ELECTROMYOGRAPHY

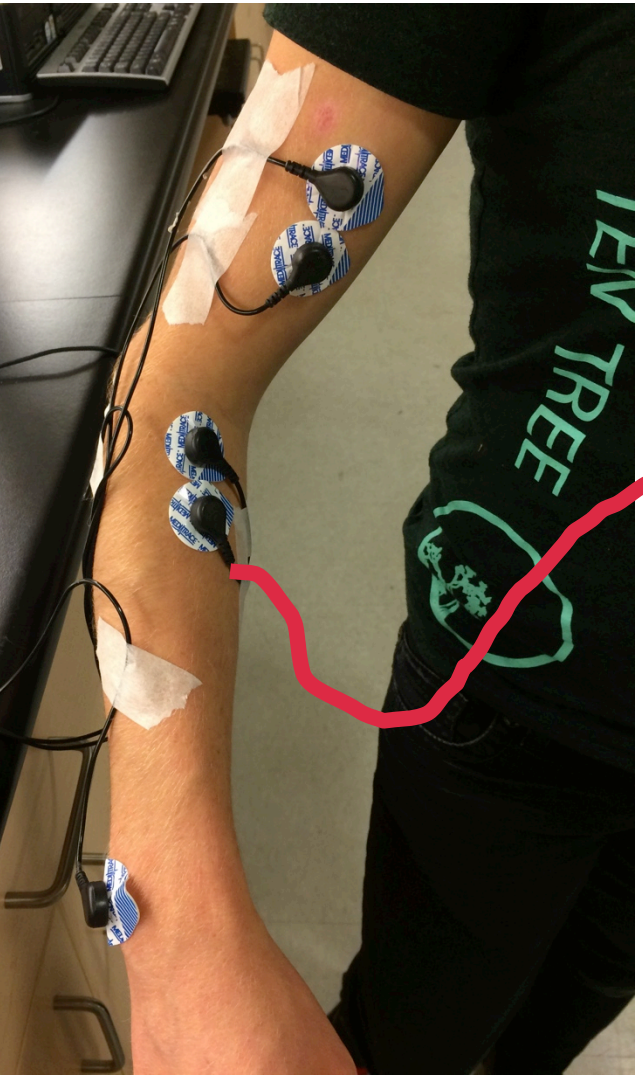
Lecture 3

Lecture 3 Outline – EMG

- Lecture Content
  - Data processing
  - EMG-Force Relationship
  - Lab 6 Review

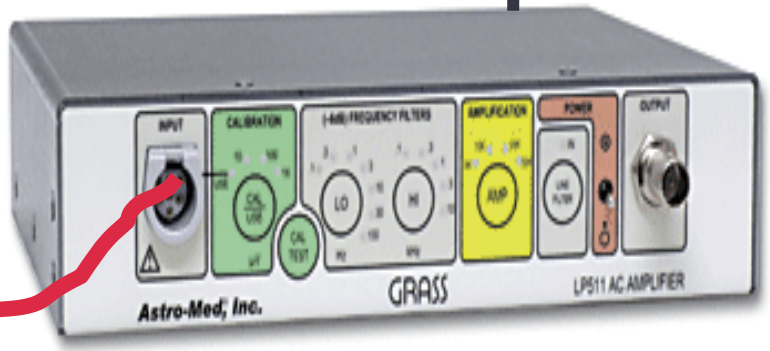
Learning Objectives

- Be able to tell me why sample rate is important.
- State why normalization of the EMG signal is important and what limitations may be involved with using a maximum voluntary contraction.
- Be able to confidently discuss the relationship between the EMG signal and force, including factors that may affect it.

