Movement Neuroscience

Exercise 2 :

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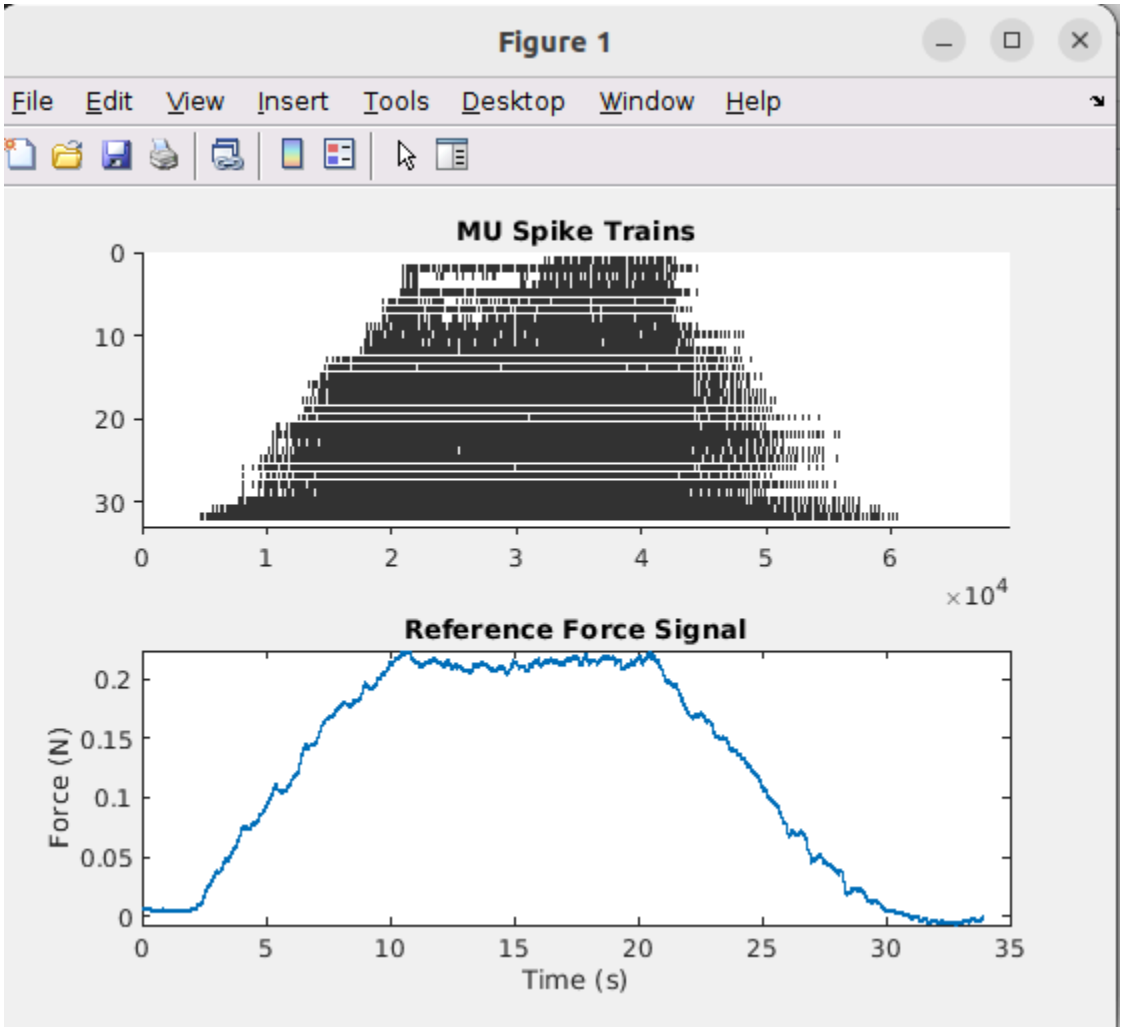
Task 1: Spike Trains

