



# Spatial Computing: Interaction Techniques

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**RWTH**AACHEN  
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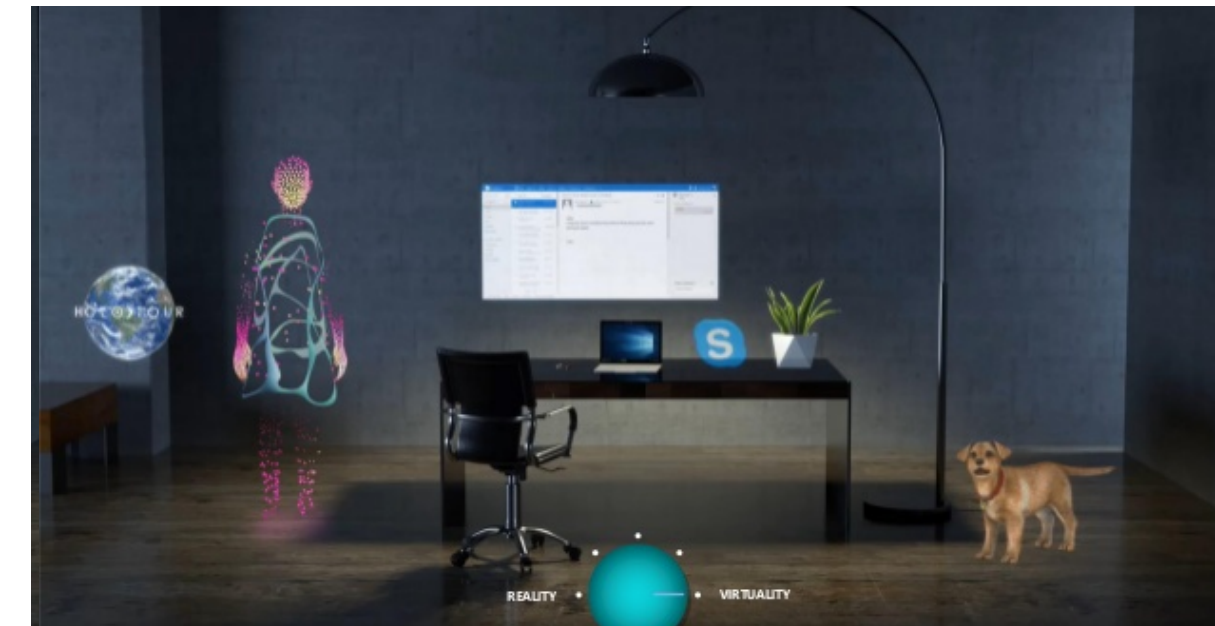
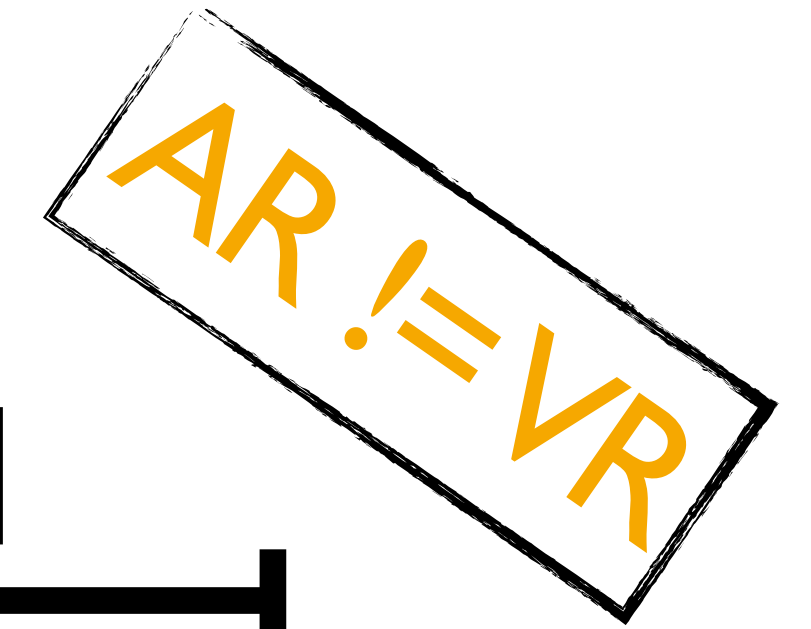
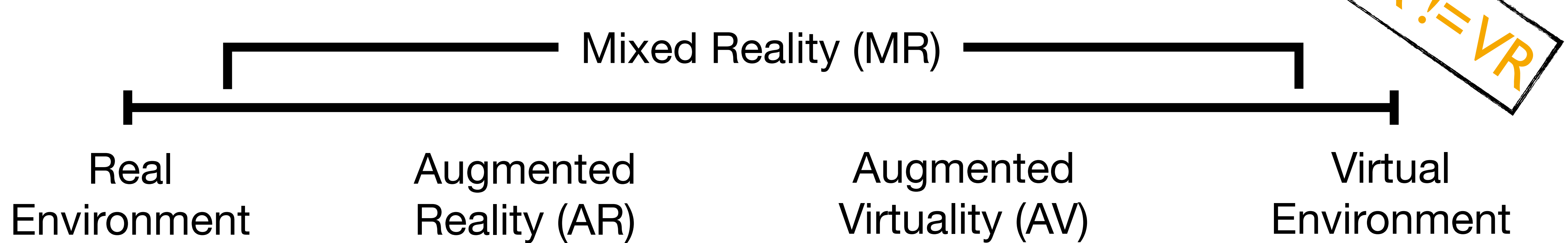
# CHAPTER 1

# Intro





# Reality-Virtuality Continuum



- In AV and VE/VR the surrounding environment is virtual;  
In AR the surrounding environment is real







# Questions

**How can we move through infinite worlds in finite spaces?**

**How to minimize the feeling of vertigo?**

**How do we measure the quality of a VR simulation?**

**How real should the VR interaction feel?**



## CHAPTER 2

# Measuring VR Quality



# Orientation

**Orientation** (or **spatial understanding**) describes a person's **awareness** of time, place and person.

Teleporting creates cracks in the usually continuously extended image that we create of our environment.



# Immersion

**Immersion** describes the **technical** multimodal **abilities** of the VR system in tricking the users that they feel being somewhere else.

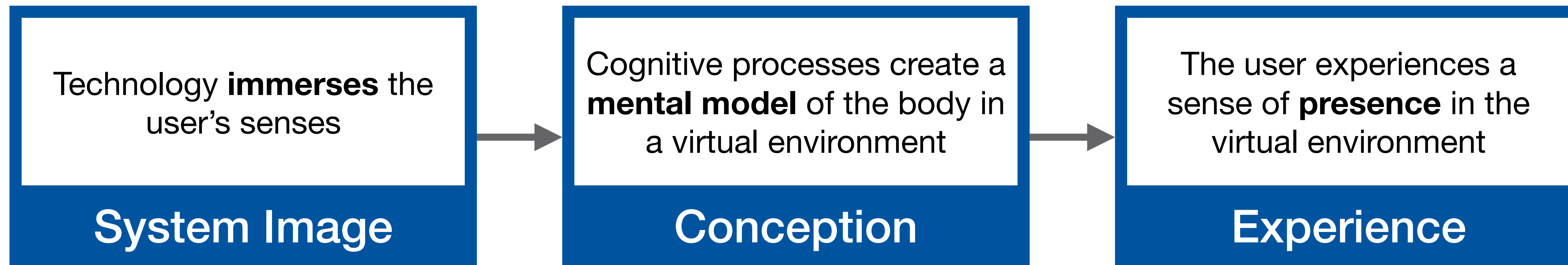
A system providing a perfect immersion would provide the same **sensorial information** as the real world and could, thus, not be identified as an illusion by our brain.



# Presence

**Presence** describes to which extent the user of a VR system develops a **sense of being in the virtual environment**.

This is also influenced by our brain building a verdict on whether the world around us and the **social interactions** with it appear “natural”.





# Measuring Presence

- Igroup Presence Questionnaire (**IPQ**)
- Examples for some of the 14 items, ranked on Likert scale:
  - In the computer generated world I had a sense of "being there"
  - I still paid attention to the real environment.
  - The virtual world seemed more realistic than the real world.



## CHAPTER 3

# Locomotion Techniques



# How to move through VR?

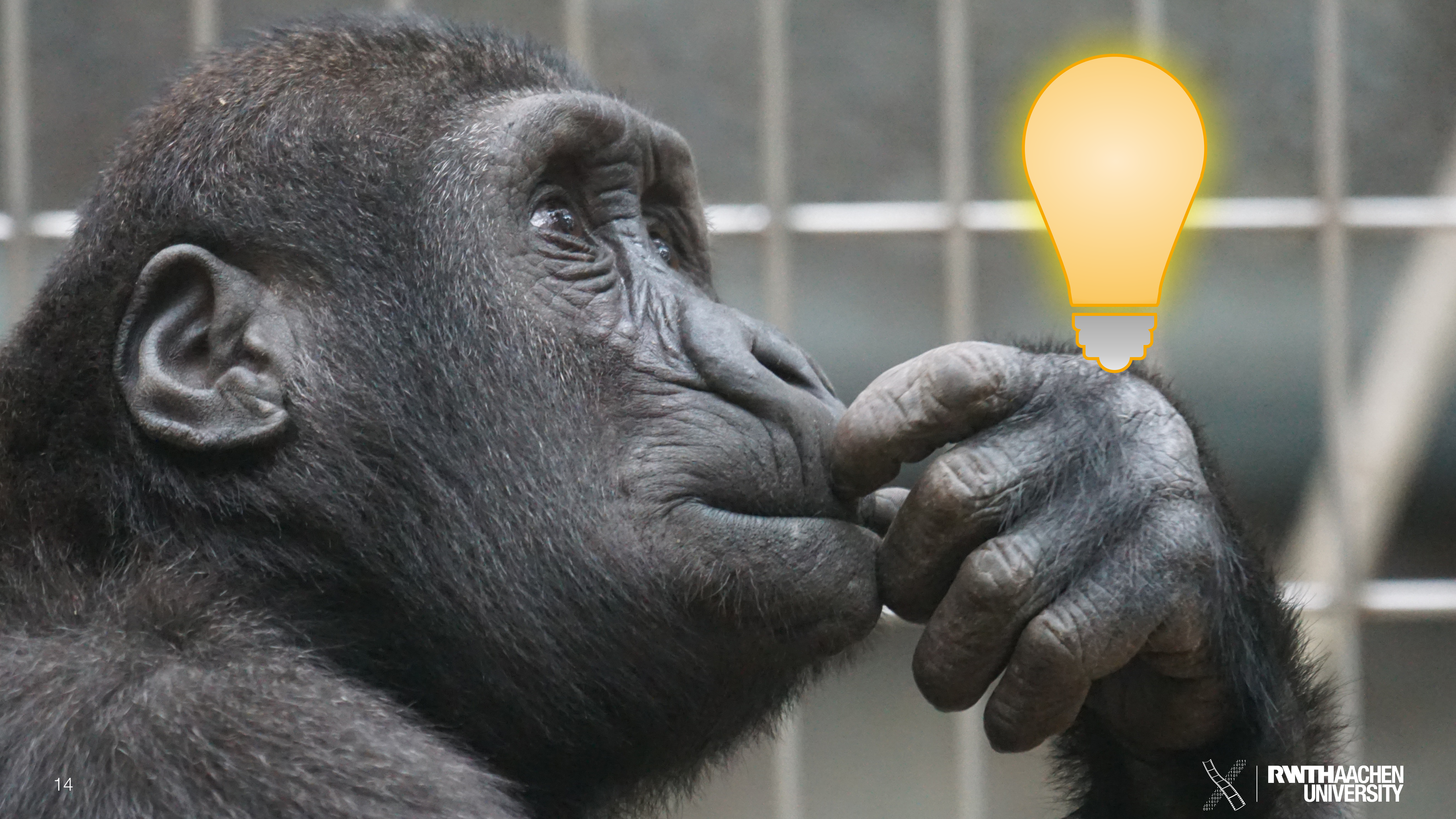
- **Walking**  
in limited rooms (not larger than tracked area)



