Vital lab worksheet #06

Electromyography

Mahdi Reza Heidari Dastjerdi 810100273 idhamazer200281@gmail.com
Mohammad Amin Kolahdoozan 810100257 m.aminkolah10@gmail.com

Analysis:

Exercise 1: Voluntary change in contractile force

1. Scroll through the recorded data and note the changes in activity in the raw biceps channel (Biceps). Note also that placing weights on the hand gives rise to little or no activity in the triceps muscle. Select a small part of the "Biceps" activity and examine it in the Zoom View. The raw EMG signal is composed of many up and down spikes.
2. Note the relationship between the raw trace (Biceps) and integrated trace (Int. Biceps). The height of the integrated trace reflects the overall activity of the raw EMG signal, and gives a simpler view of the muscle's electrical activity.
3. Measure the amplitude of the integrated trace as weights were added and removed by using the Marker and Waveform cursor. The height of the trace correlates with the force produced by the muscle. Record these results in Table 1 of the Data Notebook.

Exercise 2: Alternating activity and coactivation

1. Scroll through the recorded data and observe the EMG traces for both the biceps and triceps. Note the large-scale alternation of activity in the biceps and triceps.
2. Note that when the biceps muscle is activated forcefully, there is a minor increase of activity in the triceps. Correspondingly, there is a minor increase of activity in the biceps trace when the triceps is activated. This phenomenon is called "coactivation". Its physiological meaning is not well understood, although it perhaps serves to stabilize the elbow joint.
3. Use the **Marker** and **Waveform Cursor** to measure and record the EMG peaks during coactivation for biceps and triceps in Table 2 of the Data Notebook.

Exercise 3: Evoked EMG

1. Use the scroll bar at the bottom of the Chart View window to review data blocks recorded with stimulation at the wrist.
2. Drag over a suitable waveform to **select** it, then choose **Zoom View** from the Windows menu or click the Zoom View button in the Tool bar. The waveforms should look something like those in Figure 7.
3. In the **Zoom View**, measure the latency of a single waveform in the data display area (the size of the waveform is of no consequence). The latency is the time elapsed from the start of the stimulus pulse — the start of each block of data — to the start of the evoked response. Place the Waveform Cursor at the point where the response begins. The latency value can then be read directly from the time display at the top of the Zoom View. Record the latency value in Table 3 of the Data Notebook.

Exercise 4: Nerve Conduction Velocity

An estimate of the nerve conduction velocity is obtained from the extra time required for the nerve impulse to reach the muscle, when stimulation is at the elbow, as compared to the wrist.

1. Measure and record the distance between the marks at the elbow and at the wrist. This is the distance between stimulation sites.
2. Drag in the Chart View to **select** a waveform and then choose **Zoom View** from the Window menu. In the Zoom View, use the same steps as outlined for wrist stimulation to measure the latency of a single waveform. Record the latency value in Table 3 of the Data Notebook.
3. Using the conduction velocity equation given below, calculate the nerve conduction velocity of the subject:

$$Velocity = \frac{Distance\ between\ stimulation\ sites\ (mm)}{Difference\ between\ latencies(ms)}$$

The units of velocity are mm/ms or, equivalently, m/s. Record the calculation in Table 4 of the Data Notebook

Table 1. Effects of weight resistance on EMG amplitude.

Amin

Weight	Biceps EMG amplitude (mV)	Triceps EMG amplitude (mV)
1 kg	0.01	0.00
3 kg	0.03	0.00
5 kg	0.05	0.01

Mahdi

Weight	Biceps EMG amplitude (mV)	Triceps EMG amplitude (mV)
1 kg	0.01	0.01
3 kg	0.02	0.01
5 kg	0.04	0.02

Table 2. Coactivation between biceps and triceps.

Amin

Active muscle	EMG amplitude in “active” muscle (mV)	EMG amplitude in opposite muscle (mV)
Biceps	0.06	0.01
Triceps	0.04	0.01

Mahdi

Active muscle	EMG amplitude in “active” muscle (mV)	EMG amplitude in opposite muscle (mV)
Biceps	0.04	0.01
Triceps	0.02	0.01

Table 3. Stimulus latencies at different stimulation sites.

