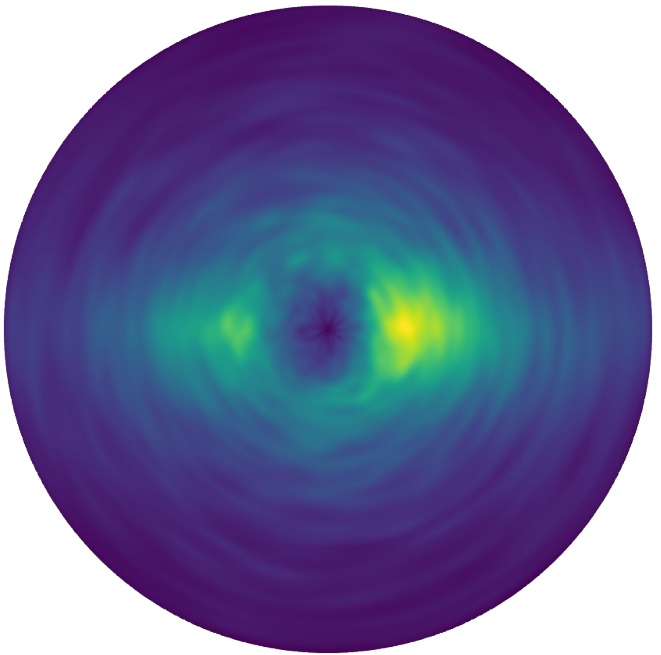
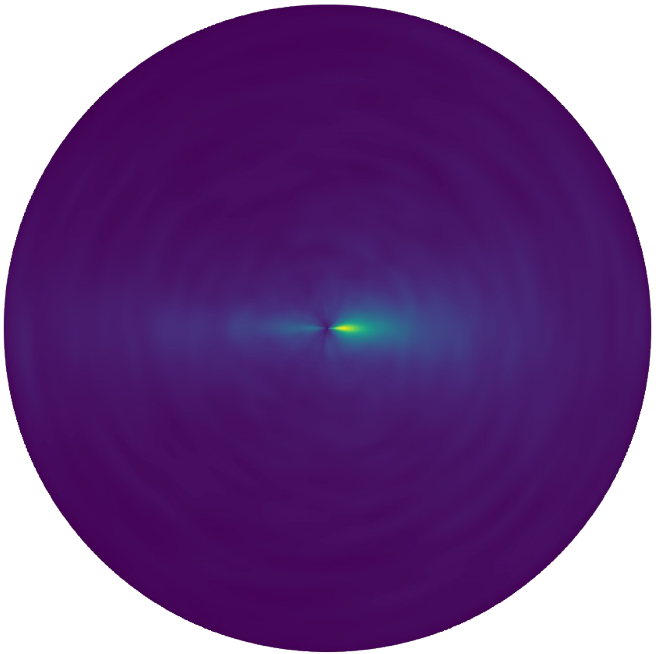
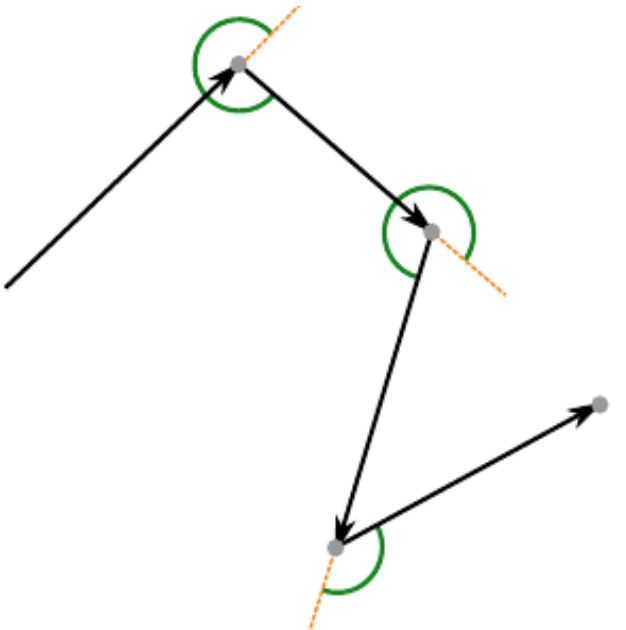
Relative angles

VR HMD



Mouse





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- Where? Comparing saliency maps

[*Showed dynamic saliency maps of VR/Onscreen side by side to demonstrate close similarity*]

