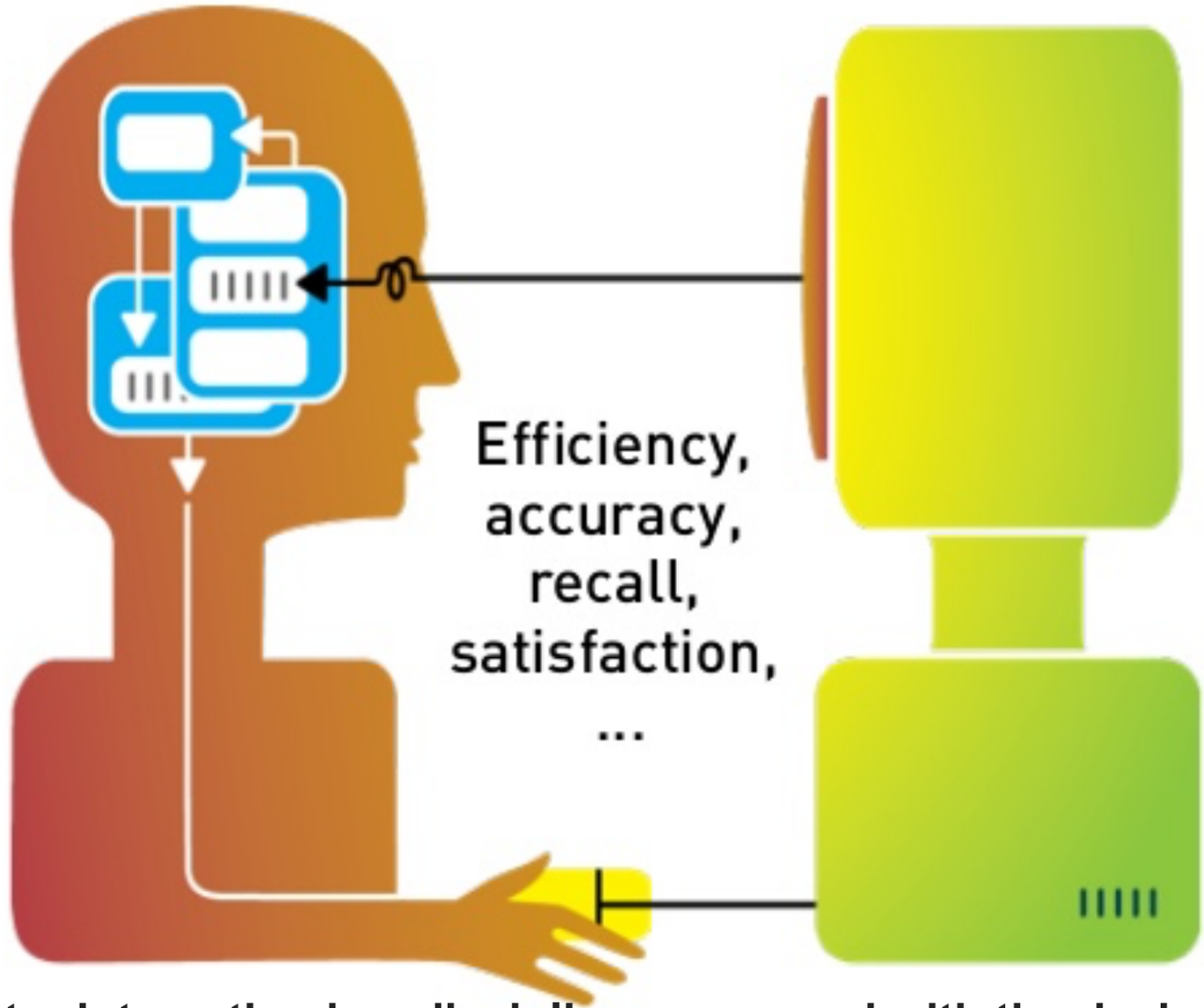
PSY 4(6)84: Evaluating VR

Human-computer interaction



Human-computer interaction is a discipline concerned with the design, evaluation, and implementation of interactive **computing** systems for **human** use and with the study of major phenomena surrounding them

http://www.smartgirl.org/brain-food/career-hubs/human-computer-interaction.png

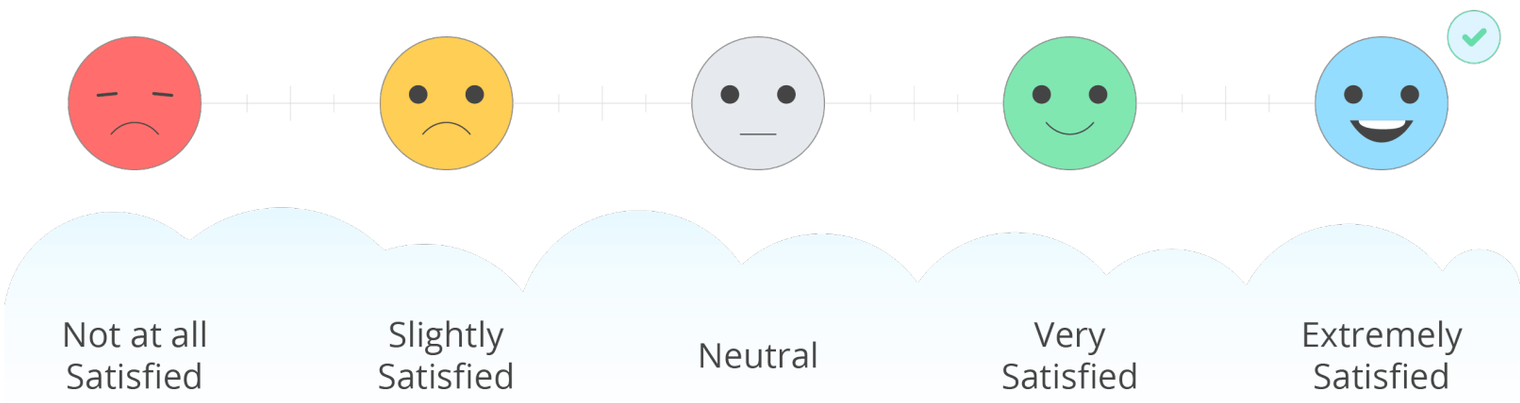
Usability (all software)

★ Efficiency - how efficient a task is to perform

★ Learnability - How easy it is to learn to use

★ Reliability - How many errors you make while using it

★ Satisfaction - Do they like using it?



