Virtual Reality for Mental Health

David Roberts

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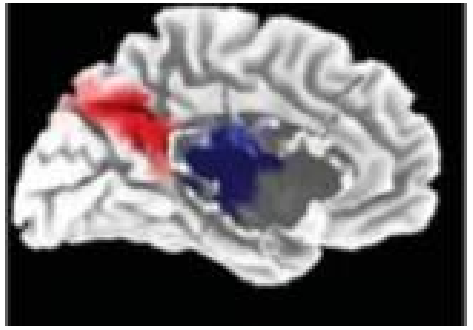
Core Principles of VR

People respond to VR as if it is real

Immersion

Picture credit: HTC

Presence



Picture credit: Baumgartner et al,
in Neural Correlates of spatial Presence

React as if real

Picture credit: Sander et al,
University of Salford

Even when they know its not

Relevance to Mental health

Psychological disorders cause people to respond differently to real world stimuli

A person's individual response to stimuli will likely be similar if that stimuli is real or virtual

Thus VR can evoke responses that are in part due to neurodiversity and are indicative of how that person responds to the real world

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Applications of VR in Mental Health

Anxiety related disorders
- Generalised Anxiety Disorder
- Phobia
- Post Traumatic Stress Disorder (PTSD)
- Eating disorders

Body image

Dementia

Anti-social behaviour

Addiction

Understanding,

Diagnosing,

Demonstrating,

Living with &

Treating a condition

VR Reminiscence therapy

Image credit: carehome.co.uk

Calming people by giving them stimuli that evokes happy memories

Helping people to live with a condition

Virtual Reality Exposure Therapy

Technology intervention

Client immersed in a simulation that includes evocative stimuli

Simulation usually controllable

Picture credit: OxfordVR

Picture credit: David Roberts Shared Realities taken at the Resilience Hub

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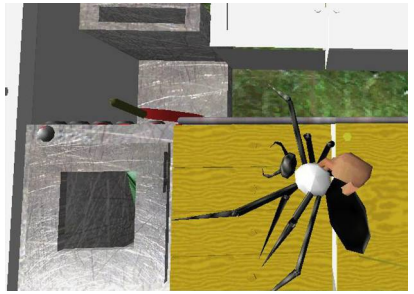
VRET applications

Social

Flying



Spiders

Heights

Shopping

Nudity

- Offers
  - The feeling of being there
  - Controllability – a form of dosage control
  - Repeatability
  - Customization
  - Shared experience (Client and therapist)
  - Potential for abstraction

VRET for PTSD

Image: Bravemind from USC courtesy Albert (Skip) Rizzo

Potential to increase engagement

Military personnel are believed a particularly resistant group to exposure therapy

Drop out rates particularly high

Many veterans may not feel as comfortable engaging in imaginal exposure therapy

Yet most have experienced video war games and a great many play them post duty

Evidence of efficacy of VRET in PTSD

5 meta studies point to efficacy similar to exposure therapy

Largest and most rigorous found that Effect size:

for treatment of PTSD lower than other anxiety related disorders;

& varies greatly across studies

While there has been hundreds of studies their has only been one large rigorous RCT for VRET treatment of PTSD

Neural biases of VRET demonstrated

Key references to evidence VRET

Latest and most compressive meta study

Carl, E., Stein, A. T., Levihn-Coon, A., Pogue, J. R., Rothbaum, B., Emmelkamp, P., . . . Powers, M. B. (2019). Virtual reality exposure therapy for anxiety and related disorders: A meta-analysis of randomized controlled trials. *J Anxiety Disord, 61*, 27-36. doi:10.1016/j.janxdis.2018.08.003

Only large RCT for VRET treatment of PTSD

Reger, G. M., Smolenski, D., Norr, A., Katz, A., Buck, B., & Rothbaum, B. O. (2019). Does virtual reality increase emotional engagement during exposure for PTSD? Subjective distress during prolonged and virtual reality exposure therapy. *Journal of Anxiety Disorders, 61*, 75-81. doi:10.1016/j.janxdis.2018.06.001

