Teacher Instructions

List of materials:

1 meter stick for every 2 students (or fewer if they work in larger groups)
calculator
computer (running MacOS or Linux), with python installed, working mouse
headphones if using more than 1 computer at a time
penlight or small flashlight (1 or 2)
place where students can sit so that their legs dangle freely
piece of cardboard

In this lab, students will measure their reaction times to various visual and auditory stimuli and observe the effects of several variables on these reaction times. They will also elicit and observe some innate, involuntary reflexes.

For the conceptual questions at the end of each section, those marked with a (*) are intended for students who have taken or are now taking some sort of biology class that covers the nervous system. Those marked with a (**) require knowledge outside of biology (in math and physics) that may only be accessible to older students.

To set up the computer-based reaction timer:

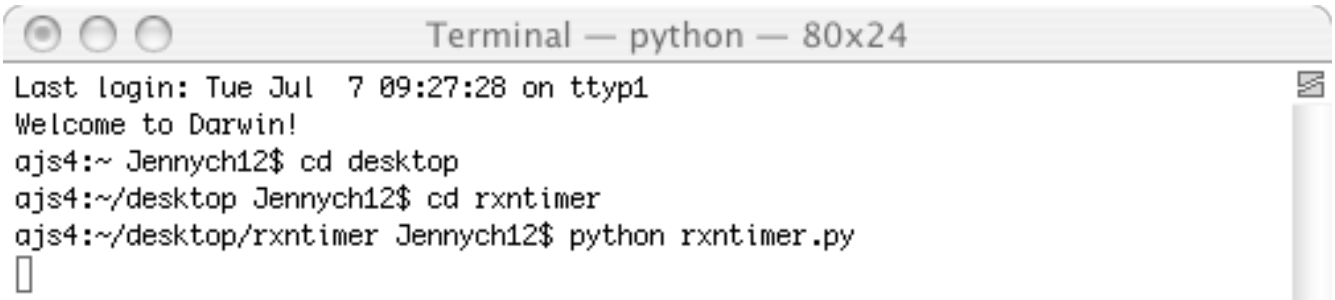
1. Go to http://www.stanford.edu/~ajspakow/
2. Click on Outreach (located on the left side of page)
3. Click on Bio 1: Reflexes
4. Open Reaction-Time Program (located at the bottom of the page). The program will automatically start downloading. A folder named rxntimer should appear on your desktop.
5. Open a terminal window on your computer.

To open a terminal window: Go to Finder > Applications>Utilities>Terminal

6. Type cd desktop and then enter.
7. Type cd rxntimer and then enter.
8. Type "python rxntimer.py" and then enter.

The program should start running until it opens.

Example:



*Make sure the volume is turned up on the computer

Answers to Questions

Note: Many of the questions are open-ended, have a number of potential answers, and/or are intended to stimulate discussions; these answers are merely a brief guide

Ruler station:

2. Typical reaction times for the ruler experiment should be on the order of 0.2 sec.
The reaction times will generally be slightly longer with the fingers starting 3in rather than 1in apart. By doing a series of such experiments, you could get an estimate of the time required to react to the stimulus versus the time required to actually move the fingers together once the signal to grasp has been received.

3a. Choice of hand will probably not affect the reaction time enough to be measurable in this experiment. This may depend on the individual, however.

3b.Reaction should increase slightly due to the distraction. In this case, the reaction time also includes the time required to process the auditory stimulus and decide whether it is or is not correct (recognition time), so the overall reaction will be slower.

Concept questions:

1. This reflex is acquired, somatic, cranial, and polysynaptic
2. (1) visual stimulus activates photoreceptors (2) the sensory optic nerve is activated (3) information is processed in the midbrain (4) the median nerve (a motor neuron) carries the signal to the hand (5) muscles in the hand cause the fingertips to come together
3. In addition to the average reaction times, one should also get a measure of how much the times vary: the standard deviation. If the difference between the reaction times in two runs of the experiment is greater than a standard deviation or so then this is most likely due to a real underlying difference in the reaction times rather than just variability in the experiment.

Computer Station:

1. The reaction times should be similar for both the computer and the ruler drop experiment. Differences could be due to the the different movements required to actually respond to the stimuli (ie: pressing and releasing the mouse button vs bringing fingers together to catch the ruler). Ruler-catching times might also be slightly shortened if the subject can see when the experimenter is about to drop the ruler.

2. Auditory reaction times, at least for loud stimuli, tend to be slightly shorter than visual ones. This is not the case for quieter stimuli, however.
3. A louder beep should shorten the reaction time. Your ear integrates the sound waves over a period of time up to 0.1 sec. A louder beep requires a shorter amount of time to reach the minimal overall level of stimulus necessary to trigger a reaction.
4. In this experiment, you have to process a stimulus and recognize whether or not it is the right one before responding to it, so your reaction time should decrease.

