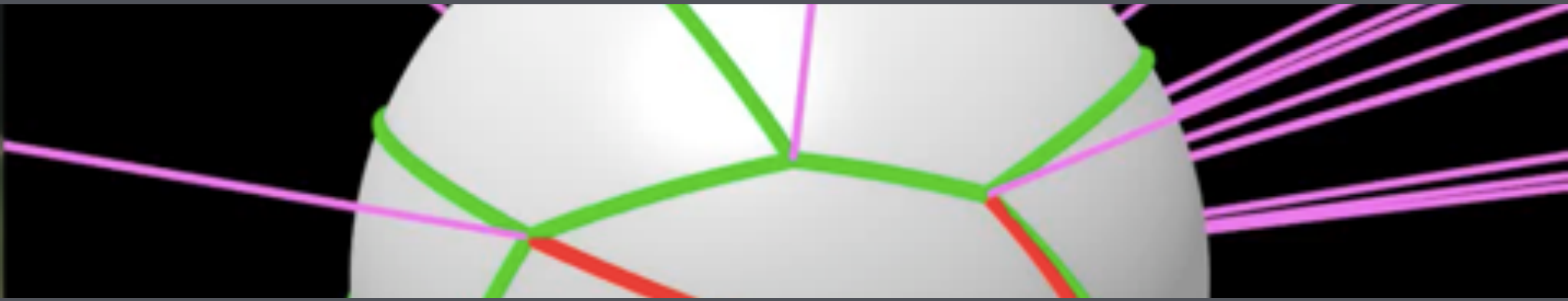
School of Psychology and
Clinical Language Sciences

University of Reading

USING VR TO STUDY 3D SPACE PERCEPTION



Andrew Glennerster

Overview

- What is necessary for high-fidelity VR?
  - minimal latency
  - good spatial calibration

- Why is VR useful for studying 3D vision in moving observers?
  - experiments that could not be done without VR

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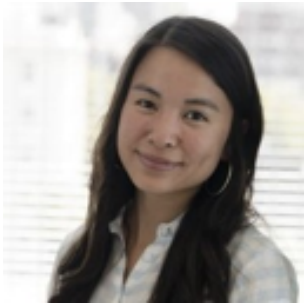

Jenny Vuong

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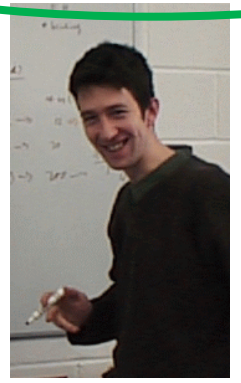


Andrew Fitzgibbon

Microsoft Research

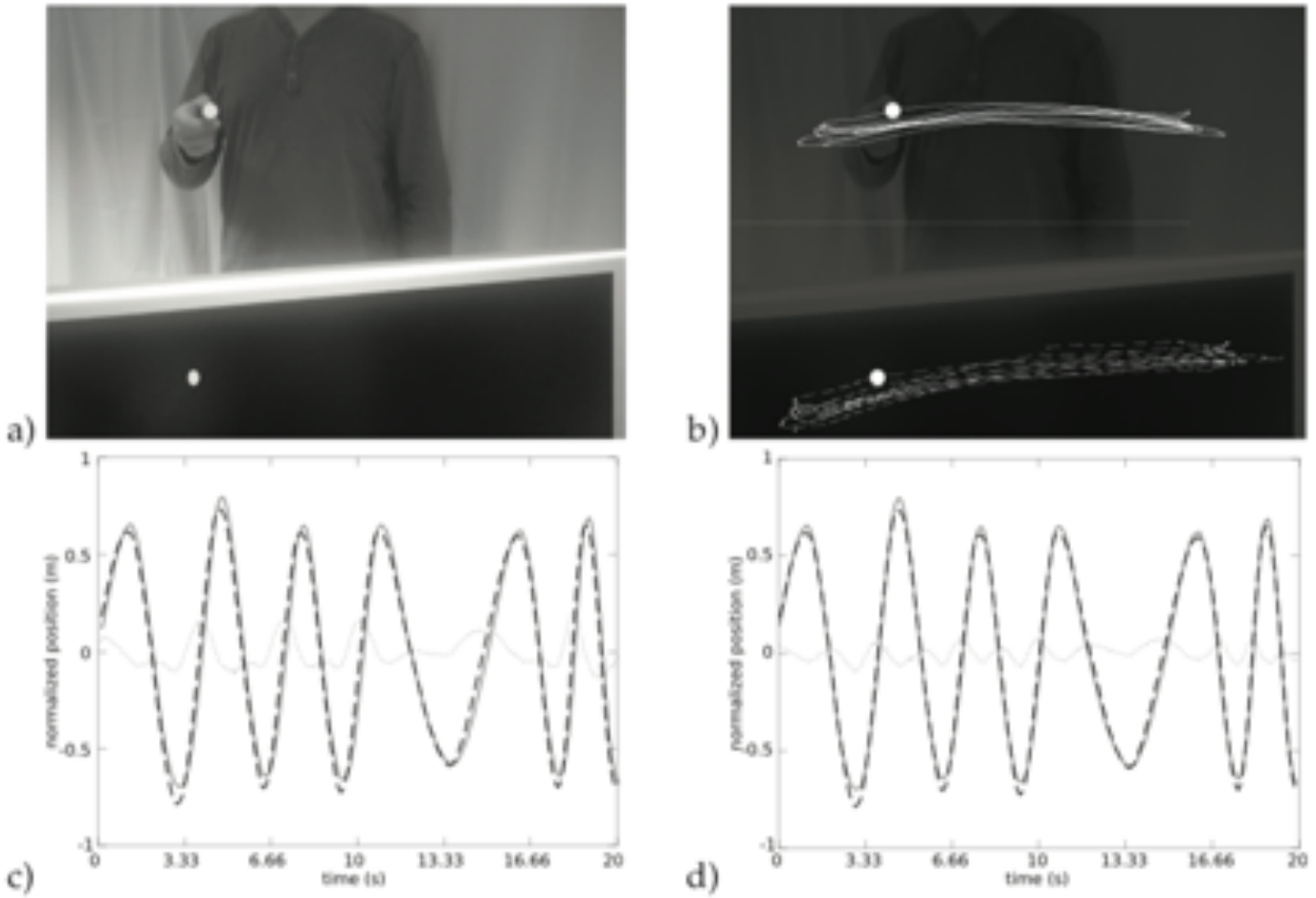
EPSRC

[dstl]

End-to-end latency of different displays

University of Reading

Stuart Gilson



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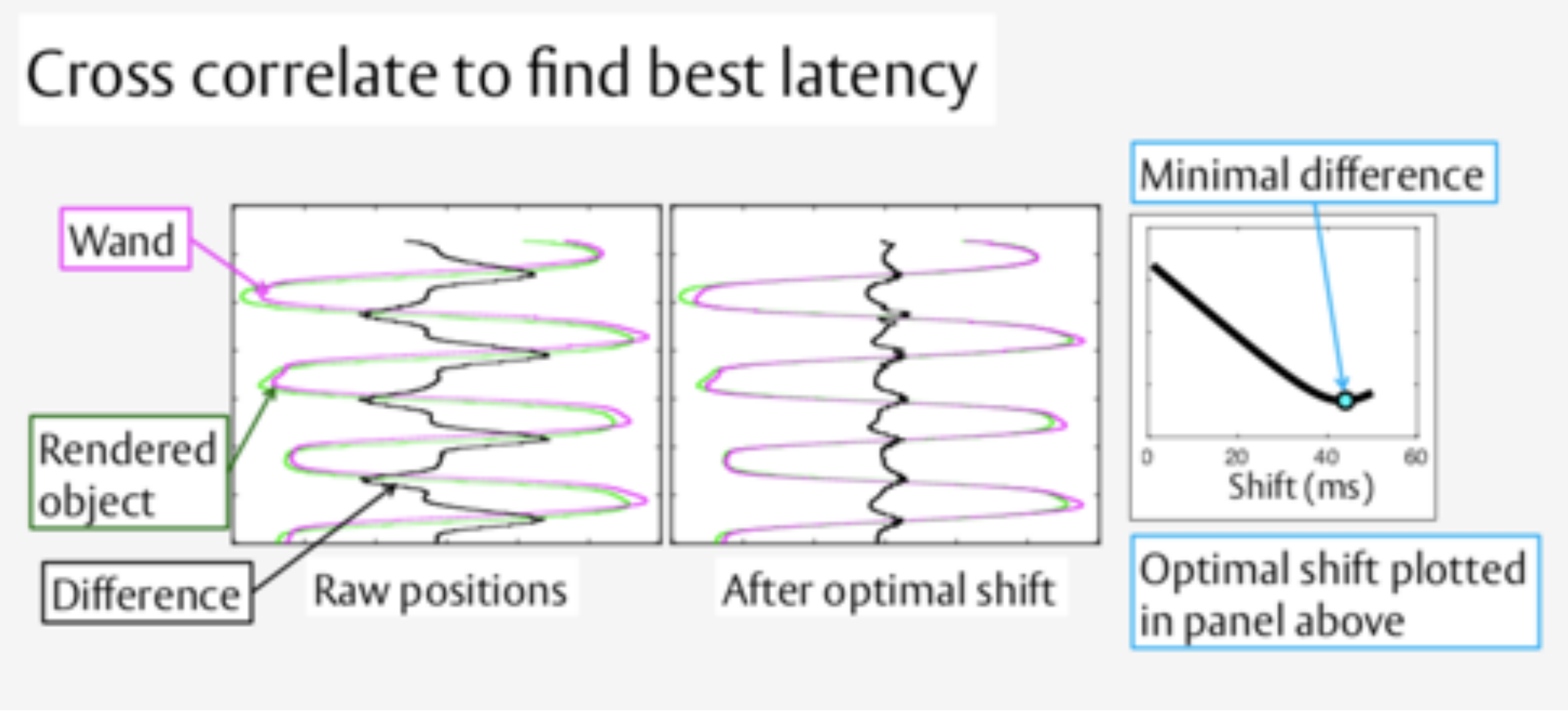