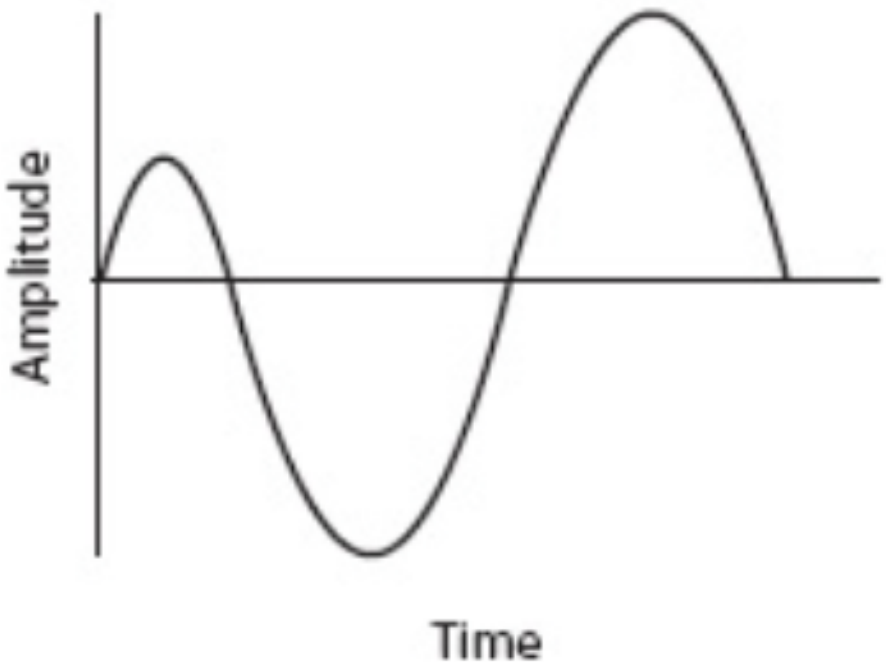


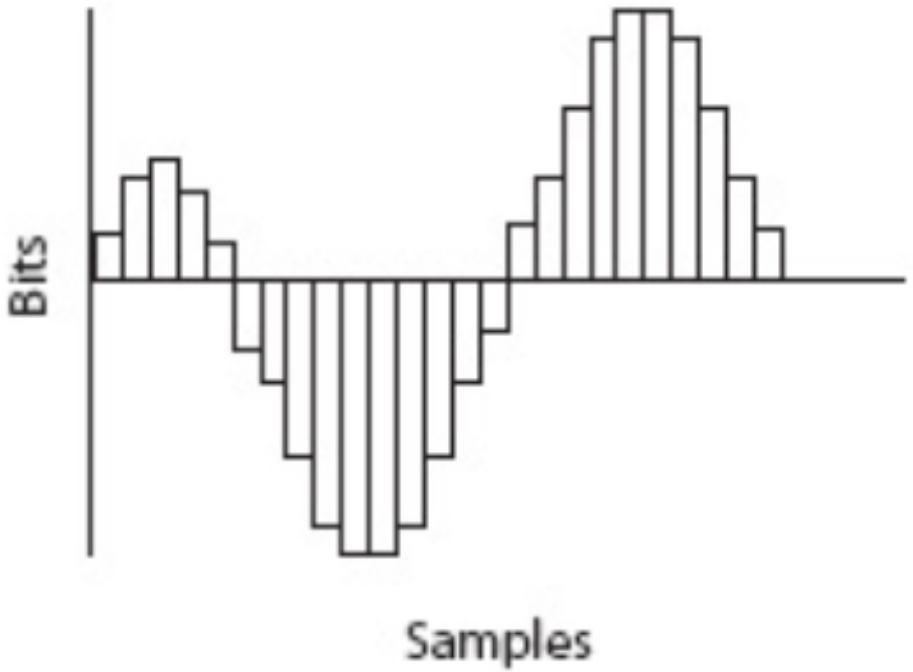
Analog/Digital Converter (A/D)

Pre-Amplifier



A/D Conversion



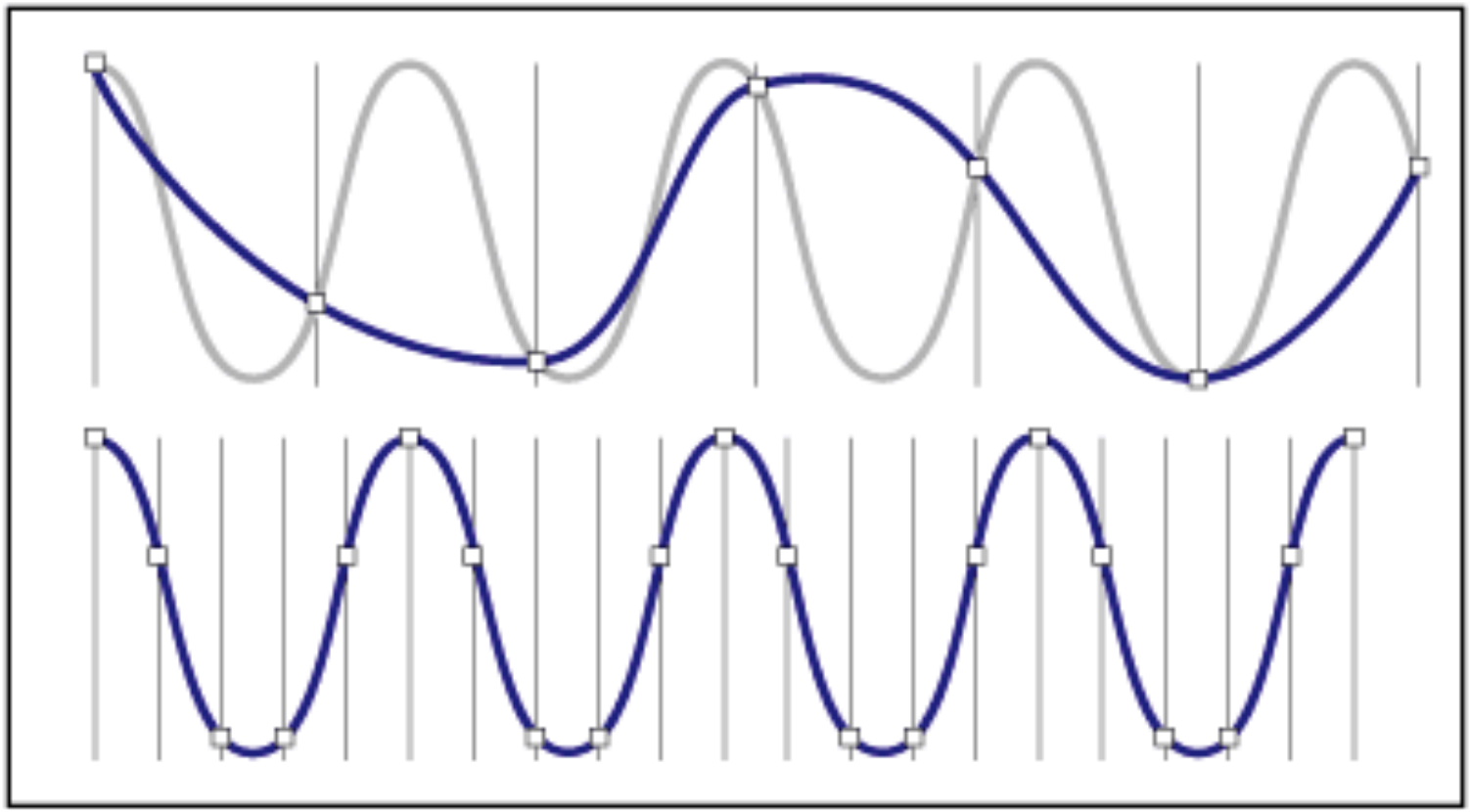


Recording EMG……Sample Rate

Importance of following the Nyquist Sampling Theorem:

