Supporting Playful Rehabilitation in the Home using Virtual Reality Headsets and Force Feedback Gloves

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INTRODUCTION

Context

- Traditional Therapies:
  - Tedious and unattractive tasks (loss of motivation) Difficult access
  - to medical facilities in remote areas

- Work on VR in Rehabilitation:
  - Exposure of patients to simulated "real world" tasks

Issue

- Emotional aspects less central to design or evaluation
- Integration of haptic information in rehabilitation is under-explored,
- How does gamification in VR make the rehabilitation process more enjoyable?

Objectives

- Build and evaluate a playful VR rehabilitation system and engaging with a mechanical force feedback.

METHODOLOGY

Hardware and software resources used

- VRCatBath, VR simulation developed with Unity.
- Oculus Quest 2 (HMD), a virtual reality headset sandalone
- Dexmo gloves for hand motion capture and force feedback

Figure 1: Oculus Quest 2, Dexmo gloves, computers

Figure 2: Dexmo gloves

Figure 3: VRCatBath

Conceptual model

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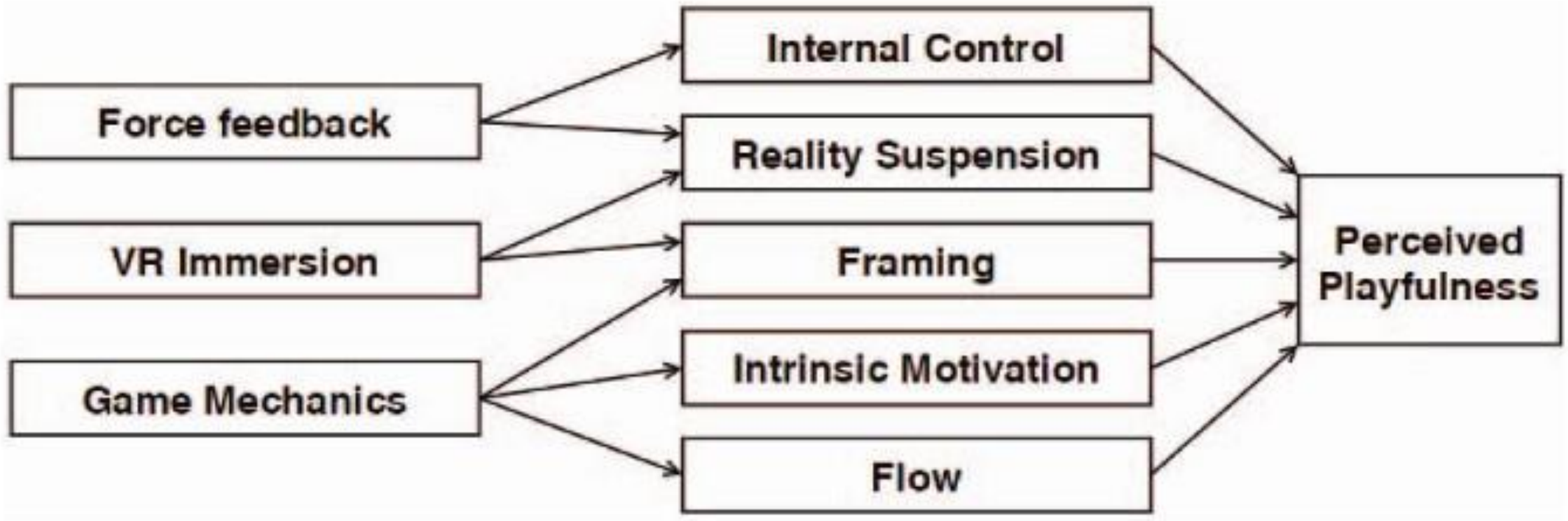

Figure 4: Conceptual model that elucidates how playfulness manifests itself through the combined effect of three factors that are VR immersion, force feedback, and game mechanics.

Procedure

- *Task 1: Prepare the cat psychologically for the bath with treats*
  - Catch snacks with moderate pinch force Upper and lower
  - pressure threshold

- *Task 2: Massage the cat sitting in the bath*
  - Different levels of sensitivity and force tolerance
  - Effects of light or excessive force (relaxation or irritation)

Procedure

- *Task 3: Drying the cat with a hair dryer*
  - Balance distance cat / hair dryer and force on the handle. Hot air
  - flow directed to the cat by rotating the hand.