People can detect quite small differences in latency

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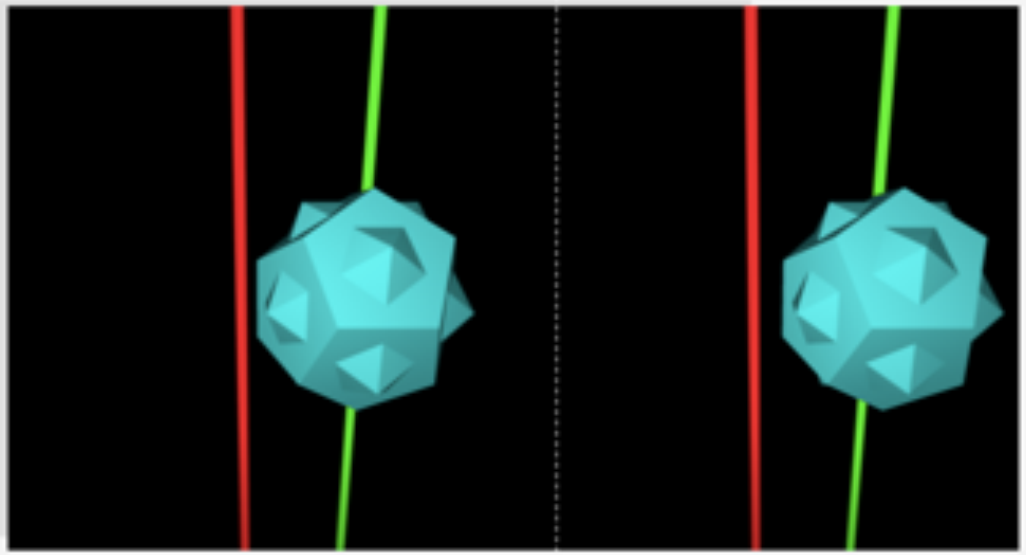
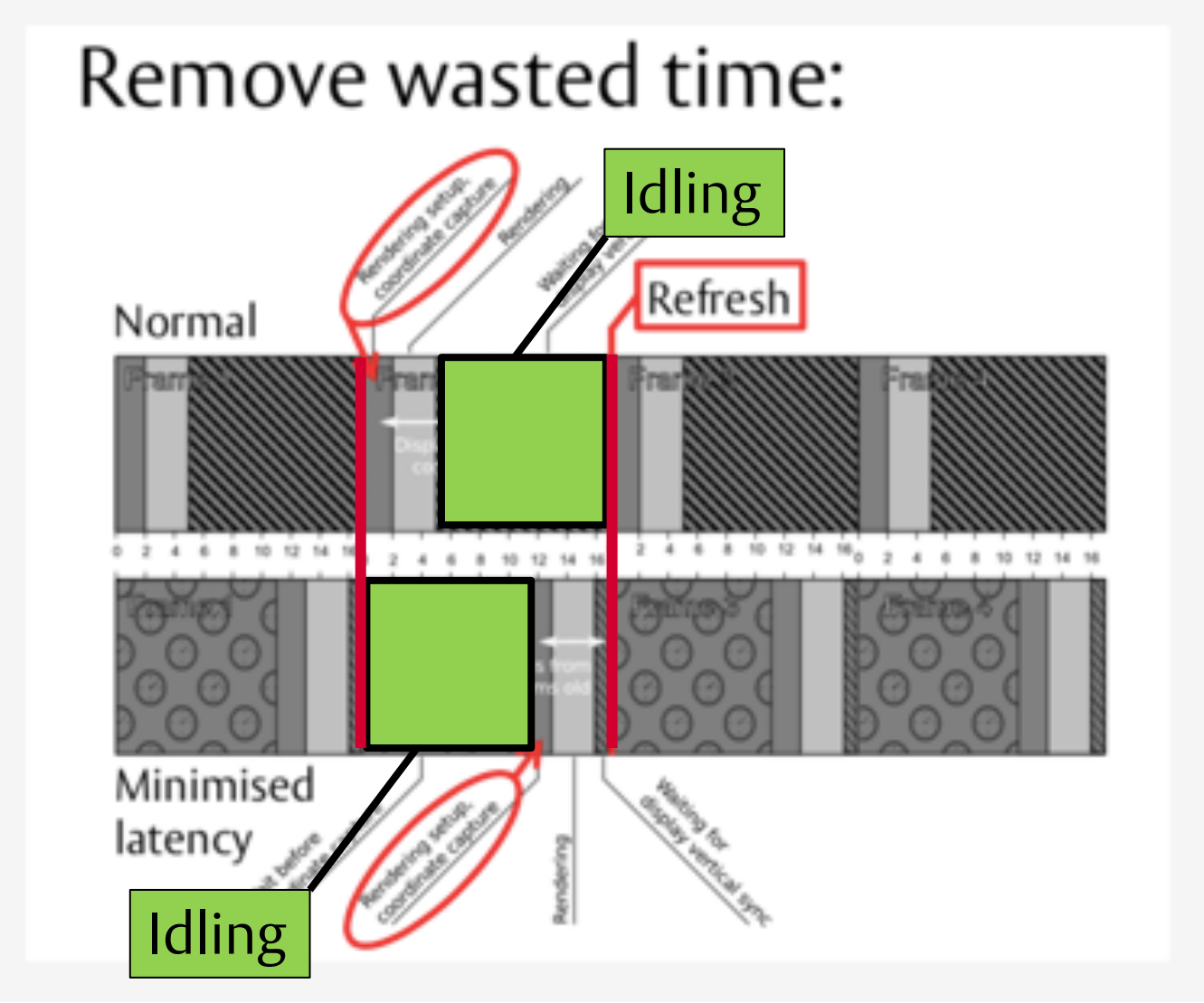


Psychophysical methods:

- In VR, using SX111 (*nVis*) head mounted display
- Participants waved a rendered wand as they wished
- Task: 2AFC 'shorter or longer latency' (50% trial of each type)
- 4 practice trials per run followed by 20 trials
- 80 trials per point

Reduce end-to-end latency



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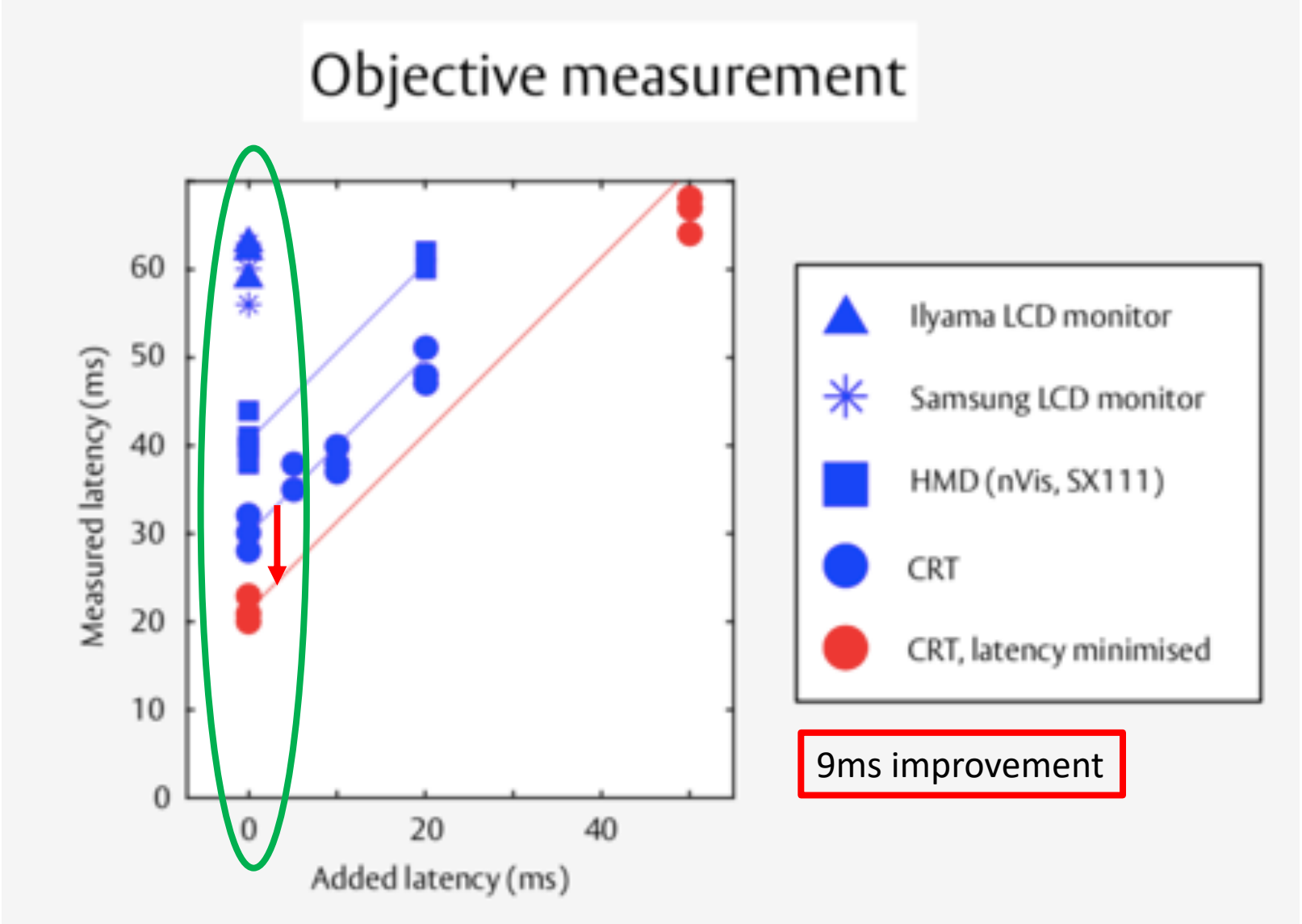

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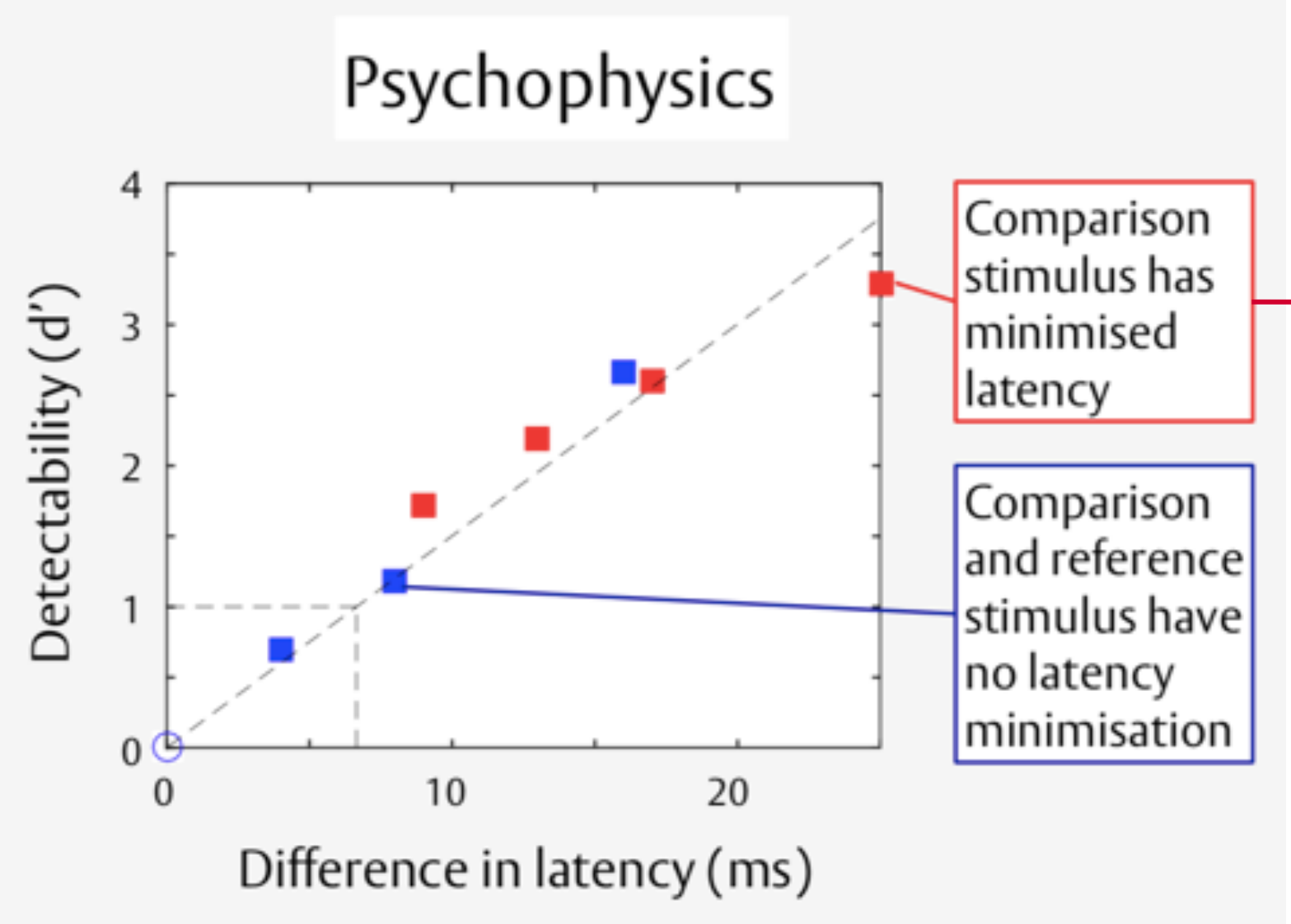

