IEEE International Conference on Multimedia and Expo 2023
Brisbane Convention & Exhibition Centre
10-14 July 2023

# The Power of Extended Reality in the AI era

**Dr Mar Gonzalez Franco**
Blended Interaction Research & Devices (BIRD), Google

http://margonzalezfranco.github.io
@twi_mar

## IEEE VR 2022

## VGTC Virtual Reality Significant New Researcher Award

Mar Gonzalez-Franco

The 2022 IEEE VGTC Significant New Researcher Award goes to Mar Gonzalez-Franco of Microsoft, in recognition of her research and incipient leadership in the field of Virtual Reality and spatial computing. Her work has provided new insights on how people behave and perceive avatars, haptics, sound and multisensory signals inside Virtual Reality. She has produced numerous new prototypes advancing the state of the art on haptic controllers and haptic displays. She has been prolific in proposing new theories and standardized methods of evaluation for different phenomena such as embodiment, locomotion, the uncanny valley of haptics, avatar self-recognition and the self-avatar follower effect. Meanwhile, Dr. Gonzalez-Franco has helped democratize access to VR technology by open sourcing of avatars and avatar animation libraries (Microsoft Rocketbox).

Mar Gonzales-Franco
Award recipient 2022


SCIENTIFIC AMERICAN®

Science Robotics

nature COMMUNICATIONS

MOTHERBOARD TECH BY VICE

engadget

INVERSE

TechCrunch

Google

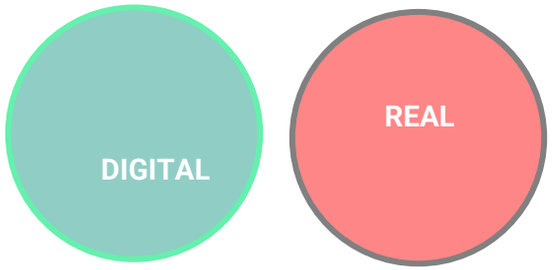
Microsoft AIRBUS UCL MIT Universitat de Barcelona Tsinghua University laSalle RAMON LLULL UNIVERSITY

# Vocabulary Development

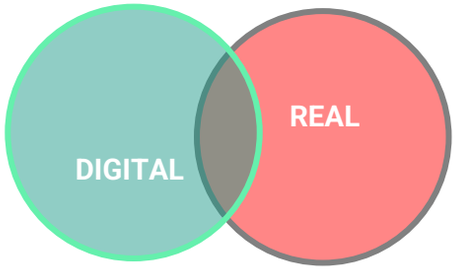

1993

VR/AR/XR, Blended reality, Spatial Computing, Immersive Tech...

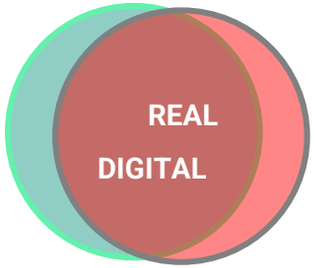
# Trends of Real + Digital




Pre-internet

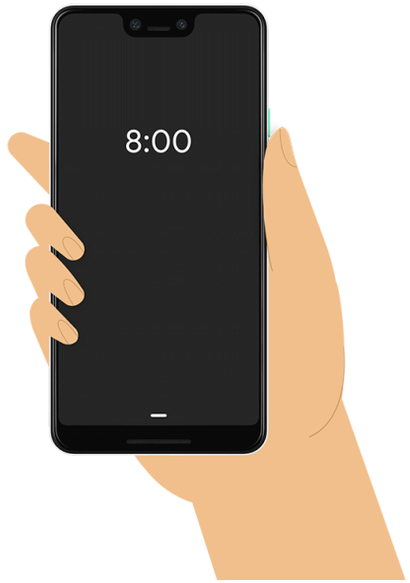



Smartphones
\+ Apps



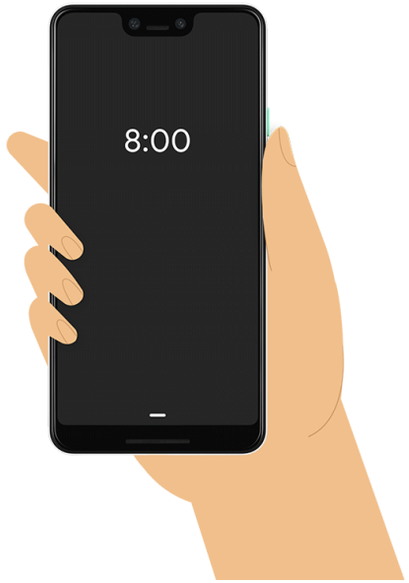

XR
+
AI

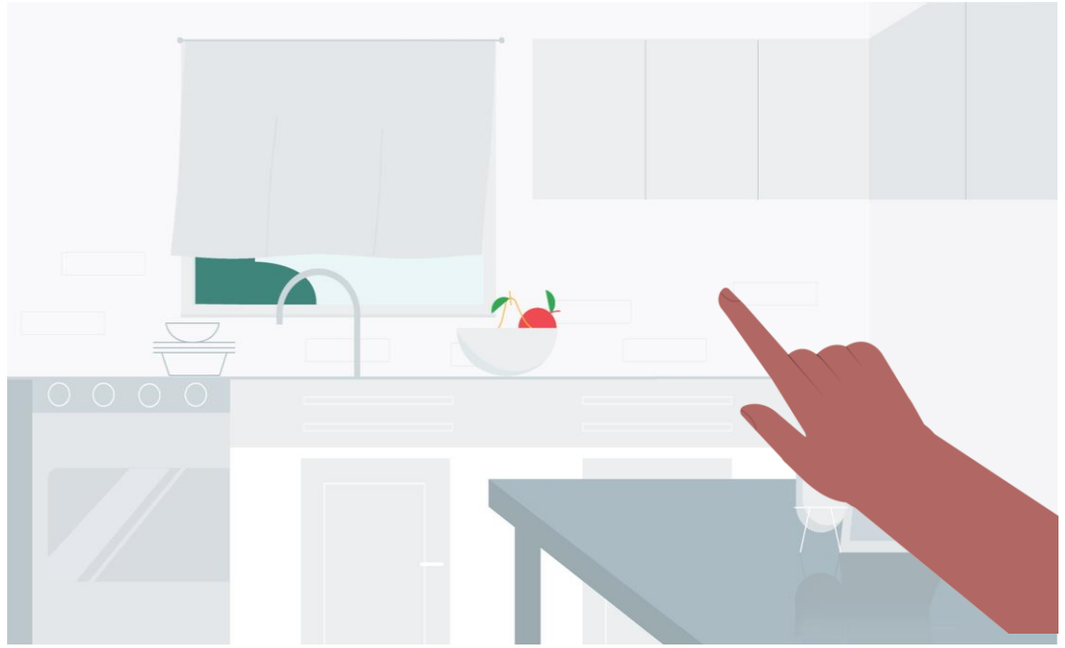
# Paradigm shift




content inside the screen

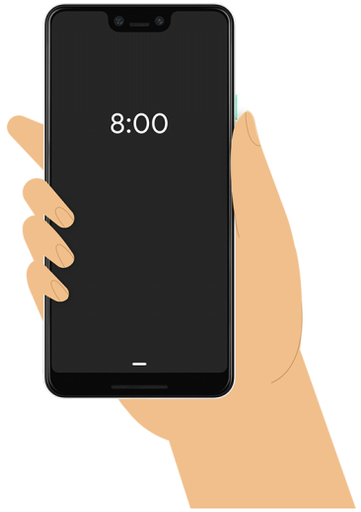
# Paradigm shift

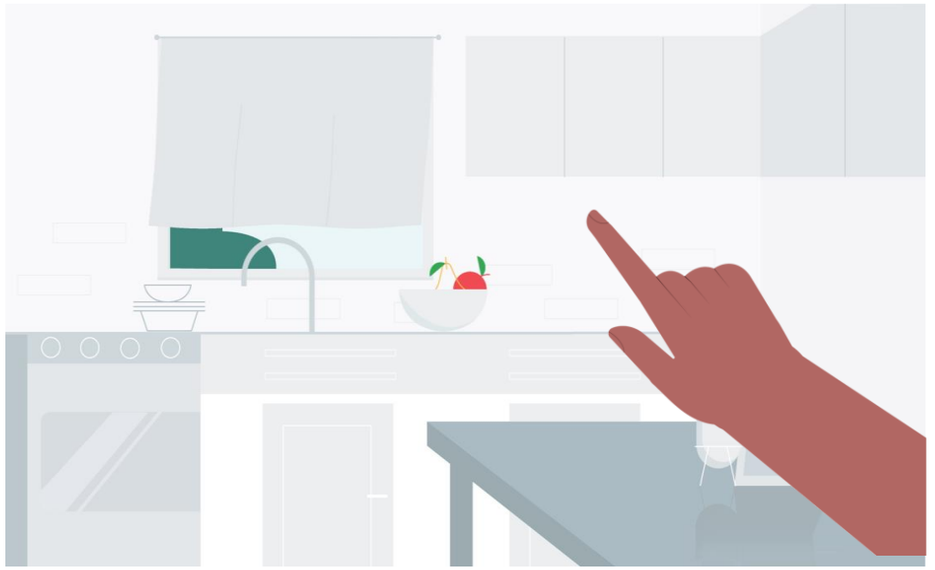


from content inside the screen, to users inside the content

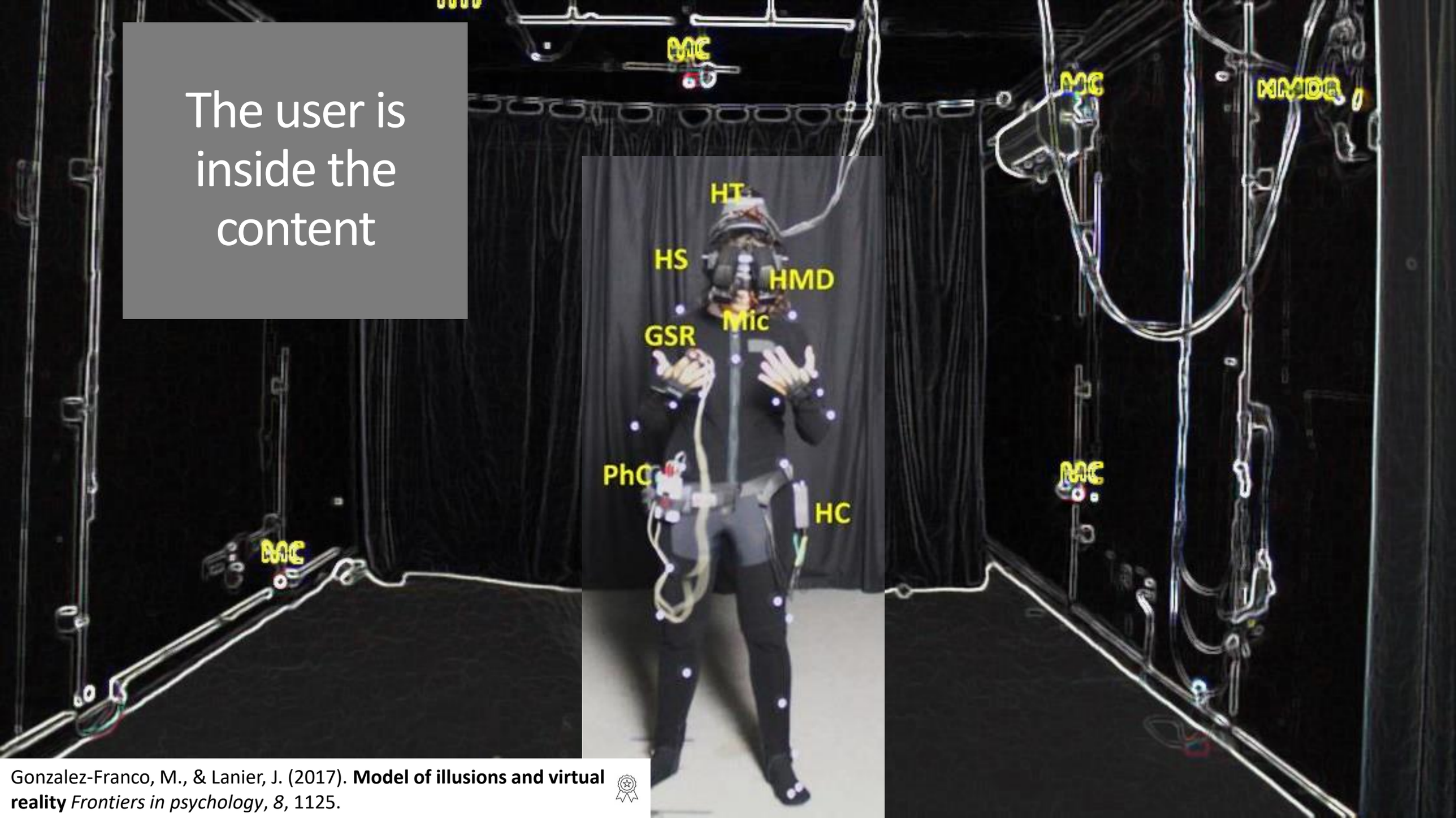
# Interaction Platforms



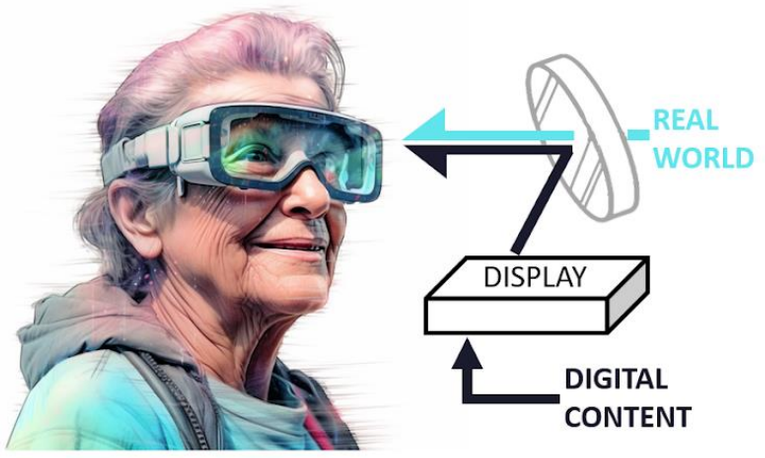
from content inside the screen, to users inside the content

# The user is inside the content

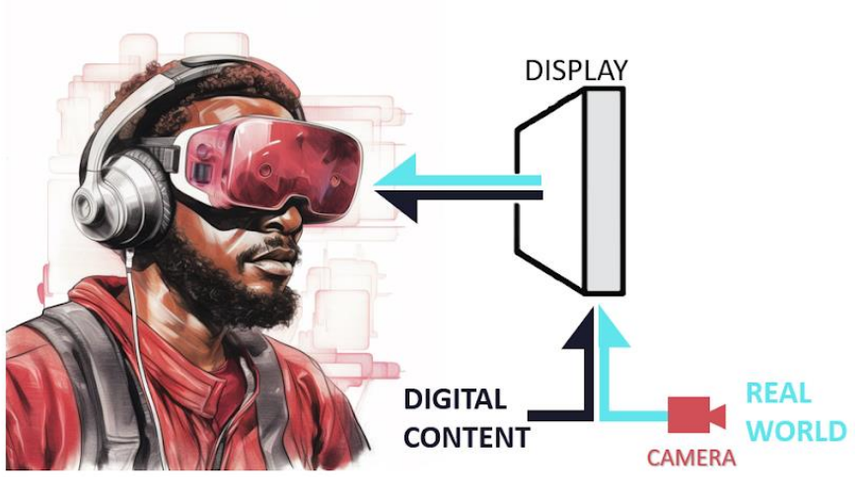



Gonzalez-Franco, M., & Lanier, J. (2017). **Model of illusions and virtual reality** *Frontiers in psychology*, *8*, 1125.

**Optical See-Through**



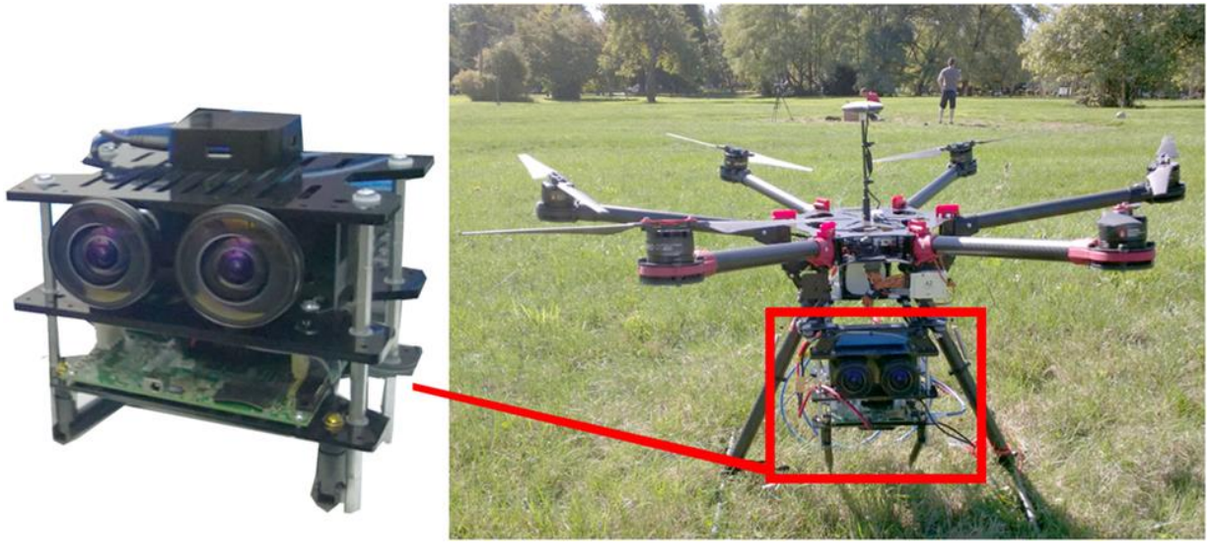

**Video Pass-Through**




# Systems that interface with reality

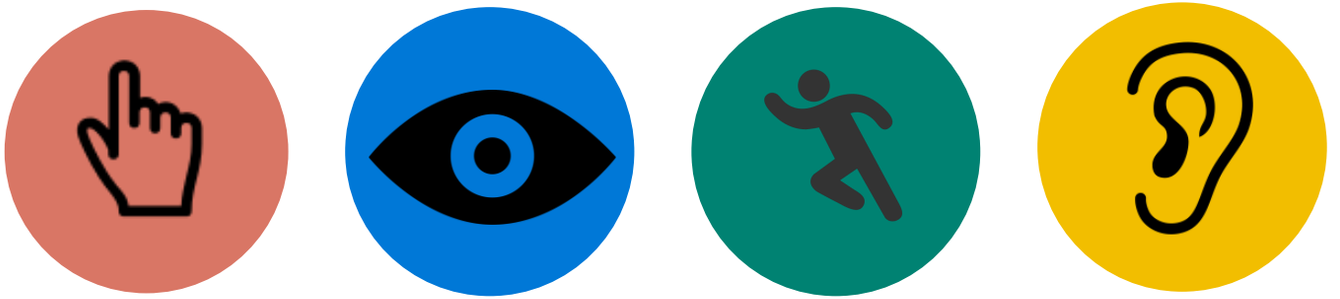
Gonzalez-Franco, M., & Colaco, A. (editing). **Guidelines for Productivity in VR**

# VR Systems + Drone

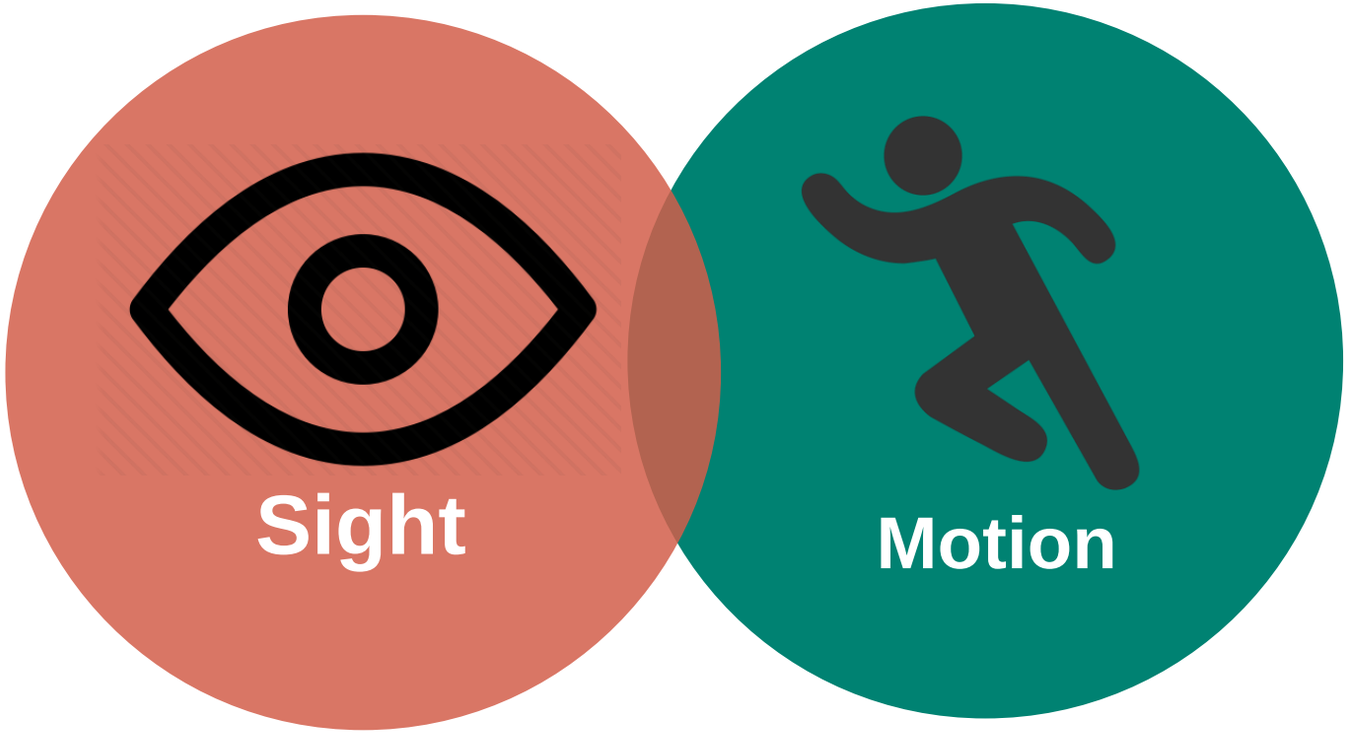


Smolyanskiy, N., & **Gonzalez-Franco, M.** (2017). Stereoscopic first person view system for drone navigation. *Frontiers in Robotics and AI*, *4*, 11.