Neural Bases of VRET

Landowska, A., Roberts, D., Eachus, P., & Barrett, A. (2018). Within- and Between-Session Prefrontal Cortex Response to Virtual Reality Exposure Therapy for Acrophobia. *Frontiers in Human Neuroscience, 12*(362). doi:10.3389/fnhum.2018.00362

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Benefits and risks of VRET

- Potential Benefits
  - Dose control
  - Engagement
  - Familiar to some populations
  - Feeling of being there
  - Safety of not being there

- Potential Risks
  - Similar to any exposure therapy
    - Chance of retraumatisation
      - Particularly in early sessions
- Isolation from real world and therapist
  - Not yet proven to be problematic

VRET is a powerful tool that should be used with appropriate care

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Engagement in VRET

Traumatised people may find it hard to engage in spoken/imaginal therapy

VRET seems more engaging to some resistant populations

But Traditional VRET replaces rather than complements traditional control of engagement

Image: Bravemind from USC courtesy Albert (Skip) Rizzo

“It puts you back there”
”it makes you sweat”
– testimony from ex military PTSD sufferers

Can VRET help balance enjoyment?

Engagement is needed to open the wound before dressing it

Too much engagement can lead to retraumatisation and dropout

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Client and therapist sharing experience

Our approach allows VRET to complement traditional control of engagement

Roberts, D. J., Barrett, A., & Landowska, A. (2018). Gradual and shared immersion in virtual reality exposure therapy. *Proc Int Conf Virtual Reality, Dissabilities and Associated Tech.*

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Supporting Survivors of the Manchester Arena Bomb

Images by Mixed Realities taken at Resilience Hub

Image by Mixed Realities taken at Resilience Hub

We helped the NHS to use a novel VRET to help survivors who wanted to return to the stadium

Image: Resilience Hub

Novelty of intervention for Arena survivors

- Graduated immersion of interface
  - Keeping people grounded through sight of the clinical setting and therapist
- 360º video
  - Rapid content tailored creation
  - Low cost
  - High realism
- Low cost phone based VR for PTSD treatment

How we helped the NHS

- Worked with the Trust to understand their incentives and concerns about using VR therapy with vulnerable clients
- Suggested the solution of combining 360 video with phone based VR
- Provided a commodity off the shelf solution
- Went with them to the scene of the attack and collaboratively captured relevant footage
- Edited and stitched the videos
- Co-developed a protocol for delivery
- Trained clinicians and their leaders
- Are now helping to validate

Content

- 360 still
  - Empty environment
  - Entrance Foyer
    - Just inside as if entering
    - Or next to where the explosion happened
- 360 video
  - Sparsely populated environment
  - Neutral environment
    - Picnic
  - Entrance Foyer
    - Just inside as if entering
- 180 video
  - walk through
  - Crossing the foyer
  - Approaching the doors that open to the bomb zone
  - Escape Routes

Image: Samsung

Stage 1: Low Immersion

Exploring 3D Video on phone

- Finger used to pan around 3D Video of environment

Both Client and therapist see

- Each other
- The stimuli

Stage 2: Medium Immersion

Magic Window

- Client pans the phone around her to look around the environment
- Aimed at increasing feeling of being there without losing site of the therapist

