



Physiology Lessons
for use with the
Biopac Student Lab

Manual Revision 3.7.3

061808

Richard Pflanzner, Ph.D.
Associate Professor Emeritus
Indiana University School of Medicine
Purdue University School of Science

William McMullen
Vice President
BIOPAC Systems, Inc.

BIOPAC[®] Systems, Inc.

42 Aero Camino, Goleta, CA 93117
(805) 685-0066, Fax (805) 685-0067

info@biopac.com | www.biopac.com

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Lesson 20

SPINAL CORD REFLEXES

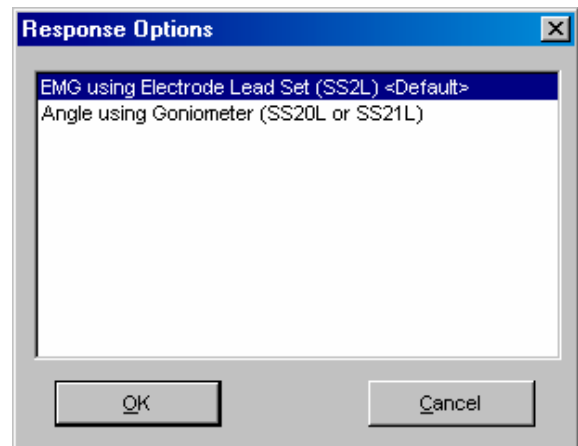
- Latent periods and reaction times
- Contractile force vs. stimulus strength
- Jendrassik maneuver influence
- Voluntary vs. involuntary activation of skeletal muscle

II. EXPERIMENTAL OBJECTIVES

1. To become familiar with anatomical and physiological elements of simple spinal reflexes.
2. To examine properties of some simple neuromuscular reflexes commonly tested in physical diagnosis.
3. To measure and compare latent periods and reaction times of extensor and flexor reflexes.
4. To elicit an extensor reflex and compare contractile force vs. stimulus strength.
5. To apply the Jendrassik maneuver and observe exaggeration of an extensor reflex.
6. To measure and compare reaction times of voluntary activation of skeletal muscle vs. involuntary (reflex) activation of skeletal muscle.

III. MATERIALS

- Reflex Hammer Transducer (SS36L)
- Response Setup
 - Via electrodes:
 - Electrode lead set (SS2L)
 - Disposable vinyl electrodes (EL503)
3-6 per subject
 - Electrode gel (GEL1)
 - Abrasive pad (ELPAD)
 - OR
 - Via goniometer:
 - Twin-axis Goniometer (SS20L or SS21L)
 - Single-sided tape (TAPE1)
- Push-pin, thumb tack or alternate media for cutaneous stimulus
- Chair
- Computer system
- Biopac Student Lab 3.7
- BIOPAC data acquisition unit (MP36, MP35, or MP30 with cable and power)



IV. EXPERIMENTAL METHODS



For further explanation, use the online support options under the Help menu.

A. SET UP

Fast Track Set Up

1. Select a Subject, a Recorder and, if appropriate in your lab group, a Director.
2. Turn the computer ON.
3. Make sure the BIOPAC MP3X unit is turned OFF.
4. Plug the equipment in as follows:
 - Reflex Hammer SS36L — CH 1
 - AND
 - Lead Set SS2L — CH 2
 - OR
 - Goniometer SS21L — CH 2
 - SS21L-Y input only
5. Turn the MP3X Data Acquisition Unit ON.
6. *If using SS2L and electrodes:* Place six electrodes on the Subject.
 - a) Place three for knee reflex (fig. 20.4).
 - b) Place three for ankle reflex (fig. 20.5).

The distance between electrodes is critical. If you do not get a measurable response during calibration, move the electrodes further apart and repeat calibration.

Set Up continues...

Detailed Explanation of Set Up Steps

This lesson is designed to teach the anatomical and physiological elements of simple spinal reflexes, which are monitored by EMG electrodes or a goniometer in this lesson.

The desktop should appear on the monitor. If it does not appear, ask the laboratory instructor for assistance.



Figure 20.3 Hardware

Abrade the site and place electrodes; use GEL1 if necessary:



Fig. 20.4 Knee Reflex

Knee Reflex Electrodes

- Two electrodes on the quadriceps muscle on front of thigh, approximately 10 cm (4") apart.
- One electrode (as ground) on the interior thigh of the same leg.

Ankle Reflex Electrodes

You can place electrodes on the same or opposite leg; clinicians might use the same leg to test the ipsilateral reflex response.

- Two electrodes on the inside of the calf muscle, approximately 13 cm (5") apart, near the midline of the leg.
- One electrode (as ground) just inside of the ankle on the same leg.