# Can't We Just Make People Walk Faster?













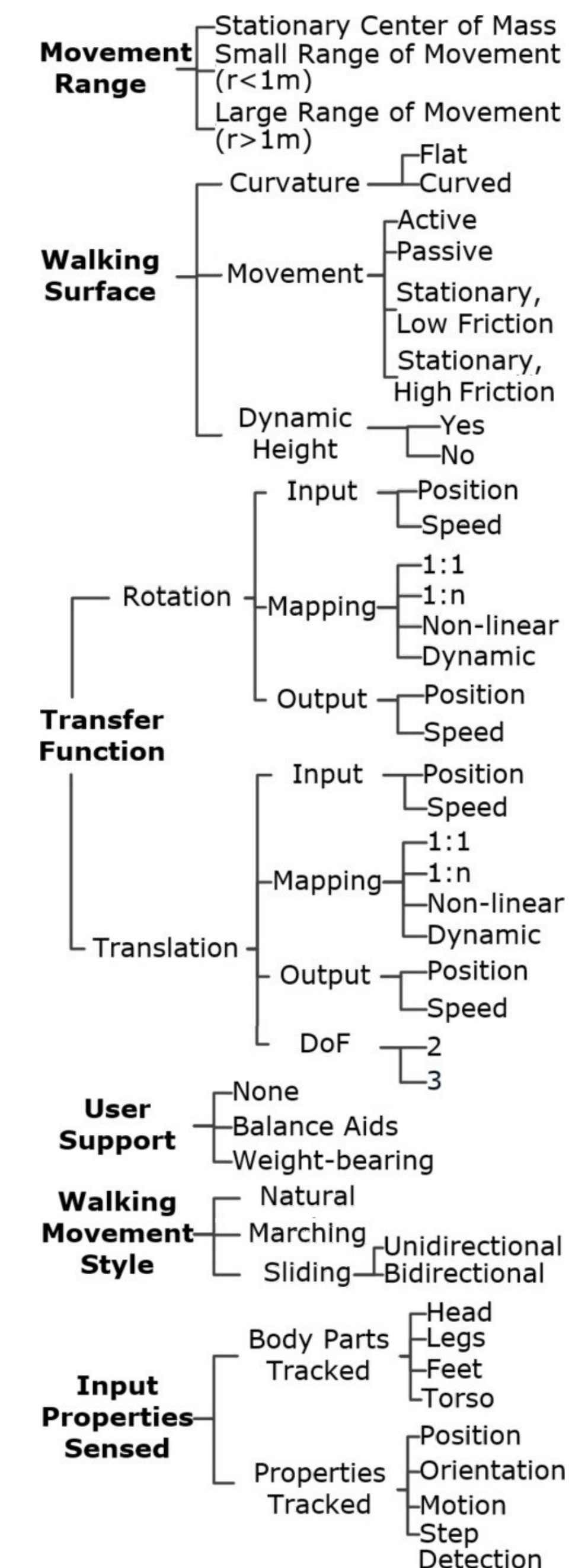
# How to move through VR?

- **Walking**  
in limited rooms (not larger than tracked area)
- **Walking-in-place**  
in open interaction spaces



# Walking-in-Place (WIP)

- While real walking creates the highest spatial understanding of our actions and enhances orientation, WIP offers an interesting alternative
- 1995: Slater et al. shows that WIP offers spatial understanding
- Large number of concrete implementations:
  - How is the velocity controlled?
  - How is the steering controlled?



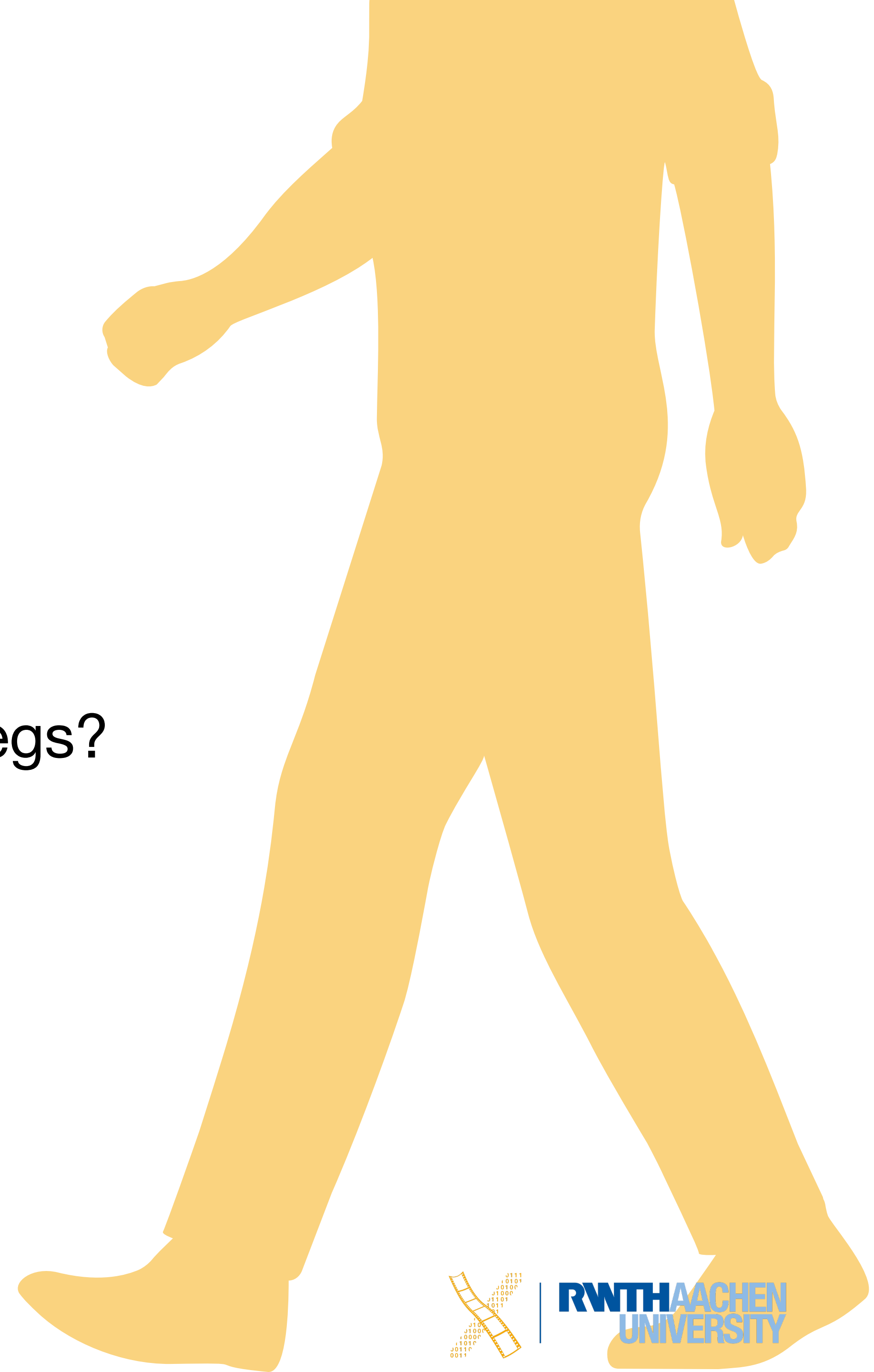


# Seated-WIP



# How to move through VR?

- **Walking**  
in limited rooms (not larger than tracked area)
- **Walking-in-place**  
in open interaction spaces
- But what can you do if it is **not possible** to use the legs?