Spatial calibration of a head mounted display

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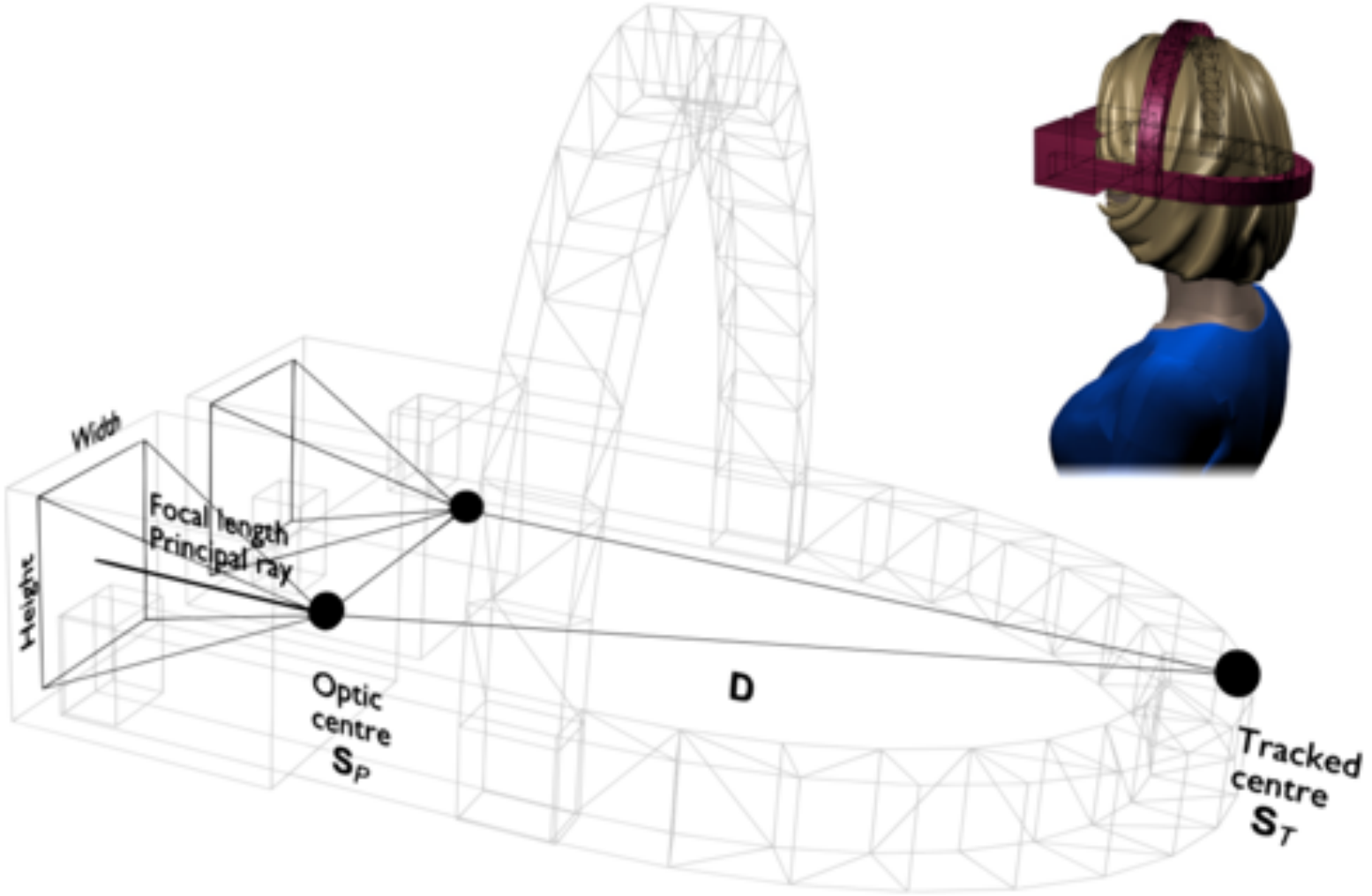

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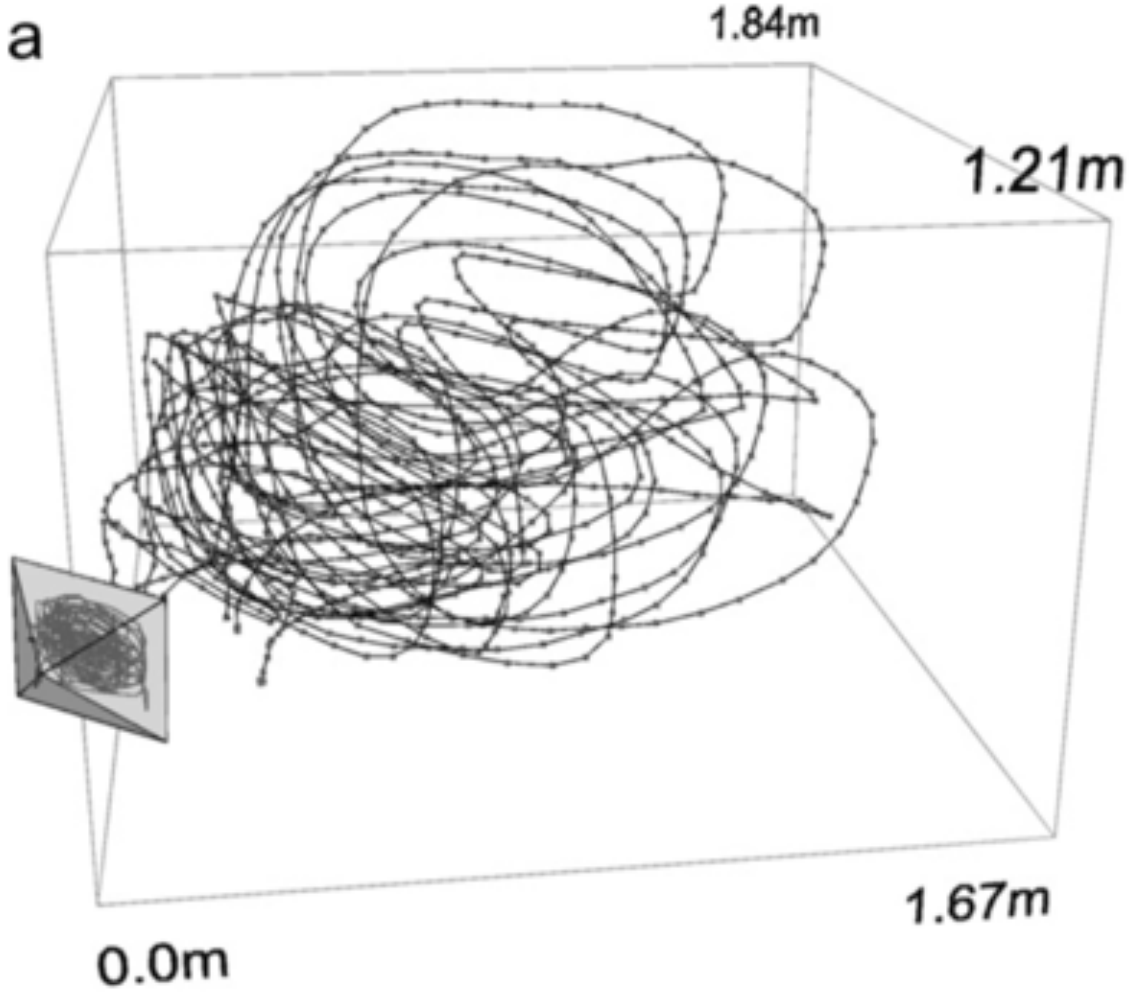

(x,y,X,Y,Z) for n frames

… allows you to solve for 11 parameters per frustum (location, orientation, focal length, aspect ratio etc)