Amin

Stimulus location	Latency (ms)
Wrist	190
Elbow	205

Mahdi

Stimulus location	Latency (ms)
Wrist	195
Elbow	207

Table 4. Determination of nerve conduction velocity.

Amin

Latency difference (ms)	Distance between stimulus points (mm)	Nerve conduction velocity (m/sec)
15	90	6

Mahdi

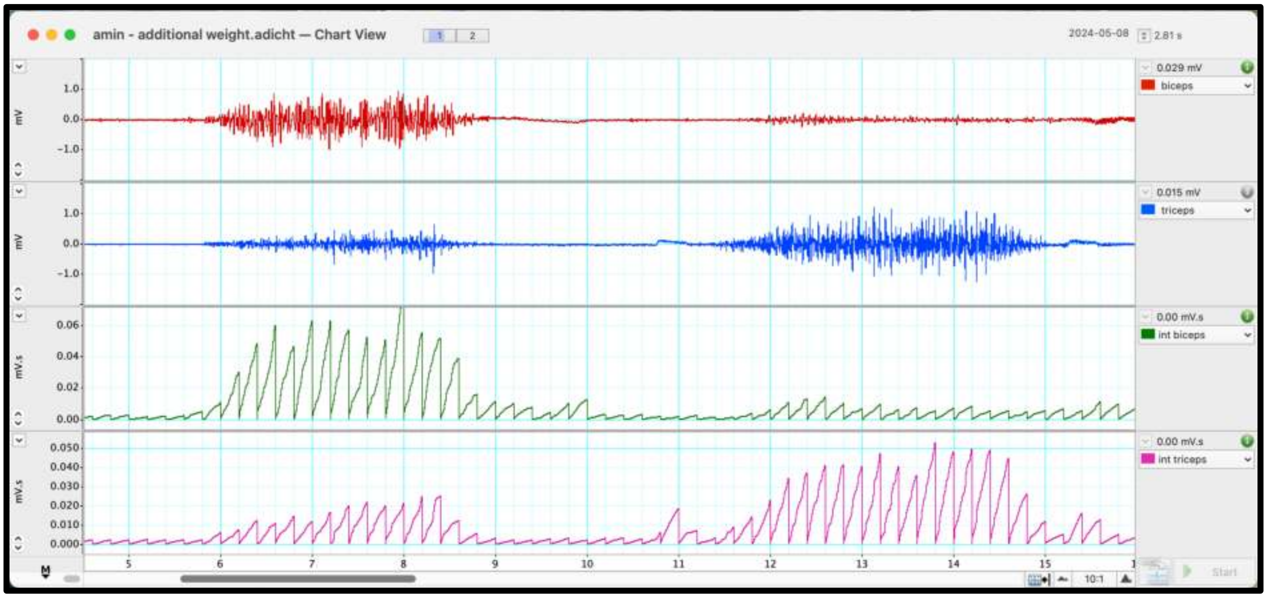
Latency difference (ms)	Distance between stimulus points (mm)	Nerve conduction velocity (m/sec)
12	200	16.66

Results:

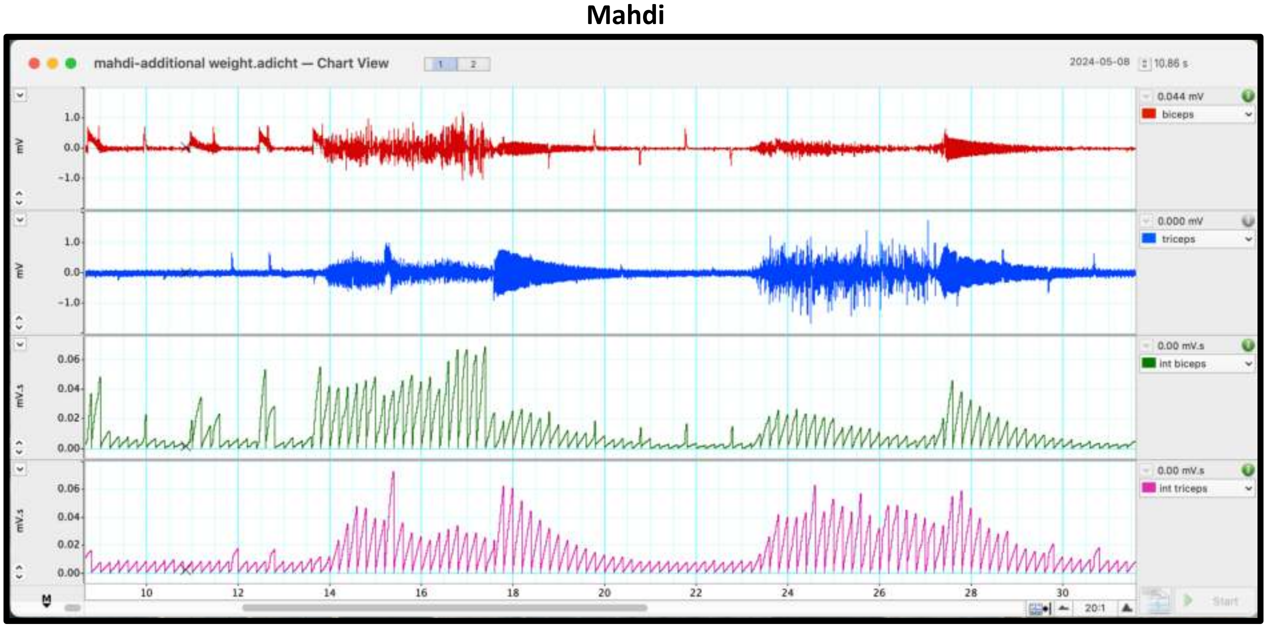
Exercise 1: Voluntary change in contractile force

Place a copy of the Zoom window showing the raw EMG and integrated trace from your biceps muscle. Explain your observation.