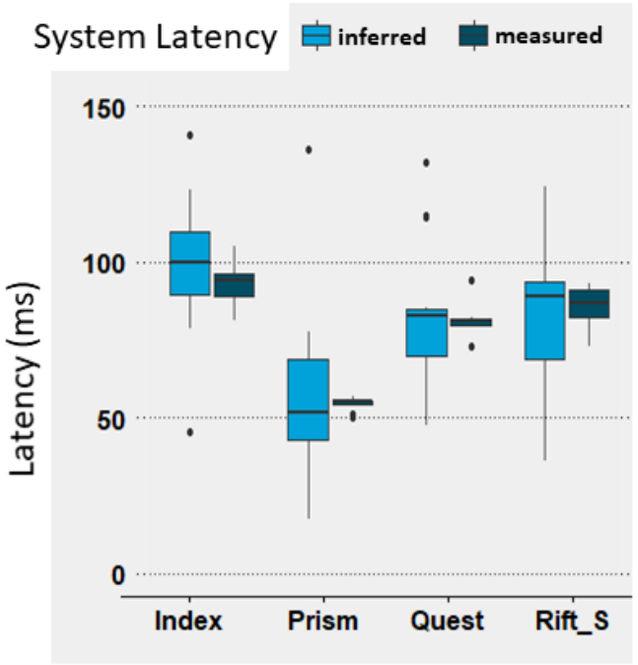

perception

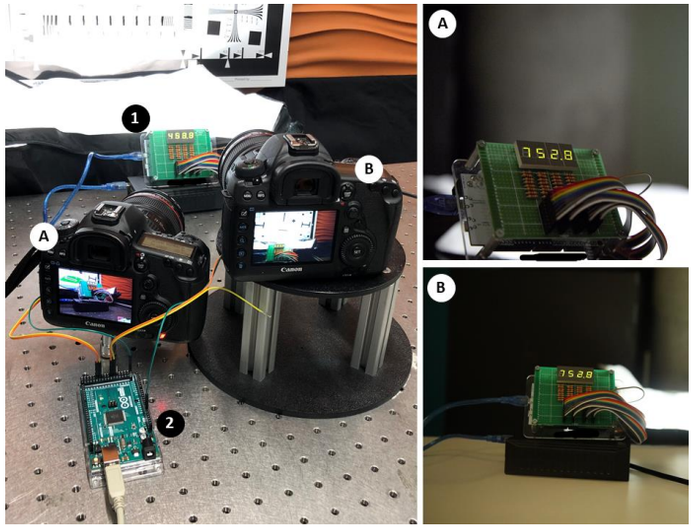


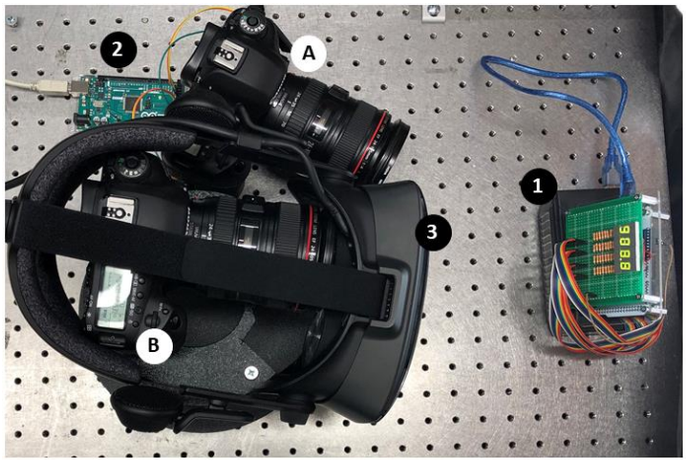
multisensory perception


Sight
Motion

# Cognitive Latency to measure VR system latency

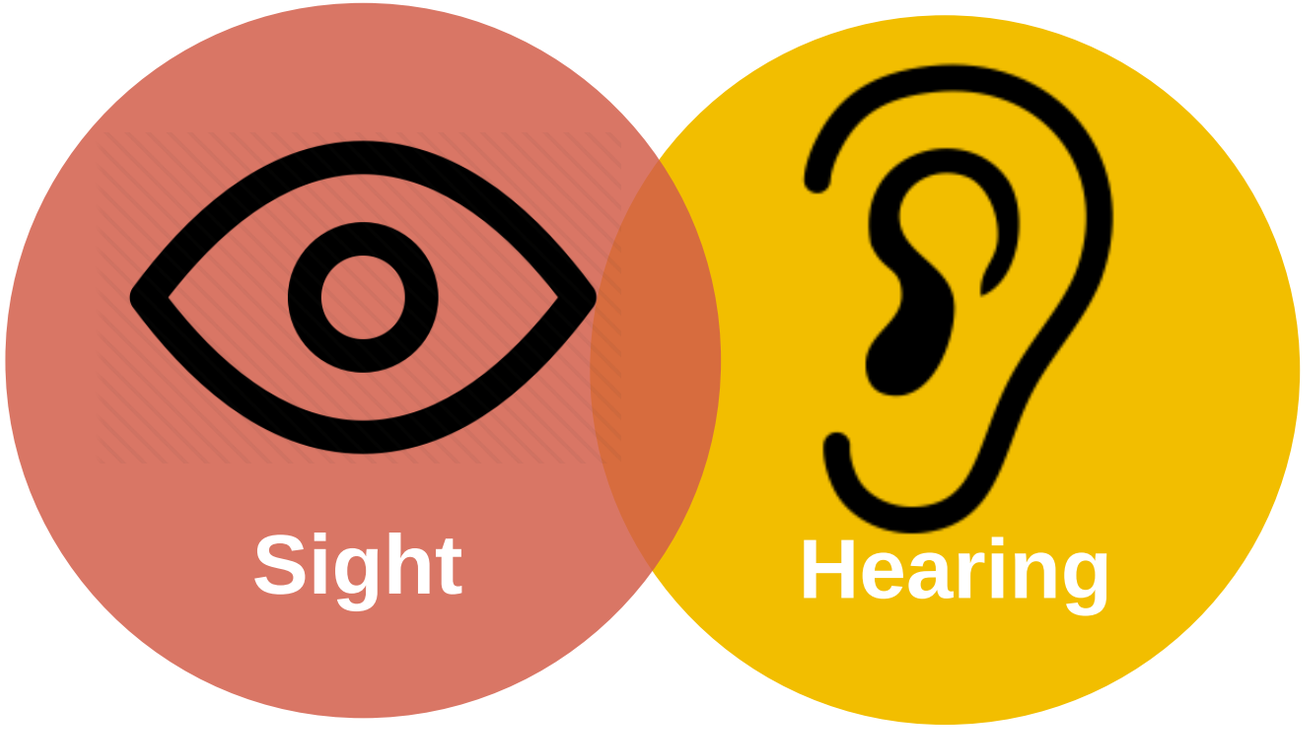


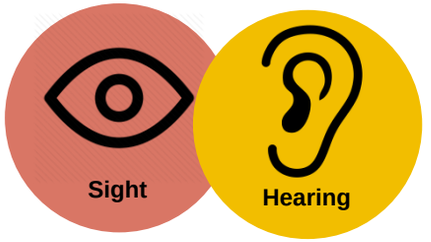

https://github.com/microsoft/Microsecond-Arduino-Latency-Clock

Gruen, Ofek, Steed, Gal, Sinclair, **M Gonzalez-Franco***, 2020. **Measuring System Visual Latency through Cognitive Latency on Video See-Through AR devices**. *IEEE VR*


Sight
Hearing

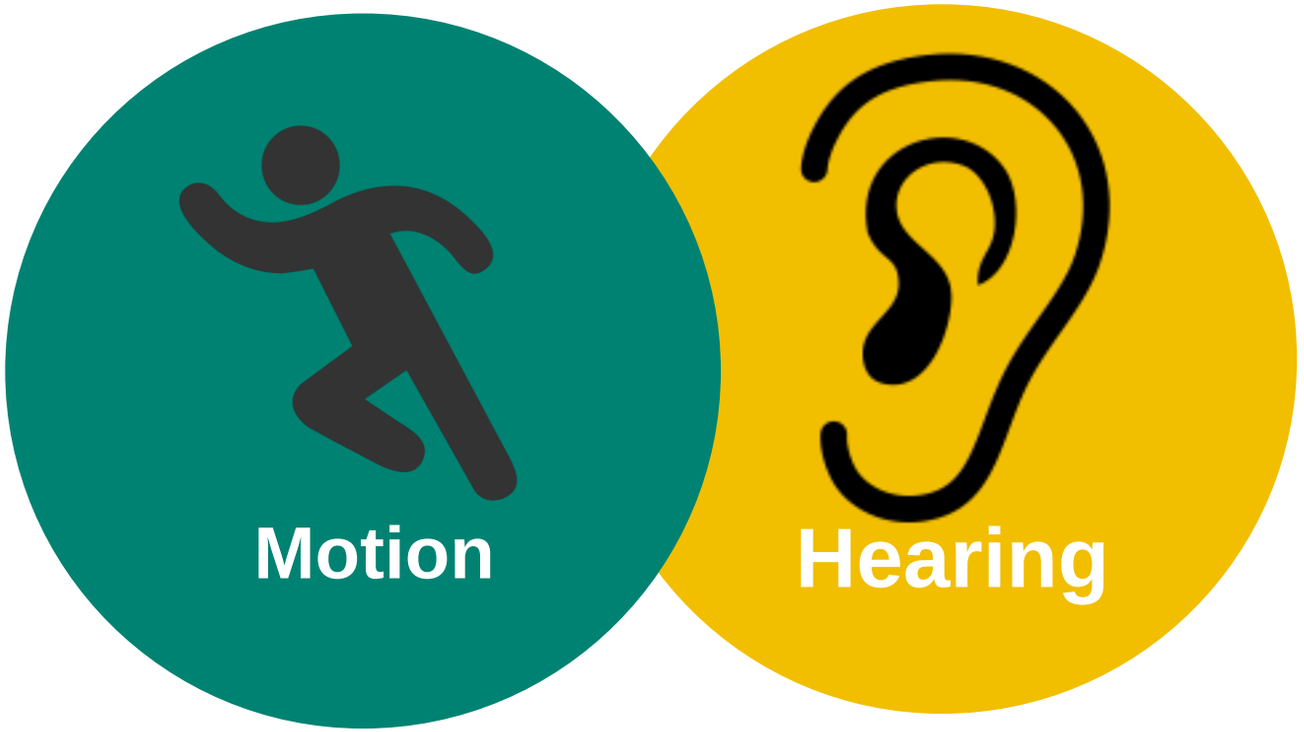
# Visual dominance Recalibration of 3D Audio


Berger, C.C., Gonzalez-Franco, M., Tajadura-Jiménez, A., Florencio, D. and Zhang, Z., 2018. **Generic HRTFs may be good enough in virtual reality. Improving source localization through cross-modal plasticity**. *Frontiers in neuroscience*, *12*, p.21.

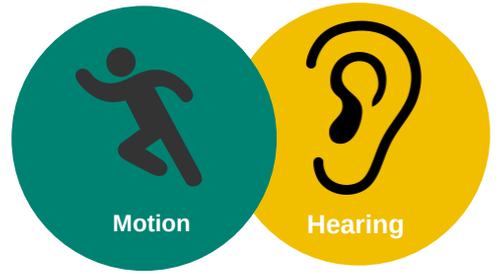


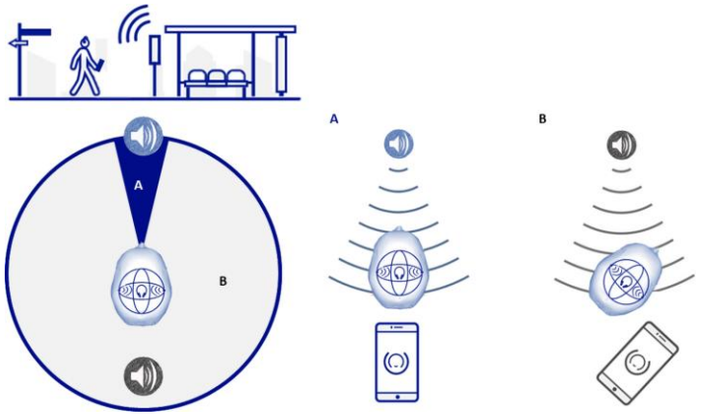

# Concurrent Talking

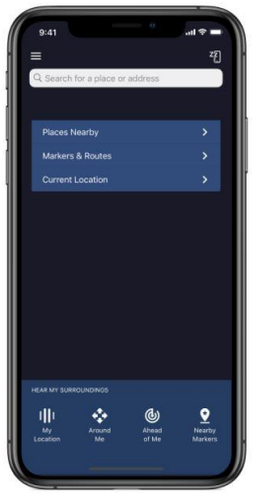

Gonzalez-Franco, et al. 2017 "**Concurrent talking in immersive virtual reality: on the dominance of visual speech cues**." *Scientific reports* 7.1: 3817.


Motion
Hearing

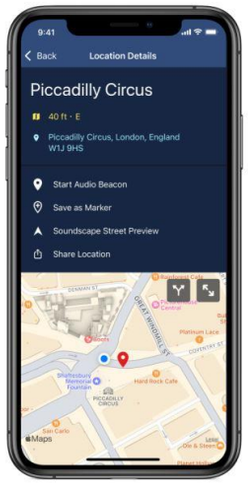
# Augmented GPS



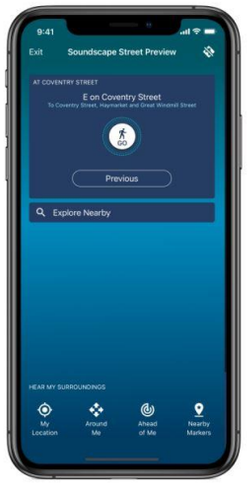



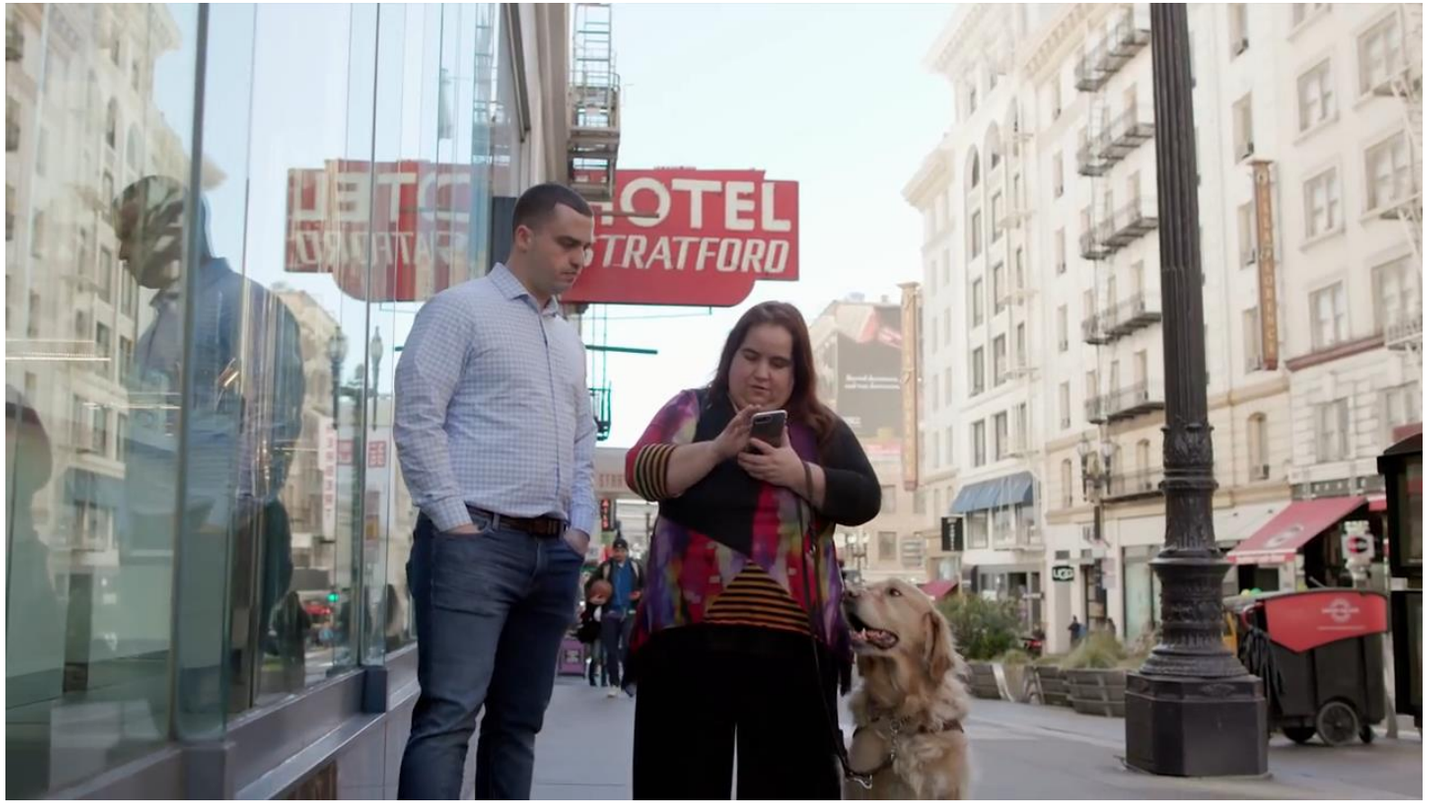

(a) Home screen




(b) Location details and options screen




(c) Street preview screen



## multisensory perception

## cognition

Cognitive processes are those responsible for knowledge and awareness. They include the processing of experience, perception, and memory, as well as overtly verbal thinking.

**From:** cognition in The Oxford Dictionary of Philosophy »

# Spatial Awareness – Mental Maps

Microsoft Soundscape

https://www.microsoft.com/en-us/research/product/soundscape/

**Rethinking GPS Navigation: Creating Cognitive Maps Through Auditory Clues**

Gregory D. Clemenson, Antonella Maselli, Alex Fiannaca, Amos Miller, Mar Gonzalez-Franco*

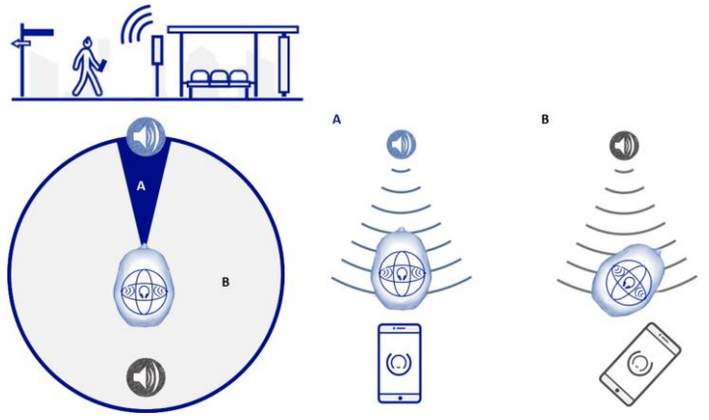
Microsoft Research, margon@microsoft.com

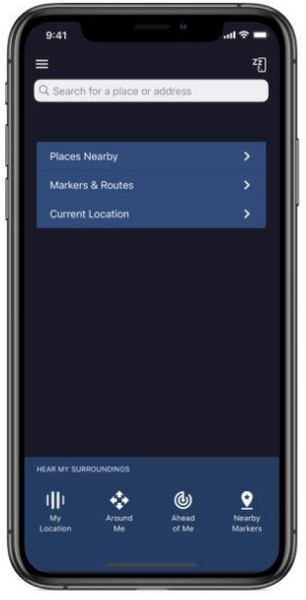
Clemenson, Maselli, Fiannaca, Miller, Gonzalez-Franco (2021). **Rethinking GPS Navigation: Creating Cognitive Maps Through Auditory Clues**. Sci Reps

Microsoft

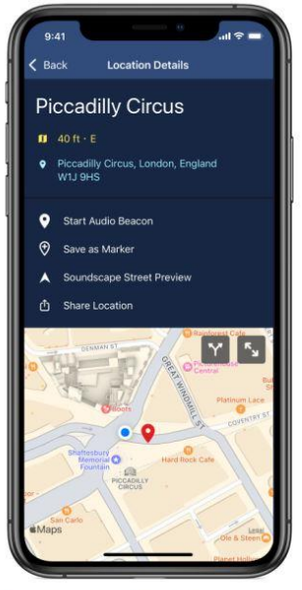
Microsoft

# Augmented GPS

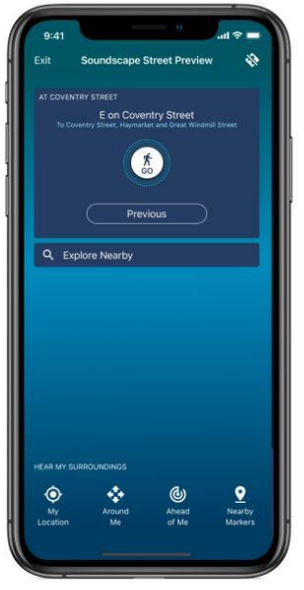



(a) Home screen




(b) Location details and options screen




(c) Street preview screen

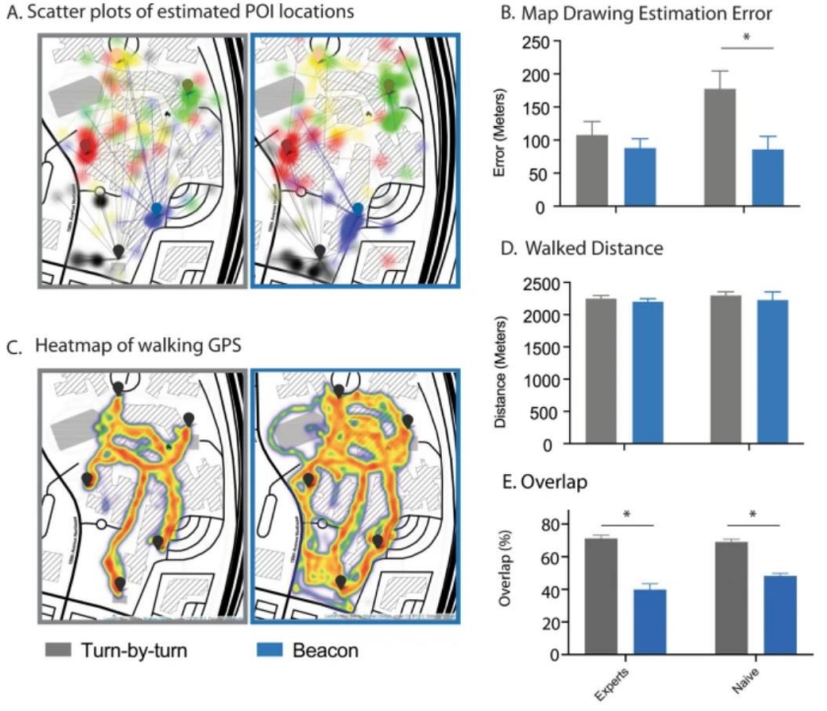
SCIENTIFIC AMERICAN

BEHAVIOR | OPINION

# How GPS Weakens Memory—and What We Can Do about It

A new app helps you navigate, not with turn-by-turn directions but via audio "beacons"

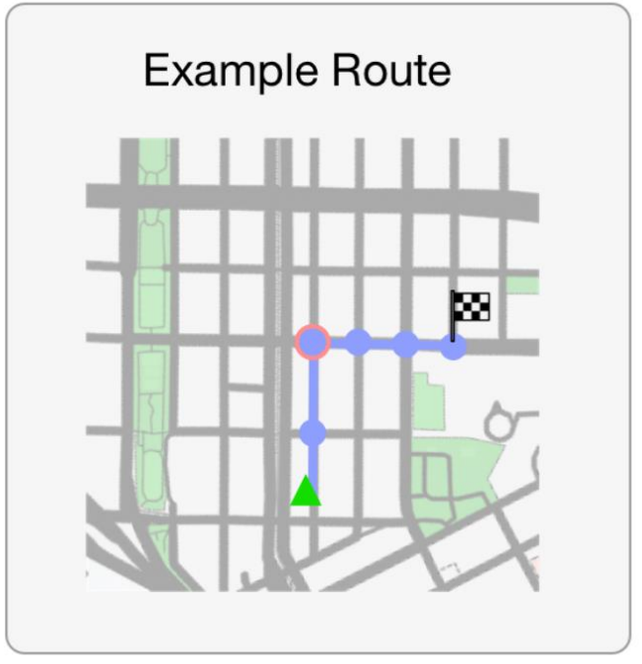
By Mar Gonzalez-Franco, Gregory Dane Clemenson, Amos Miller on May 7, 2021




Clemenson, Gregory D., et al. "Rethinking GPS navigation: creating cognitive maps through auditory clues." *Scientific reports* 11.1 (2021): 1-10.

# The problem with systems: grow!

# What if we do route planning?



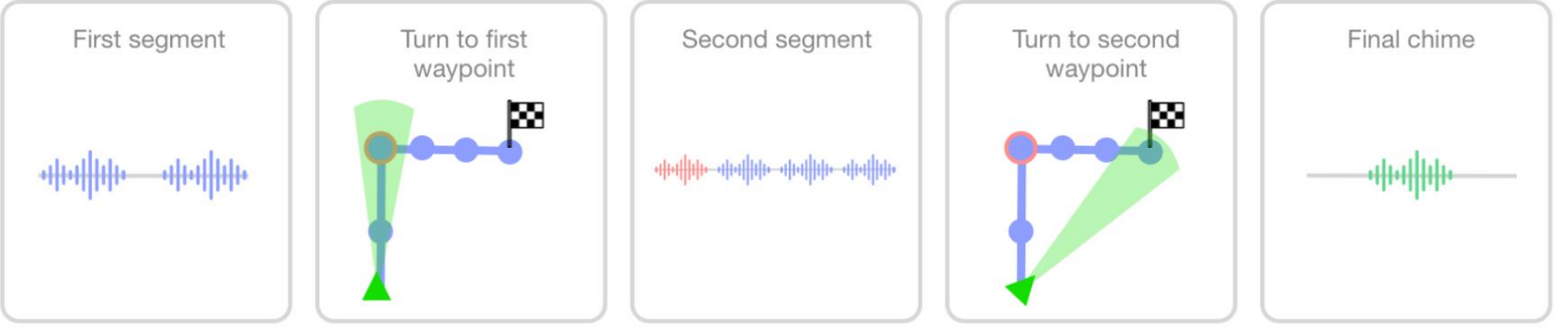

## Mode 1: Isolated Audio

AUDIO

MEANING

"Straight" – "Straight" – "Right Turn" – "Straight" – "Straight" – "Straight" – "End"

## Mode 2: Simulated Audio-Visual




*J Gordon et al. 2023.* ***Hearing the Way Forward: Exploring Ambient Navigational Awareness with Reduced Cognitive Load through Spatial Audio-AR.*** (CHI '23).

# What if we do route planning?

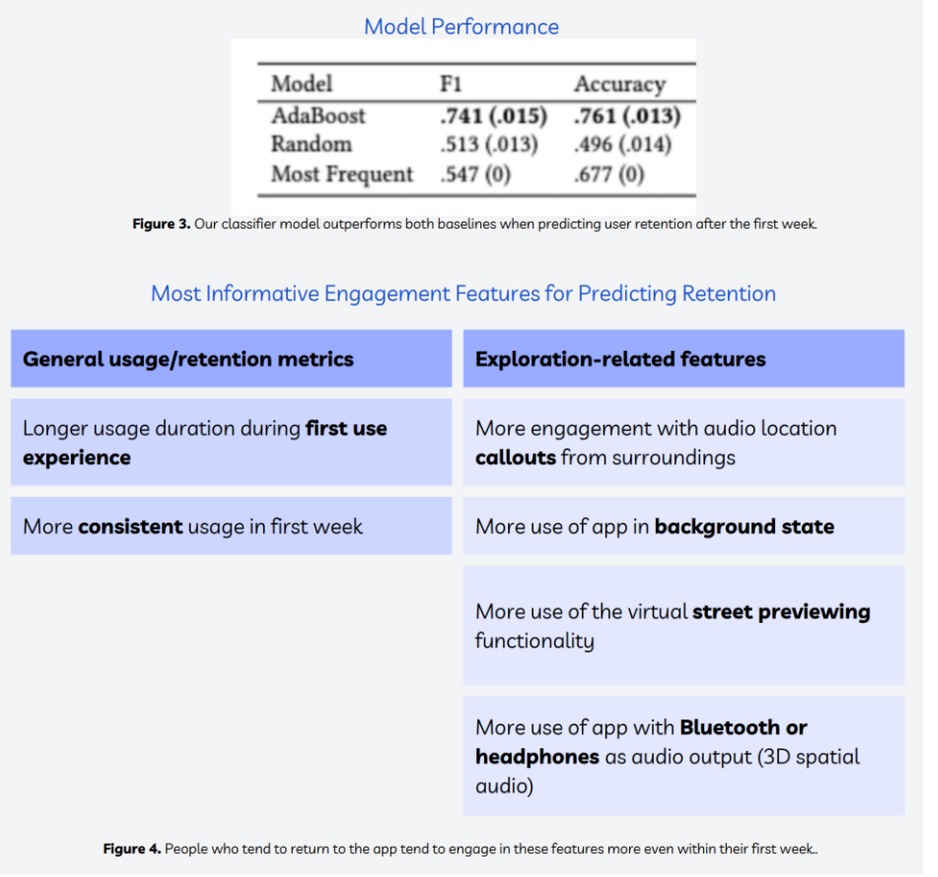
Prompt 6 (map 2)

Prompt 13 (map 4)

*J Gordon et al. 2023.* ***Hearing the Way Forward: Exploring Ambient Navigational Awareness with Reduced Cognitive Load through Spatial Audio-AR.*** (CHI '23).