Figure 4: The game starts by preparing the cat for the bath psychologically through food treats.

Figure 6: In the final scene, the user blow-dries the cat with a hair dryer.

Figure 5: In the second task, the user cleans and massages the cat with appropriate force.

Figure 7: The rules of the game are explained in the voice of the cat to add more fun.

Figure 5: Screenshots of the three tasks

Performance

- Quality of the action
- Execution time

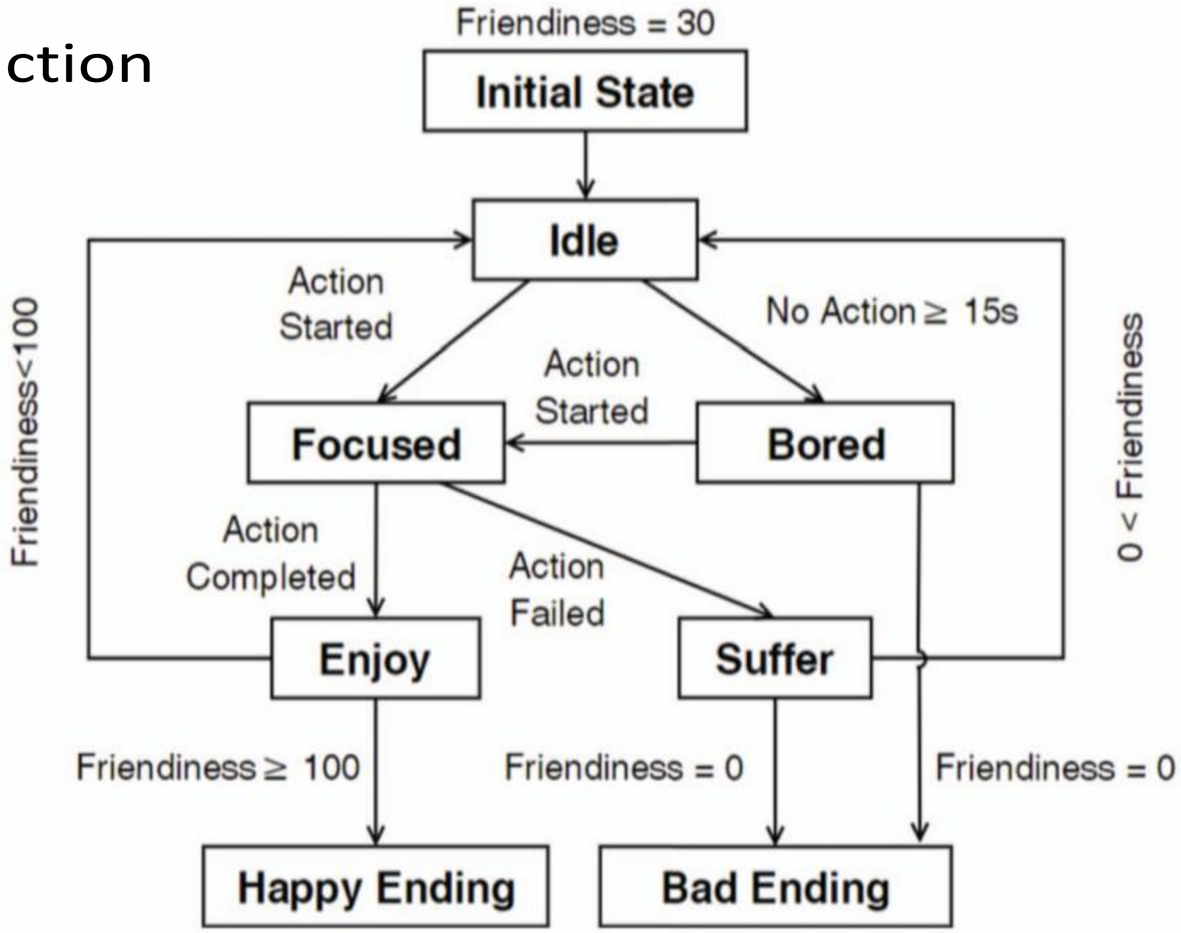

Figure 6: User performance is reflected in the cat's kindness attribute. The game is won if the value of "Friendliness" reaches 100 and the game is lost if it falls to zero, as shown in the flowchart.