# Locomotion Techniques



**Arm-Cycling**

# Locomotion Techniques



**Arm-Cycling**



**Point-Tugging**

# Locomotion Techniques



Arm-Cycling



Point-Tugging



Teleporting



# Locomotion Techniques



Arm-Cycling



Point-Tugging



Teleporting



Joystick



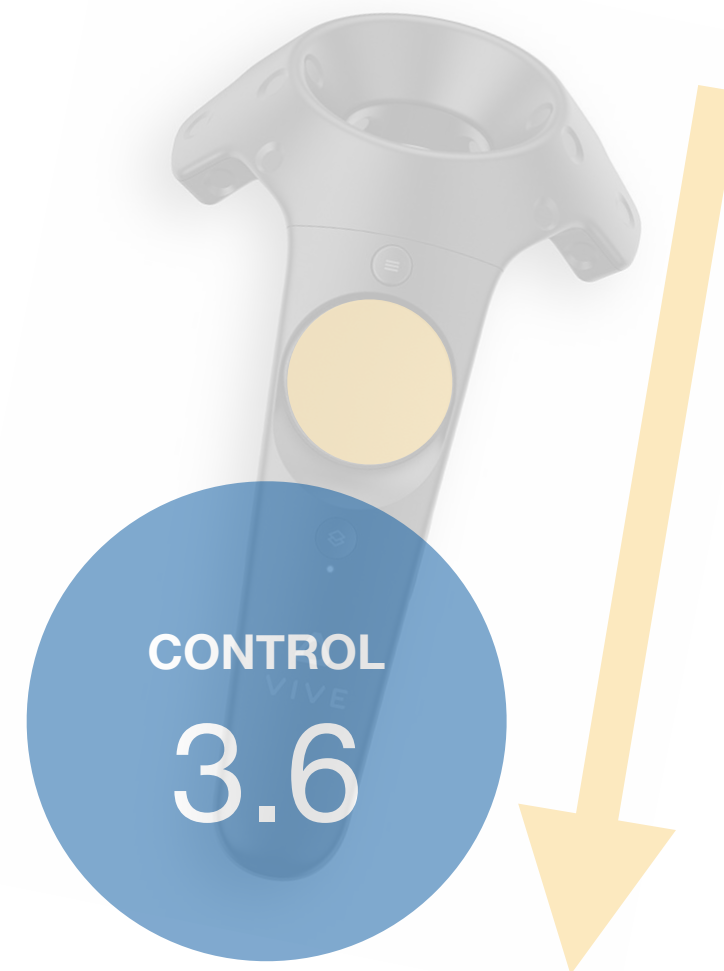
