Presence in Virtual Reality

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Outline

1. Presence, Place Illusion and Plausibility Illusion

2. Embodiment and Cognition

Outline

1. **Presence, Place Illusion and Plausibility Illusion**

2. Embodiment and Cognition

Immersion

- Immersion is *a description of the technology*
  - Inclusive – sensory experience from VE only
  - Extensive – more sensory modalities
  - Surrounding – from all directions
  - Vivid – high fidelity
  - Egocentric – first person point of view
  - Plot – things are happening and the VE responds to the user
  - Proprioceptive match – between sensory data and proprioception

The Pit, a “Presence” response

"Physiological Measures of Presence in Stressful Virtual Environments," Meehan, et al., 2002

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B

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Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments

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In this paper, I address the question as to why participants tend to respond realistically to situations and events portrayed within an immersive virtual reality system. The idea is put forward, based on the experience of a large number of experimental studies, that there are two orthogonal components that contribute to this realistic response. The first is 'being there', often called 'presence', the qualia of having a sensation of being in a real place. We call this place illusion (PI). Second, plausibility illusion (Psi) refers to the illusion that the scenario being depicted is actually occurring. In the case of both PI and Psi the participant knows for sure that they are not 'there' and that the events are not occurring. PI is constrained by the sensorimotor contingencies afforded by the virtual reality system. Psi is determined by the extent to which the system can produce events that directly relate to the participant, the overall credibility of the scenario being depicted in comparison with expectations. We argue that when both PI and Psi occur, participants will respond realistically to the virtual reality.

Keywords: virtual reality; virtual environment; presence; telepresence; plausibility

1. INTRODUCTION

The technology for immersive virtual reality (IVR) has existed for 40 years, initially as a demonstrated laboratory-based idea (the ultimate display) (Sutherland 1965) and for the past 20 years as practical, affordable and useful systems. The vast majority of research and development in this area has been to use it as a way to simulate physical reality. Yet it is a medium that has the potential to go far beyond anything that has been experienced before in terms of transcending the bounds of physical reality, through transforming your sense of place and through non-invasive alterations of the sense of our own body. In other words, virtual reality has rarely been seen as a medium in its own right, as something that can create new forms of experience, but rather as a means of simulating existing experience (Brooks Jr 1999). As has been mentioned before (Pausch *et al.* 1996), it is much like both cinema and television in their early days, which were used essentially as a medium for theatre. Our approach is to treat virtual reality as providing a fundamentally different type of experience, with its own unique conventions and possibilities, a medium in which people respond with their whole bodies, treating what they perceive as real.

This paper presents concepts that may help towards understanding how IVR has the power to transform place and even self-representation. These concepts are immersion, place illusion (PI), plausibility illusion (Psi) and the fusion of these last two in the notion of a virtual body. Throughout this paper I use the notation PI to represent place illusion and Psi to represent plausibility illusion. The reason for this is that we do not want the everyday meaning, for example, of 'plausibility', to intrude but rather only the specific meanings that we give to these concepts.

2. IMMERSION AND SENSORIMOTOR CONTINGENCIES

An ideal IVR system will typically consist of a set of displays (visual, auditory, haptic) and a tracking system. The computer maintains a dynamic database, which is a digital description of an environment, and the displays are continually rendered from this. The visual images displayed will be determined as a function of at least the position and orientation of the human participant's head, enabled through head tracking, and ideally should also include tactile, force-feedback, heat and smell displays so that all of the senses may be catered for. A typical IVR system today delivers stereo vision that is updated as a function of head tracking, possibly directional audio and sometimes some type of limited haptic interface. For example, the Cave (Cruz-Neira *et al.* 1993), is a system where between four and six walls of an approximately 3 m^3 room are back-projected stereo projection screens. The images are determined as a function of head tracking so that, at least with respect to the visual system, participants can physically move through a limited space and orient their head arbitrarily to be able to perceive (but not necessarily from

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One contribution of 17 to a Discussion Meeting Issue 'Computation of emotions in man and machines'.

- Prior to 2009, most work on presence was based on based on subjective ratings of what participants report with a few works on behavioural models
- Mel Slater's seminal paper introduced two new concepts of presence, place illusion and plausibility illusion

PI
Place Illusion

The illusion of being in the rendered virtual place

$\pi + \psi$

Response as if Real
(RAIR)