Quantitative feedback

★ Usability

★ Efficiency - task completion time

★ Learnability - how long it takes to master task

★ Reliability - errors made while completing task

★ Satisfaction - only subjective

Qualitative feedback

Kali Forms is easy to use *

	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Strongly agree

Kali Forms is intuitive *

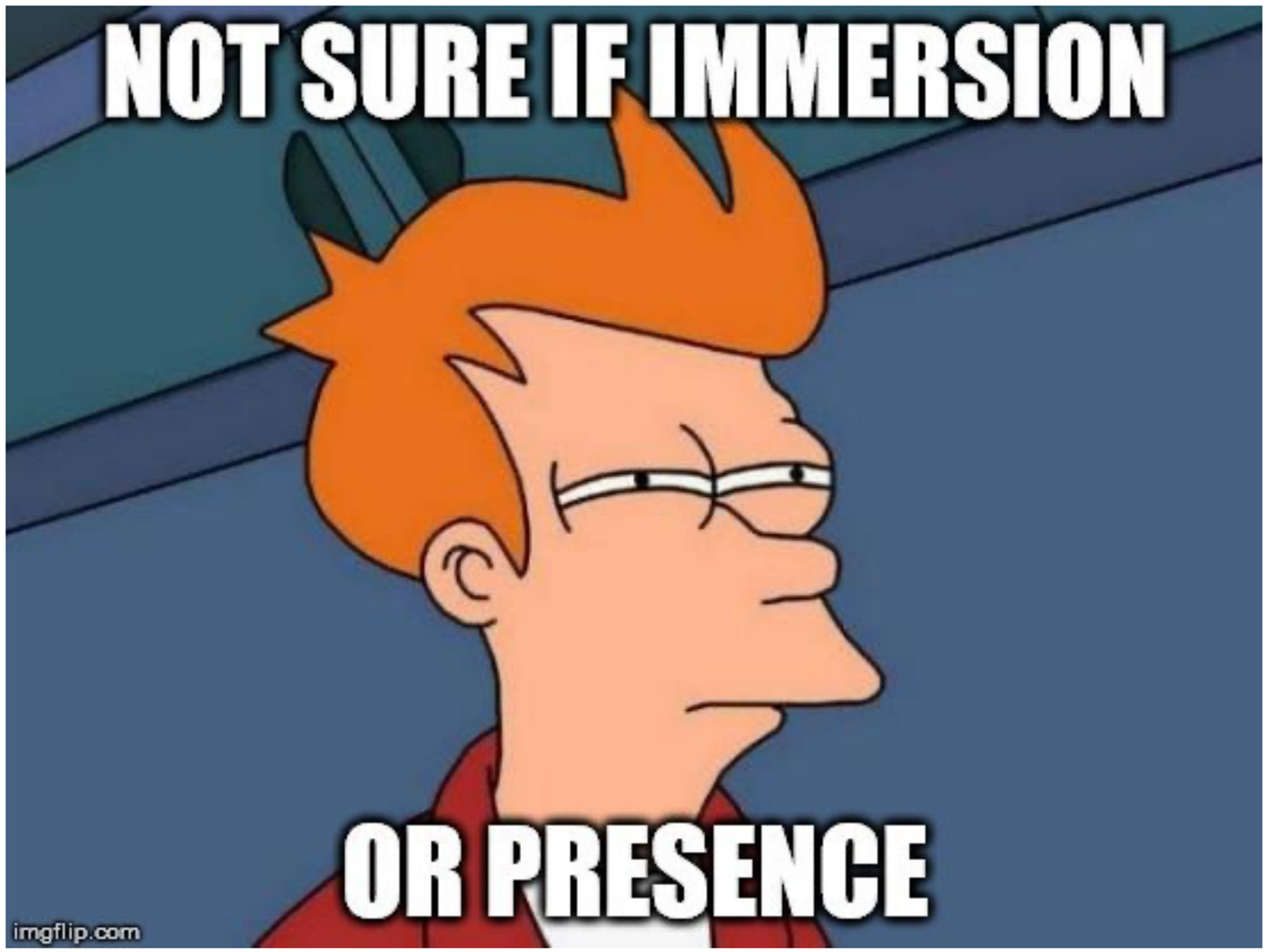
	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Strongly agree

VR is different

VR should feel like in the real world

VR flaws: locomotion, perception lack of haptics

Users may blame all of VR



Immersion is the ability of the virtual reality system of actually tricking you in feeling that you’re somewhere else - more related to the senses with a strong technological focus (e.g, framerate, resolution)

Presence is how you’re really engaged and feel yourself inside the virtual world - more focusing on the features (story, visuals, gameplay) of the VR experience