# Evaluation



# Perceived Control



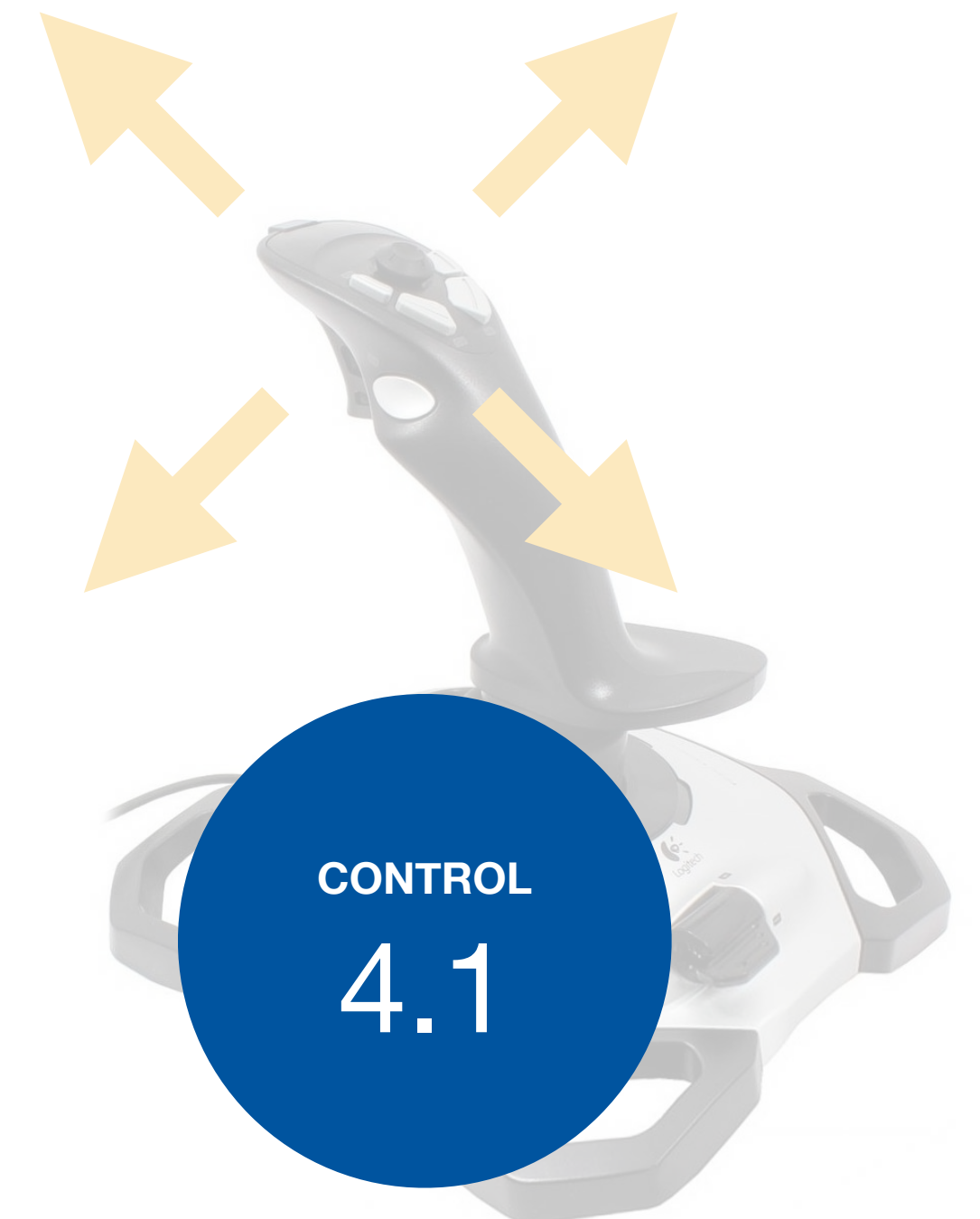
**Arm-Cycling**



**Point-Tugging**



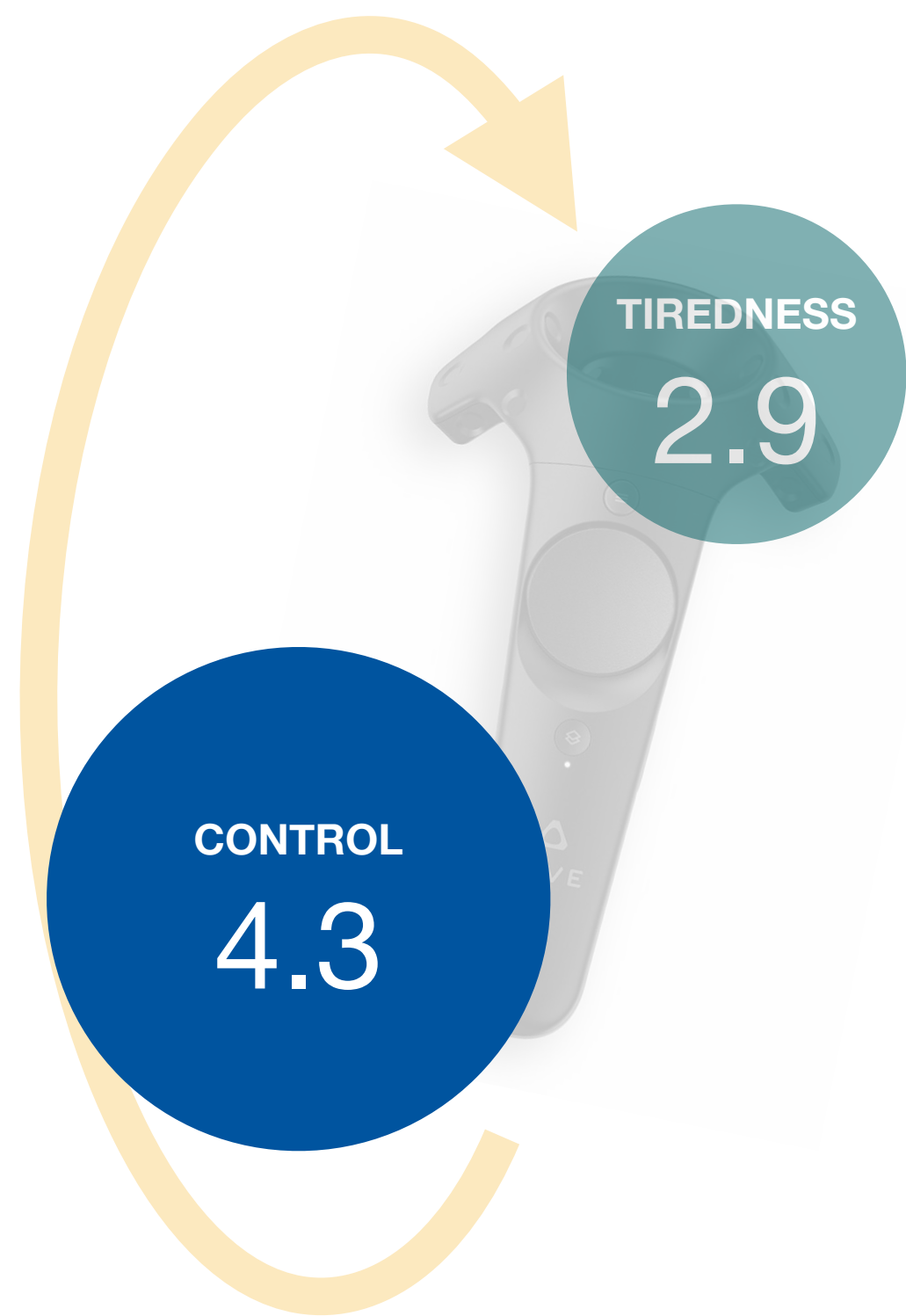
**Teleporting**



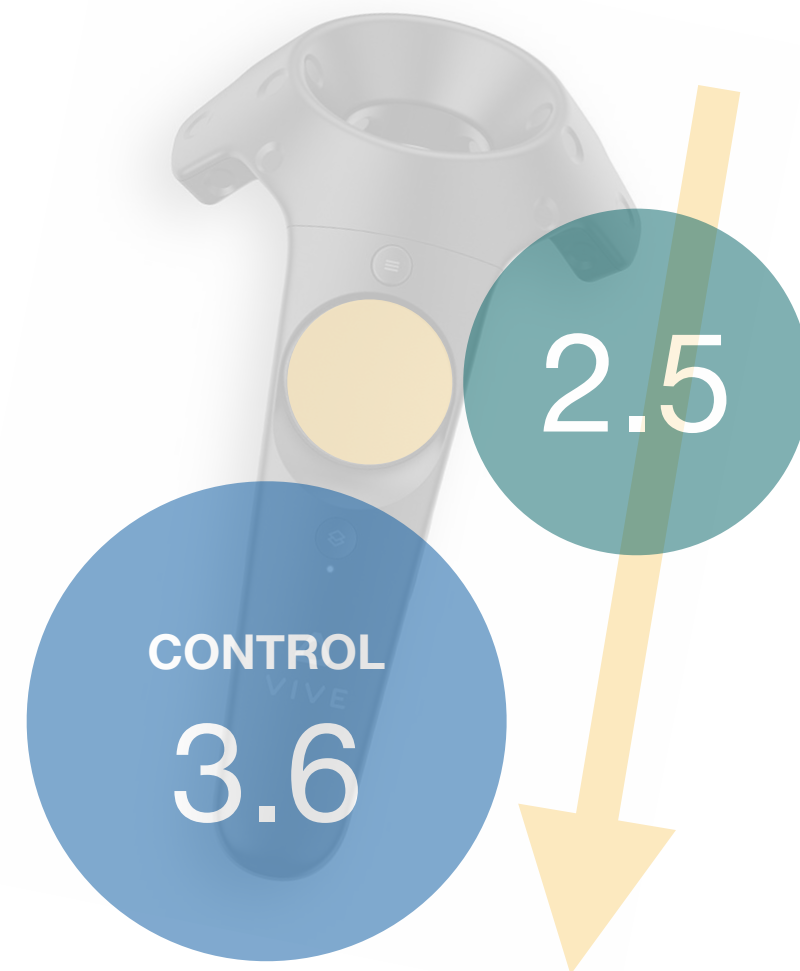
**Joystick**



# Perceived Tiredness



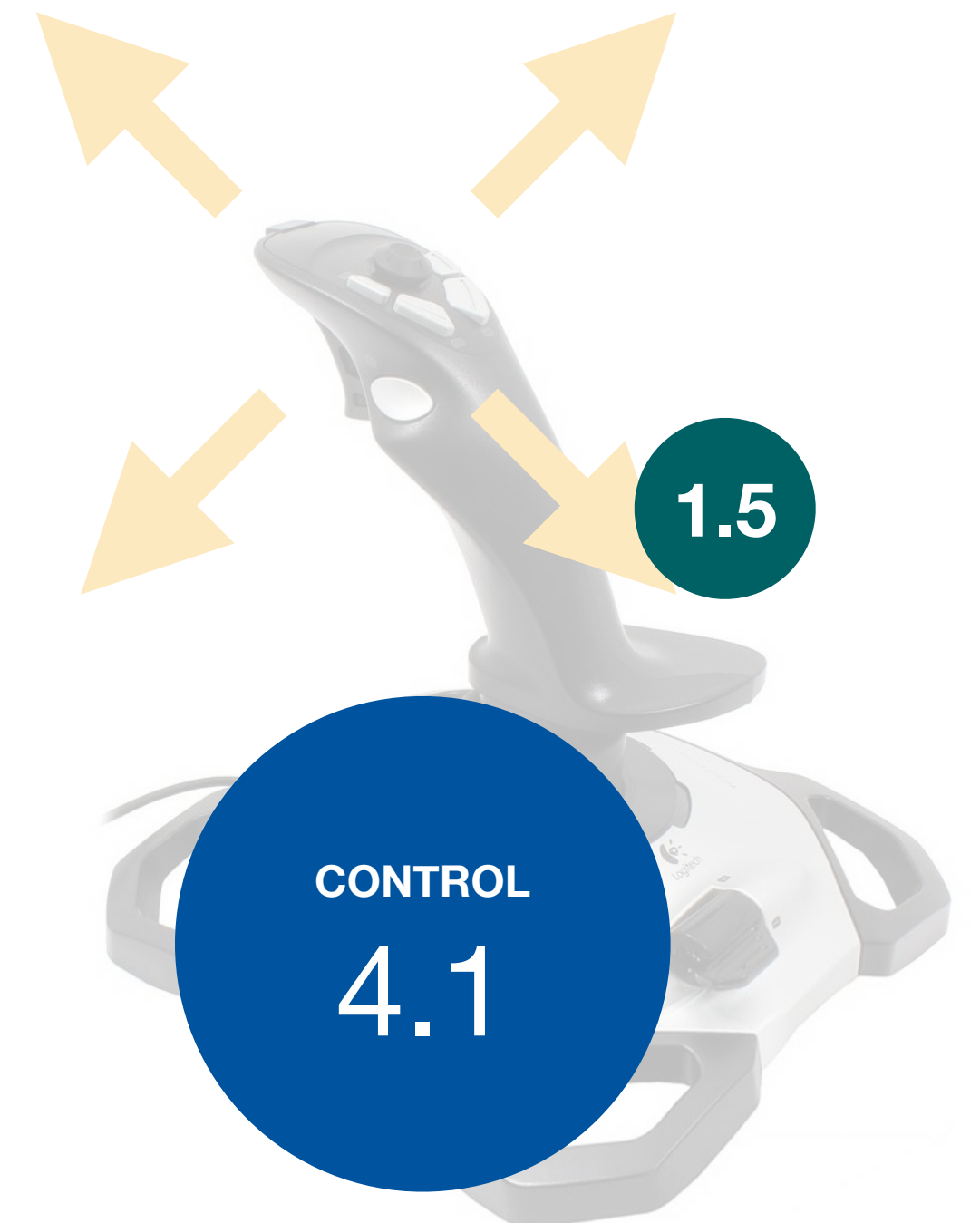
**Arm-Cycling**



**Point-Tugging**

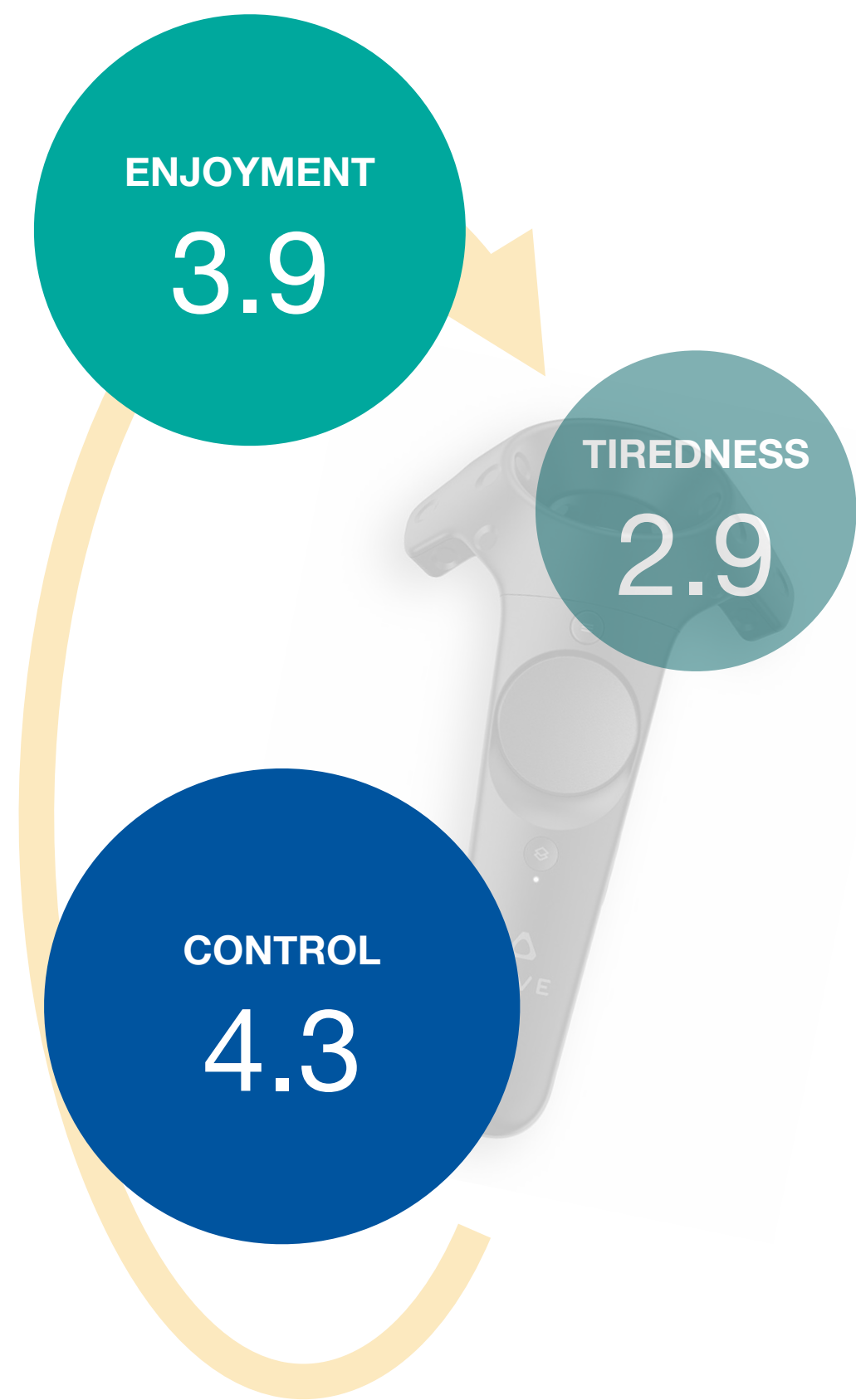