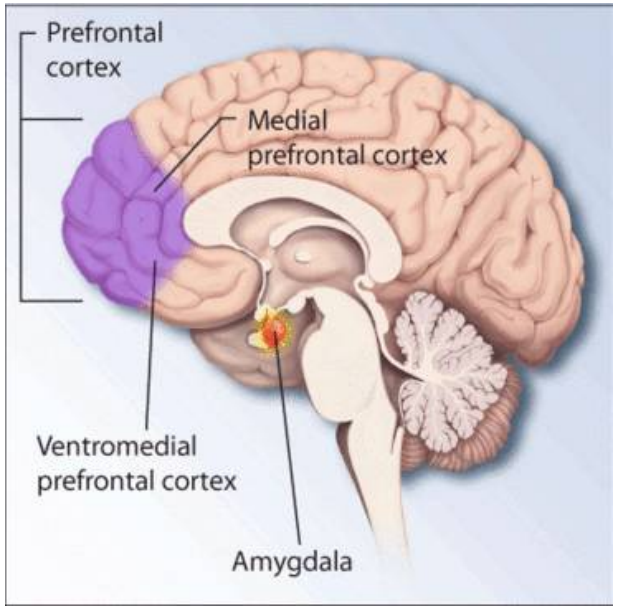
Stage 3: High immersion

- When ready
  - Client puts on Head Mounted Display (HMD)
- Strong feeling of being there
- Putting it together and on them selves
  - Designed to increase feeling of control

Neural Basis for VRET

Fear response happens deep in the brain and thus cant currently be measured without lying in a tube

Picture credit: David Roberts of Shared Realities and University of Salford



Picture credit:
National Institute of Mental Health

However, fear inhibition happens in the Prefrontal Cortex

We can measure this while people are in the kinds of VR that let them move around

Neural Learning During VR Exposure Therapy

Research questions

Does inhibitory learning take place within as well as between Virtual Reality Exposure Therapy?

Can we do VRET without isolating the client from the therapist?

Can fNIRS be combined with immersion projection technology?

Motivation
Understanding, diagnosing and treating anxiety related disorders. It was known that ET “normalises” pFC activation thought associated with inhibitory response. Drury out on whether learning takes place during ET session. pFC to VRET not measured. IR light and motion artefact might complicate things.

Contribution
First within session study of prefrontal response to virtual reality exposure therapy

PhD of Alex Landowska - Supervised by David Roberts and Pete Eachus

Experiments

Studies
"Healthy" subjects
Subjects with acrophobia

Apparatus
Display
Immersive projection technology (OcTAVE)
Stimuli
"Pit Room" from seminal presence experiment
Instruments
fNIRS neural imagining
Heart rate monitor
Video camera
Subjective Units of Distress questionnaire

- **Task**
- Participant gets used to VR in what appears a room in a small house. Walking through a door, they see a gaping hole in the floor looking down to the room below. They are asked to walk around the edge.
- **Design**
- Block: Training room; neutral; Pit room.

Findings

Study 1:

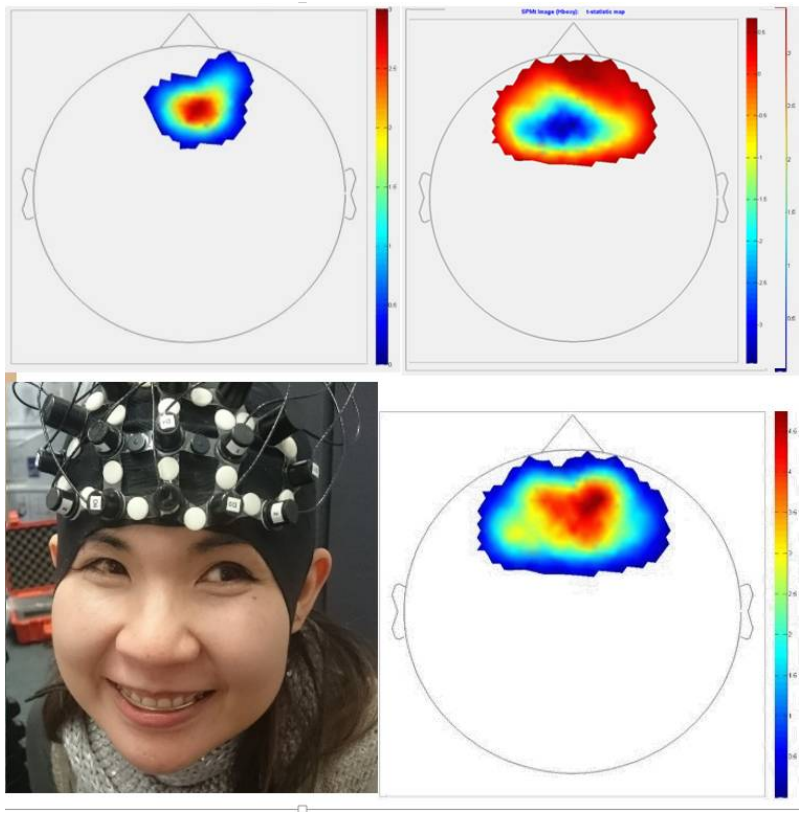
pFC activation indicative of inhibitory response when “healthy” subjects encounter the pit.

