



Virtual Rehabilitation:

Virtual reality and interactive digital game technology as a clinical tool

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What is Virtual Reality?



VR and rehabilitation



Challenges and opportunities

”Don’t sit too close to the tv!”



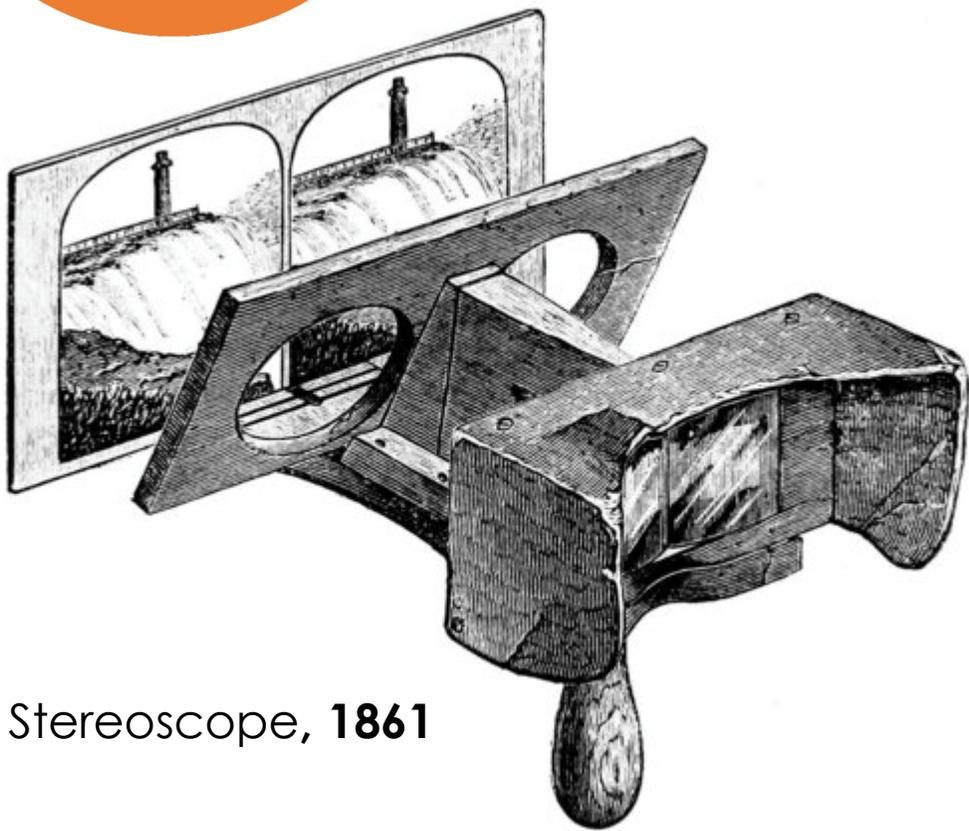
Now...



What
is VR?



A new
Idea?



Stereoscope, 1861

Around the world in 60 minutes



Laughable, interesting and exciting scenes from every land—A set of views of absorbing interest and a beautiful aluminum, Crystal lens stereoscope for **ALMOST NOTHING**

Hundreds of people are daily taking advantage of our very liberal and decidedly interesting offer.

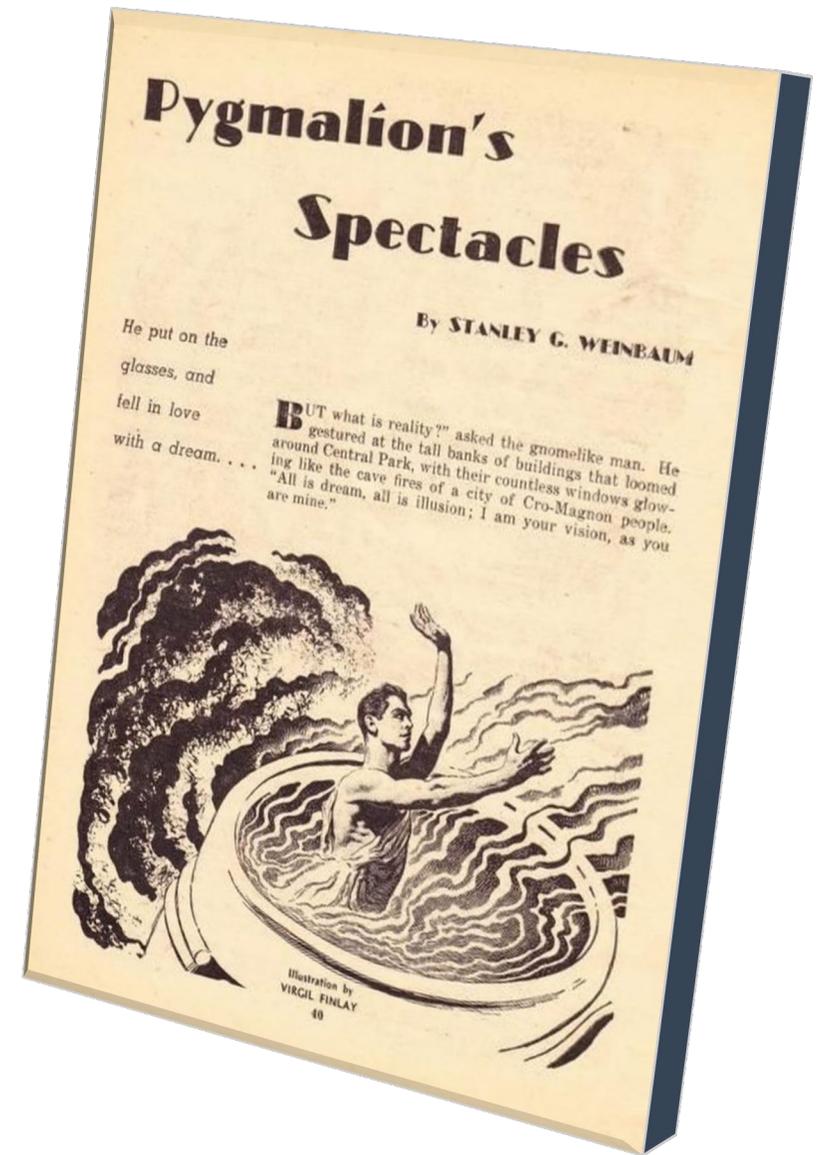
Magnificently finished and exquisitely colored photo views in place of the antiquated old-timers. A most pleasant and interesting way to spend an hour journeying around the globe, viewing places of greatest interest, most beautiful scenery and incidents and sights of travel. Fun, interest and instruction combined. Every view an actual photograph in natural colors, an effect never before attained excepting at many times the cost.