Psi
Plausibility Illusion

The illusion that what is happening is real

Physiological
Behavioural
Emotional
Cognitive

Examples

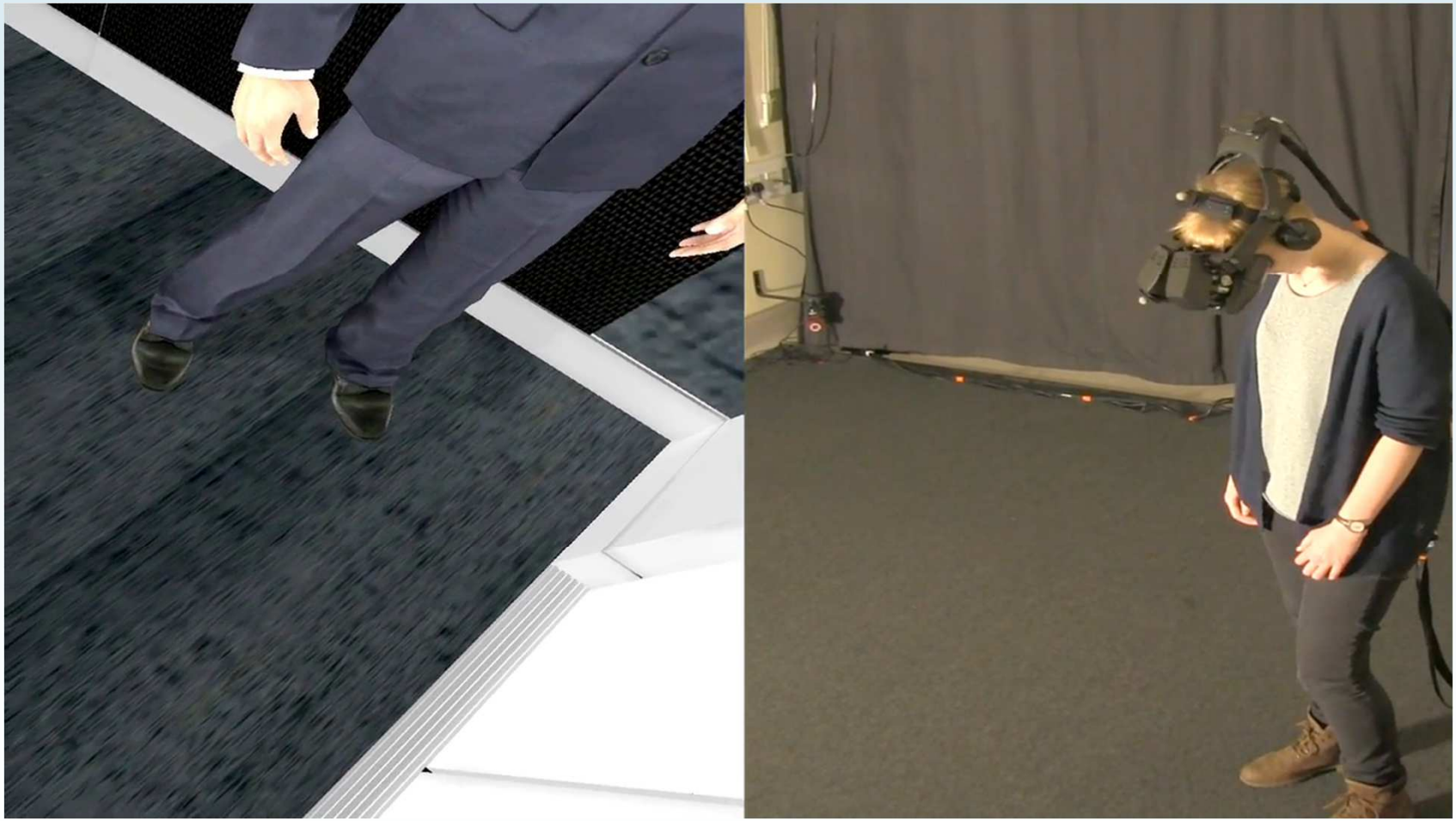
- In the pit experiment, the “place illusion” is itself the main effect
  - *We can argue about whether you have to believe that it is plausible that you be there*

- In other experiences, it is obvious what it is “supposed to be”, but plausibility is more complex
  - *Plausibility is not “realism” as often the simulation is quite crude, never the less reactions are strong*

Virtual reality in the treatment of persecutory delusions: randomised controlled experimental study testing how to reduce delusional conviction

Daniel Freeman, Jonathan Bradley, Angus Antley, Emilie Bourke, Natalie DeWeeve, Nicole Evans, Emma Černis, Bryony Sheaves, Felicity Waite, Graham Dunn, Mel Slater, David M. Clark

The British Journal of Psychiatry, May 2016



Characterisation

- For this to happen, participants must have the illusions:
  - They are in a different place (train ride, elevator, with other people) (Place Illusion, PI)
  - The events are really happening (Plausibility, Psi)
  - In spite of knowing that these are illusions

Characterisation

- PI
  - Perceptual illusion
    - real-world sensorimotor contingencies
- Psi
  - Cognitive illusion
    - events respond to your actions
    - events relate to you personally
    - situation is coherent with expectations (if applicable)

Difficulties

- What does it mean for something to be **plausible**
  - –Depends on knowledge (e.g. knowledge about similar situations)
  - –Depends on story (e.g. what do you know about what you are going to see)

- Easy to see that some things are **implausible**
  - –Cups breaking with the wrong sound
  - –Objects floating
  - –People not interacting with you

- **Opportunities for new research**

Outline

1. Presence, Place Illusion and Plausibility Illusion

2. **Embodiment and Cognition**

Embodiment

- A key part of place and plausibility illusions is whether you see yourself
- We've known this is important since the early 1990s: reactions to the virtual pit seemed to be stronger if you saw a body
- Now based on work in neuroscience on "body ownership illusions" we know that seeing a body in VR activates neural circuits in a similar way to a real body

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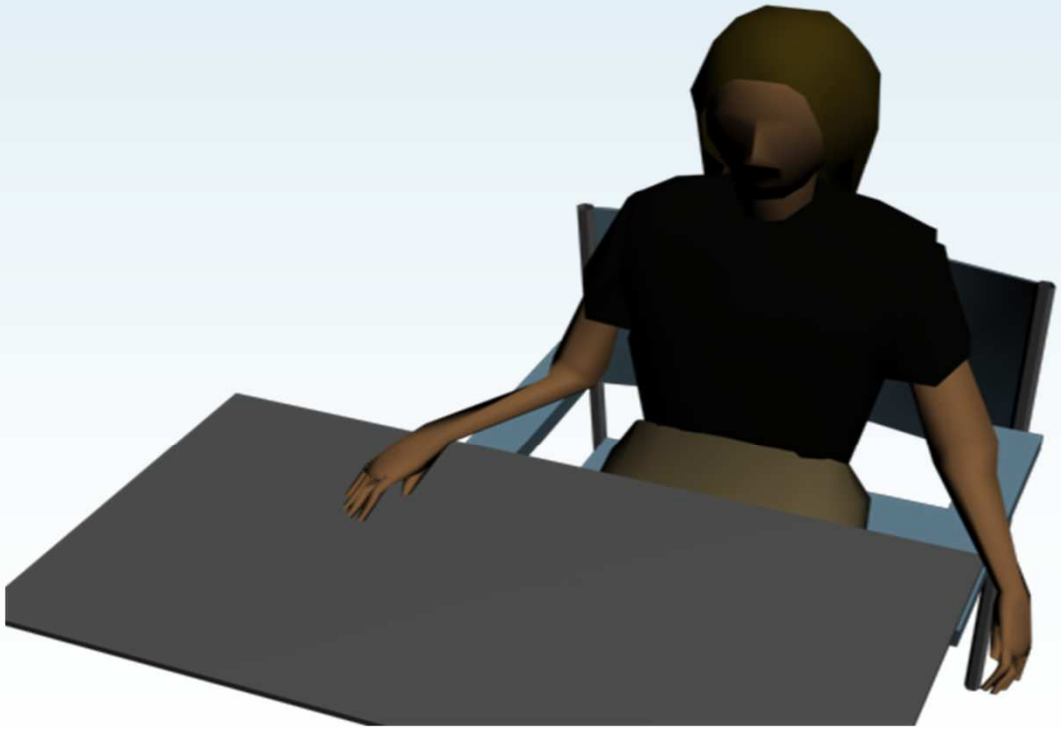