**Teleporting**

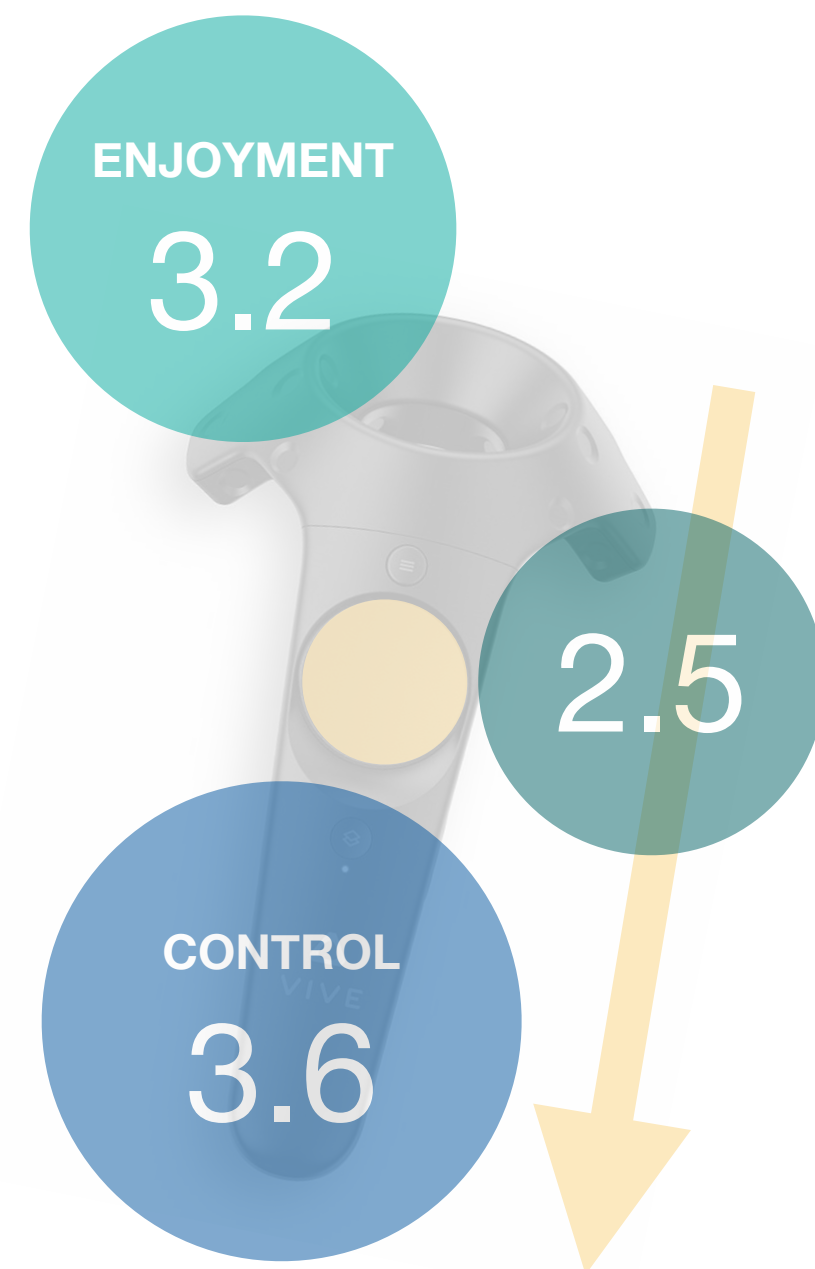


**Joystick**

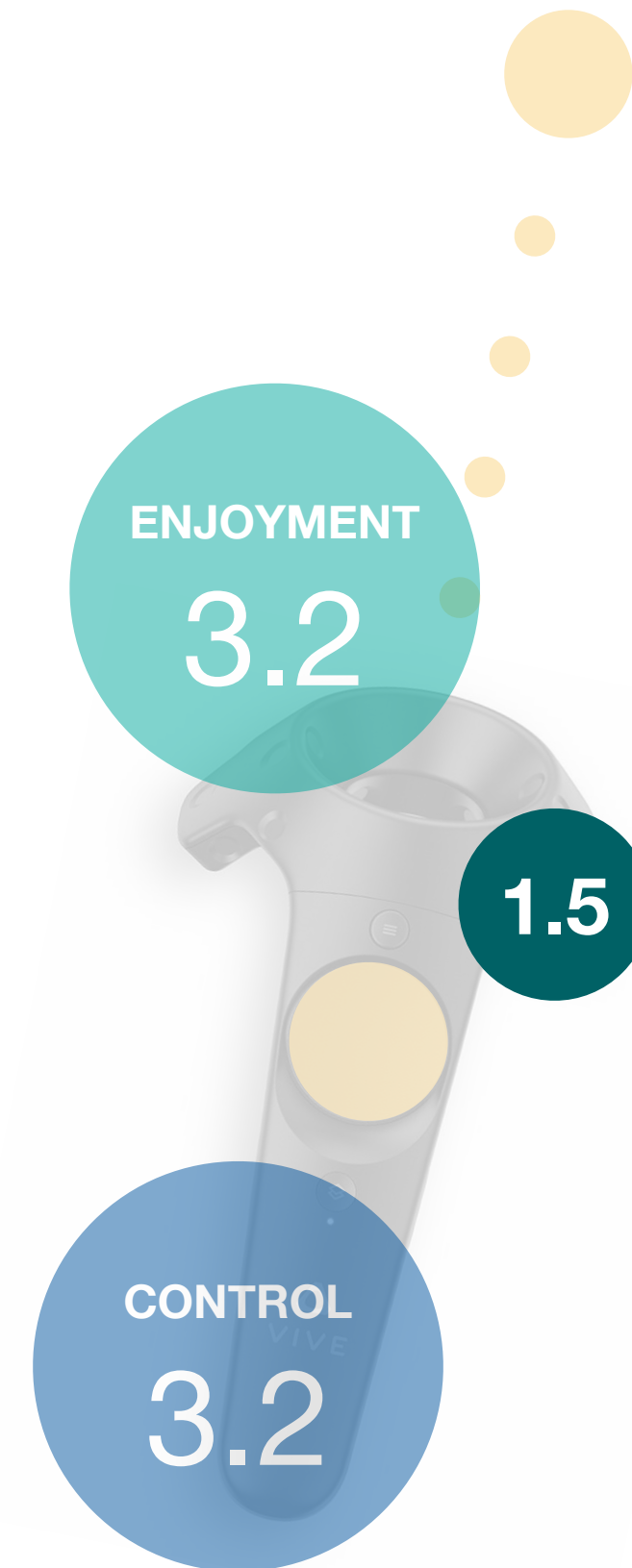
# Perceived Enjoyment



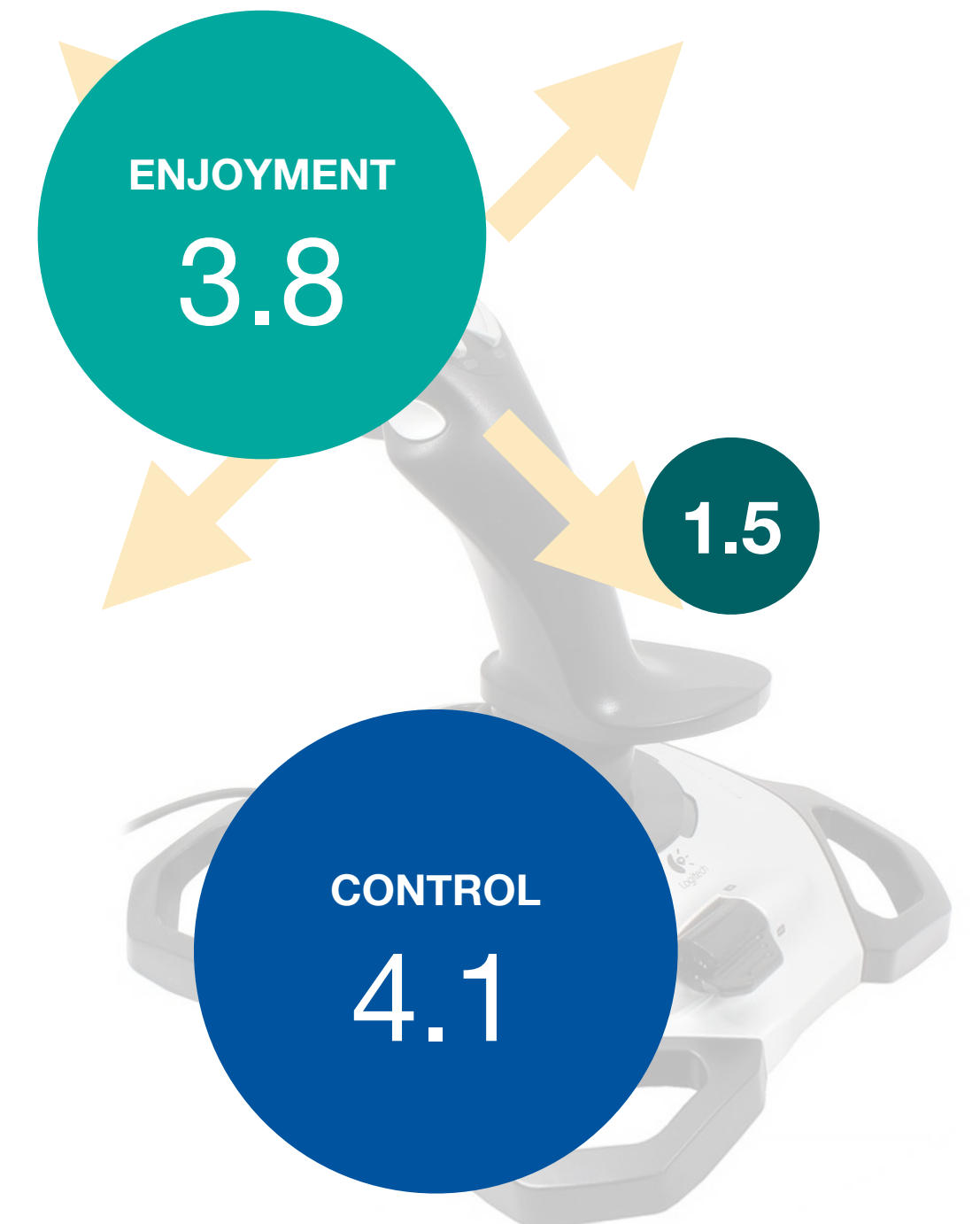
Arm-Cycling



Point-Tugging



Teleporting

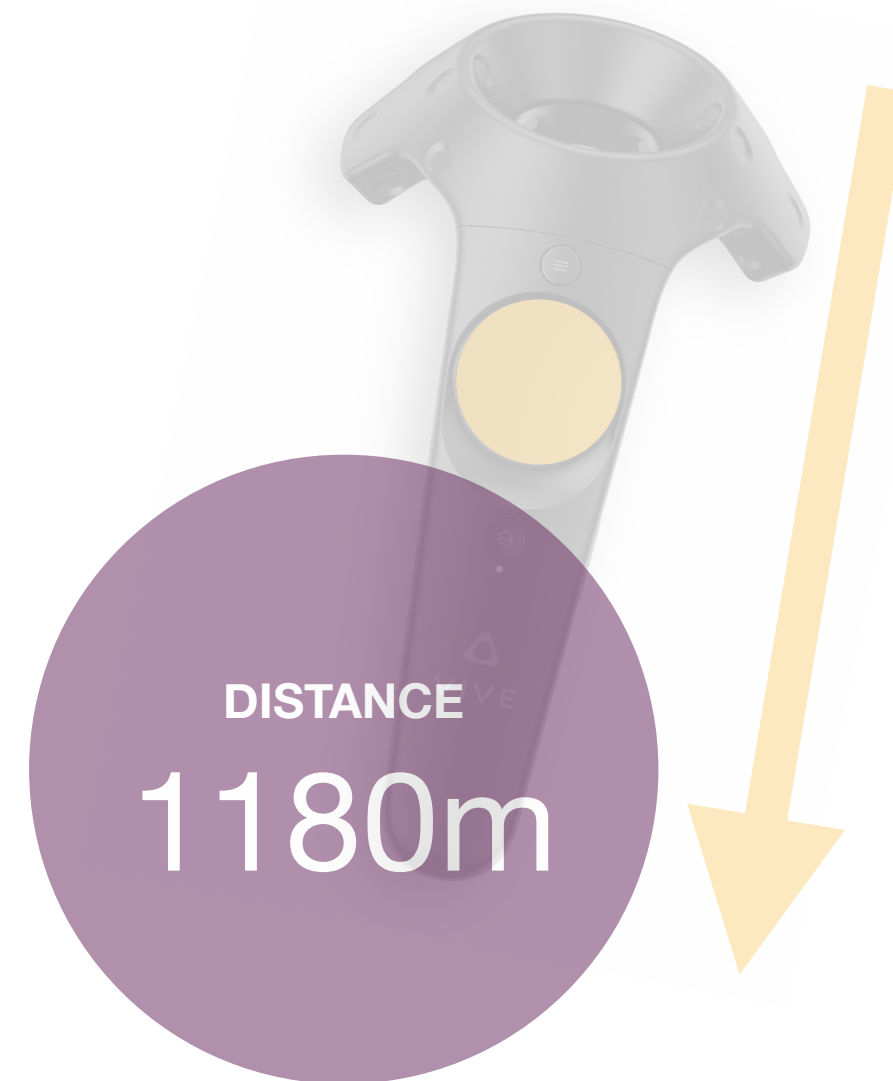


Joystick

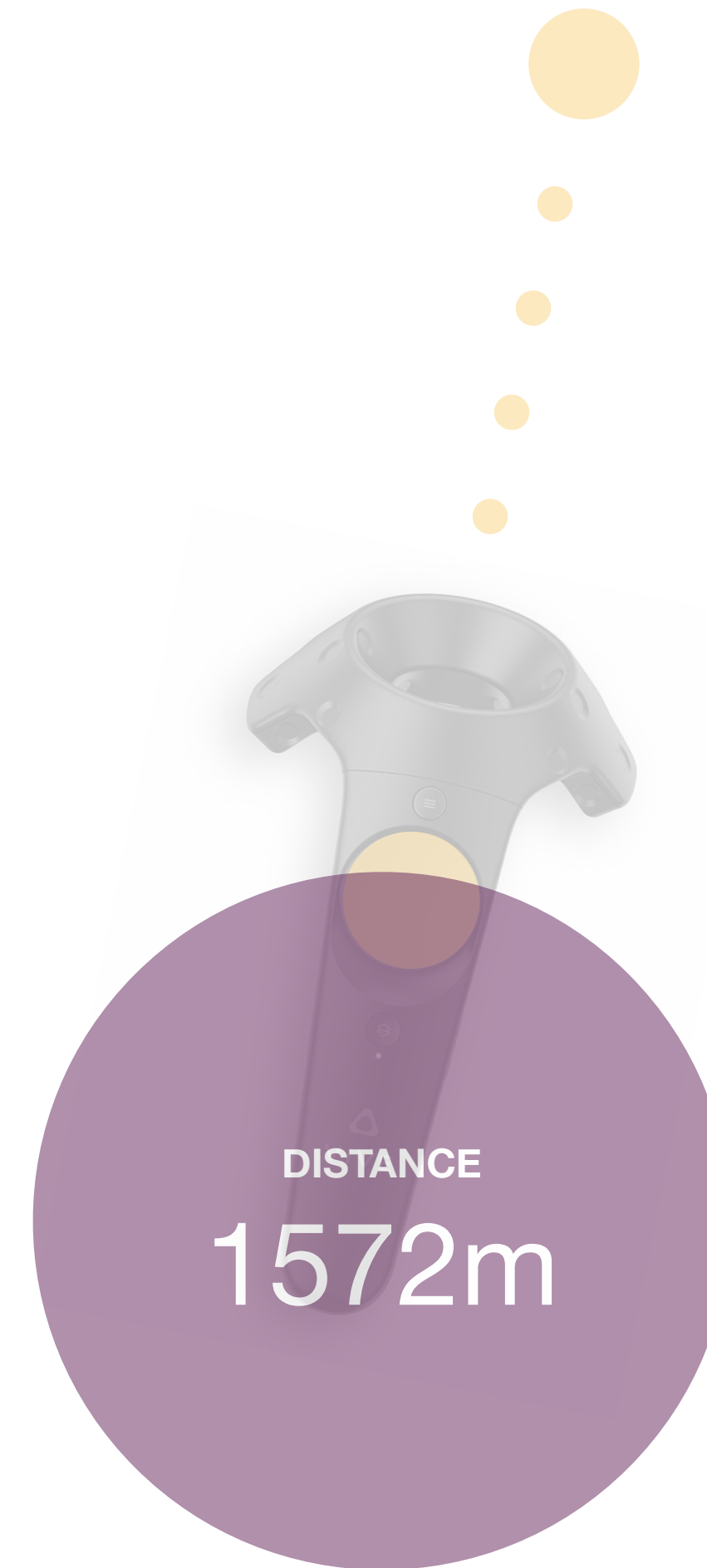