# Insights

Unstructured app activity data logs of 4,725 BLV users across 65 countries/regions, all of whom began using the app between January and June of 2021

Model Performance

| Model | F1 | Accuracy |
|---|---|---|
| AdaBoost | **.741 (.015)** | **.761 (.013)** |
| Random | .513 (.013) | .496 (.014) |
| Most Frequent | .547 (0) | .677 (0) |

**Figure 3.** Our classifier model outperforms both baselines when predicting user retention after the first week.

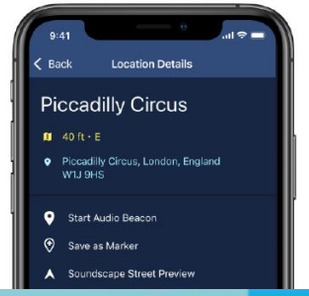
Most Informative Engagement Features for Predicting Retention

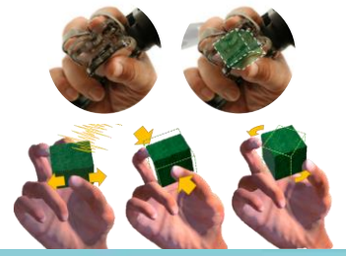
| General usage/retention metrics | Exploration-related features |
|---|---|
| Longer usage duration during **first use experience** | More engagement with audio location **callouts** from surroundings |
| More **consistent** usage in first week | More use of app in **background state** |
| | More use of the virtual **street previewing** functionality |
| | More use of app with **Bluetooth or headphones** as audio output (3D spatial audio) |

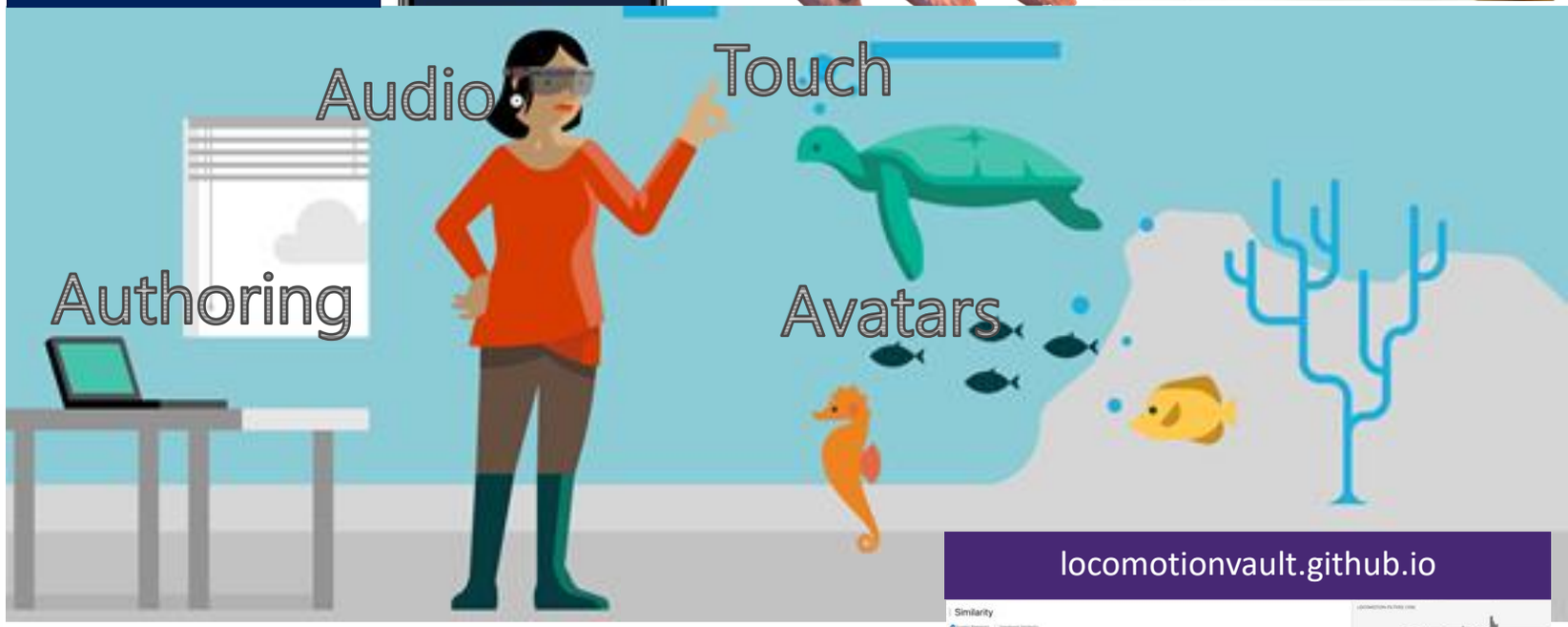
**Figure 4.** People who tend to return to the app tend to engage in these features more even within their first week.

Liu, Tiffany, et al. "Characterizing and Predicting Engagement of Blind and Low-Vision People with an Audio-Based Navigation App." *CHI* 2022.

# What is really impossible with other tech?

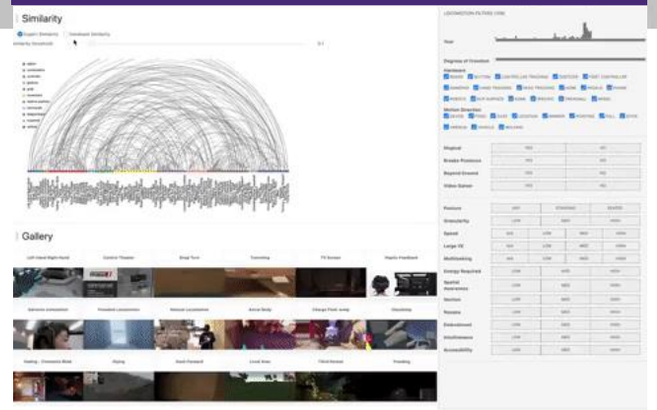




## Microsoft Rocketbox


## locomotionvault.github.io




margonzalezfranco.github.io

TIME

# THE BEST INVENTIONS OF 2022

## Meet in the Metaverse

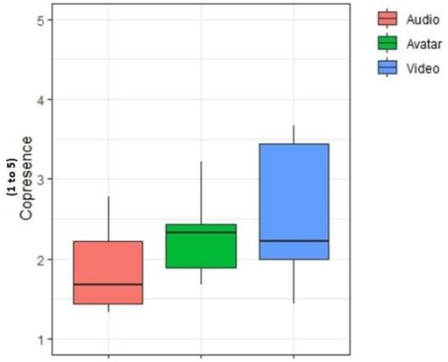
### Microsoft Mesh for Teams

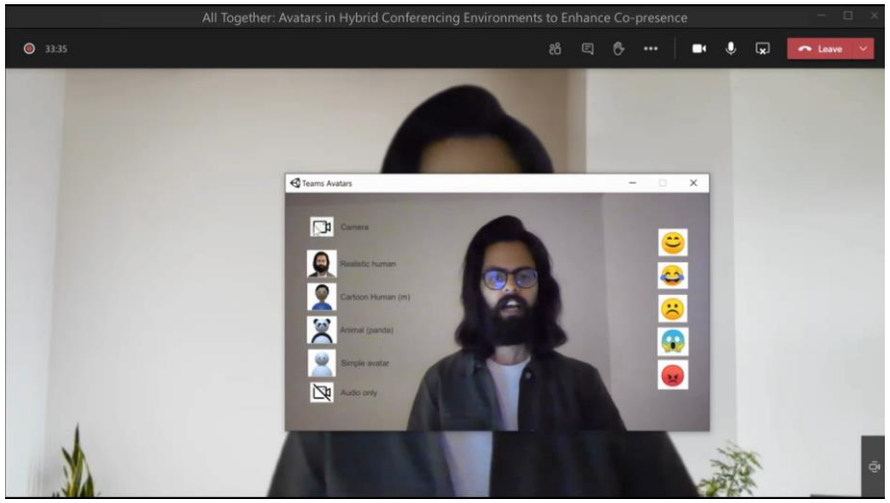
Tired of zooming into work via webcam and staring at colleagues' faces? This mixed-reality application for Microsoft's Teams collaboration platform is a step toward the metaverse promised land, at least for desk-bound knowledge workers. Strap on a HoloLens 2 headset and pop into a meeting as an avatar that sounds and (sort of) looks like you. Mesh for Teams—part of Microsoft's broader metaverse platform still under development—also includes pre-built meeting spaces and is accessible from smartphones and laptops as well. A goal, says Jeff Teper, president of Microsoft Collaborative Apps and Platforms, is to make online meetings "more personal, engaging, and fun." People can go "beyond the current binary choice of video or no video."

# Avatars in Video Conferencing

## 18 participants - 3 sessions (total 54 datapoints)

Co-presence data from the post-session questionnaires supports this observation. A repeated measures non-parametric Friedman test on the co-presence ratings revealed a significant difference between conditions $\chi^2 = 9.5882, df = 2, p = 0.008$ (Figure 7). Post-hoc pairwise comparisons using Conover's test for a two-way balanced complete block design with Bonferroni correction revealed that Audio participants experienced significantly lower co-presence than both avatar (p=0.0015) and video participants (p<0.0001). Avatar and video participants' co-presence scores were not significantly different (p=0.17).




## 18 participants - 2 weeks regular meetings – 313 people survey

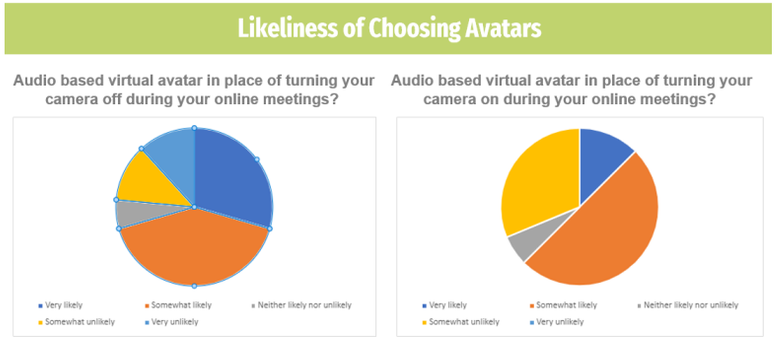
### Before joining the avatar meeting

6. Hypothetically speaking, if a feature that allowed you to be represented by an avatar were available in Teams, how likely would you be to use a feature like this?

More Details

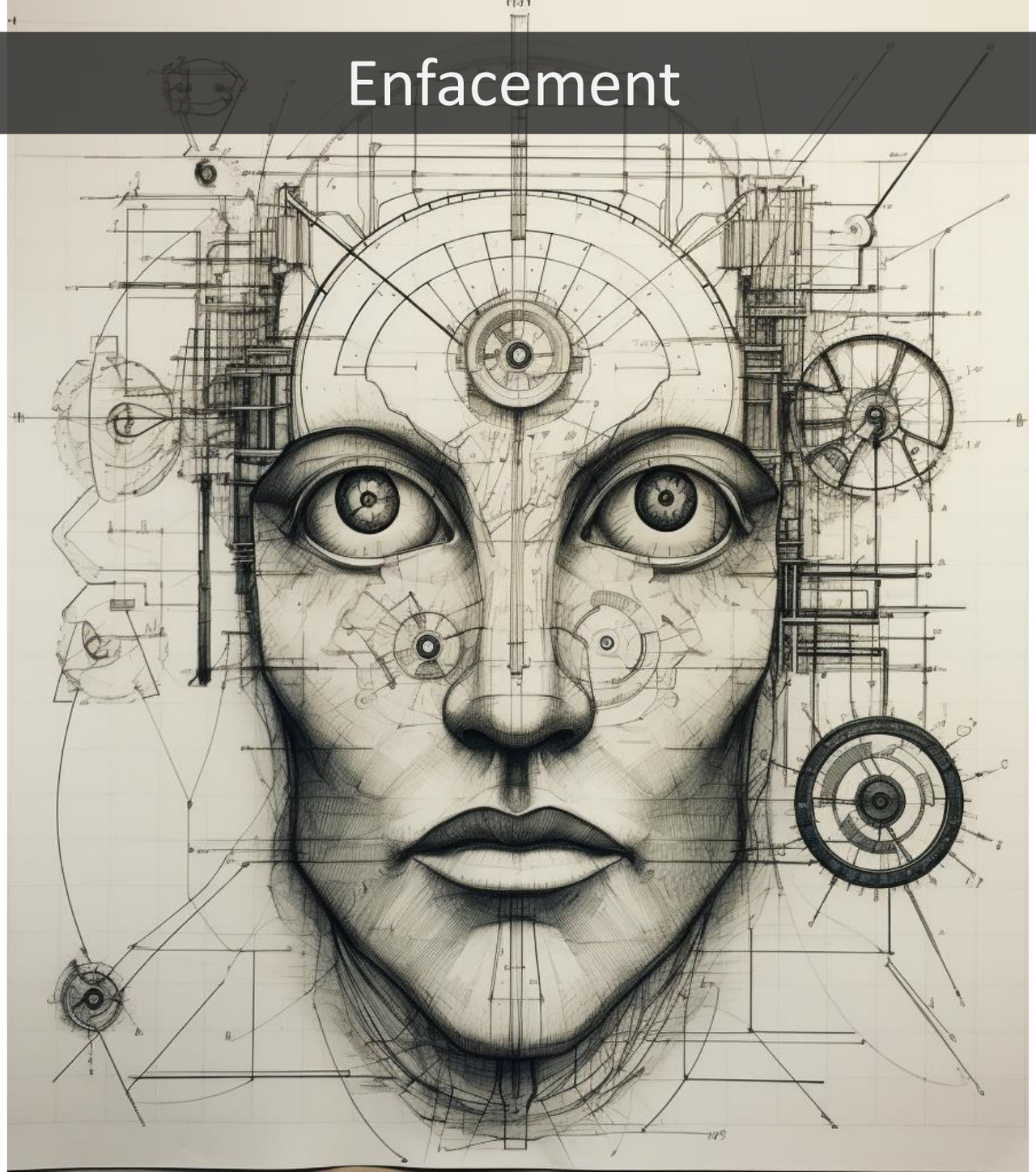
| | |
|---|---|
| Very likely | 64 |
| Somewhat likely | 88 |
| Neither likely nor unlikely | 30 |
| Somewhat unlikely | 54 |
| Very unlikely | 77 |

