Vital lab worksheet #04

Muscle stimulus

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Analysis:

Exercise 2: Twitch response and recruitment

1. Use the Waveform Cursor to measure the amplitude of each peak: place it over the peak and read off the force in the Range/Amplitude display above the channel title.
2. Refer to the comments in the Chart View to determine the current applied to produce each response.
3. Write down the data in Table 1 of the Data Notebook. Graph the relationship between stimulus current and response size. Note the stimulus intensity at which the maximal response first appears.

Exercise 3: Summation and tetanus

1. Calculate the stimulus interval in seconds for each stimulation frequency. Enter the data in Table2 of the Data Notebook.

2. Using the Marker and Waveform Cursor, measure the amplitude of the first two responses at each stimulus interval. Enter these results in Table 2 of the Data Notebook.

3. Examine the tetanic response. Calculate the stimulation interval in seconds and enter the value in Table 3 of the Data Notebook.

4. Drag across the tetanic response to select it, and examine the selected data in the Zoom window. Determine the maximum force amplitude using the Marker and Waveform Cursor and enter these results in Table 3 of the Data Notebook.

5. If the tetanus experiment with four pulses was repeated, repeat the analysis and add it to Table3.Otherwise, leave the second line blank in Table 3.

Table 1. The effects of varying stimulus strength on twitch force.

Amin

Stimulus	Response	Stimulus	Response	Stimulus	Response
0.0 mA	0 V	**7.0 mA**	0 V	**14.0 mA**	0 V
0.5 mA	0 V	**7.5 mA**	0 V	**14.5 mA**	0 V
1.0 mA	0 V	**8.0 mA**	0 V	**15.0 mA**	0 V
1.5 mA	0 V	**8.5 mA**	0 V	**15.5 mA**	0.008 V
2.0 mA	0 V	**9.0 mA**	0 V	**16.0 mA**	0.013 V
2.5 mA	0 V	**9.5 mA**	0 V	**16.5 mA**	0.024 V
3.0 mA	0 V	**10.0 mA**	0 V	**17.0 mA**	0.033 V
3.5 mA	0 V	**10.5 mA**	0 V	**17.5 mA**	0.057 V
4.0 mA	0 V	**11.0 mA**	0 V	**18.0 mA**	0.087 V
4.5 mA	0 V	**11.5 mA**	0 V	**18.5 mA**	0.103 V
5.0 mA	0 V	**12.0 mA**	0 V	**19.0 mA**	0.115 V
5.5 mA	0 V	**12.5 mA**	0 V	**19.5 mA**	0.132 V
6.0 mA	0 V	**13.0 mA**	0 V	**20.0 mA**	0.164 V
6.5 mA	0 V	**13.5 mA**	0 V		

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Stimulus	Response	Stimulus	Response	Stimulus	Response
0.0 mA	0 V	**7.0 mA**	0 V	**14.0 mA**	0 V
0.5 mA	0 V	**7.5 mA**	0 V	**14.5 mA**	0 V
1.0 mA	0 V	**8.0 mA**	0 V	**15.0 mA**	0.013 V
1.5 mA	0 V	**8.5 mA**	0 V	**15.5 mA**	0.037 V
2.0 mA	0 V	**9.0 mA**	0 V	**16.0 mA**	0.050 V
2.5 mA	0 V	**9.5 mA**	0 V	**16.5 mA**	0.085 V
3.0 mA	0 V	**10.0 mA**	0 V	**17.0 mA**	0.113 V
3.5 mA	0 V	**10.5 mA**	0 V	**17.5 mA**	0.149 V
4.0 mA	0 V	**11.0 mA**	0 V	**18.0 mA**	0.185 V
4.5 mA	0 V	**11.5 mA**	0 V	**18.5 mA**	0.214 V
5.0 mA	0 V	**12.0 mA**	0 V	**19.0 mA**	0.229 V
5.5 mA	0 V	**12.5 mA**	0 V	**19.5 mA**	0.259 V
6.0 mA	0 V	**13.0 mA**	0 V	**20.0 mA**	0.289 V
6.5 mA	0 V	**13.5 mA**	0 V		

Table 2. Results for summation experiment in Exercise 3.

Amin

Stimulus frequency (Hz)	Stimulus interval(sec)	Amplitude of first response(mV)	Amplitude of second response(mV)
1	1	0.229 V	0.098 V
2	0.5	0.125 V	0.068 V
5	0.2	0.156 V	0.060 V
10	0.1	0.164 V	0.047 V
20	0.05	0.211 V	0.056 V

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Stimulus frequency (Hz)	Stimulus interval(sec)	Amplitude of first response(mV)	Amplitude of second response(mV)
1	1	0.533 V	1.458 V
2	0.5	0.350 V	0.577 V
5	0.2	0.585 V	2.535 V
10	0.1	2.792 V	0.382 V
20	0.05	1.937 V	0.323 V

Table 3. Results from the tetanus experiment in Exercise 3.

