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A class-room conducive protocol for reaching experimentation

Naveed Reza Aghamohammadi[1], Mattia Demasi[1], Aman Anand[1] and James L. Patton[1*]

***Abstract*— Targeted reaching experimentation is the bread and butter of motor control research, such experiments are typically implemented using expensive and complicated tools such as robots. This makes them inaccessible to the average student and impractical for classroom projects. This paper presents a step-by-step tutorial as an educational tool for implementing a visuomotor adaptation experiment using Unity® game-engine, computer, and a mouse device. By the end of the tutorial, the student will know how to set up a complete visuomotor adaptation experiment that demonstrates neuroplasticity in a hand-eye coordination task. We found that this simple tool resulted in real evidence of motor learning, with significant after-effects of adaptation. This fundamental building block can be expanded to other experiments and other interface devices and lends itself well to online education, rehabilitation, and computational neuroscience.**

***Clinical relevance*— This tutorial can function as a building block for a future device or software developments that require motor training surgery, piloting, and neurorehabilitation.**

I. INTRODUCTION

Targeted reaching experimentation is where subjects are typically asked to move the handle of a manipulandum or a robot, allowing analysis of error statistics, variability, adaptation, or other aspects. It has been the principal research tool across decades for researchers in neuroscience, robotics and biomedical engineering to study human motor control [1], [2]. Despite their widespread use in research, projects using them are not conducive to classroom education as they usually require sophisticated, expensive, and specialty tools such as robots. Such costly hardware dependence restricts their widespread adoption as an educational tool and accessibility to students. In this paper, we will detail a step-by-step tutorial so that students can construct a Visuomotor adaptation experiment. All the necessary codes and material can be accessed though this GitHub repository [4].

II. METHODS

In order to begin tutorial, students should have access to a computer and digital pointing device(a mouse) and they install Unity game-engine on their computer. Unity provides a free license for students and also provides free training[3]. The students will begin by creating an spherical object representing mouse cursor which we call ”player” and another spherical object representing the reaching target called ”Target.” The students are provided the code[4] such that they can read the mouse cursor on the screen as an input and have the ”Player” position change accordingly. The students will also become familiar with creating an experimental protocol and and how to create a 30^o visuomotor rotation experiment demonstrating neural adaptation [5]. The students will also become familiar with how to store time-series records of movement data and how to analyze those data using MATLAB.

*Correspondence: pattonj@uic.edu
[1]Richard and Loan Hill Bioengineering Department, University of Illinois at Chicago, Morgan St, 60607 Chicago, USA

III. RESULTS

We tested the program on an undergraduate student. The results show adaptation to the visuomotor challenge during training and washout phases of the experiment.

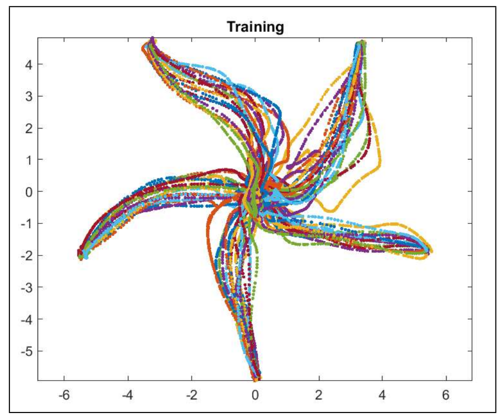

Fig. 1. Reaching movements made by the mouse during early training

IV. DISCUSSION & CONCLUSIONS

This tutorial can function as a building block for a future device or software developments that require motor performance, including sports, music performance, surgery, piloting, and neurorehabilitation.

REFERENCES

[1] R. Shadmehr and F. A. Mussa-Ivaldi, “Adaptive representation of dynamics during learning of a motor task,” The Journal of Neuroscience, vol. 14, no. 5, pp. 3208–3224, 1994.
[2] J. L. Patton and F. A. Mussa-Ivaldi, “Robot-Assisted Adaptive Training: Custom Force Fields for Teaching Movement Patterns,” IEEE Transactions on Biomedical Engineering, vol. 51, no. 4, pp. 636–646, 2004.
[3] U. Technologies, “Get a Unity Student plan today; VR software for students: Unity,” Unity Store. [Online]. Available: https://store.unity.com/academic/unity-student. [Accessed: 23-Jul-2021].
[4] N. R. Aghamohammadi, “EMBC 2021: A class-room conducive protocol for reaching experimentation,” GitHub, 23-Jul-2021. [Online]. Available: https://github.com/naveed1366/EMBC-2021-VISUADAPT-Tutorial.git. [Accessed: 23-Jul-2021].
[5] W. T. Thach, H. P. Goodkin, and J. G. Keating, “The Cerebellum and the Adaptive Coordination of Movement,” Annual Review of Neuroscience, vol. 15, no. 1, pp. 403–442, 1992.