Topic 8: Body Systems – 8c. Nervous System
8c1. Reaction Time Lab

Resources:

Miller, K., Levine, J. (2004). *Biology.* Boston, MA: Pearson Prentice Hall.

Reflex [Internet]. The Free Dictionary. Helicon Publishing. 2009. Available from: http://encyclopedia.farlex.com/Reflex+reaction

Carlson, C. Biological Baseball [Internet]. Exploratorium: the Museum of Science, Art, and Human Perception. San Francisco, CA. Cited 1 Aug. 2009. Available from: http://www.exploratorium.edu/baseball/biobaseball.html

Building on:

Reflexes are primarily intended to protect you. Things like blinking your eye, the contraction of your pupil, or pulling your hand back from a hot surface are all *reflex actions.* Reflexes involve *sensory and motor neurons* of your *peripheral nervous system* and often *inter-neurons* of the *spinal* portion of your *central nervous system*. Reflexes don't require higher brain activity. If you touch a hot surface, you will actually pull your hand back before your brain perceives the heat.

Reactions require *higher brain function.* Putting your foot on the brake of the car when the car in front of you slows or comes to a stop is an example of a reaction. You must first see the leading car's brake lights; that information must be processed by your brain and a signal must be sent to the muscles of your back and legs. The signal not only tells you to step on the brake, but how hard to step on the brake.

Links to Chemistry:

Organic chemistry
Biochemistry
Change in membrane potential
Neurotransmitters
Ions that function in nerve stimulation and muscle contraction (Na^{+}, K^{+}, and Ca^{+2})

Links to Physics:

Speed and velocity
Free fall
Gravitational pull

Stories:

One of the toughest things in sports is supposed to be hitting a fastball in baseball. According to Charles Carlson of the Exploratorium Museum, a fastball thrown at 95 mph will cover the distance from the pitcher's mound to home plate (60 ft. 6 inches) is about .4 seconds. For a batter to hit the ball, he must have a visual on the ball by the time it has traveled about 12 feet from the pitcher. During the mid-portion of the ball's trip, the batter's

brain must measure the speed and decide when to swing. The swing has to start when the ball is about 25 to 30 feet from the plate. At that distance, the ball will reach the plate and the bat in about .0025 seconds. This is considered close to the limit of human reaction time.

If the batter is off by even a few thousandths of a second, the result will be a strike or a foul ball. Hitting high or low will determine if the ball is a grounder or a fly ball.

When Major League batters hit 3 out of every 10 at-bats, it is considered outstanding. Interestingly, according to Carlson, cheetahs and lions only bring down their prey about a third of the time.

To get the full story go to the following website:
http://www.exploratorium.edu/baseball/biobaseball.html

Materials for the Lab:

- Meter sticks
- Calculators

Instructions for the Teacher:

This is a very simple lab. The students really enjoy it. It is interesting to talk to them about the impact of distractions on their reaction time and apply that to other class activities like test taking and note taking.

There are two different formulas for the calculation of reaction time speed. One requires the distance be measured in meters and the other measures the distance in centimeters. The two will get a very similar answer; the second equation is more accurate. 980 cm/sec^2 is the strength of the gravitational field at the surface of the earth. Choose the equation to use based on the math skills of your students.

Biology: Reaction Time Lab

Introduction: A meter stick can be held perpendicular to the floor, dropped, and a student can catch it to determine how far it falls before the student reacts. The slower the reaction on the part of the student, the farther the meter stick will fall. The student can convert distance into times and measure reaction time. Differences in the reaction time of the student to different stimuli can be compared.

Hypothesis: Hypothesize which type of stimulus will elicit the fastest reaction time: visual, auditory, or tactile. Why?

Procedure: For this lab, all distances must be recorded in <u>METERS</u>!

1. A meter stick will be held vertically between the experimental student's thumb and index finger. The stick should be held so that the 10 cm (.1 meter) mark is between the thumb and index finger. (This makes it easier on the student scientist.)

2. The lab partner (student scientist) will drop the meter stick and the experimental student must catch it between his/her thumb and index finger as quickly as possible. The distance the meter stick traveled before being caught will be measured and recorded on the Evidence Table (remember to subtract the 10 cm that were below the finger level at the beginning of the experiment) for visual stimuli.

3. The experimental student will repeat the procedure for a total of three trials and then determine the average reaction distance for visual stimuli, recording it on the Evidence Table.

4. The experimental student will now measure reaction to an auditory signal; the experimental student will close his/her eyes and the student scientist will hold the meter stick as before. As the student scientist releases the meter stick he/she will say, "Now," and the experimental student will catch the meter stick. The distance will be measured and recorded on the Evidence Table. After three trials, the average reaction distance for auditory stimuli will be calculated and recorded on the Evidence Table.

5. Finally, the reaction distance for tactile (touch) stimuli will be measured. This time the experimental student will close his/her eyes, and the while the student scientist holds the meter stick in one hand, he/she places the other hand on the experimental student's shoulder. When the student scientist drops the meter stick, he/she should simultaneously lightly squeeze the experimental student's shoulder. After three trials, the average reaction distance for tactile stimuli will be calculated and recorded on the Evidence Table.

6. Now the reaction times will be calculated in seconds. The formula is:

$$\text{Time in seconds} = .45\sqrt{\text{distance in meters}}$$

Or

$$\text{Time in seconds} = \sqrt{2 \text{ X the distance in cm} / 980 \text{ cm/sec}^2}$$

Record the average reaction time for each type of stimuli on your Evidence Table.

Evidence Table

Type of Stimuli	Trial 1 (m)	Trial 2 (m)	Trial 3 (m)	Avg. Distance (m)	Reaction Speed (sec)
Visual					
Auditory					
Tactile					

Analysis Questions:

1. Specifically, which parts of the nervous system were used when the student responded to the dropped meter stick in the tests for visual stimuli?

2. If you continued to repeat the test for visual stimuli, do you think you would get faster? Why or why not?

3. What factors would ultimately limit your speed of response?

4. How does a reaction differ from a reflex?

5. Draw a simple reflex arc that would occur when a person steps on a nail. Label all of the neurons involved.

6. Write a conclusion and a next logical question.

Optional Activity:
Go to the following website:
www.getyourwebsitehere.com/jswb/rttest01.html

You will be instructed to test your reaction time using a simulation of a stop light.
Complete the five trials and record your average time (seconds) below.

Average visual reaction time (seconds) =_____

Question: How does your average reaction time calculated by the website compare to your average visual reaction time calculated using the meter stick? Which do you think is more accurate, and why?