Amin

Stimulus frequency (Hz)	Stimulus interval (sec)	Number of pulses	Amplitude of response (mV)
20	0.05	**3**	0.156 V
20	0.05	**4**	0.178 V

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Stimulus frequency (Hz)	Stimulus interval (sec)	Number of pulses	Amplitude of response (mV)
20	0.05	**3**	3.565 V
20	0.05	**4**	-

Results:

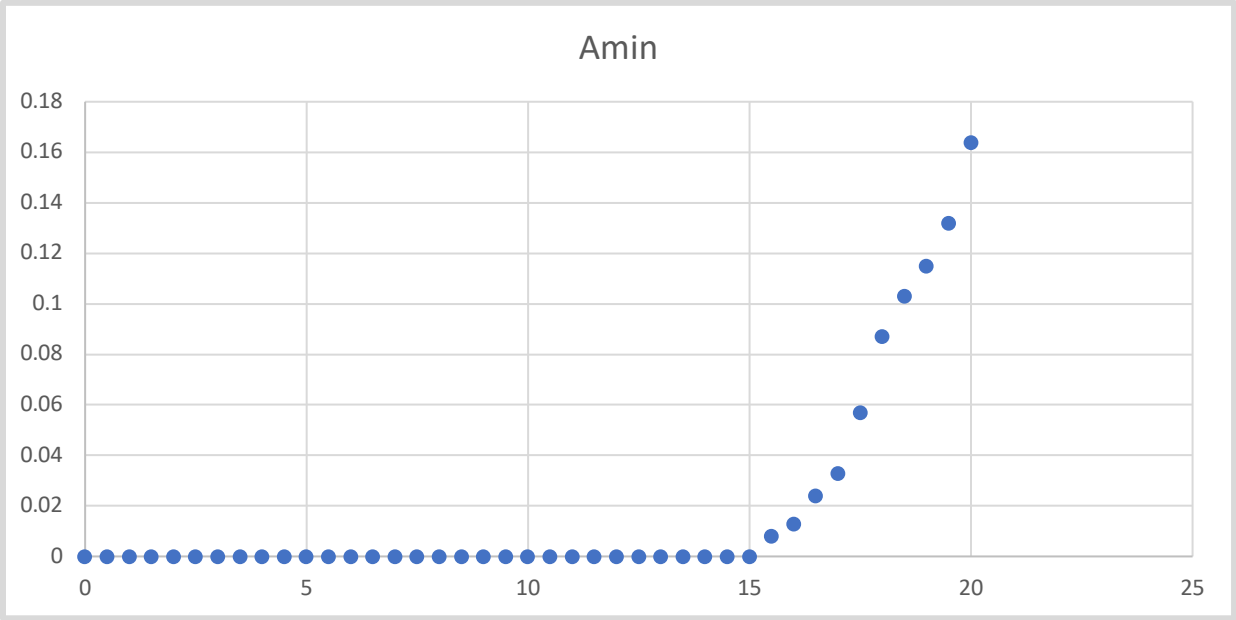
Exercise 1: The effects of nerve stimulation

