

Experiment HM-2: Electromyogram (EMG) Activity in Antagonistic Muscles

Equipment Required

PC or Mac Computer

IXTA, USB cable, IXTA power supply

iWire-B3G ECG cable and electrode lead wires

Disposable electrodes

Alcohol swabs

Small weight

Note – You must connect the iWire-B3G to the IXTA prior to turning it on.

EMG Cable Setup

1. Locate the iWire-B3G EMG cable and electrode lead wires in the iWorx kit.
2. Insert the connector on the end of the EMG cable into the iWire 1 input on the front of the IXTA.



Figure HM-2-S1: A five lead EMG cable connected to an IXTA.

3. Use an alcohol swab to clean and scrub the areas where the electrodes will be placed. Let the areas dry before attaching the electrodes.
4. Locate the muscles of the forearm over which the recording electrodes will be placed. Muscles can be located by flexing or extending the hand and noting the areas of the forearm where the muscles are tense during these hand positions:

- One pair of recording electrodes will be placed over the flexor muscles on the anterior surface of the forearm. The first electrode in this pair will be placed about 8 centimeters below the inside of the elbow and about 4 centimeters from the medial margin of the forearm. The second electrode in this pair will be placed about 8 centimeters below the other electrode along the midline of the anterior surface of the forearm.
 - A second pair of electrodes will be placed over the extensor muscles on the posterior surface of the forearm. The first electrode in this pair will be placed about 9 centimeters below the tip of the elbow along the midline of the posterior surface of the forearm. The second electrode in this pair will be placed about 6 centimeters below the first electrode and about 3 centimeters from the lateral margin of the posterior surface of the forearm.
 - A fifth electrode, used as the ground, is centered between the positions of the four recording electrodes.
4. Snap the recording lead wires onto the electrodes, so that:
- the red “+1” lead is attached to the electrode on the anterior forearm that is nearest the elbow.
 - the black “-1” lead is attached to the electrode on the anterior forearm closest to the middle of the forearm.
 - the white “+2” lead is attached to the electrode on the posterior forearm that is nearest the elbow.
 - the brown “-2” lead is attached to the electrode on the posterior forearm closest to the middle of the forearm.
 - the green “C” lead (the ground) is attached to the electrode in the center of the box formed by the positions of the four recording electrodes.

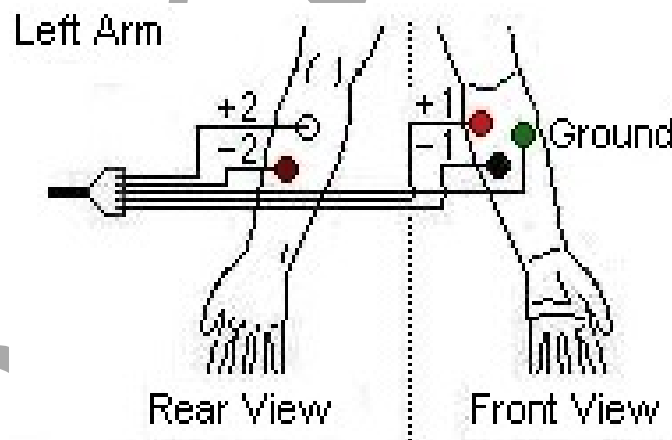


Figure HM-2-S2: Position of electrodes used to record EMG from muscles in the forearm during flexion and extension.

Experiment HM-2: Electromyogram (EMG) Activity in Antagonistic Muscles

Exercise 1: Antagonistic Muscles in Forearm

Aim: To study the EMG activity in muscles that work in opposition to each other to flex or extend the hand.

Approximate Time: 30 minutes

Procedure

1. Instruct the subject that he or she will be doing the following during this exercise:
 - Before the recording begins, the subject extends their arm in front of their body with the palm facing upward. This position is defined as the neutral position.
 - Keep their hand open during the recording.
 - Move their hand upward (flexion) from the neutral position as far as possible and hold it in this position for four seconds.