` Amin



Mahdi

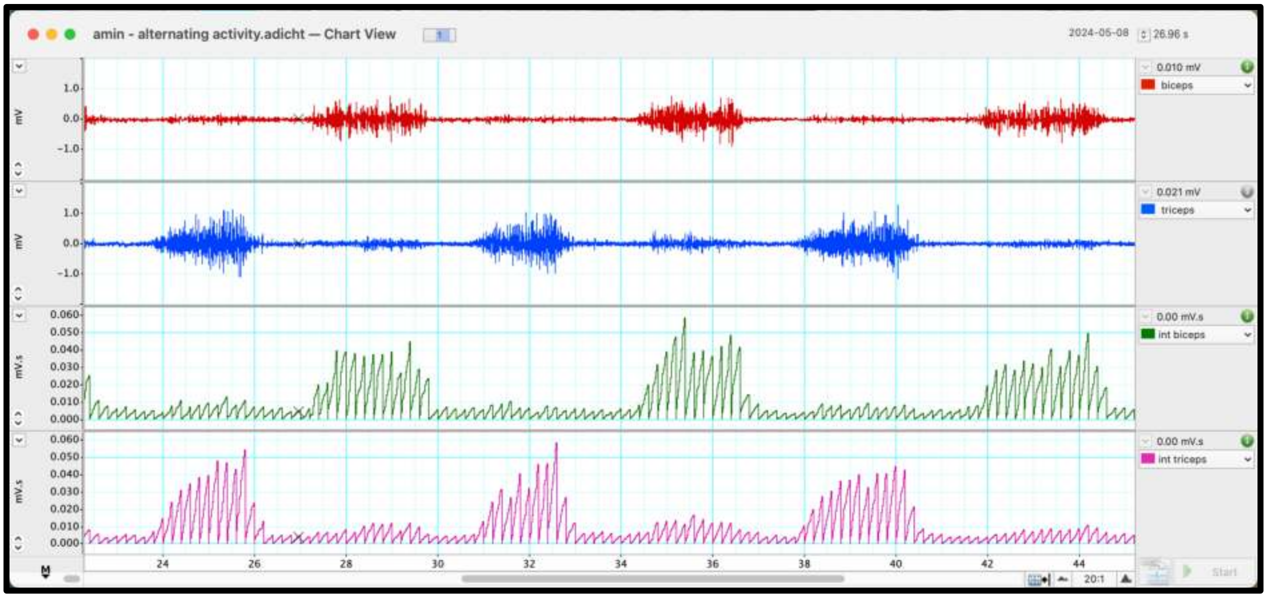


As shown in figures when performing a maximum contraction on each muscle the opposite muscle will contract a little bit as well.

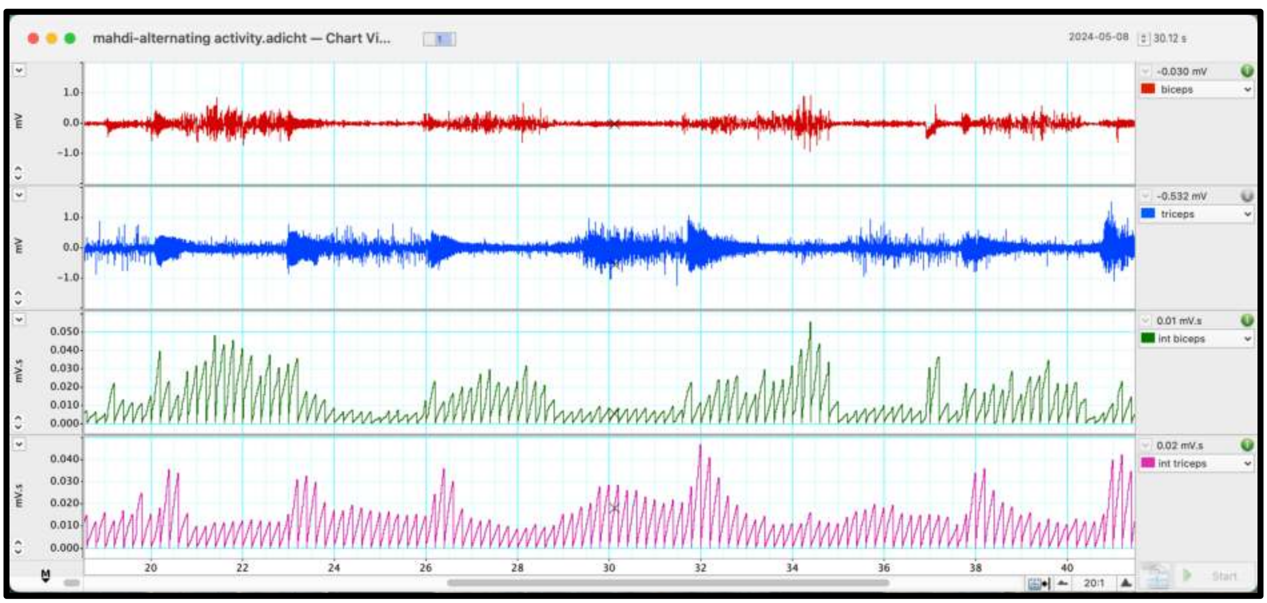
Exercise 2: Alternating activity and coactivation

Place a copy of the Zoom window showing the integrated traces from the biceps and triceps during coactivation. Explain your observation.