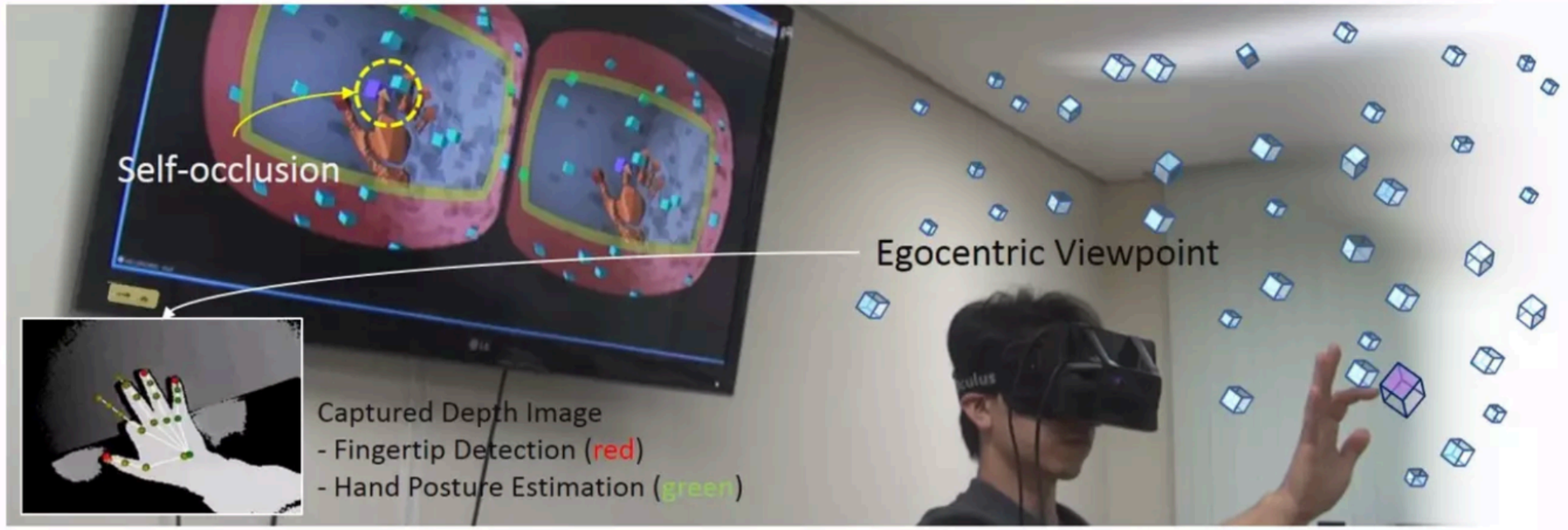
Why 3D interaction

- 3D / VR application should be useful
  - Support immersion
  - Use natural skills
  - Provide immediacy of visualization
- But many current VR apps either
  - Support only simple interaction
  - Or, have serious usability problems
- We need good 3D user interface guidelines

Some definitions

- 3D Interaction:
  - Human-computer interaction in which the user's tasks are carried out in a 3D spatial context
    - 3D input devices, 2D input devices mapping into 3D
- 3D user interface (3D UI):
  - A UI that involves 3D interaction
- 3D interaction technique:
  - A method (hardware and software) allowing a user to accomplish a task in a 3D UI

What makes 3D interaction difficult?



- Spatial input
- Lack of constraints
- Lack of standards
- Lack of tools
- Lack of precision
- Fatigue
- Layout more complex
- Perception

Vision vs. Reality – Still Work to Do..

Natural interface
Gesture, speech
Wide field of view
Full body input

Limited input
Wireless, limited range tracking
Reduced field of view
2D GUI in VR

Universal 3D Interaction Tasks in VR

- Object Interaction
  - *Selection:* Picking object(s) from a set
  - *Manipulation:* Modifying object properties
- Navigation
  - *Travel:* motor component of viewpoint motion
  - *Wayfinding:* cognitive component; decision-making
- System control
  - Issuing a command to change system state or mode

OBJECT INTERACTION

Selection and Manipulation

- Selection:
  - specifying one or more objects from a set
- Manipulation:
  - modifying object properties
    - position, orientation, scale, shape, color, texture, behavior, etc.

Goals of selection

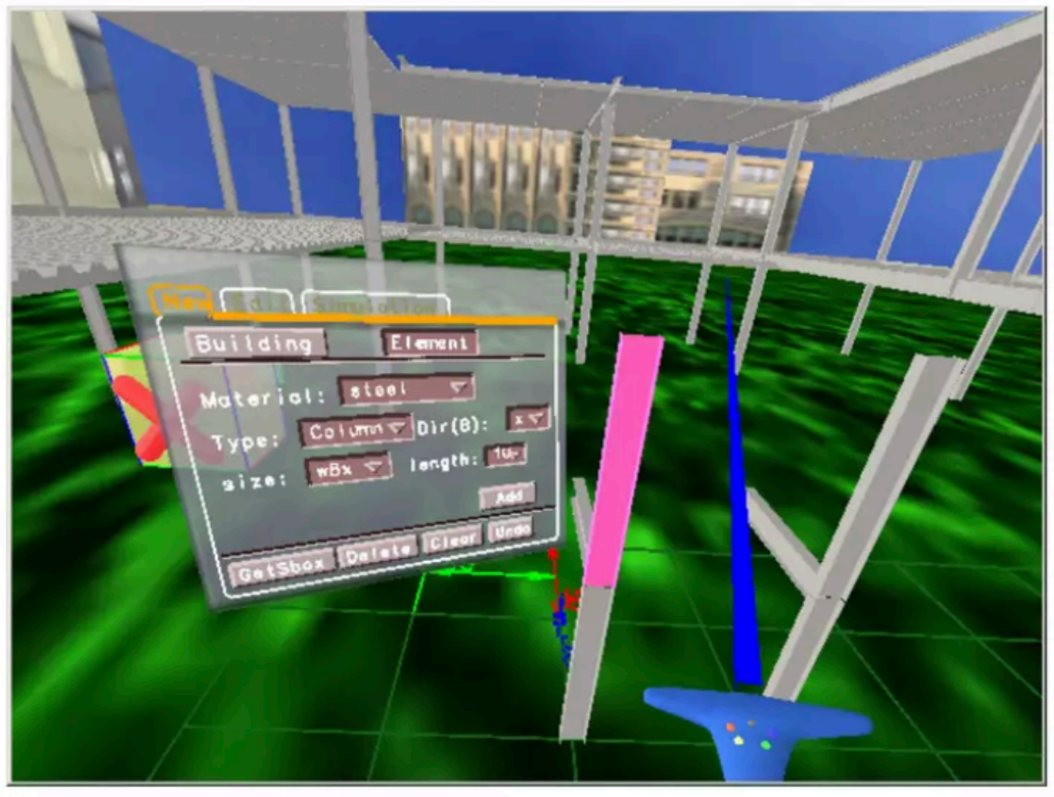
- Indicate action on object
- Query object
- Make object active
- Travel to object location
- Set up manipulation

