Debriefing Sheet for IRB #2000027351, Psychological Mechanisms of Skill Learning

Thank you very much for participating in this study.

Learning a novel motor skill such as driving a car can be quite demanding. The novice must learn how rotational movements on a steering wheel map onto changes in the heading of the vehicle. If the car involves a manual transmission, there is the additional challenge of coordinating various gestures of the hands and feet. With time, these complex actions become highly automatized. Learning such skills is initially facilitated by explicit instructions and strategic plans, but with time, the skilled performer may even come to have difficulty articulating all the components that form the skilled action. Determining how cognitive-based motor strategies interact with an automatic motor learning process is fundamental in understanding how humans learn new motor skills and develop long-term motor memories, and this experiment investigates the cognitive and neural mechanisms that underlie these abilities.

In this experiment, we are testing whether movement planning, without execution, is sufficient to drive automatic motor learning processes. We asked you to reach to visually displayed targets or withhold movements to targets. When you made reaching movements to targets, we introduced a visuomotor perturbation on your reaches, which caused a mismatch between the visual percept of the hand and the actual position of the hand. Your motor system will slowly and automatically adapt to this displacement with continued training (see the “Adaptation” section in [1] for a review). Previous research (see [2] and [3]) has shown that motor adaptation processes continue despite participants using successful cognitive strategies, suggesting a strong segregation between explicit strategic processes and implicit motor adaptation processes.

We tested our hypothesis via trials where the movement was withheld. By showing visual feedback on these trials corresponding to a reaching error that might have been made due to a visuomotor perturbation, we tested whether movement planning alone can lead to adaptation, or whether movement execution is necessary to drive those effects. In pilot experiments, we have observed effects consistent with our prediction that movement planning alone is sufficient to drive adaptation, though follow-up studies are necessary.

The overarching aim of this project is to characterize the multiple learning processes involved in motor learning (see [4] and “Multiple components of motor adaptation” section in [1] for a review), with a long-term goal of improving rehabilitation strategies for recovering motor function following stroke and disease. If you are interested in further details about this experiment, skill learning in general, or have any other questions, please contact Dr. Samuel McDougle at samuel.mcdougle@yale.edu or (203) 432-4500.

If you have concerns about your rights as a participant in this experiment, please contact the Human Subjects Committee, (203) 785-4688, human.subjects@yale.edu.

Publications relevant to the current study:

[1] Krakauer JW, Hadjiosif AM, Xu J, Wong AL, and Haith AM. Motor Learning. *Comprehensive Physiology*. (2019)

[2] McDougle SD and Taylor JA. Dissociable cognitive strategies for visuomotor learning. *Nature Communications*. (2019)

[3] Sheahan HR, Franklin DW, & Wolpert DM. Motor Planning, Not Execution, Separates Motor Memories. *Neuron*. (2016)

[4] McDougle SD, Ivry RB, & Taylor JA. Taking aim at the cognitive side of learning in sensorimotor adaptation tasks. *Trends in Cognitive Sciences*. (2016)