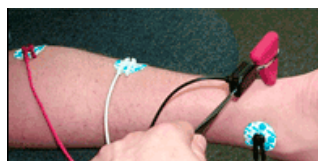


Figure 20.5 Ankle Reflex

OR

If using SS21L Goniometer:

- a) Tape the telescopic endblock laterally on the leg so the axes of the leg and endblock coincide, when viewed in the sagittal plane.
- b) Tape the leg fully (extend the goniometer to max length), and attach the fixed endblock to the thigh so the axes of the thigh and endblock coincide.

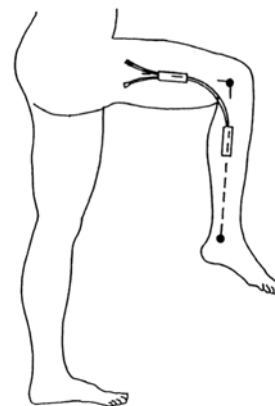


Figure 20.6 Attach a goniometer (SS20L) to the outside of the knee.

Ensure that the goniometer (SS20L) is attached to the outside of the knee (as seen in figure 20.5). This will measure angular movement of the leg, which is proportionate to the force of the strike from the reflex hammer.

7. *If using SS2L and electrodes:* Clip the lead set (SS2L) to the electrodes as described for Knee Reflex (Fig. 20.4 and Table 20.1).

Attach the SS2L leads to the knee reflex electrodes (as seen in figure 20.3 and described in Table 20.1).

Lead Color	Signal	Position
Red	(+)	middle electrode
White	(-)	closest to waist
Black	(ground)	interior thigh

Table 20.1 Electrode lead attachment for Knee Reflex

The electrode cables are each a different color — follow the figure provided to ensure proper connection between each cable and electrode.

Position the electrode cables so they do not pull on the electrodes. Clip the electrode cable clip (where the cable meets the three individual colored wires) to a convenient location (such as Subject's clothes) to relieve cable strain.

8. Mark the optimal reflex spot on the Subject.
 - Have the Subject sit with his or her legs hanging over the edge of a chair or desk at 90 degrees.
 - Find the optimal reflex spot on the Subject's knee and mark the spot.

Tips to help locate the optimal reflex spot:

- a) relax leg
- b) locate midline ridge on the knee cap
- c) feel below the ridge, no more than an inch below the tip of the patella
- d) tap this spot with the reflex hammer to confirm a strong response

Mark the optimal reflex spot—if you prefer, use tape and a pen mark rather than marking the subject directly.



9. Start the Biopac Student Lab program.

10. Choose Lesson 20.

11. Type in your filename.

12. Click OK.

Use a unique identifier.

This ends the Set Up procedure.

END OF SETUP

B. CALIBRATION

The calibration procedure establishes the hardware's internal parameters (such as gain, offset, and scaling) and is critical for optimum performance. Pay close attention to the calibration procedure.

Fast Track Calibration

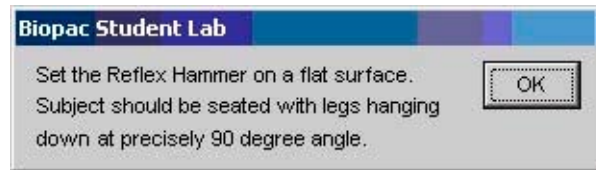
1. Set the Reflex Hammer on a flat surface. Subject should sit with legs hanging at precisely 90° degrees.
2. When ready, click Calibrate.
 - a. Confirm Subject's legs are hanging at 90° degrees and then click OK.
 - b. Lightly tap the Reflex Hammer two or three times on a flat surface.
 - c. Subject should fully extend leg to 0° and then return to 90°.

The calibration procedure will stop automatically after 12 seconds.
3. Check the calibration data.
 - If similar, proceed to Data Recording.
 - If different, Redo Calibration.

The distance between electrodes is critical. If you do not get a measurable response using EMG electrodes, move the electrodes further apart and repeat calibration.

Detailed Explanation of Calibration Steps

The Calibrate button is in the upper left corner of the Setup window. Clicking the Calibrate button will generate a prompt to confirm that subject is seated properly:



When Subject is ready, click OK to start the calibration recording. The calibration procedure will stop automatically after 12 seconds.

