Patrícia Szabó

DEVELOPMENT OF BIOFEEDBACK-BASED VIRTUAL REALITY THERAPIES, RESEARCH OF EFFICIENCY AND PRESENCE

Review:

The revised dissertation presents a comprehensive and improved investigation into the development and evaluation of biofeedback-based virtual reality (VR) therapies in rehabilitation. The topic remains timely and relevant, and the candidate has addressed most of the concerns raised in the previous review. The current version demonstrates clearer scientific positioning, methodological transparency, and a more concise presentation of findings..

1. Topic Relevance and Scope:

The focus on VR therapies for rehabilitation, particularly targeting aspects such as user experience, cognitive assessment (e.g., VR-adapted Corsi Block Tapping Test), and anxiety reduction in different VR environments, is highly relevant.
The current version contains a dedicated "Research Gaps and Differentiation" subsection, where the candidate articulates the original scientific contribution. The development of a best practices framework for VR rehabilitation is a novel and practical output, enhancing the scientific and applied value of the thesis.

2. Methodological Considerations:

Systematic Literature Review (PRISMA): The revised version includes a clear PRISMA flow diagram and a detailed table describing databases, keywords, inclusion/exclusion criteria, reasons for exclusion, and the final number of studies. This significantly improves reproducibility.

Participant Selection and Sample Size: The thesis now explicitly states that the experimental participants were healthy adults, and acknowledges that the clinical generalization is a future step. Ongoing collaborations with clinical institutions (e.g., Semmelweis University) are described to extend the research to patient populations.

Statistical Methods: Welch's t-tests are applied where appropriate to address variance inequality. While normality testing is not always explicitly reported, the statistical approach is more robust than in the earlier version.

Experimental Setup and Instrumentation: Device specifications (Oculus Quest 2, Polar H10) and standardized pedaling power ranges (84–107 W) are now documented. Although refresh rate and field-of-view standardization are implied, a brief explicit statement could further strengthen clarity.

Design of VR Environments: The experimental design now ensures that only the emotional tone (positive, neutral, dark) differs while the underlying 3D environment remains constant, reducing confounding effects from scene changes.

3. **Literature Review and Referencing:**

   The literature review has been enriched with precise citations for previously unsupported statements (e.g., presence, stress reduction, UX in VR). The scope of references remains extensive (123 sources), covering both classical and recent works. This strengthens the academic rigor.

4. **Presentation of Research Results**

   The "Thesis Summary" tables (Q–H–T–R format) present the research questions, hypotheses, theses, and results in a concise manner, eliminating much of the earlier redundancy.

   The findings, while aligned with known trends (e.g., higher immersion in HMDs), now clearly emphasize the candidate's original contributions::
   - A validated VR-based Corsi test with positive UX outcomes and lower heart rate compared to non-VR.
   - A best practices framework derived from four experimental studies.
   - Evidence for the anxiety-reducing effect of positive affective VR environments.
   - Comparative UX and usability evaluation of devices for rehabilitation games.

5. **Structure and Organization:**

   The dissertation's structure is now more logical and streamlined, reducing repeated background content and making it easier to follow the research narrative. Results flow naturally into discussion and conclusion.

6. **Publication Activity and External Contributions:**

   The candidate's publication record is strong, with international journal articles (including a Software Impacts paper in 2024) and conference presentations. Minor title overlaps (e.g., P12, P16) could be addressed with more distinctive subtitles, but the overall dissemination effort is commendable.

7. **Responses to Key Questions from Previous Review:**

   - Pulse differences: Controlled pedaling power addresses the possible confound of physical exertion differences.
   - Movement speed: Not applicable for stationary experiments; controlled in cycling setup.
   - Healthy vs. patient population: Clearly acknowledged, with ongoing clinical data collection plans.
   - Transfer learning integration: Not central in this version; presented as a future development direction

Summary:

The revised thesis is significantly improved, methodologically sound, and clearly presents original scientific and practical contributions. While a few minor clarifications (e.g., VR display parameters, normality testing) could be added, these are not critical for acceptance.

I acknowledge that the dissertation contains new scientific findings.

I recommend allowing the public defense, and—if successfully defended—awarding the PhD degree.

Budapest, 2025. August 10.

Ildikó Horváth PhD. habil.