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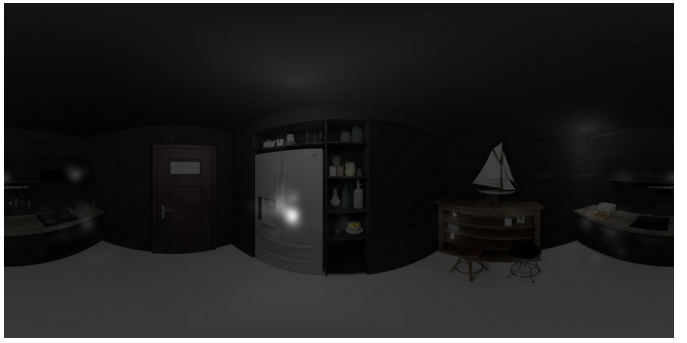
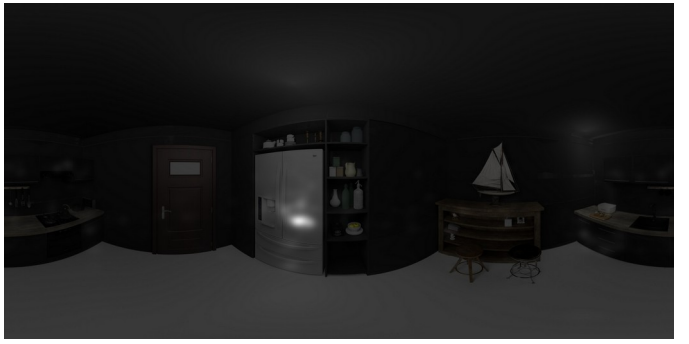
- Where? Comparing saliency maps

  - CC: 0.55
  - KLD: 1.75
  - SIM: 0.48

- Take home

  - **How** we look
    - Density distributions: same shapes at different scales
    - Saccade angles: same absolute and relative biases

  - **Where** we look
    - Saliency maps are very similar
    - People look at the same locations


Thank you
for your attention

The Scene Grammar Lab recruits

2 post-doc positions will open soon!

Contact Melissa Võ at
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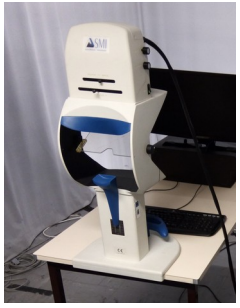
Why Melissa couldn’t make it to ECVP

- **Pros** – high data quality
  - High tracking accuracy
  - High stimuli resolution
  - Low latency

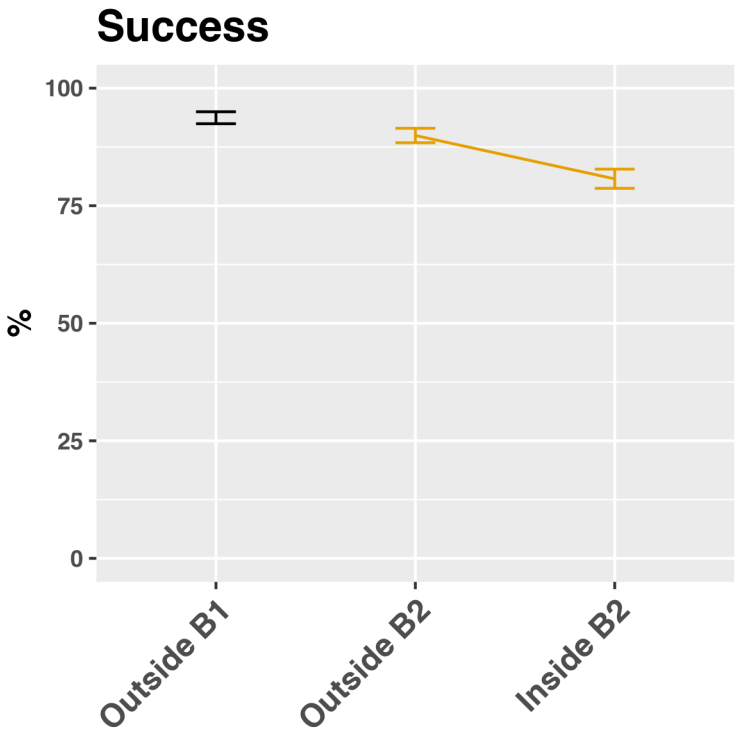


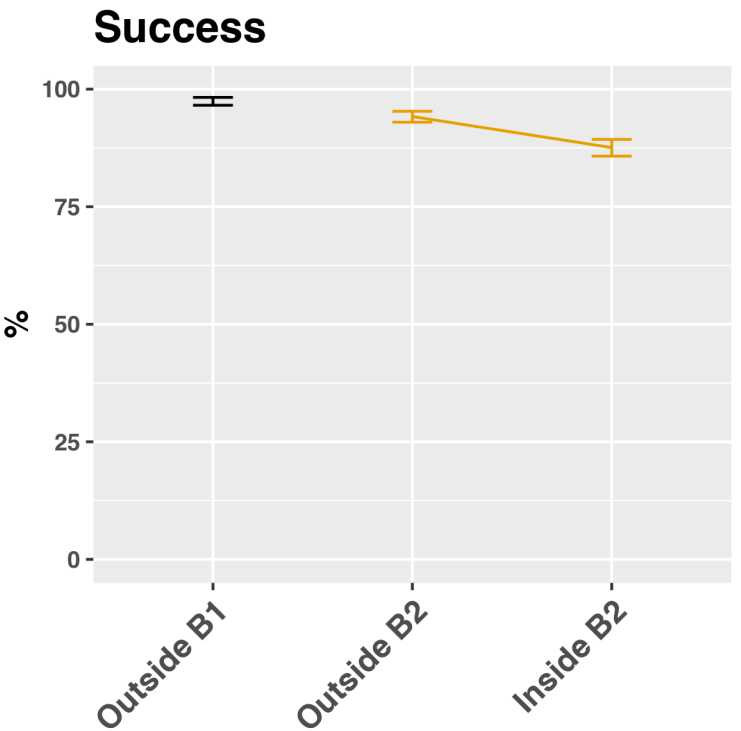
- **Cons** – less ecological
  - Very limited head movements
  - No body movements
  - Limited field of view