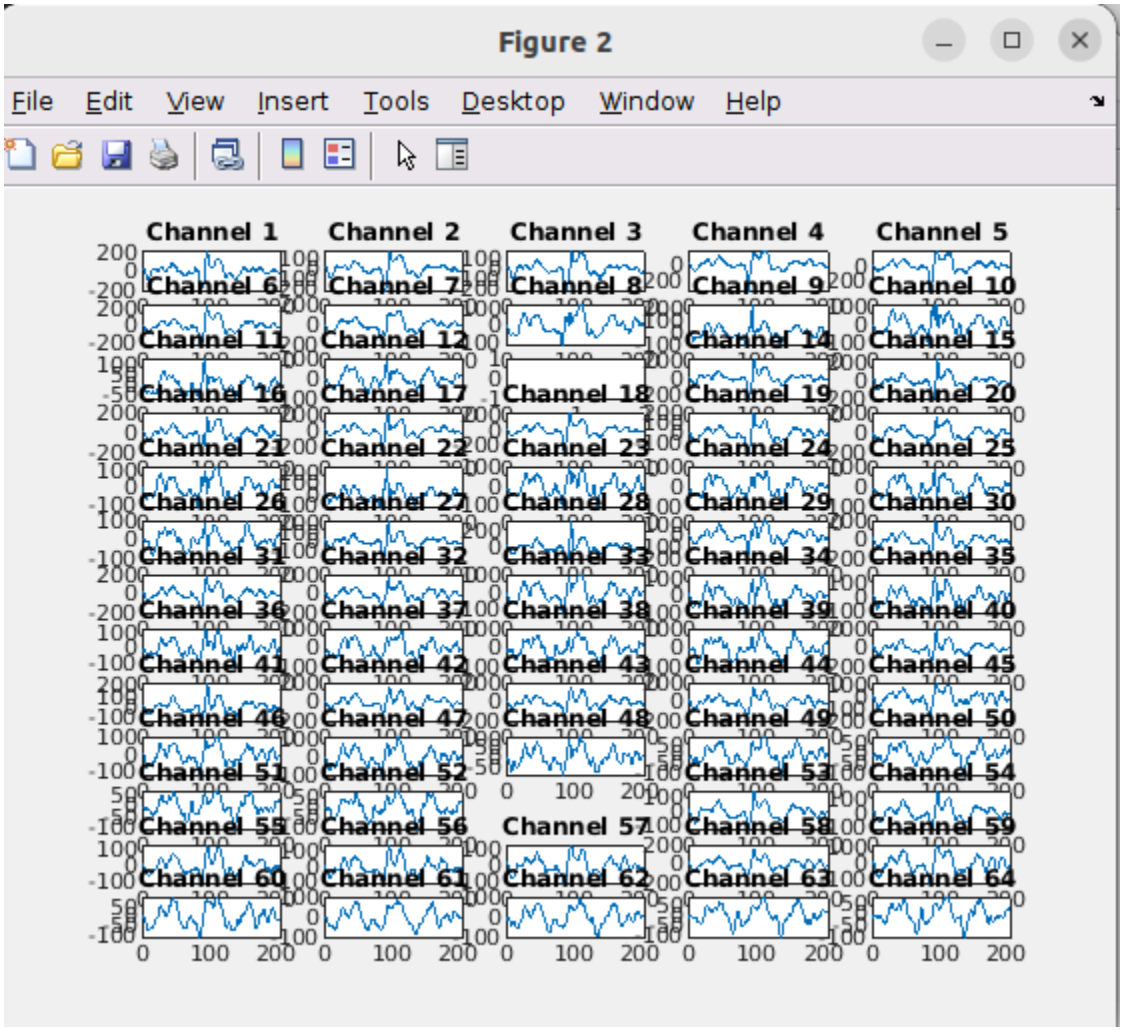
1.1. The visual representation in Figure 1, displaying the spike trains in conjunction with the reference force signal, suggests a direct relationship between the two. The denser the spike trains appear, the higher the force measured. This indicates that as more force is exerted, motor units tend to fire more frequently, supporting the notion of motor unit recruitment and rate coding during muscle contraction.

1.2. The spike trains reveal distinct differences between motor units. Variability in firing rates and patterns is noticeable, with some motor units firing more consistently than others. Parameters such as the recruitment threshold, the frequency of firing, and the pattern consistency can be discerned from these trains. Such data provides valuable insights into the motor units' properties, including their size, fibre type, and endurance capabilities.



Task 2: Spike-Triggered Averaging (STA)