These views illustrate some of the most noted places in the world—mountain scenery, waterfalls and other famous natural phenomena—some of the world's most famous buildings, places of historical interest and places famous for beautiful architecture or beautiful natural scenery. This set is of great educational value, presenting, as it does, realistic likenesses of scenes and places that we all should know about.

A new
Idea?



'Sensorama',
Morton Heilig (1962)



Pygmalion's Spectacles (1935)

Why is VR
different?



VR is
IMMERSIVE



It's about
presence



Three illusions



'Presence' According to Professor Mel Slater

Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments.

Three illusions

The Place Illusion

"The sense of being there"



Three illusions

The Place Illusion

"The sense of being there"



The Plausibility Illusion

"It feels like it's happening"



Three illusions

The Place Illusion
"The sense of being there"

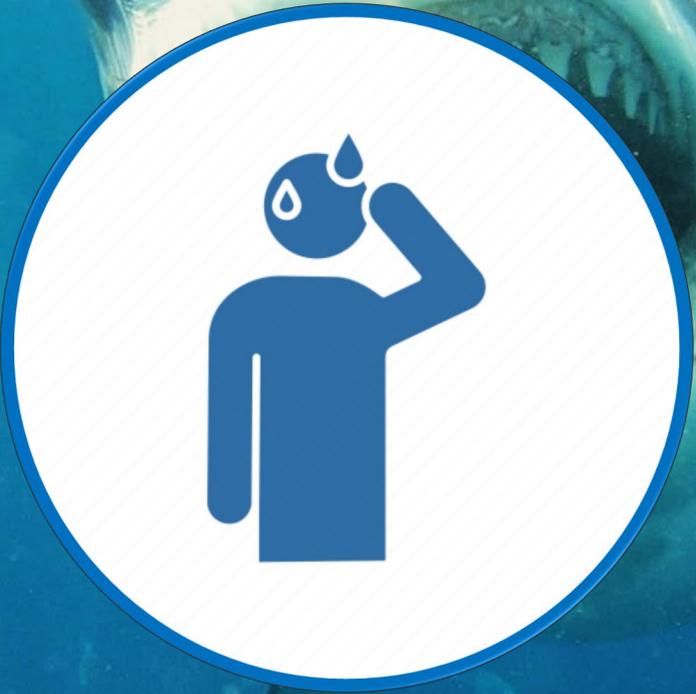


The Plausibility Illusion
"It feels like it's happening"



Virtual Body-Ownership
"It feels like your body"