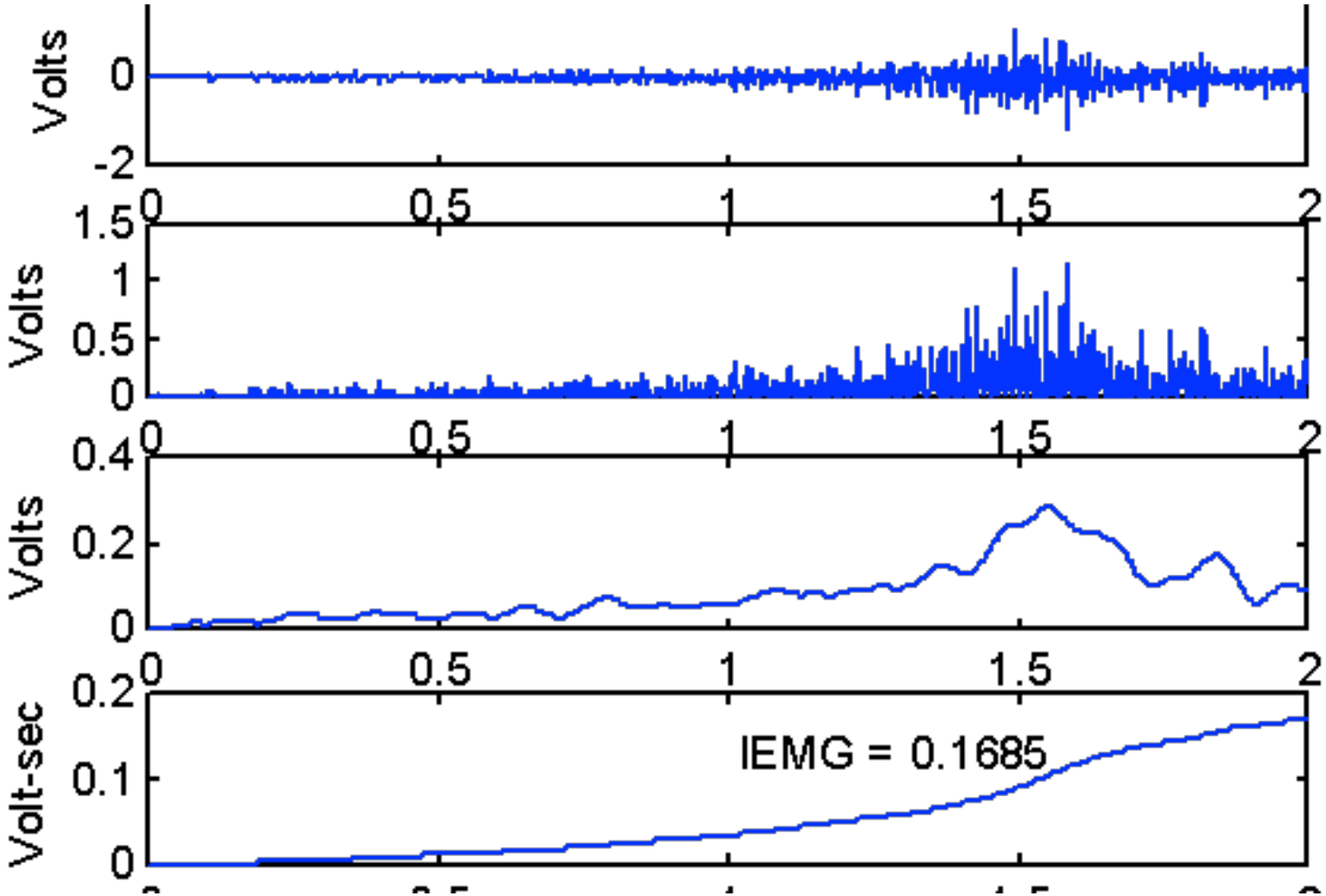
to adequately sample need sample rate =2n+1