At the end of the calibration recording, the screen should resemble Fig. 20.7 or Fig. 20.8

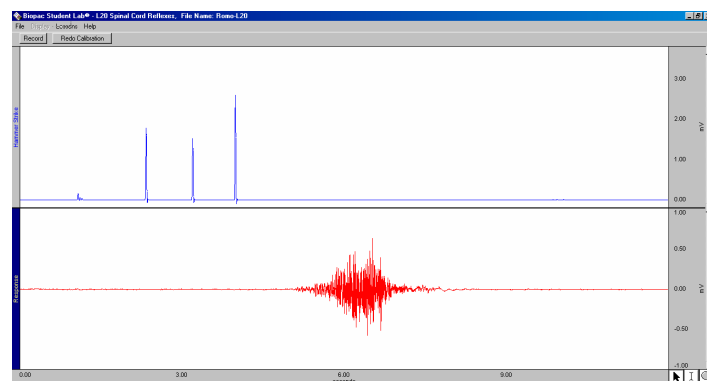


Figure 20.7 – Reflex & Response Calibration via EMG Electrodes

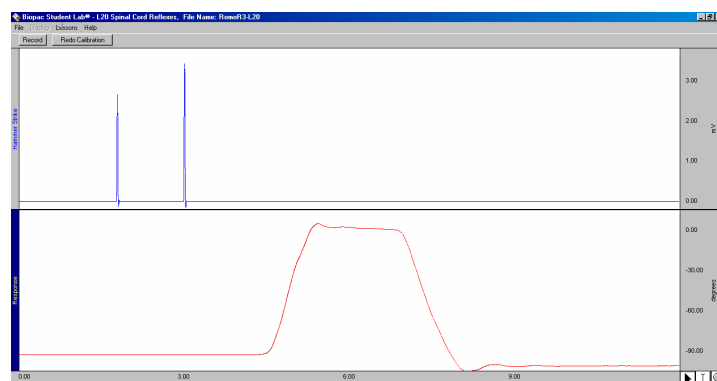


Figure 20.8 – Reflex & Response Calibration via Goniometer

The Hammer Strike channel should show a clear spike to indicate when the reflex hammer was lightly tapped and the Response channel should clearly indicate a response following the strike.

If your data resembles Fig. 20.7/ Fig. 20.8, proceed to the Data Recording section.

If you need to redo the calibration, recheck your connections and click Redo Calibration, then repeat the entire calibration sequence.

END OF CALIBRATION

C. RECORDING LESSON DATA

Fast Track Recording

1. Review the spinal reflex positions.
2. Prepare for the recording.
 - a) Prepare five math problems.
 - b) Select media for cutaneous stimulus.

Segment 1: Knee Jerk Reflex

3. Ask subject to close eyes and then click Start.
4. Strike the optimal reflex spot of the patellar tendon and observe the resulting muscle contraction.
5. Repeat the patellar tendon strike every 5 seconds, four times. Start with a light tap and INCREASE strike force.
6. Click Suspend.
7. Review the data on the screen.
 - If correct, go to Step 8.
 - If incorrect, click Redo.

Recording continues...

Detailed Explanation of Recording Steps

In this lesson, you will note the spinal cord reflexes in the following six scenarios. Two channels of data will be displayed during the recording: Reflex Hammer Strike and Response.

- Knee Jerk Reflex—tests the femoral nerve
- Knee Jerk Reflex—during Jendrassik maneuver
- Knee Jerk Reflex—with mental distraction
- Flexor Withdrawal Reflex—tests delay in knee jerk when another reflex is stimulated
- Voluntary Knee Jerk Reflex
- Ankle Jerk Reflex—tests the medial popliteal nerve

For Segment 3: Prepare five addition problems consisting of two three-digit numbers (e.g., $247 + 498$).

For Segment 4: Prepare a push-pin, thumb tack, or alternate media for cutaneous stimulus (to prick to the skin).

Use a 5-sec interval between strikes in each segment to allow the leg to return to rest between strikes.

Use INCREASING force in Segment 1, and try to apply the SAME FORCE for each strike in Segments 2-6.

Tests the femoral nerve

The optimal reflex spot was marked in Setup.

The optimum response was marked in Setup. When you click Start, the recording will begin and an append marker labeled “Knee Jerk Reflex” will be inserted automatically.

Note To obtain accurate goniometer data, it is crucial that the leg come to a resting position between strikes in this segment.

Use INCREASING force for each strike.

When you click Suspend, the recording will halt, giving you time to review the data and prepare for the next recording segment.

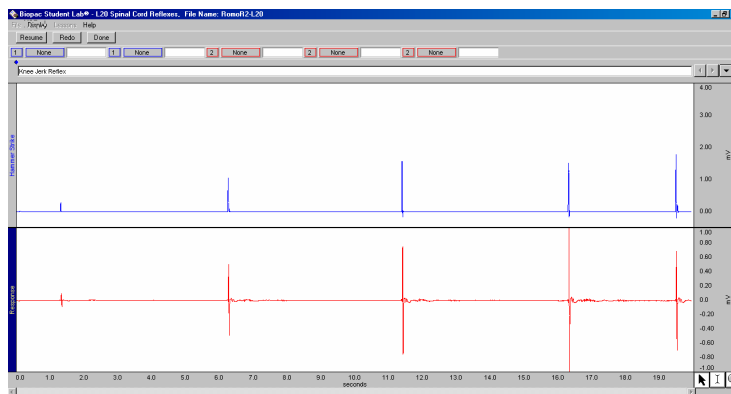


Figure 20.9

Channels should show clear spikes to indicate when the reflex hammer was lightly tapped and a response following each strike.