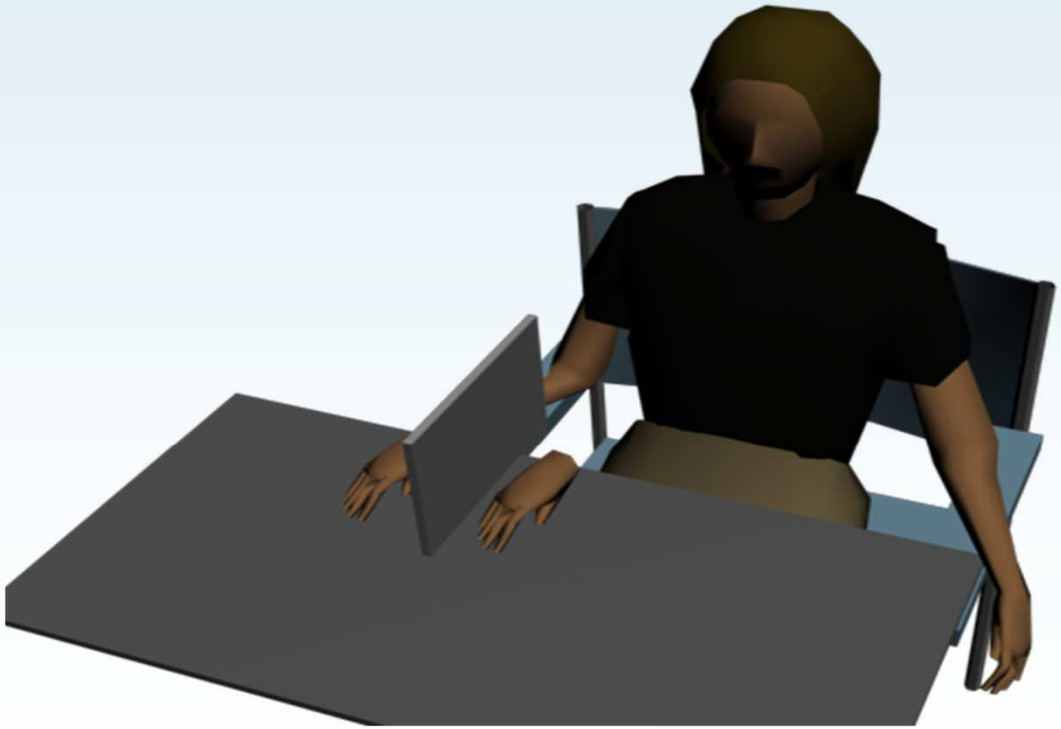

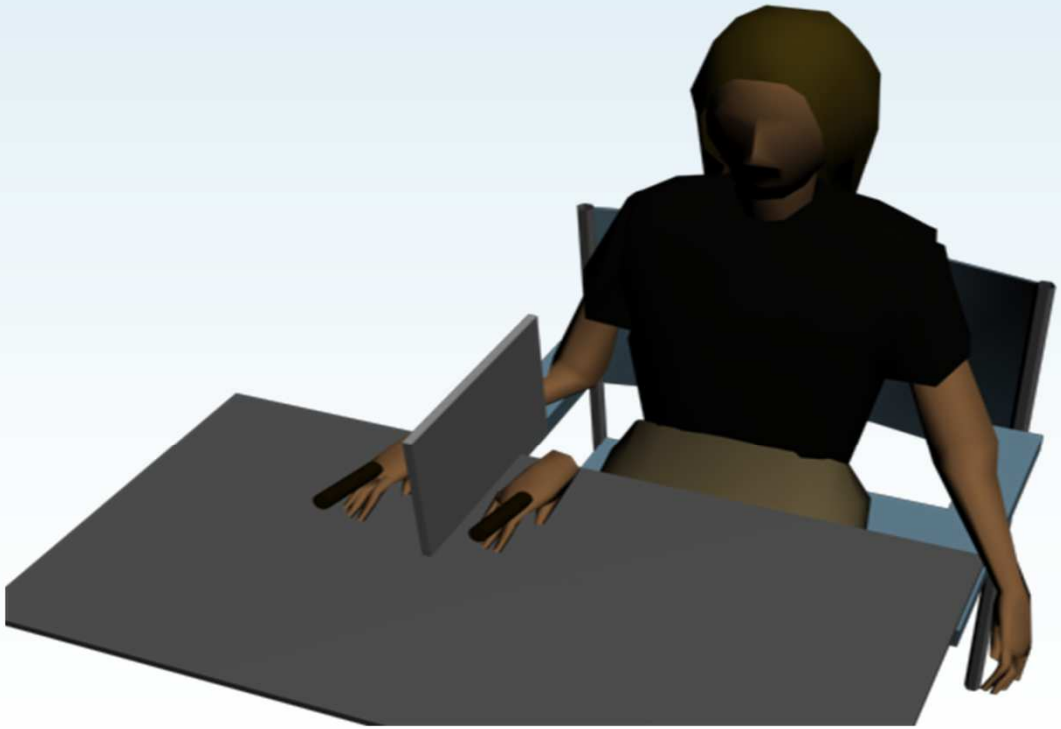

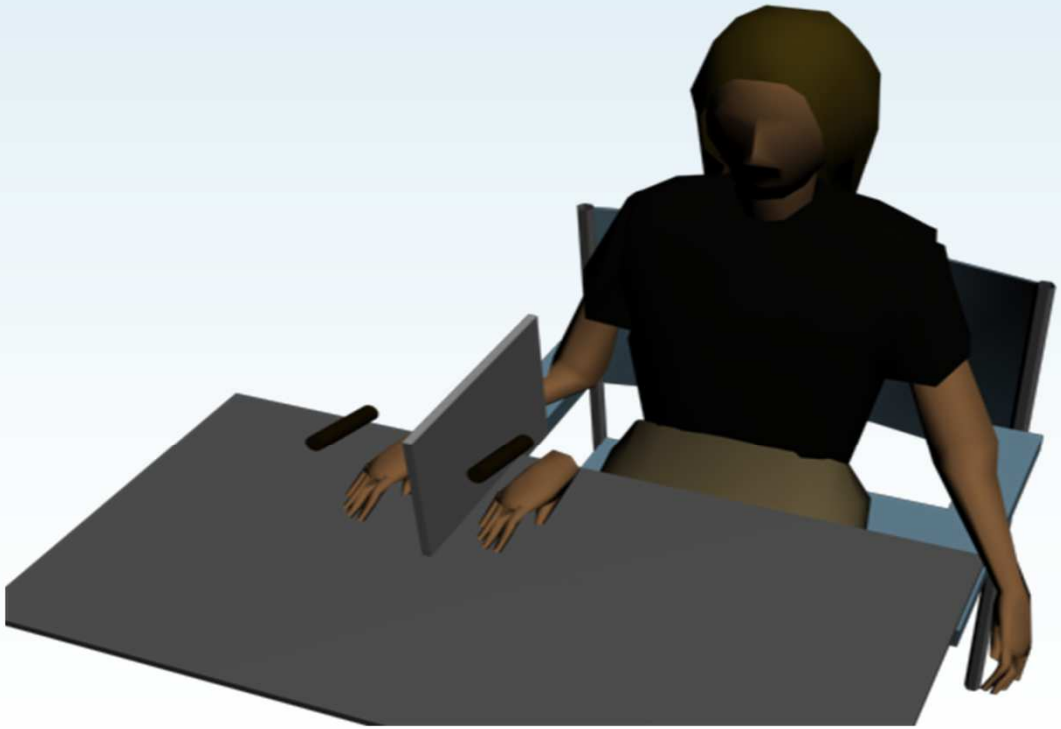

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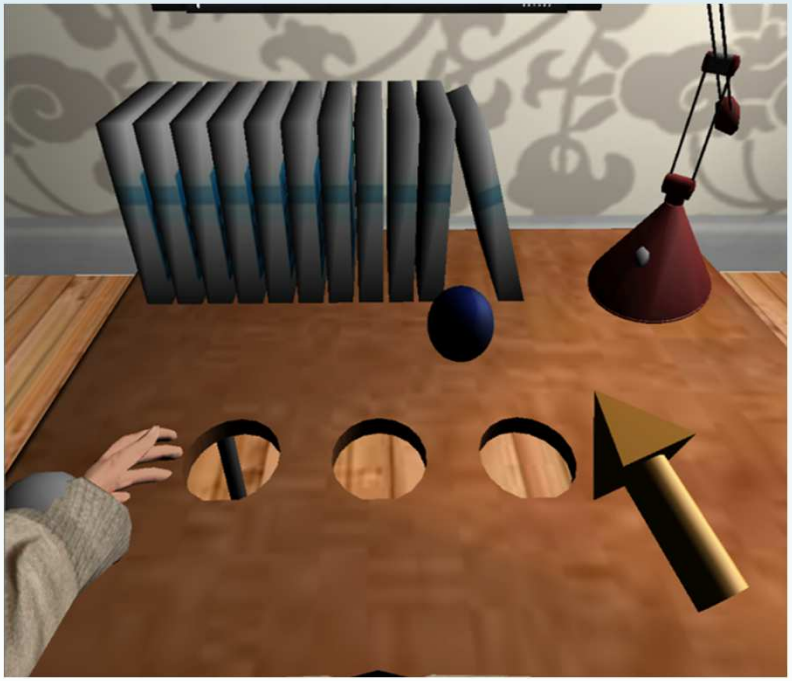