Study 2:

Learning during 3rd session

- Increase in pFC response
- Decrease in Subjective Units of Distress
- Behavioural response

One participant got back in touch to say how she could now walk across a bridge near her house



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Virtual Humans in neuroscience & therapy

Research question:
Can a virtual human evoke prefrontal cortex activity indicative of inhibitory response?

Secondary research question:
What kind of VR display is best for combining with wearable neural imaging for measuring response to conversational interactions with virtual humans

Image: the Brexit experiment. Godson, Roberts and Eachus.

PhD by Godson Ahamba

Supervised by David Roberts and Pete Eachus

Study 1 – Headset: Method

- ***Hypothesis***
- The annoying avatar will:
- H1 – be disliked (Godspeed questionnaire);
- H2 – evoke dorsolateral pFC activation;
- H3 – evoke medial pFC activation. and
- H4 – Prior experience of games/VR will impact.
-

Participants

- N = 20 Neurotypical
- 2 groups: those with or without either gaming or VR experience

Variables

Dependent

Perceived likeability of virtual human; Activation of pFC

Independent

Friendliness of virtual human; Experience games/VR

Design

2x2 counterbalanced repeated measure

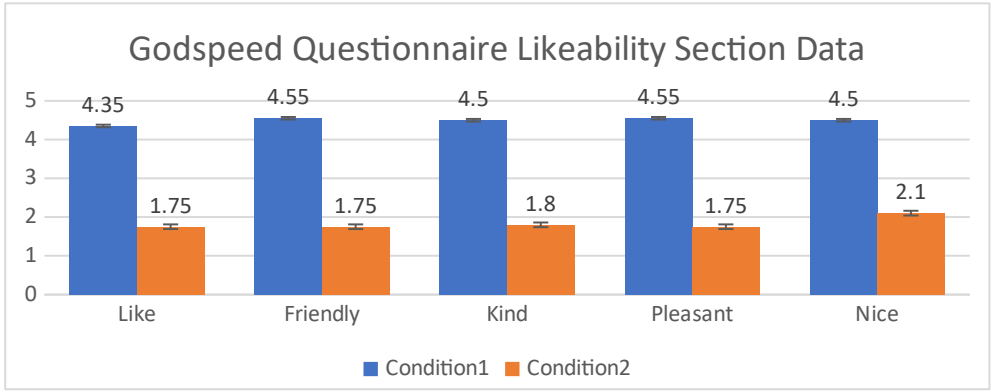
Materials

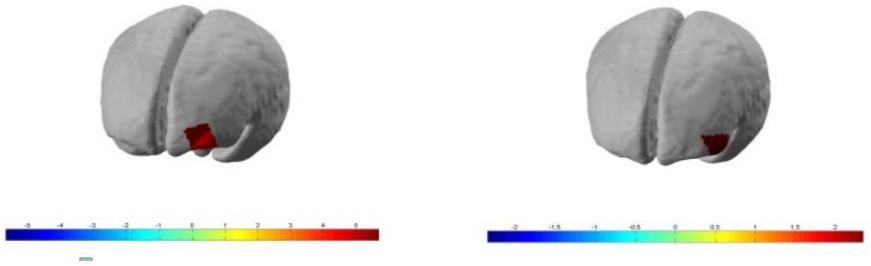
Oculus rift headset modified to fit fnirs sensors

Instruments: fnirs & Godspeed questionnaire

Study 1 – Headset: Findings

- Significant data loss from participants fiddling with headset as it pressed on sensors
- SPM Level 2 analysis across friendliness of virtual human & prior experience:
- Gamers or VR
  - higher activation in mpfc
- Non-gamers and no VR
  - higher activation in dlpfc