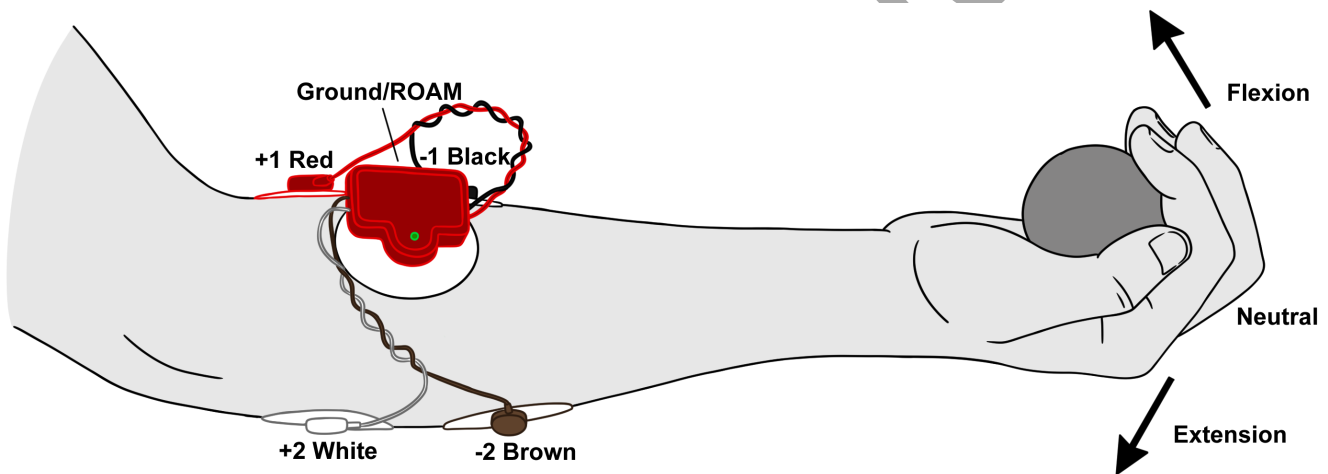


Figure HM-2-L1: Movements performed while recording from muscles of the forearm responsible for flexion and extension of the hand.

- Return the hand to the neutral position for four seconds.
 - Move the hand downward (extension) as far as possible and hold it in this position for four seconds.
 - Return the hand to the neutral position for at least two seconds.
 - Repeat this cycle of flexion and extension two more times while recording.
2. Before starting the recording, type **Neutral** in the Mark box. Instruct the subject to place their hand in the neutral position.
 3. Click Record. Click on the Mark button to label the recording.

- While the subject's hand is in the neutral position, type **Flexion** in the Mark box. When the subject flexes their hand, click on the Mark button.
- While the subject's hand is in the flexed position, type **Neutral** in the Mark box. When the subject returns their hand to the neutral position, click on the Mark button.
- While the subject's hand is in the neutral position, type **Extension** in the Mark box. When the subject extends their hand, click on the Mark button.
- Repeat Steps 2 through 6 two more times.
- Repeat Steps 2 through 6 three times while the subject has formed a fist.
- When the last cycle is completed, click the Stop button.
- Click AutoScale All to amplify the signals. The recording should be similar to the image below.
- Select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