### After joining the avatar meeting

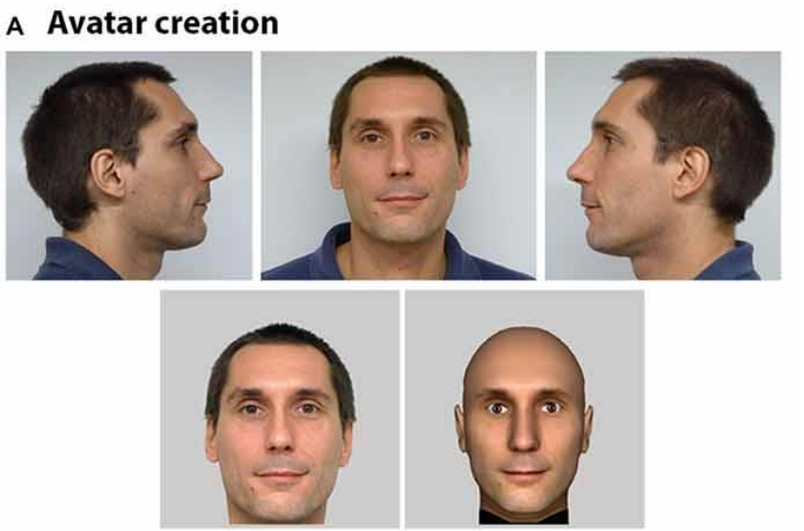


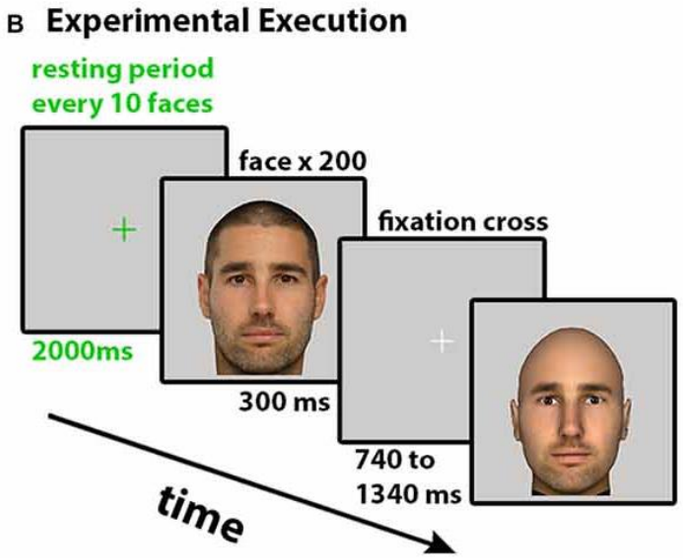

**P Panda** et al. 2022**. All Together! Avatars in Hybrid Conferencing Environments to Enhance Co-Presence**

# Enfacement

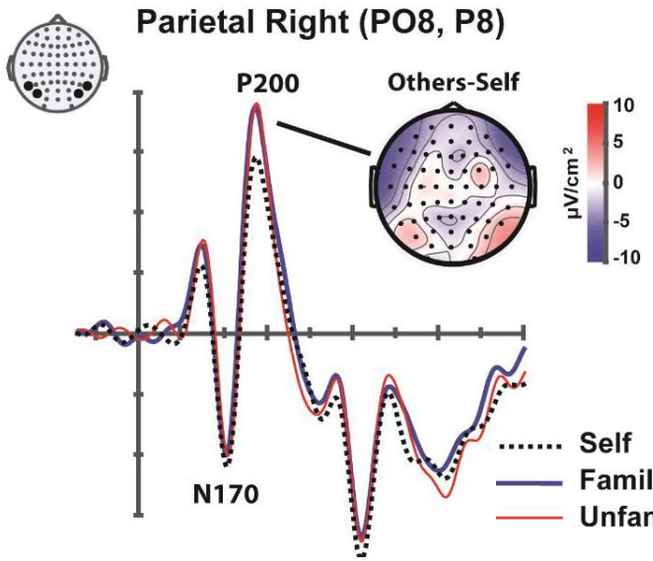


# Self-recognition on Avatars

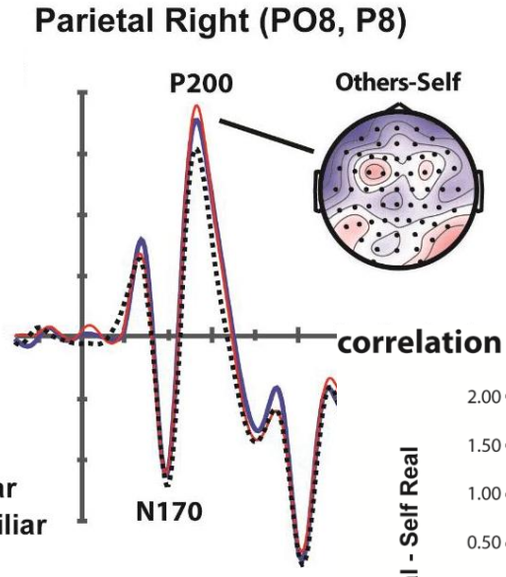


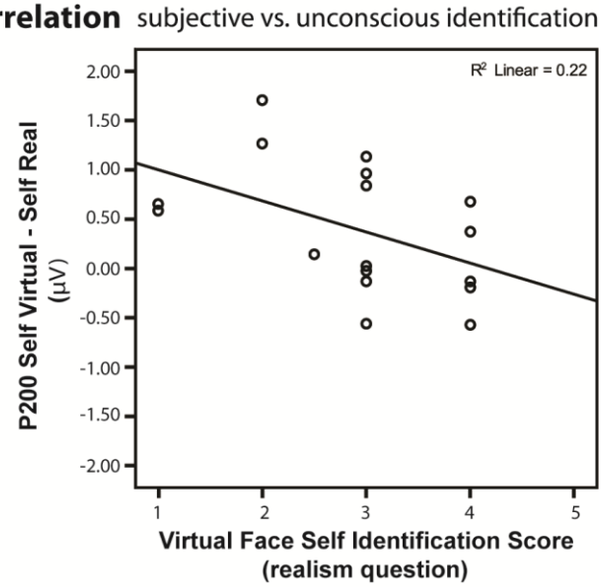




**Real Faces**




**Virtual Faces**



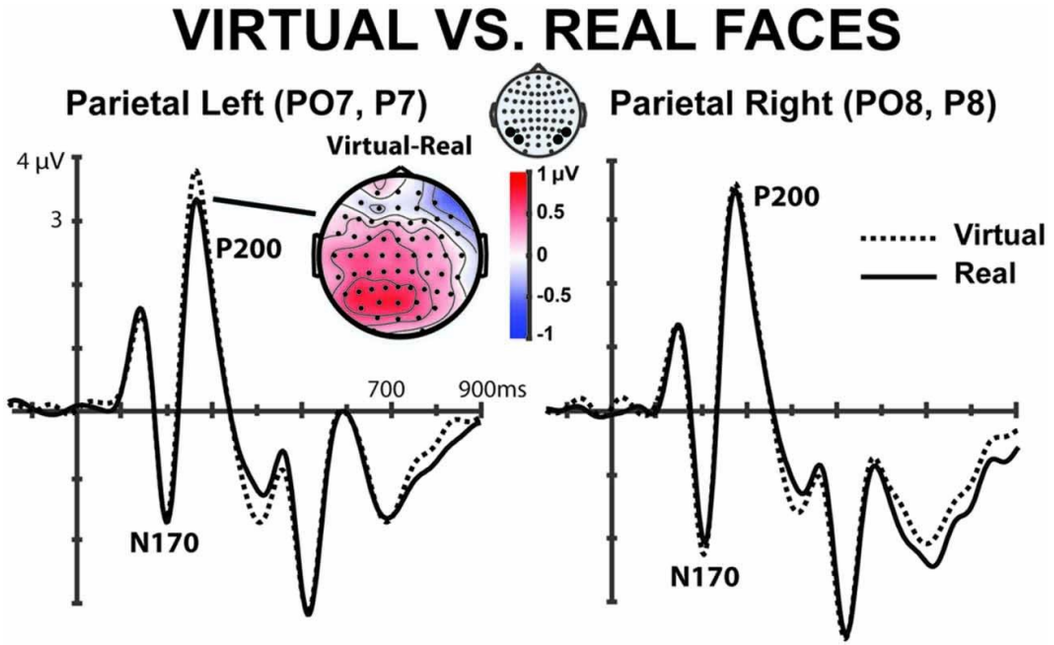

No N170 differences:
same class of object

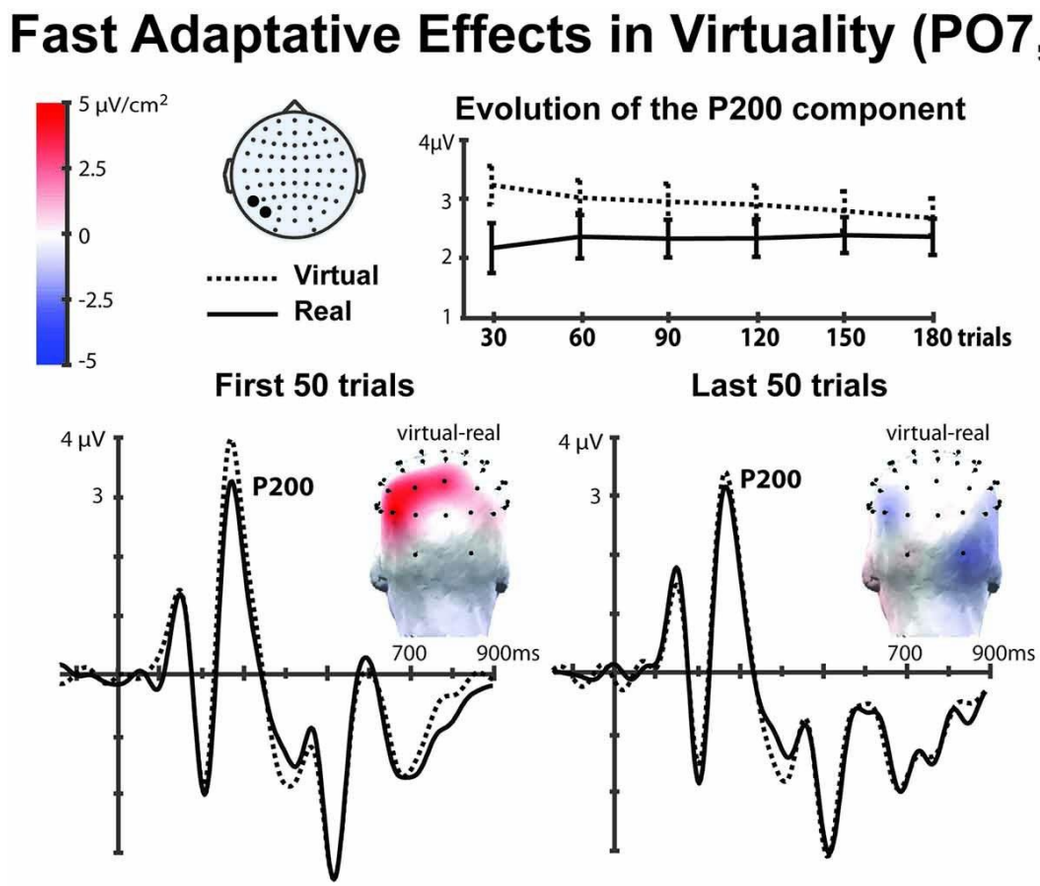
P200/N250 250-300ms
self-recognition

**Gonzalez-Franco** et al. 2016**. The neurological traces of look-alike avatars**
Frontiers in Human Neuroscience

# Self-recognition on Avatars

Spatial



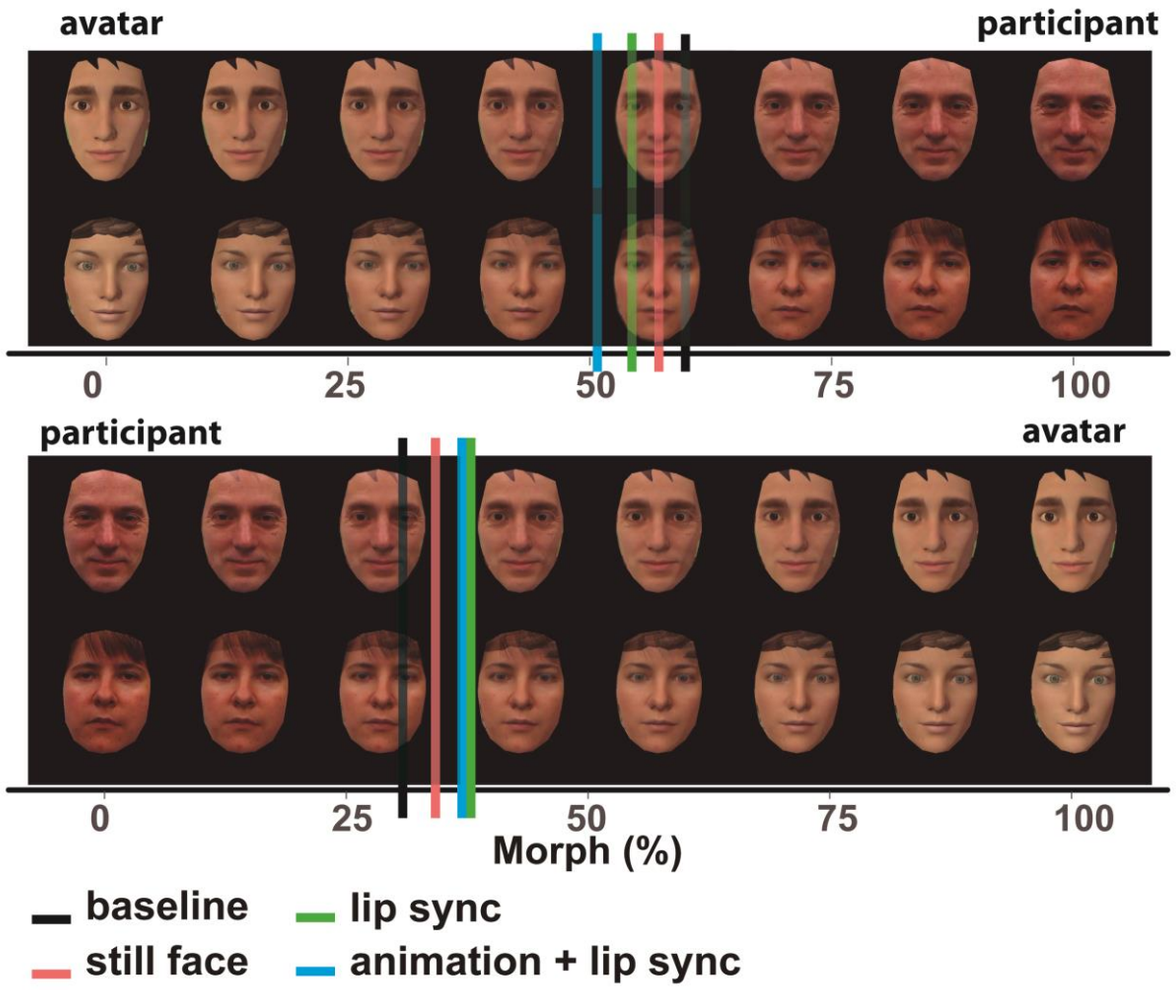



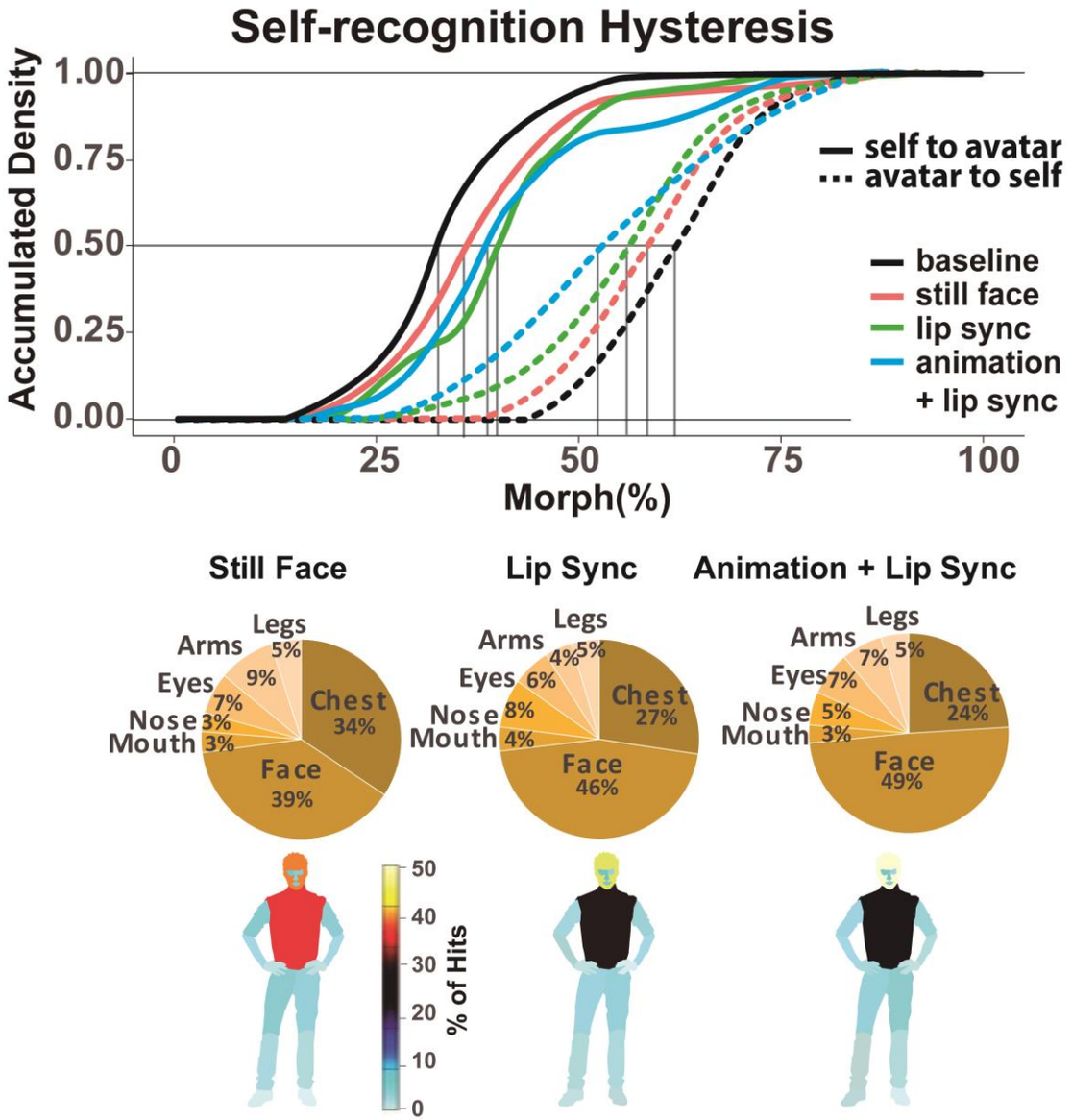

**Gonzalez-Franco** et al. 2016**. The neurological traces of look-alike avatars**
Frontiers in Human Neuroscience

# Enfacement on Avatars

Gonzalez-Franco et al. 2020 **Using Facial Animation to Increase the Enfacement Illusion and Avatar Self-Identification**. IEEE VR.
IEEE Transactions on Visualization and Computer Graphics

# Enfacement on Avatars




Gonzalez-Franco et al. 2020 **Using Facial Animation to Increase the Enfacement Illusion and Avatar Self-Identification**. IEEE VR.
IEEE Transactions on Visualization and Computer Graphics

# Bodily illusions on avatars

Spanlang et al. (2014) ***How to Build an Embodiment Lab: Achieving Body Representation Illusions in Virtual Reality*** Frontiers in Robotics and AI

**EVENTLab – Universitat de Barcelona**

multisensory perception

cognition

Cognitive processes are those responsible for knowledge and awareness. They include the processing of experience, perception, and memory, as well as overtly verbal thinking.

**From:** cognition in The Oxford Dictionary of Philosophy »

processing

multisensory perception

- Proprioception
- Interoception (internal state of the body, self-awareness, emotion)
- Exteroception (senses: vision, audition, touch, olfaction, gustation)

cognition

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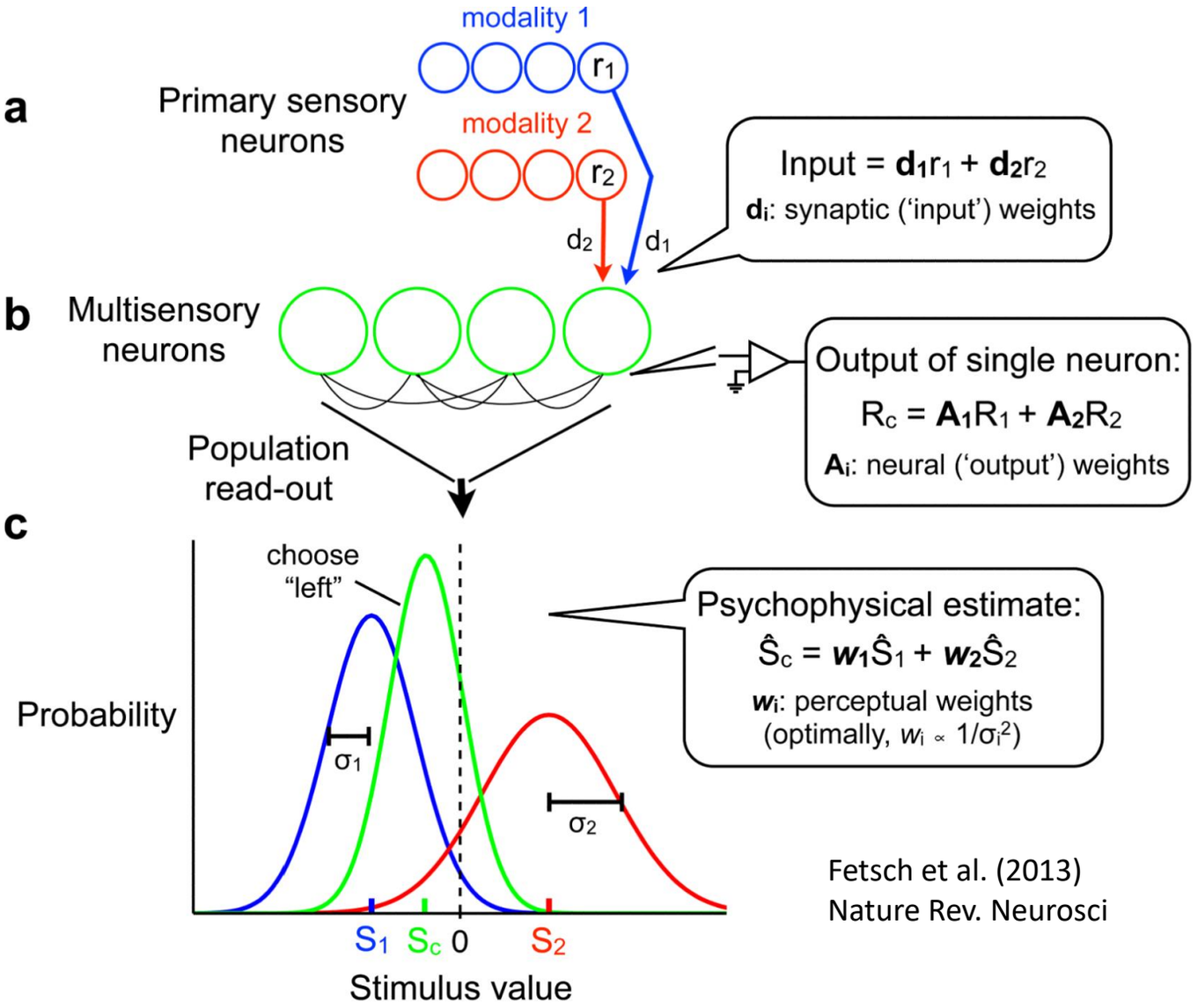
**From:** cognition in The Oxford Dictionary of Philosophy »

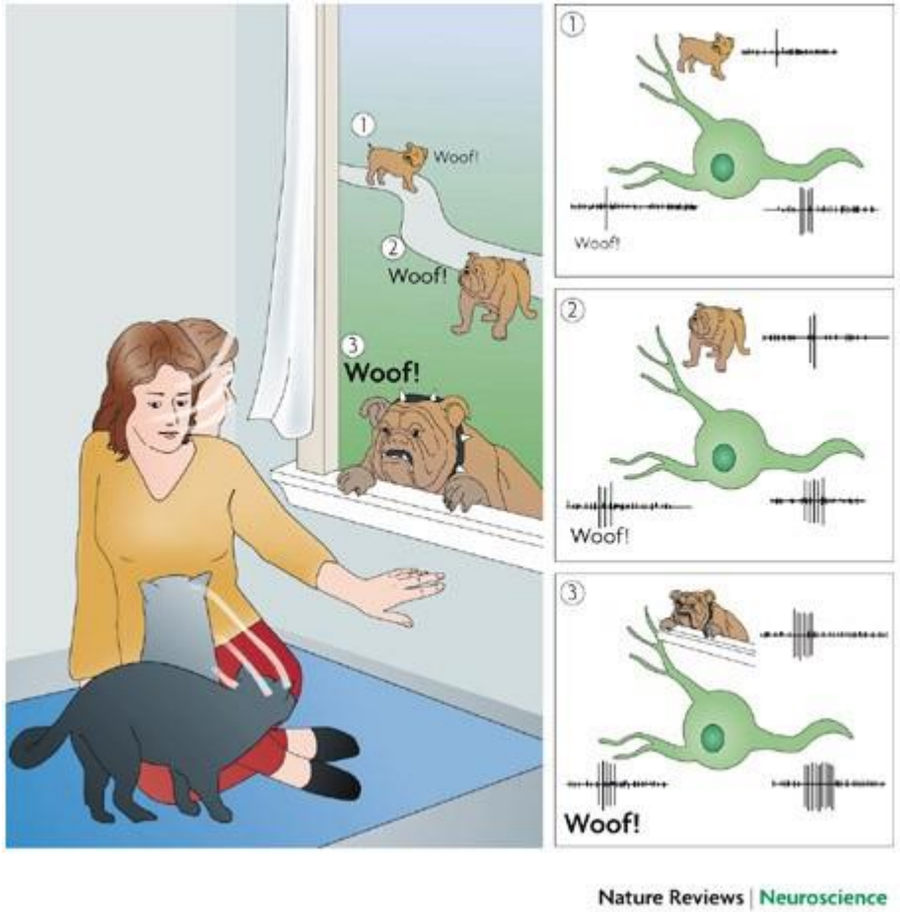

Ramon y Cajal - Nobel Prize

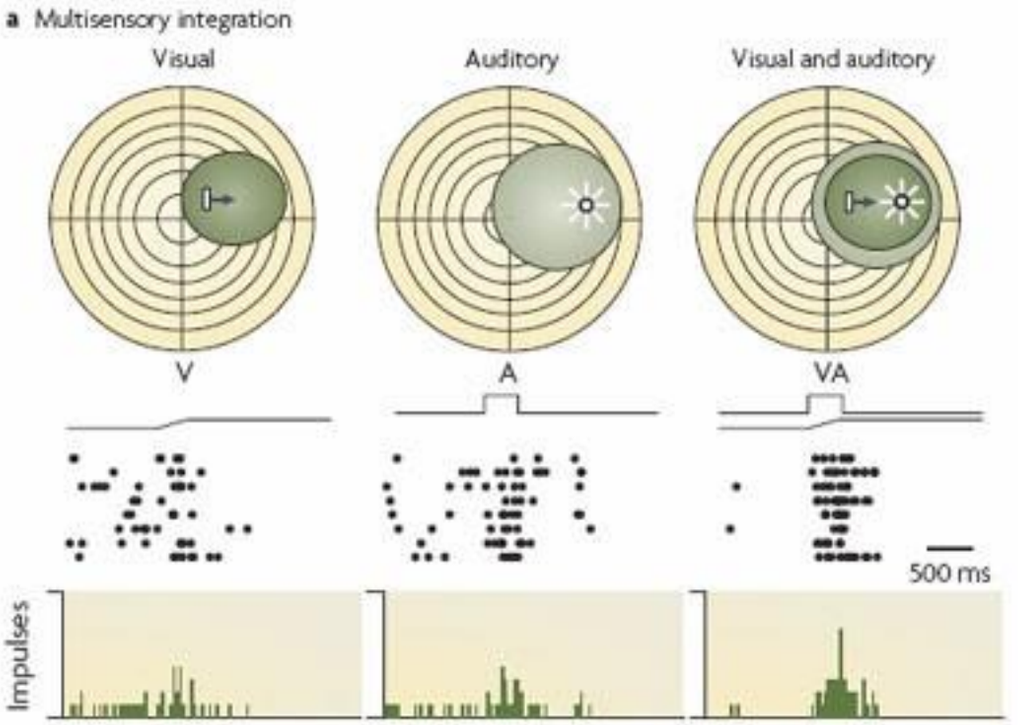
# Multisensory Integration

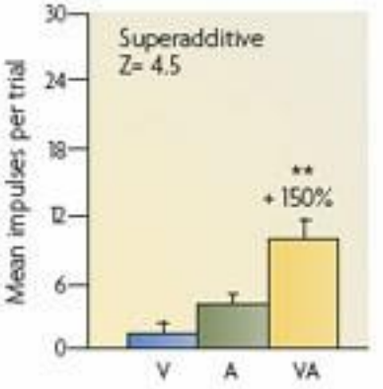



Fetsch et al. (2013)
Nature Rev. Neurosci

# Multisensory Integration




Stein, Barry E., and Terrence R. Stanford. "**Multisensory integration: current issues from the perspective of the single neuron.**" *Nature Reviews Neuroscience* 9.4 (2008): 255-266.

# Complex System

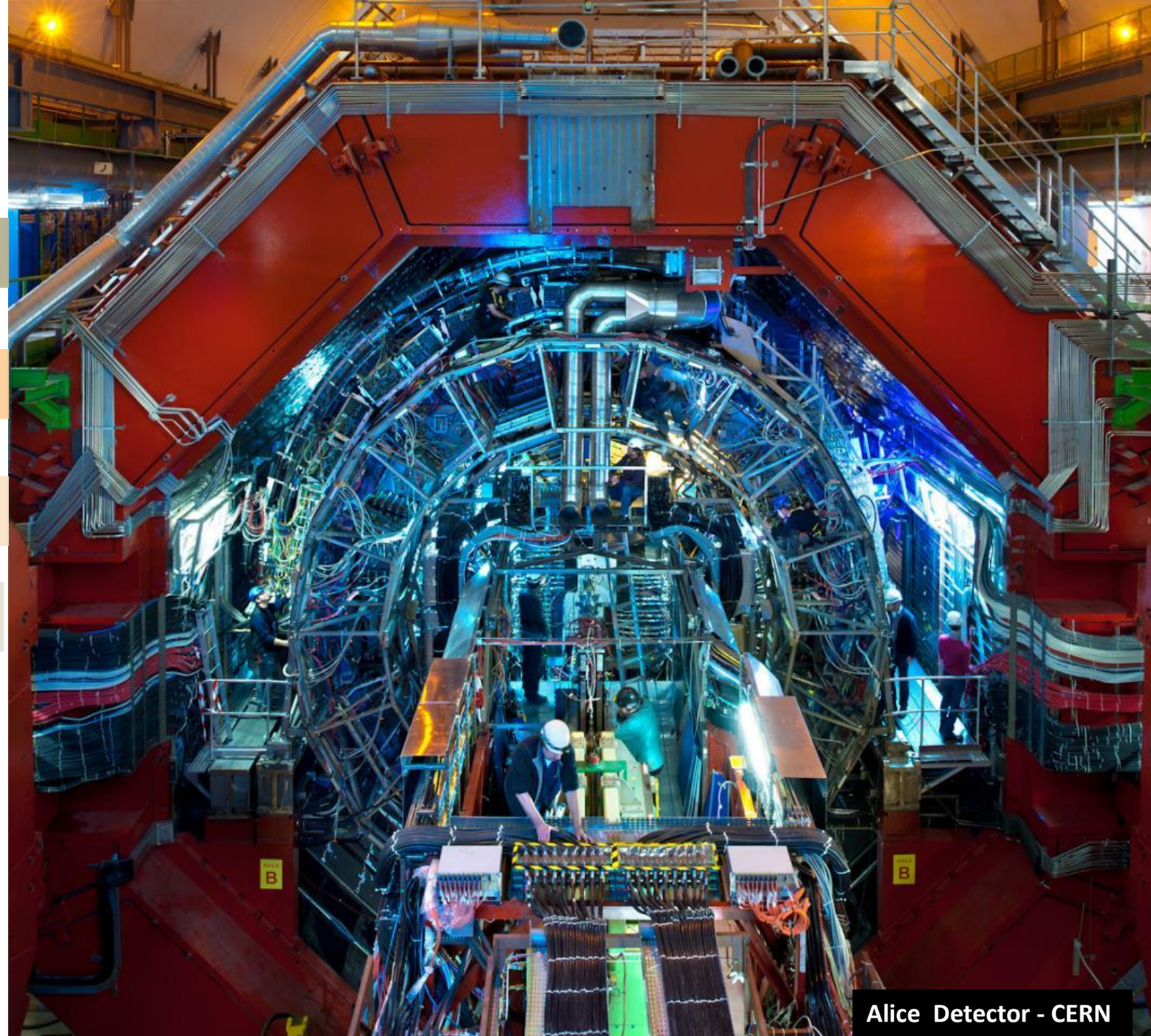
behavior

processing

multisensory perception

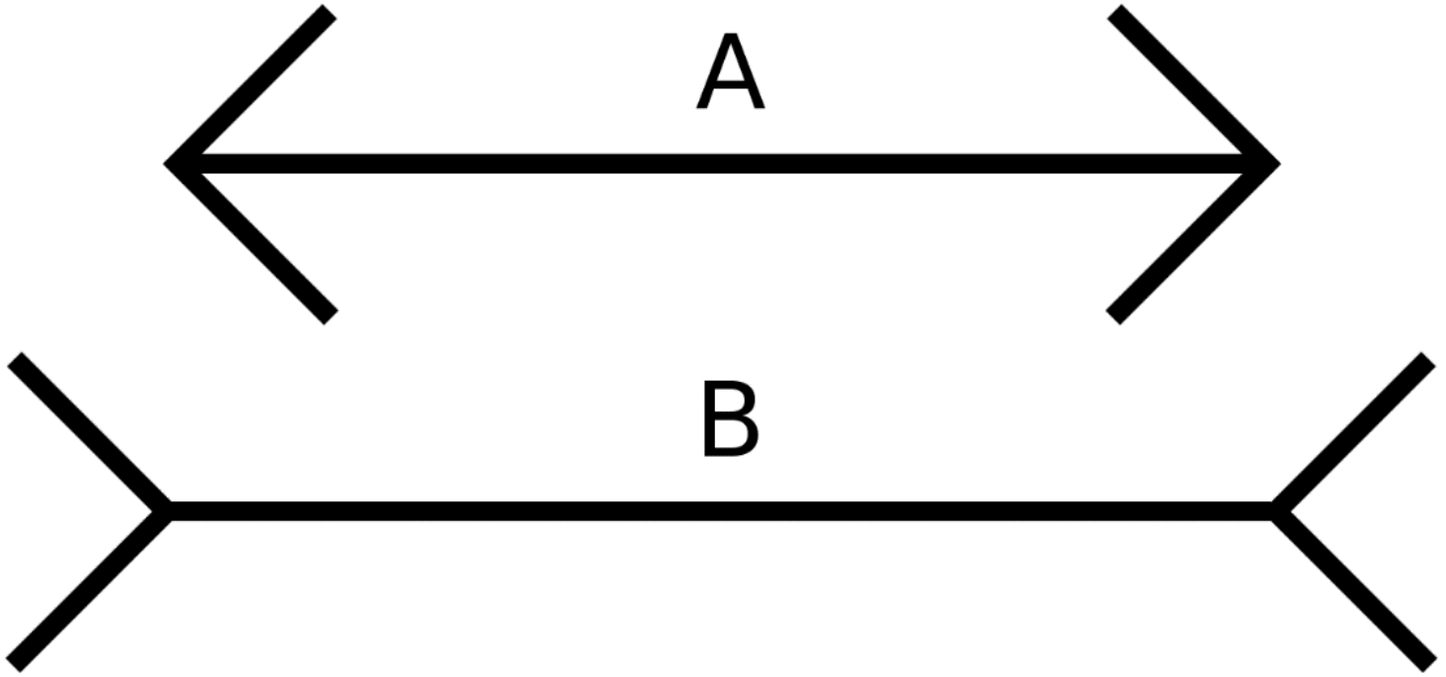
cognition

- Dynamic
- Priors + Pathways
- Errors + Corrections
- Concurrent stimuli of different type



Alice Detector - CERN

# Trick the brain




Gonzalez-Franco, M., & Lanier, J. (2017). **Model of illusions and virtual reality** *Frontiers in psychology*, *8*, 1125.


