Nervous System: Reaction Time
Student Version

Key Concepts:

- Your nervous system allows your body to react to different **stimuli** (external events)
- Reactions can be **voluntary** (eg: swinging a bat at a ball flying at you) or **involuntary** (eg: blinking at a puff of air)
- A **reflex** is a fast, automatic response
    - examples: shivering if the temperature is too cold; moving your hand if it gets too close to a hot surface.
- Reflexes require at least two **neurons**, or nerve cells, to function. **Sensory neurons** take in information (**input**) from the outside world, whereas **motor neurons** give information (**output**) to muscles and joints.
- Some reflexes are processed in the brain, while others are processed in the spinal cord.

Part 1 – Ruler Station

Holding your thumb and index finger about 4 cm apart, catch the ruler when your partner drops it. Do 5 practice runs without recording the results.
Now record the results for 3 more trials of the experiment.
Repeat the experiment holding your fingers 10 cm apart. Record your results in the chart below.

Repeat the experiment saying every other letter of the alphabet while waiting for the ruler to drop. *Record your results.*

	4 cm	**10 cm**	**Alphabet (4 cm)**	**Key Word (4 cm)**
Trial 1	cm	cm	cm	cm
Trial 2	cm	cm	cm	cm
Trial 3	cm	cm	cm	cm
Average length	cm	cm	cm	cm
Reaction time	sec	sec	sec	sec

To calculate the average length, use the formula **length = (trial 1 + trial 2 + trial 3) ÷ 3**
To calculate the reaction time, use the formula: $time = \sqrt{length / 490}$
(calculator buttons: length, ÷, 490, √)

Q1. Is there a difference in the calculated reaction time between the 4 cm and 10 cm trials? Which one seems to be faster? Why do you think this is?

Q2. Did your reaction time increase or decrease while you were saying the alphabet? Explain

why you think this happens.

Now repeat the experiment with the following twist: only catch the ruler when your partner says the key word **"monkey"**. Be sure to say the word *before* dropping the ruler. Your partner should try to trick you by occasionally dropping the ruler while saying other, incorrect, words. (For instance, if the experimenter says "banana" and then drops the ruler, don't catch it!). Keep trying until you catch the ruler 3 times in a row on the correct word WITHOUT any mistaken catches on the wrong word. *Record the length at which the ruler was caught for those three times.*

Q3. Did your reaction time increase or decrease? Explain why.

Part 2 – Computer Station

The reaction timer should already be open on your laptop. Ask your teacher if you can't see it.

Visual: Click on the "Visual" button near the top of the window. You should see two gray circles and a button labeled "Start" to the right of them. Click on the Start button. The top circle will turn red and the timer will wait for a few seconds. As soon as you see the red light on top switch to a green light on the bottom, click and release the button (now labeled "End"). The timer will record your reaction time in the table to the left. If you click the End button before the light turns green, that test will not count. If you want to erase the last recorded time, click on the Undo button at the bottom. **Do a few practice runs first*, then record the average of 5 trials.***

	Visual	**Auditory: loud**	**Auditory: soft**	**Decision**
Average:	sec	sec	sec	sec

Q4. How does your reaction time, as measured in this experiment, compare with the reaction times calculated in the first part of the ruler-drop section? Are they close? Why might there be differences?

Auditory: Now click on the button labeled "Auditory" to record your reaction time to an auditory stimulus. Again, click on the Start button to start the test. The light will turn red, the computer will wait a few seconds and then produce a beep. If you do not hear a beep for more than 10 seconds, make sure that the volume on the computer is turned up. As soon as you hear the beep, click on the End button and your reaction time will be recorded. *Record your results in the chart above.*

Run the auditory test first with the volume turned up to produce a loud beep, then with the volume turned down for a softer (but still audible beep).

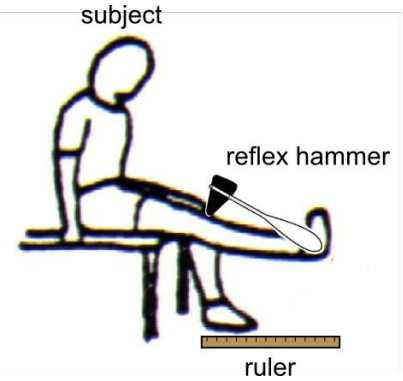
Q5. Was there a difference between your average reaction time for the visual and the auditory stimuli?

Q6. Did you notice a difference in your reaction times for loud versus soft stimuli? Why do you think a louder beep might lead to shorter (or longer) times?

Decision: Now click on the button labeled "Decision". Click the Start button to run the test. After a short pause, a picture will appear on the screen. Click the End button **only** if it is a picture of a cat. If the picture does not show a cat, it will disappear on its own in 2 seconds, or you can click on the Clear button to reset the test. Repeat until you measure 5 reaction times where you correctly clicked on the cat pictures only. You must click on the Start button each time, regardless of whether the picture showed a cat!

Q7. Which ruler drop experiment do you expect to yield similar times to the ones obtained here? Why are the two experiments comparable? Are the times, in fact, similar?

Part 3 - Reflex Station



Work in teams of 3 – the subject, the experimenter, and the data recorder. The subject should sit on a desk or someplace where his/her legs can dangle freely. The experimenter should try to elicit the **patellar reflex** (also known as the knee-jerk reflex). Using the side of your hand, tap one of the subject's legs just below the kneecap. You should not need to hit very hard! By looking straight down at the ruler, the data recorder should measure the horizontal distance that the foot travels relative to the height at the bottom. Trade roles so that all of you have a chance to be the subject.

	Trial 1	**Trial 2**	**Trial 3**
Distance of kick	cm	cm	cm

Q8. Is this a voluntary or involuntary reaction? Are you able to stop yourself from kicking your leg?

Q9. What are some variables that might affect the magnitude (how far you kick) of the observed response?

Direct / consensual pupillary reflex: If possible, dim the lights in the room. Hold a piece of cardboard at your nose, separating your left and right eye. The experimenter should briefly shine the penlight in the your left eye (5-10 cm away from the eye) and observe the size of the pupil in the left eye. Wait a little while for the pupil to readjust and repeat the experiment, this time shining a light in the left eye while observing the right.

Q10. What happened to the pupil in each eye when you shone the light in the left eye? Is this a voluntary or involuntary reaction?

Concept Questions

Q11. (a) What is the role of the pupillary light reflex? Why is it important to us?

(b) Can you think of a useful role for the knee jerk reflex?

Q12. Why do we need to have innate reflexes at all? Why do we need involuntary reflexes? Wouldn't we be better off being able to control everything that our body does?

Q13. Why do doctors measure reflexes during a diagnostic exam? What information can they get out of these measurements? Why is the knee-jerk reflex particularly useful for diagnosing the location of a problem in your nervous system?

Q14. Based on data you measured in this lab, why is it a bad idea to talk on your cell-phone while driving?

Q15. The distance from the pitcher to the batter in a baseball game is about 60 feet. A fast-ball travels at approximately 147 feet per second (this is about 100 mph).
How long (in seconds) does it take the ball to reach the batter after it is thrown?
(use the formula: time = distance divided by speed)

Q16. Suppose an insane pitcher decided to pitch a cat at you instead of a baseball. If you had your eyes closed until the instant when the pitcher let go, would you have time to react before the cat hit you in the face (compare to data you measured in this lab)?

Q17. Based on data you measured in this lab, do you have enough time after the ball leaves the pitcher's hand to decide how the ball will fly and to aim for it? How do you think good baseball players manage to actually hit the ball?