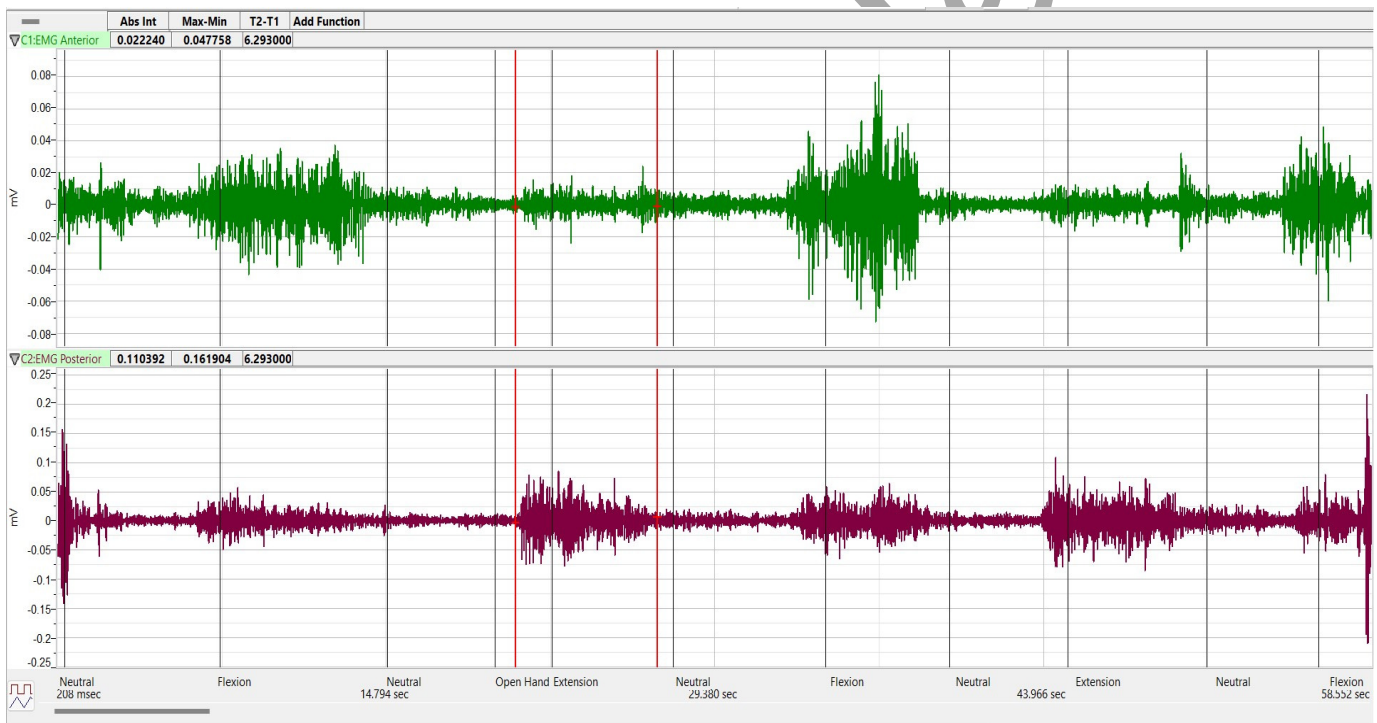


Figure HM-2-L2: Recordings from anterior (top) and posterior (bottom) muscles of the forearm during flexion and extension of the hand while the subject's fingers are extended.

Data Analysis

- Scroll through the recording and find the section of data recorded while the subject was flexing and extending their hand.
- Use the Display Time icons to adjust the Display Time of the Main window so all three flexion-extension cycles appear on the Main window.
- Click on the Analysis window icon in the LabScribe toolbar.

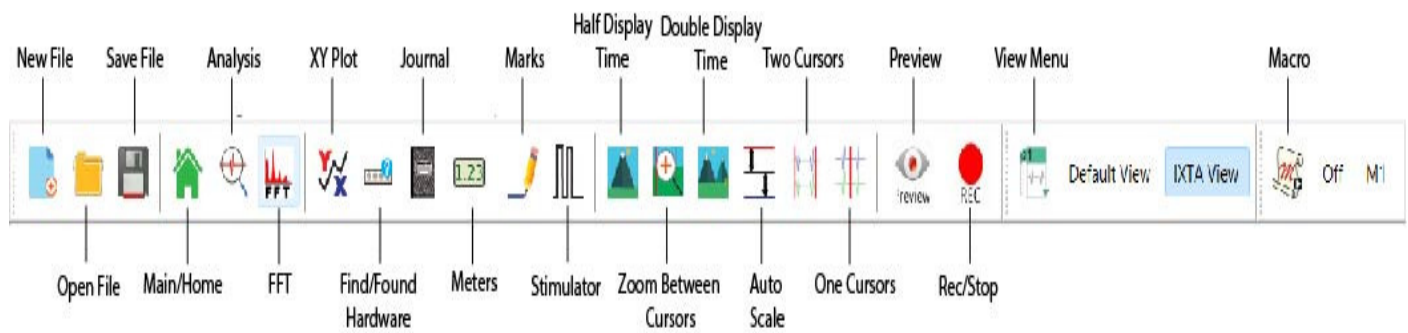


Figure HM-2-L3: The LabScribe toolbar.

- Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions, Abs. Int., Max-Min, and T2-T1 should appear in this table. The values for Abs. Int., Max-Min, and T2-T1 on each channel are seen in the table across the top margin of each channel.