Study 2 - Large screen

Method

As previous experiment apart from:

Design

Within subject

Participants

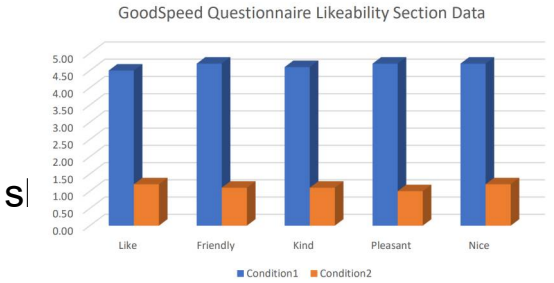
N=10, (4F, 6M), 19-25 y/o, 6 with prior experience of games or VR.

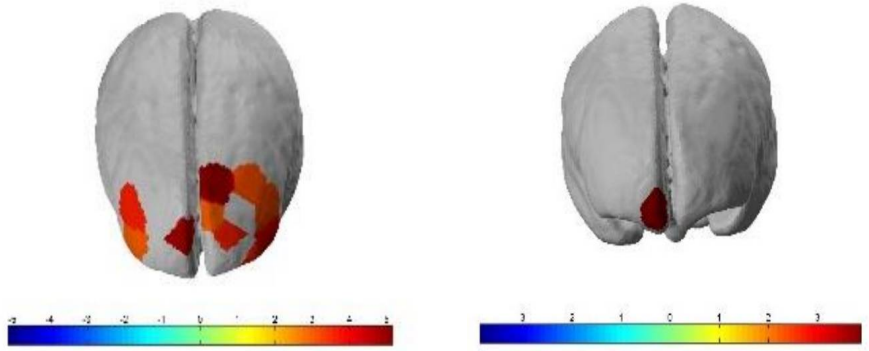
Materials

VR headset replaced by large (50”) display monitor

- **Findings**
- Very similar to previous study but much less data loss

MANOVA s
studies





With (left) & without (right) VR or gaming experience

Study 3 - Surround Projection

Method

As previous experiment apart from:

Variables

Independent variables

Friendliness of virtual human (No grouping of participants)

Design

Counterbalanced within subject

Participants

N=14, (9F, 5M), 18-31 y/o

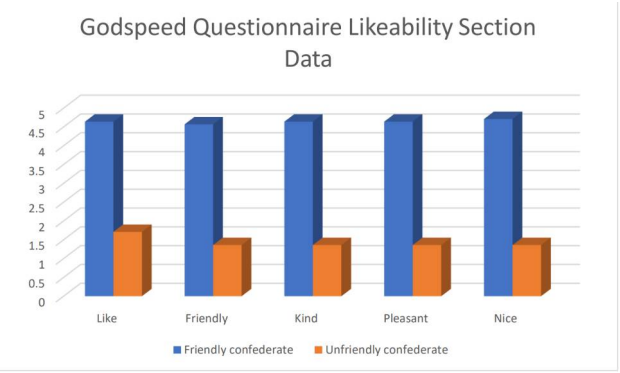
Materials

Display -projection onto surrounding walls and floor of a small room.

Analysis

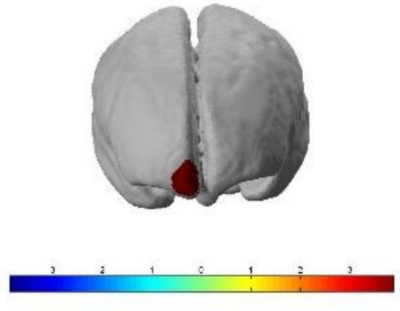
Better band filter

Findings



Increase in DLPFC when the virtual human was unfriendly

Low data loss.



Tele-Therapy

Using our 3D video based telepresence system to demonstrate a possible future of teletherapy

Roberts, D., Fairchild, A., Campion, S., García, A., & Wolff, R. (2016). *Bringing the client and therapist together in virtual reality telepresence exposure therapy*. Paper presented at the Int Conf VR Dissabilaties & Assct Tech., LA.

