

Objectives and goals for the project

RAs will be assigned a preprogrammed and carefully designed experiment. The objectives and goals of this project with respect to the RA is simply to automate the data collection process. Specifically, they must learn about the experiment I give you to field basic questions, advertise and setup experiments on the RPP website, administer and keep track of participant paperwork, provide instructions and answer questions, and transfer data from experiment computer to dropbox folders for later analysis. RAs that only complete these tasks are called level 1 RAs. Level 1 RAs can earn authorship on conference posters, but are not eligible for authorship on peer reviews papers.

RAs will also be expected to learn to program and experiment from scratch, perform basic data analyses, and report their findings at lab meetings. RAs that complete this are called level 2. Level 2 RAs can earn secondary authorship on papers and possibly primary authorship on conference posters.

I am only accepting motivated RAs who have a legitimate interest in graduate school. Thus, the training program for everyone will be geared towards slowly becoming an independent researcher, picking up the requisite skills, and developing new methods of thinking. RAs will learn something, they will perform valuable services, and they will be expected to place their research with me at the same level of priority that they place their school work.

Project Specifics

All projects will eventually lead to brain stimulation (TMS and tDCS) experiments. However, RAs will first be given pilot versions of the experiments to run on RPP participants. This pilot version will be the focus of the entire semester. Interested and capable RAs will be rehired for the following semester to assist with brain stimulation.

Specific Aim 1 will examine visuomotor adaption after targeted brain stimulation of the PFC, M1, or the CB. We take visuomotor adaption as our model motor skill because it has been an active source of research, work that has produced rich computational models of learning. Studies of visuomotor adaptation have been extremely valuable in understanding a variety of brain disorders, with an

emphasis on the cerebellum. Recent work has inspired sophisticated models that specify how multiple learning processes interact to influence performance. We will employ a variant of visuomotor adaptation that includes an explicit aiming component, allowing us to dissociate the contribution of multiple systems to task performance. We use disruptive repetitive transcranial magnetic stimulation (rTMS) to induce temporary lesions at our target sites and transcranial direct current stimulation (tDCS) to temporarily improve function at our target sites.

Specific Aim 2 will examine category learning after targeted brain stimulation of the PFC, M1, or the CB. We take category learning as our model cognitive skill because it is a powerful source of evidence for the involvement of multiple systems in cognitive skill learning. Moreover, some types of category learning are well known to have a strong execution, or response-related processes. As with visuomotor adaptation, this work has produced detailed computational models, allowing us to generate formal predictions. We use rTMS to induce temporary lesions at our target sites, and tDCS to temporarily improve function at our target sites.

In summary, we propose parallel visuomotor adaptation and category learning experiments, examining changes in performance following the application of targeted brain stimulation. By disrupting or potentiating function through the stimulation at a set of cortical and subcortical sites, the research plan offers a novel approach to develop a multiple systems theory of skill learning, while simultaneously exploring the viability of brain stimulation as a tool for improved human skill learning.

Work procedures and, methods, and additional readings

Almost all of life as an RA requires a computer. Unfortunately, the Ivry Lab and I cannot provide computers to all RAs. RAs must therefore be able and willing to provide your own computer to do your work on. I will personally instruct them how to get subjects, give them credit, and track them so that we don't go over our unit allocation, etc. A huge part of advancing through the ranks is learning how to program. There are a ton of useful programs for the tasks RAs need to accomplish, but we will focus on Python (and R for data analysis, if they like). We will immediately begin working through tutorials to get these things down. I will provide a standard experiment for RAs to program and sample data for them to analyze once I feel that they are ready. RAs must be willing and able to meet 1-2 times per week for a total of between 1 to 4 hours of face time. We will set these up for regular times to make it easier on everybody's schedule. I will give RAs small manageable tasks to accomplish each week, and they will be expected to complete these tasks or else to demonstrate significant

progress towards completion. We will also spend weekly meetings discussing background papers and connecting the dots to the broader literature.

Student's role

Level 1 responsibilities are to collect data on an existing project: Schedule RPP participants online give experimental instructions to RPP participants, supervise participants during the experiment, debrief the participants after the experiment, administer credit online, and transfer the data to a dropbox folder shared with me. Additionally, they must demonstrate understanding of their project at 3 distinct levels: Project motivation in relationship to the universe, project motivation in relationship to field and project motivation in relationship to adjacent literature. They demonstrate such an understanding by persuasively and concisely stating project summary for RPP debriefings and persuasively and concisely stating predicted results in meetings with me. They will obtain this knowledge and ability by reading, processing, and exhaustively discussing background papers with me. Level 2 responsibilities include all level 1 responsibilities, but extend into programming new experiments performing basic data analyses, and reporting findings at lab meetings. They will chip away at level 2 tasks through completing tutorials and working with me during our weekly meetings.

Criteria for final evaluation and grading

To receive a passing grade RAs must adequately satisfy level 1 responsibilities. Specifically, the RA must be able to persuasively and concisely state project summary for RPP debriefing and persuasively and concisely state predicted results in conversations with me. Additionally, RAs must have collected at least 6 hours of RPP participants, met with me to discuss all elements of their position for at least 1 hour per week, and made significant progress towards achieving level 2 functionality. Significant progress towards level 2 functionality will be assessed as follows:

- A --- Completed programming at least 90% an experiment from scratch
- B --- Completed programming at least 80% of an experiment from scratch
- C --- Completed programming at least 70% an experiment from scratch

Mentor Contributions

I oversee every aspect of the RAs training thus far discussed in this proposal. I design the experiments, teach programming in small chances during weekly assignments, coach them to become more proficient at running participants in experiments and at communicating scientific ideas effectively in academic environments like lab meetings and conferences. I devote explicit one-on-one time to to each RA for between 1 and 4 hours per week, and am available to handle miscellaneous issues that pop up during the week via email or unscheduled visits.