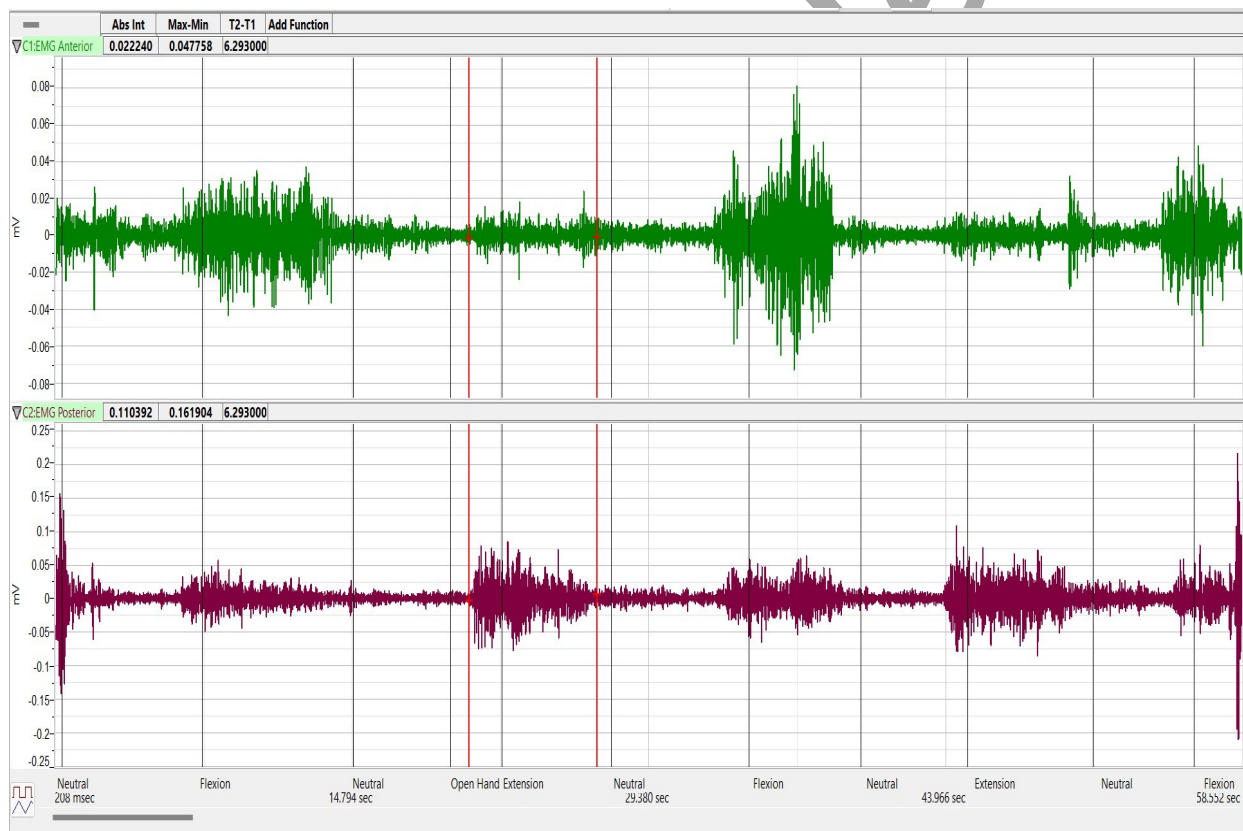


Figure HM-2-L4: EMG activity from opposing muscles. Cursors are placed to measure the EMG activity taking place simultaneously in flexors and extensors.

- Use the mouse to click on and drag the cursors to the onset and offset of the EMG burst during the first flexion. The values for Abs. Int., Max-Min, and T2-T1 on the Anterior channel are the relative amounts of the EMG activity, the differences between maximum and minimum EMG amplitudes, and the durations of the EMG burst in the anterior muscle group during the flexion.

The values for these parameters, listed in the table above the Posterior channel, are the same properties from the posterior muscle group during the same flexion.

6. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters to the Journal. To use these functions:
 - Place the cursors at the locations used to measure the absolute integrals as above.
 - Transfer the name of the mathematical function used to determine the absolute integrals to the Journal using the Add Title to Journal function in the Anterior Channel pull-down menu.
 - Transfer the values for the absolute integrals to the Journal using the Add All Data to Journal function in the Anterior Channel pull-down menu.
7. Once the cursors are placed in the correct positions for measuring an EMG burst, the values can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the Journal, or on a data table.
8. Record the values from each muscle group during the first flexion in the Journal, or on a data table.
9. Use the mouse to move the cursors to onset and offset of the next EMG burst, which is the first burst that occurs during extension. Measure and record the values for Abs. Int., Max-Min, and T2-T1 from both groups of muscles during this extension.
10. Measure the Abs.Int, Max-Min, and T2-T1 for the EMG bursts from the anterior and posterior muscles from the remaining flexions and extensions.
7. Average the values for each parameter taken from the anterior muscles during flexion and extension. Find the averages for the parameters from the posterior muscles during flexion and extension. Enter the averages for each parameter, from each muscle group during flexion and during extension, on Table 1.
8. Select Save from the File menu.

Questions

1. Which muscles, anterior or posterior, had the most EMG activity during flexion?
2. Which muscles, anterior or posterior, had the most EMG activity during extension?
3. Does flexion or extension of the fingers affect the strength of EMG activity in either group of muscles?

Exercise 2: Antagonistic Muscles Doing Work

Aim: To study the EMG activity in muscles that lift weight by flexion or by extension.

Approximate Time: 20 minutes

Procedure

1. Use the same experimental setup used in Exercise 1.
2. Instruct the subject to rest their forearm, with the electrodes, on a flat surface with the palm up.
3. Place a weight (2-3kg) in the palm of the subject's hand. Click Record. Record the EMG activity from the muscles of the forearm as the subject lifts the weight by the flexion. The subject should raise and hold the weight up for four seconds and then return the weight to the table top for four seconds. Repeat this cycle two more times.
4. Click Stop to halt the recording.

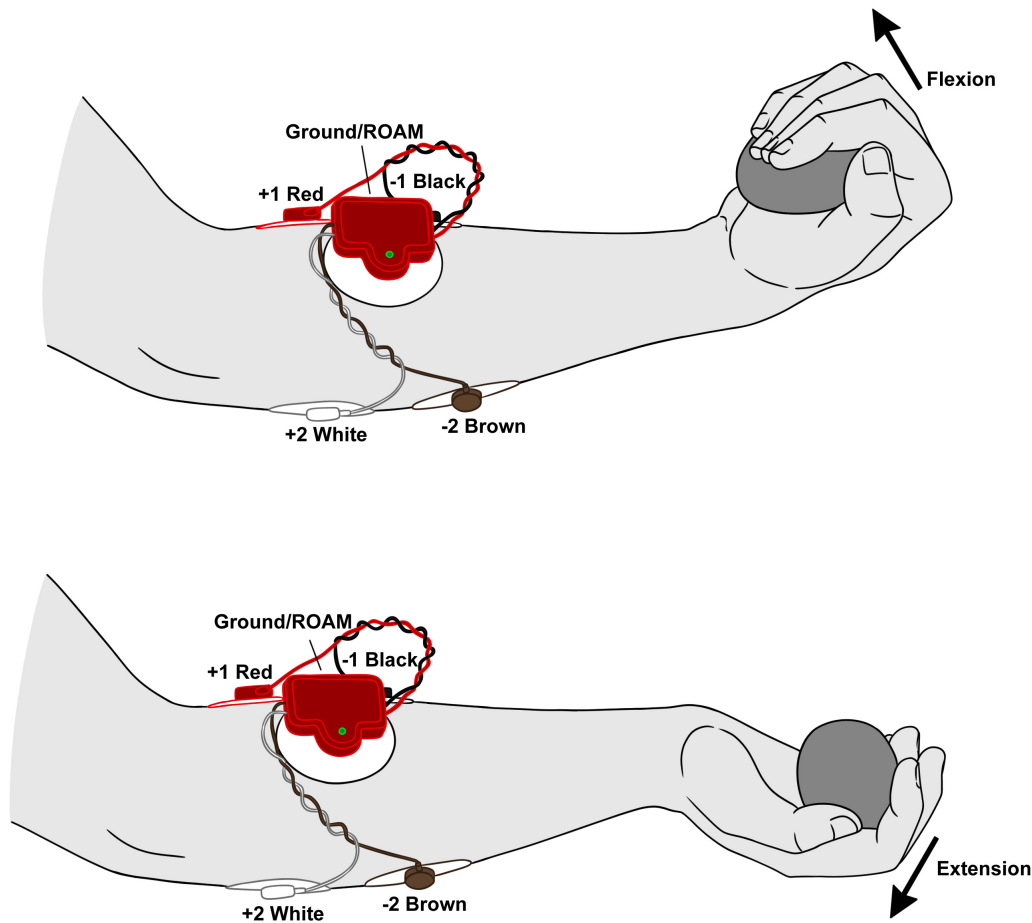


Figure HM-2-L5: Hand in the palm-up position for lifting the weight by flexion (top), and the hand in the palm-down position for lifting the weight by extension (bottom).