Picture credit: David Roberts of Shared Realities and University of Salford

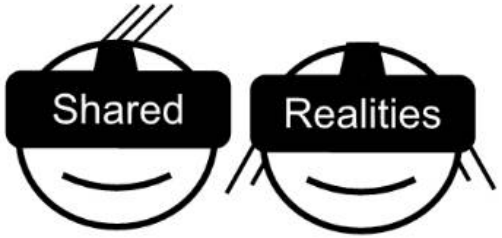
David Roberts – David@sharedrealities.com

Shared Mixed Reality for clinic and home

Image: Shared AR exposure therapy demo. Ian Drum and Alexandra Landowska, University of Salford

David Roberts – David@sharedrealities.com

Manipulating Perception via Self Avatar



- One's own avatar is known as a self avatar
- In immersive VR is seen from first person perspective
- A self avatar looking or behaving different to its owner can alter how they perceive themselves and others

A sense of **Embodiment**
is that of having a body
and consists of the senses of

Ownership
feeling that a body is yours

Agency
feeling of control over it

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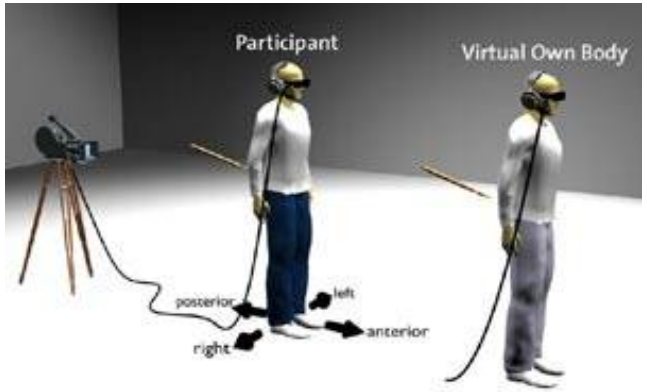
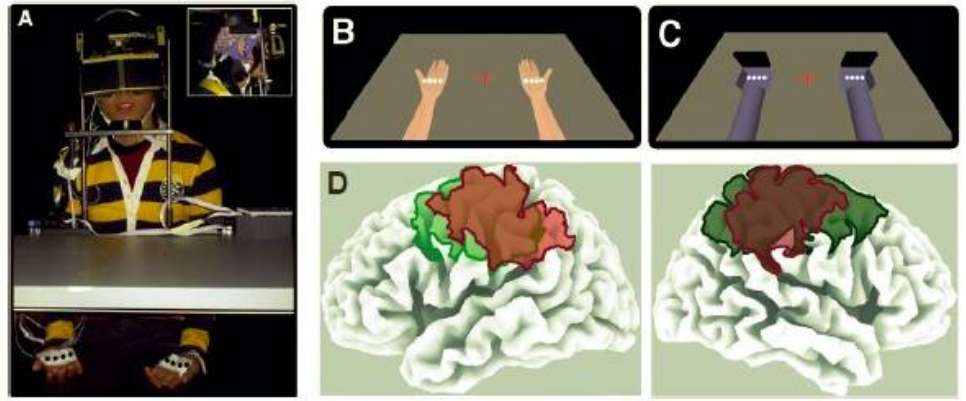
Early studies



Lenggenhager - People think they stood where their avatar stood

Slater -Black avatar reduces racial bias



A. Experimental setup for inducing illusory hand ownership in an automated, computer-controlled manner using virtual reality while recording 64-channel EEG. B. Participants saw either stereoscopic virtual arms or C, virtual non-body objects. D. Anatomical overlap of fronto-parietal activation during illusion condition (red) and motor imagery (green).

Blank – shows activation relative to anthropomorphism in rubber hand experiment

David Roberts – David@sharedrealities.com

Conversations with Self and Sigmund Freud

Where VRT makes use of self and other avatars

Participant sees themself talking about their problems and then as a therapist trying to help

Independent variable: Therapists has appearance of self or Sigmund Freud

Finding: Discussing your problems with yourself can be therapeutic but is it more therapeutic if you look and sound like Sigmund Freud when you answer?