Segment 2: Knee Jerk Reflex

8. Subject remains seated with legs hanging over the edge of a chair/desk at 90 degrees and prepares to perform the Jendrassik maneuver (see description at right).
 9. Ask subject to close eyes and perform the Jendrassik maneuver, then click Resume.
10. While the Subject is performing the Jendrassik maneuver, strike the patellar tendon and observe the resulting muscle contraction.
 - Subject should relax grip between strikes and resume on Cue from the Director.
 11. Repeat the simultaneous Jendrassik maneuver/patellar tendon strike every 5 seconds with the SAME FORCE, four times.
 12. Click Suspend.
 13. Review the data on the screen.

- If correct, go to Step 14.
- If incorrect, click Redo.

Recording continues...

Jendrassik maneuver



To perform the Jendrassik maneuver, Subject hooks the hands together by the flexed fingers at chest level and concentrates on pulling the hands apart with as much force as possible without breaking the interlock.

Figure 20.10 Subject in position for Jendrassik maneuver

- The patellar tendon is tapped while the Subject attempts to pull apart the interlocked fingers.
- Immediately after the strike, Subject should relax grip (hands hooked together but not pulled apart), then repeat grip on cue from the Director before each strike.

When you click Resume, the recording will continue and an append marker labeled “Knee Jerk during Jendrassik maneuver” will be inserted automatically.

Note To get accurate goniometer data, it is crucial that the leg come to a resting position between strikes in this segment.

Subject should relax grip immediately after each strike, then repeat on cue from the Director before the next strike.

IMPORTANT: Try to apply the SAME FORCE for each strike.

When you click Suspend, the recording will halt, giving you time to review the data and prepare for the next recording segment.

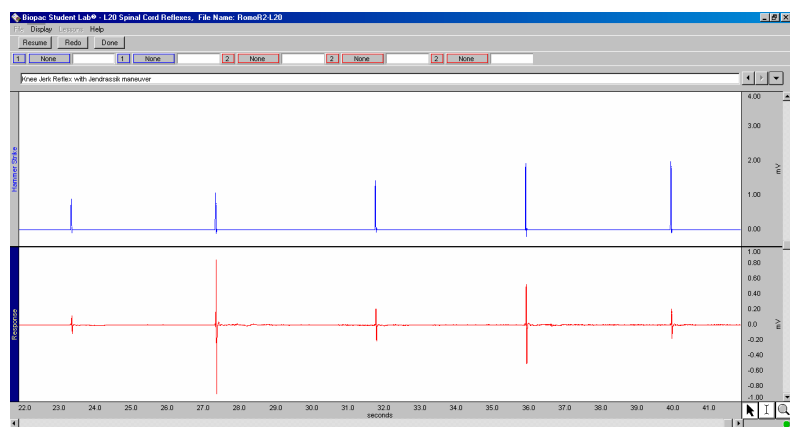


Figure 20.11 Knee Jerk Reflex during Jendrassik maneuver

Channels should show clear spikes to indicate when the reflex hammer was lightly tapped and a response following each strike.

Segment 3: Knee Jerk Reflex

With mental distraction

14. Get your prepared addition problems.
15. Subject remains seated with legs hanging over the edge of the desk/chair at 90 degrees.
16. Ask subject to close eyes and then click Resume.
17. Director verbally provides the first math problem and then, as the Subject tries to quickly solve it silently in his or her head, strikes the patellar tendon and observes the resulting muscle contraction.
18. Repeat the simultaneous mental math/patellar tendon strike every 5 seconds with the SAME FORCE, four times. Use a new math problem each time.
19. Click Suspend.
20. Review the data on the screen.
 - If correct, go to Step 21.
 - If incorrect, click Redo.

Director reads the five addition problems, each consisting of two three-digit numbers (e.g., $247 + 498$), that were prepared in Step 2.

When you click Resume, the recording will continue and an append marker labeled “Knee Jerk with mental distraction” will be inserted automatically.

Note To get accurate goniometer data, it is crucial that the leg come to a resting position between strikes in this segment.

The Subject should attempt to solve each problem in the shortest amount of time possible without using a pen or calculator. While the Subject performs mental math, the Director should strike the patellar tendon.

IMPORTANT: Try to apply the SAME FORCE for each strike.

When you click Suspend, the recording will halt, giving you time to review the data and prepare for the next recording segment.