5. Instruct the subject to rest their forearm on a flat surface with the palm down.
6. Have the subject grip the same weight (2-3kg).
7. Click Record. Record the EMG activity from the muscles of the forearm as the subject lifts the weight by extension. The subject should raise and hold the weight up for four seconds and then return the weight to the table top for four seconds. Repeat this cycle two more times.
8. Click Stop to halt the recording.

9. Select Save in the File menu.

Data Analysis

1. Scroll through the recording and find the section of data recorded while the subject was lifting a weight by flexion and extension.
2. Use the same procedures used in Exercise 1 to measure and record the Abs. Int., Max-Min, and T2-T1 from each muscle group while the weight was lifted by flexion and by extension.
3. Average the values for each parameter taken from the anterior muscles during flexion and extension with weight. Find the averages for the parameters from the posterior muscles during flexion and extension with weight. Enter the means for each parameter, from each muscle group during flexion and during extension, on Table 1.
4. Select Save from the File menu.

Questions

1. Does the strength of the EMG activity in the muscles of the anterior forearm differ between flexion with a weight and without a weight?
2. Does the strength of the EMG activity in the muscles of the posterior forearm differ between extension with a weight and without a weight?.

Table HM-2-L1: Relative EMG Activity in the Muscles of the Forearm during Flexion and Extension.

Forearm Action	Averages from Anterior Muscles			Averages from Posterior Muscles		
	Abs.Int.	V2-V1 (V)	T2-T1 (sec)	Abs.Int.	V2-V1 (V)	T2-T1 (sec)
Flexion, Hand Open						
Extension, Hand Open						
Flexion, Hand Closed						
Extension, Hand Closed						
Flexion, Lifting Weight						
Extension, Lifting Weight						

Exercise 3: Antagonistic Muscles in Lower Leg

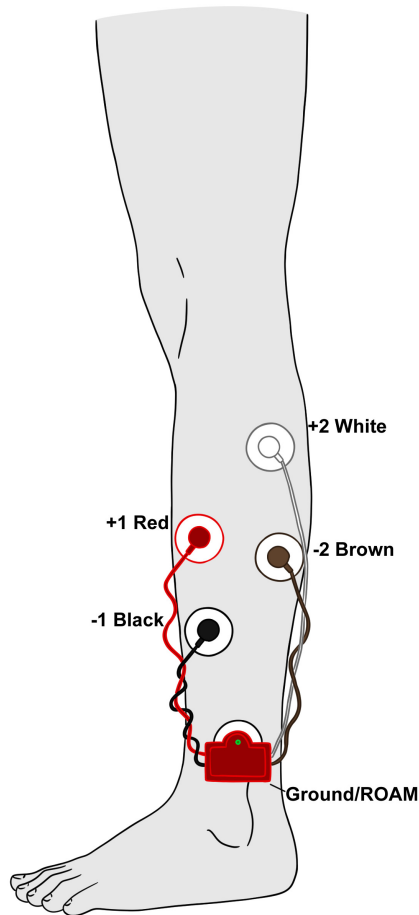
Aim: To study muscles working in opposition to each other to maintain balance while standing.