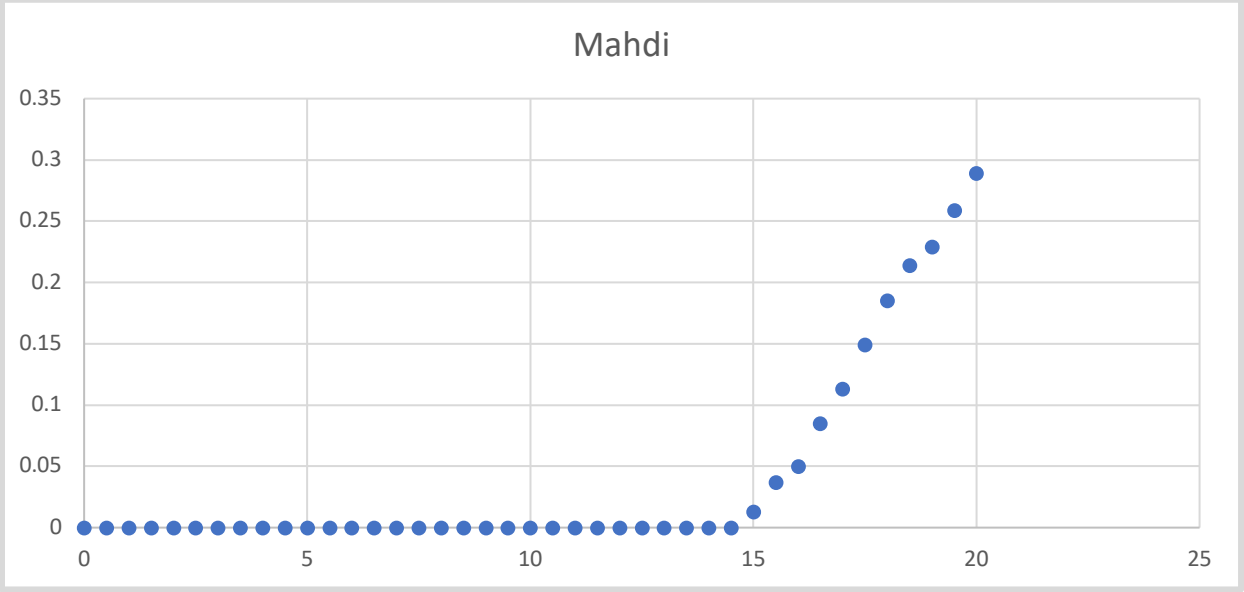
Describe your observations and sensations experienced when the ulnar nerve was stimulated.

Initially, until the current was below 8 mA, no response was received. But from 8 to 15 mA, the little finger twitched, and above 15 milliamperes, the thumb twitched. The purpose of the experiment was to measure the threshold and response of the thumb to the stimulation.

Exercise 2: Twitch response and recruitment

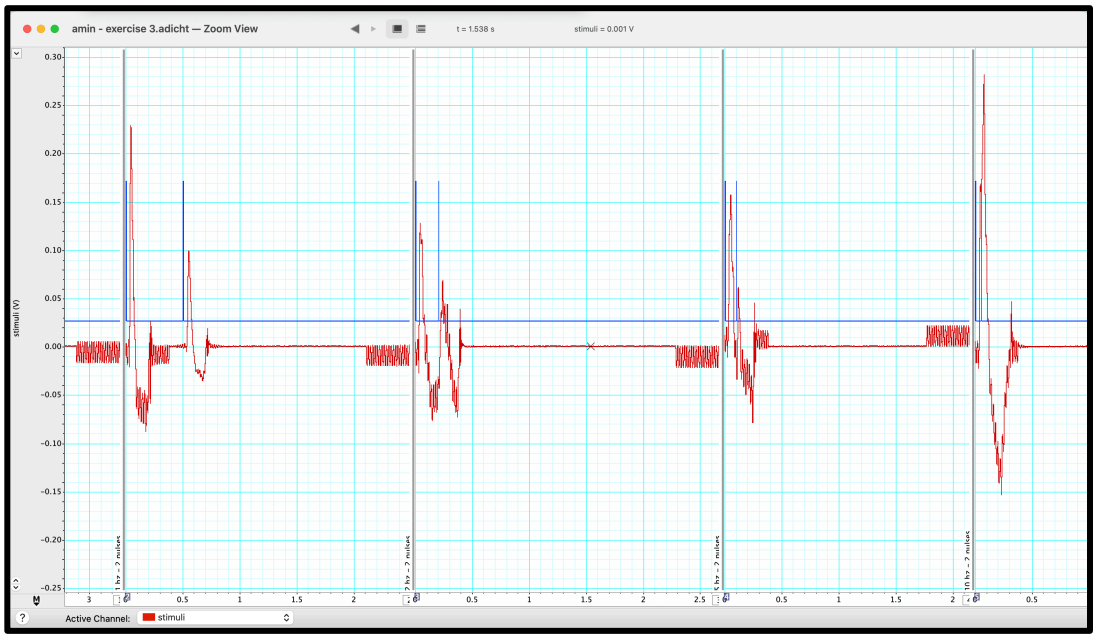
Draw a scatter plot graph of stimulus intensity (mA) versus twitch response (mV). Use the data from Table 6-1.