RESPONSE-AS-IF-REAL

Immersion

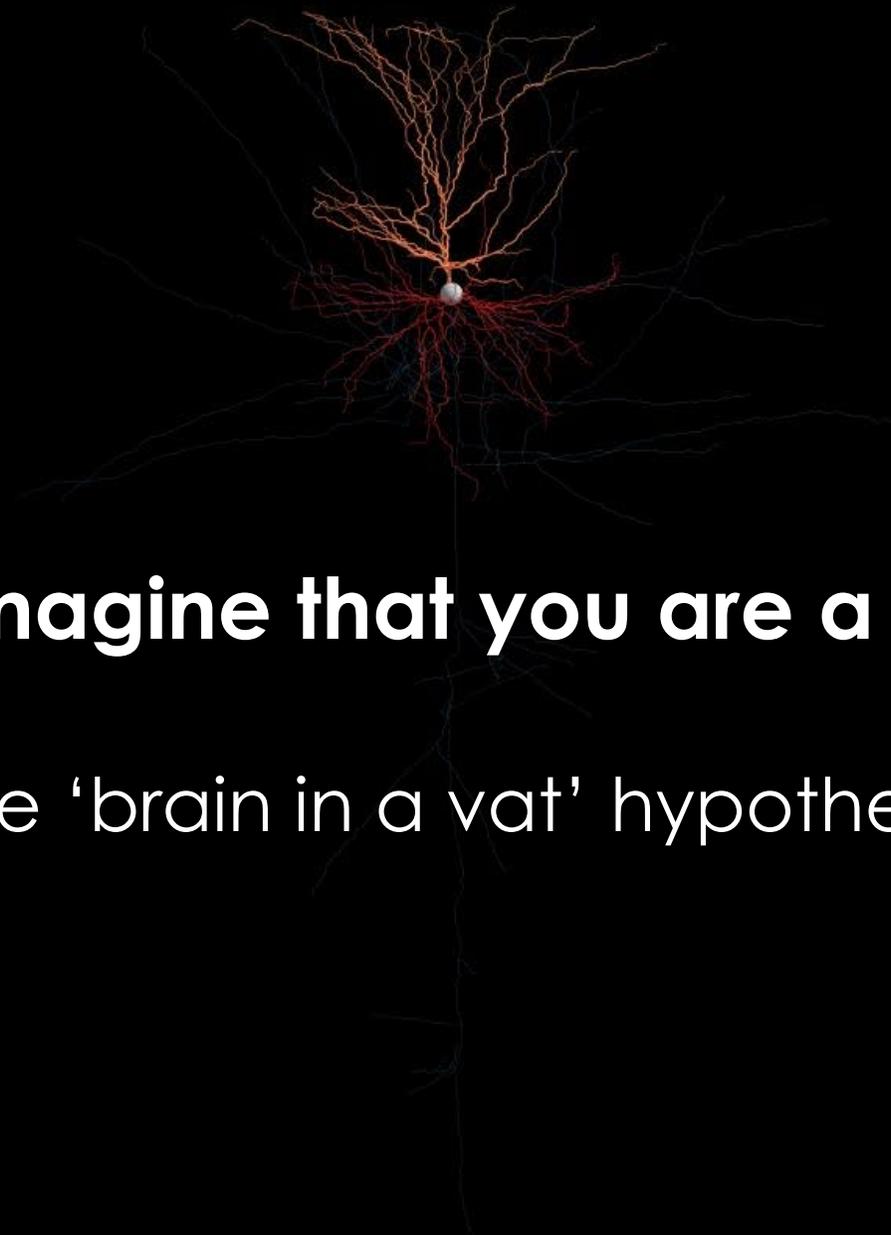
A diver is silhouetted against a bright light source, likely the sun, in a deep blue underwater environment. The diver is surrounded by a massive school of small fish, creating a sense of immersion. The light source is positioned in the upper right, casting a strong glow and creating a lens flare effect. The fish are scattered throughout the scene, some closer to the diver and others further away, adding to the depth and scale of the environment.

Immersion provides the perceptual system with enough sensory cues so that the sense of **PRESENCE** can be achieved



2

What does this have to do with rehabilitation?



