Visual Motor Adaptation
Neuroscience Teaching Team

Module Overview
In this lab, students will learn how the brain adapts to changes in visual input using prism goggles! This lab includes three separate demonstrations which can be completed sequentially.

Materials
Quantities provided are per 2 students/demonstration.
One (1) Pair of prism goggles
One (1) Ping pong ball or clay ball

Introduction
We are going to learn about visual motor adaptation
- What is visual?
- What is motor? (movements)
- What is adaptation? (get used to something…temperature, glasses, etc.)
- The cerebellum is important for adapting motor movements or learning new movements. *Show students where it is and what it looks like.*

We will be doing a couple experiments. What are the parts of the scientific method?
- Observation, Hypothesis, Methods/Experiment, Results/Analysis, Conclusion

<u>Demonstration 1: How long does it take to adapt to prism goggles?</u>
Divide the students into 2 groups and ask them to sit in two rows, facing each other.

Observation: Have 1 student put on a pair of prism goggles and tell them to look at your finger. Ask the student what they notice. See if they can figure out what goggles are doing, then explain that prism goggles bend light to the right or left.

Hypothesis: Ask the students, “If you had to put these goggles on in the morning, how long do you think it would take for you to get used to the goggles?”

Methods/Experiment
To test how the goggles affect your hand eye-coordination, we can do a reaching task. First, discuss a good control experiment to see how long it will take to get used to the goggles.
1. Each student should touch the finger of the student across from them, then their own nose. Repeat this several times first without goggles.
2. Instruct one row of students to put the prism goggles on. Make sure students have their eyes closed when putting on the goggles. On your signal, they can open their eyes and begin touching their nose and their partner’s finger as fast as possible for 1-minute.
3. Switch and have the other student wear the goggles.

Results: Have the experimenters report their results (first they miss their target, then they begin to gradually adapt)

Conclusion: Without thinking about it, subjects start to move their arms so that they hit their target every time. This is visual motor adaptation, and your cerebellum at work!

Hypothesis (again): What do students hypothesize will happen when they take the goggles off?

Methods/Experiment:

1. Ask students to close their eyes and remove the prism goggles. On your signal, they can open their eyes.
2. Instruct the students to repeat the reaching task.

Results: Students now point to the opposite side of their partner's finger, but adapt.

Conclusion: Students had adapted to the goggles, but then adapted back. Probe the students for how useful visual motor adaptation is in everyday life (i.e., glasses).

Demonstration 2: How does your cerebellum help you adapt to prism goggles when throwing a ball?

Hypothesis: What will happen when the students try to hit the target with the balls while wearing goggles?

Methods/Experiment:

1. Setup a target on the blackboard or large sheet of paper.
2. Choose students to be:
    a. Subject - wears goggles and throws balls at the target
    b. Recorder - marks where the balls hit on the target
    c. Clay ball supplier - hands clay balls to the subject so that the subject can keep looking at the target, and not at their hand
    d. (2) Clay ball retrievers - retrieve clay balls from the floor to give to the clay ball supplier
3. Have the subject stand ~20 feet from the target
4. Control Condition: Baseline without goggles (~10 throws)
    a. Ensure that the subject is not looking at their hand or the ball before throwing; the supplier should place the ball directly in the subject's hand
    b. The recorder should make where the balls hit on the target in ONE color
5. Experimental Condition: Close eyes, put on the goggles, and begin throwing (~20 throws)
    a. Ensure that the subject is not looking at their hand or the ball before throwing; the supplier should place the ball directly in the subject's hand
    b. The recorder should make where the balls hit on the target in a SECOND color

Results: In the experimental condition, the subject consistently misses to one side of the target and then gradually adapts

Conclusion: This is visual motor adaptation, and your cerebellum at work!

Hypothesis (again): Where will the balls hit when the subject takes the goggles off?

Methods/Experiments:

1. Instruct students to repeat the control condition (without the goggles) and have the recorder mark where the balls hit the target with a THIRD color

Demonstration 3: Is adaptation to goggles specific to one movement (overhanded throw), or does it extend to other movements (underhanded throw)?

Hypothesis: Is adaptation movement specific (i.e., if you adapt your overhand throw, does this carry over to your underhand throw)?

Methods/Experiment:

1. Choose new students for each position.
2. Control Condition: Baseline without goggles (~10 throws overhand & ~10 throws underhand)
    a. Ensure that the subject is not looking at their hand or the ball before throwing; the supplier should place the ball directly in the subject's hand
    b. The recorder should make where the balls hit on the target in THIRD color
3. Experimental Condition: Close eyes, put on the goggles, and begin throwing overhand (~20 throws)
    a. Ensure that the subject is not looking at their hand or the ball before throwing; the supplier should place the ball directly in the subject's hand
    b. The recorder should make where the balls hit on the target in a FOURTH color
4. Experimental Condition: Close eyes, put on the goggles, and begin throwing underhand (~20 throws)
    a. Ensure that the subject is not looking at their hand or the ball before throwing; the supplier should place the ball directly in the subject's hand
    b. The recorder should make where the balls hit on the target in a FIFTH color

Results: Students should observe and understand that the underhand throw is not adapted.

Conclusion: Adaptation IS movement specific (i.e., each movement will adapt on its own).