Approximate Time: 60 minutes

Procedure

1. Locate the muscles of the lower leg over which the recording electrodes will be attached. Muscles can be located by performing dorsiflexion (lifting the toes towards the shin), or plantar flexion (pointing the toes toward the ground), and noting the areas of the lower leg where the muscles are tense during each flexion:
 - One pair of recording electrodes will be placed over the anterior tibialis muscle. This muscle is located just lateral to the tibia (shinbone) in the upper part of the calf. To locate the tibialis anterior, feel for the subject's tibia. Place your fingers 2 cm to the lateral side of the margin of the tibia and 8-12 cm below the kneecap. As the subject points their foot inward (supination) and upward (dorsiflexion), you should be able to see and feel the contraction of the anterior tibialis muscle beneath the skin. The first electrode in this pair will be placed about 10 centimeters below the knee on the midline of the muscle. The second electrode in this pair will be placed on the midline of the muscle, about 10 centimeters below the first electrode.
 - A second pair of recording electrodes will be placed over the gastrocnemius (calf) muscle on the back of the lower leg. The first electrode in this pair will be placed about 8 centimeters below the back of the knee, along the midline of the calf muscle. The second electrode in this pair will be placed in the middle of the calf muscle along its midline, about 10 centimeters below the first electrode.
 - A fifth electrode, used as the ground, is placed on the inside of the lower leg just above the ankle.
2. Snap the recording lead wires onto the electrodes, so that:
 - the red “+1” lead is placed on the electrode in the upper portion of the tibialis anterior.
 - the black “-1” lead is placed on the electrode in the middle portion of the tibialis anterior.
 - the white “+2” lead is attached to the electrode near the back of the knee.
 - the brown “-2” lead is attached to the electrode in the middle of the calf muscle.
 - the green “C” lead (the ground) is attached to the electrode above the ankle.
4. While the subject is sitting, click Record. Have the subject alternate between plantar flexion and dorsiflexion of their foot. Click AutoScale on all channels to amplify signals. Use the techniques explained in Exercise 1 to mark the recording with plantar flexion and dorsiflexion. Click Stop when finished.
5. Have the subject stand erect. Click Record. Have the subject rock on their feet from heels to toes and back to heels, 4 times. Mark the recording with comments that identify the EMG activity that took place.

6. Continue recording and have the subject rock backward and forward, 4 times, while putting more weight on the leg with the electrodes. Mark the recording with comments that identify the EMG activity that took place.



7. Continue recording while the subject stands on one foot and remain motionless. Co-contraction of the antagonistic muscles mechanically stabilizes the joints when the subject is motionless. The stretch reflexes prevent twisting and slipping to help to maintain balance. Mark the recording with comments that identify the EMG activity that took place. Click Stop when finished.

Figure HM-2-L6: Position of electrodes used to record EMG from muscles in the lower leg during plantar flexion and dorsiflexion.

8. Joint stabilization is particularly important to leg and postural muscles involved in bipedal locomotion. Within the limits of artifacts induced by leg movement and cable lengths, explore the activity of the ankle flexors.
 - Click Record.
 - Have the subject either squat or stretch upward on their toes. Mark the recording with comments that identify the EMG activity that took place. Click Stop to halt recording.
9. Select Save in the File menu.

Data Analysis

1. Scroll to the data where EMG activity was recorded from the muscles of the anterior and posterior lower leg.
2. Use the same procedures used in Exercise 1 to measure and record the absolute integral, difference in amplitudes, and durations of the EMG bursts from the anterior and posterior muscles of the lower leg while the subject moved their legs and body in different positions:
 - Sitting dorsiflexion/neutral/flexion of feet
 - Standing erect on both legs;
 - Rocking back and forth on both legs;
 - Rocking back and forth on the leg with the electrodes;
 - Standing erect on the leg with the electrodes;
 - Ankle flexing by squatting or standing on the toes.
3. Enter the means for each parameter, from each muscle group during the various motions, on Table 2.

Questions

1. Compare the parameters for the EMG bursts from the tibialis anterior during each of the activities. When was tibialis anterior activity the greatest? The least?
2. Compare the parameters for the EMG bursts from the gastrocnemius during each of the activities. When was gastrocnemius activity the greatest? The least?
3. How does EMG activity in the gastrocnemius correlate to EMG activity in the tibialis anterior?

Table HM-2-L2: Relative EMG Activity in the Muscles of the Lower Leg during Changes in Posture.

Leg Activity	Averages from Anterior Tibialis			Averages from Gastrocnemius		
	Abs.Int.	V2-V1 (V)	T2-T1 (sec)	Abs.Int.	V2-V1 (V)	T2-T1 (sec)
Standing Erect, Both Legs						
Rocking Forward, Both Legs						
Rocking Backward, Both Legs						
Rocking Forward, One Leg						

Rocking Backward, One Leg						
Standing Erect, One Leg						
Ankle Flex, Squat						
Ankle Flex, Standing on Toes						