Botvinick & Cohen - Nature 1998

# Bodily illusions on avatars

Spanlang et al. (2014) ***How to Build an Embodiment Lab: Achieving Body Representation Illusions in Virtual Reality*** Frontiers in Robotics and AI

**EVENTLab – Universitat de Barcelona**

# Embodiment illusion

*{Tao, et al. CHI '23}*

- Normally when we have direct control (agency) of the avatar we experience embodiment: "A 1 to 1 substitution of our body".
- Research has shown that embodiment can alter perception and behavior in different ways

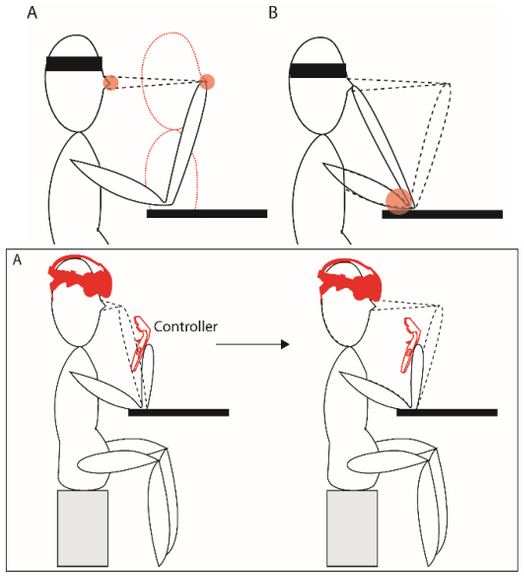
Sense of Body Ownership

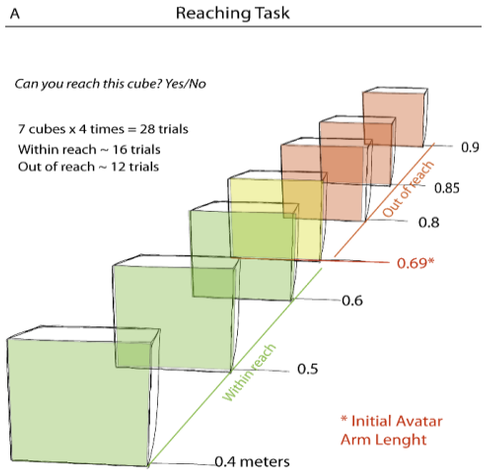
Sense of Self Location

Sense of Agency

Gonzalez-Franco et al. (2010) **The Contribution of Real-Time Mirror Reflections of Motor Actions on Virtual Body Ownership in an Immersive Virtual Environment** IEEE VR

# Body plasticity: Pinocchio Illusion in VR




**Follow Your Nose: Extended Arm Reach After Pinocchio Illusion in Virtual Reality**

**Gonzalez-Franco et al. (Frontiers in VR 2022)**

# Avatar Embodiment

## How to create embodiment

Spanlang et al. (2014) ***How to Build an Embodiment Lab: Achieving Body Representation Illusions in Virtual Reality*** Frontiers in Robotics and AI

Gonzalez-Franco et al. (2010) **The Contribution of Real-Time Mirror Reflections of Motor Actions on Virtual Body Ownership in an Immersive Virtual Environment** IEEE VR

### Effects of Embodiment

#### Follower Effect

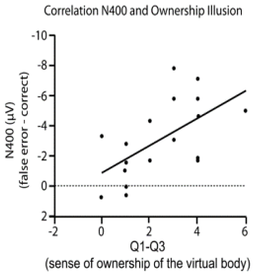
Gonzalez-Franco et al (2020) **The Self-Avatar Follower Effect in Virtual Reality** *IEEE VR*

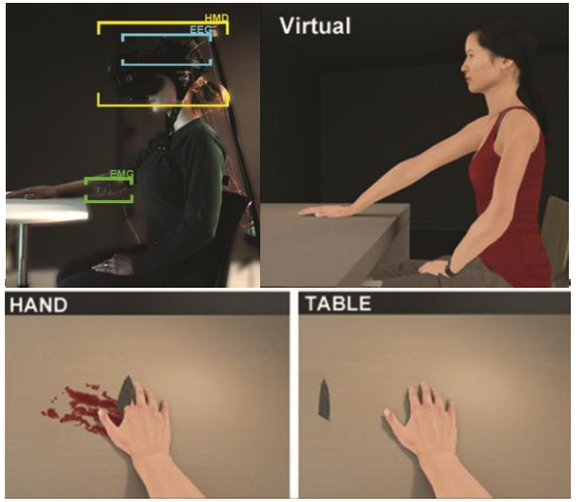
#### Enhanced Presence and Co-Presence

## How to measure embodiment

### Brain (Electrophysiology)

Gonzalez-Franco et al. **A threat to a virtual hand elicits motor cortex activation.** Experimental Brain Research (2014)




### Questionnaires

Gonzalez-Franco M and Peck TC (2018) **Avatar Embodiment. Towards a Standardized Questionnaire** *Front. Robot.* AI

Analyzed 30 famous experiments and extracted 25 questions

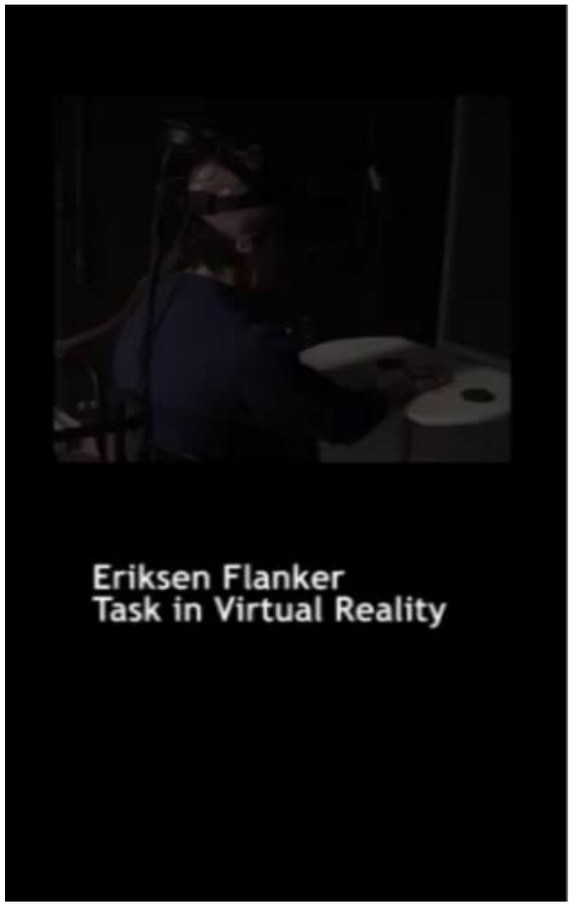
↓ **400 questionnaires later**

Peck TC and Gonzalez-Franco M (2021) **Avatar Embodiment. A Standardized Questionnaire** *Front. In VR*

16 questions

## How to break embodiment

Padrao, Gonzalez-Franco et al. 2016. **Violating body semantics: neural signatures of self-generated and external-errors**. NeuroImage (2016)



# Avatar Embodiment

# Follower Effect

*If we drift the avatar, will the participant try to compensate?* ***Yes***

We have an implicit need to fill the spatial gap between the physical and the self-avatar bodies, whenever the system allows for these types of compensation.

That is the self-avatar follower effect.

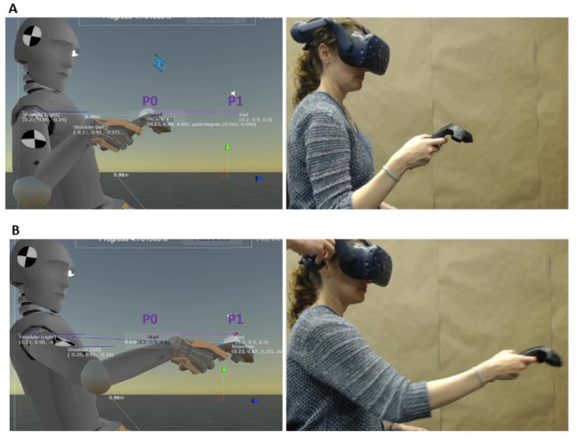
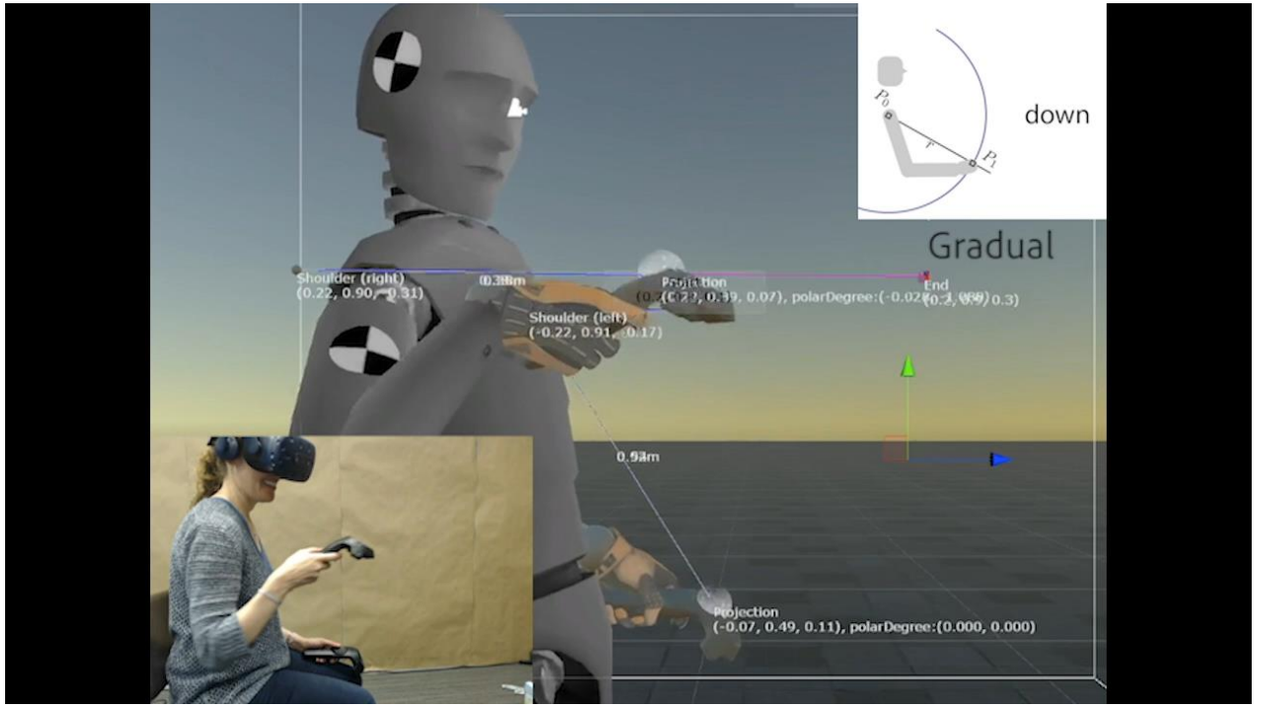


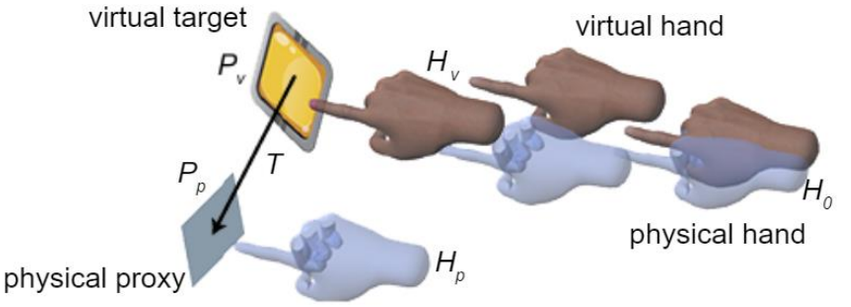

Figure 3: Reaching task performed by participants. A) represents the P0 point near the body, and B) represents the P1 point far from the body. Here we can see a participant performing the reaching task between P0 and P1 and the avatar matching in the straight reach. Reaches were performed in quick succession of one another ($\mu$ =1.1s, $sd$ =0.19)



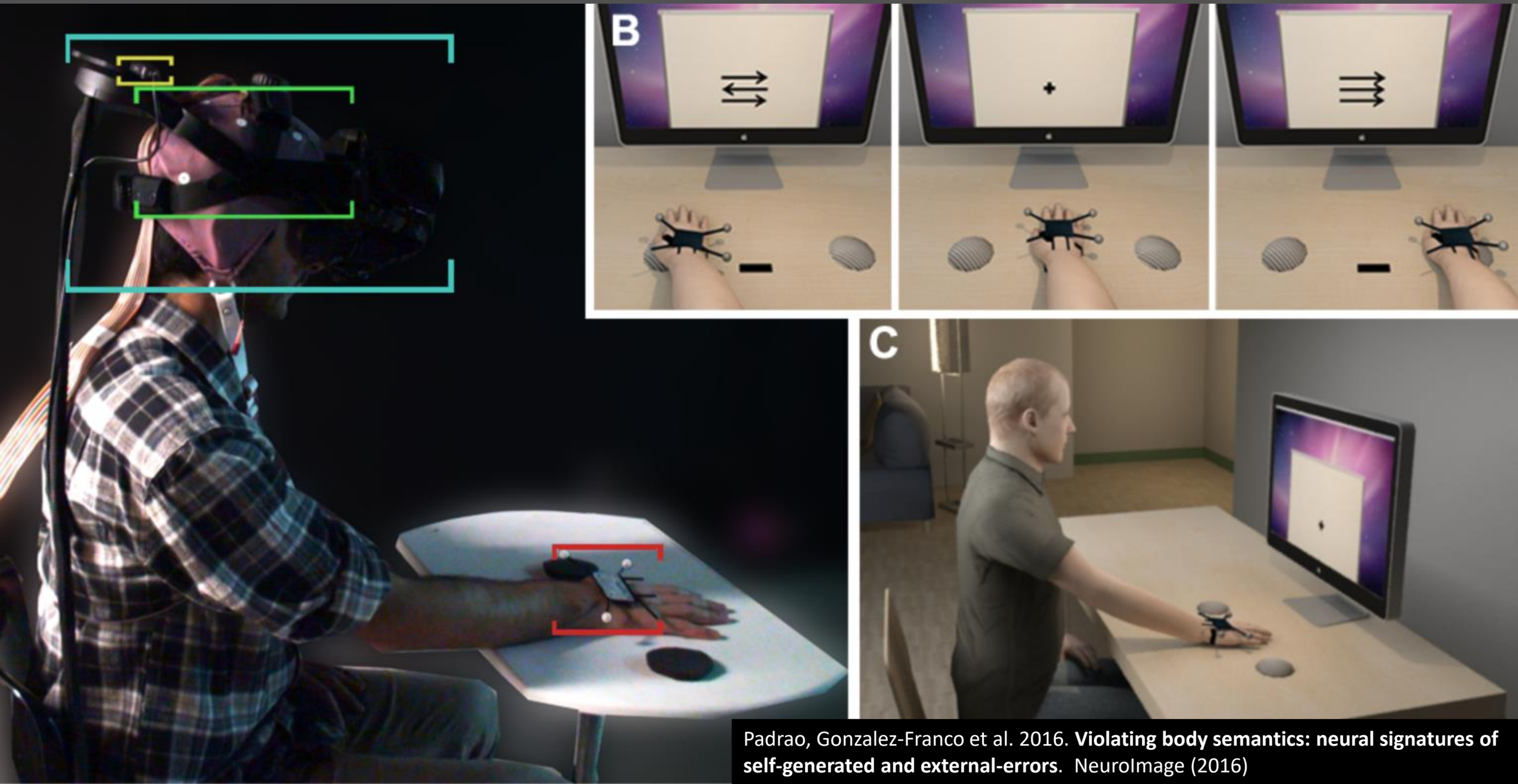

González-Franco, Mar et al. "The Self-Avatar Follower Effect in Virtual Reality." *2020 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)* (2020): 18-25.

# VR Motor Control - Redirection

Maselli, A., et al. 2022 **Enhanced efficiency in visually guided online motor control for actions directed towards the body midline**. Transactions of the Royal Society



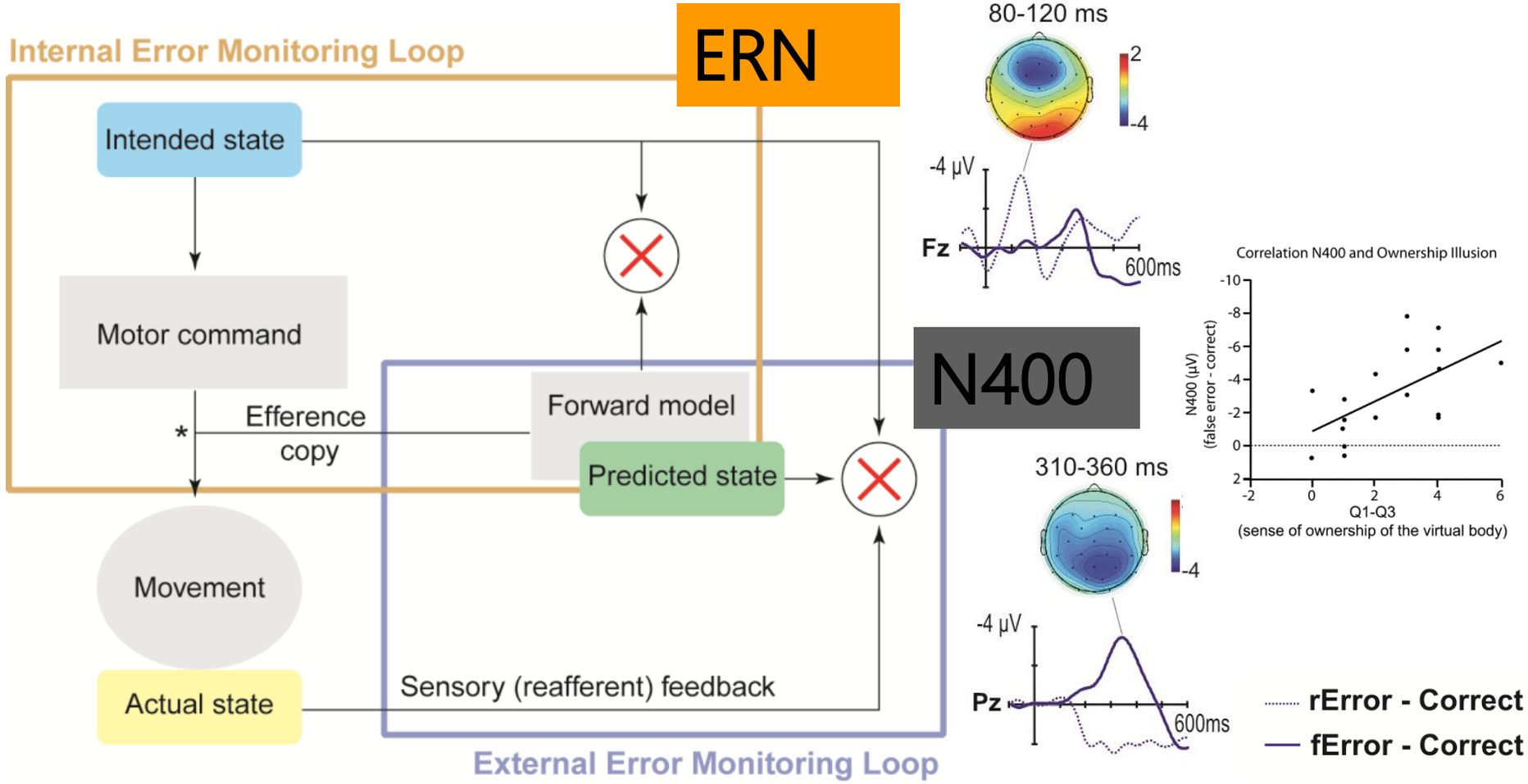

# Sense of Agency




Padrao, Gonzalez-Franco et al. 2016. **Violating body semantics: neural signatures of self-generated and external-errors**. NeuroImage (2016)

# Disrupting the sense of agency of the VB

## Error Monitoring Models. Motor Control


[Gallagher 2000, Frith et al. 2000 ]

Padrao, Gonzalez-Franco et al. 2016. **Violating body semantics: neural signatures of self-generated and external-errors**. NeuroImage (2016)

# Embodying Physics-Aware Avatars in Virtual Reality

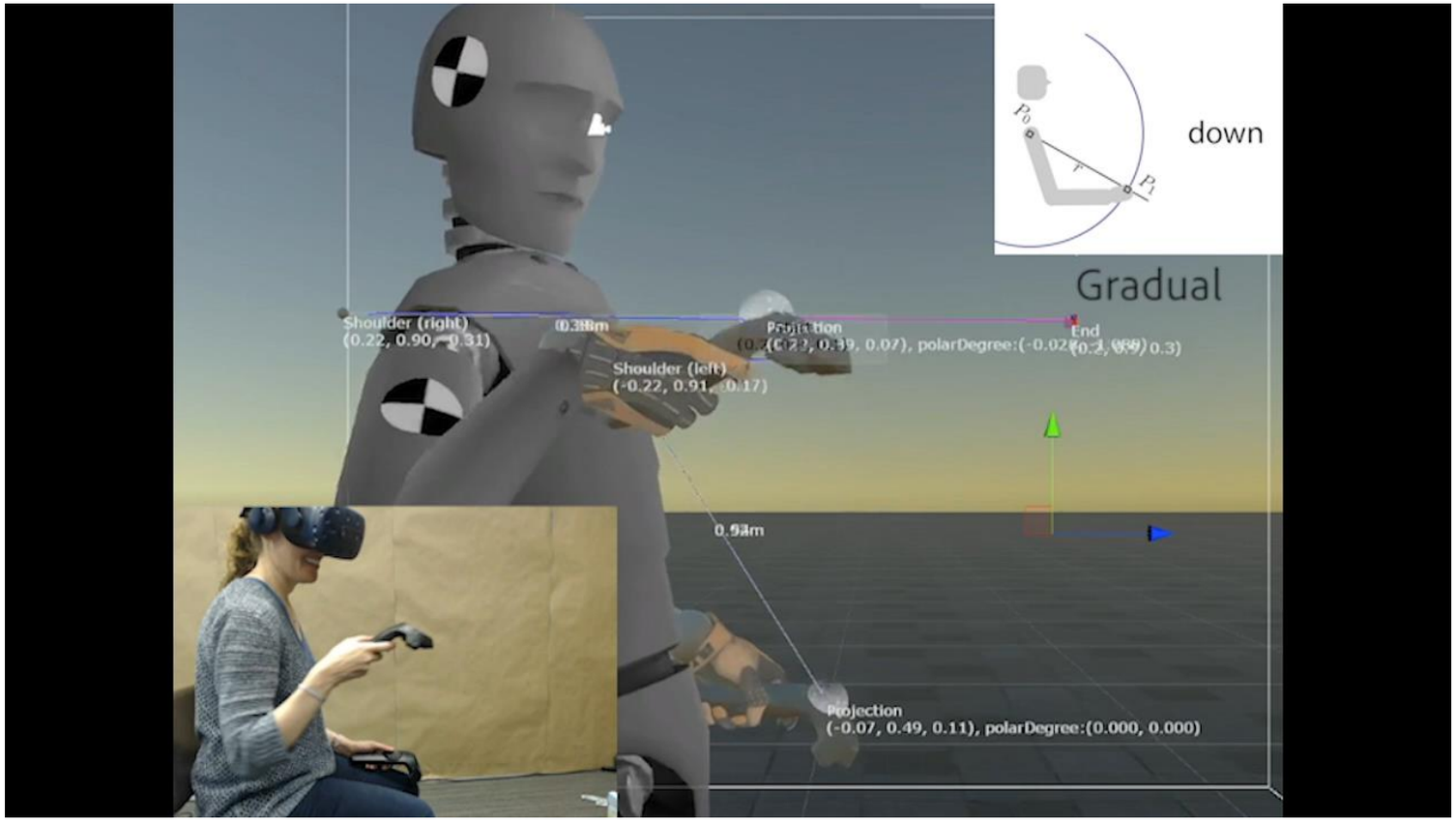
Yujie Tao[1], Cheng Yao Wang[2], Andrew D. Wilson[3],
Eyal Ofek[3], Mar Gonzalez-Franco[3]

[1] Stanford University [2] Cornell University [3] Microsoft

*Yujie Tao, et al. 2023.* ***Embodying Physics-Aware Avatars in Virtual Reality.*** *CHI '23*

# Embodied Interaction

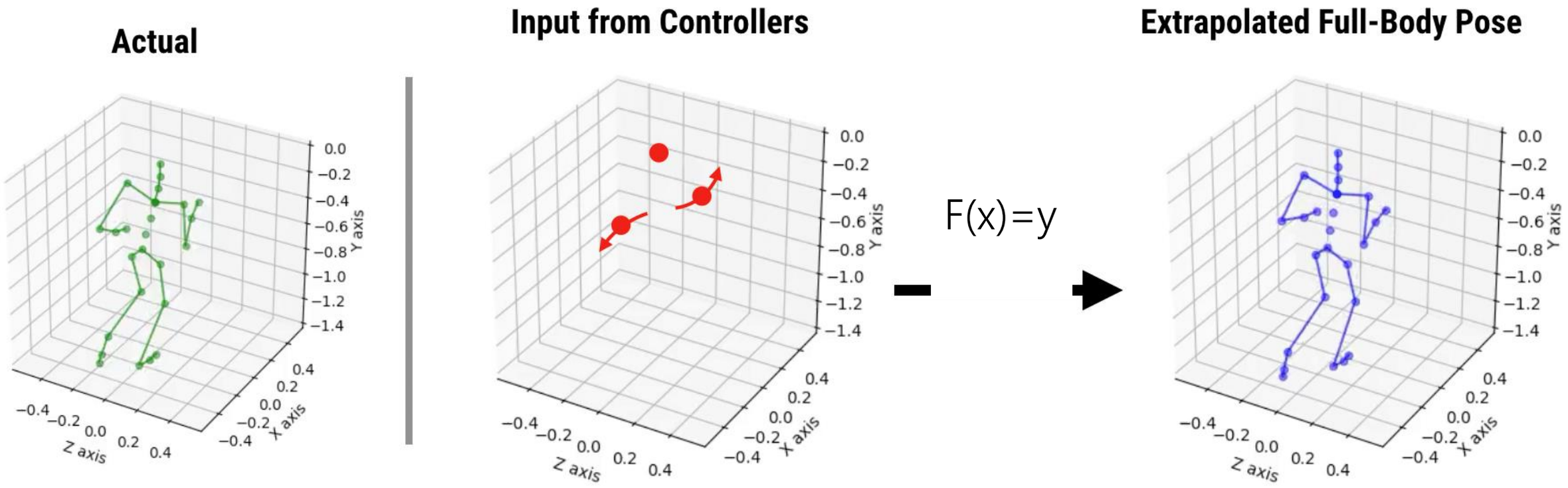
## Decoupling 1 to 1 mapping of your body motions




Cohn et al. “SnapMove: Movement Projection Mapping in Virtual Reality.” *IEEE AIVR* (2020): 18-25.