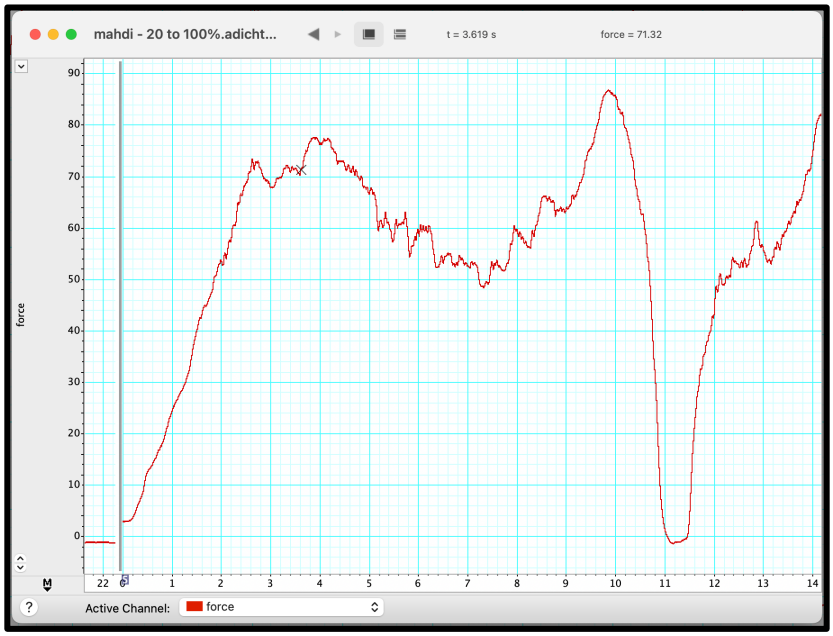
Exercise 3: Summation and tetanus

Attach a copy of the Zoom window showing a tetanic response.



Exercise 5: Muscle fatigue

Attach a copy of the Zoom window showing muscle fatigue using the hand dynamometer.



As shown in figure the volunteer was meant to apply 80% of their power but because of muscle fatigue they couldn't hold it at 80 %.

Conclusions:

1. What was the smallest current required to produce a contraction (the threshold current)? What proportion of the fibers in the muscle do you think were contracting to produce this small response? What was the smallest current required for a measurable muscle contraction?

The threshold to stimulate the medial nerve was 8 mA. (contraction of little finger.) but to overstimulate to medial nerve to stimulate the ulnar nerve the current was pushed up to 15 mA. (for the contraction of thumb.) Although there is a small difference for each person in the current required for a measurable muscle contraction.
Muscle fibers are organized into motor units, which consist of a motor neuron and the muscle fibers it innervates. When a motor neuron fires, all the muscle fibers within its motor unit contract. The size of a motor unit can vary, with smaller motor units being recruited first for fine control tasks and larger motor units recruited as more force is required. In the case of a small response to ulnar nerve stimulation, it suggests that only a small subset of motor units, or a small proportion of the muscle fibers innervated by the ulnar nerve, are being activated. In our case, the proportion of fibers (for ulnar nerve) are the lowest and become more as we increase the amplitude of current applied to the nerve.

2. What was the smallest current required to produce the maximum (largest) contraction? What proportion of the fibers in the muscle do you think were contracting to produce this maximal response?

the smallest current required to produce the maximum contraction was about 19 - 20 mA. By increasing the current more than a range the nerve becomes over stimulated and the proportion of fibers won't grow any larger.

3. What happened to the twitch force at the highest currents? Was the increase in contraction force linear? If not, how can you explain your result in terms of muscle physiology?

As shown in the scatter plot graph the increase in contraction force was not linear, at first there is a threshold to be reached for the finger to twitch, secondly due to limitation of the device applying current, the saturation region could not be found.

4. What was the stimulus interval required to cause tetanus?

As shown in table 2 and the figure around 10 – 20 Hz frequency we start to see tetanus.

5. How long did it take for your hand muscles to fatigue? Explain one mechanism that could cause muscle fatigue.

The time it takes for hand muscles to fatigue can vary depending on factors such as the intensity and duration of the activity, etc.
But for the volunteers of the class after a few exercises they start to feel muscle fatigue. One mechanism that could cause muscle fatigue is the depletion of energy substrates, particularly ATP, within the muscle cells. ATP is the primary energy source for muscle contraction. During sustained activity, ATP is continuously broken down into ADP and inorganic phosphate (Pi) to fuel muscle contraction. As ATP levels decline, the rate of muscle contraction may decrease, leading to fatigue. The other important

factor in the overstimulation of motor nerve. If the amount of neural activity becomes higher than a limit, the motor nerve can not reply to all incoming stimulations so the tetanus occures.

6. Did the time to reach muscle fatigue differ between the members of your group? Explain why different people may have different rates of muscle fatigue.

Yes it was different, and it can be due to few reasons, the proportion of muscle fiber types, they could be slow-twitch or fast-twitch, the faster the twitch the more the fatigue. Other reasons could be genetic reasons or fitness level of the volunteer or the amount electrolytes in the volunteers body. The psychological effects are also a reason for different rates of fatigue. For example the motivation or pain tolerance are important factors.