# Travelled Distance



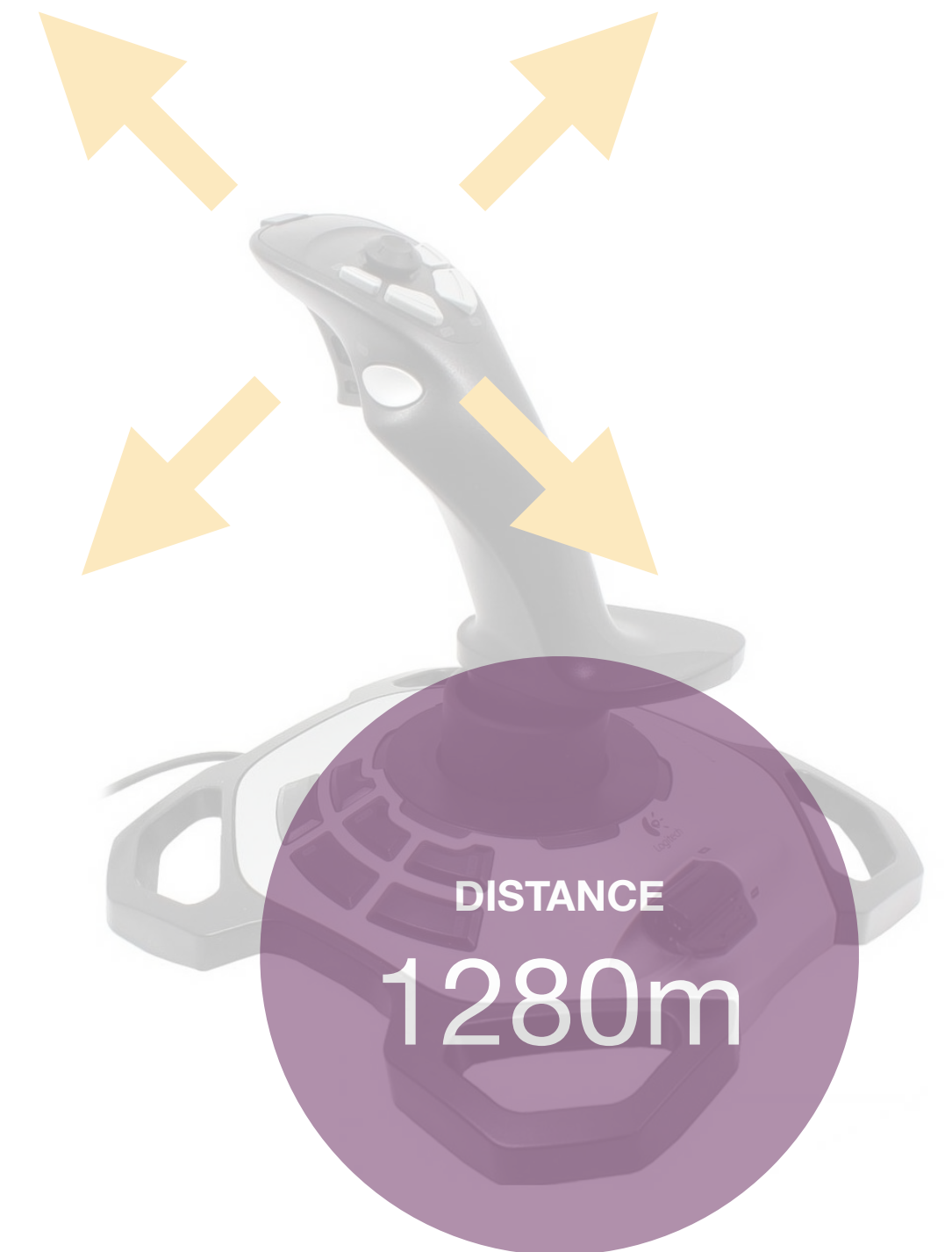
**Arm-Cycling**



**Point-Tugging**



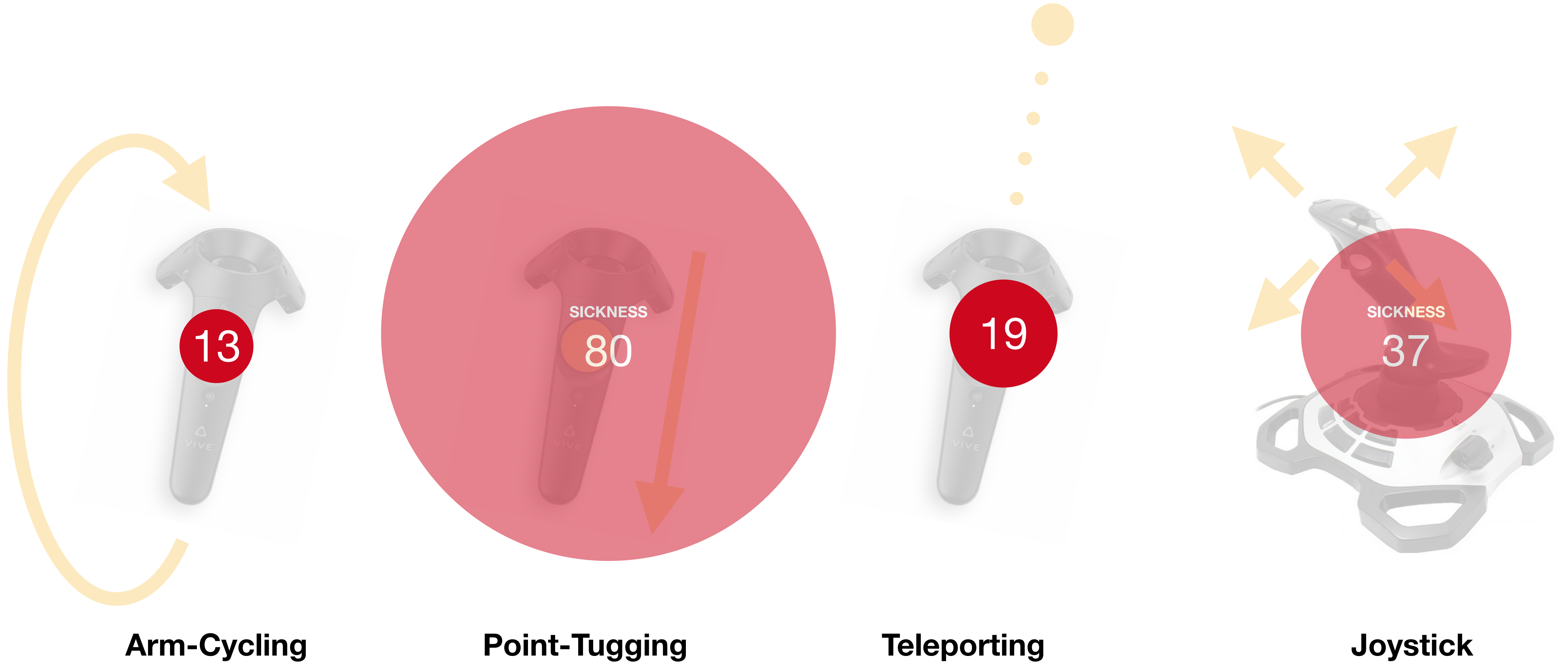
**Teleporting**



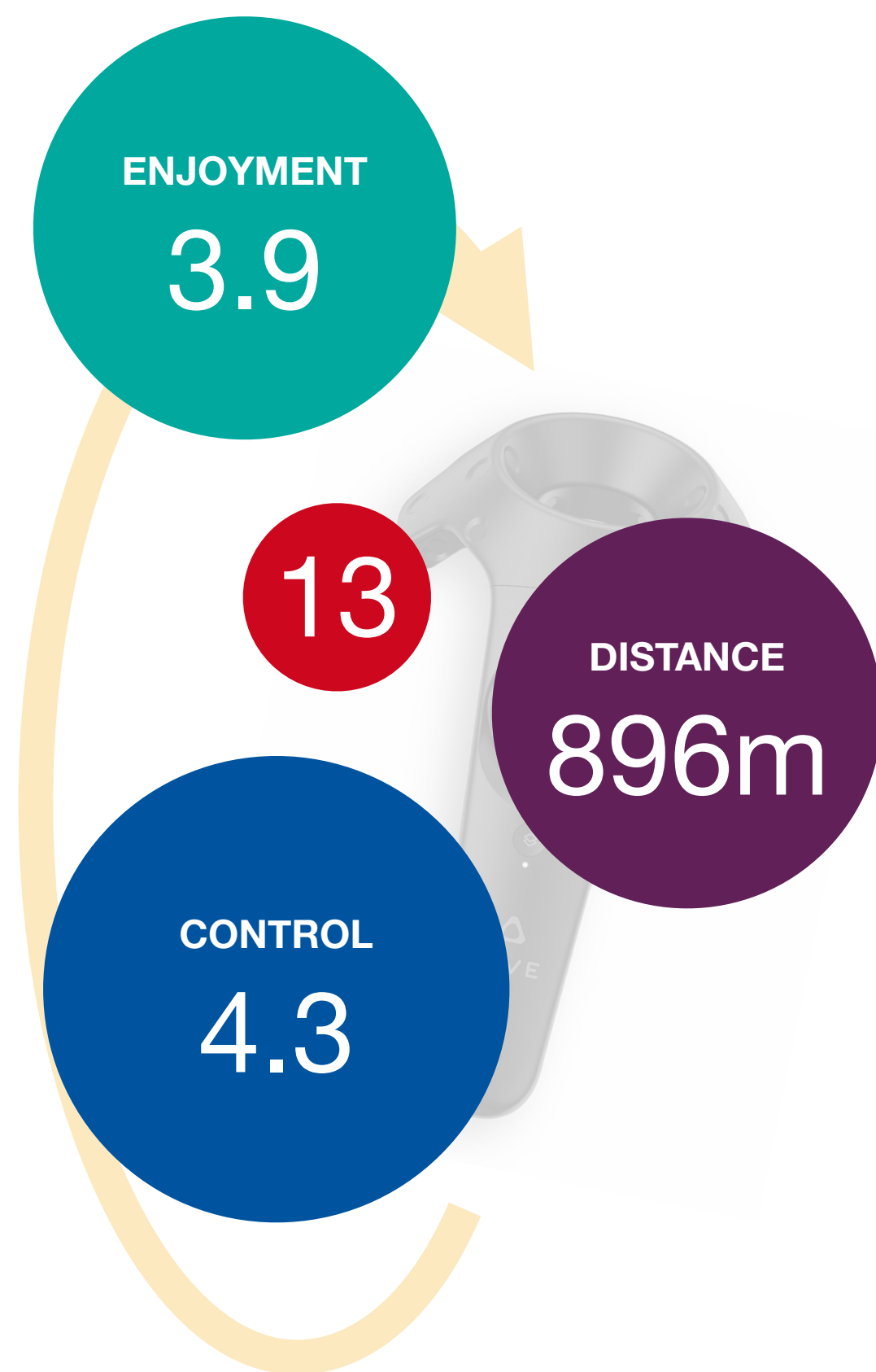
**Joystick**



# Sickness



# Locomotion Techniques: Verdict



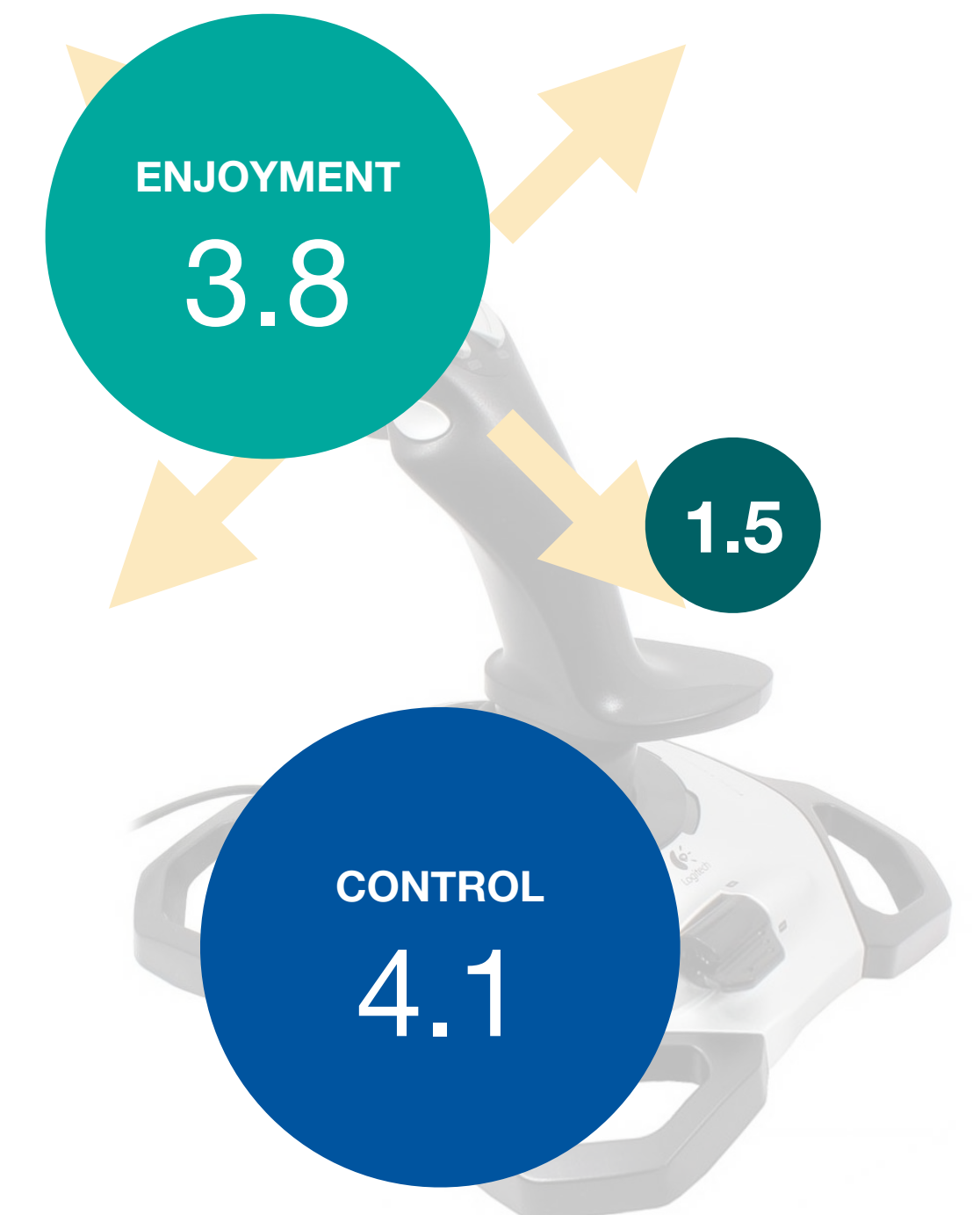