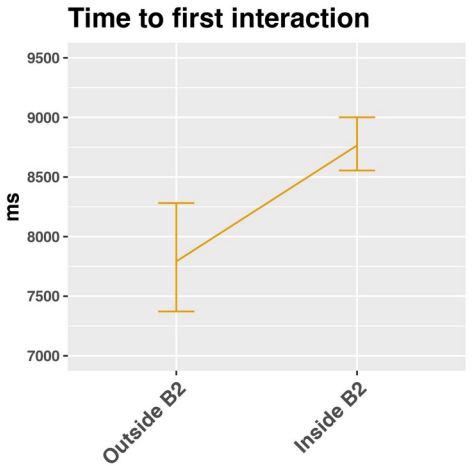
- **Pros** – more ecological
  - Free body and head movements
  - Full 360° content
  - Bigger field of view

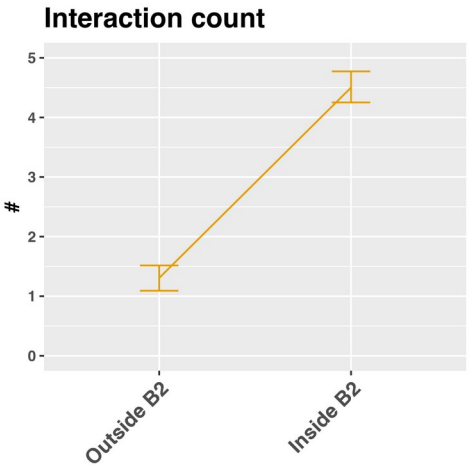
- **Cons** – lower quality
  - Medium-to-low tracking accuracy
  - Low display resolution
  - Higher latency

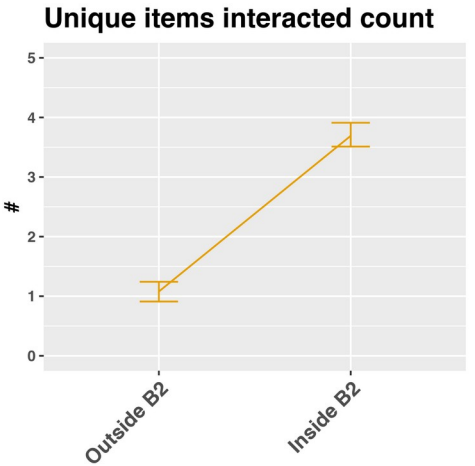
- Search behaviour and interacting
  - Search success



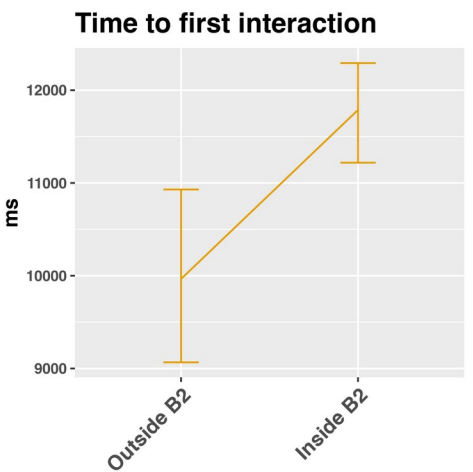


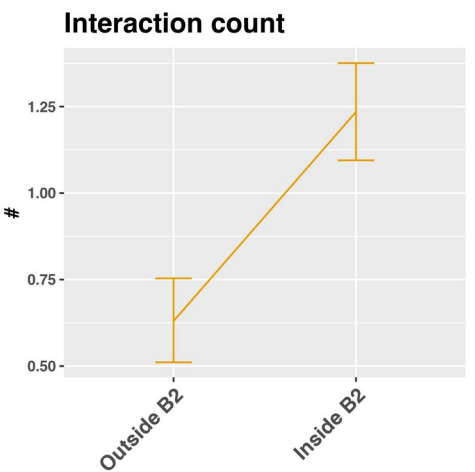


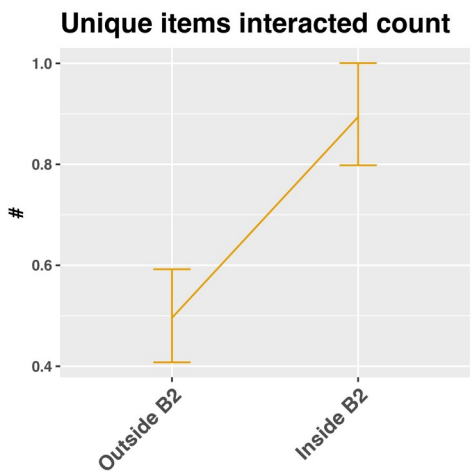




- Search behaviour and interacting







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