n=frequency

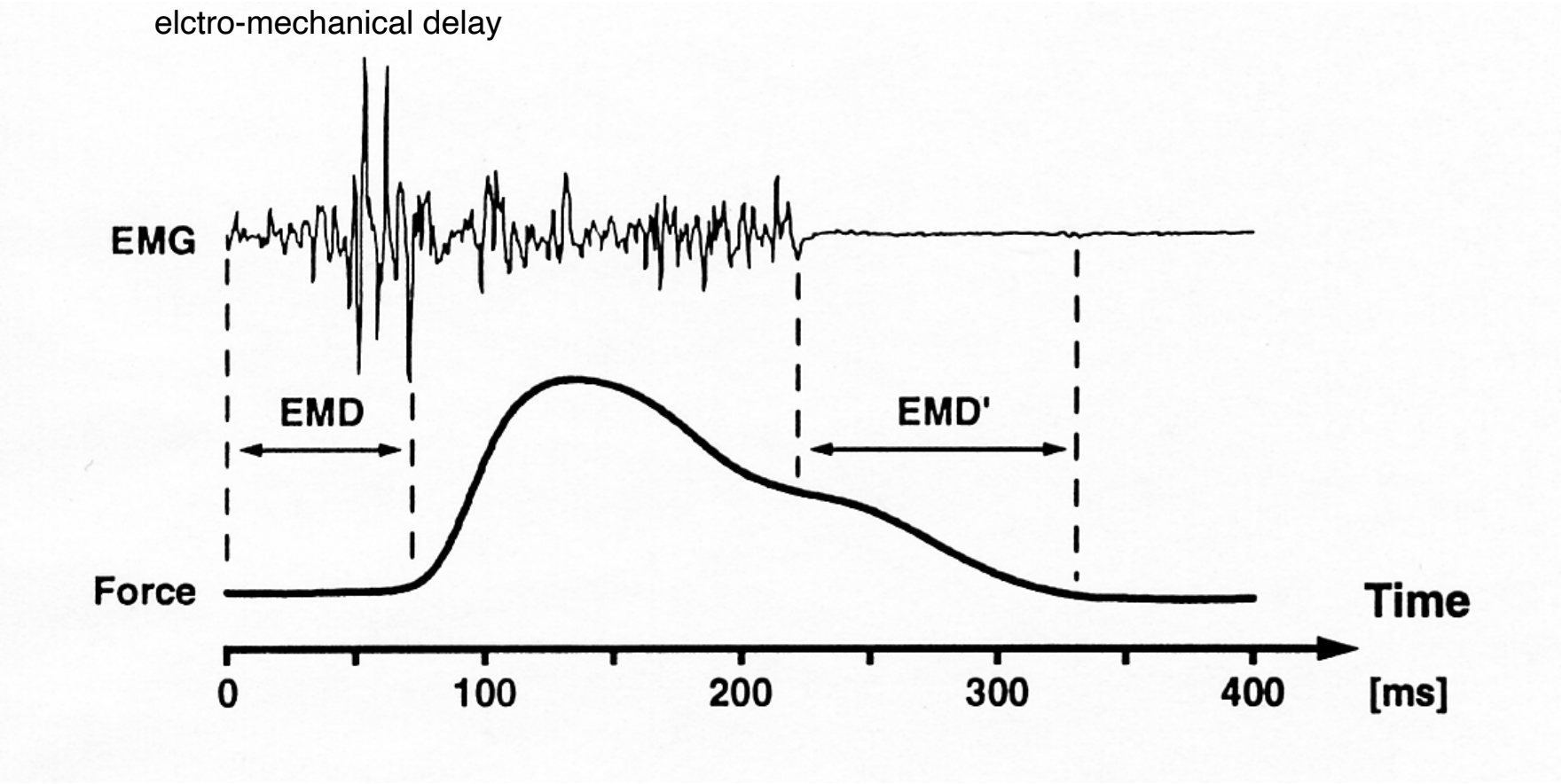


Processing

low pass filter introduces a time delay in data



When relating EMG to force, time lag is actually representative of force onset



Issues to Consider with MVC Norm

- Is it really the true maximum?
  -Practice
  -How much can we truly voluntarily contract? Trained/motorM- a stimulated contraction would get around this issue
- What about fatigue?
  How can you minmize this? rest between contractions
- Is it painful?
  Could be. Clinical populations would use a sub-max reference
- Will it make sense for your research question?
  -You are using an isometric contraction to find max. Application to dynamic movement?

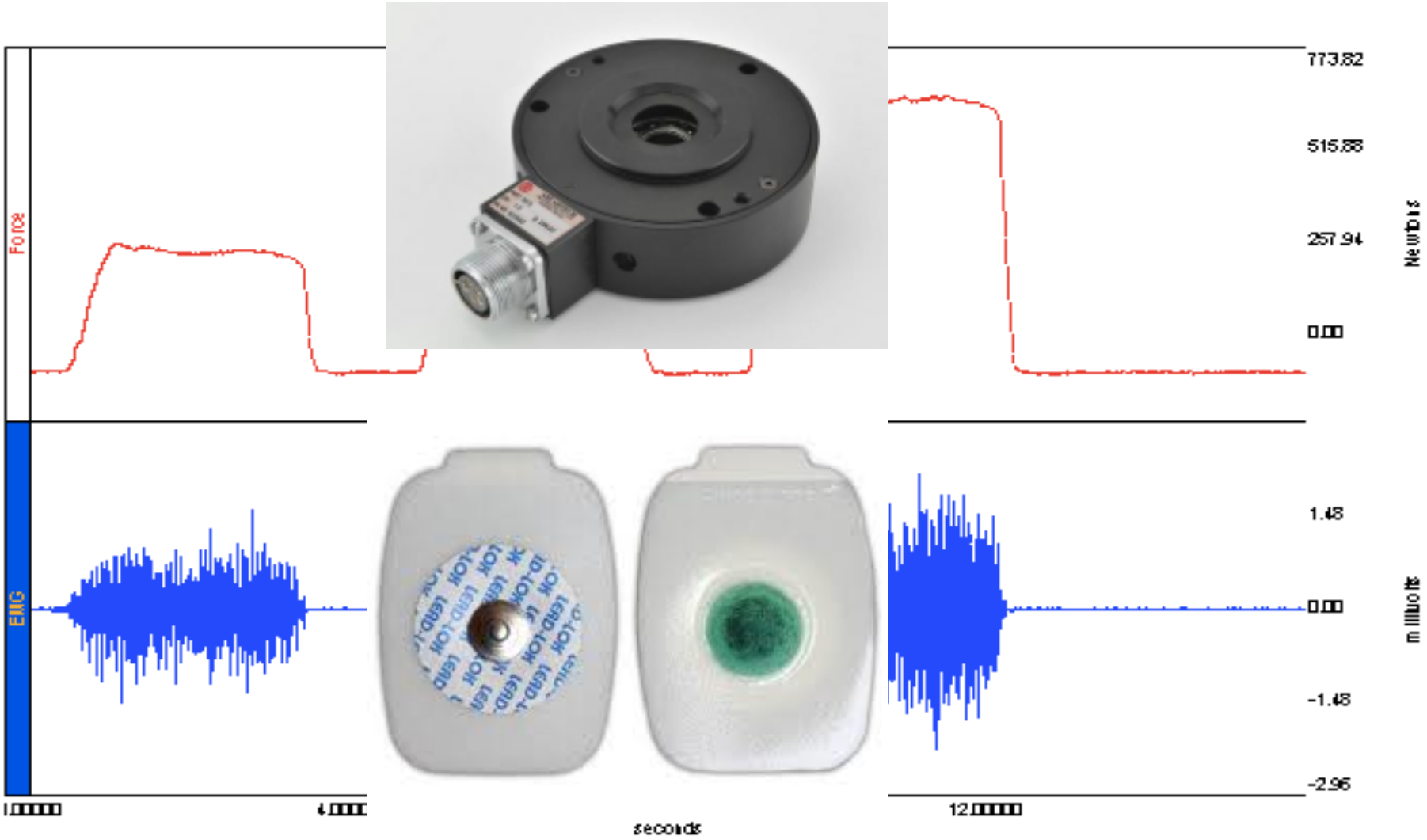
Calculating %MVC

- For each data point in your **processed emg signal** subtract the resting value (0%) and then divide by the maximum EMG amplitude (100%)