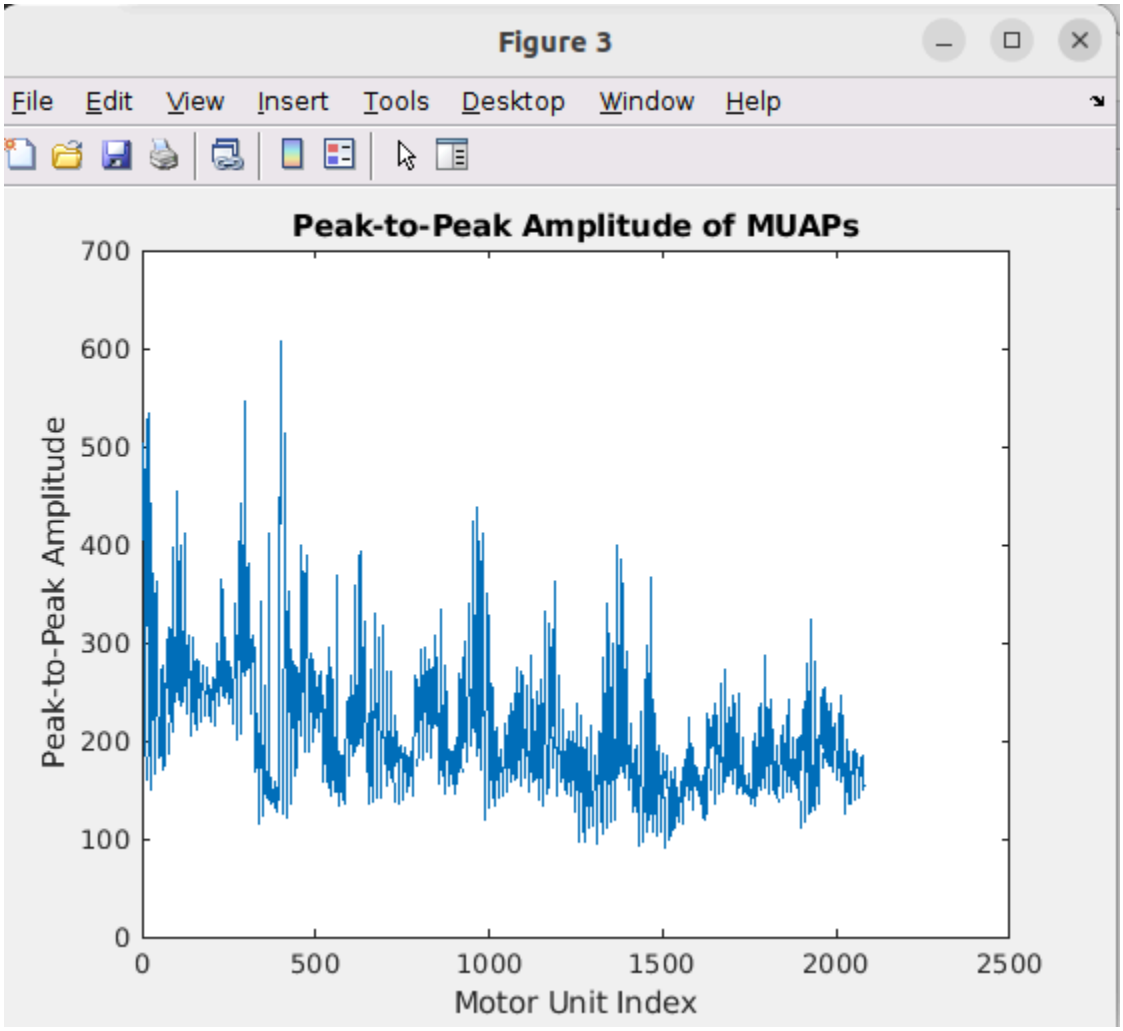
2.1. The STA technique, as depicted in Figure 2, is instrumental in correlating spike trains with a continuous signal, such as the raw EMG. The average MUAP shape for each channel, derived from STA, aids in understanding the unique electrical profiles of motor units. This information is pivotal in determining how each motor unit contributes to muscle contraction, with the spatial arrangement of the plots mirroring the EMG grid to illustrate the potential location of motor unit fibres.



Task 3: Motor Unit Action Potential Amplitudes

3.1. The peak-to-peak values of the MUAP shapes provide a quantitative measure of the motor unit action potential amplitudes. Typically, a higher peak-to-peak value would imply a larger motor unit.

3.2. In Figure 3, the peak-to-peak amplitude plot may suggest a trend that aligns with the recruitment order of motor units. According to the size principle, it would be expected that as the force requirements increase, larger motor units with higher amplitude peaks would be recruited.



Task 4: Motor Unit Locations

4.1. The heatmap displayed in Figure 4, which shows the RMS values of MUAPs for a selected motor unit, offers an indication of the unit's activity about the EMG electrode grid. Higher RMS values signify a stronger signal, which implies proximity to the active motor unit.

4.2. By arranging RMS values in a grid layout, the heatmap visually conveys the motor unit's location. This spatial visualization allows for the identification of the motor unit's position concerning the electrode grid.