**Arm-Cycling**



**Point-Tugging**



**Teleporting**



**Joystick**

# CHAPTER 4

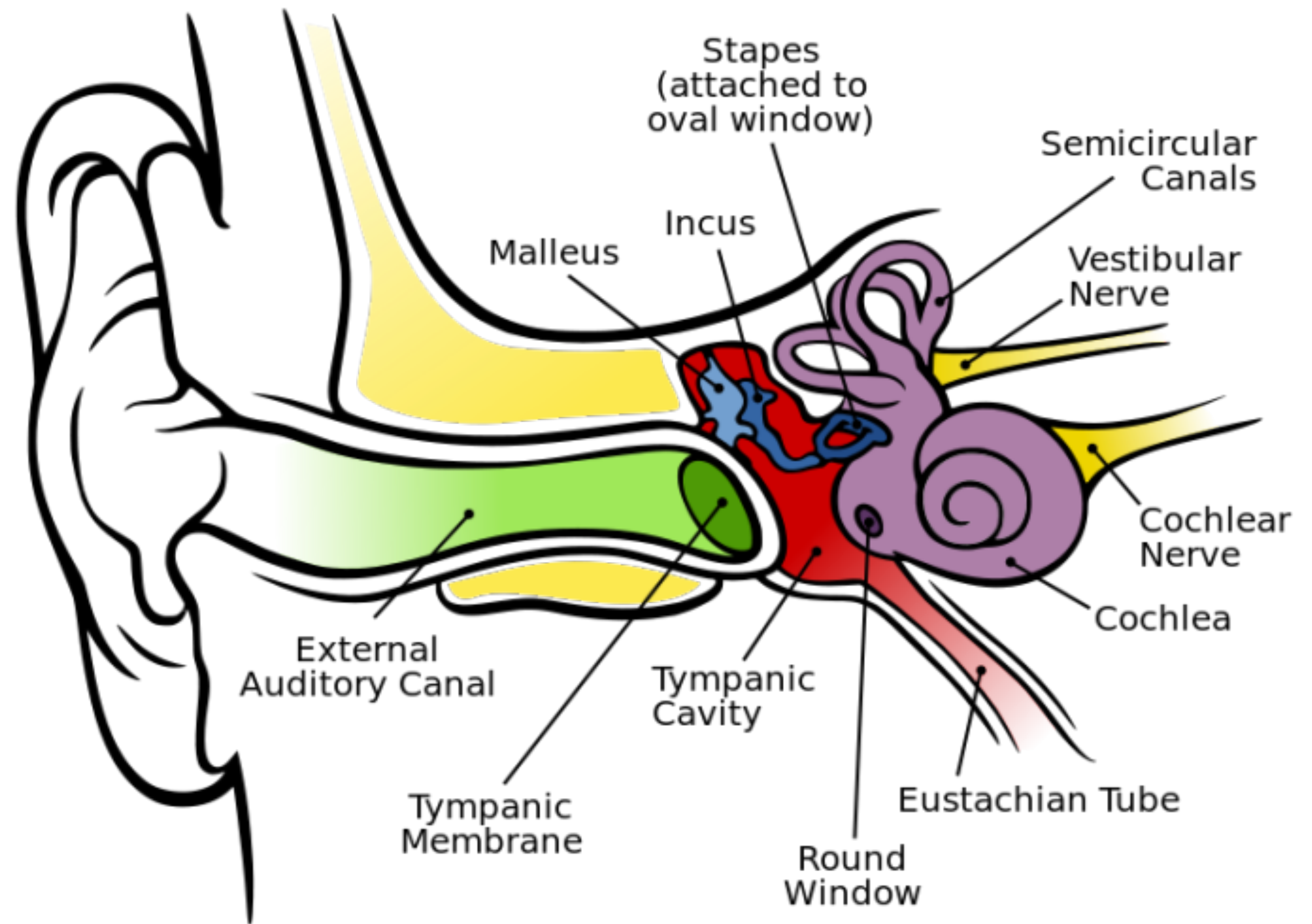
# Vertigo





# The Vestibular System

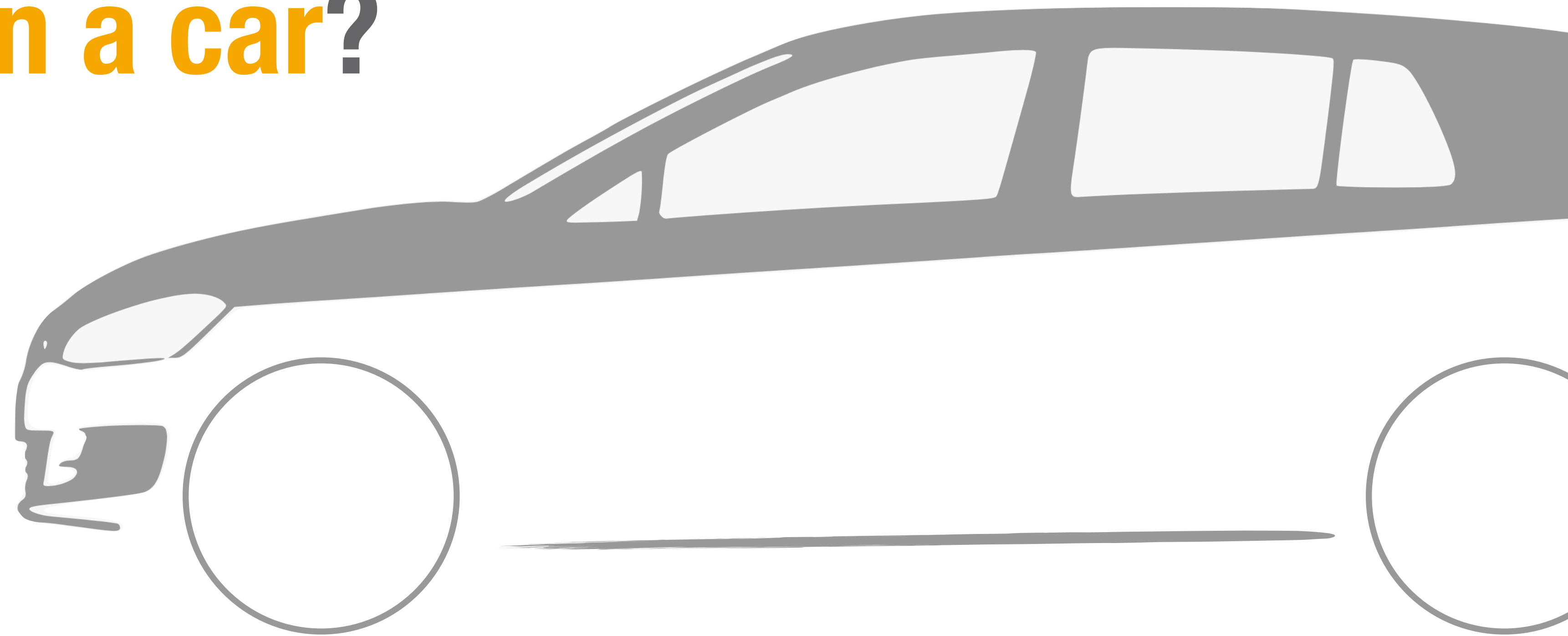
- The semicircular canals in our internal ear determine how our head is rotated in the world
- Contradicting information from other senses lead to vertigo