- **This changes your values from mV to %MVC.**

$$Normalized\ EMG = \frac{(\boldsymbol{Data\ (mV)} - Resting\ Value\ (mV)}{Maximum\ Value\ (mV)}$$

EMG – FORCE Relationship



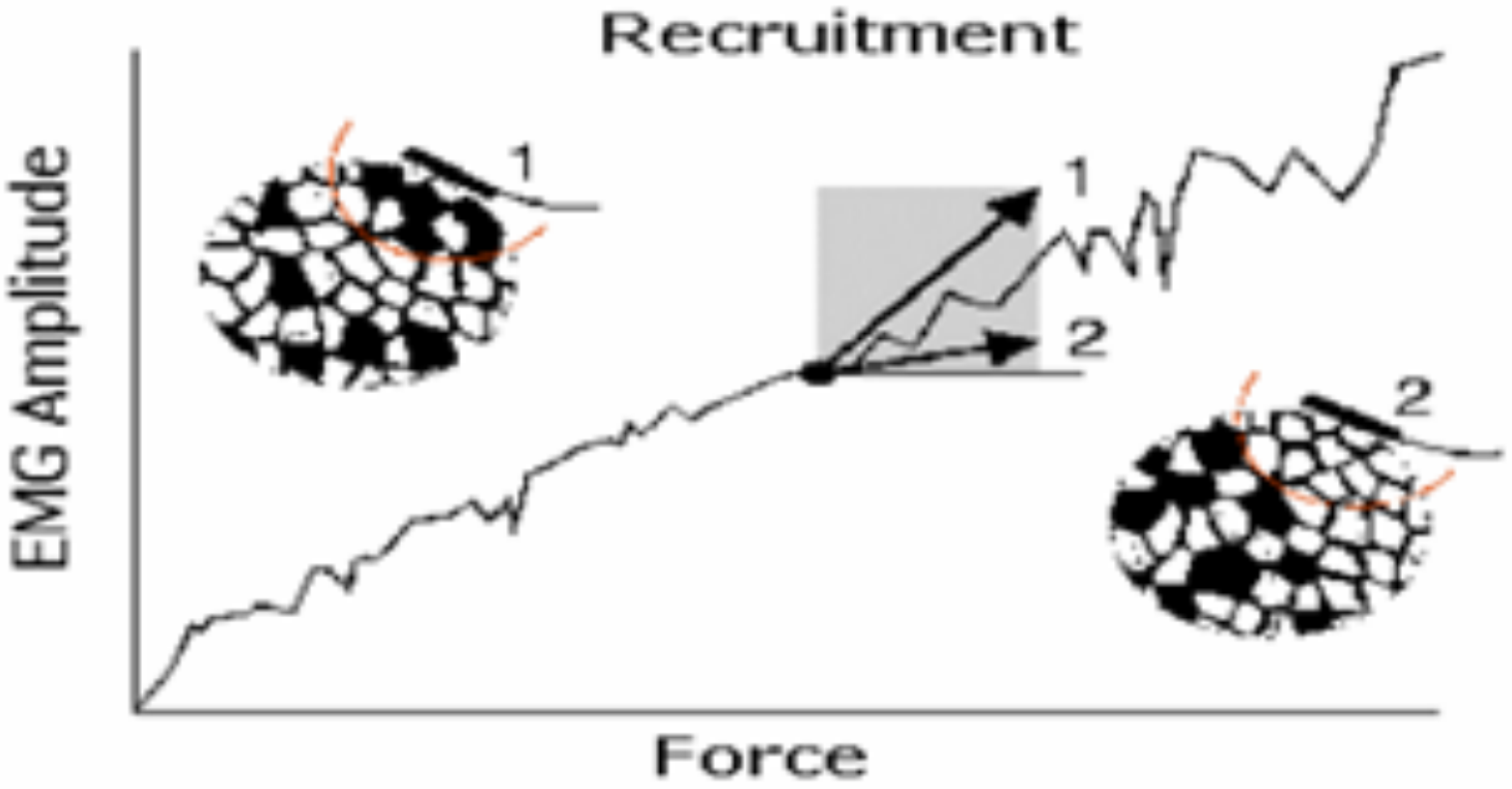
Elbow Flexion

- Controlled by biceps brachii, brachioradialis and brachialis (which one is the prime mover?)
- As the movement occurs, how does the muscle activation strategy occur?
  - Taking into account length changes and velocity
  - Would depend on the initial position as well