Spatial calibration of a head mounted display

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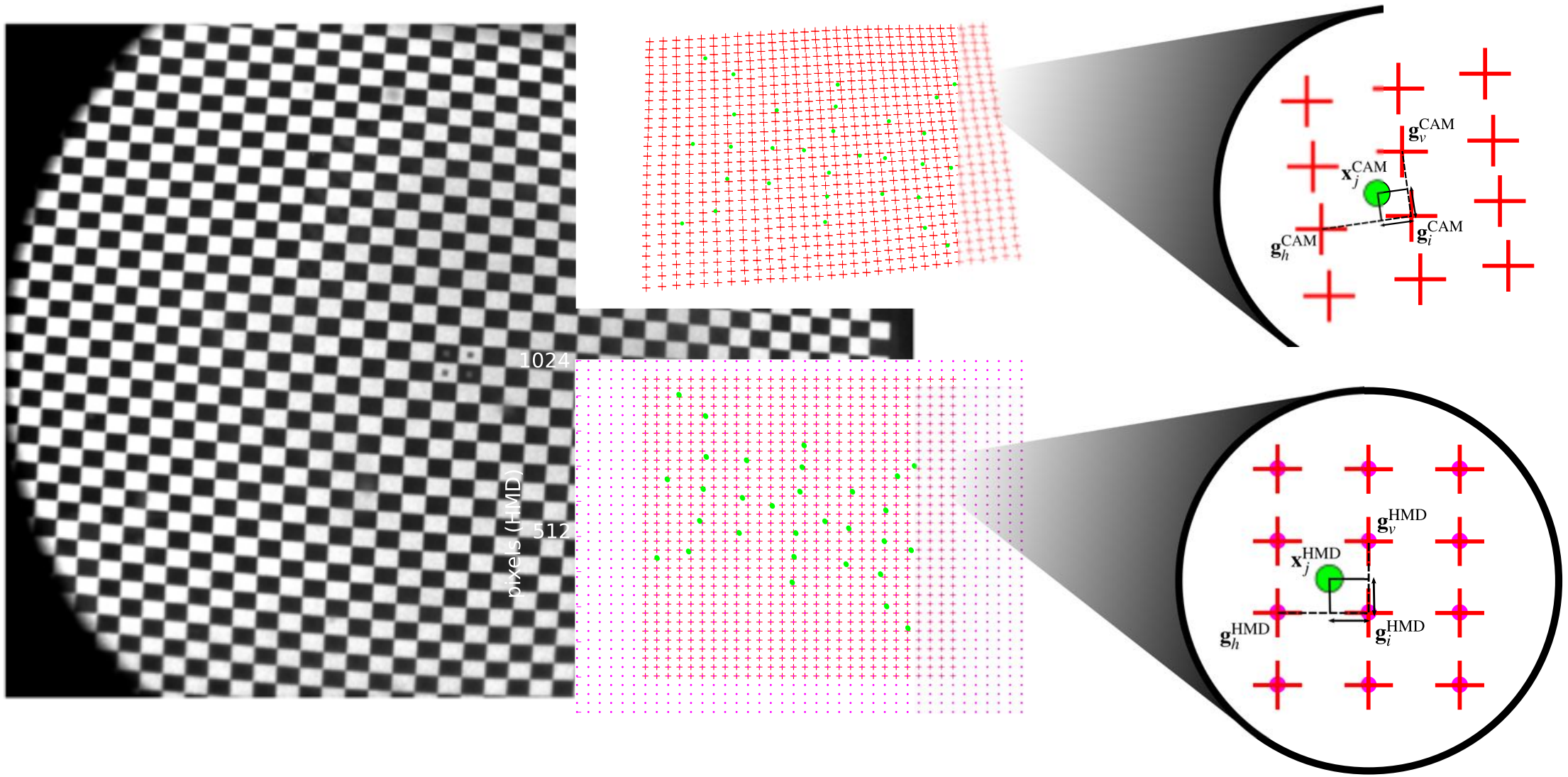

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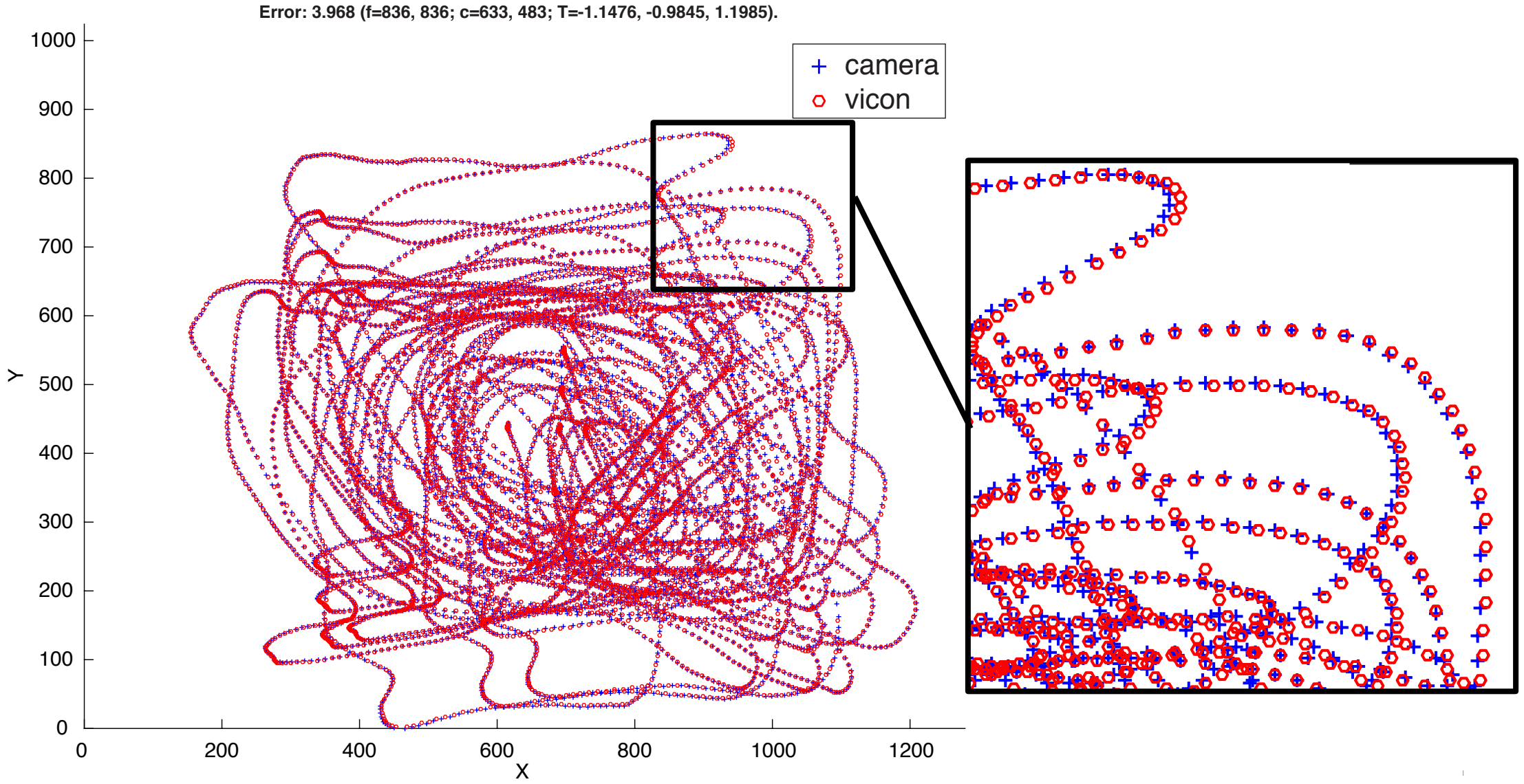

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Psychophysical evidence against 3D reconstruction

- Intransitivity of depth relations (A>B>D but A<C<D)
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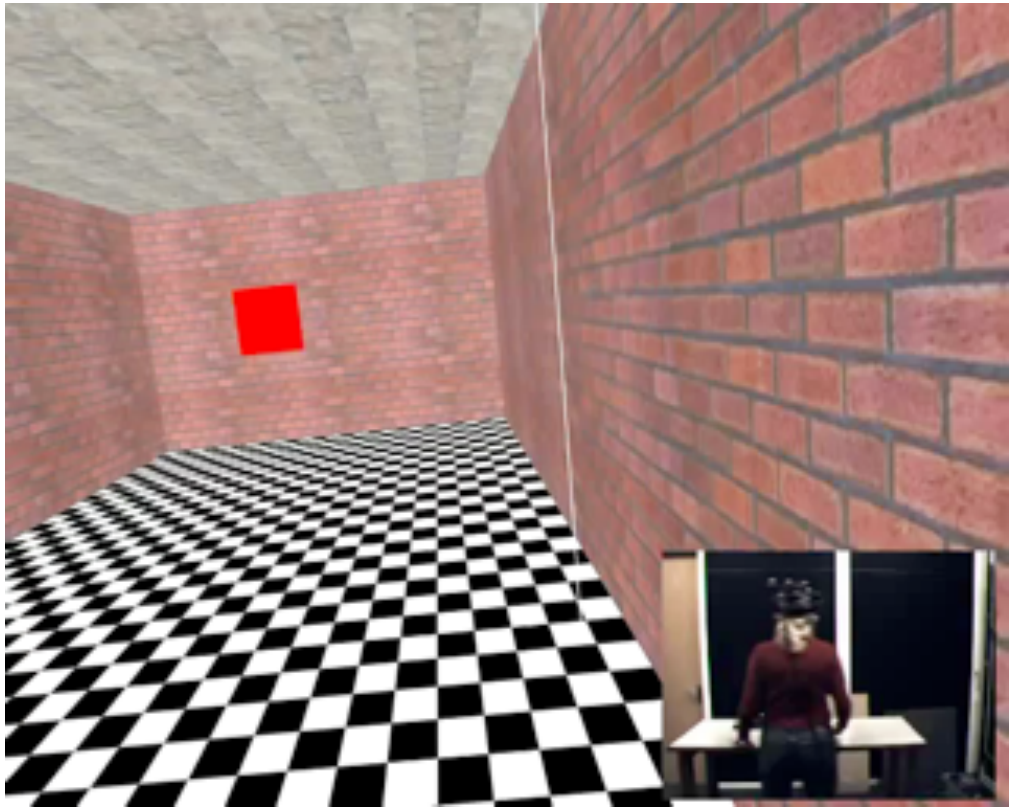
Psychophysical evidence that requires VR

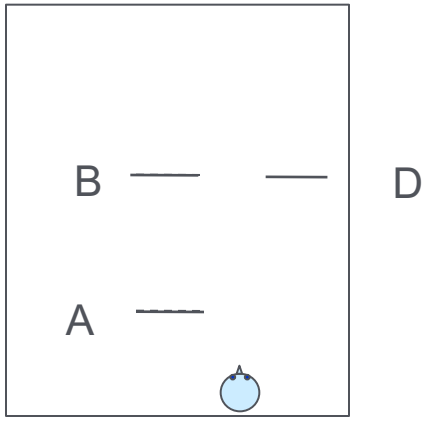


- Task:

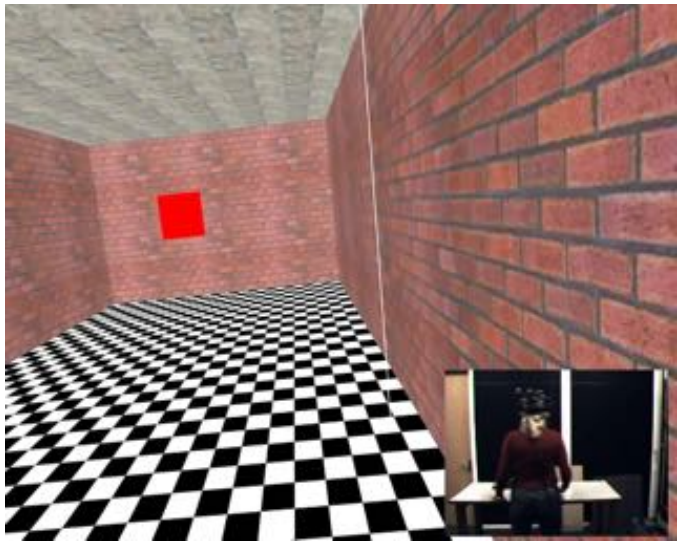
  ‘Is the square closer or farther away in the second interval?’