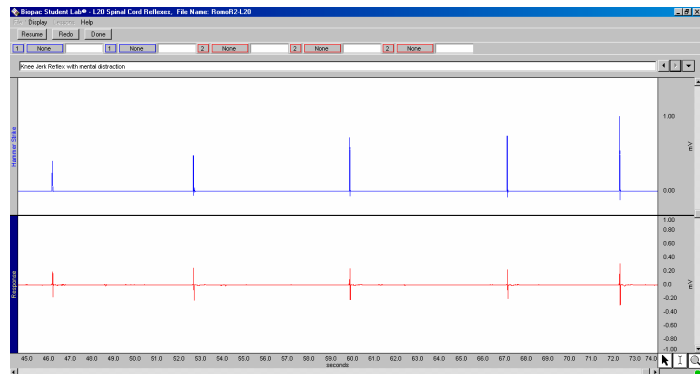


Figure 20.12 Knee Jerk Reflex with mental distraction

Channels should show clear spikes to indicate when the reflex hammer was lightly tapped and a response following each strike.

Segment 4: Flexor Withdrawal Reflex

Knee jerk when another reflex is stimulated

21. Subject remains seated with legs hanging over the edge of a chair/desk at 90 degrees.
22. Ask subject to close eyes and then click Resume.

When you click Resume, the recording will continue and an append marker labeled “Flexor Withdrawal Reflex” will be inserted automatically.

Note To get accurate goniometer data, it is crucial that the leg come to a resting position between strikes in this segment.

Recording continues...

23. Apply a cutaneous stimulus on the front of the thigh and simultaneously strike the patellar tendon and observe the response.
24. Repeat the simultaneous cutaneous stimulus/patellar strike every 5 seconds with the SAME FORCE, four times.
25. Click Suspend.
26. Review the data on the screen.
 - If correct, go to Step 27.
 - If incorrect, click Redo.

Use a push-pin, thumb tack, or alternate media for cutaneous stimulus (to prick to the skin) on the front of the thigh; at the same time, strike the patellar tendon and observe the resulting muscle contraction.

You want to introduce the cutaneous stimulus on the same path the neurons stimulated by the reflex hammer strike follow. In this case, the rectus femoris, which is part of the quadriceps femoris.

IMPORTANT: Try to apply the SAME FORCE for each strike.

When you click Suspend, the recording will halt, giving you time to review the data and prepare for the next recording segment.

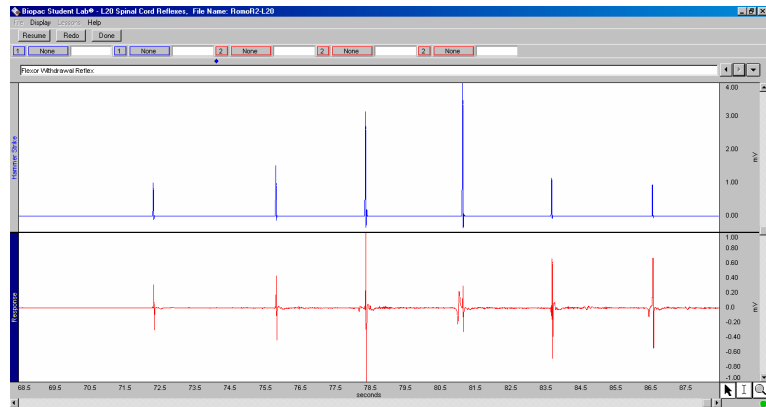


Figure 20.13 Flexor Withdrawal Reflex

Channels should show clear spikes to indicate when the reflex hammer was lightly tapped and a response following each strike.

Segment 5: Voluntary Knee Jerk Reflex

27. Subject remains seated with legs hanging over the edge of a chair/desk at 90 degrees.
28. Ask subject to close eyes and then click Resume.
29. Strike the hammer on a flat surface and ask Subject to voluntarily jerk the knee upon hearing the hammer strike.
30. Repeat the table strike/voluntary knee jerk every 5 seconds with the SAME FORCE, four times.
31. Click Suspend.

Response to sound of strike

When you click Resume, the recording will continue and an append marker labeled “Voluntary Knee Jerk Reflex” will be inserted automatically.

Note To get accurate goniometer data, it is crucial that the leg come to a resting position between strikes in this segment.

IMPORTANT: Try to apply the SAME FORCE for each strike.

Recording continues...

32. Review the data on the screen.

- If correct, go to Step 33.
- If incorrect, click Redo.

When you click Suspend, the recording will halt, giving you time to review the data and prepare for the next recording segment.