Concept questions:

1. (a) the precise effector muscles
   (b) the sensory receptors, and sensory nerve
   (c.) the neurons involved in processing the information
2. (a) A signal has to go from the screen to your eye (or ear), be processed in your brain, and then travel to your fingertips to press the mouse button. The overall distance that the neural impulses must cover is on the order of 1 m. So the average rate of signal propagation is about 5 m/s.
   (b) This rate includes: response of the sensory cell (rods/cones in eye or hair cells in ear) to the stimulus, transmission of signal across synapses between neurons, transmission of the action potential along a single neuron, and contraction of finger muscles in response to the signal.

3. At low volume, having the beep last longer may lead to shorter reaction times due to the time-integration of the auditory stimulus. Similarly, since the human ear has different sensitivity to different frequencies, changing the frequency of the beep while keeping the volume constant should also affect the reaction time (whether it increases or decreases depends on how close the frequency is to the optimal frequency for human ears). There are many other possible answers here.

Reflex Station:

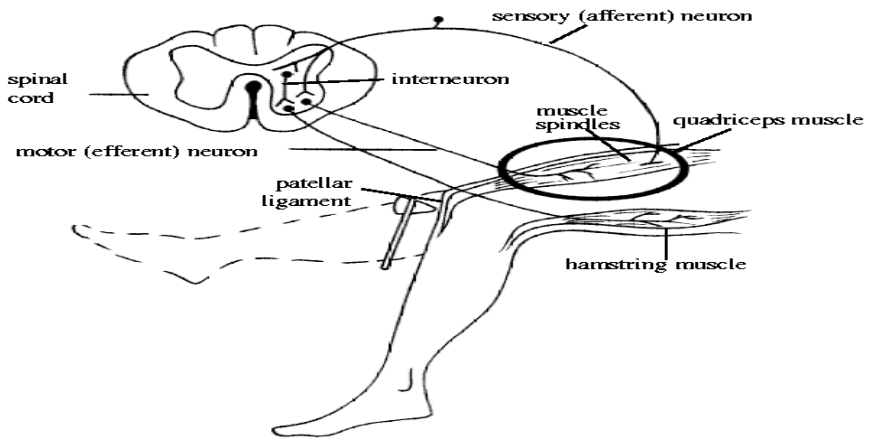
1. (a).This is an involuntary reflex.

Direct/ Consensual Pupillary Reflex:

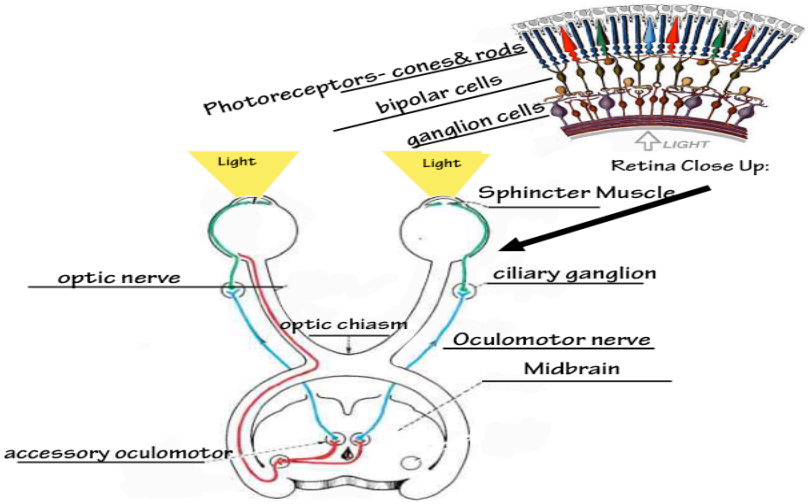
1. Both pupils should dilate in response to light. This is also an involuntary reflex.

Concept questions:

1.



2.



The optic chiasm is the point at which the signal can cross to the opposite side to the brain.

3. (a) This reflex regulates the total amount of light hitting our photoreceptors. It helps protect against overexposure of the receptors and also to maintain visual sensitivity at a larger range of background light levels.

(b) This reflex can help maintain posture and balance. When the quadriceps is stretched, the brain responds by contracting it and relaxing the opposing muscle (the hamstring) to restore balance.

4. Innate reflexes allow your body to perform basic survival functions (blinking, breathing, etc.) without conscious thought, so that attention can be focused on other things. Involuntary reflexes can also be faster than voluntary ones since the signal doesn't have to go through processing centers in the brain (eg: the knee-jerk reflex only goes through the spinal cord).

5. Doctors measure reflexes to pinpoint the location of any damage to the nervous system. Loss of the knee-jerk reflex indicates damage to the femoral nerve and/or L2-L4 spinal segments. Loss of either the direct or consensual pupillary light reflex can indicate damage in the optic nerve or the oculomotor nerve of one side (depending whether both the direct and the consensual response are gone).