MUSCLE STRETCH REFLEX

How long does it take for a stimulus to induce an involuntary muscle contraction?

Objectives

- Determine the Achilles reflex time in response to a stimulus.

Materials and Equipment

- Data collection system
- Force sensor with rubber bumper and thumbscrew
- Rod to fit force sensor rod clamp opening, ~20 cm
- EKG sensor
- Electrode patches (3)
- Non-alcohol cleansing wipe

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- The electrode patches are intended for use with a single student and cannot be re-used after completing this investigation.
- The EKG sensor is not intended for use as a medical instrument.
- If an individual has foot or leg pain, have them work as a data recorder instead of a test subject.

Procedure

1. Connect the EKG sensor and force sensor to your device, then select the Muscle Stretch Reflex Quick Start Experiment file.

   NOTE: If the file is not available, make sure only the Voltage and Force measurements are enabled with all other measurements disabled, then choose the Graph template. Change the x-axis units for Time to milliseconds (ms). Open the Sampling Options menu to set the Sensor option to Common and set Sample Rate to 1 kHz.

2. Work in pairs. One student will work as a data recorder while the other student will work as a test subject.

3. Let the test subject choose which leg to use. Roll long pants up to expose the leg from the knee down and remove the shoe. Have the subject flex their foot so they can easily find the lateral side of their calf muscle. Cleanse the area with a wipe. Remember: lateral is sideways away from the body's midline.

4. Have the test subject place electrode patches in line with one another on the lateral side of the calf muscle in the areas shown in Figure 1. Grip electrode patches by their non-adhesive tabs and place them 1-2 cm apart.

5. Attach the black (R) clip to the non-adhesive tab on the electrode patch closest to the heel. Attach the red (+) clip to the center electrode patch, and attach the green (−) clip to the electrode patch nearest to the knee. If necessary, push the plastic cover away from each alligator clip tip to maximize clip-to-tab contact.

Figure 1. 1=Black(R); 2=Red(+); 3=Green(-)
6. Set the EKG sensor on the floor and make sure the electrode wires can move freely while the alligator clips remain securely attached to the electrode tabs.

7. Have the test subject stand with one leg straight and the selected leg kneeling on a chair, as shown in Figure 1. They may lean against the chair for added support, if needed. Have the test subject relax their selected leg with the foot flexed as shown.

8. Find the test subject’s Achilles tendon which prominently extends from the heel to the calf area.

9. Grasp the force sensor reflex hammer at the end of the rod. Align the reflex hammer so that the force sensor’s rubber bumper will strike the tendon directly in the region indicated by the arrow in Figure 1. A swift, well-placed strike results in an involuntary reflex noted by the foot jerking towards the sole. The test subject must stay relaxed and face away from the data display. They should not see the stimulus coming. Practice striking the tendon with the bumper. When you are able to consistently produce a reflex, move on to the next step.

**NOTE:** Use the force sensor only as directed. If you are struggling to produce reflexes, try increasing the height between the force sensor hammer and tendon to increase the force of the strike, strike a point further from the ankle along the tendon, or switch test subjects. The sensor has a maximum force load of 50 N. This value is greater than the force required to generate a reflex.

10. Remind the test subject to relax their bent leg completely and remain perfectly still. The subject can anticipate a strike, but they should not be warned of its timing.

11. Quickly complete the following:
   a. **Zero** the force sensor.
   b. Start recording data.
   c. Strike the tendon.
   d. Stop recording data.

12. You should see a single spike on the force graph with a maximum force between 20 N and 50 N (see Figure 2).

13. Compare your EKG waveform to the sample graphs shown in Figure 2 (note the expanded scale on each shared x-axis). Notice how a similar force applied to two different subjects produces different EKG waveforms with common characteristics. As seen in the sample graphs, acceptable EKG waveforms show a stable voltage before force is applied, some fluctuation after force is applied, a noticeable voltage decrease after the peak force is achieved, and a series of waves after the initial decrease. If your EKG waveform is acceptable, move on to the next step. Otherwise repeat step 10 until you have recorded an acceptable waveform.

![Figure 2. Acceptable waveforms from two different subjects](image-url)
14. Complete the following to determine reflex time:
   a. Use the Multi-Coordinates tool to record the time at which the force sensor first contacted the tendon (T₁; see Figure 2) indicated by the first point of the abrupt force increase. Record the result in Table 1.
   b. Move the Multi-Coordinates tool to find the time at which the reflex signal began, as indicated by the EKG voltage change (T₂; see Figure 2); record the result in Table 1.
   c. Calculate the subject's reflex time by subtracting T₁ from T₂. Record the result in Table 1.
15. Repeat the procedure until you have 5 acceptable reflex times. For any trial, the acceptable reflex times should all fall within a range of ±10 ms compared to other trials.
16. Calculate the mean (average) reflex time for the 5 trials. Record the mean in Table 1 and share data your with the class as instructed by your teacher.
17. Calculate the class mean reflex time and record the result in Table 1.

Data Collection

<table>
<thead>
<tr>
<th>Trial #</th>
<th>Time contact made, T₁ (ms)</th>
<th>Time reflex signal begins, T₂ (ms)</th>
<th>Reflex time, T₂ - T₁ (ms)</th>
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<tbody>
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<td>Mean reflex time - test subject (ms)</td>
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<tr>
<td>Mean reflex time - class average (ms)</td>
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</tbody>
</table>

Questions and Analysis

1. Describe how the ankle responded to the reflex hammer stimulus in specific anatomical terms of movement from start to finish.

2. How does the subject's individual mean reflex time compare to the class average? How much variation would you expect to see with a larger sample size? Explain your reasoning.
3. For an average healthy adult, would you expect the patellar (below-the-kneecap) mean muscle stretch reflex time to differ from the Achilles mean reflex time? Why or why not?

4. Identify at least two different conditions that a delayed or absent Achilles reflex may indicate.