

Virtual Reality Games for Rehabilitation: Perspectives from the Users and New Directions

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Abstract—Virtual reality-based games are becoming increasingly popular as rehabilitation interventions for people with movement disorders. The goal of this study was to perform a qualitative evaluation of a novel system for upper limb stroke rehabilitation to provide guidance for future system development. Participants completed 18 sessions with the intervention over six weeks. They found the intervention to be enjoyable and challenging. The concept of being stretched, the scoring and feedback systems, and the scope for competition were important aspects that influenced participant response to the intervention.

Keywords - hemiplegia; rehabilitation; virtual reality

I. INTRODUCTION

Patient motivation and adherence to treatment protocols are major barriers to recovery in people with long-term conditions [1]. Virtual reality-based games can create fun environments that engage users and increase motivation [2, 3]. While positive benefits of virtual reality games have been seen in stroke survivors, there is a lack of structured information on the users' perspective of such interventions. In order to develop games that successfully engage users, it is important to involve the users themselves in product development. The goals of the current feasibility study were to: 1) design a virtual reality-based intervention to improve upper limb movement in people with stroke, 2) determine the effect of the intervention on arm function, and 3) determine the users' perspective of the intervention, and 4) based on user feedback, further develop the system to more specifically meet the needs of the users.

II. METHODS

Six people with chronic hemiparesis participated in the study (age 55-75, 5 male). Participants were seated in front of a computer monitor with their impaired forearm and wrist secured in a fiberglass cast that was mounted on a 6 degree-of-freedom load cell. Application of forces and torques to the load cell controlled the movement of a submarine through an ocean environment (shown on the computer monitor). A series of eight games were developed that progressed in complexity from single-axis movement through to games requiring multi-axial control. Each game could also be individually manipulated through changes in the sensitivity of the load cell in each axis.

Participants attended three 1-hour sessions per week for a six week period, during which they were individually progressed through the games. Arm function was assessed using standardized tests at the first and last sessions. The feasibility of the games was assessed by the participants' attendance at the intervention sessions and their progression through the series of games. Participant perspectives of the intervention were assessed using a questionnaire and individual interviews with an independent researcher. Interviews were conducted within two weeks of the last session and each interview was recorded and transcribed. Interview data were analyzed using qualitative methodology with a content analysis approach. For each theme identified in the data, we have proposed developments to the virtual reality system and its implementation that address the comments and aim to improve user engagement with the system.

III. RESULTS

All six participants attended all 18 sessions over the 6-week intervention period. Three of the participants played all of the available games; the remaining three participants were unable to complete the more complex games but the level of difficulty was able to be progressively increased in the games they did complete. In all games attempted, all participants demonstrated improvements in performance over time. However, there were no clinically significant changes in the functional outcome measures for any of the participants.

Results from the post-intervention questionnaire indicated that most of the participants enjoyed the intervention, believed that their arm function improved during the treatment period, and rated the control and usability of the games as high. The interview data were used to explore these areas in more depth. Three themes emerged that captured the breadth of the participants' experiences. The first theme centered on the participants' perception of stretching themselves by taking part. The second theme was the participants' perspectives on the purpose of the study and their expectations they had around their involvement. The final theme focused on areas for improvement and included scoring and the virtual environment.

In the theme of stretching themselves, several participants commented positively on the novelty of the games and the fact that they challenged their current ability,

both physically and mentally. The game-based nature of the intervention appealed to those who enjoyed the competitive aspect and scoring lowly often provided an incentive to try again and improve. Not all the participants enjoyed the mental challenge or looked upon the novelty favorably. The cognitive requirements of the games meant that they could be quite tiring and one participant highlighted that there are a lot of new things to learn after a stroke and the virtual reality games were another new experience. Several participants commented that it was good to get out of the house and come to the research laboratory to play the games. *New directions:* 1) differing levels of cognitive requirement in the games created, easier and harder games mixed within a session to prevent mental fatigue; 2) the physical difficulty of the games must be able to be progressively increased to continue to challenge users as they improve; 3) be considerate of other interventions or activities patients are involved in so as not to overload them with novel experiences; 4) continue development as a clinic-based system (rather than home-based) to facilitate community and social interaction benefits.

The second theme identified that participants had a clear purpose for participating in the intervention: they wanted to improve their arm function. One participant indicated that they would not play the games if they did not have a beneficial therapeutic component. Some participants had unrealistic expectations of how the intervention may alter their arm function, to the extent that they had stopped other therapy during the project period. *New directions:* 1) activities/movement performed and progression of difficulty should be based on sound rehabilitation principles; 2) the potential therapeutic benefit to the users should be explained at the outset and aligned with patient expectations; 3) the ability to “cheat” the games should be negated so that the performance of appropriate movement patterns is encouraged.

In the final theme regarding the participants’ suggestions for areas of improvement, one participant said that some of the games were very low scoring, which led to

disappointment, while others wanted to see how their scores compared to previous scores more easily. One participant found it distracting that aspects of the submarine movement were not realistic. Others, who were not familiar with submarines, said that being unfamiliar with the environment was beneficial, as they had fewer expectations of how the environment should look and respond. *New directions:* 1) games scores will involve larger numbers, with 10 a standard minimum score on any one game; 2) users will have the option of viewing a personal scoreboard and performance graph at the conclusion of each game; 3) the use of high quality graphics will be maintained with attention given to animation details; 4) new environments developed will be intentionally unfamiliar to most users, such as outer space or mountain ranges.

IV. CONCLUSIONS

Participants found taking part in this pilot study enjoyable and challenging. All participants improved in game performance over time, although some participants were unable to attempt the more complex games due to more severe impairment. Participant feedback suggests that the virtual reality games may be more motivating and engaging for future users if key aspects of progression, cognitive challenge, enhanced score feedback, and realistic graphical environments are developed.

REFERENCES

- [1] N. Maclean and P. Pound, "A critical review of the concept of patient motivation in the literature on physical rehabilitation," *Soc. Sci. Med.*, vol. 50, pp. 495-506, 2000.
- [2] D. Jack, R. Boian, A. S. Merians, M. Tremaine, G. C. Burdea, S. V. Adamovich, M. Recce, and H. Poizner, "Virtual reality-enhanced stroke rehabilitation," *IEEE Trans. Neural Syst. Rehabil. Eng.*, vol. 9, pp. 308-318, 2001.
- [3] D. Reid, "The influence of a virtual reality leisure intervention program on the motivation of adult stroke survivors. A pilot study," *Phys. Occup. Ther. Geriatr.*, vol. 21, pp. 1-19, 2004.