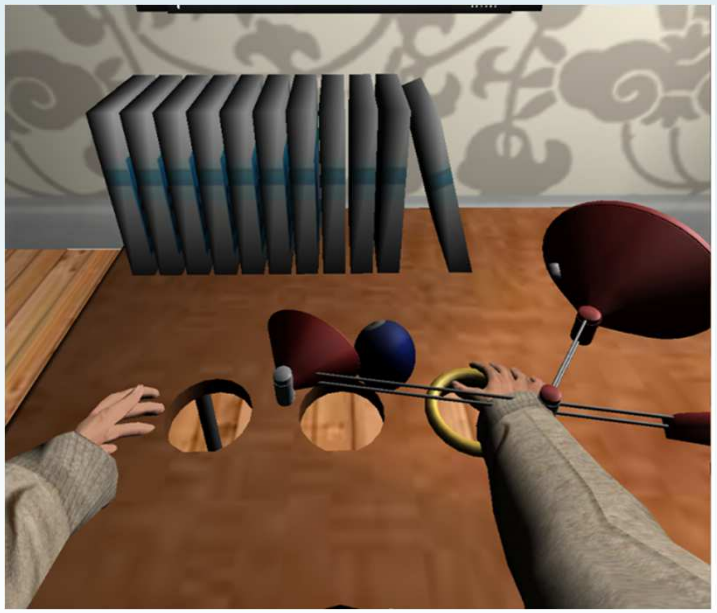
Four Conditions

- Drift or no drift
  - In drift condition, whilst playing Simon game, the hand-tracker offset is slowly increased from 0m to 0.1m (0.56 mm/s)
- Virtual body or arrow