Try to imagine that you are a **brain...**

The 'brain in a vat' hypothesis

Vision is a **strong** modality



That often **"dominates"** the other senses

Rubber-hand illusion



Rubber-hand illusion

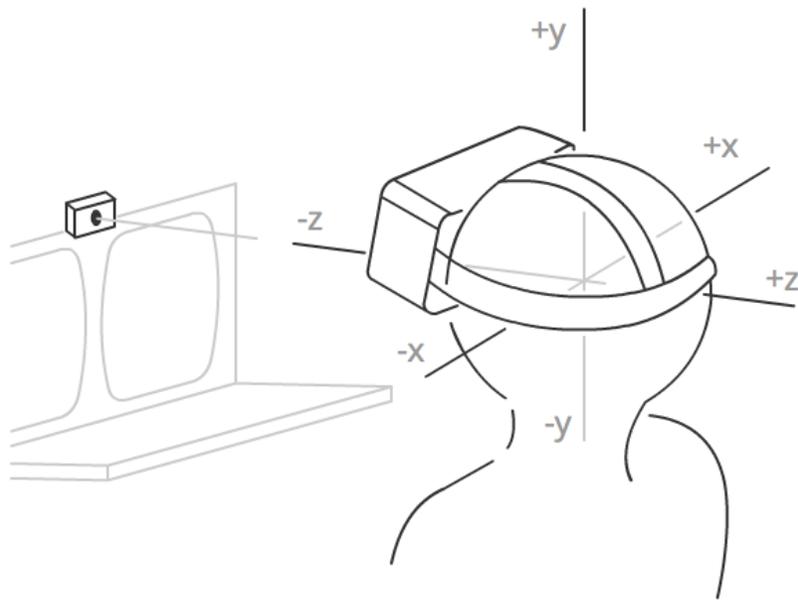


Vision
dominates
Proprioception
=
Intersensory Bias

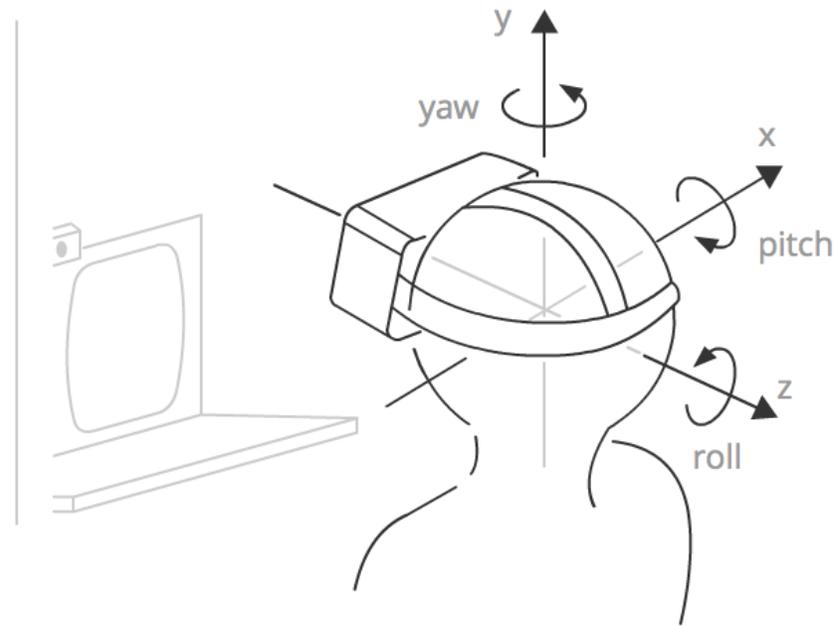


VR-technology support the sensorimotor interplay

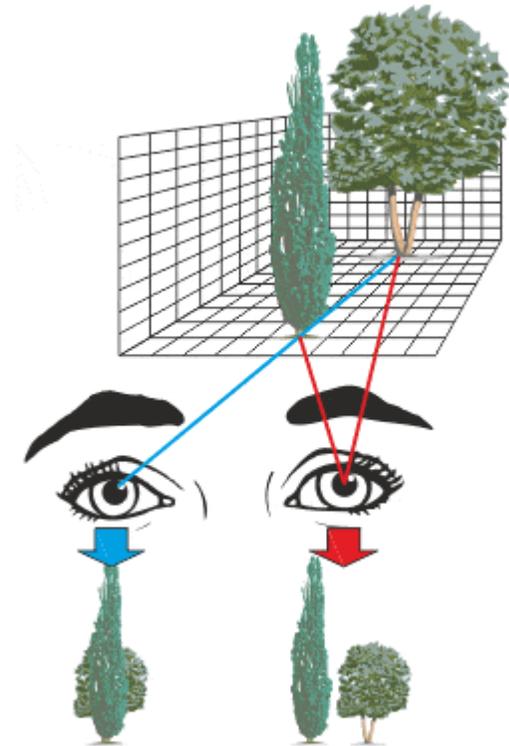
Position



Orientation



Stereoscopic vision

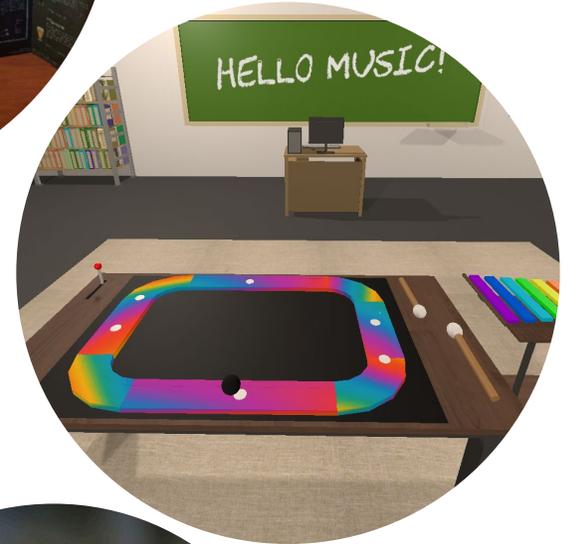


VR Therapy Psychology & Psychiatry



Anxiety and PTSD





<https://melcph.create.aau.dk/>

Prof. Stefania Serafin
sts@create.aau.dk



Neurorehabilitation



Motivation

- Distraction from repetitive exercises
- Increased performance
- Increases exercise duration
- Increased adherence



Høeg, E.R *et al.* Buddy biking: a user study on social collaboration in a virtual reality exergame for rehabilitation. *Virtual Reality* (2021). <https://doi.org/10.1007/s10055-021-00544-z>

Acute and Chronic pain



"It's just a fleshwound!"