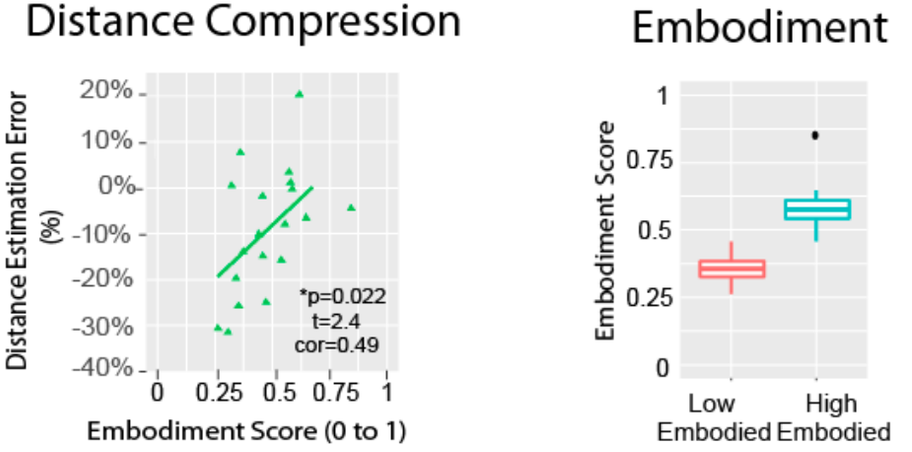
# Decoupling the 1 to 1 mapping

Full Body Interactions



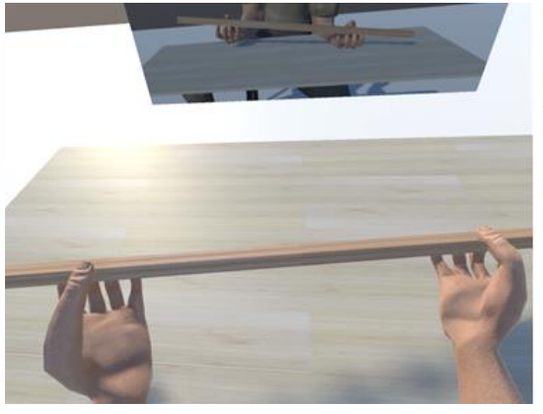

Ahuja, Karan, et al. "CoolMoves: User Motion Accentuation in Virtual Reality." *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 5.2 (2021): 1-23.

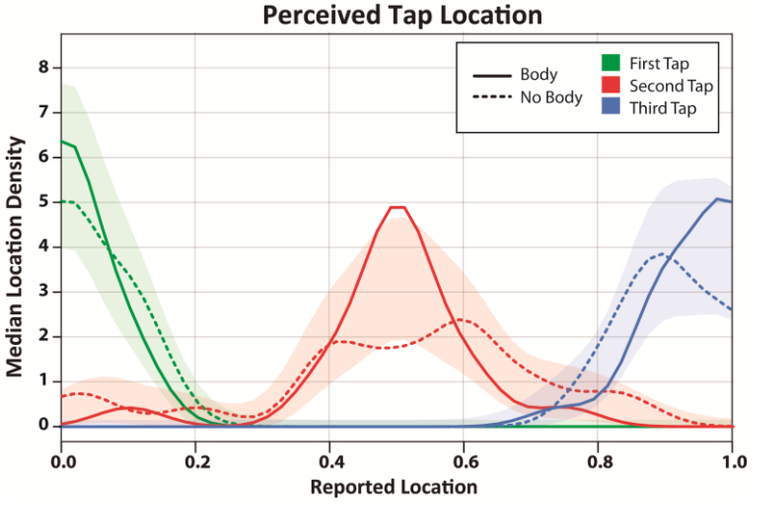
# Distance Compression


Gonzalez-Franco et al. (2019) Individual Differences in Embodied Distance Estimation in Virtual Reality, IEEE VR

# Perception of touch




Gonzalez-Franco & Berger (2019) Avatar Embodiment Enhances Haptic Confidence on the Out-of-Body Touch Illusion. IEEE Transactions on Haptics

behavior

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**From:** cognition in The Oxford Dictionary of Philosophy »

# Avatar BEHAVIOUR

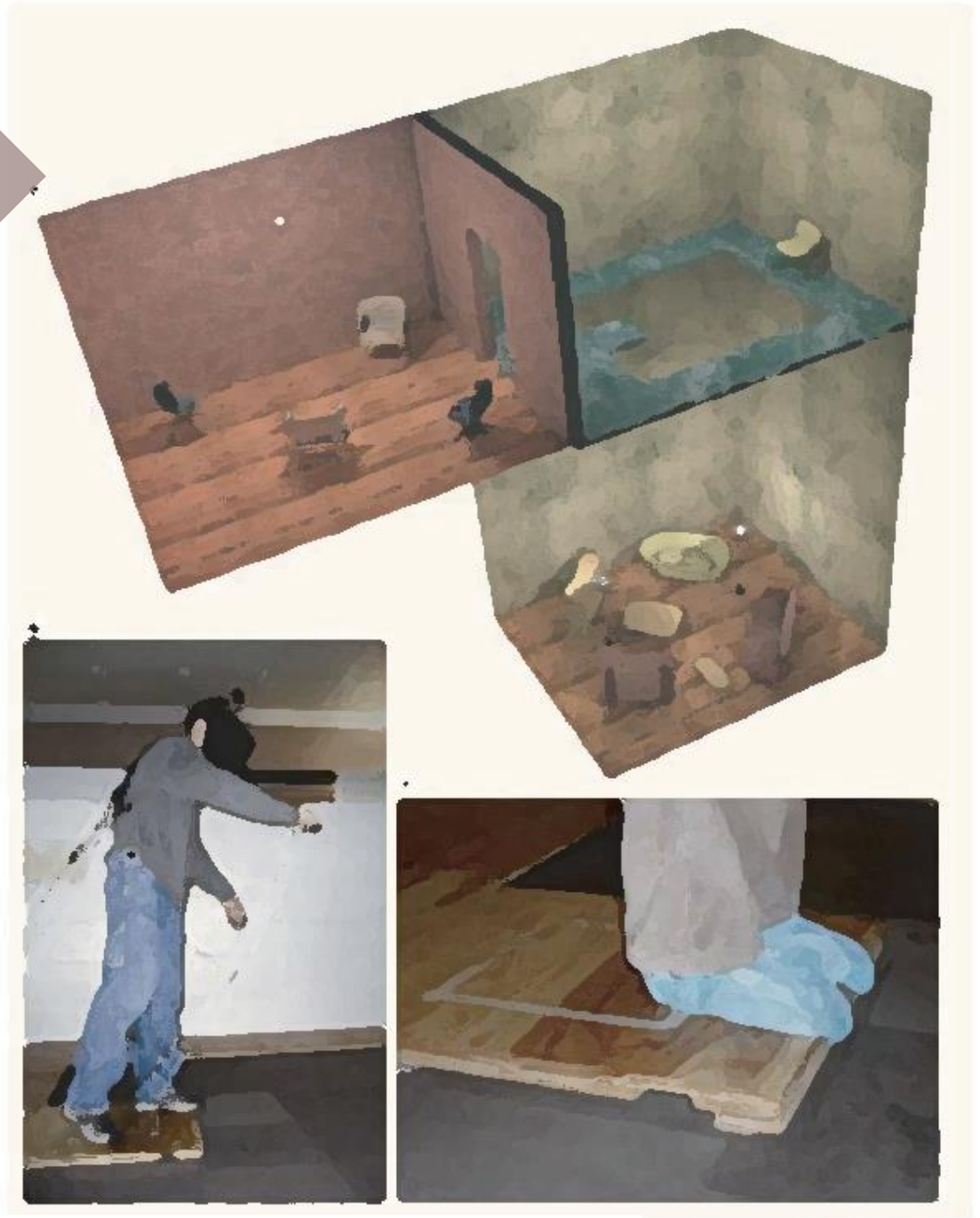
REALISTIC BEHAVIOR

Place Illusion

Presence Illusion

Plausibility Illusion

Sanchez-Vives & Slater Nat Neurosci 2005



Meehan et al. Siggraph 2002

Nature Reviews | Neuroscience

SCIENTIFIC AMERICAN

# Would You Give a Virtual Electric Shock to an Avatar?

In a repeat of a classic experiment, we find that people who are only unenthusiastically obeying unethical orders still experience trauma

By Mar Gonzalez-Franco, Mel Slater on April 12, 2019

One common trait of repressive governments or laws is the emergence of an organized resistance, often involving high-ranking officials and civil figures who aren't keen on obeying their leaders.

clear evidence of a kind of disobedience among our participants. They did not enter an "agentic" state, blindly and carefully carrying out the orders of the experimenter, as executioners of harmful behavior. Instead they fit more the profile of an "engaged follower," someone who apparently engages but nevertheless tries to get around the specifics of the orders. Essentially, they were disobeying or quietly resisting while appearing to follow orders.

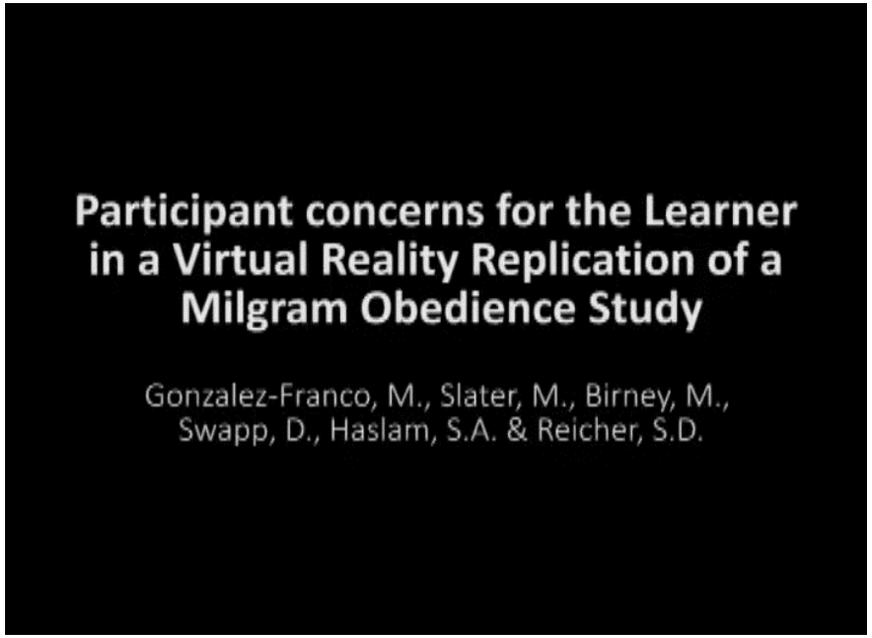
# Moral Dilemmas

SCIENTIFIC AMERICAN

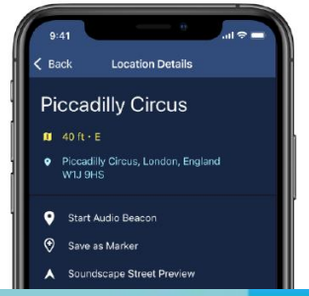
## Would You Give a Virtual Electric Shock to an Avatar?

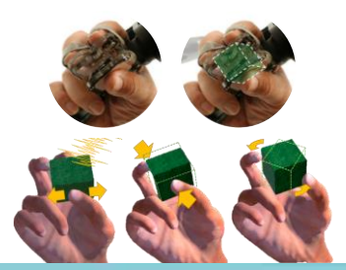
In a repeat of a classic experiment, we find that people who are only unenthusiastically obeying unethical orders still experience trauma

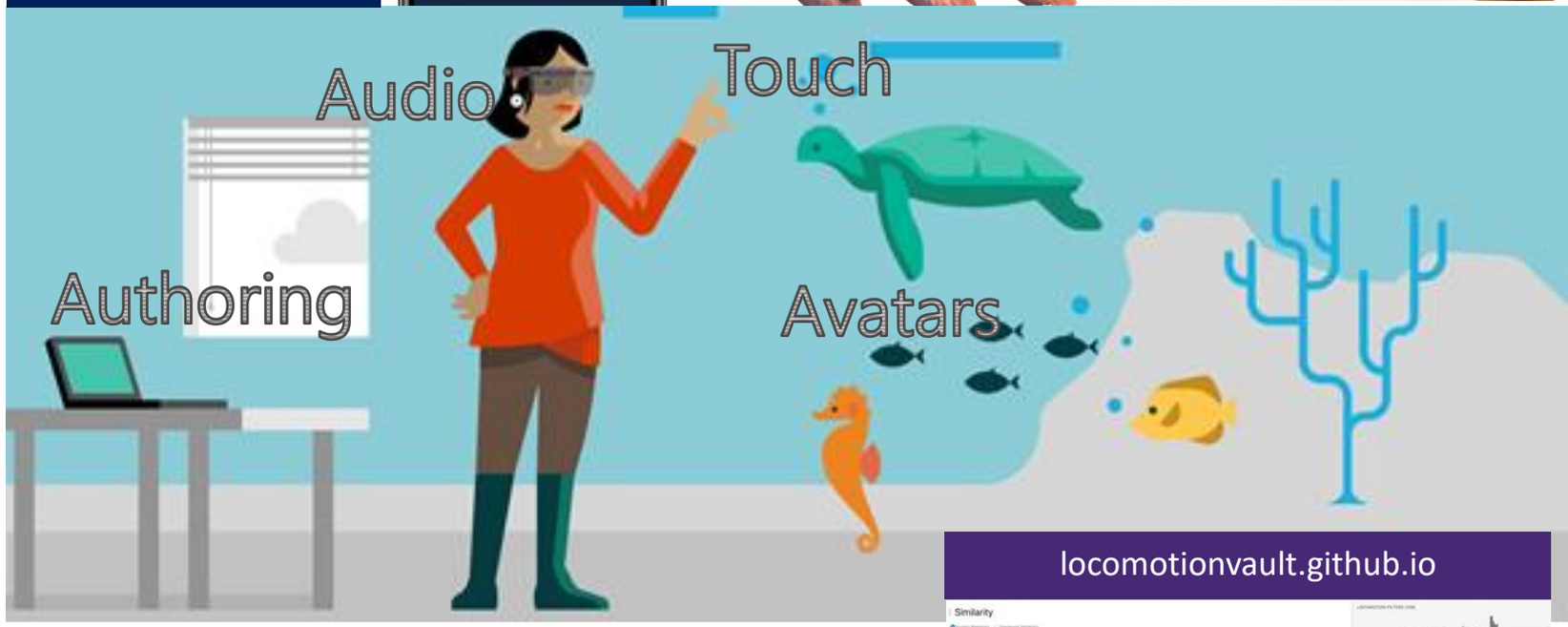
By Mar Gonzalez-Franco, Mel Slater on April 12, 2019




Gonzalez-Franco et al. 2019 **Participant concerns for the Learner in a Virtual Reality replication of the Milgram obedience study**. Plos One

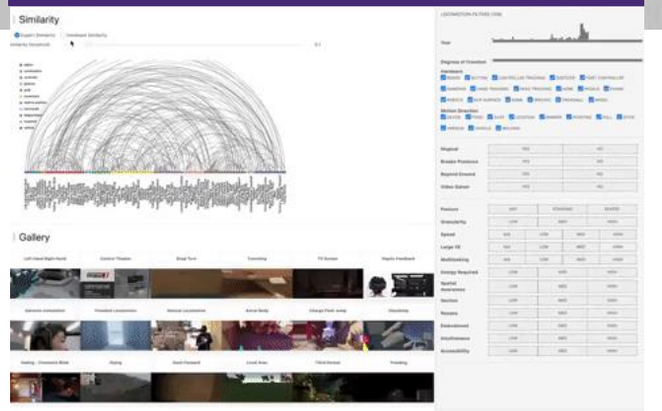




Microsoft Rocketbox


locomotionvault.github.io




We need tools,
open source and for all levels

# Microsoft Rocketbox

library of rigged avatars free for academic and research use


https://github.com/microsoft/Microsoft-Rocketbox

Gonzalez-Franco, Ofek, Pan, Antley, Steed, Spanlang, Maselli, Banakou, Pelechano, Orts Escolano, Orvahlo, Trutoiu, Wojcik, Sanchez-Vives, Bailenson, Slater, and Lanier. Frontiers in VR (2020) "**The Rocketbox library and the utility of freely available rigged avatars**." Frontiers in VR

MoveBox: Democratizing MoCap for the Microsoft Rocketbox Avatar Library

https://github.com/microsoft/MoveBox-for-Microsoft-Rocketbox

Gonzalez-Franco et al. Movebox: democratizing MoCap for the Microsoft Rocketbox Avatar Library IEEE AIVR 2020

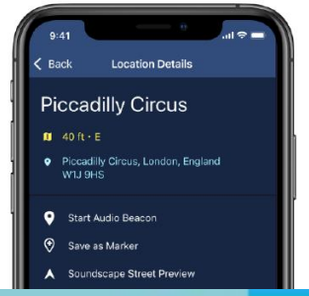
# HeadBox: A Facial Blendshape Animation Toolkit for the Microsoft Rocketbox Library

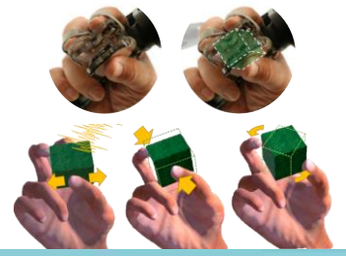
Matias Volonte, Eyal Ofek, Ken Jakubzak, Shawn Bruner, Mar Gonzalez-Franco

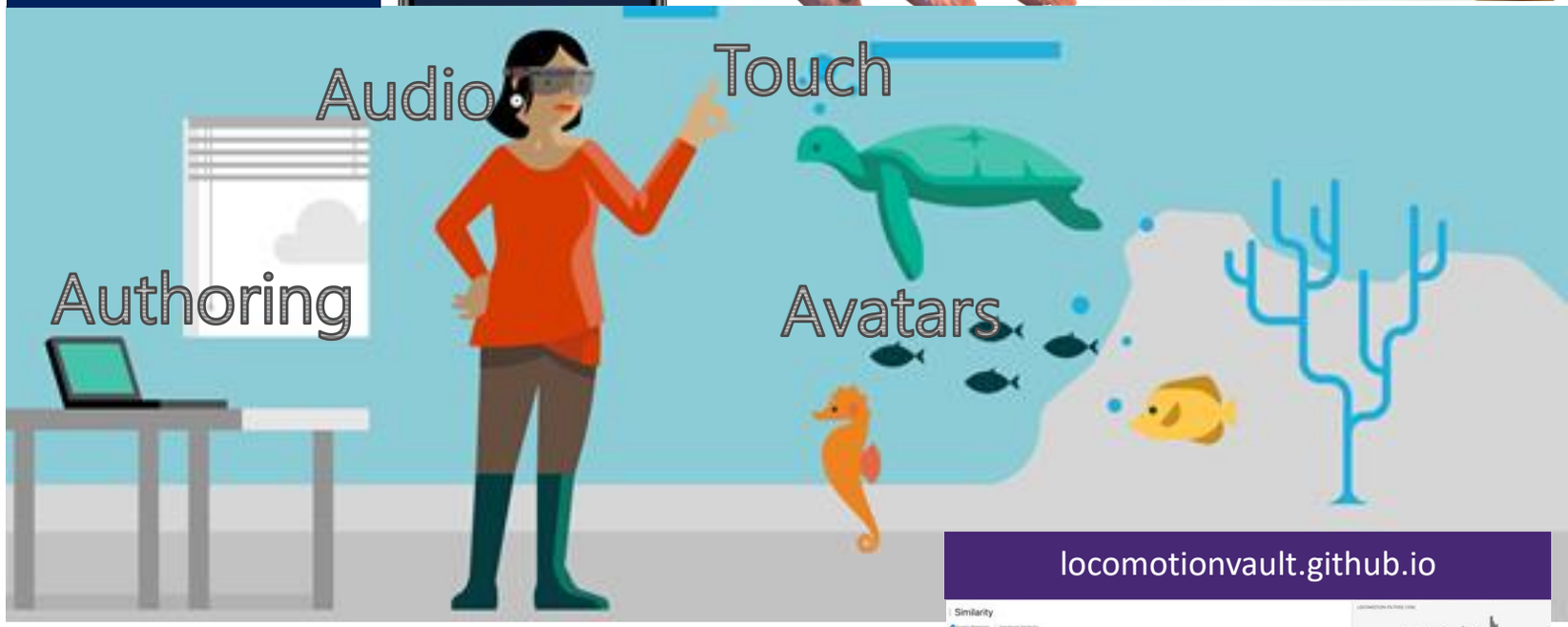
**OpenVRLab**
*IEEE VR 2022 Workshop - Open Access Tools and Libraries for Virtual Reality*

Matias Volonte, Eyal Ofek, Ken Jakubzak, Shawn Bruner, Mar Gonzalez-Franco
HeadBox: A Facial Blendshape Animation Toolkit for the Microsoft Rocketbox Library. IEEE VR 2022

https://github.com/openVRlab/Headbox

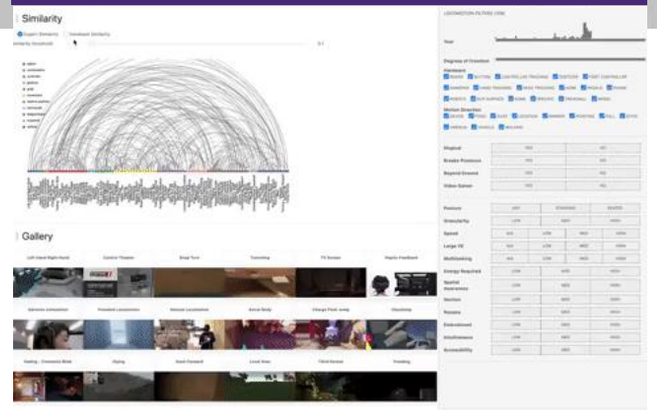




## Microsoft Rocketbox


## locomotionvault.github.io



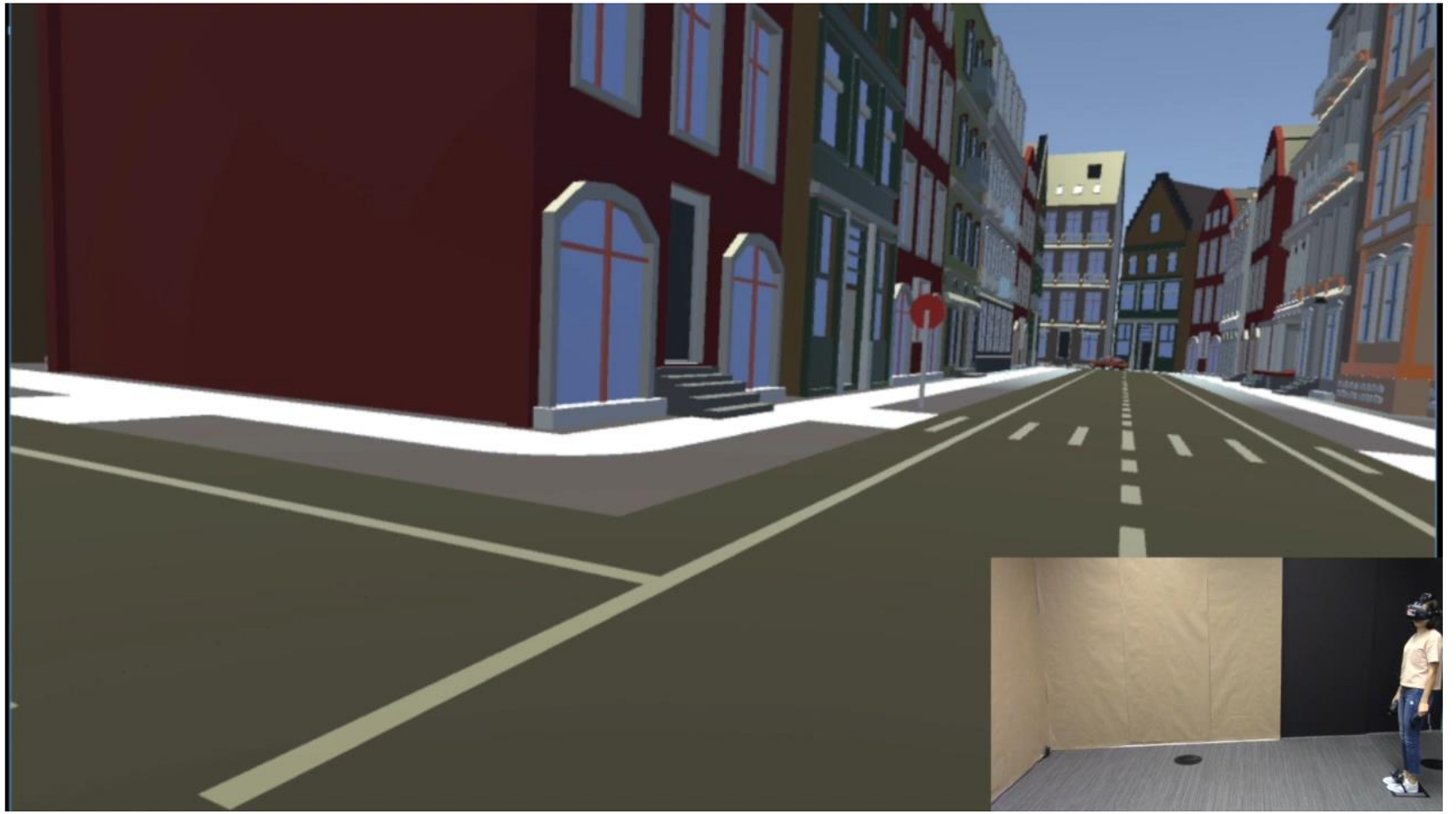

margonzalezfranco.github.io

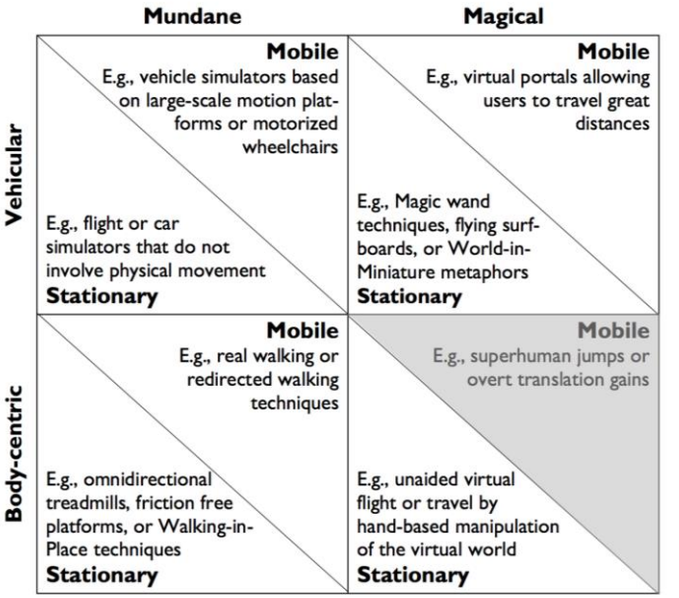
# Embodied Interaction

1 to 1 mapping of your body motions

**Limited Space**

***Locomotion***






Abtahi et al. I'm a Giant: Walking in Large Virtual Environments at High Speed Gains, CHI 2019