Psychophysical evidence that requires VR

Requires VR



A, B and D are at the same **perceived distance**



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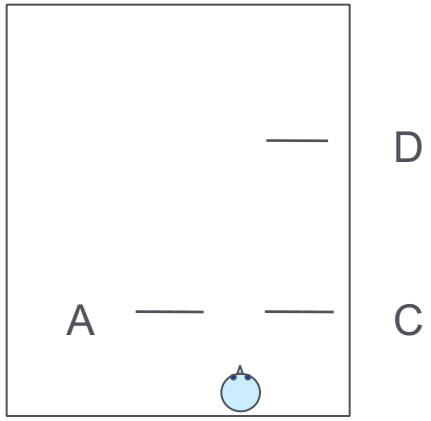
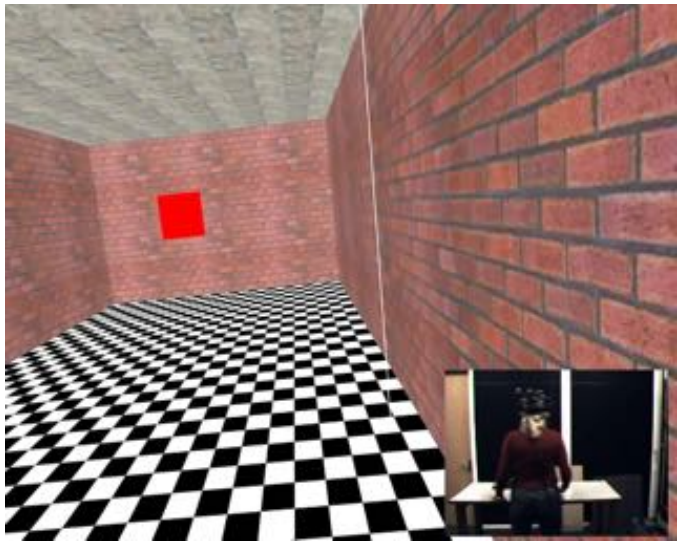


A, C and D are at the same **perceived distance**



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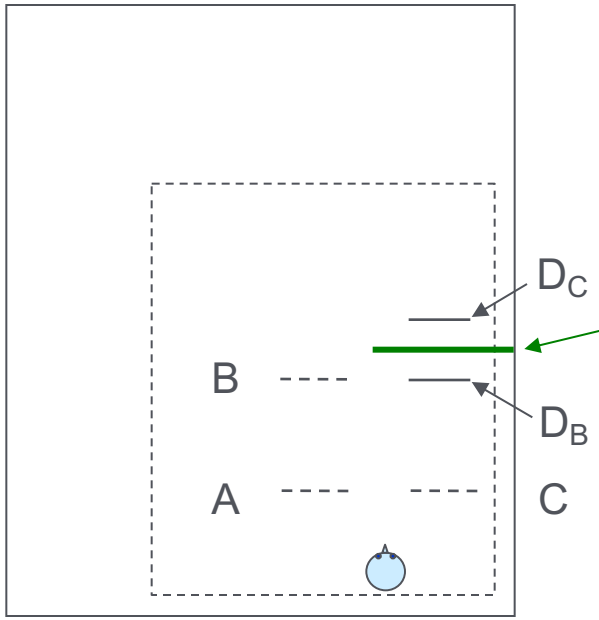
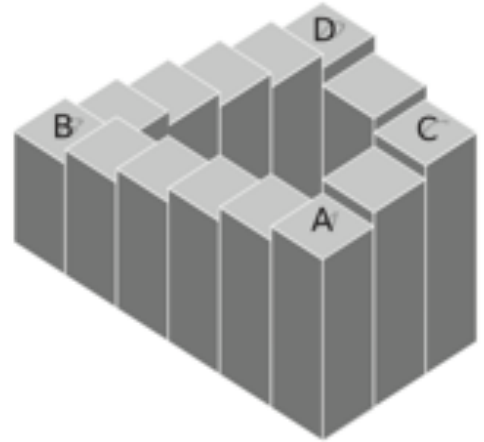
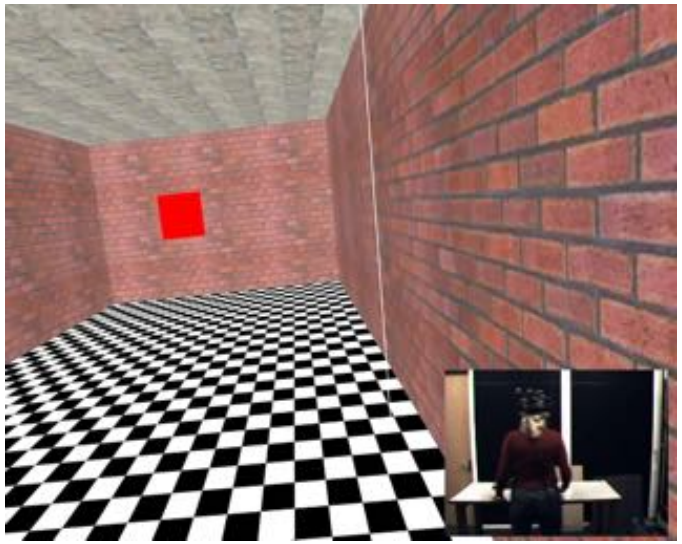


Further than A (via B)
but
Nearer than A (via C)





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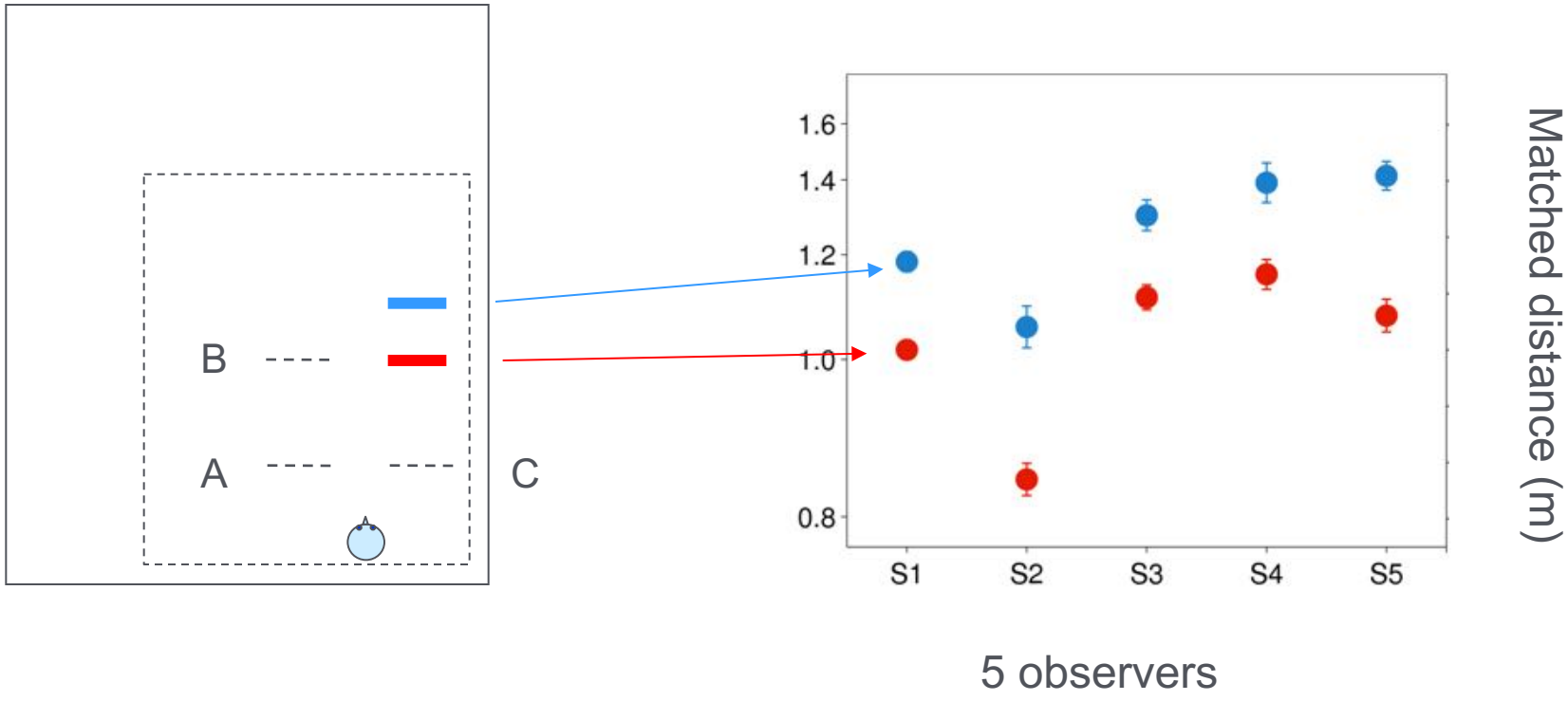

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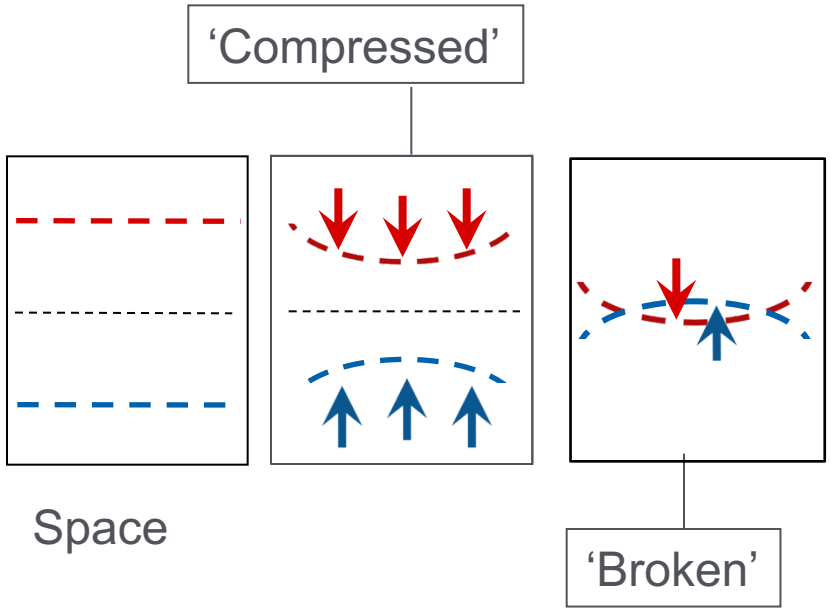