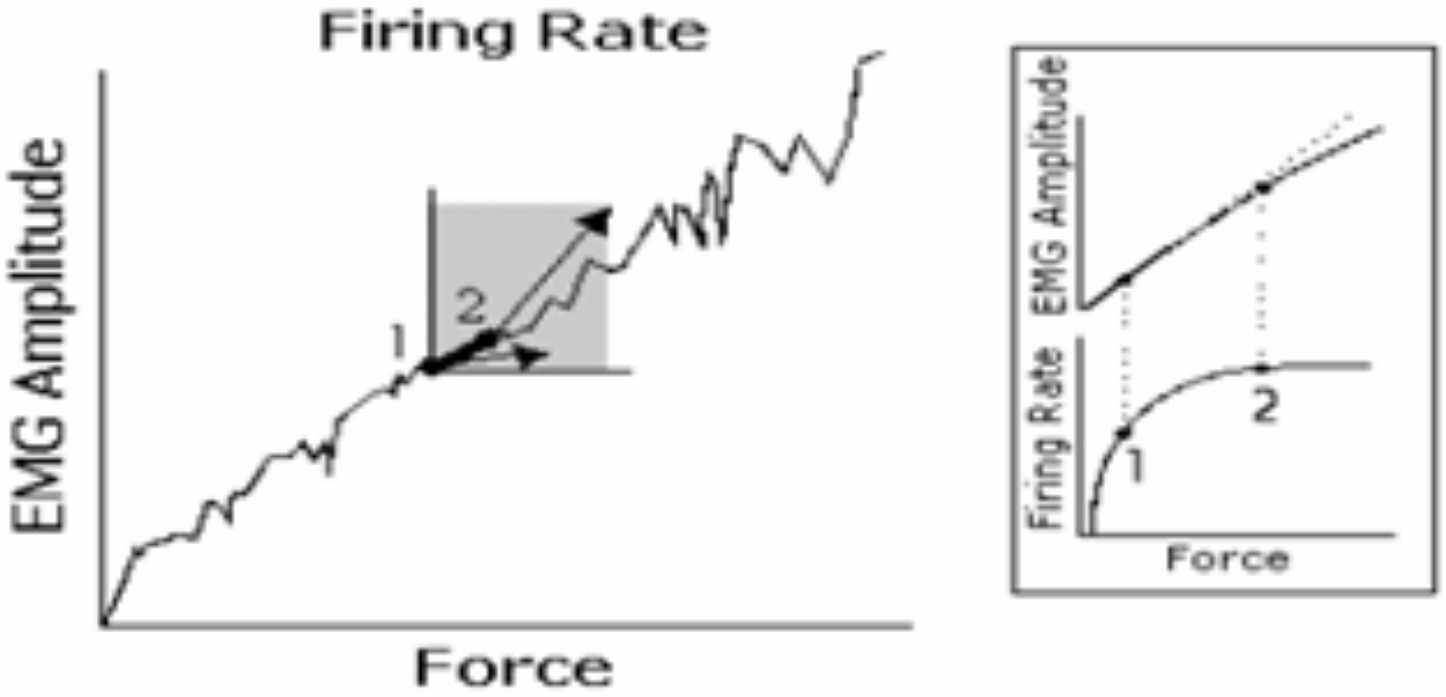
- Most work investigating this relationship has involved isometric contractions

4 Factors to Consider….

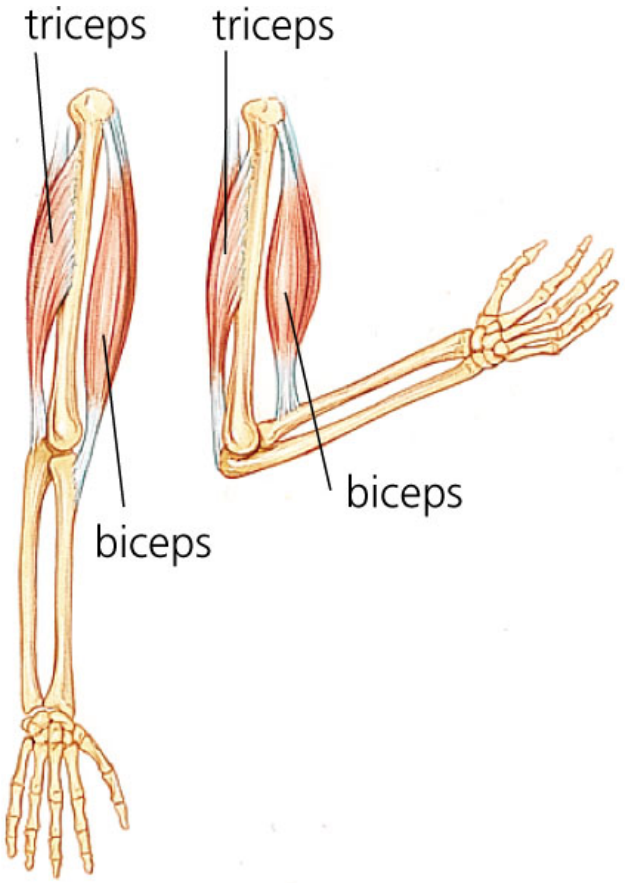
1) Muscle Characteristics
   - Size of the Muscle
   - Type of Muscle Fibers
2) How closely the EMG recording represents the muscle electrical activation.
3) Saturation of motor unit force production
4) Muscle Force generated by Agonist/Antagonist muscles around the joint.


Recruitment
EMG Amplitude
Force
1
2
1
2

At Max force output increases in rate coding (frequency) will contribute to EMG but the contribution to force is saturated for most MUs.