Response to Threat

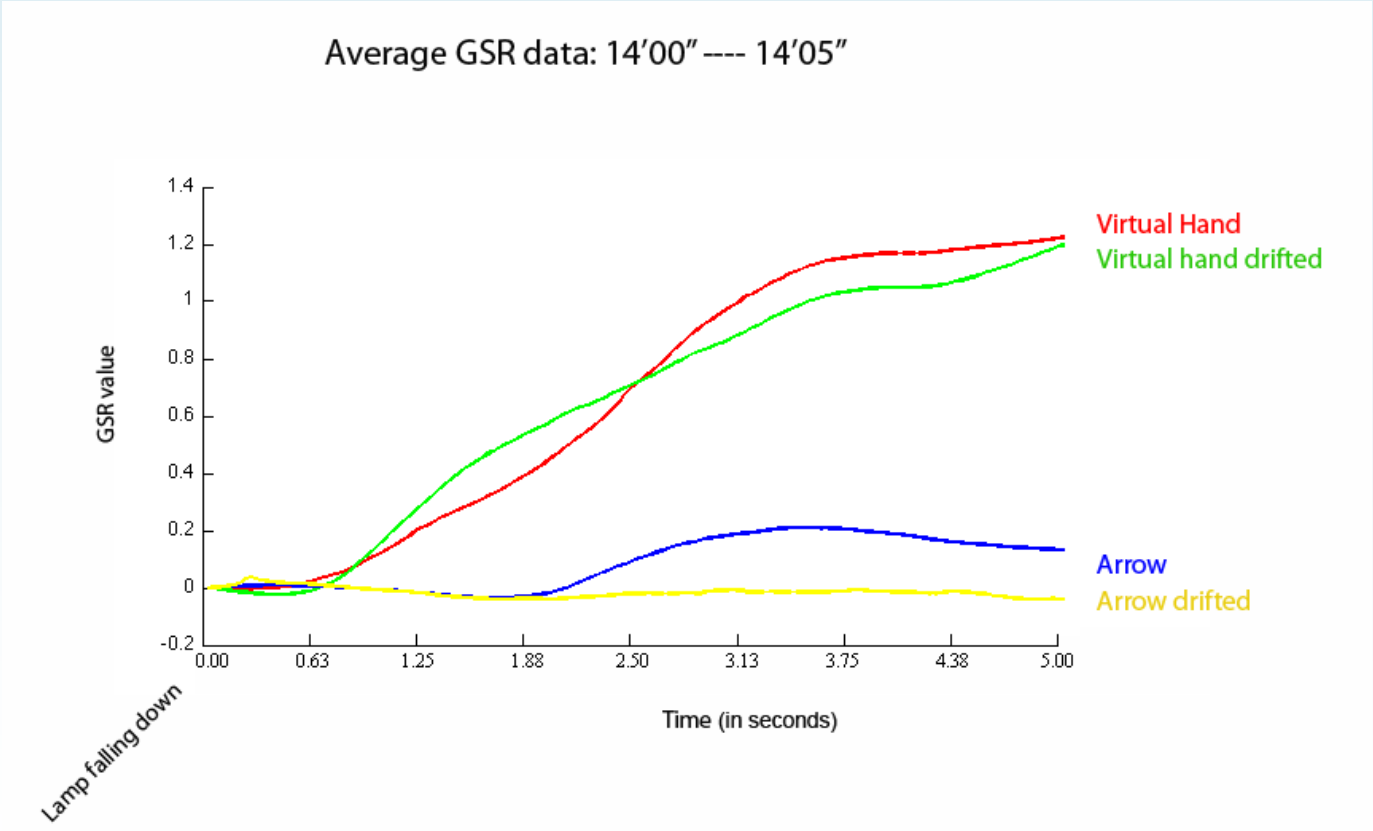
- At a specific time, the lamp falls over
- The ball and hole have been pre-cued so that the hand is in the region where the lamp falls
- Looking for a stress response



Galvanic Skin Response

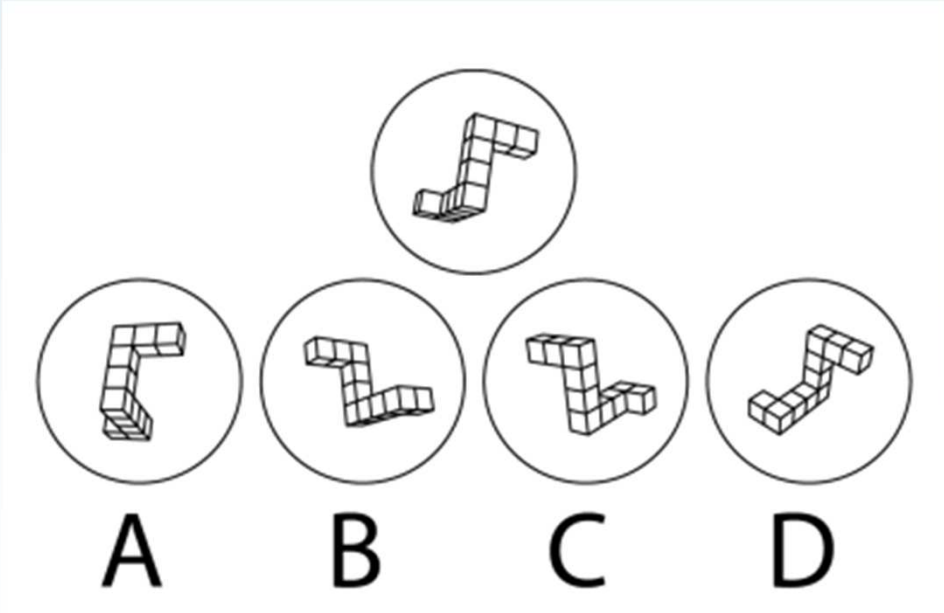
- Use GSR
- Measured by Nexus-4 device & Biotrace software
- Sensor on left (passive) hand

GSR Response to Threat at 14’00’’



GSR measured in micro-siemens

Which two of the lower four figures are rotated versions of the upper?