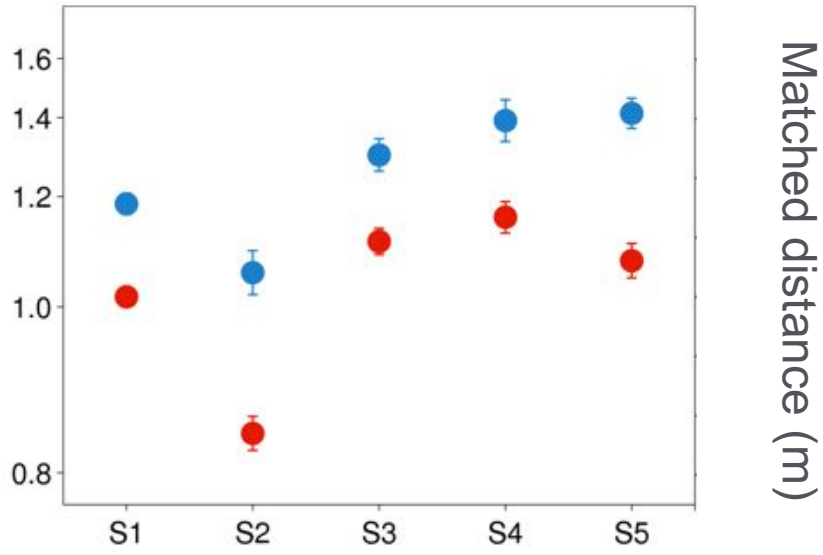

5 observers

Psychophysical evidence against 3D reconstruction

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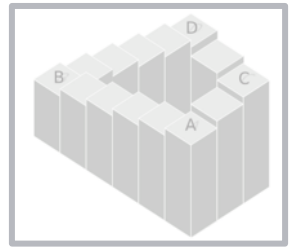

- Spatial updating is biased in a way that is inconsistent with 3D reconstruction:
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Psychophysical evidence against 3D reconstruction

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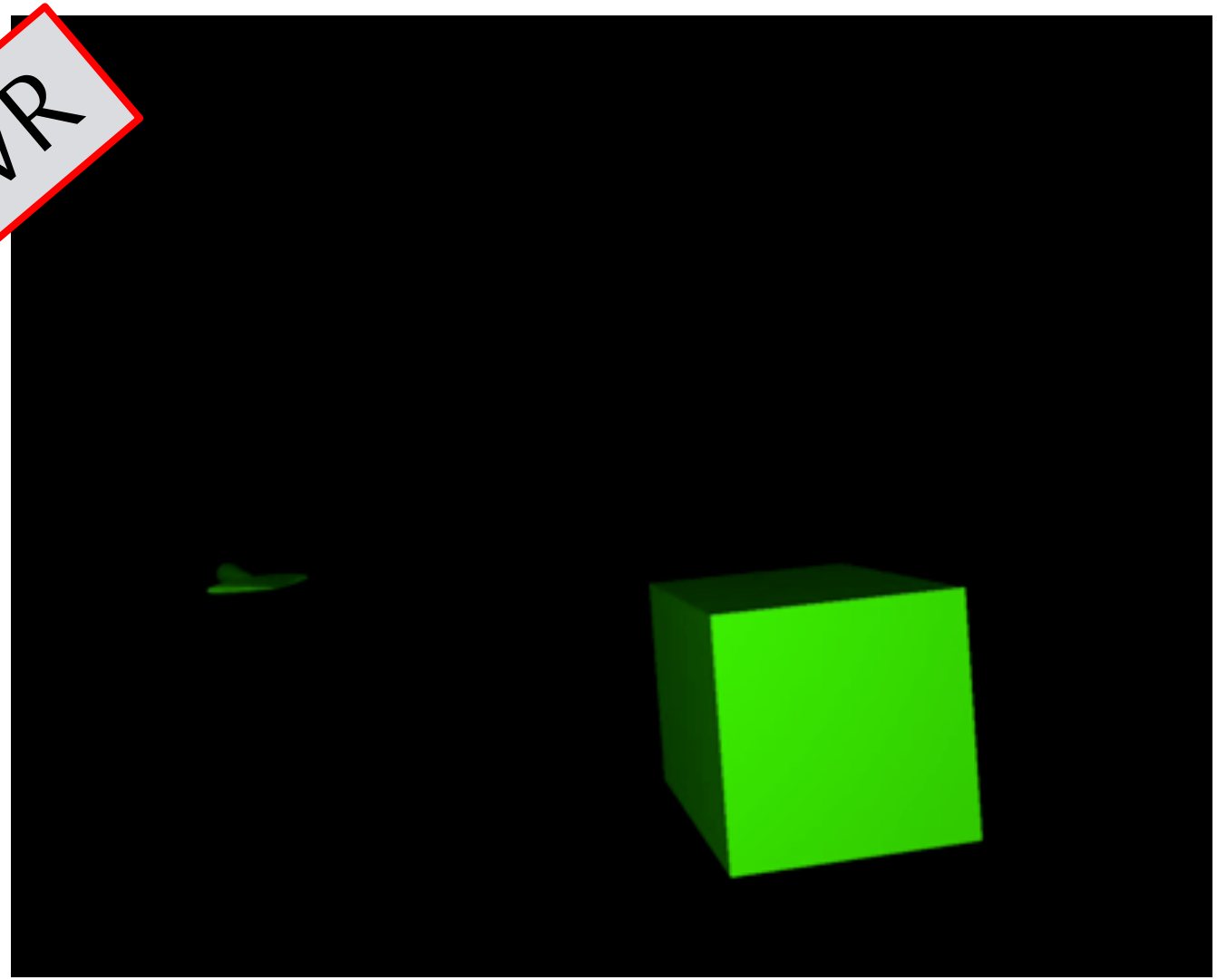

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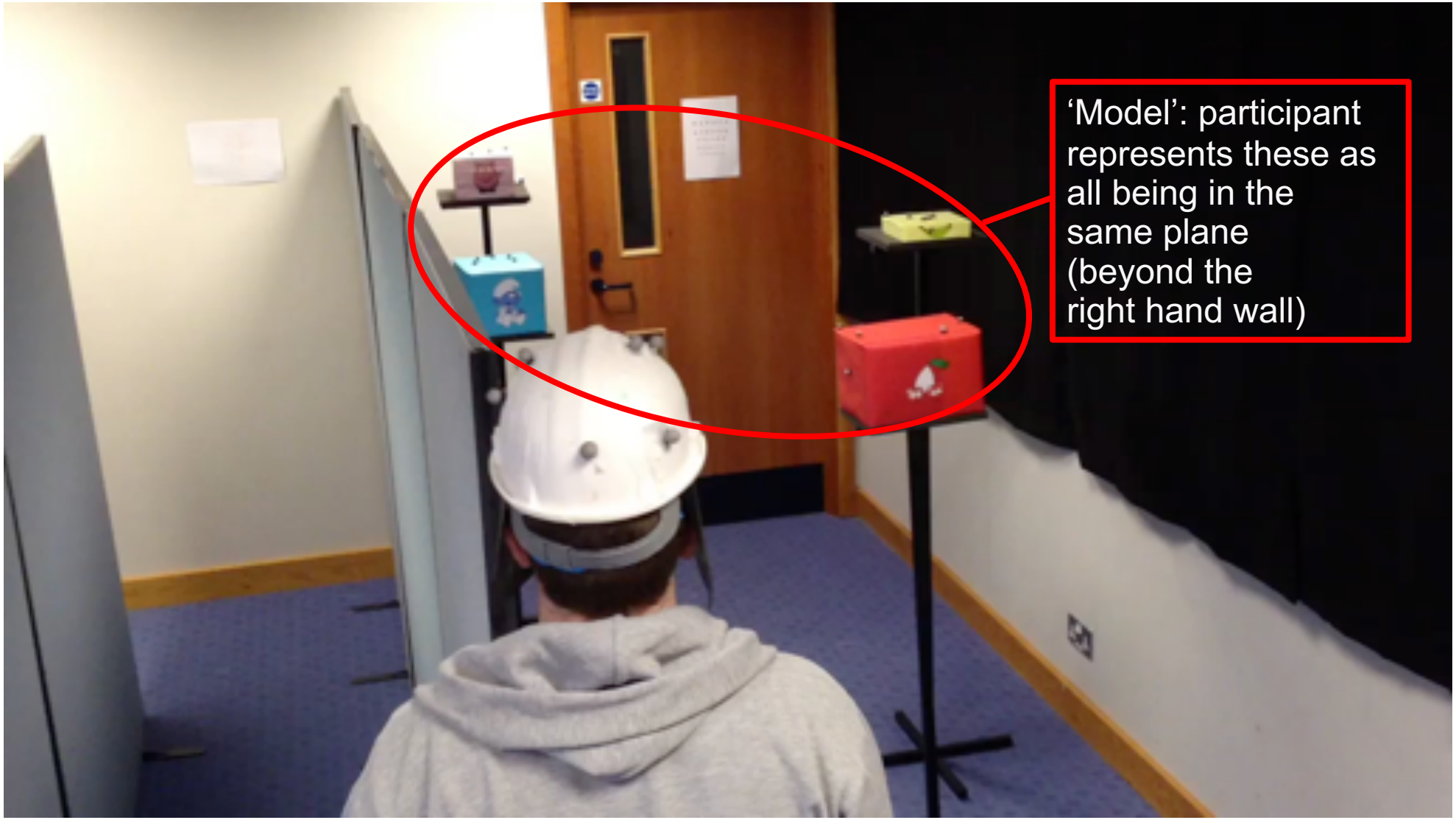

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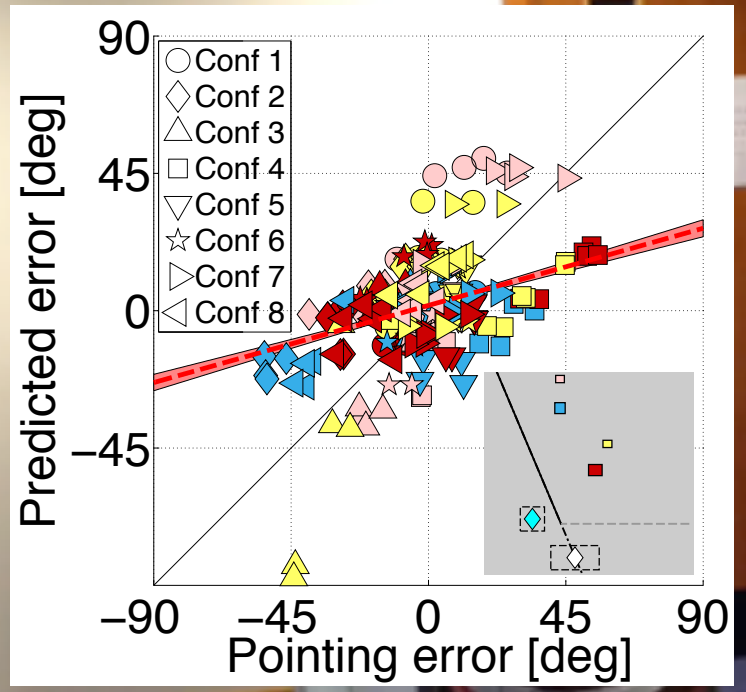
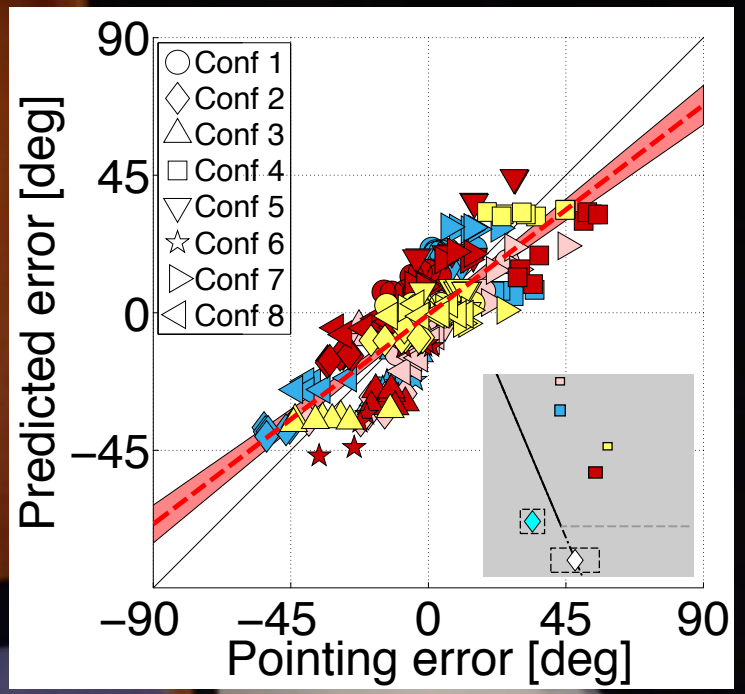