VR and pain

Unprotected arm



Neutral arm

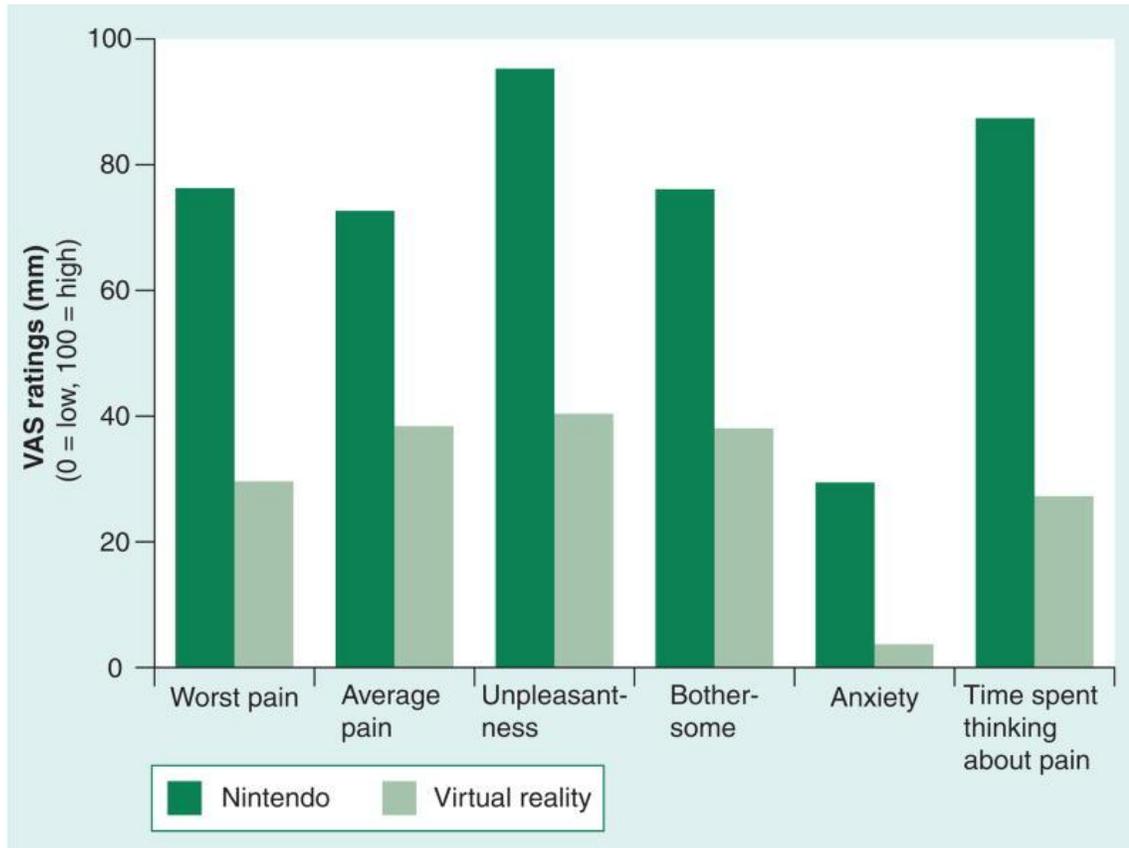


Protected arm (chain mail)



Was it less painful for knights? Influence of appearance on pain perception (2017)

VR and pain



Virtual reality as an adjunctive pain control during burn wound care in adolescent patients (2000), Hoffman HG *et al*

VR equipment



1996

370 €

100.000 €



2020



What is VR?



VR and rehabilitation



Challenges and opportunities

What
is VR?



Non- Immersive VR



Immersive VR



Commercial
(non-specific)



Wii Fit

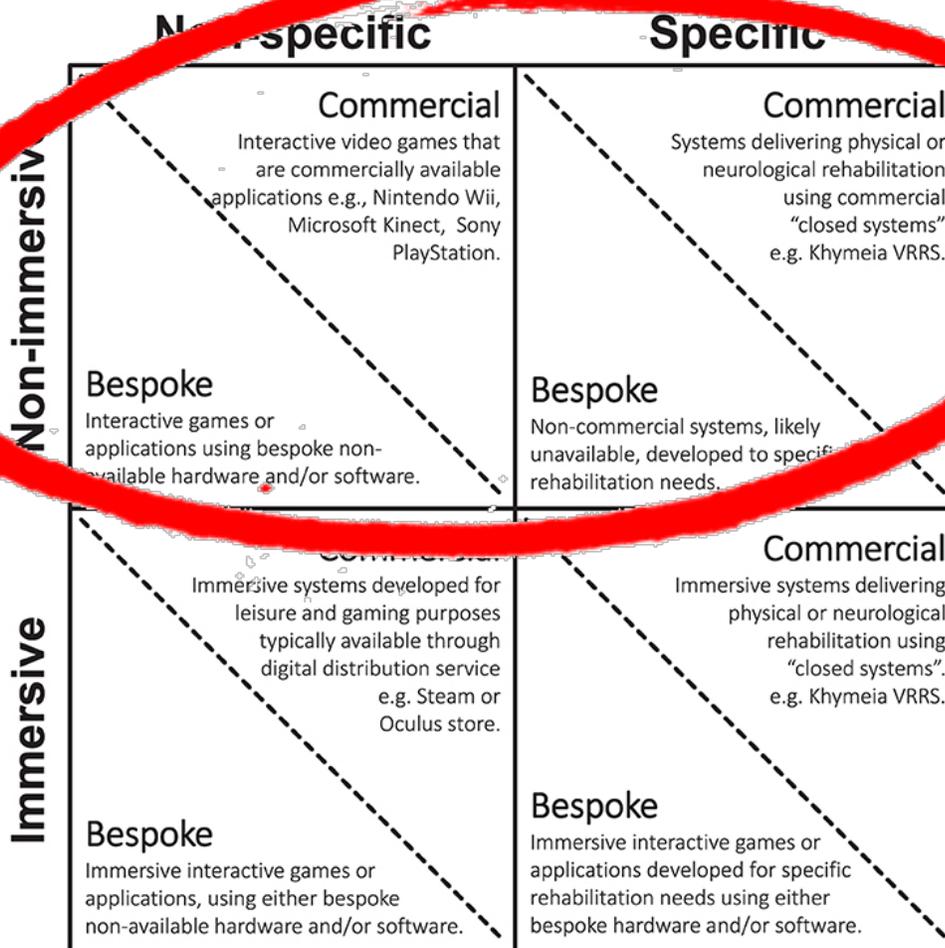
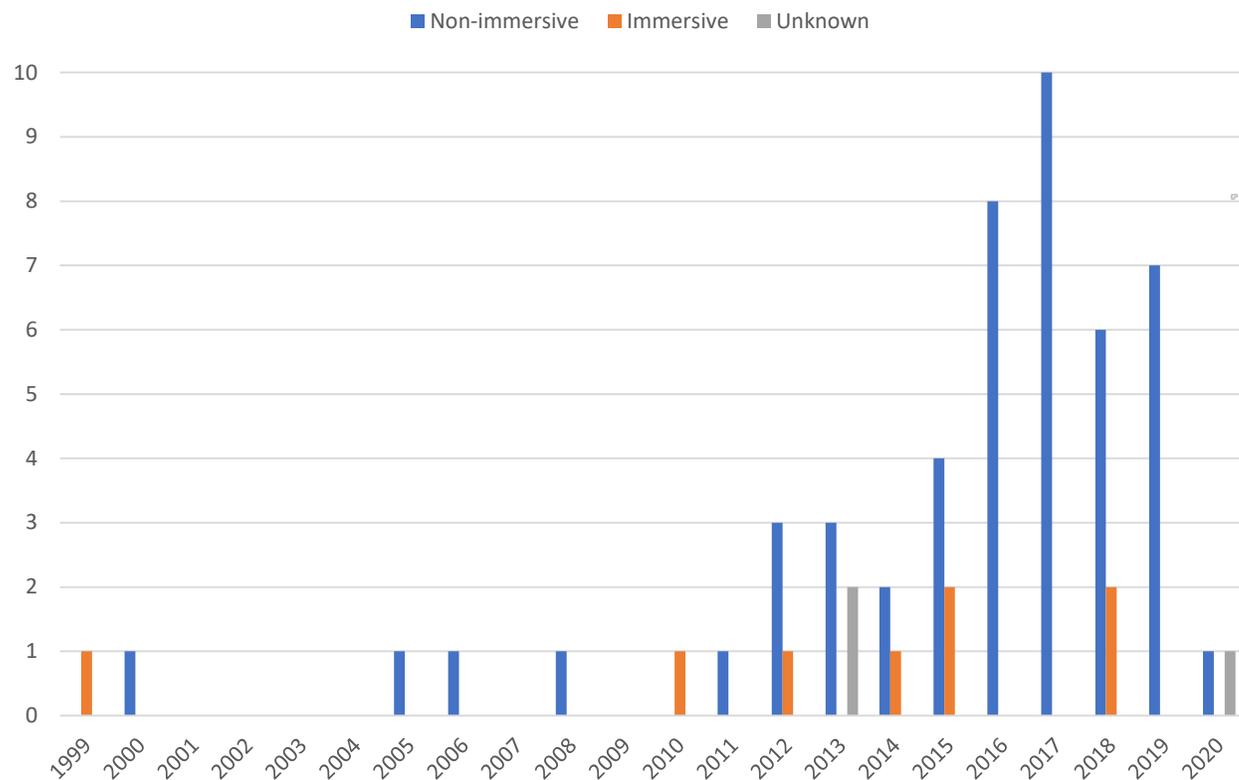
Bespoke (tailored)
specific