Evaluation

- Objectives
  - Quantitative evaluation (user interviews in both studies)

Table 1: Attitude questionnaire.

Items (5 point Likert scale, 0 = strongly disagree, 5 = strongly agree)
Attitude Towards Using
- Using this system is a (bad/good) idea.
- Using this system is a (foolish/wise) idea.
- Using this system is a (unpleasant/pleasant) idea.
Intention to Use
- To what extent would you like to begin or continue playing the game right now?
- To what extent would you recommend the game to others?
Expected/Perceived Playfulness
- How playful do you expect the game to be/did you think the game was? (0 = not at all; 10 = very)

Table 2: In-game experience questionnaire.

Items (5 point Likert scale, 0 = strongly disagree, 5 = strongly agree)
Force Feedback
- To what extent did you feel that the gloves control was easy to pick up?
- To what extent did you feel that the force feedback added a sense of reality to the game?
- To what extent did you feel that the force feedback added a sense of enjoyment to the game?
- At any point did you find yourself become so involved that you were unaware you were wearing gloves?
VR Immersion
- To what extent did you lose track of time?
- To what extent did you feel you were focused on the game?
- To what extent did you feel as though you were separated from your real-world environment?
- At any point did you find yourself become so involved that you were unaware you were even using controls?
Game Mechanics
- To what extent did you feel motivated while playing?
- What motivated you the most in the game? (write down the answer directly)
- To what extent were you interested in seeing how the game's events would progress?
- Were you in suspense about whether or not you would win or lose the game?

Figure 7: User questionnaires

Evaluation

- *Study 1: Indicative study with seven healthy adults*
  - Evaluate feasibility & gamification of VR rehabilitation system Gather design
  - information for next cycle
  - 4 men, 3 women aged 23 to 30 with a medical background

- *Study 2: Enhanced study with 14 healthy adults*
  - Evaluate the feasibility & gamification of the system with experts.
  - Improved design of the VRCatBath simulation.
  - 13 men, 1 woman aged 22 to 26 from universities.