# Locomotion Vault: the Extra Mile in Analyzing VR Locomotion Techniques

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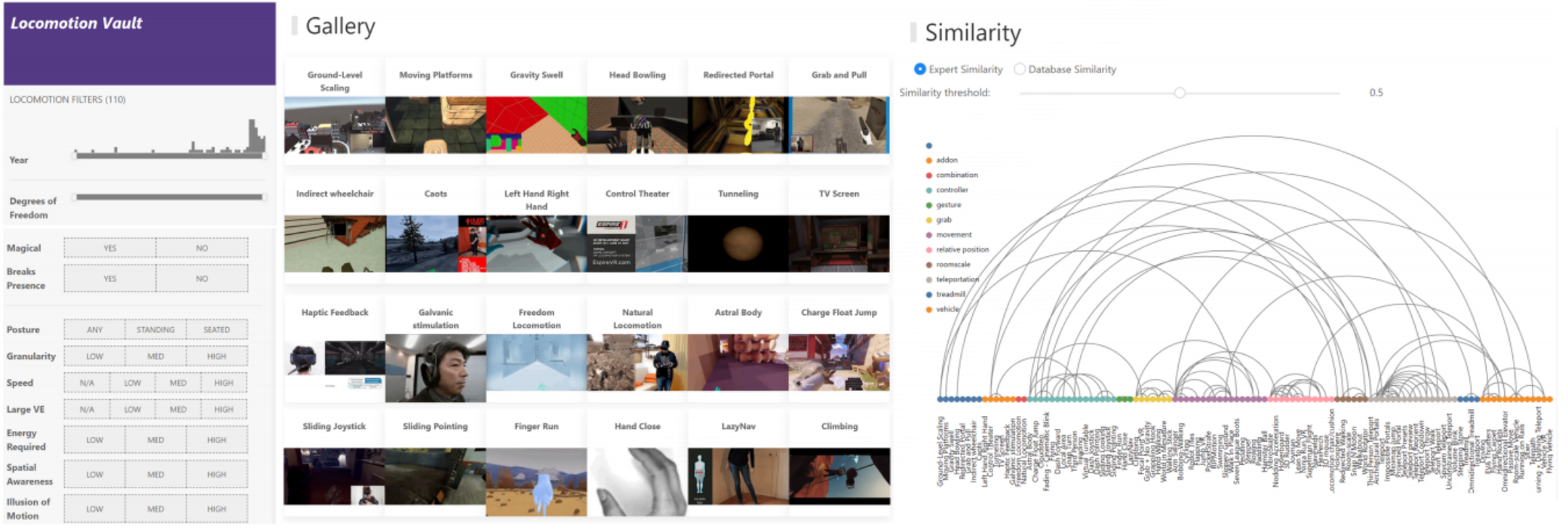
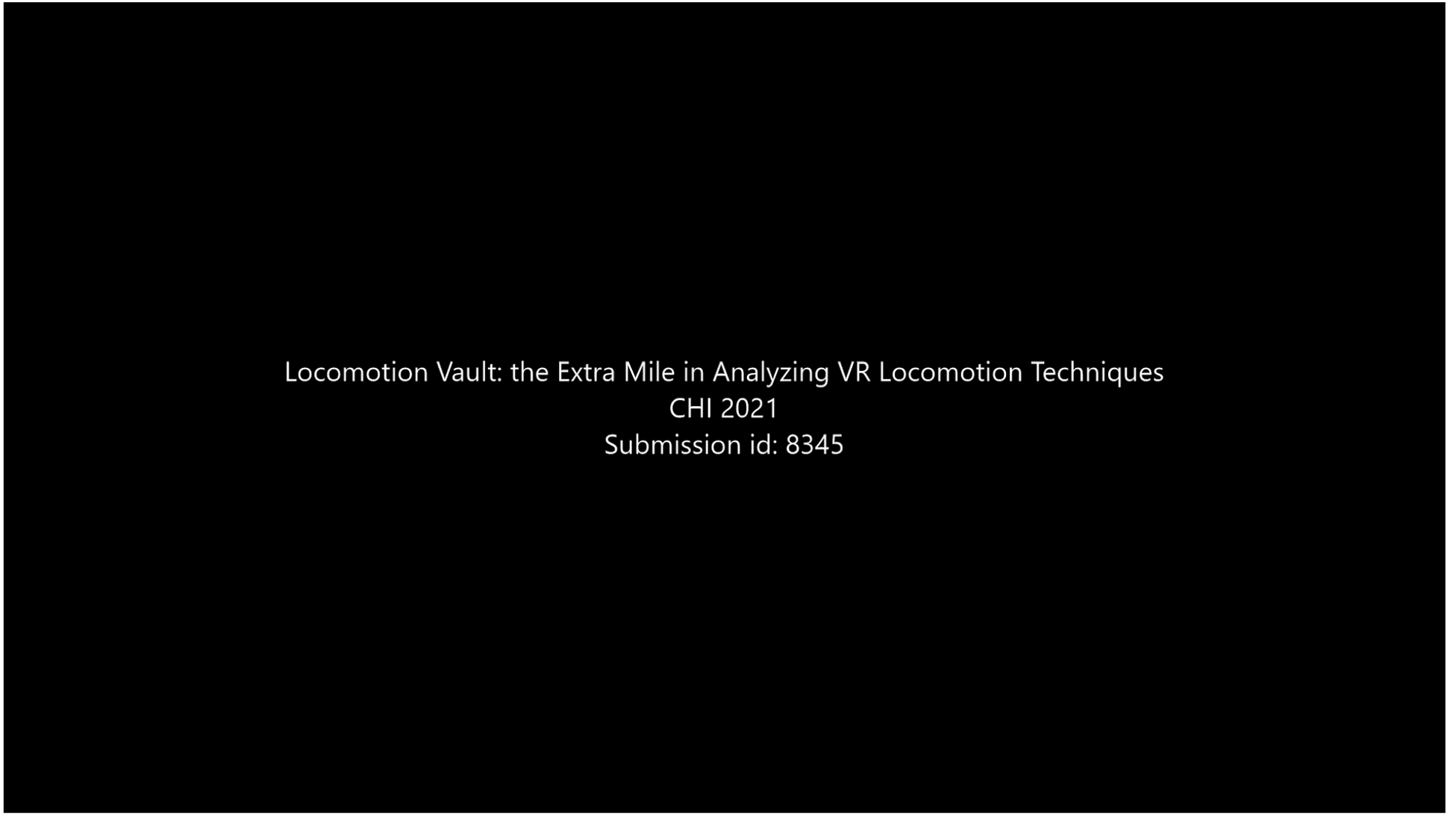
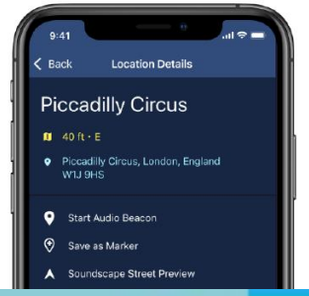
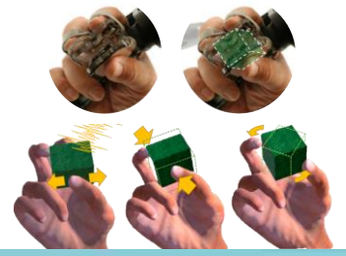


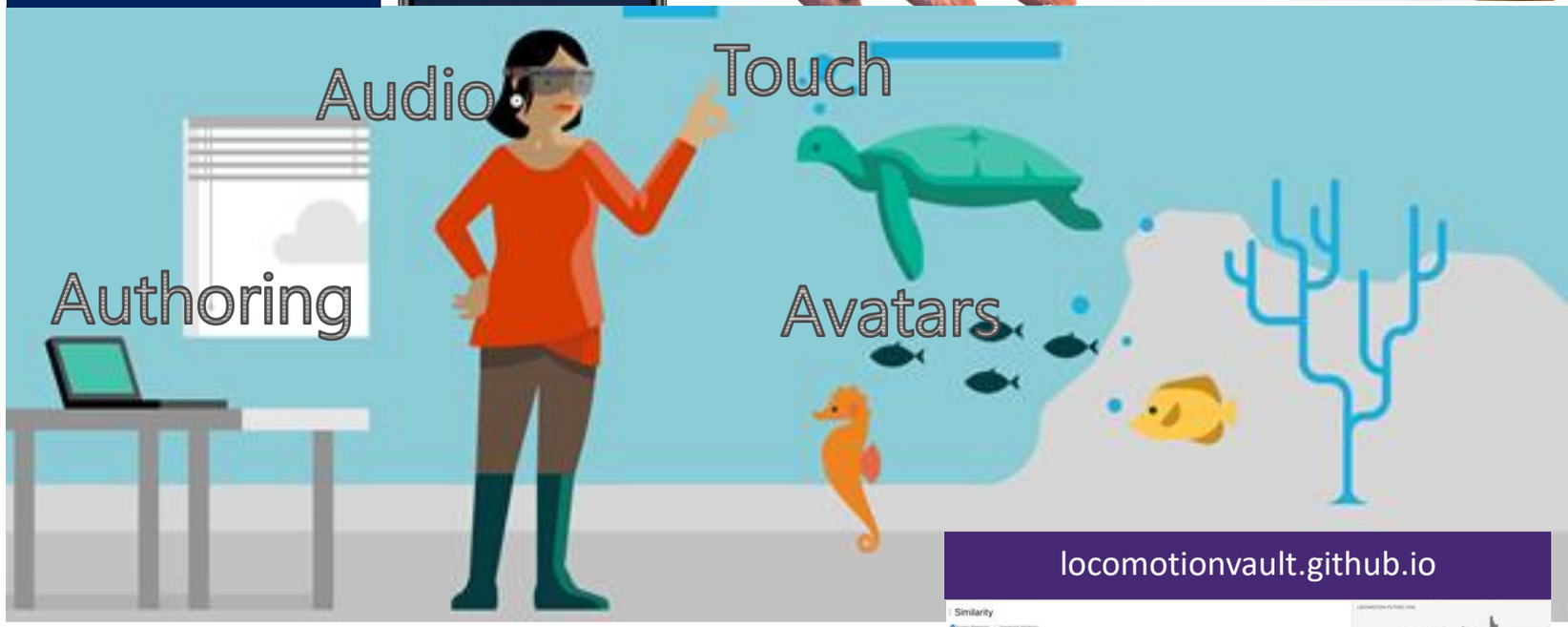

Microsoft

Locomotion Vault (https://locomotionvault.github.io/), an interactive database and visualization of over 100 LTs (Locomotion Techniques) from academia and industry.



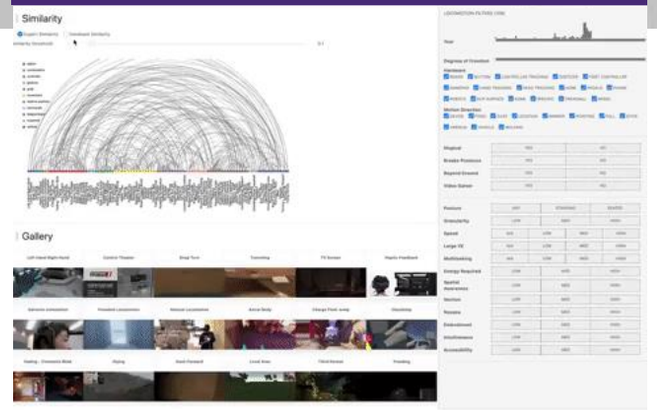



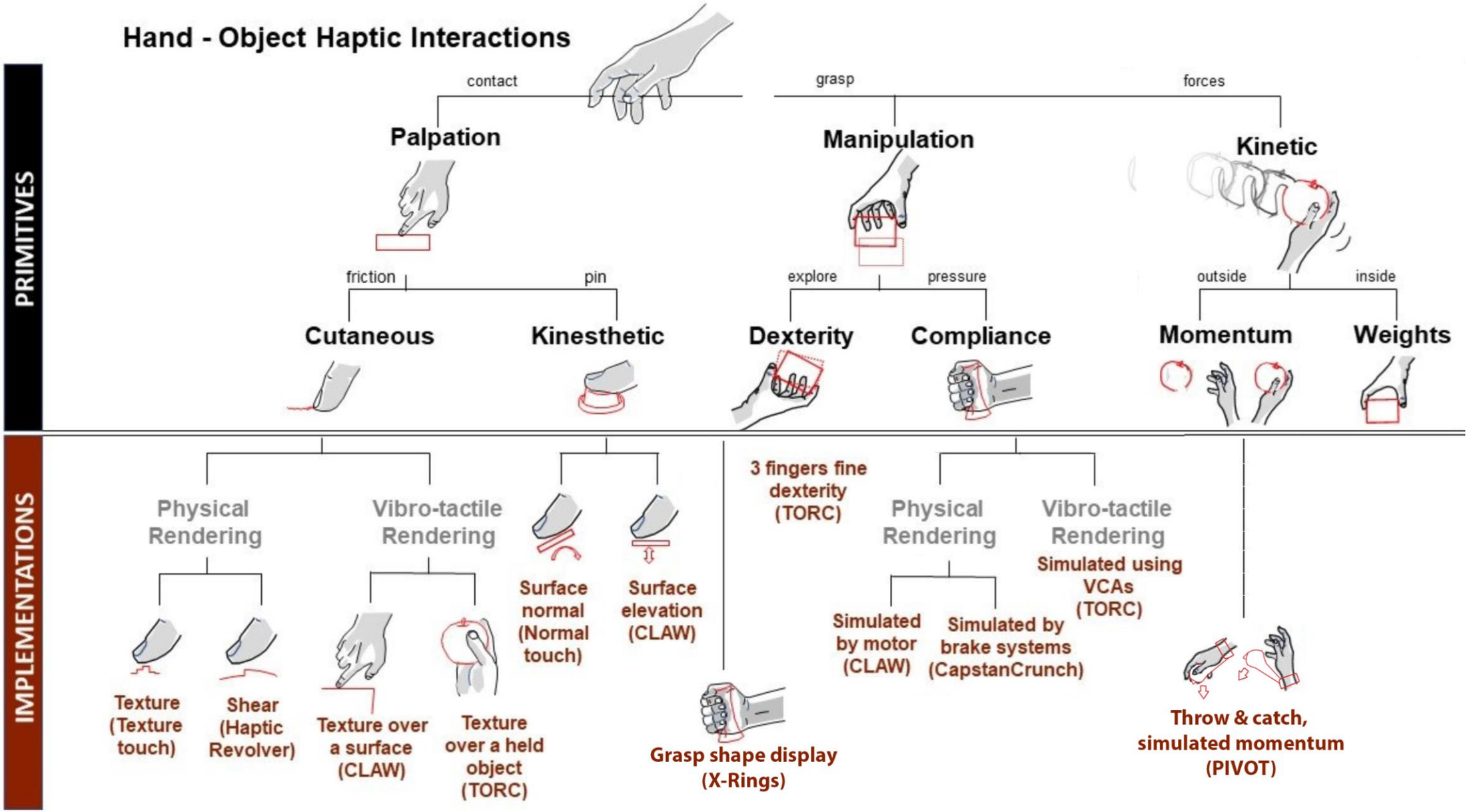




## Microsoft Rocketbox


## locomotionvault.github.io




margonzalezfranco.github.io




Gonzalez-Franco, M; Ofek, E; Holz, C; Steed, A; Lanier, J; Buxton, B; et al. (2022): Taxonomy of Hand-Object Haptics for Virtual Reality. TechRxiv.

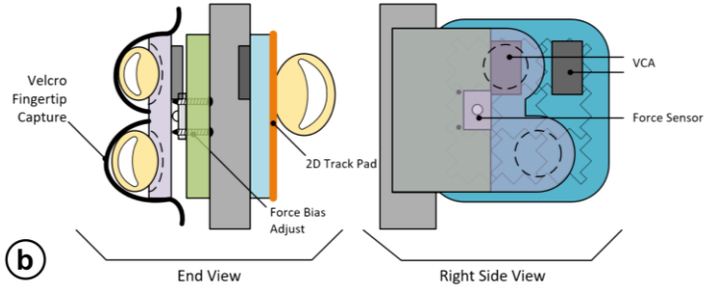
CHI 2019

# TORC: A Virtual Reality Controller for In-Hand High-Dexterity Finger Interaction

Jaeyeon Lee[1,2], Mike Sinclair[2], Mar Gonzalez-Franco[2], Eyal Ofek[2], and Chrsitian Holz[2]

[1]HCI Lab, School of Computing, KAIST
[2]Microsoft Research, Redmond

Video Figure




1 x force sensor
2 x VCA
1 x 2D Track Pad

# TORC

dexTerOus Rigid Controller

Jaeyeon Lee, J., Sinclair, M., Gonzalez-Franco, M., Ofek, E. & Holz, C. (2019) **TORC: A Virtual Reality Controller for In-Hand High-Dexterity Finger Interaction**. *Proc. 2019 CHI Conf. Hum. Factors Comput. Syst.* (2019).

# HAPTIC PIVOT

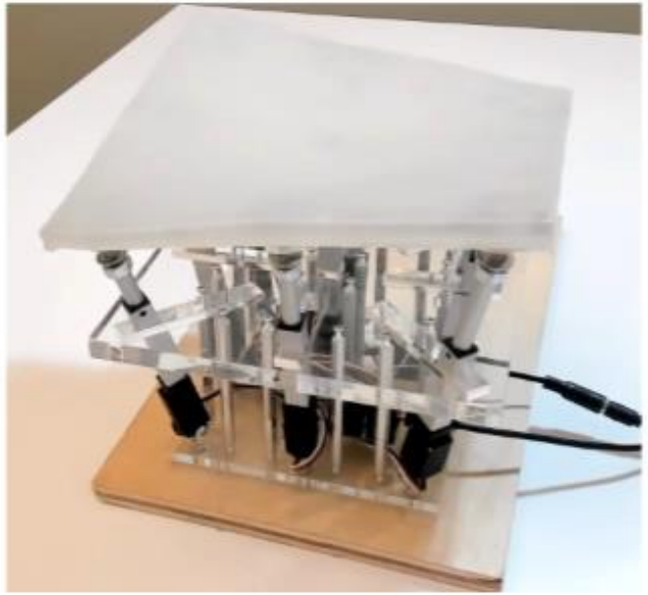
Kubacs, R., et al. (2020). **Haptic Pivot: On-Demand Handhelds in VR**. ACM *UIST*

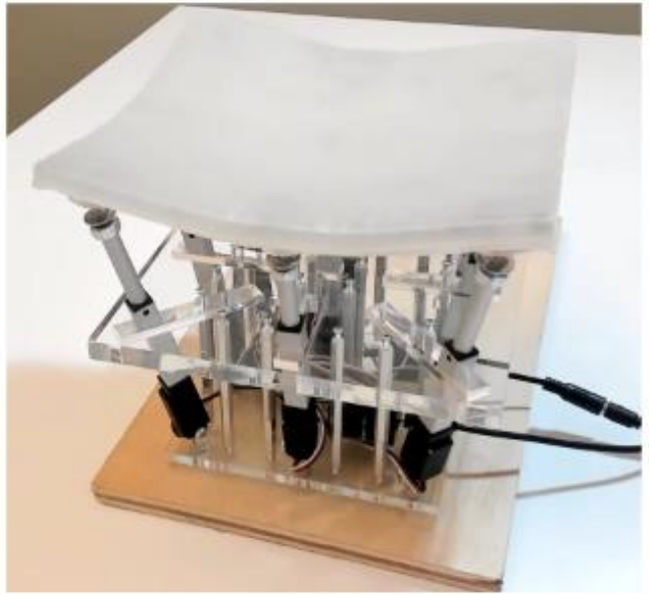
# X-RINGS

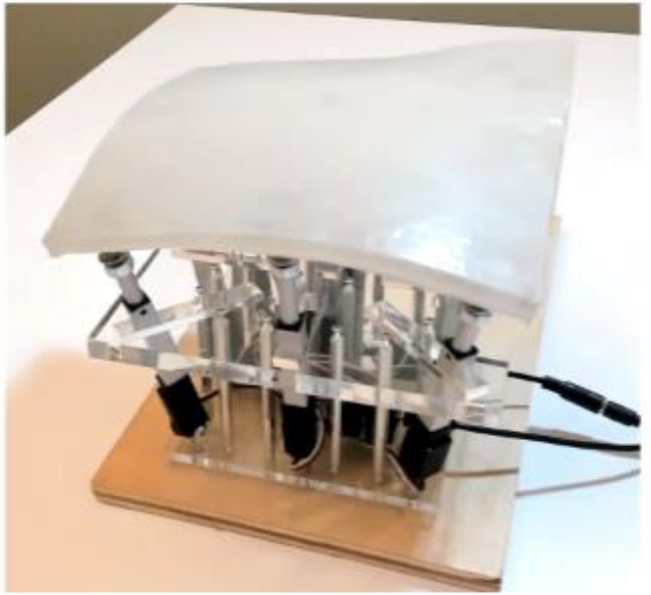
*Eric J Gonzalez et al (2021).* ***X-Rings: A Hand-mounted 360° Shape Display for Grasping in Virtual Reality****. UIST*

# A Mechatronic Shape Display based on Auxetic Materials

Anthony Steed, Eyal Ofek, Mike Sinclair, Mar Gonzalez-Franco*





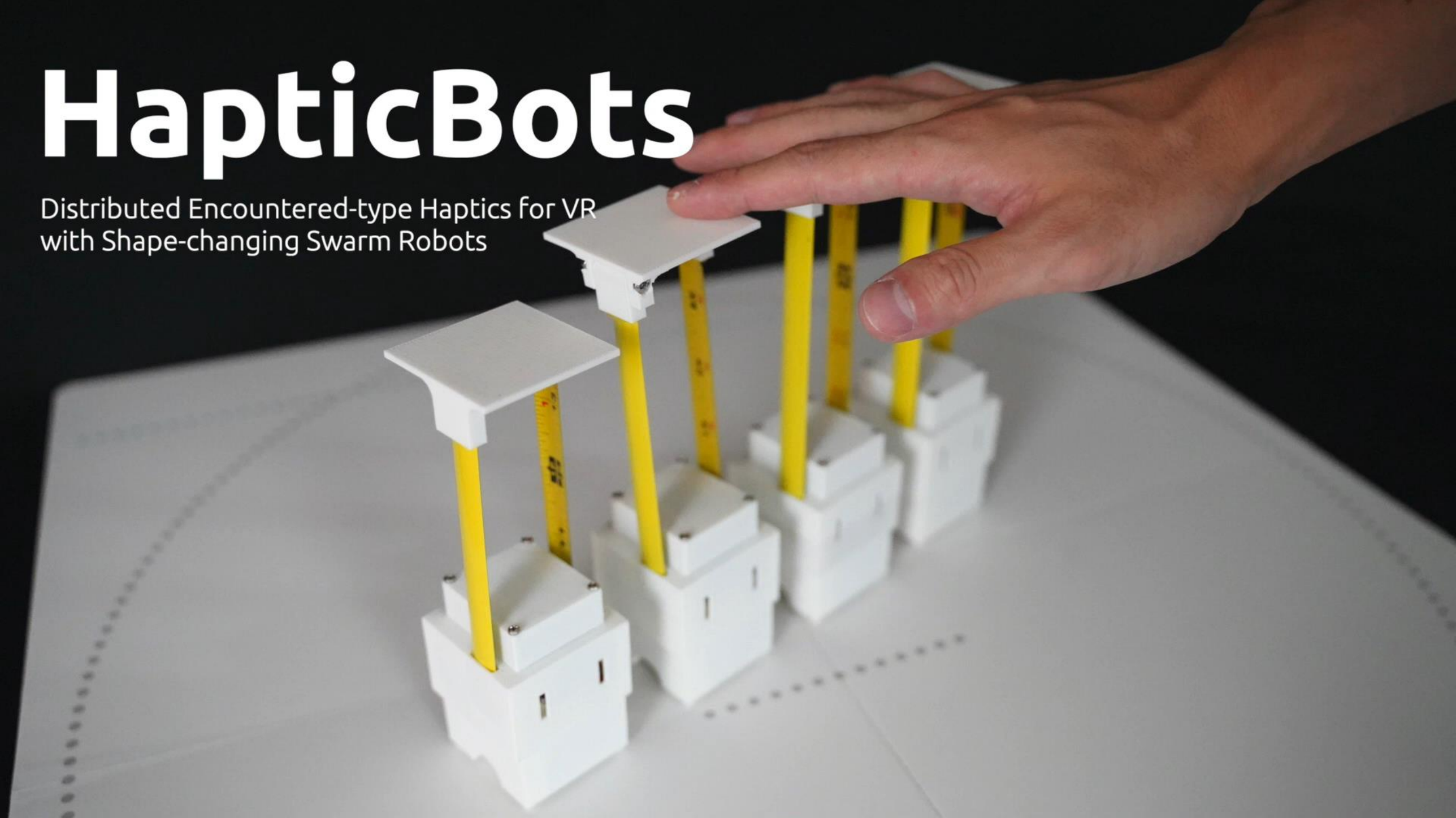


Microsoft

nature COMMUNICATIONS

# HapticBots

Distributed Encountered-type Haptics for VR
with Shape-changing Swarm Robots



# Theories of touch in VR.

SCIENCE ROBOTICS | FOCUS

HUMAN-ROBOT INTERACTION

## The uncanny valley of haptics

Christopher C. Berger,*† Mar Gonzalez-Franco,†‡ Eyal Ofek, Ken Hinckley

(2018). **Expanding the sense of touch outside the body**. ACM Symposium on Applied Perception

(2019) **Avatar embodiment enhances haptic confidence on the out-of-body touch illusion** IEEE Transactions on Haptics

A community from nature portfolio

ENGINEERING

Search Nature Portfolio Engine

Contributor | Nature Communications

Behind the Paper

## Building the next generation of Shape Displays

Shape displays are devices that can mechanically deform their surface to render particular objects or shapes. If a regular display is made of an array of pixels, a shape display is made of an array of physical parts that can move.