Rehab system

Taxonomy of VR-systems

Distribution of publications



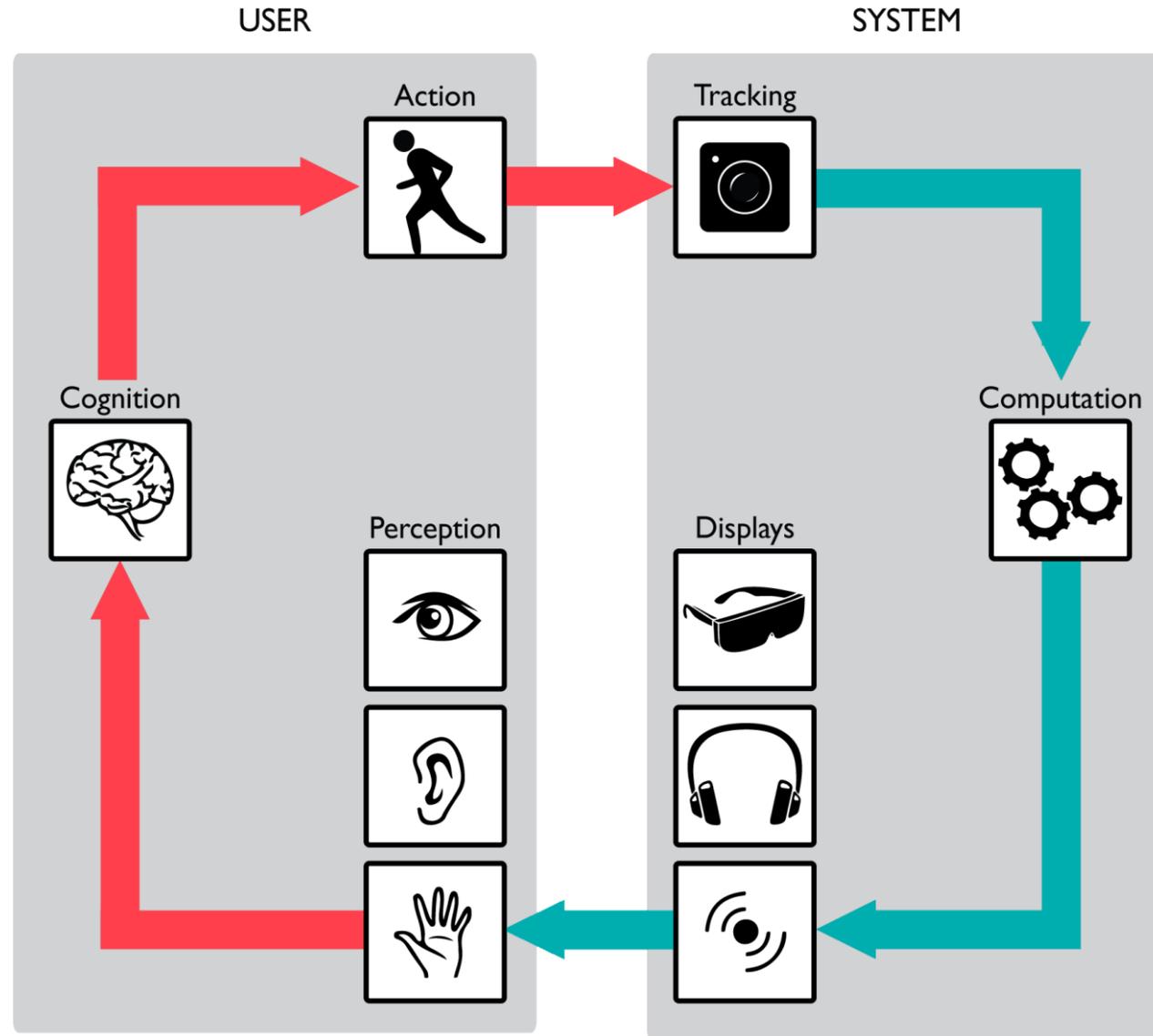
Høeg, E. R *et al.* (2021). System immersion in virtual reality-based rehabilitation of motor function in older adults: a systematic review and meta-analysis. *Frontiers in Virtual Reality*