Osimo, S. A., Pizarro, R., Spanlang, B., & Slater, M. (2015). Conversations between self and self as Sigmund Freud - A virtual body ownership paradigm for self counselling. *Scientific Reports*, *5*.

https://www.youtube.com/watch?v=JX0Rk2BlqKw

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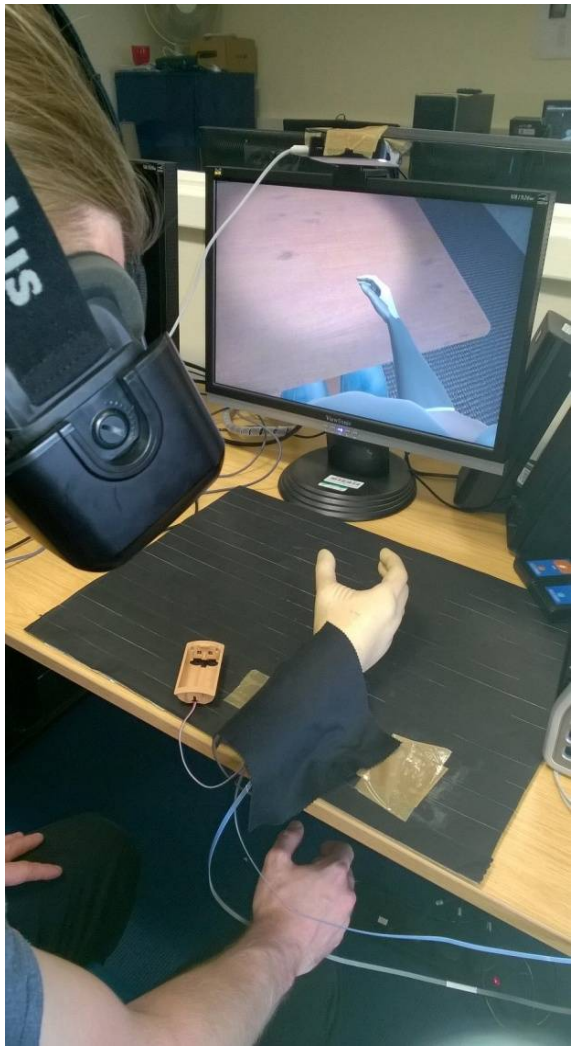
VR for understanding prosthesis acceptance

Research Question
What factors influence acceptance of prosthesis?
and Can VR help us understand this and specifically what are the roles embodiment and agency?

Motivation
Individual differences in acceptance of prosthesis. Appearance, functionality/controllability, ownership and agency thought to be relevant.
VR used in embodiment experiments and offers manipulation of appearance and behaviour, and eases recruitment by allowing subjects to appear to have a prosthesis in place of a limb.

Studies
Qualitative – Online questionnaire, not reported here.
Quantitative - VR experiment, reported here.



PhD of Andrew Hodrien
Supervised by Adam Galpin, Los Kenny and David Roberts

Method

- ***Hypothesis***
- Ownership, agency, overall embodiment, SCR to a threat would be lower for EMG control than anatomical hand control of the virtual prosthesis.

- ***Participants***
  N = 32 (17M + 15F)
  "healthy" – intact limbs
- Mean age 32. 3
- left-handed
- 12 experienced VR and 2 experienced controlling myoelectric prosthesis.