4.3. Heatmaps from different motor units can display unique patterns, reflecting variations in the anatomical placement and size of the motor units. These disparities could originate from how superficial or deep the motor units are within the muscle, impacting the signal amplitudes captured. Such spatial differentiation informs us about the diverse physiological attributes of motor units and their recruitment during muscle activation.

These analytical observations gleaned from the spike trains, STA, and MUAP amplitude measurements provide a multifaceted understanding of muscle function. They not only elucidate the activation patterns of motor units during contraction but also shed light on their anatomical locations within the muscle tissue, contributing valuable knowledge for applications in both clinical and athletic development settings.

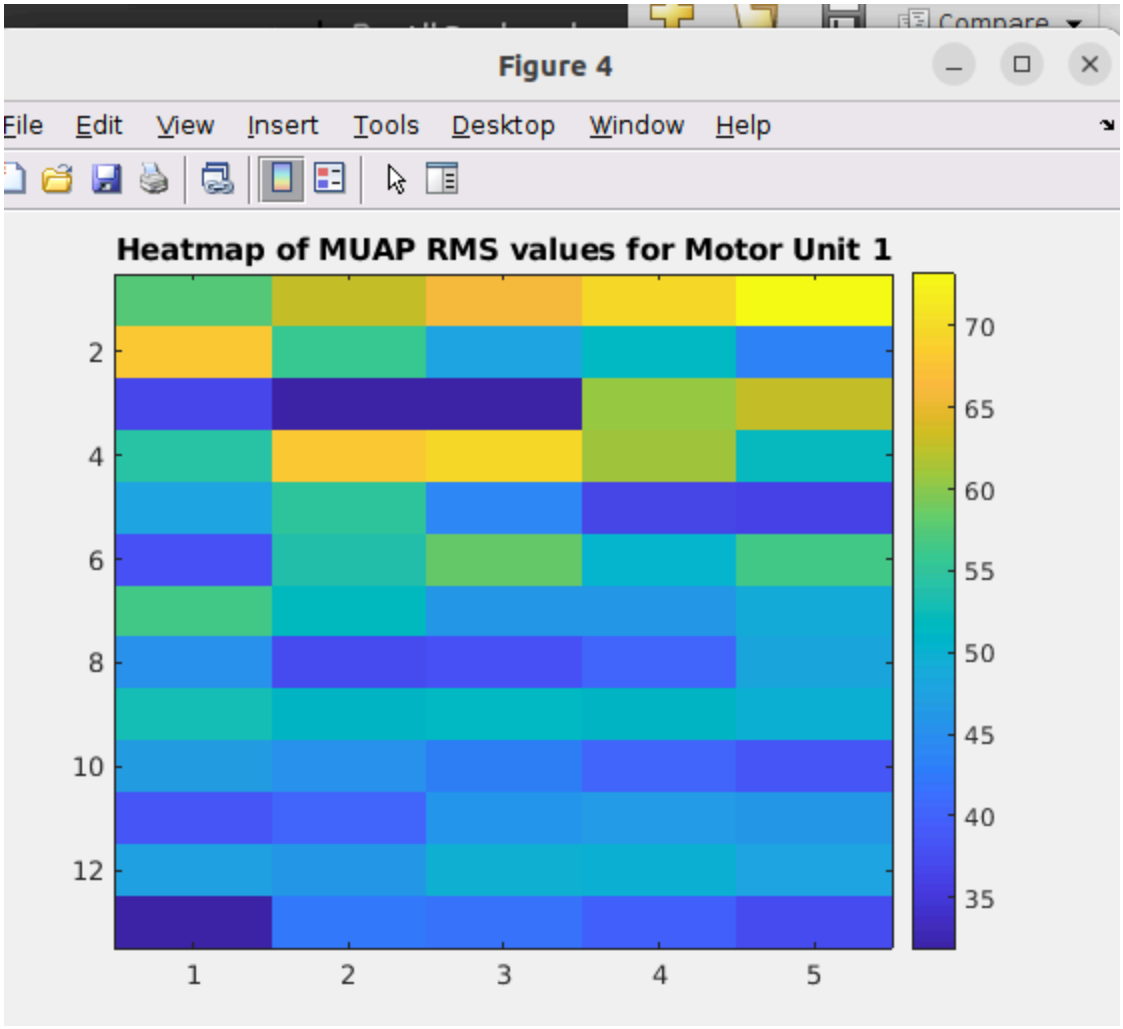


Figure 4
File Edit View Insert Tools Desktop Window Help
Heatmap of MUAP RMS values for Motor Unit 1
2
4
6
8
10
12
1
2
3
4
5
70
65
60
55
50
45
40
35