49 out of 60 (82%)

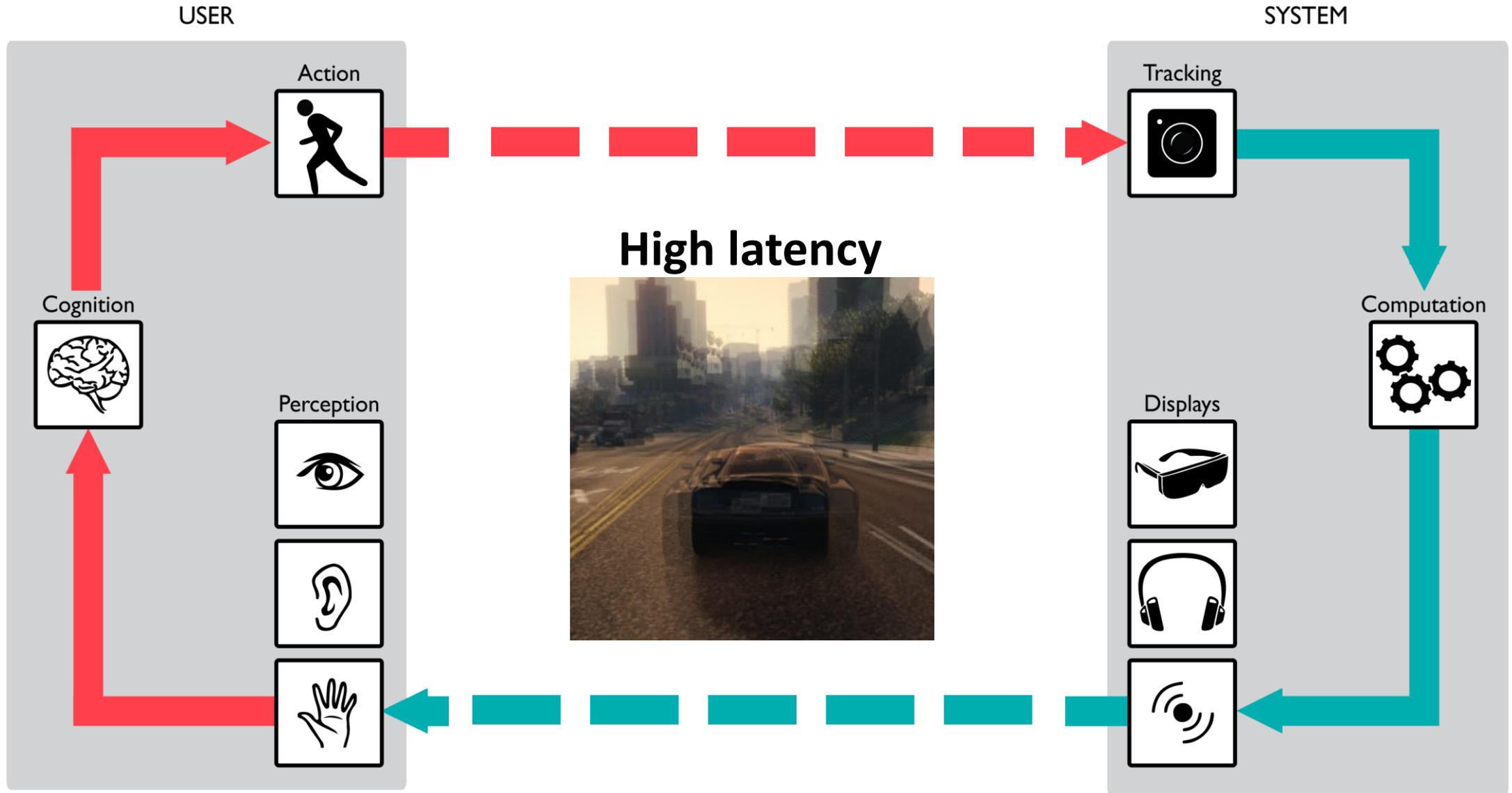


**VR-
sickness**

VR sickness



VR sickness



Clinical challenges

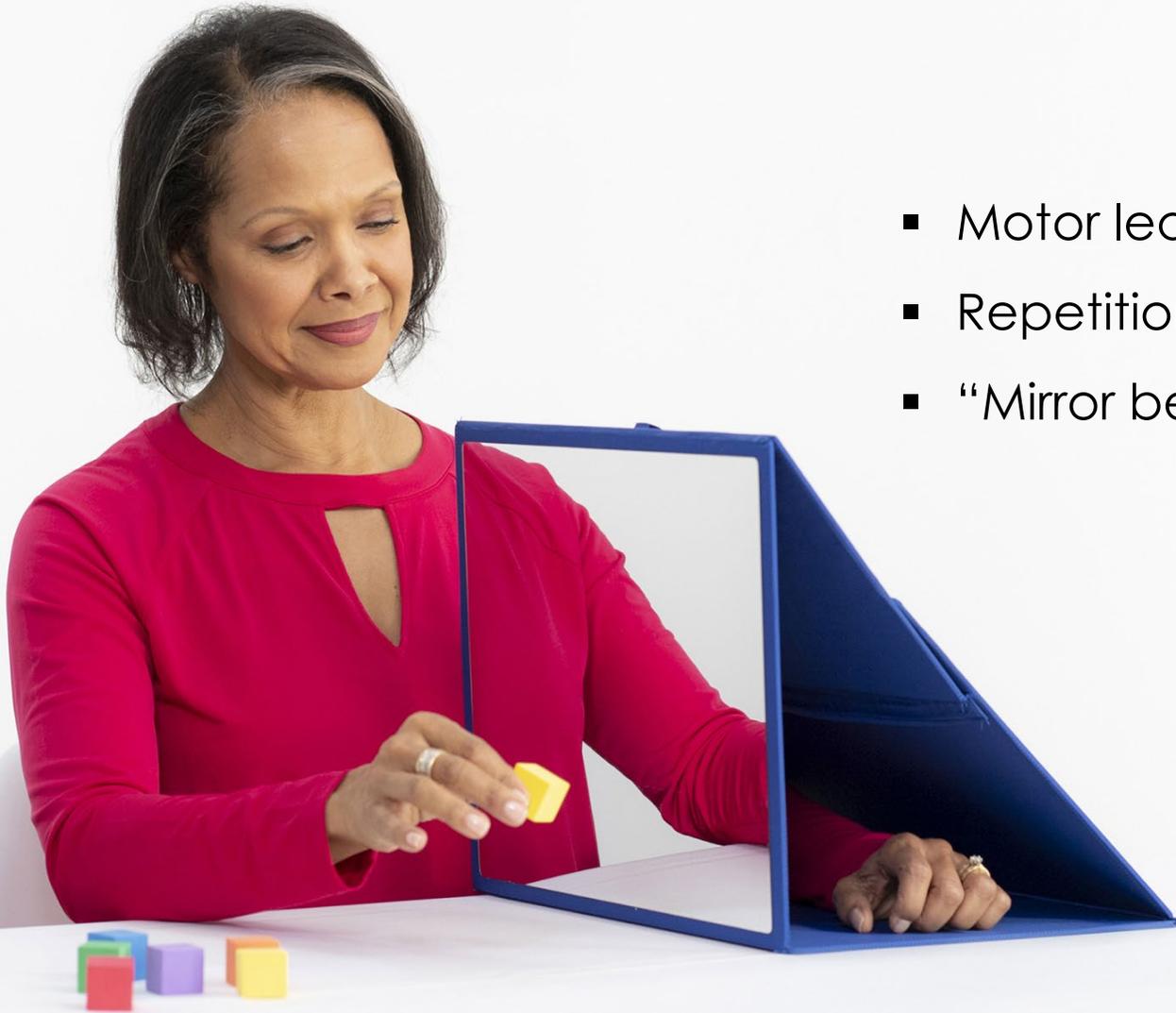
- Larger studies
- Better quality of evidence
- Better control of risk of bias

- Better control of risk of bias
- Better quality of evidence



Mirror therapy

- Motor learning
- Repetition of movement (non-repetitive feedback)
- “Mirror behavior” that is not possible in the real world



Engineering challenges & opportunities



Thank
you



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References and related reading

- Martini, M., (2016). [Real, rubber or virtual: The vision of “one’s own” body as a means for pain modulation. A narrative review.](#) *Consciousness and cognition*, 43, 143-151.
- Coleshill, M. J., George, D. N., & Mazzoni, G. (2017). [Placebo analgesia from a rubber hand.](#) *The Journal of Pain*, 18(9), 1067-1077.
- McGurk, H. & MacDonald, J. (1976). [Hearing lips and seeing voices.](#) *Nature* 264, 746-748.
- Osumi, M., Imai, R., Ueta, K., Nobusako, S., & Morioka, S. (2014). [Negative body image associated with changes in the visual body appearance increases pain perception.](#) *PLoS One*, 9(9), e107376.
- Senkowski, D. & Heinz, A. (2016) [Chronic pain and distorted body image: Implications for multisensory feedback interventions](#)