Best possible 3D model



A different model, dependent on the scene at the moment of pointing

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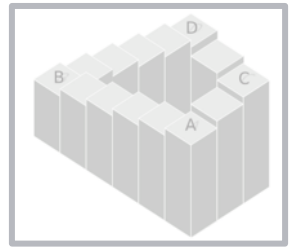

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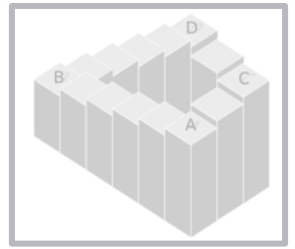

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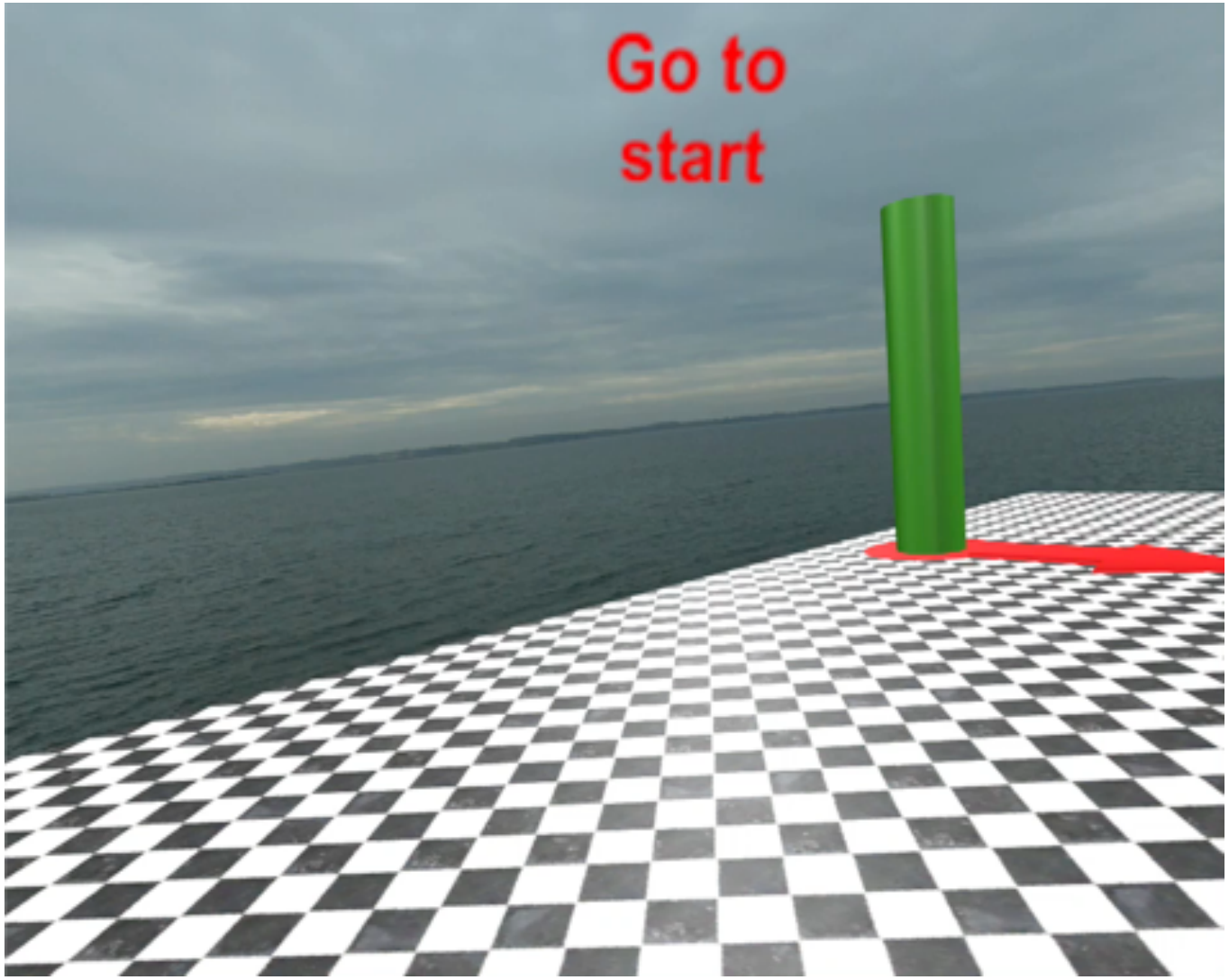

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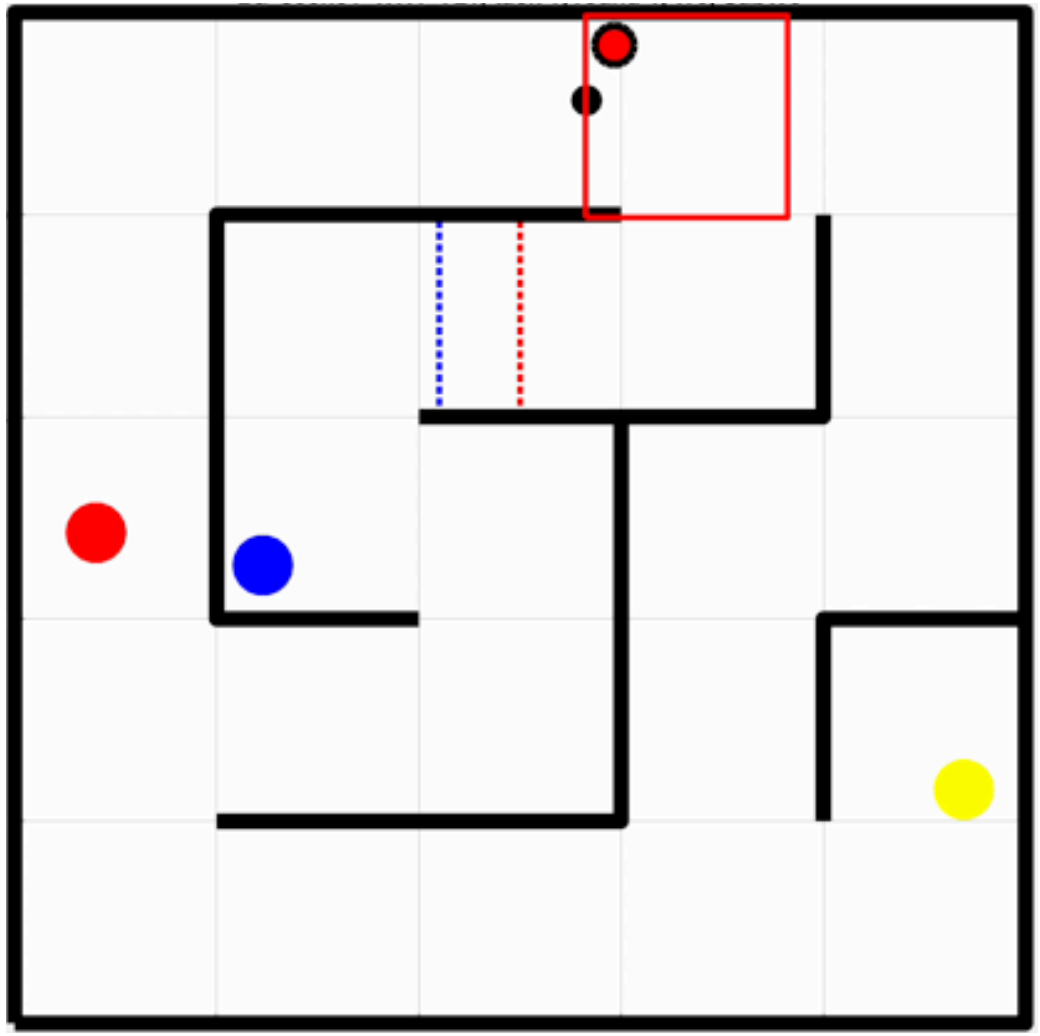

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Psychophysical evidence against 3D reconstruction