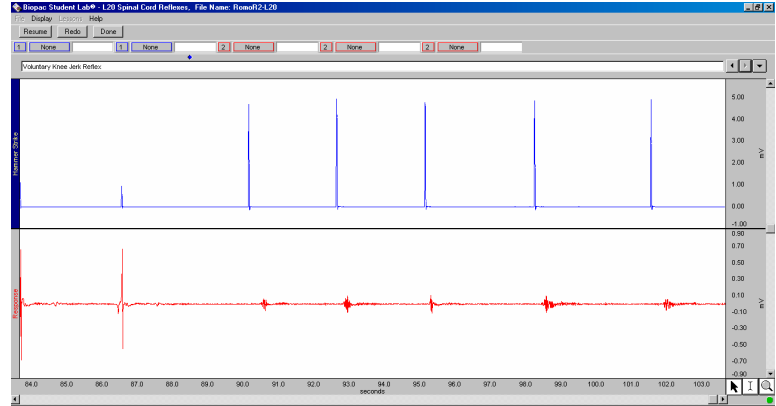


Figure 20.14 Voluntary Knee Jerk Reflex

Channels should show clear spikes to indicate when the reflex hammer was lightly tapped and a response following each strike.

Segment 6: Ankle Jerk Reflex

Tests the medial popliteal nerve

33. Switch the setup to Ankle Reflex (description at right).

Ankle Reflex setup

If using SS2L Leads

Using electrodes—disconnect the leads from the Knee Reflex setup electrodes and clip to the electrodes on the calf and ankle (as described in Table 20.2).

Switch the leads to Ankle Reflex as designated in Table 20.2.

Lead Color	Signal	Position
Red	+	calf, close to knee
White	-	middle of calf
Black	ground	inside of ankle



Table 20.2 Electrode Lead Attachment for Ankle Reflex

If using SS21L Goniometer

Move the goniometer to the ankle so that one end is vertical along the line of the tibia and the other end is horizontal along the lateral surface of the foot.

Using the goniometer—carefully untape the goniometer from the Knee Setup. With the foot at a right angle to the leg (close to 90° lateral aspect of the foot and tibia), tape one end vertically along the line of the tibia and tape the other end horizontally along the lateral surface of the foot (not on the medial surface—the arch may interfere with good setup).



34. Subject should bend the leg at the knee and rest the knee and shin on the seat of a chair. The foot should hang over the edge of the chair.



Relax the ankle so the foot is hanging freely from the leg (this is usually at about 90°).

Figure 20.15 Subject in position for Ankle Jerk Reflex

Recording continues...

35. Ask subject to close eyes and then click Resume.
36. Strike the Achilles tendon behind the ankle just above the heel and observe the resulting muscle contraction.
37. Repeat the Achilles tendon strike every 5 seconds with the SAME FORCE, four times.
38. Click Stop.
39. Review the data on the screen.
 - If correct, go to Step 40.
 - If incorrect, click Redo.

When you click Resume, the recording will continue and an append marker labeled “Ankle Jerk Reflex” will be inserted automatically.

Note To get accurate goniometer data, it is crucial that the leg come to a resting position between strikes in this segment.

IMPORTANT: Try to apply the SAME FORCE for each strike.

When you click Stop, the recording will halt, giving you time to review the data. Channels should show clear spikes to indicate when the reflex hammer was lightly tapped and a response following each strike.

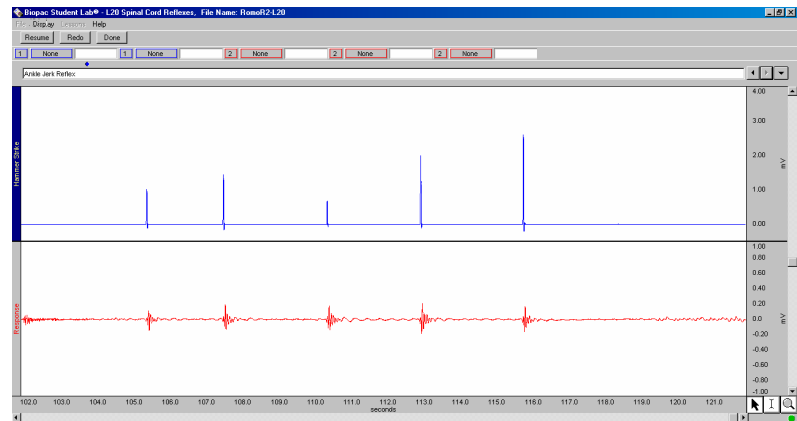


Figure 20.16 Ankle Jerk Reflex

40. Click Done and then Yes to confirm recording is complete.

When you click Done, you will be prompted to confirm that you are done with all recording segments. When you click Yes, a window with options will be generated. Make your choice and continue as directed.

If choosing the “Record from another Subject” option:

- Repeat the entire lesson from Set Up Step 6 for the new Subject.
- Each Subject will need to use a unique file name.

41. Remove the electrodes or the goniometer.

Remove the electrode cable pinch connectors and peel off the electrodes and throw them out the electrodes are not reusable).