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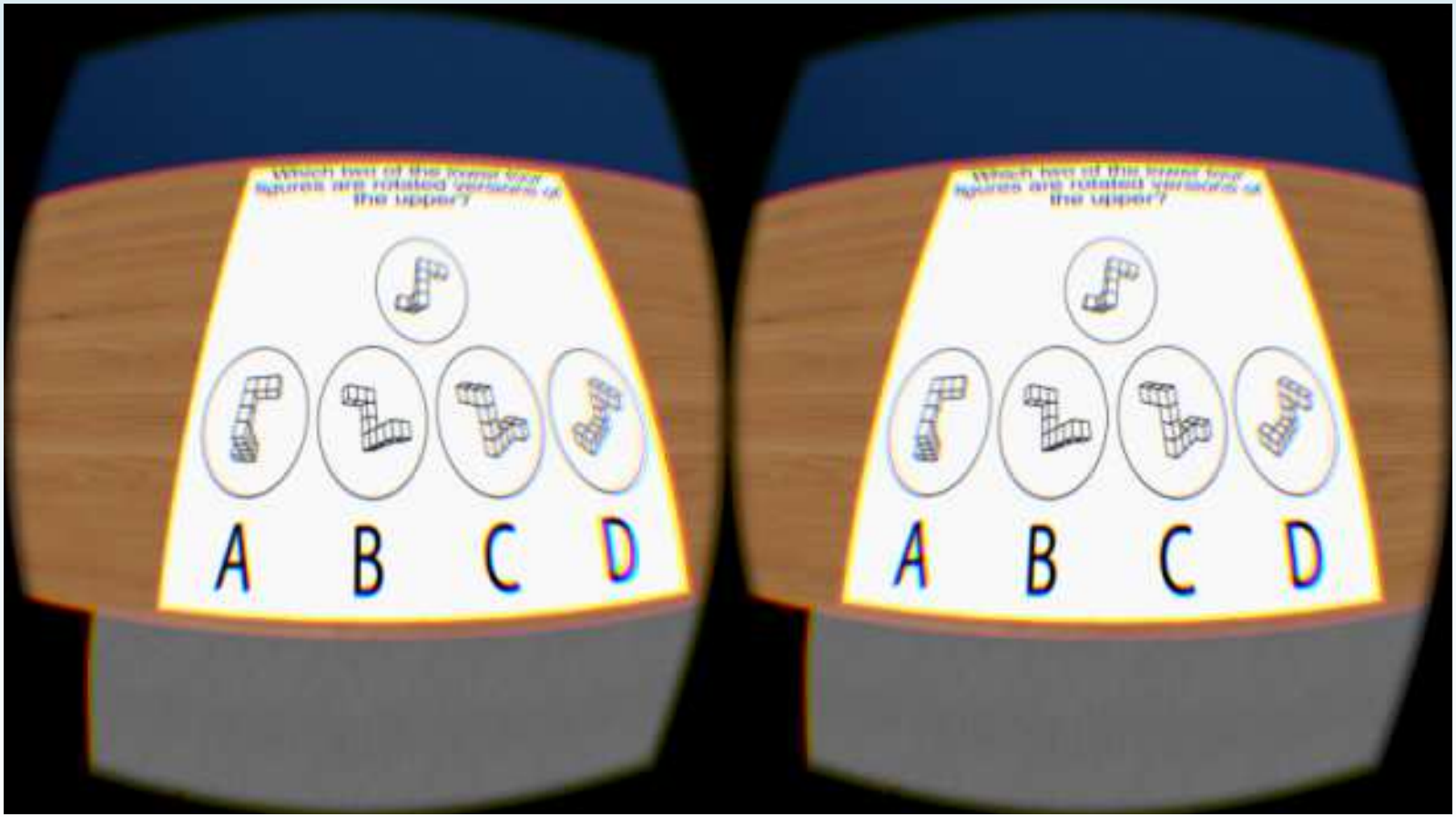