- Laver, Kate E., et al. (2017). [Virtual reality for stroke rehabilitation.](#) Cochrane database of systematic reviews
- Hoffman, H. G., et al. (2006). [Using fMRI to Study the Neural Correlates of Virtual Reality Analgesia.](#)
- Slater, M. & Sanchez-Vives, M. V., (2016). [Enhancing Our Lives with Immersive Virtual Reality](#)
- Corbetta, D. *et al*, (2015). [Rehabilitation that incorporates virtual reality is more effective than standard rehabilitation for improving walking speed, balance and mobility after stroke: a systematic review](#)
- D. Cano Porrás, *et al.*, (2018). [Advantages of virtual reality in the rehabilitation of balance and gait,”](#) *Neurology*, vol. 90, no. 22

Videos

"Your brain hallucinates your conscious reality" Professor Anil Seth, University of Sussex

https://www.ted.com/talks/anil_seth_how_your_brain_hallucinates_your_conscious_reality

"Galvanic Vestibular Stimulation" Assistant Professor Misha Sra, MIT Media Lab

<https://www.youtube.com/watch?v=t4SLrr62N2M>

"McGurk effect" Professor Lawrence Rosenblum, University of California

<https://www.youtube.com/watch?v=G-IN8vWm3m0>

"Science of Self – Rubber hand illusion" Dr. Lee Walsh, Neuroscience Research Australia

<https://www.youtube.com/watch?v=ASM12lpDDy0>