Gently remove the tape from the goniometer and set it on a flat surface.

END OF RECORDING

V. DATA ANALYSIS

Fast Track Data Analysis

1. Enter the Review Saved Data mode and choose the correct file.
2. Note Channel Number (CH) designations:

<i>Channel</i>	<i>Displays</i>
CH 1	Reflex Hammer Strike
CH 2	Response

3. Set up the measurement boxes as follows:

<i>Channel</i>	<i>Measurement</i>
CH 1	Delta T
CH 1	Max
CH 2	Max

4. Set up the display for optimal viewing of the first recorded segment.

5. Zoom in and select each strike in Segment 1 to complete measurements for the data report.

 A, B

Detailed Explanation of Data Analysis Steps

 Enter the Review Saved Data mode.

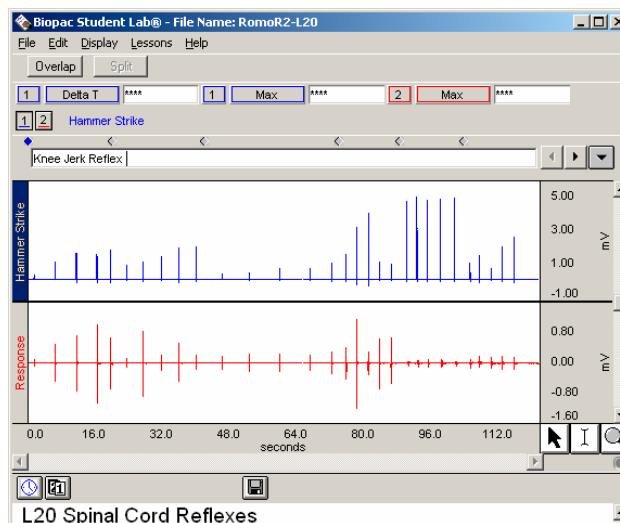



Figure 20.17

 The measurement boxes are above the marker region in the data window. Each measurement has three sections: channel number, measurement type, and result. The first two sections are pull-down menus that are activated when you click them.


The following is a brief description of these measurements.

Delta T time change used here to determine the response time from hammer strike to muscle response.

Max maximum amplitude; used here to determine strike force and angular displacement of the knee

The result applies to the “selected area” as selected by the I-Beam tool (including the endpoints).

Segment 1 starts at the append marker labeled “Knee Jerk Reflex” (Time 0) and ends at the marker labeled “Knee Jerk Reflex during Jendrassik maneuver.”

 The following tools help you adjust the data window:

Autoscale horizontal	Zoom Previous
Autoscale waveforms	Horizontal (Time) Scroll Bar
Zoom Tool	Vertical (Amplitude) Scroll Bar

To measure reaction times, select the area from the onset of the hammer strike in CH 1 to the onset of EMG activity in CH 2.

Data Analysis continues...

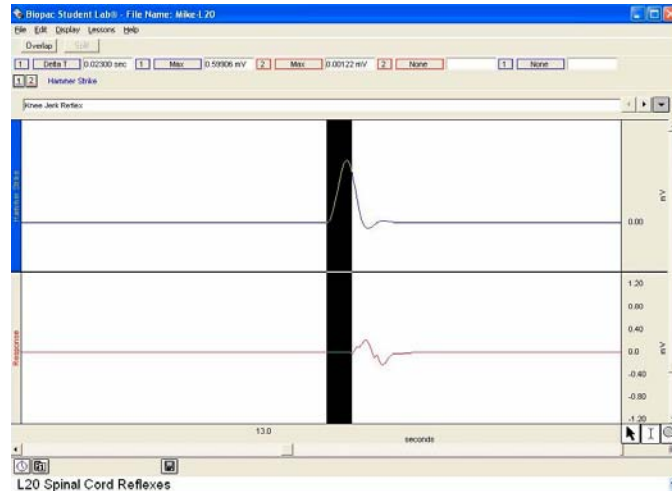


Figure 20.18

6. Click the marker menu and select the Append marker for Segment 2, then choose Display > Autoscale Waveforms, then zoom in and select each strike to complete measurements for the data report.

☰ A, B

Segment 2 starts at the “Knee Jerk Reflex during Jendrassik maneuver” marker and ends at “Knee Jerk Reflex with mental distraction.”