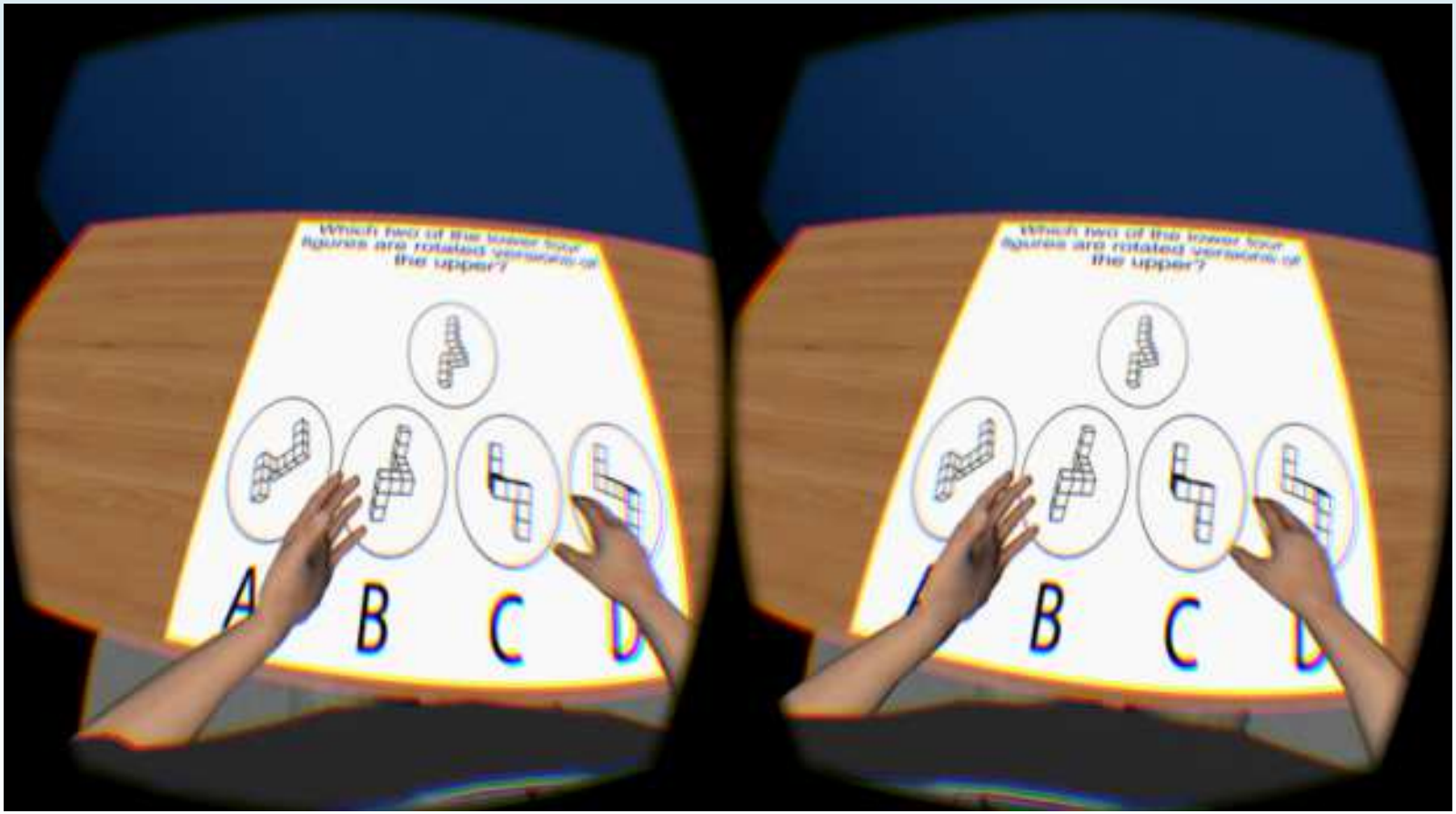
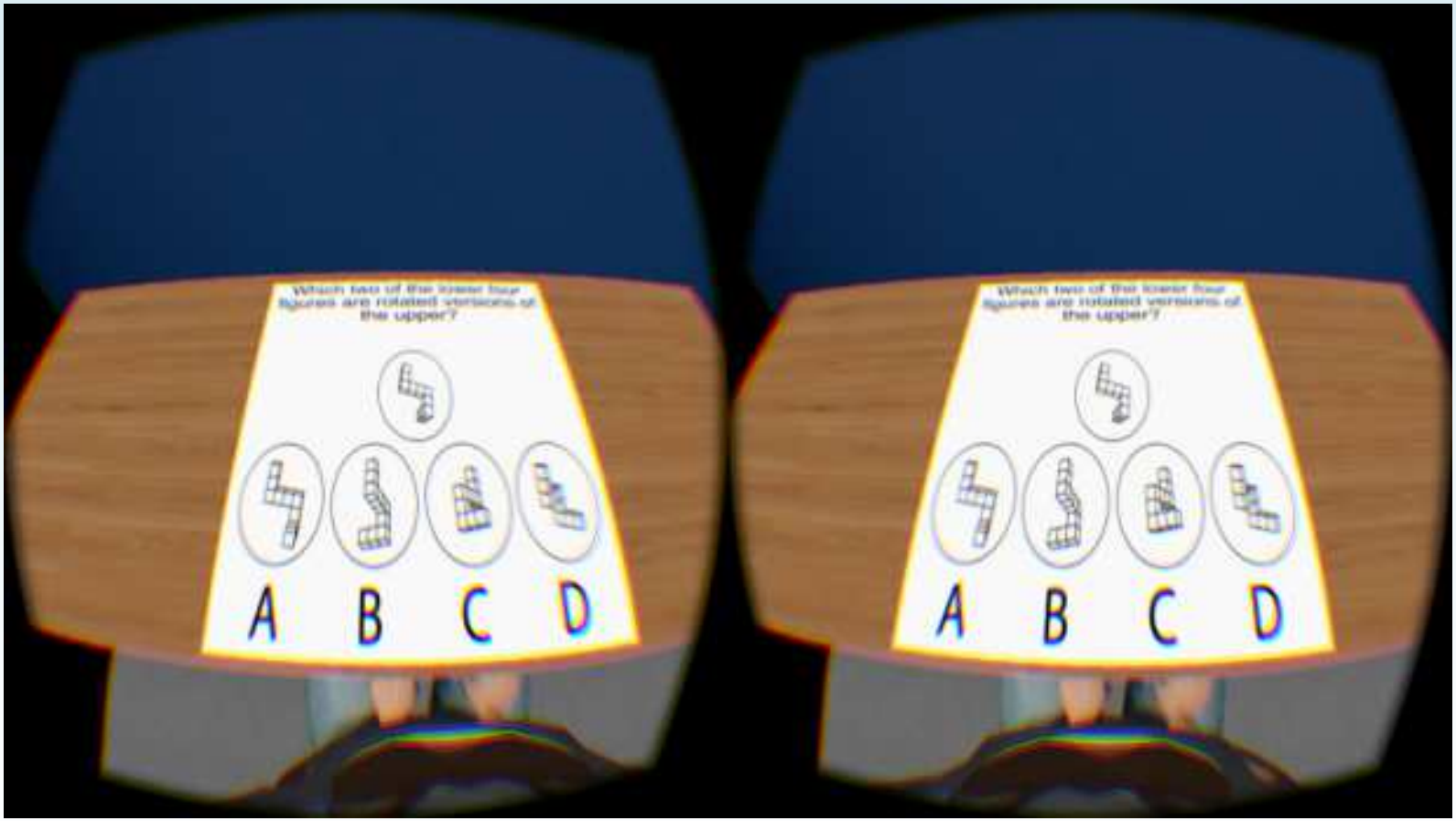