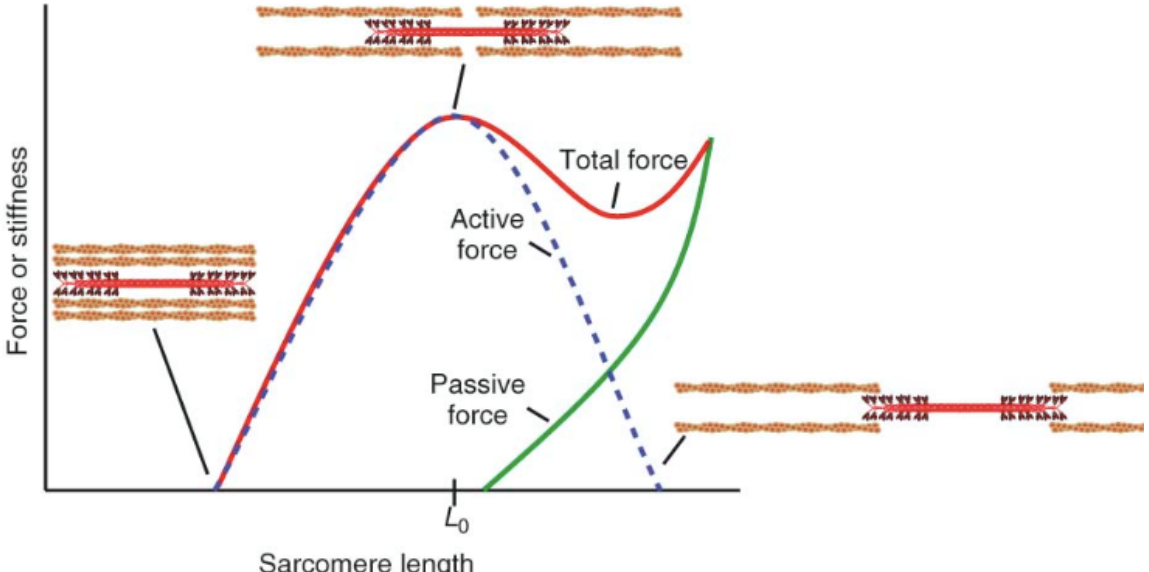
Agonist/Antagonist Muscles

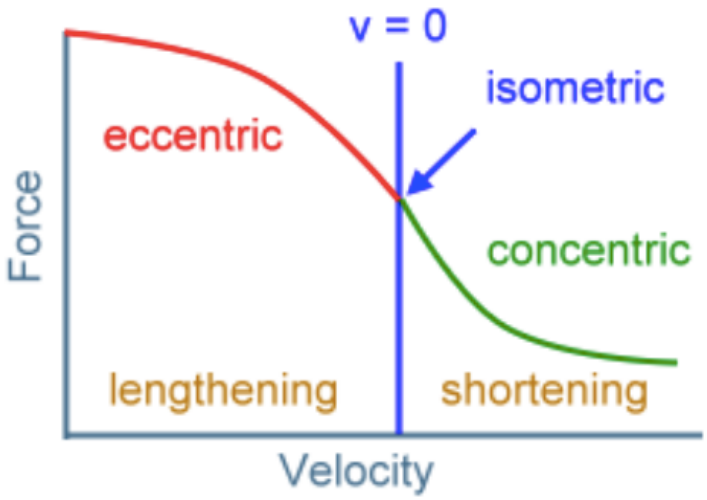


- Agonists will contribute to force but not to EMG
- Antagonists may act against the force production.

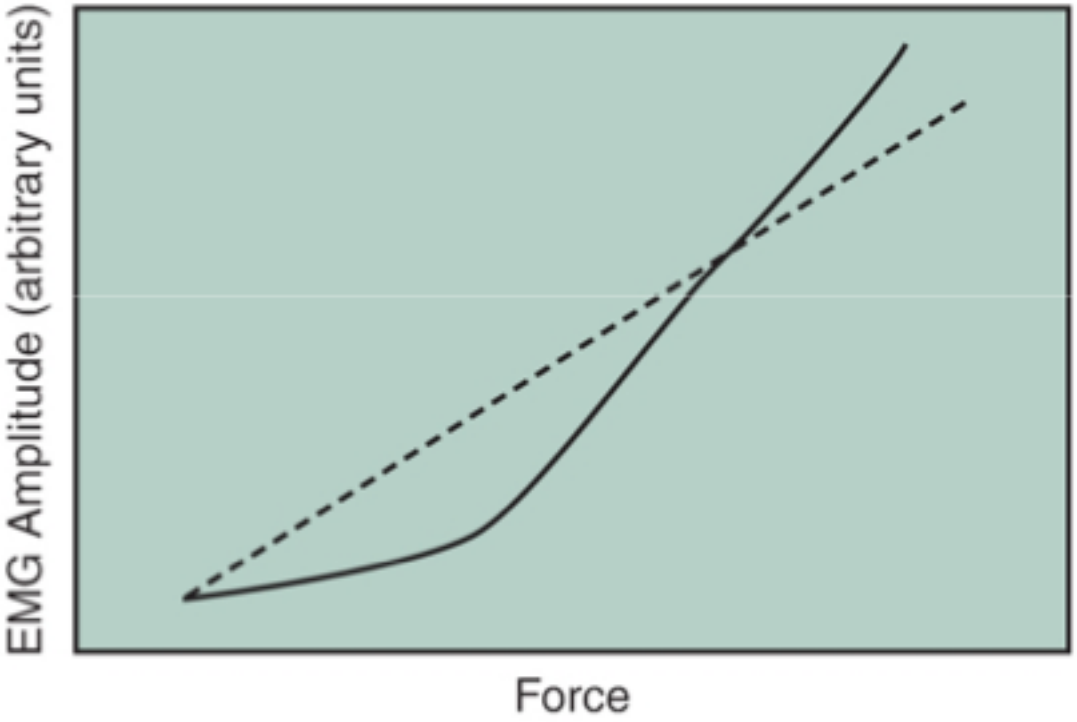
Movement also plays a part

- The length of the muscle affects the EMG-force relationship
- The velocity of the movement affects the EMG-force relationship.





Relationship?

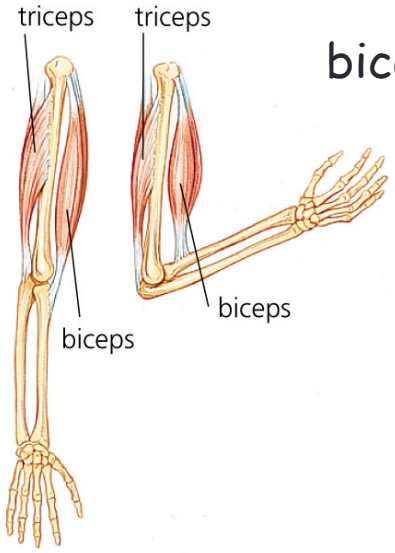


Force – EMG: linear versus non-linear

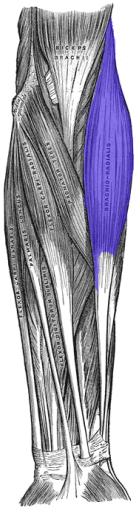
Lab 6 Data Collection

Part A – Relationship of %MVC to Force

- MVC trials for two elbow flexors (Biceps and Brachioradialis)
- Mild (25%), medium (50%) and strong (75%) contraction
- Simultaneous recording of EMG and Force data.