Selection performance

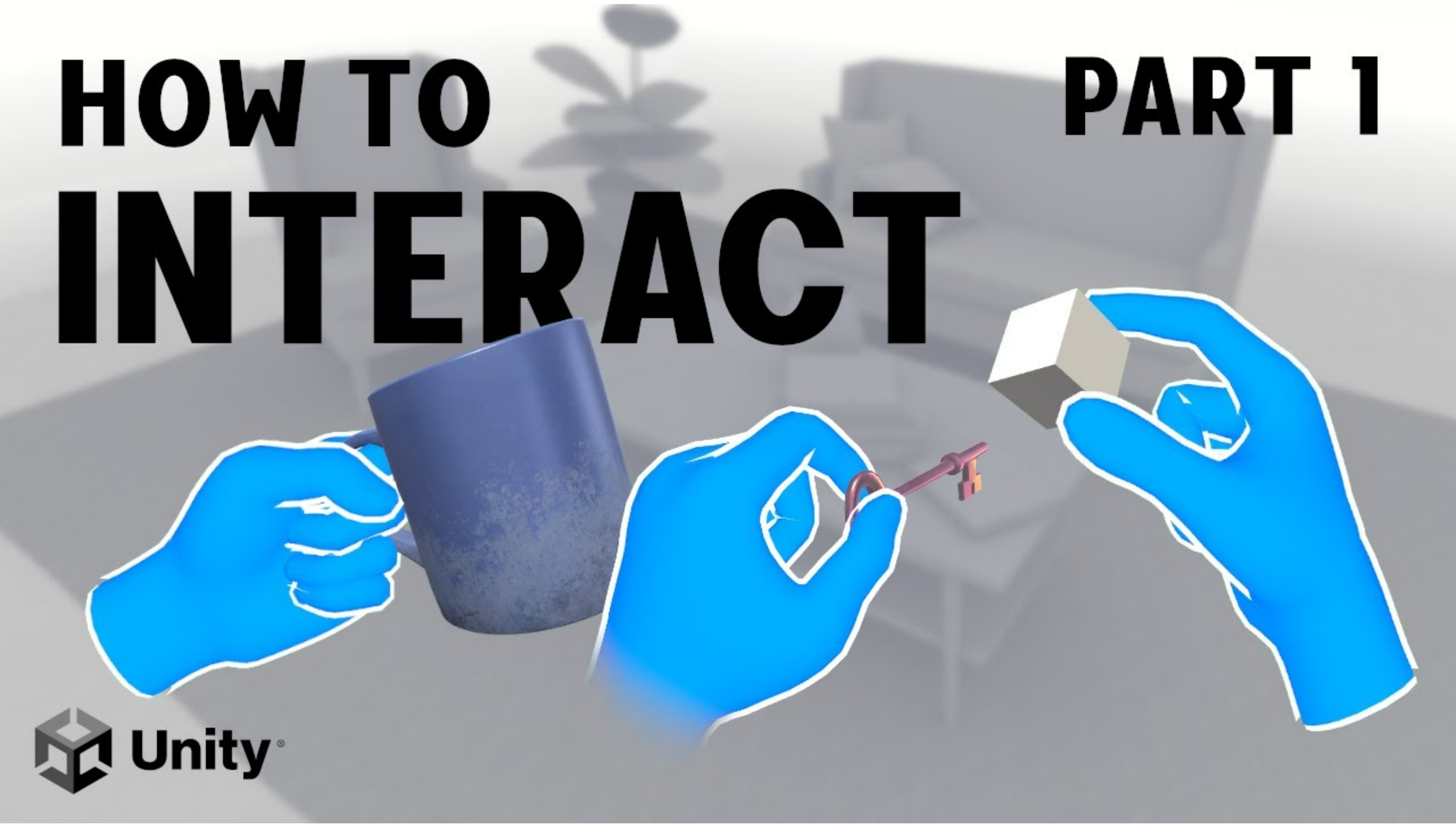
- Variables affecting user performance
  - Object distance from user
  - Object (visual) size
  - Density of objects in area
  - Occluders