No self-avatar with and without gesture allowed



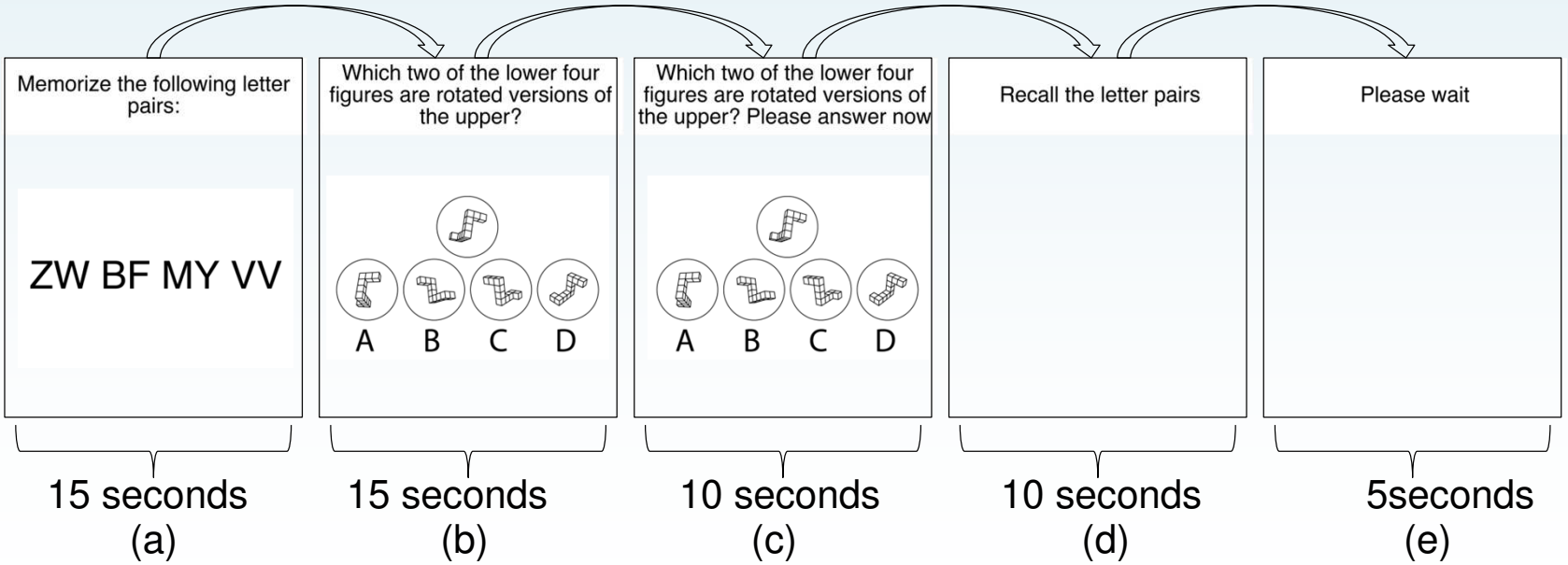
Self-Avatar with gesture allowed



Self-Avatar with gesture not allowed

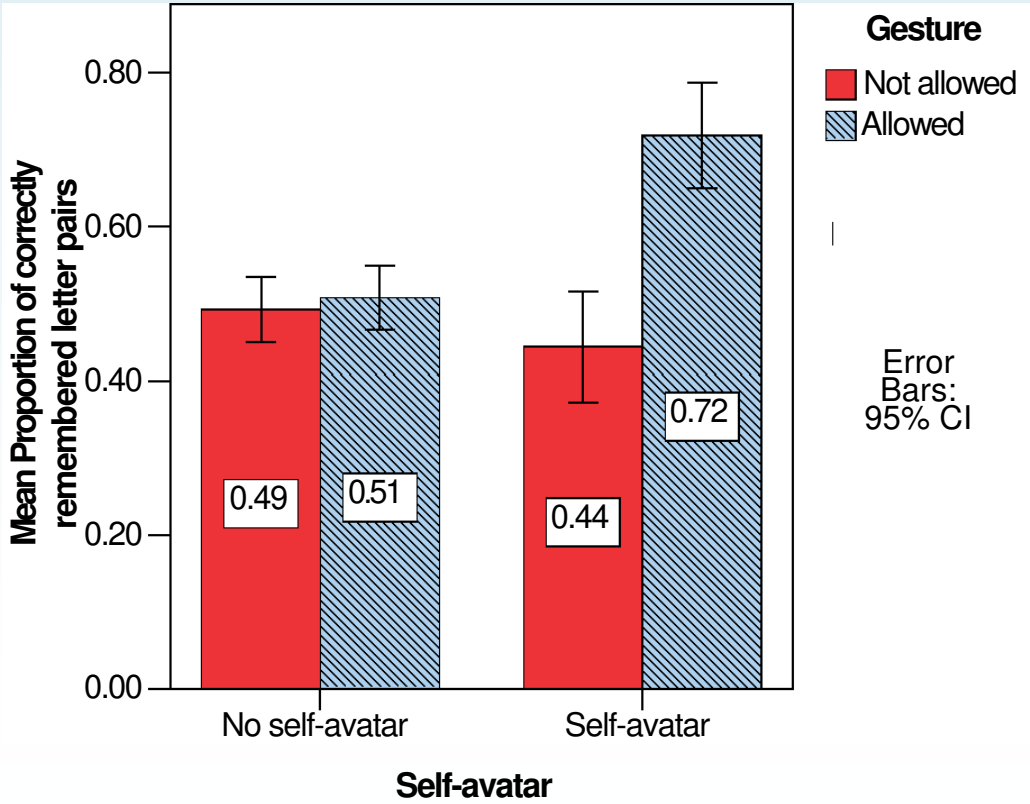
Method

- Procedure
  - Practice (3 trials); Section 1 (10 trials); Section 2 (10 trials)



Result - Letter Recall

- In the self-avatar condition, participants remembered 28% more letter pairs when gesturing than when not gesturing
- In the without a self-avatar condition, the difference between the two gesture conditions was not significant



Implications for Consumer VR

https://owlchemylabs.com/tomatopresence/

Tomato Presence: Virtual Hand Ownership with a Disappearing Hand, Steed & Drga, IEEE VR 2023

Conclusion

- Presence as ‘being there’ (Place Illusion) has huge amount of research, outlines of a theory exists
- Presence is evidenced by “reacting as if real”
- Plausibility is the more difficult problem, with relatively little research
- It is completely plausible that if you see something where you expect to see your hand, it probably is your hand
- People treat a virtual hand “as if real”
- This then leads to improved cognition in a task where people normally use their hands