INTRODUCTION

The automatic response of a muscle to a stimulus is called a reflex. The patellar reflex results from tapping the patellar tendon below the knee with a reflex hammer. This causes contraction of the quadriceps muscle and extension of the leg. Stretching of the muscle activates nerve impulses which travel to the spinal cord. Here the incoming impulses activate motor neurons, which travel back to the muscle and result in muscle contraction. This reflex arc is primarily a spinal reflex, but is influenced by other pathways to and from the brain. (Figure 1).

A reflex may be reinforced (a term used by neurologists to mean enhanced) by slight voluntary contraction of muscles other than the one being tested. For example, voluntary activation of arm muscles by motor neurons in the central nervous system “spills over” to cause a slight activation of the leg muscles as well. This results in the enhancement of the patellar reflex. There are other examples of central nervous system influences on reflexes. Health care professionals use knowledge of these influences to aid in diagnosis of conditions such as acute stroke and herniated lumbar disk, where reflexes may be absent; and spinal cord injury and multiple sclerosis, which may result in exuberant reflexes.

In this experiment, you will use an EKG sensor to measure the relative strength (amplitude) of the impulse generated by a stimulus with and without reinforcement. This sensor, developed to measure the electrical events occurring within the heart, can be used to measure the electrical activity resulting from the contraction of other muscles, as well.
Important: Do not attempt this experiment if you have pain in or around the knee. Inform your instructor of any possible health problems that might be exacerbated if you participate in this exercise.

OBJECTIVES

In this experiment, you will
- Obtain graphical representation of the electrical activity of a muscle activated by a reflex arc through nerves to and from the spinal cord.
- Associate muscle activity with involuntary activation.
- Observe the effect of central nervous system influence on reflex amplitude.

MATERIALS

LabQuest    electrode tabs
EKG Sensors    reflex hammer

PROCEDURE

Each person in the group will take turns being subject and tester.
1. Connect the EKG Sensor to the LabQuest. If you have older sensors that do not auto-ID, manually set up the sensors.
2. On the Meter screen, tape Rate. Change the data-collection rate to 100 samples/second and the data-collection length to 30 seconds. Select OK
3. Have the subject sit comfortably in a chair that is high enough to allow his/her legs to dangle freely above the floor.
4. Attach two electrode tabs above one knee along the line of the quadriceps muscle between the knee and the hip. The tabs should be 5 and 13 cm, from the middle of the patella (see Figure 2). A third electrode tab should be placed on the lower leg.
5. Locate the subject’s patellar tendon by feeling for the narrow band of tissue that connects the lower aspect of the patella to the tibia. Place a pen mark in the center of the tendon, which can be identified by its softness compared with the bones above and below (see Figure 3).
6. Attach the red and green leads to the electrode tabs above the knee with the red electrode closest to the knee. Attach the black lead (ground) to the electrode tab on the lower leg.

7. Start data collection. If your graph has a stable baseline, stop data collection and continue to Step 8. If your graph has an unstable baseline, stop data collection and repeat data collection until you have obtained a stable baseline for 5 s.

8. Collect patellar reflex data without and with reinforcement. **Note:** Read this entire step before collecting data to familiarize yourself with the process.
   
   a. Have the subject close his/her eyes, or avert them from the screen.
   
   b. Start data collection.
   
   c. After recording a stable baseline for 5 s, swing the reflex hammer briskly to contact the mark on the subject’s tendon. If this does not result in a visible reflex, aim toward other areas of the tendon until the reflex is obtained.
   
   d. After 5 or 6 successful reflexes have been obtained, have the subject reinforce the reflex by hooking together his/her flexed fingers and pulling apart at the chest level, with elbows extending outward (see Figure 4).

   e. Continue obtaining reflexes until data collection is completed at 30 x. A total of 10-15 reflexes should appear on the graph.

9. Determine the average amplitude of the reinforced and unreinforced reflexes.
   
   a. To analyze the data, tap and drag from just before the first area that represents the increased amplitude (depolarization) to just after muscle contraction (see Figure 5).
   
   b. Choose Zoom In from the Graph menu and ensure that you have selected an area of data that represents the increased amplitude (depolarization).
   
   c. Tap and drag over the exact area of the first depolarization (see Figure 5).
   
   d. Choose Statistics from the Analyze menu.
   
   e. Record the minimum, maximum and Δy value (amplitude) for this depolarization in Table 1, rounding to the nearest 0.01 mV.
   
   f. Choose Statistics from the Analyze menu to remove statistics for this region.
   
   g. Choose Autoscale Once from the Graph menu.
   
   h. Repeat this process for 5 unreinforced and 5 reinforced depolarization events. Ignore rebound responses. Record the appropriate values in Table 1.
   
   i. Determine the average amplitude of the reinforced and unreinforced depolarization events examined. Record these values in Table 1.
DATA

Table 1

<table>
<thead>
<tr>
<th>Reflex response</th>
<th>Reflex without reinforcement</th>
<th>Reflex with reinforcement</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Max (mV)</td>
<td>Min (mV)</td>
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<tr>
<td>1</td>
<td></td>
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<tr>
<td>5</td>
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<tr>
<td>Average values</td>
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</tbody>
</table>

DATA ANALYSIS

1. Assume that there are nerve fibers that travel from the brain to the motor neurons in the spinal cord involved in this reflex arc. Some nerve tracts from the brain stimulate the spinal neurons, and some inhibit the same neurons. Speculate on the mechanism that would result in the differences you observed in the ∆mV values between reflexes with and without reinforcement.

2. Describe the differences between the wave forms resulting from a reflex stimulus with and without reinforcement. What can you hypothesize about the number of nerve fibers involved in a reinforced reflex as compared to one without reinforcement?
3. Compare the data you obtained in this experiment with other members of your group/class. Can individual differences attributed to any physical differences (body shape, size, muscle mass, physical fitness level)?

EXTENSIONS

1. Explore the ankle and elbow reflexes.

2. Perform the experiment with the subject watching the reflex hammer as it hits the patellar tendon. Compare this data to data gathered while the subject is focusing on an object elsewhere in the room.

3. Research how various diseases (such as those mentioned in the Introduction to this experiment) can affect reflexes.