Ray-casting technique

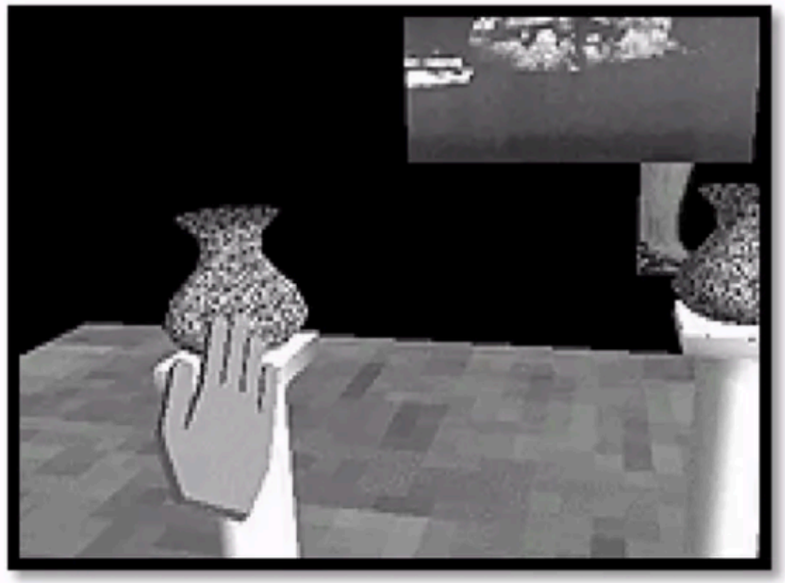
- "Laser pointer" attached to virtual hand
  - First object intersected by ray may be selected
  - User only needs to control 2 DOFs
- Proven to perform well for remote selection
- Variants:
  - Cone casting
  - Snap-to-object rays

