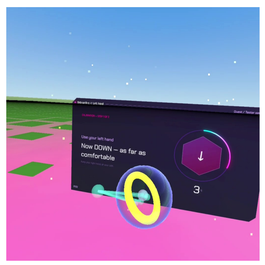
Comparing Hand Tracking and Standard Controllers in a Rhythm-Based VR Exergame

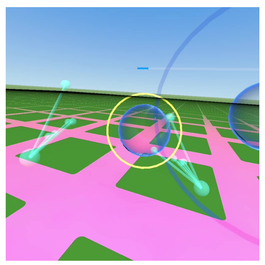
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Introduction

By 2030, 1 in 6 people worldwide will be aged 60 or over, and by 2050 this group will double to 2.1 billion [1]. Staying active helps older adults keep their balance, mobility and independence, but many exercise little because of low motivation and fear of injury [2]. **Exergames can help**. Games that combine exercise with play improve motivation [3] and can improve balance and mobility [4]. However, most past studies used non-immersive systems such as the Nintendo Wii [3], and handheld VR controllers may be hard for some older adults to grip and learn.

RhythmExer is a rhythm-based VR exergame. Players pop bubbles in time to music, which builds upper-body movement into play.





Methods

Participants: 14 neurotypical young adults (university students and staff).
Design: Within-subjects. Each participant played RhythmExer with both standard controllers and hand tracking, in counterbalanced order (8 started with controllers, 6 with hand tracking).
Apparatus: Meta Quest 3, played seated.
Measures (after each condition): System Usability Scale (SUS) [5, 6], NASA-TLX [7], Presence Questionnaire [8], MiSSES [9], and open-ended feedback.
Analysis: Wilcoxon signed-rank tests compared conditions. Non-inferiority on SUS was tested with a 5-point margin.



Preliminary Results

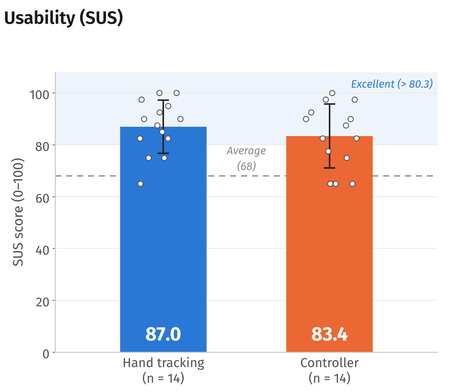


Figure 1
System Usability Scale (SUS) scores by input method (mean ± SD; dots show individual responses). Both input methods scored above the 68-point average benchmark and within the "excellent" range.

Hand tracking was non-inferior to controllers in usability (+3.6 SUS points, 95% CI [−1.9, 9.0], p = .002). 13 of 14 participants rated it above the SUS average of 68.

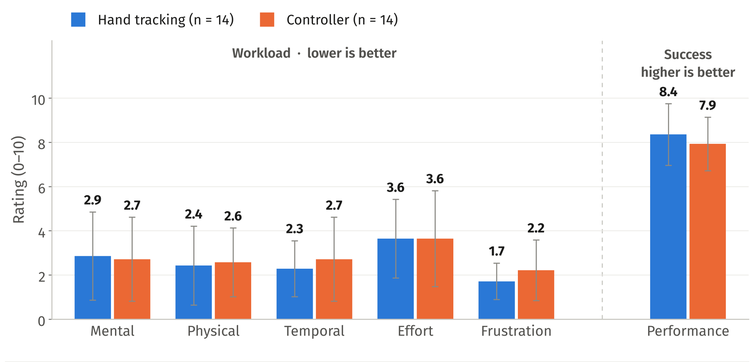


Figure 2
NASA-TLX subscale ratings by input method (mean ± SD, 0–10). Workload was low for both methods. Lower scores are better on the five workload subscales; higher scores are better for Performance.

Discussion

Hand tracking was non-inferior in usability, and workload and presence stayed similar, so removing controllers did not make the game harder or less immersive.

Why it matters for older adults:
Controllers require grip strength and learning button mappings, which can be barriers for older users. Hand tracking removes both, so these results support it as the default input for later phases.

Limitations: small sample (n = 14), young adults only, seated play.

Conclusions

Hand tracking was non-inferior to standard controllers in usability, with similar workload and presence. All 14 participants rated hand tracking equal to or higher than controllers overall. This supports controller-free hand tracking as a valid and more accessible input method for RhythmExer.

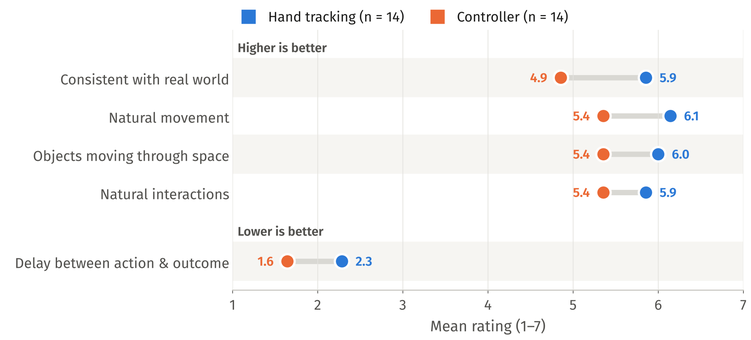


Figure 3
Presence Questionnaire items with the largest differences between input methods (mean ratings, 1–7 scale). Higher scores are better for the top four items; lower scores are better for delay.

Future Work

- Spawn bubbles further from the hand and from each other
- Add a short tutorial and a clearer pause gesture
- Test prop tracking as a third input method
- Phase 2 with caregivers and clinicians, then Phase 3 with older adults

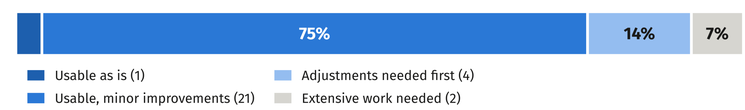


Figure 5
Overall readiness-for-use rating, with both input conditions combined (n = 28 responses).

References

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