

Sense of Agency and Movement Control Training Task

Kwabena Boateng

1.0 Introduction:

The movement control training environment is a virtual training task that focuses on the training the sense of agency (SoA) and movement control through various training exercises. In the United States, 1 in 6 adults have a disability that limits or neutralizes motor functionality [1]. The rehabilitation of these disabilities requires training that is engaging, repeatable, and adaptive [2, 3], however, traditional rehabilitation methods tend to be stagnant and only lead to the partial recovery of limb function [4].

Rehabilitation also has to include the training of SoA to improve the connection between a user and limb function. The sense of agency is the feeling of volition over an action, as agency is built, performance improves as well [5, 6]. The use of virtual training exercises in rehabilitation has been growing as it provides training in an engaging and accessible manner. Thus, this training environment was developed to provide movement coordination and SoA training through the use of sensory feedback and intentional binding.

2.0 How-to-Use:

The training environment consists of two different tasks. The sense of agency tasks and the movement coordination task. The training tasks were designed to resemble different games. The movement coordination task is based off of a dodge-the-blocks game, the sense of agency tasks resemble a hit-the-target game.

2.1 How to Play:

In the sense of agency tasks, the user has to control a 3D modeled hand to contact a moving target. The hand is controlled through using the WASD keys, or alternatively, the arrow keys to move along the x and z axis (side-to-side, forward-to-back). To move

along the y axis (up-and-down) the user can use either a trackpad, if on a laptop, or the scroll wheel of a mouse. Once the hand contacts the target an auditory or visual cue will occur between 0.1 – 1 second. In the auditory variant, a ping sound will occur after contact; in the visual variant, the background of the screen will turn green. After experiencing the sensory feedback, the user has to estimate the time at which the sensory cue occurred, using buttons on the left-hand side (Figure 1).

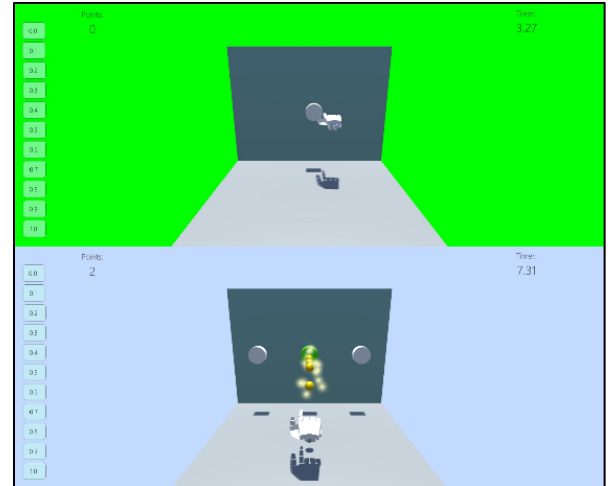


Figure 1: Screenshots of the sense of agency tasks.

In the movement coordination task, the goal is to dodge the falling blocks for as long as possible. The task is fully controlled by the cursor. The user can use a mouse or a trackpad for control. The user controls a ball and is meant to dodge the blocks as they fall in waves (Figure 2).

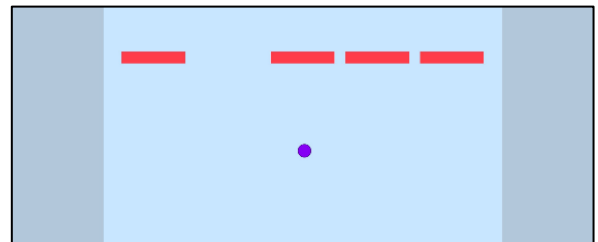


Figure 2: Screenshot of the movement control task.

3.0 References:

- [1] CDC. "FastStats - Disabilities or Limitations." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 24 June 2020, www.cdc.gov/nchs/fastats/disability.htm
- [2] Sigrist, R., Rauter, G., Riener, R., & Wolf, P. (2013). Augmented visual, auditory, haptic, and multimodal feedback in motor learning: A review. *Psychonomic Bulletin & Review*, 20(1), 21–53. <https://doi.org/10.3758/s13423-012-0333-8>
- [3] Nataraj, R. (2018). *Chapter 4 Optimizing User Integration for Individualized Rehabilitation*. [/paper/Chapter-4-Optimizing-User-Integration-for-Nataraj/df68296ca9e9a24157f62c9715b549a2956ea18](https://doi.org/10.1007/978-1-4939-9818-8_4)
- [4] Ying, W., & Aimin, W. (2017). Augmented reality based upper limb rehabilitation system. *2017 13th IEEE International Conference on Electronic Measurement Instruments (ICEMI)*, 426–430. <https://doi.org/10.1109/ICEMI.2017.8265843>
- [5] R. Nataraj and S. Sanford, "Control Modification of Grasp Force Covaries Agency and Performance on Rigid and Compliant Surfaces," *Frontiers in Bioengineering and Biotechnology*, vol. 8, p. 1544, 2021.
- [6] R. Nataraj, S. Sanford, A. Shah, and M. Liu, "Agency and Performance of Reach-to-Grasp With Modified Control of a Virtual Hand: Implications for Rehabilitation," *Frontiers in human neuroscience*, vol. 14, 2020.