Amin



Mahdi

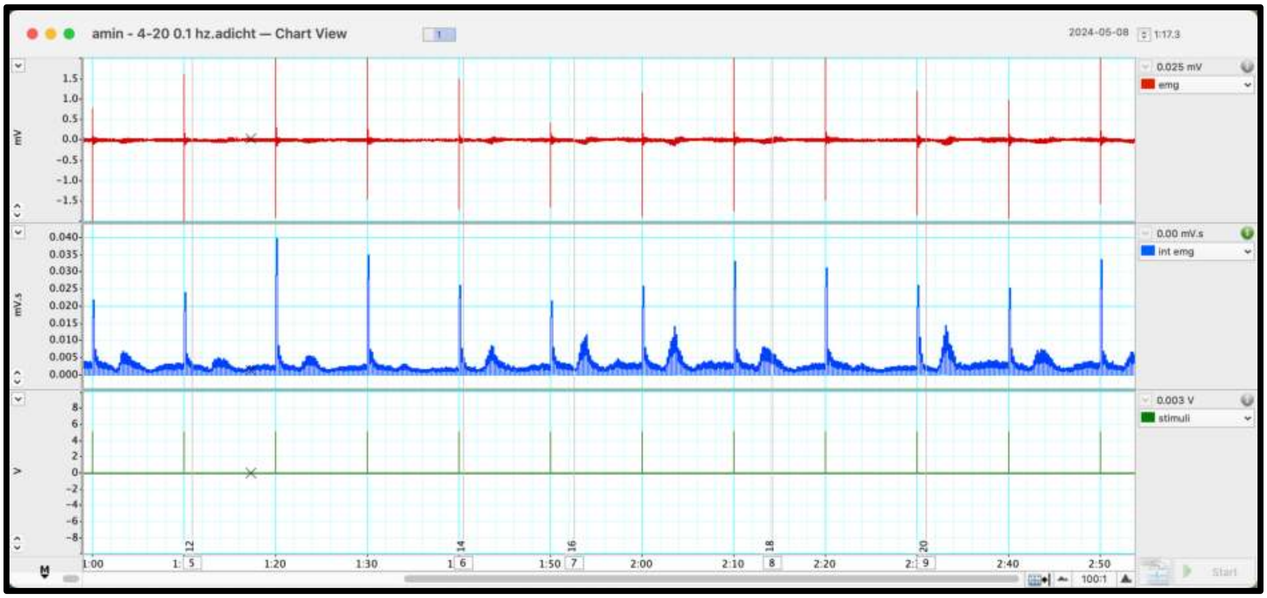


As explained in the previous question while contracting the biceps, the triceps muscle will contract a little as well.
The same is applied for the triceps.