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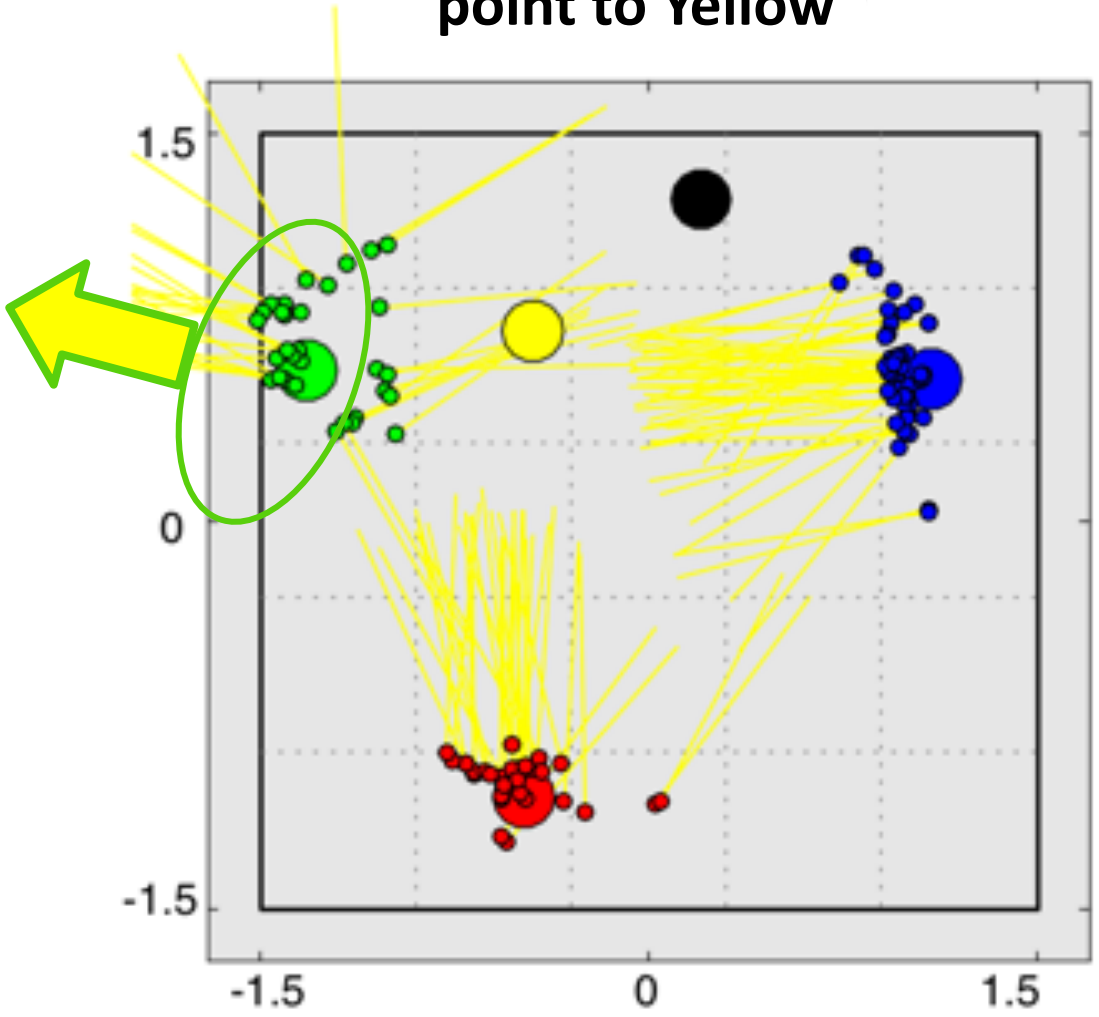
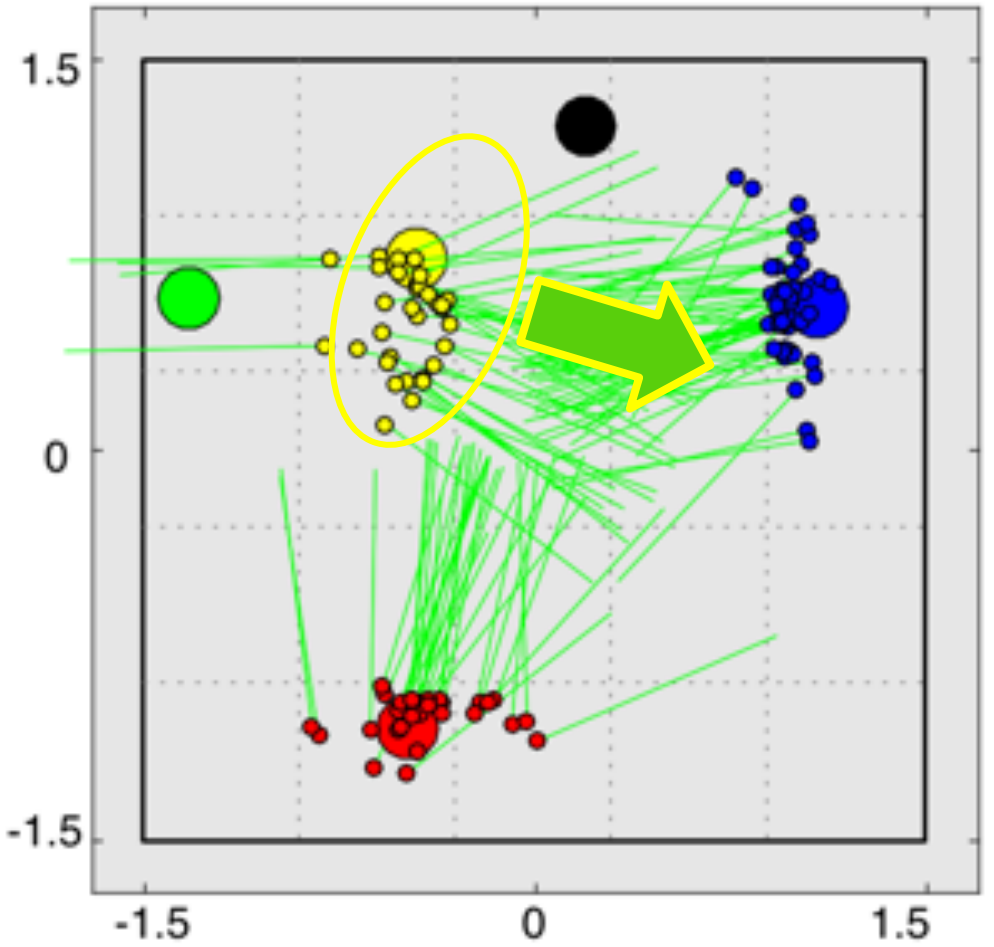
point to Yellow



point to Green



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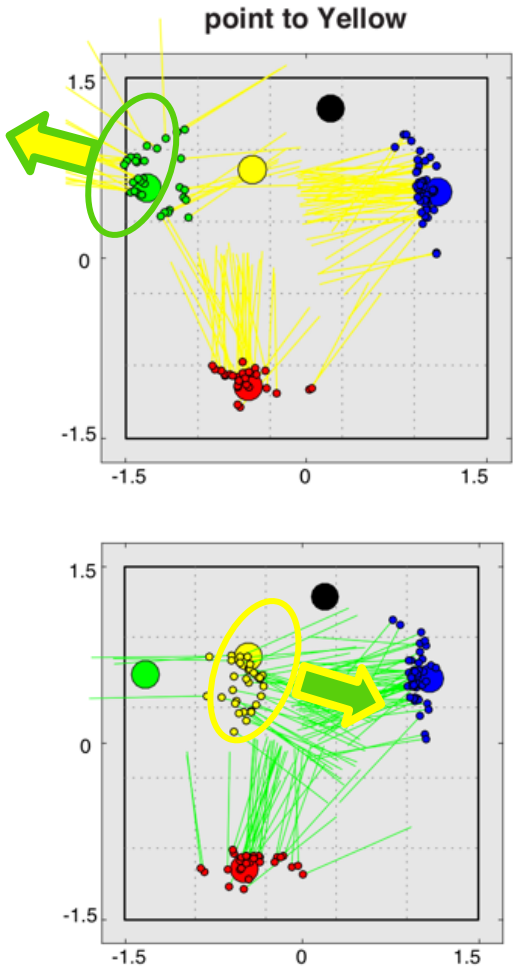

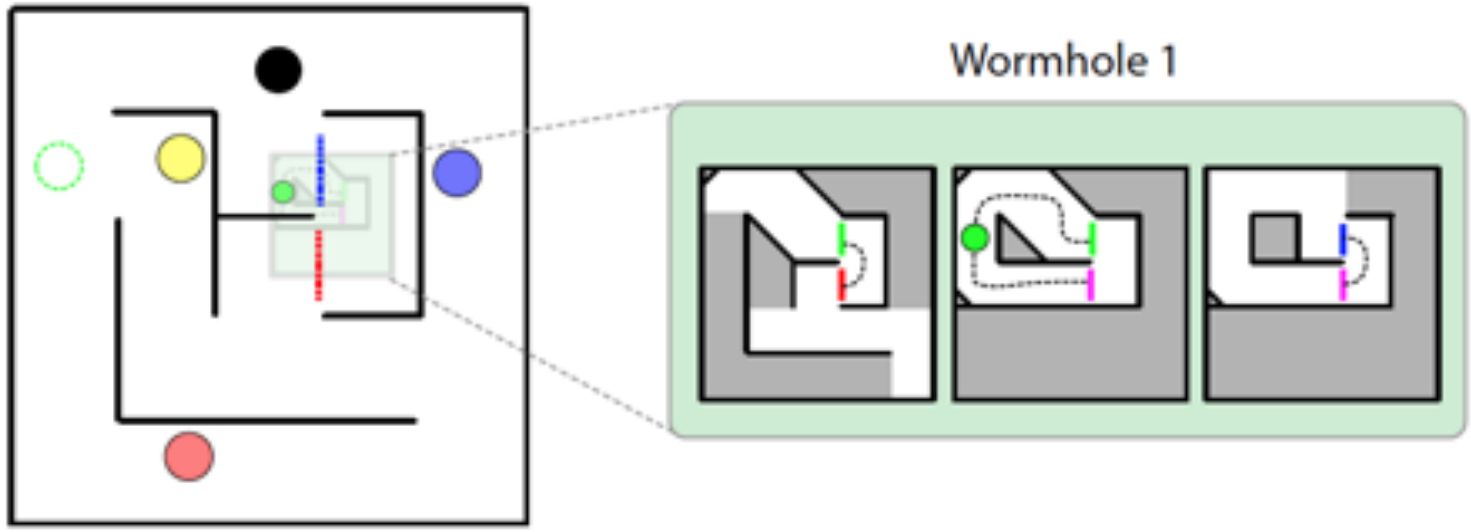

This experiment raises questions about whether constructing a consistent map is something we only do after a lot of experience and consistency-checking

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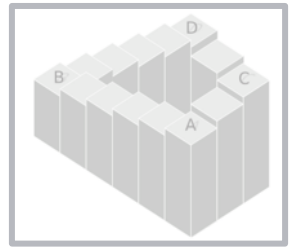

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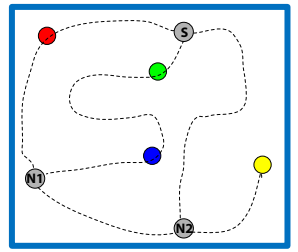

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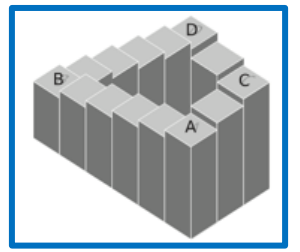

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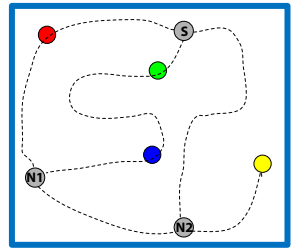

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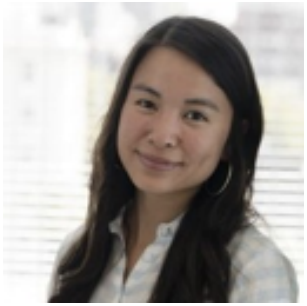

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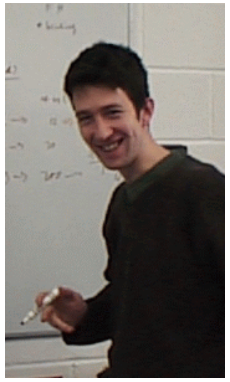

Andrew Fitzgibbon

Peter Scarfe