RESULTS

Result: Attitude towards the system

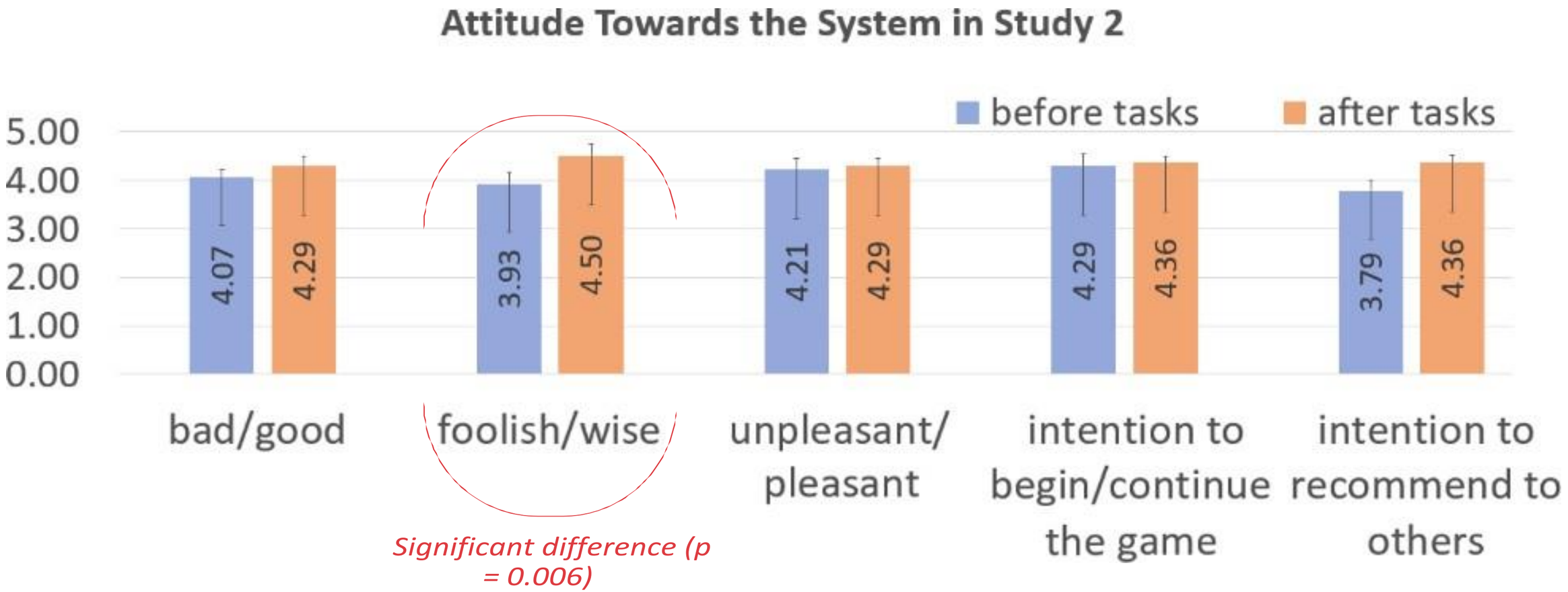

Figure 8: Participants' attitudes (mean values; error bars indicate standard error) toward the system reported before and after the three tasks in Study 2.

Result: Experience in play

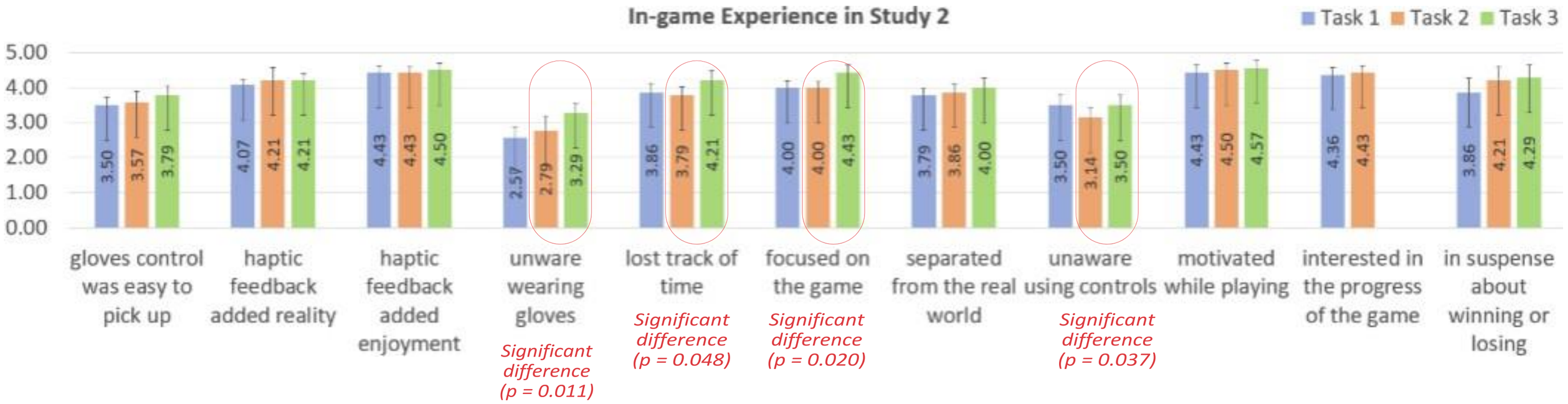

Figure 9: In-game experiences reported by participants after each task (mean values; error bars indicate standard error) from Study 2.

DISCUSSION

Learning and improvement components

- *Component 1: Potential of gamification & VR in rehabilitation.*
  - Create an emotional connection with the system.
  - Ability to create scenarios beyond the reach of hospitals/clinics. Risk of
  - weakening therapeutic effectiveness if too much gamification

- *Component 2: Imperfection of the equipment*
  - Periocular pain, caused by simultaneous wearing of glasses/earpiece Glove
  - size that exceeded the average size of women's hands

- *Component 3: Evaluation Methodology*
  - Reading the questionnaires aloud

CONCLUSION

Conclusion

- *Creation of a new playful system of "VR rehabilitation*
  - What are the results on people in rehabilitation? What are the
  - long-term results?

- *Evaluation of playfulness as a driving force*
  - What are the results on an audience between 50 and 60 years old?
  - What are the effects of long-term simulation on motivation?

- *Evolution*
  - Evaluate generalizable design advice for the population
  - Requires a concerted effort by many research teams

THANK YOU!