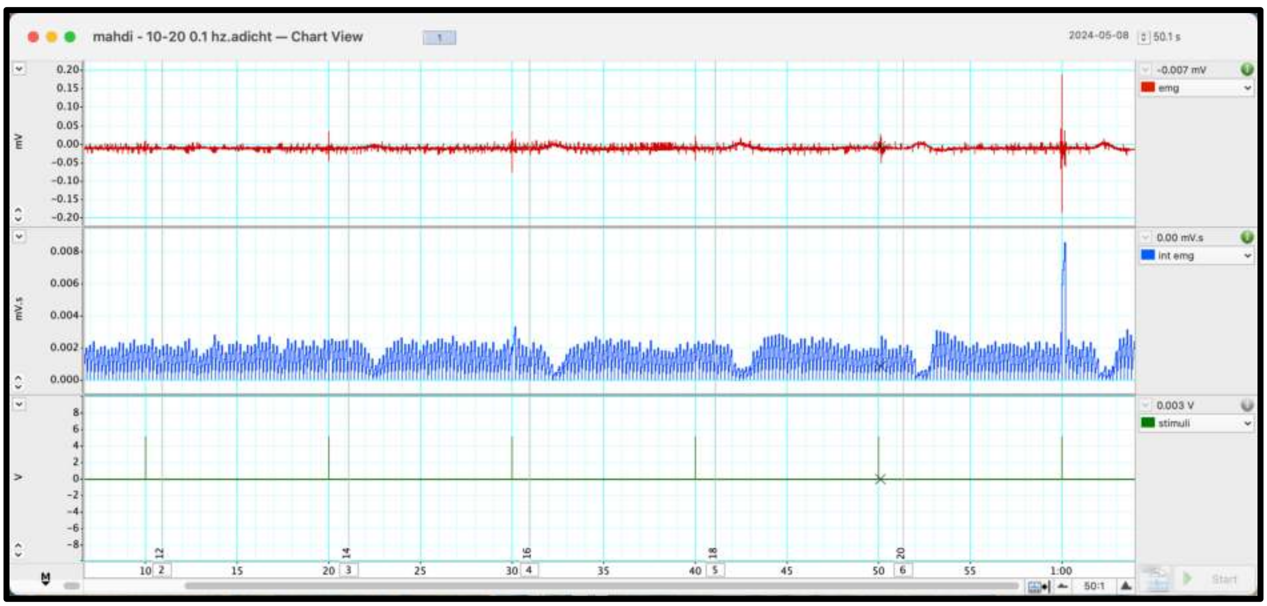
Exercise 3: Evoked EMG activity

Place a copy of the Zoom window showing a representative trace of an evoked EMG from the abductor pollicisbrevis muscle. Indicate on the trace the stimulus artifact, latent period, and start of response. Explain your observation.

Amin



Mahdi



As shown in the figures is it much easier to read and calculate the latency from the integrated signal. Note that the signals that were generated by the second volunteer was not as clean as the first one, this was because of the misplacement of the stimulator.

Exercise 4: Nerve conduction velocity

Fill in the table below. Note: for the last column, you will have to convert your units to meters per second.

Amin

Distance between stimulation sites (mm)	Time difference between latencies (ms)	Nerve conduction velocity (mm/ms)	Nerve conduction velocity(m/sec)
90	15	6	6

Mahdi

Distance between stimulation sites (mm)	Time difference between latencies (ms)	Nerve conduction velocity (mm/ms)	Nerve conduction velocity(m/sec)
200	12	16.66	16.66

- Note: the latency itself should be in order of 2.5 – 3.5 ms and the nerve conduction velocity should be around 60 – 70 meters per second.
  Our deduction for the mismatch in our results compared to the theoretical result is the displacement of the stimulator on the median nerve.

Conclusions:

1. Unlike the discrete waveform from an electrocardiogram, the electromyogram waveform is irregular. Why do you suppose this is?

The irregularity of the electromyogram waveform compared to the discrete waveform of an electrocardiogram stems from several differences:

1. **Muscle vs. Heart Activity**: EMG measures skeletal muscle activity, which involves voluntary, asynchronous contractions of numerous muscle fibers, leading to a complex and irregular waveform. In contrast, ECG measures the heart's electrical activity, which is highly coordinated and rhythmic, producing a consistent and discrete waveform.
2. **Synchronization**: The heart's contractions are synchronized by its conduction system, resulting in regular electrical patterns. Skeletal muscles lack this synchronization, as different motor units are activated at different times.

2. How did the EMG trace change when you added weights to your arm? What do your results indicate?

After adding additional weight, the EMG trace of the biceps increased in voltage, after adding more weights the EMG trace of the triceps also increased. but as shown in figure the increase of the amplitude in the biceps was greater than the triceps.

3. Describe co-activation. Why do you think this phenomenon occurs?

Co-activation is the simultaneous activation of agonist and antagonist muscles around a joint. it occurs to Enhance joint stability and Improve control and precision of movements. Causes of Co-activation are Neurological control by the central nervous system, Proprioceptive feedback from muscles and joints, Muscle fatigue, leading to compensatory activation of additional muscles.

4. Describe the meaning of the latent period in your trace from evoked EMG activity. Did latency change with increasing stimulus amplitude?

The latent period in the context of an evoked EMG trace refers to the time interval between the application of a stimulus. This period encompasses the time it takes for the electrical stimulus to travel along the nerve, reach the neuromuscular junction, cause the release of neurotransmitters, and finally result in muscle fiber depolarization leading to contraction.
By increasing the amplitude the latency didn't change noticeably.

5. Based on your results and calculations for nerve conduction velocity, how long would it take for a nerve impulse to travel from the spinal cord to the big toe? Assume that the distance traveled is one meter.

From our calculation it will take about 0.16 to 0.0620 second for a nerve impulse to travel from the spinal cord to the big toe. In theoretical methods the calculation should result in 0.017 seconds for a nerve impulse to travel from the spinal cord to the big toe.