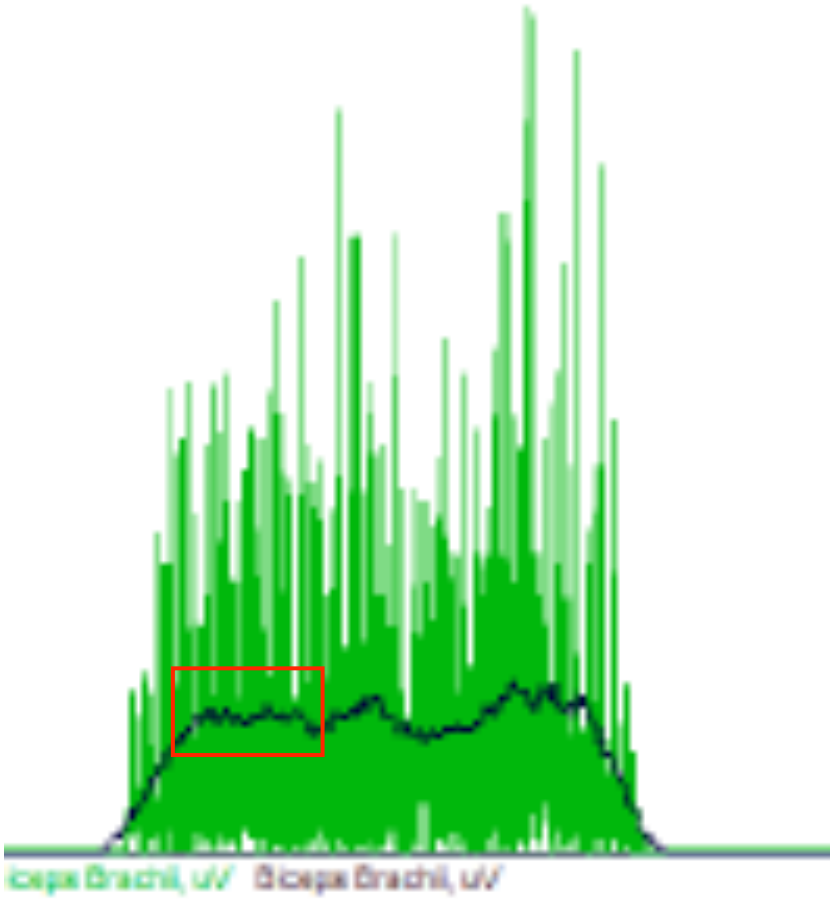
biceps



brachioradialis

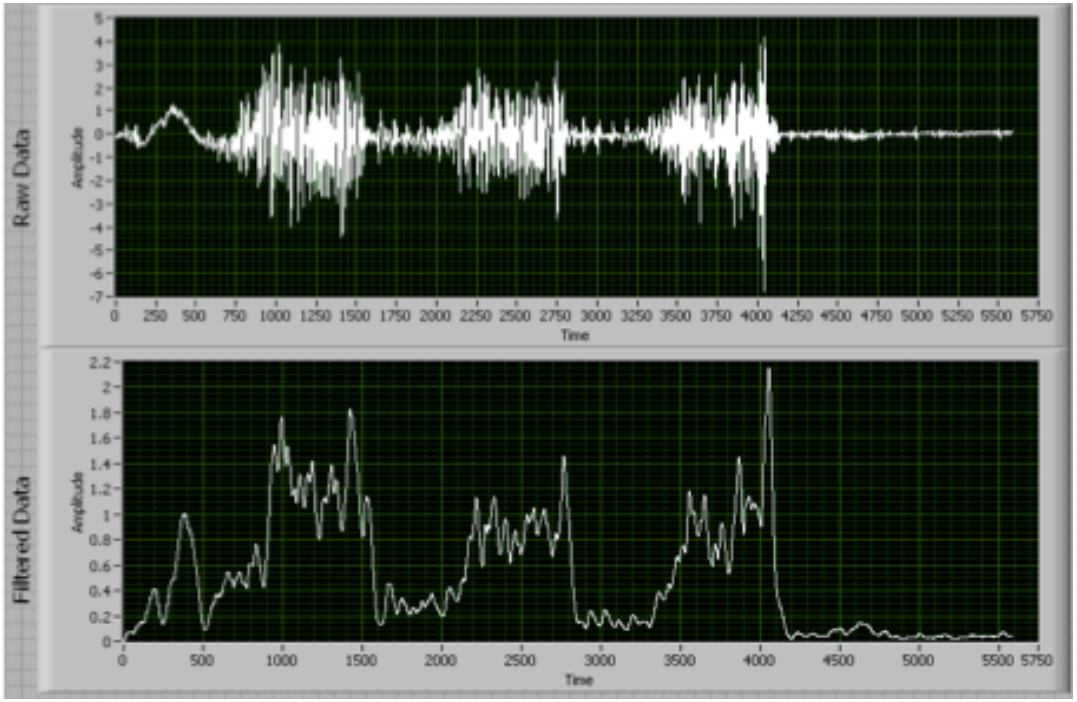
Processing in Lab

- Rectification
- Filtering
- Normalization (%MVC)
- Amplitude Calculation
  - Average data over 100ms of peak EMG.



Part B – Integrated EMG vs Power

- Examining the concentric work done during biceps curls
  - Biceps curl to a metronome/count
  - Three curls per weight
  - Same distance (measured)



Calculating Power

$$\text{Power (W)} = \frac{[\text{Load (kg)} + (0.033 \times \text{B.W. (kg)})] \times 9.8\ \text{m/s/s} \times \text{distance (m)}}{1\ \text{s (contraction time)}}$$

Weight

Anthropometric measure

Body Weight

Gravity

Distance of movement

- Power = the rate of doing work (work = F*d)

Formal Lab Report

- A mini publication ☺
- Marking Scheme:
  - Introduction (2)
    - Background information that leads to your purpose and hypothesis statements.
  - Methods (3)
    - Exact recipe for how you collected your data (including participants)
    - I should be able to use your methods section and be able to collect the same data based on the information your provide. To specific? I think not…..
  - Results (5)
    - What you found and only this (no interpretation). Graphs, tables produced in excel with appropriate captions.
  - Discussion (5)
    - Do not just answer the questions, this is where you address your results and talk about what you found. How do your findings match your hypotheses and the existing literature? What were the limitations of your study and how might they have impacted what you found?
  - Conclusion
    - Summing it all up in a few sentences.
  - Spelling/grammar/overall presentation (1)