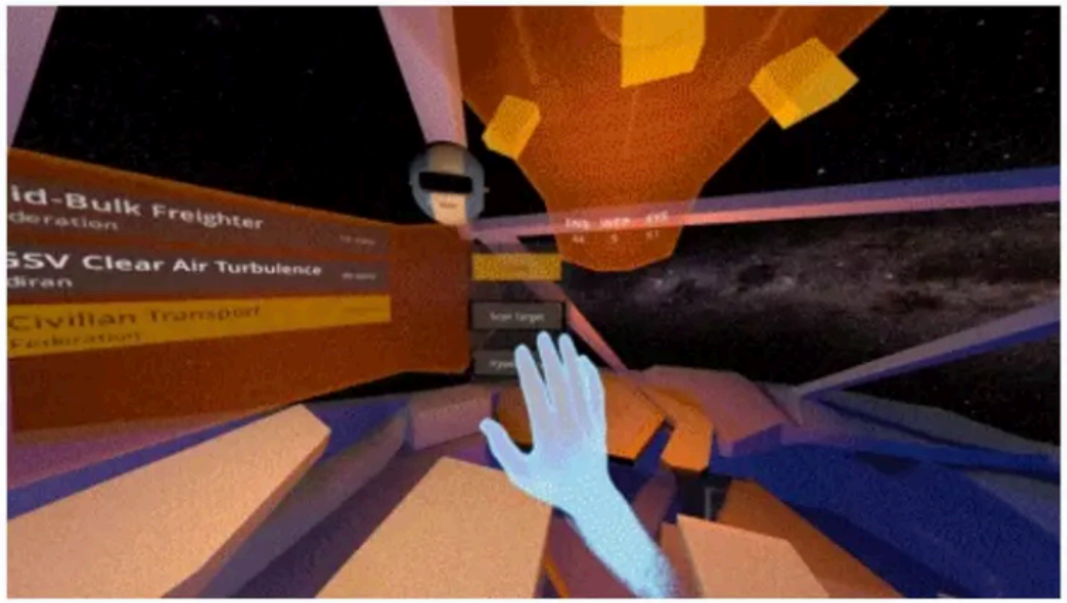


3D interaction tasks

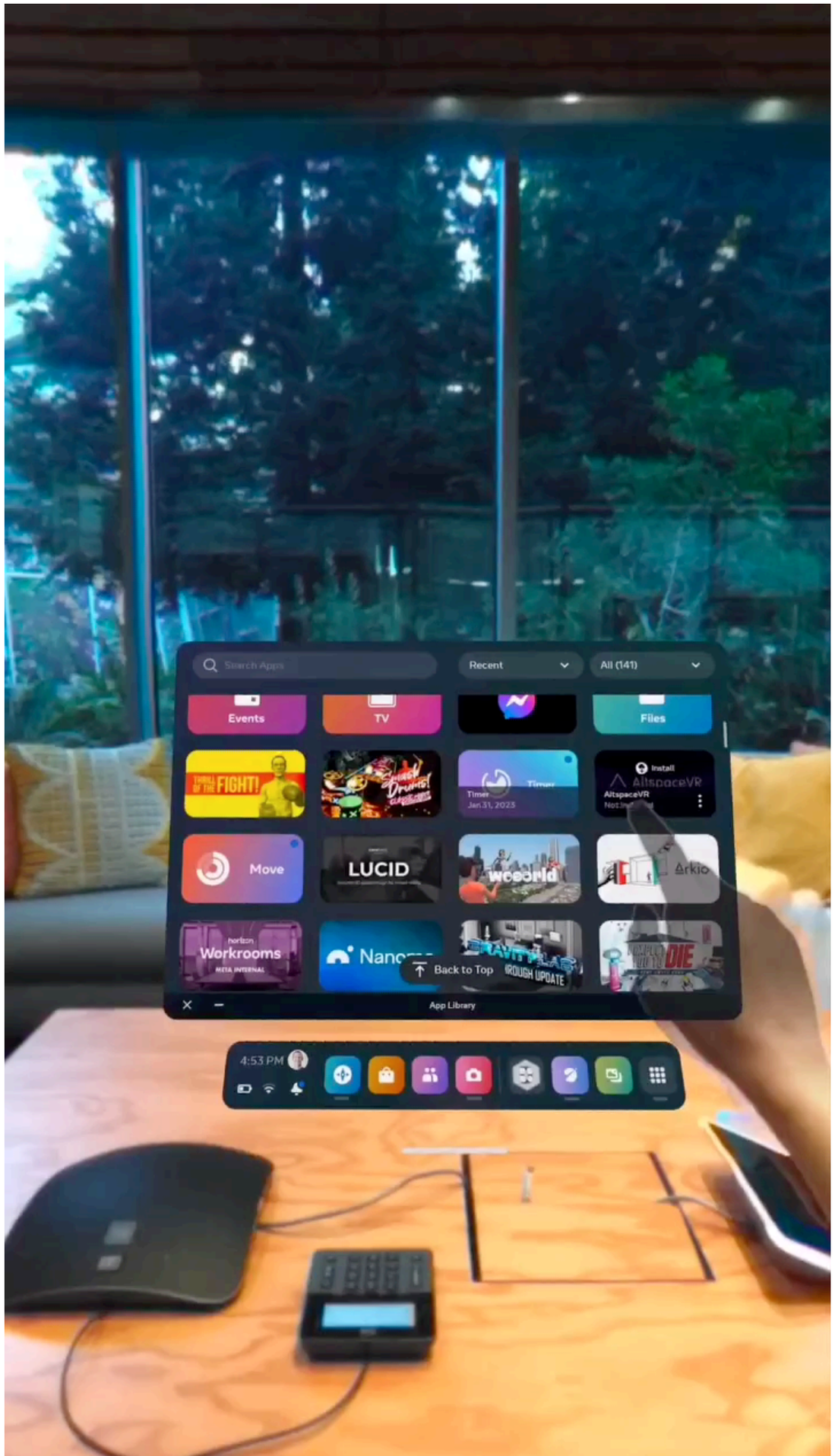


Simple virtual hand technique





- Process
  - One-to-one mapping between physical and virtual hands
  - Object can be selected by “touching” with virtual hand
  - “Natural” mapping
- Limitation:
  - Only select objects in hand reach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Developer Questions

★ **Hardware and Performance:**

- ★ What are the minimum hardware specifications required to run the VR system smoothly?
- ★ How does the VR system handle motion tracking and user movement?
- ★ What is the ideal frame rate for a seamless VR experience, and how can it be achieved?
- ★ How do we minimize latency to prevent motion sickness in users?
- ★ What are the considerations for designing VR controllers and input devices?

Developer Questions II

★ **Software and Development:**

★ What development platform or engine (e.g., Unity, Unreal Engine) is best suited for the VR system?

★ How can we ensure compatibility with various VR headsets and devices?

★ What techniques are most effective for optimizing VR content for different levels of hardware?

★ How can we implement realistic physics and interactions within the VR environment?

Developer Questions III

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Developer Questions IV

★ **Content and Application:**

★ What are the key considerations for developing engaging and immersive VR content?

★ How can we balance graphical fidelity with performance in the VR system?

★ What security measures are necessary to protect users and data in a VR application?

★ How can VR be leveraged for educational or training purposes effectively?

Recommendations for developers

Recommendations

★ **Popular game experience do not translate well to VR experiences.**

★ **Locomotion@scale**

https://developer.oculus.com/resources/bp-overview/

Virtual worlds

★ Use units in the VE that match the real world

★ Make sure objects are completely modeled

★ Thin objects may look incorrect

★ Require less locomotion (I don't agree with this)

★ Consider visual and auditory rendering performance

Visual rendering

★ Never allow objects to be fixed to part of the screen

★ Reconsider texture mapping & antialiasing techniques

★ Maintain a high framerate (90fps)

★ Avoid viewpoint changes that do not match head tracking

★ accommodate the correct interpupillary distance

★ reduce brightness and contrast

Tracking

★ Never allow head tracking to be frozen

★ Make sure the eye viewpoints are correctly located

★ Beware of real world obstacles (and vice versa).

★ When approaching the border of the tracking space reduce contracts and brightness.

★ Or use chaperone.

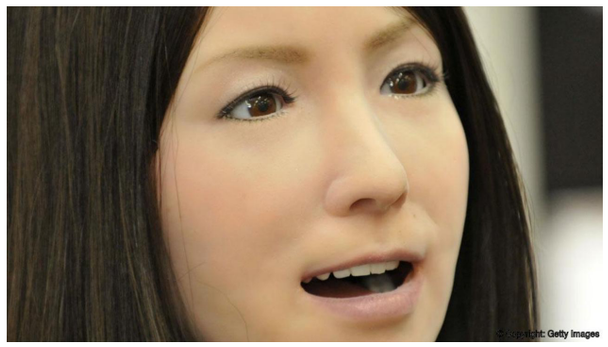
Interaction

★ Consider superhuman powers (teleportation)