**Moving in a direction  
that you are not facing  
will cause sickness**



# What happens if you try to use VR **in a car**?





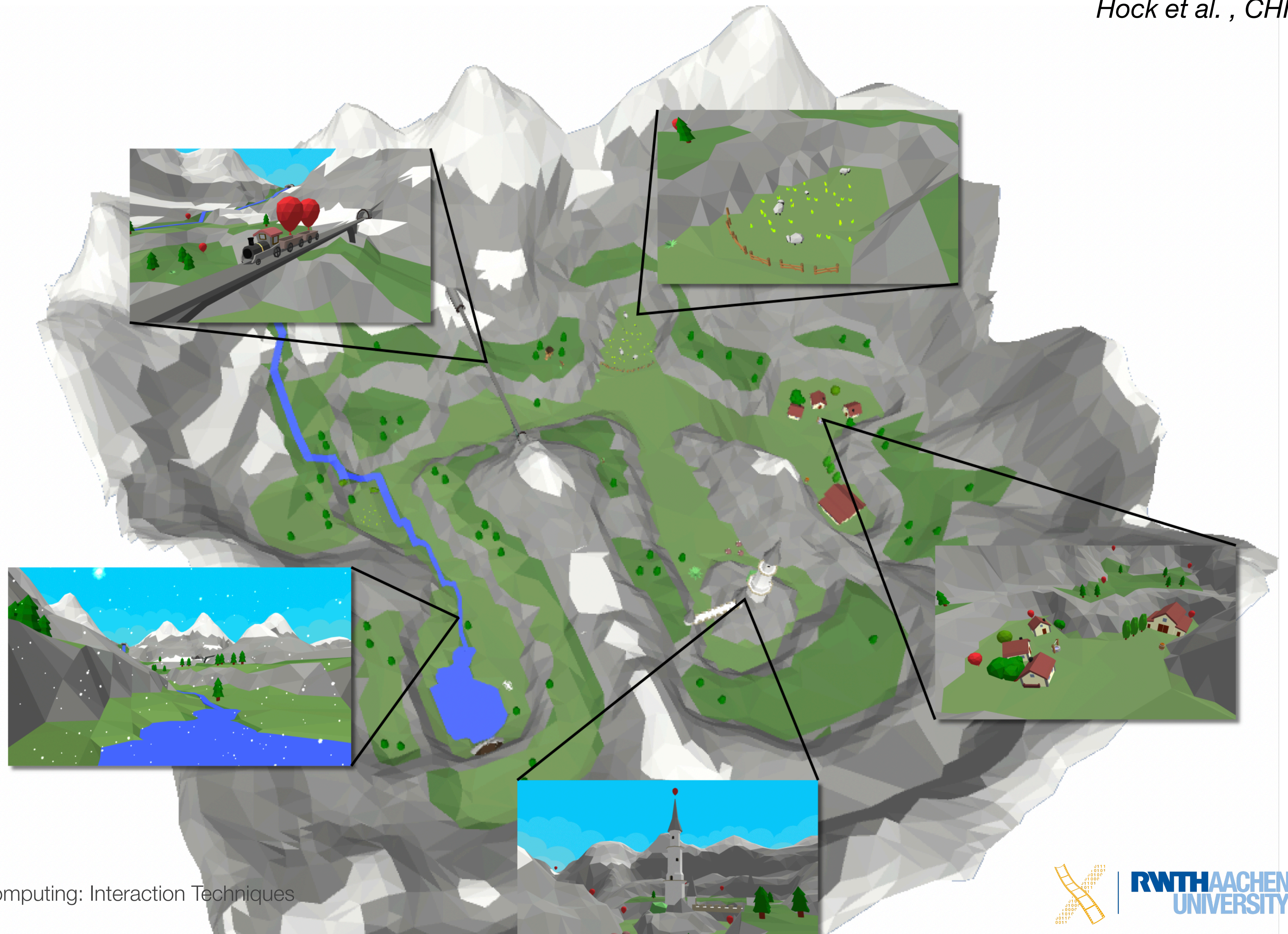
# CarVR

- Prototype that measures vehicle dynamics and translates them into the virtual reality
- Parking condition vs driving condition



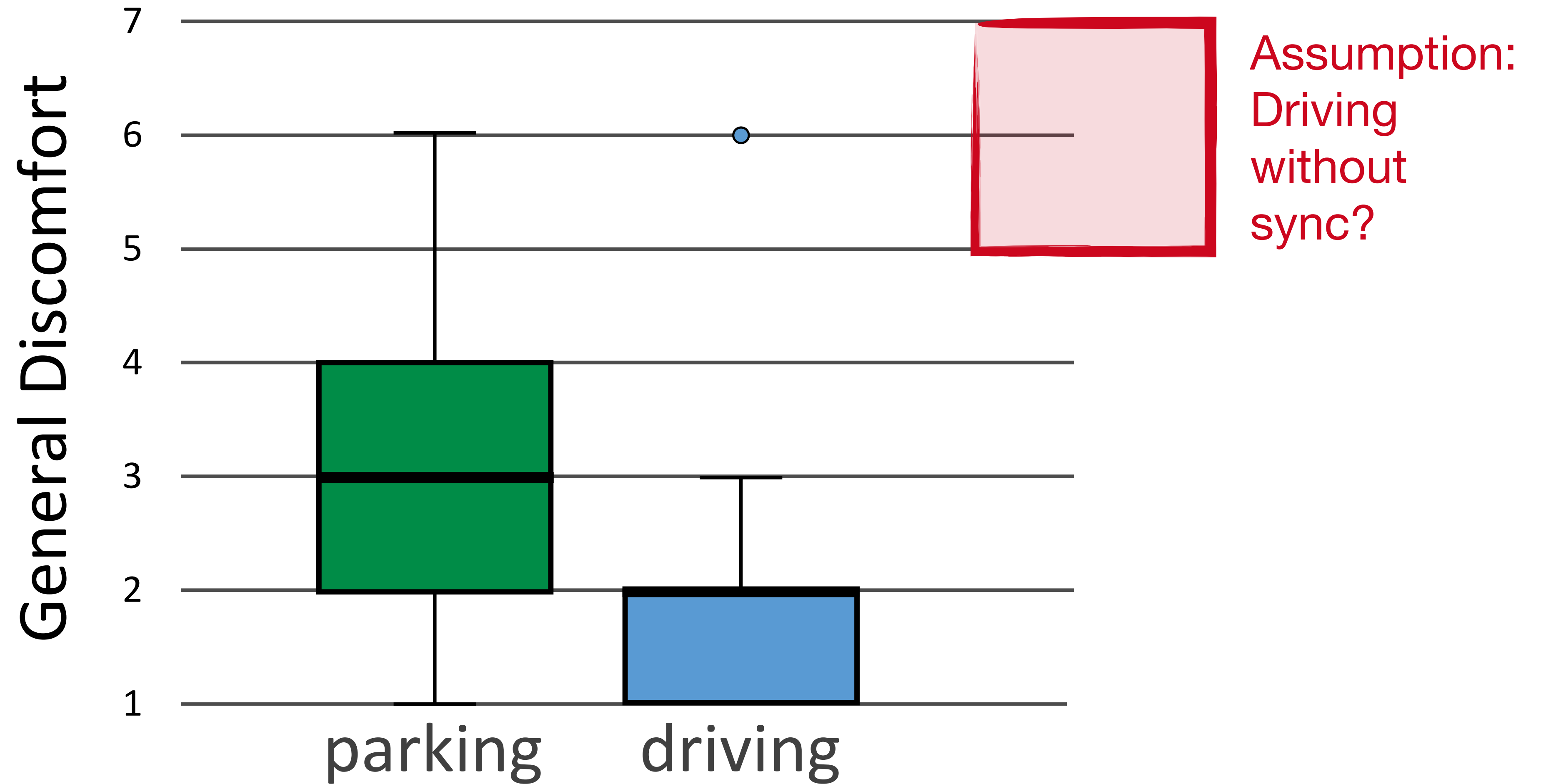


# CarVR





# CarVR









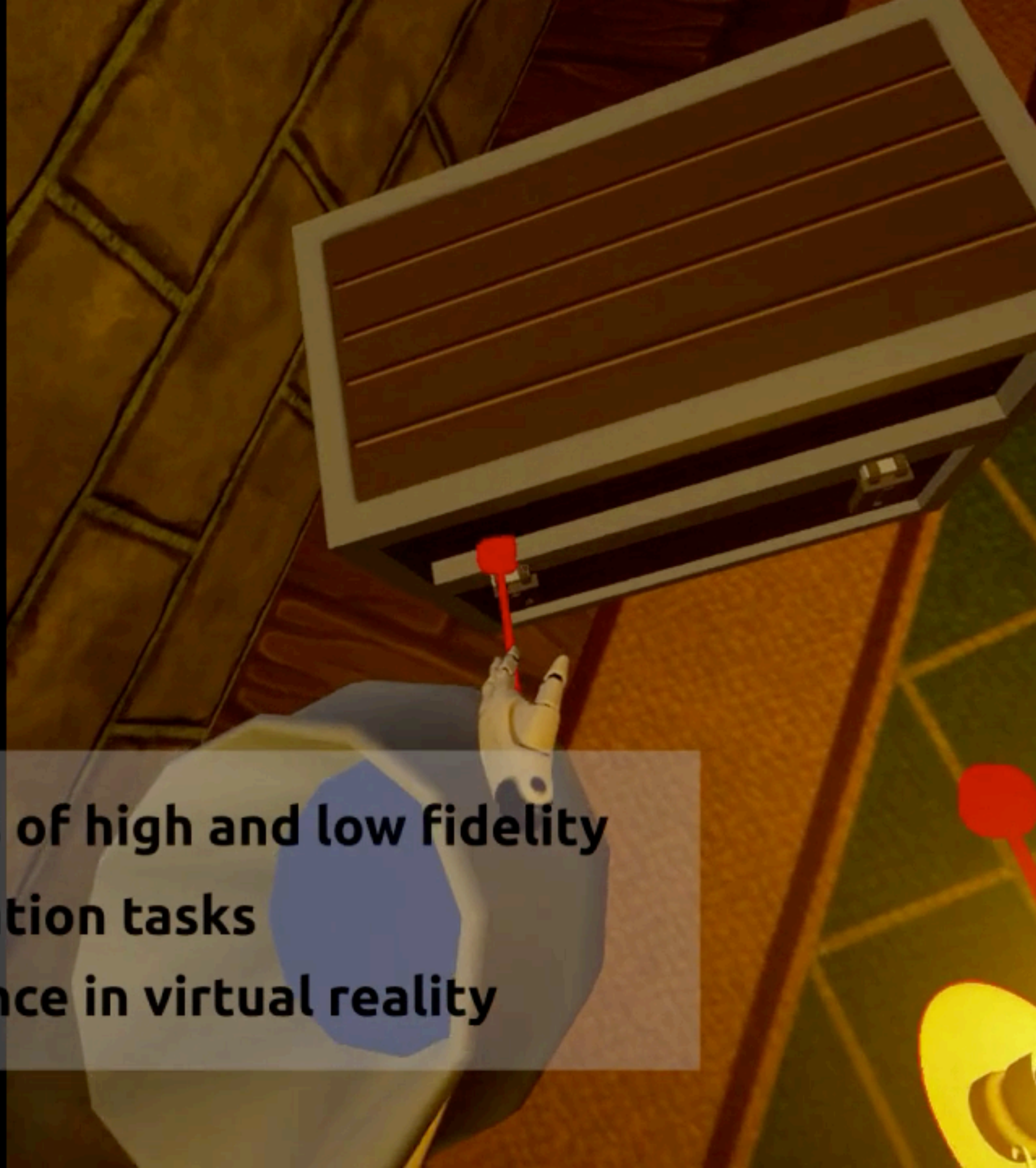
## CHAPTER 5

# Interaction Fidelity



# Is **realism** always favorable?

**Comparing effects of high and low fidelity  
in object manipulation tasks  
on player experience in virtual reality**





# Realism vs Abstraction

- In order to get items out of a chest
- High Fidelity: Open the two buckles, push the lid and take items out, no inventory menu (a,b)
- Low Fidelity: Click on chest and move items between inventories (c)



# Implications on the Design of VR Games

- Prefer high interaction fidelity for object manipulation
- Strive for moderate interaction fidelity for whole-body movements
- Larger enjoyment of exploration in VR
- Consider onlooker effects



# Interested in the topic?

