



VCU College of Engineering

Department of Biomedical Engineering

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Dear Commonwealth Neurotrauma Initiative Board,

Thank you for considering our request for a 1-year no cost extension for our project titled, “Immersive virtual reality (VR) and noninvasive spinal stimulation to promote arm function in individuals with tetraplegia”. In this letter, we briefly outline what has been accomplished to date, reasons for project delays, and what we will accomplish in the upcoming year if a no cost extension were to be granted. We have also provided a recorded presentation.

What has been accomplished?

The home-based VR upper limb rehabilitation platform has been developed through iterative stakeholder involvement. Individuals with tetraplegia and SCI physical therapists identified key movements for practice in the VR environment. As such, we have developed 4 training modules each with specific intent. The boxing module encourages movement and exercise. The firefly catching module allows for practice grasping and moving objects. The arm raise module was designed for individuals seeking strength improvements above the horizontal plane, and stretching module was designed to replicate stretching exercises that individuals with tetraplegia are routinely expected to perform. Each of these modules have areas of modification and increased difficulty. For example, the number of fireflies, the speed of the fireflies, and the location of the catch basket can be adjusted for increased difficulty. Further, we have established protocols for transspinal stimulation (TS), that is paired with the VRArm training.

What is left to do? With development complete, we are transitioning to the formal testing phase. We will test the safety and feasibility of the VRArm + TS intervention in my lab. This will be done in 10 individuals with tetraplegia, each performing 3 sessions per week. Safety and feasibility will be assessed using the Treatment Evaluation Inventory (TEI) and Usefulness, Satisfaction, and Ease of Use (USE) Questionnaire. We will then evaluate the safety and feasibility of the VRArm + TS intervention delivered as a home-based intervention in 10 individuals with tetraplegia (reduced # of participants from originally proposed).

Completion of the lab and home-based safety and feasibility testing will provide compelling data to support our planned funding applications to test the efficacy of the intervention in improving upper limb function.

Reasons for project delays: The primary reason for project delay was the unforeseen difficulty in implementing infrared hand tracking, as opposed to tracking movement with hand-held controllers. We need to avoid use of hand-held controllers with buttons because: 1) we need individuals to practice hand tasks like grasp and grip, and 2) using the hand-held controllers is too difficult for most individuals with tetraplegia. Overcoming this hurdle involved testing of various new-generation VR hardware, and overwriting software to allow for accurate hand tracking. Secondary reasons for delay were due to personnel demands and changes. Dr. Trost moved institutions and can no longer commit effort to the project as her new institution is out of state. We were not able to secure a graduate student to work on the project until later in the project. However, given the technical delays in the VR hand tracking, the graduate student is most useful now for the lab and home-based testing. If the no-cost extension is granted, we can complete that work.



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Table 1. Proposed No Cost Extension Timeline

| YEAR | Month: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|--|--------|---|---|---|---|---|---|---|---|---|----|----|----|
| Continued Participant Recruitment | | | | | | | | | | | | | |
| TESS + VR Alpha Testing in Laboratory | | | | | | | | | | | | | |
| Home-based TESS + VR Intervention | | | | | | | | | | | | | |
| Analysis of Findings | | | | | | | | | | | | | |
| Manuscript Preparation | | | | | | | | | | | | | |
| Preparation of efficacy funding applications | | | | | | | | | | | | | |

Please let us know if you require further information. At the time of the recorded presentation, the VR unit with our most updated modules was with one of our stakeholders. If desired, we could make and send a recording of the newest modules when the VR unit is returned to us in late June.

Sincerely,

Carrie L. Peterson, Ph.D.
Associate Professor