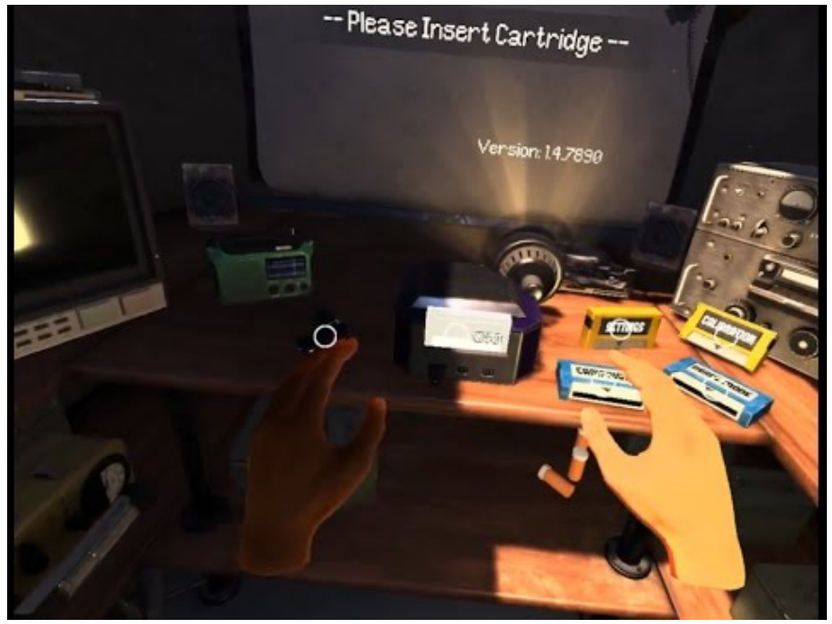
★ Minimize vection during locomotion

★ avoid gorilla arms

★ for social interaction avoid the uncanny valley



User Interfaces



★ Floating menus should be rendered at a distance to minimize vergence-accommodation mismatch

★ Minimize size of menus

★ embed UIs in the virtual world (example)

User Interfaces

User Interfaces

Skeuomorph

Audio

★ Difference between headphones and external speakers.

★ Auralization should take into account user orientation and locomotion.

★ Doppler effects provide a strong motion cue

★ Geometric Audio rendering can be simpler than visual rendering.

self appearance

★ Higher presence when being able to see your own body

★ A simple virtual body is better than none

★ Differences between VR body and real body can be disconcerting

★ If only using head tracking, body should be subject to some basic kinematic constraints.

★ Users self appearance affects social behavior.

Comfort and VR sickness

Comfort & cybersickness

★ VR sickness considered part of motion sickness.

★ vestibular feedback / people without do not get motion sick

★ car sickness, sea sickness, air sickness.

Visually induced motion sickness.

★ Vection e.g. the illusion of self-motion

★ Body thinks it is moving based on optical flow but there are no vestibular or proprioceptive cues.

★ especially apparent during locomotion.