Design
Repeated measures

Variables
Dependent
Embodiment, ownership and agency*; &* SCR

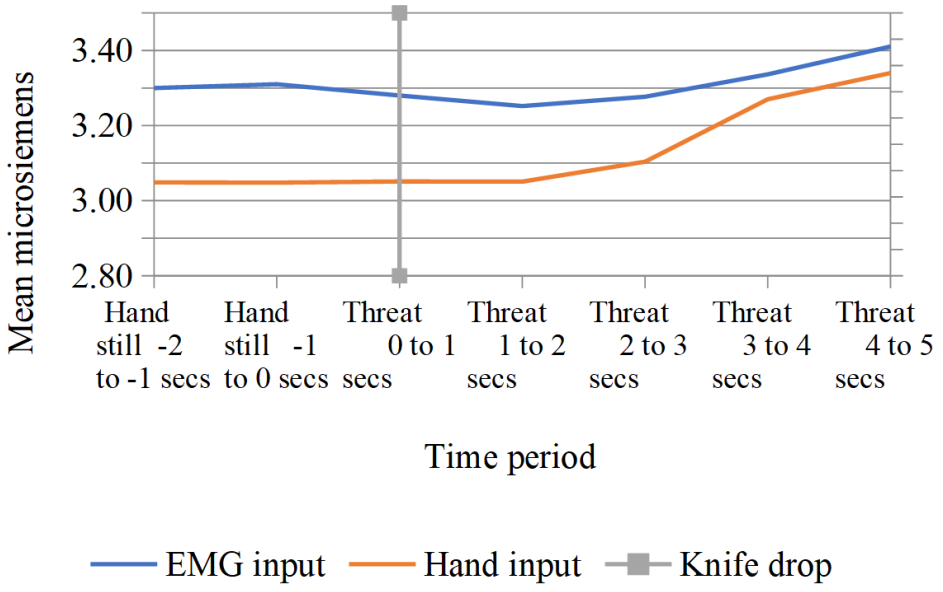
Independent
Control of virtual prosthesis (via tracking of): Myoelectric prosthesis; or real hand.

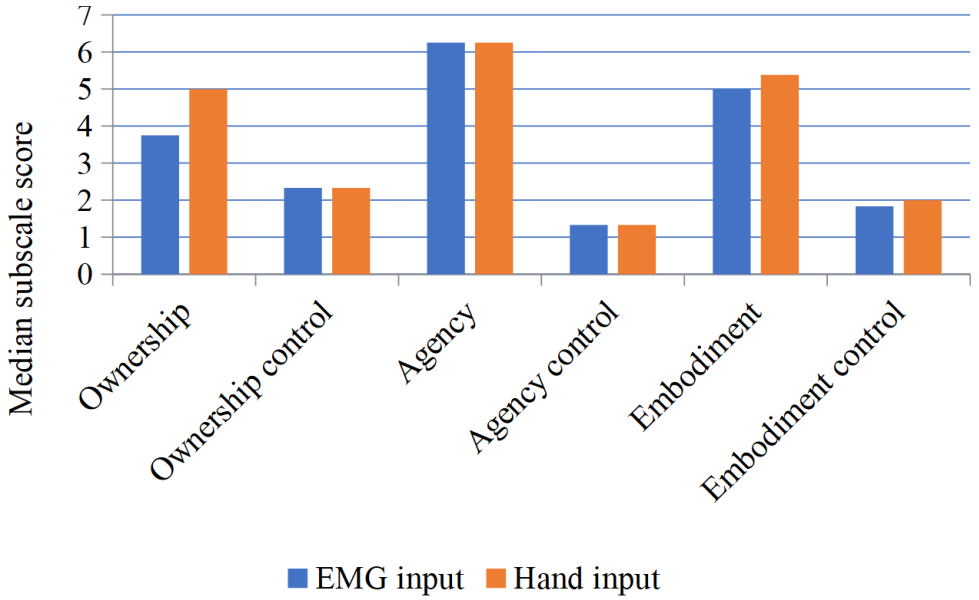
Materials
Myoelectric prosthesis (controlled by EMG sensors arm), passive finger tracker, VR headset &unity simulation
*Instruments - O*wnership and agency questionnaire adapted from Kalckert and Ehrsson (2012), including separate scores for ownership, agency, and embodiment; and SCR

Findings

Ownership was perceived and SCR sensitive to threat, across conditions

Ownership but neither agency or embodiment diminished by EMG prosthesis control.





Thank you

Picture credit: NBC News

The paradox of blurring boundaries of reality in people whose condition already blurs them

Don’t let vulnerable people feel alone in something that they may falsely believe is real