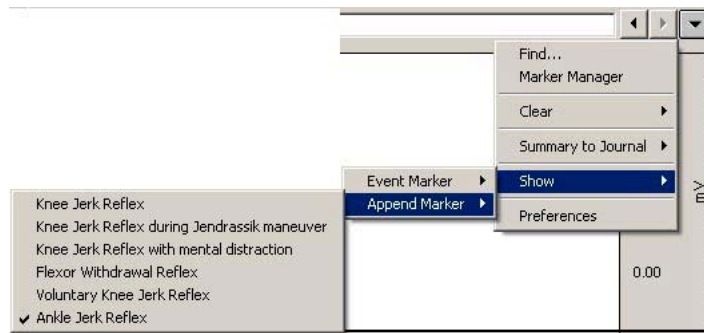


Figure 20.19

7. Click the marker menu and select the Append marker for Segment 3, then choose Display > Autoscale Waveforms, then zoom in and select each strike to complete measurements for the data report.

☰ A, B

Segment 3 starts at the “Knee Jerk Reflex with mental distraction” marker and ends at the “Flexor Withdrawal Reflex” marker.

8. Click the marker menu and select the Append marker for Segment 4, then choose Display > Autoscale Waveforms, then zoom in and select each strike to complete measurements for the data report.

☰ A, B

Segment 4 starts at the “Flexor Withdrawal Reflex” marker and ends at the “Voluntary Knee Jerk Reflex” marker.

9. Click the marker menu and select the Append marker for Segment 5, then choose Display > Autoscale Waveforms, then zoom in and select each strike to complete measurements for the data report.

☰ A, B

Segment 5 starts at the “Voluntary Knee Jerk Reflex” marker and ends at the “Ankle Jerk Reflex” marker.

Data Analysis continues...


10. Click the marker menu and select the Append marker for Segment 6, then choose Display > Autoscale Waveforms, then zoom in and select each strike to complete measurements for the data report.

 A, B

11. Save or print the data file.

12. Exit the program.

Segment 6 starts at the “Ankle Jerk Reflex” marker and ends at the end of the data file.

 Save the data to a drive, save notes that are in the journal, or print the data file.

END OF DATA ANALYSIS

End of Lesson 20

Complete the Lesson 20 Data Report that follows.

Data Report starts on next page.

DATA REPORT

Student's Name: _____

Lab Section: _____

Date: _____

Subject Profile

Subject's Name: _____

Gender: Male / Female Age: _____ Height: _____ Weight: _____

I. DATA TABLES—SPINAL CORD REFLEX MEASUREMENTS

- A. Complete Table 20.3 with reaction time (latent period) data for each segment and complete the required calculations. Reaction time is measured from onset of hammer strike to onset of EMG activity.

	Knee Jerk	Jendrassik maneuver	Mental Math Distraction	Flexor Withdrawal	Voluntary Knee Jerk	Ankle Jerk
Trial #	CH 1 Delta T	CH 1 Delta T	CH 1 Delta T	CH 1 Delta T	CH 1 Delta T	CH 1 Delta T
1	msec	msec	msec	msec	msec	msec
2	msec	msec	msec	msec	msec	msec
3	msec	msec	msec	msec	msec	msec
4	msec	msec	msec	msec	msec	msec
5	msec	msec	msec	msec	msec	msec
Average	msec	msec	msec	msec	msec	msec

Table 20.3

- B. Complete Table 20.4 with Strike Force and Response Amplitude data for each segment and complete the required calculations. Use the result to calculate the relationship between strike force and EMG amplitude.

Trial #	Measure	Knee Jerk	Jendrassik maneuver	Mental Math Distraction	Flexor Withdrawal	Voluntary Knee Jerk	Ankle Jerk
1	CH 1 Max	Volts	Volts	Volts	Volts	Volts	Volts
	CH 2 Max	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.
2	CH 1 Max	Volts	Volts	Volts	Volts	Volts	Volts
	CH 2 Max	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.
3	CH 1 Max	Volts	Volts	Volts	Volts	Volts	Volts
	CH 2 Max	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.
4	CH 1 Max	Volts	Volts	Volts	Volts	Volts	Volts
	CH 2 Max	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.
5	CH 1 Max	Volts	Volts	Volts	Volts	Volts	Volts
	CH 2 Max	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.
Average							

Table 20.4

II. QUESTIONS

1. What is the physiological meaning of the term “reflex”?

2. List the anatomical components of a reflex pathway in correct sequence from beginning to end.

3. What is the difference between an ipsilateral reflex and a contralateral reflex?

4. Define “reciprocal inhibition” and explain its importance.

5. The stronger the percussion hammer tap on the patellar tendon, the greater the reflex contraction of the quadriceps femoris. Explain.

6. The Jendrassik maneuver may exaggerate spinal reflexes such as the patellar reflex. Explain.

7. When a physician elicits the patellar reflex, what physiological activities are being examined? List four. (Hint: think of the function of each component of the reflex pathway.)

8. Briefly explain the function of the supraspinal descending inhibitory motor pathways.

9. There are two pathways by which the Jendrassik maneuver facilitates alpha motor neuron output. Describe one.

End of Lesson 20 Data Report