VR sickness symptoms

★ Nausea

★ Dizziness

★ Drowsiness

★ increased salivation

★ cold sweats

★ Pallor

★ warmth/flushing

★ Headaches

★ fatigue

★ eye strain

★ Blurred vision

Variation among users

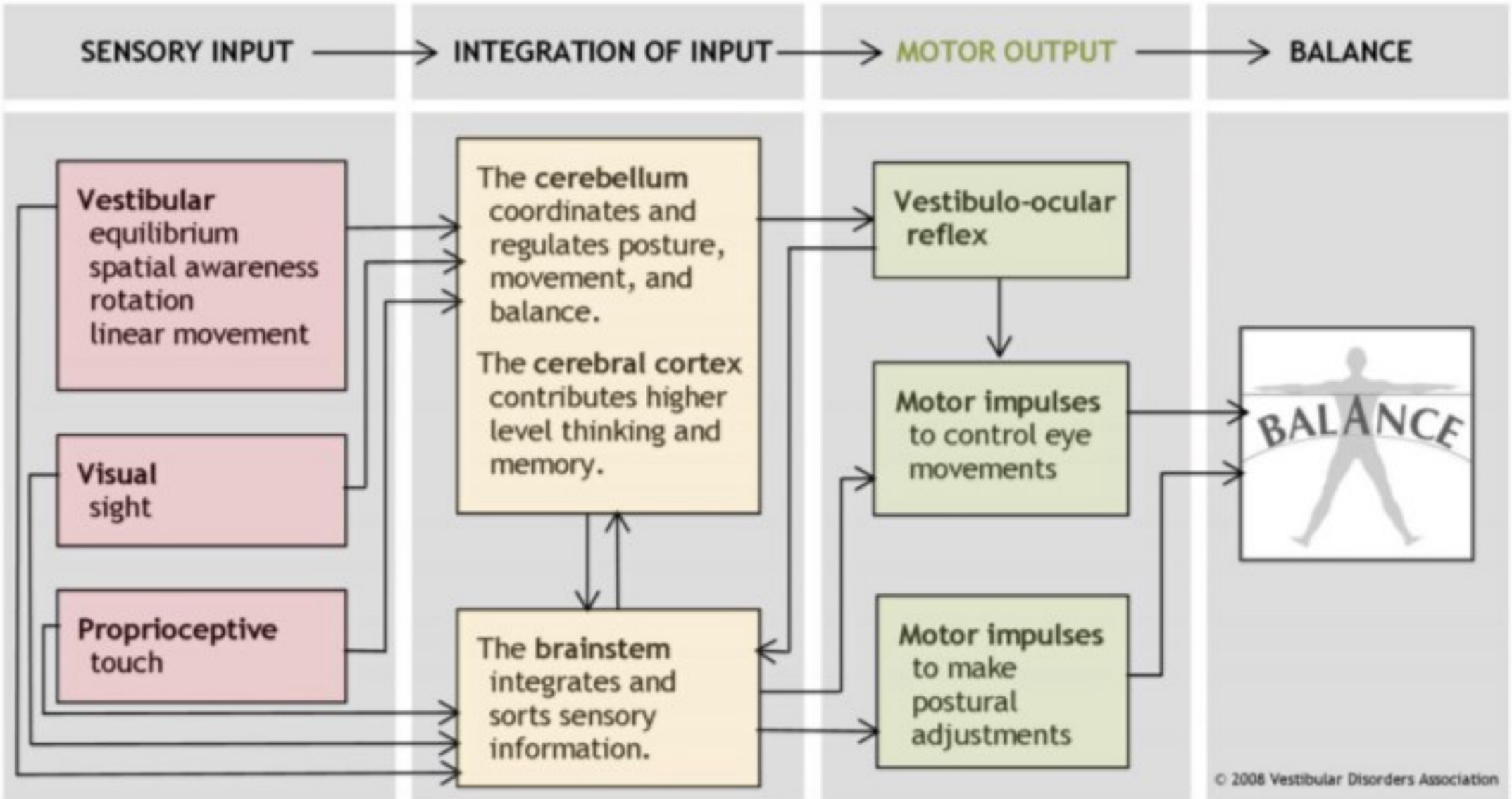
★ Up to 80% experience mild symptoms

★ Females more likely to get sick

★ Children under 12 more likely to get sick

★ Chinese people more likely.

sensory conflict theory



Measuring VR sickness

★ SSQ questionnaire

★ Physiological measures

★ ECG/EGG/EOG/PPG

★ Heart rate

★ Galvanic Skin response

★ skin pallor

★ head motion

Reducing VR sickness

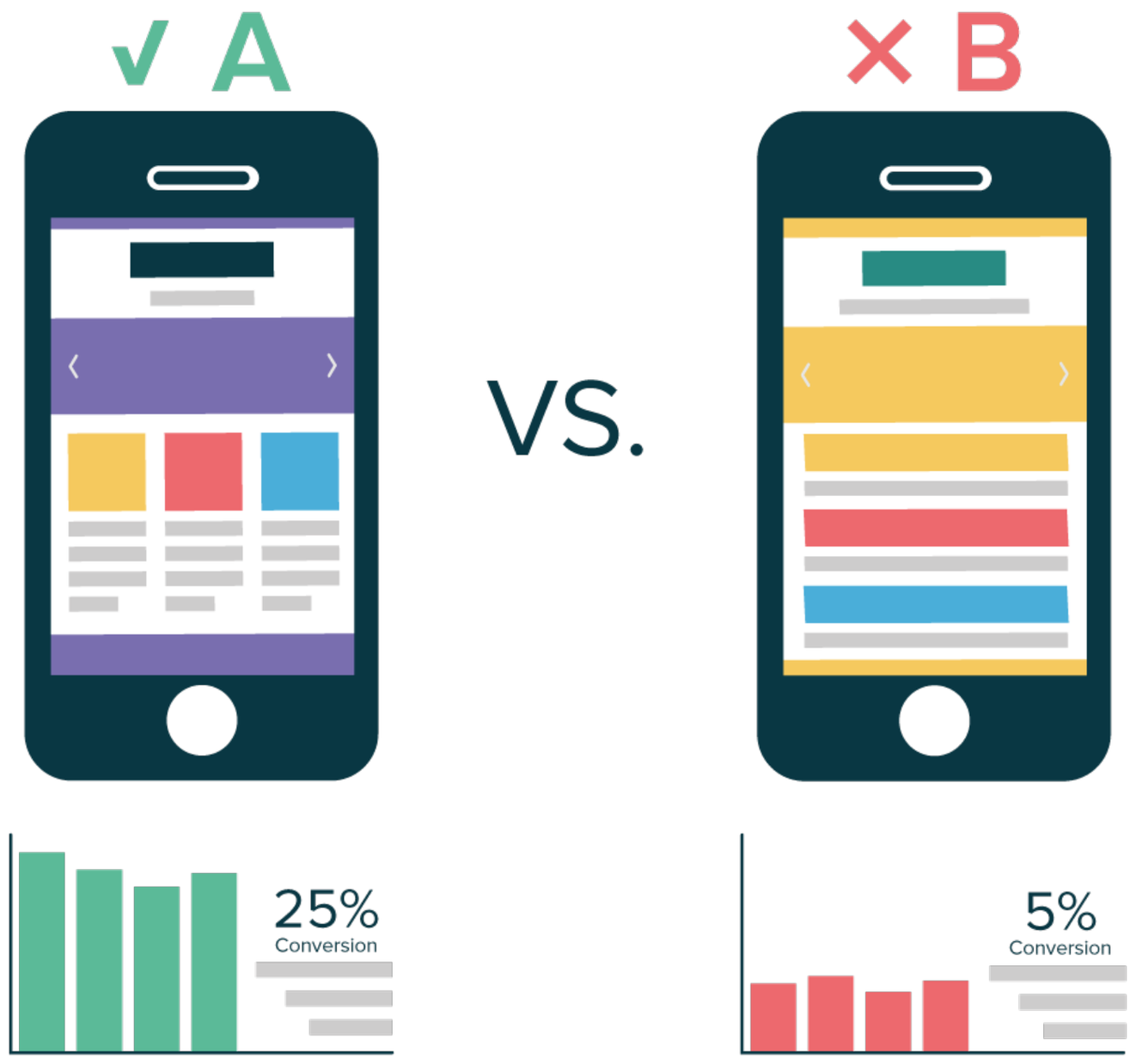
★ Minimize vection

★ Reduce locomotion (don’t agree with)

★ Use locomotion techniques that generate vestibular/proprioceptive feedback

★ walking in place / leaning input

User studies



User studies

★ Recruit subjects (IRB approval)

★ Compensate participants

★ Objective measurements (time, performance, error)

★ Subjective measurements

  ★ Simulator Sickness Questionnaire

  ★ Presence questionnaire

  ★ Interviews