Published Oct 11, 2021

Mar Gonzalez-Franco and Eyal Ofek
2 contributors

https://engineeringcommunity.nature.com/posts/shape-displays-building-the-next-generation-desktops

SCIENTIFIC AMERICAN

*Observations*

**If (Virtual) Reality Feels Almost Right, It's Exactly Wrong**

## Asymmetry of Grasp

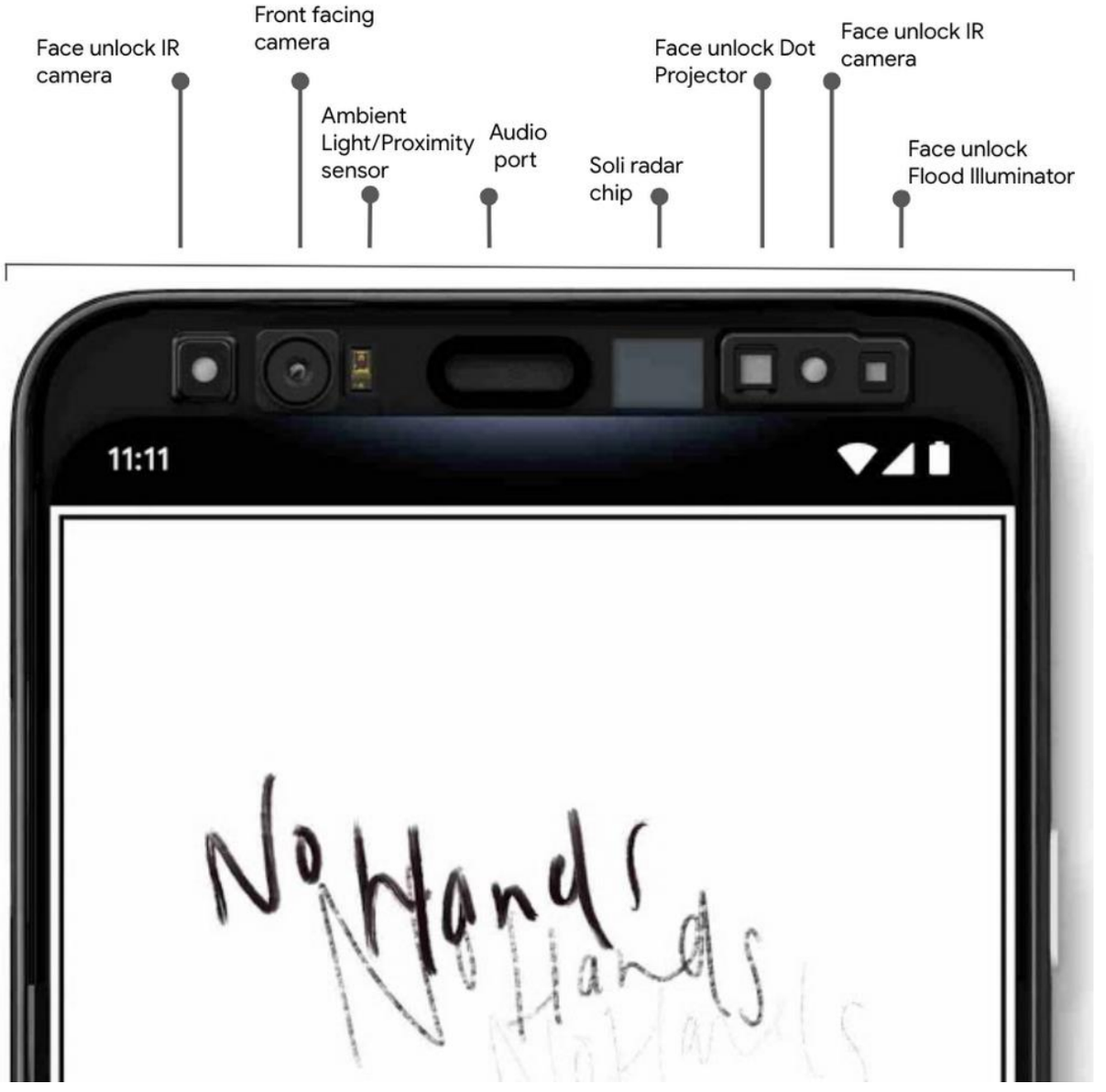
(2020) Gonzalez-Franco, Sinclair, Ofek
*ACM Symposium on Applied Perception*

# XR a tech aggregator

Just like smartphones,
**XR is also a tech aggregator.**

The selection of tech will be defined by the interactions we want to create.

That is why **interaction research is at the core of XR.**




*S Marwecki et al (2019).* ***Mise-Unseen. Using eye tracking to hide virtual reality scene changes in plain sight****. UIST*

# Design Spaces

(touch, head orientation, mid-air)

**Gesture type**

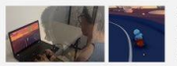
**+**

**Context**

(application, body, environment)

Panda, P., Nicholas, M., et al. (2023). **"Beyond Audio: Towards a Design Space of Headphones as a Site for Interaction and Sensing" DIS 2023**

**Type of input gesture**

| Design space of headphones as a site of interaction and sensing | Touch-based gestures [GES-TC] | Mid-air gestures [GES-MA] | Head orientation [GES-OR] | Touch and mid-air gestures [GES-TC & GES-MA] | Mid-air gestures and head orientation [GES-MA & GES-OR] | Head orientation and touch-based gestures [GES-OR & GES-TC] |
|---|---|---|---|---|---|---|
| **Context-free [CONT-FR]** | e.g., a volume knob, **Tap Control [2011], Headphone Tap [2012], EarTouch [2017], I/O Braid [2018]** | **FreeDigiter [2004], EarTouch [2017]** | e.g. universal spatial sound from device, **Apple AirPods Max [2020]** | e.g., while using volume dial, gestures with other hand create a preset volume level. | e.g., using gesture to control audio level while tilting head left and right to adjust stereo L/R balance. | e.g., while using volume dial, tilting head left or right adjusts L/R stereo balance. |
| **Application context [CONT-APP]** |  Lift earpiece to mute mic and speaker during call. | e.g., a "goodbye" gesture leaves a video call meeting. |  Look at another video game player to have private conversation. | e.g., during 3D modelling, volume knob controls currently selected object and a gesture simultaneously controls its scale. | e.g., looking at app on different screen and making a "click" gesture maximizes it and brings it to front. | e.g., looking at app window on any screen and tapping the headphone triggers a user-defined function for that app. |
| **User body context [CONT-BOD]** | e.g., a user's touch near the eye, ear, or mouth controls a visual / aural / mic function. |  Cupping gesture near the ear increases volume. | e.g., drowsy head nods decrease headphone volume. | **EarPut [2014]** | e.g., looking at left hand and making "closing finger" gesture makes it dominant hand universally for operating system. | e.g., shaking head vigorously triggers the universal "undo" function, tap on headphone to confirm it. |
| **Environment context [CONT-ENV]** | e.g., a button press in home environment triggers a different function than in the office environment. | e.g., a salutation gesture mutes mic if another person is present, otherwise triggers "hi" emoji in call. |  Look at a device to control it; turn head away towards person to mute mic, video. | e.g., swiping on earcup selects the next environment interactable device (e.g. lights), and a gesture toggles it on or off. | e.g., looking at room lights and doing a "cut-off" gesture turns the light off. | e.g. looking at room lights and tapping headphone turns it on or off. |
| **Application & user body context [CONT-APP & CONT-BOD]** | e.g., touching the earcup (on the ear) mutes the mic on a video call, but resumes / pauses playback in music player. |  Closing mouth ("hush" gesture) mutes mic in video call. |  Control video game by leaning with your body, e.g. turning in racing games. | e.g., tapping top of headband starts finger sensing. Pointing at eyes or mouth toggles camera or mic. | e.g., looking at video player app and making a "reducing" gesture near eyes reduces brightness, near ears reduces volume. |  Head rotation moves avatar, buttons trigger emotions on avatar in video call. |
| **User body & environment context [CONT-BOD & CONT-ENV]** | e.g., turning dial on earcup (on the ear) while watching movie increases volume while also dimming environment lights. | e.g. blocking eyes with hands turns off lights in the room. |  Talk on multiple video calls on different devices. | e.g., tapping earcup toggles hearing surrounding audio, gesture controls level of ambient audio in the mix. | e.g., looking at a TV in the background environment and making a "cut-off" gesture near ear mutes the TV. | e.g., looking at computer screen, tapping top of head recalls memorized settings for surrounding lights. |
| **Environment & application context [CONT-ENV & CONT-APP]** | e.g., earcup touch mutes mic in call or toggles playback in media player. Outside sound amplified if a person is talking to user. | e.g. while watching a movie in lighted room, clapping hands turns off lights. |  Control the current screen being shared on video call by looking at it. | e.g., tapping toggles sharing surrounding audio in a video call with others, gesture controls level of ambient audio in the mix. | e.g., looking at screen while browsing a website and making a "camera click" gesture casts it on the TV display in background. | e.g., while on video call, looking at large side display and tapping the headphone transfers call to that display. |

**Context of input gesture**

# AI – VR lives in parallel

IN DEPTH | STRUCTURAL BIOLOGY

# 'The game has changed.' AI triumphs at protein folding

In milestone, software predictions finally match structures calculated from experimental data.

ROBERT F. SERVICE Authors Info & Affiliations

*SCIENCE* • 4 Dec 2020 • Vol 370, Issue 6521 • pp. 1144-1145 • DOI: 10.1126/science.370.6521.1144

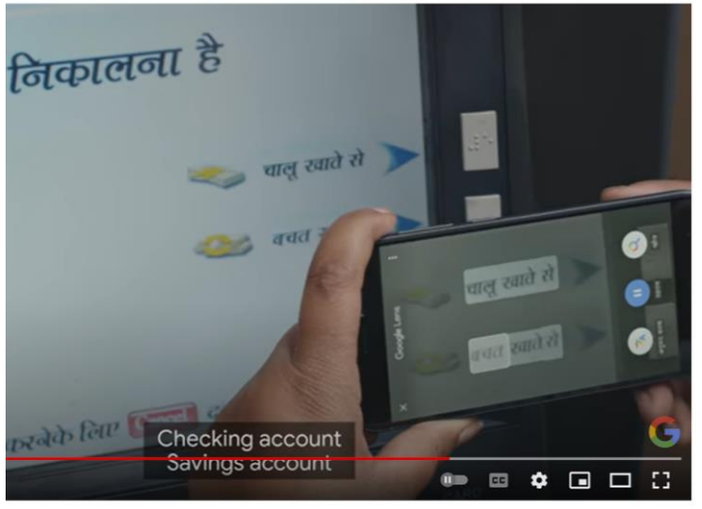
https://www.linkedin.com/in/miguelgfierro/

# But how do we consume AI?

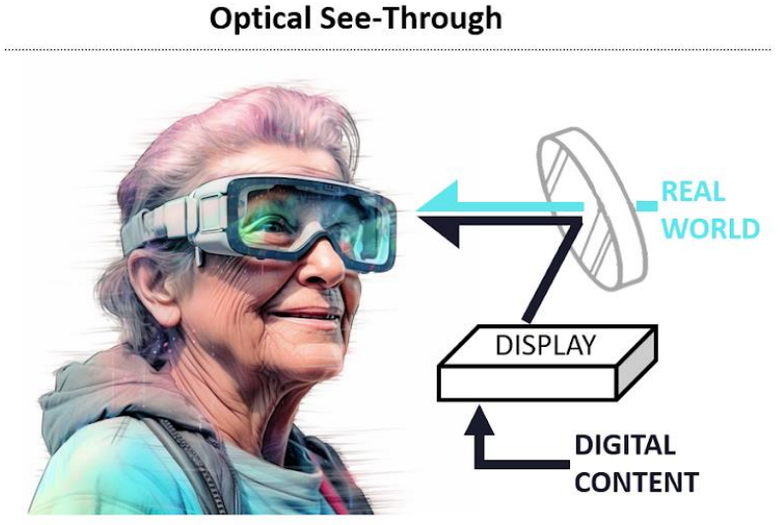
Stable diffusion

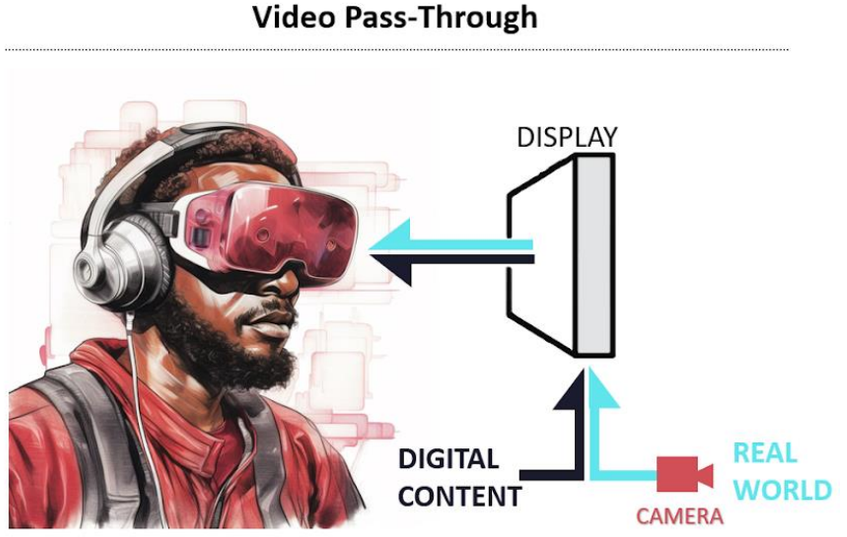
# But how do we consume AI?

## We augment the world around the user




https://www.youtube.com/watch?v=ePwKgKp69GE



# Content Creation

**DreamFusion**: Text-to-3D using 2D Diffusion

Ben Poole, Google Research
Ajay Jain, UC Berkeley
Jonathan T. Barron, Google Research
Ben Mildenhall, Google Research

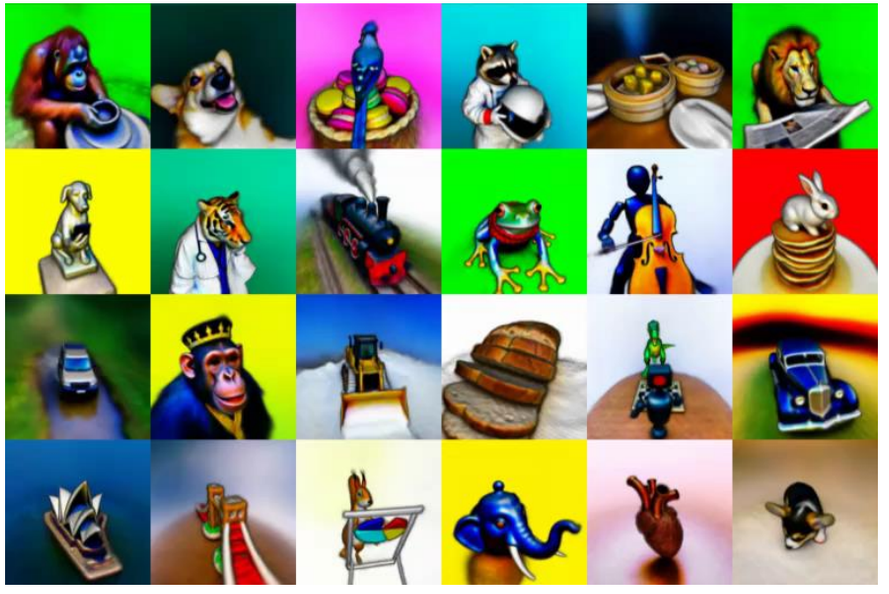
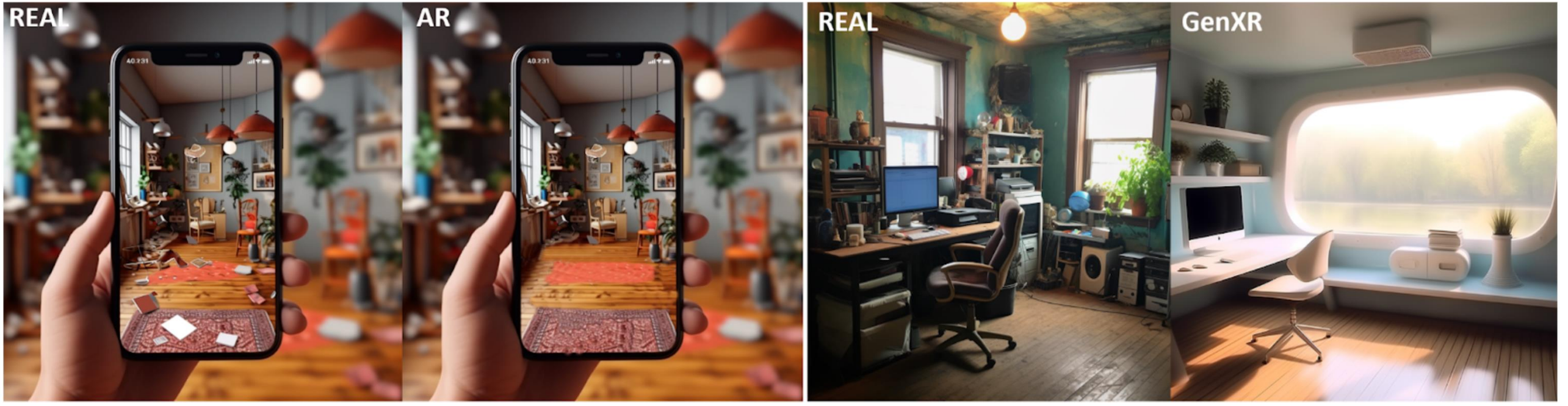


**FiG-NeRF:**
**Figure Ground Neural Radiance Fields for 3D Object Category Modelling**

Christopher Xie[1], Keunhong Park[1], Ricardo Martin-Brualla[2], Matthew Brown[2]
[1]University of Washington, [2]Google Research

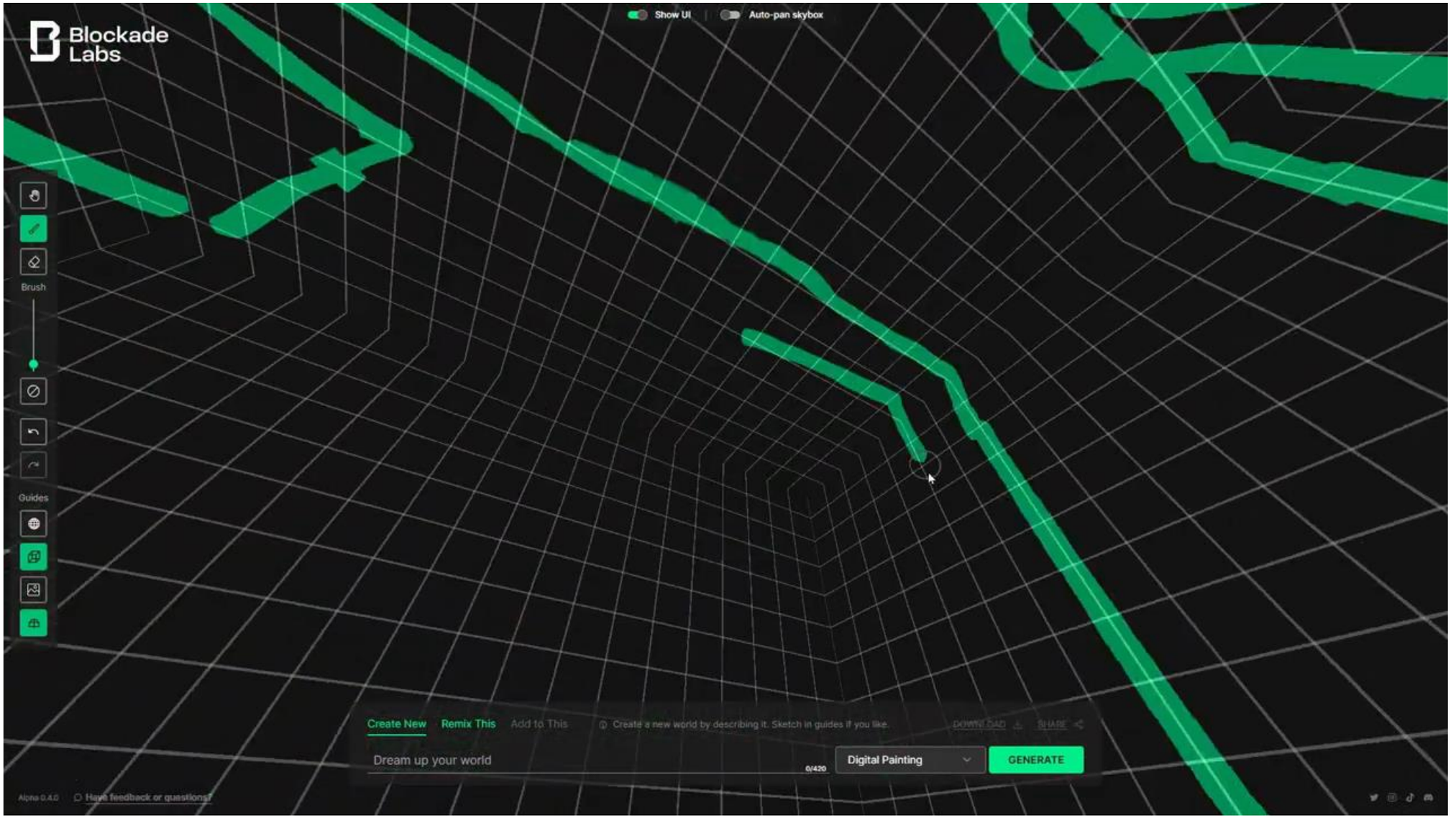
https://github.com/NVlabs/instant-ngp
Instant Neural Graphics Primitives

# Scene Understanding and Generative AI




Gonzalez-Franco, M., & Colaco, A. (editing). **Guidelines for Productivity in VR**

# Scene Understanding and Generative AI




Blockade labs – Skybox AI

# AI – VR are merging into XR

MIT Technology Review

# 10 Breakthrough Technologies

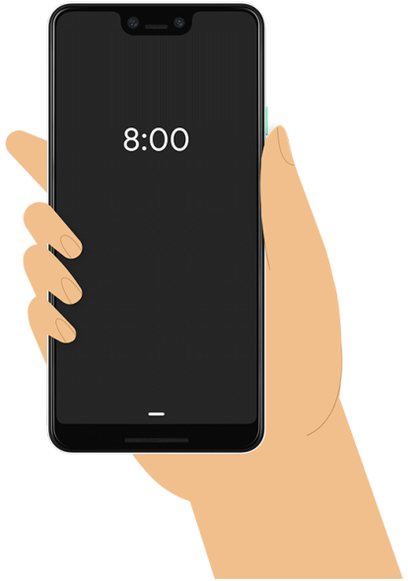
**AI**

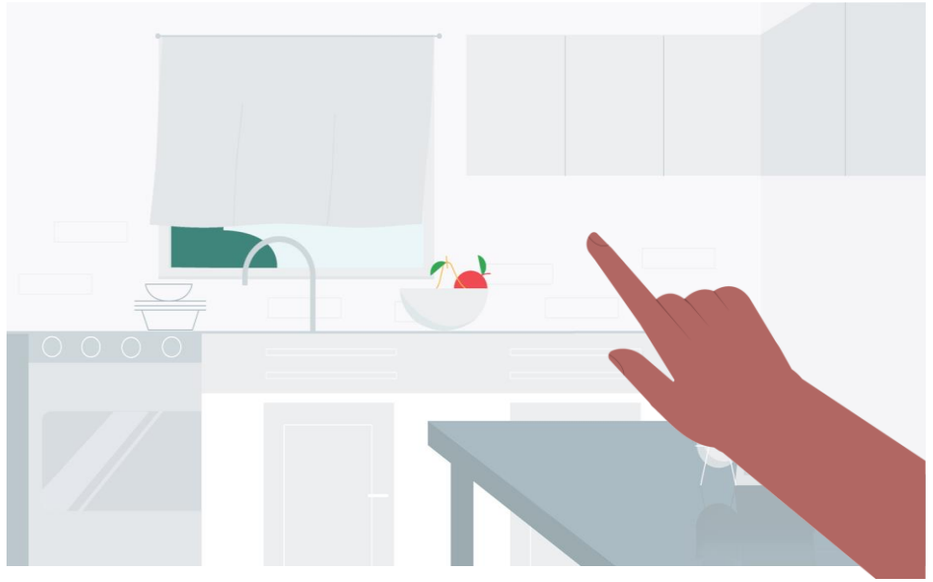
**FUSION REACTORS**

**VACCINE**

**+ QUANTUM COMPUTING**

Technologies that we all agree change everything



Technologies that change how we interact with content often bring the biggest surprises.
Internet, SmartPhones, XR

# Thanks!


Eyal Ofek


Ken Hinckley


Mike Sinclair


Andy Wilson


Amos Miller


Jaron Lanier


Eric Gonzalez


Max Di Luca

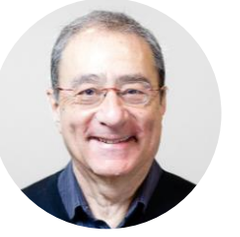

Christopher Berger


Tabitha Peck


Antonella Maselli


Anthony Steed


Laura Trutoiu


Mel Slater


Andrea Colaço

Ana Tajadura, Zhengyou Zhang, Dinei Florencio, Nikolai Smolyanski, Domna Banakou, Bigna Lenggenhager, Baihan Lin, Rob Kovacs, Karan Ahuja, Sebastian Marwecki, Ryo Suzuki, Brian Cohn, Jaeyeon Lee, Parastoo Abtahi, Dane Clemenson, Payod Panda, Sean Rintel…

IEEE International Conference on Multimedia and Expo 2023
Brisbane Convention & Exhibition Centre
10-14 July 2023

# The Power of Extended Reality in the AI era

**Dr Mar Gonzalez Franco**
Blended Interaction Research & Devices (BIRD), Google

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