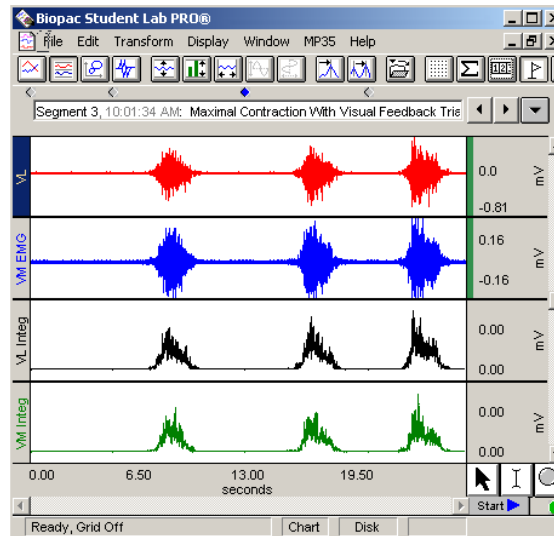# BSL *PRO* Lesson H36: Muscular Biofeedback

Lesson developed by:
Heather Medema-Johnson, M.S., ATC, CSCS

Introduction

Biofeedback is a form of self-regulation in which an individual is provided information in the form of sensory feedback about a biological condition or function in order to gain control over that biological function. Biofeedback is often used as a therapeutic tool by which therapists, sports medicine/rehabilitation professionals, neurophysiologists, and psychophysiologists can use electrophysiological instrumentation to measure, process, and "feedback" the recorded information to the subject (client, patient, athlete). The feedback is usually given through auditory and/or visual means. Biofeedback is considered advantageous, as it provides the subject with a chance to use their visual and auditory senses to become more aware of how they are performing during therapy or training, attempt to improve upon it, and immediately see the improvement as it is occurring. Because the subject immediately notes improvements, they are "rewarded." This reward will hopefully lead to larger improvements and accomplishments.

There are many types of biofeedback modalities available. One of the most popular and widely accepted modalities used in a clinical setting is **surface EMG** biofeedback. EMG (electromyography) bioinstrumentation measures muscle activity by recording electrochemical activity of a muscle occurring during depolarization and recruitment of a skeletal muscle motor unit. This modality is used for **muscle reeducation** and control when orthopedic injuries or surgeries have taken place, or when the peripheral nervous system has been impaired. It is also used to promote muscle relaxation to decrease muscle guarding, pain, stress, and anxiety.

Read more about it…

- Arnheim DD, Prentice, WE. *Principles of Athletic Training*. 10th Ed. McGraw Hill, 2000.
- Bengston WF, Krinsley D: "The effect of the 'laying on of hands' on transplanted breast cancer in mice." *Journal of Scientific Exploration* 2000; Vol. 14, No. 3, Article 2.
- Bickers MJ. Does verbal encouragement work? The effect of verbal encouragement on a muscular endurance task. *Clin Rehabil* 7: 196-200, 1993.
- J. M. Jakobi and E. Cafarelli: **"**Neuromuscular drive and force production are not altered during bilateral contractions" *J Appl Physiol* 84: 200-206, 1998.

Objectives

1. To measure changes in EMG with maximal contraction, as compared to baseline, incorporating different combinations of visual and auditory feedback.

2. To design experiments by selecting different types of muscles and variations of contractions/activities relating to biofeedback that the subject will perform.

Equipment

BSL Data Acquisition Unit (MP35 or MP30)

BSL *PRO* software

Electrode lead set (SS2L) – 2 per subject

Disposable pre-gelled electrodes (EL503) – 6 per subject

Electrode gel (GEL1) and abrasive pad (ELPAD)

Optional: Headphones (OUT1) or speaker for variation on exercise

Experiment Design

Design an experiment to measure how electrical activity changes when a muscle contracts with varying types of biofeedback. Experiment must:

1. Specify which muscle will be used.
2. Specify how the type of biofeedback will be altered.
3. Specify what measurements will be taken and how they will be recorded (table, etc.).
4. Conform to the *Scientific Method*; specifically:
   A. Identify a problem or objective.
   B. Form a hypothesis
   C. Test the hypotheses by observation and experimentation
   D. Interpret the data
   E. Draw conclusions (design a new experiment if data do not support the hypothesis)
   F. Report observations and conclusions.

Setup

This setup demonstrates EMG of the Vastus Medialis and Vastus Lateralis muscles. Student setup may vary according to experiment design.

▪ **Hardware**

CH 1 for lead for vastus lateralis

CH 2 for lead for vastus medialis

1. Plug the **Electrode Lead Set** for the vastus lateralis muscle into **CH 1** on the **MP35** unit.
2. Another **Electrode Lead Set** for the vastus medialis muscle into **CH2** on the **MP35** unit.
3. Turn the **MP35** data acquisition unit **on**.

- **Software**

    1. Turn the **computer on**.
    2. Launch the **BSL *PRO*** software on the host computer.
    3. Open the Muscular Biofeedback lab by **File menu > Open > choose Files of type: GraphTemplate (*GLT) > File Name: h36.gtl**.
        - The file can be downloaded from the BIOPAC web site *PRO* Lessons page, or Help>*PRO* Lessons from Web for BSL *PRO* v3.7 users.
        - If not using the template, confirm that Acquisition Setup is in "Append" mode.

- **Calibration**

    No calibration is required.

- **Subject – Electrode Connections**

    Hints for minimizing data error

    - Lightly abrade the surface of the skin before placing electrodes.
    - Wait at least five minutes after attaching the electrodes so the skin has ample time to absorb the gel.
    - Remove all jewelry or other metal objects.
    - Check all cable connections.
    - Make sure that the electrodes are making good contact with the surface of the skin.
    - Use the lead clip as necessary to avoid straining the lead or pulling the electrodes loose; use surgical tape to adhere the leads to skin if necessary.

Placement on the vastus lateralis (CH 1)
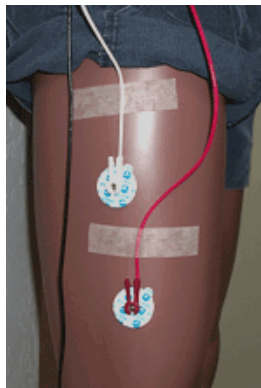
Placement on the vastus medialis (CH 2)
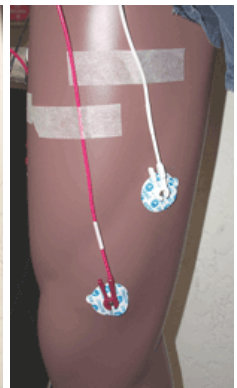
1. Place electrodes on the **Vastus Lateralis** muscle and connect the electrode lead set from **CH1**.

    Important:

    - You should place the electrodes vertically (parallel to the muscle fibers), over the muscle belly, or largest part of the muscle.

2. Place electrodes on the **Vastus Medialis** muscle and connect the electrode lead set from **CH2**.

3. Place a Ground electrode for each channel where movement is not an issue, such as one on each side of the lower calf.

Placement for Ground lead from CH 1

Example Experiment:

- Advise subject to avoid excessive extraneous movement throughout the recording.
- Make sure the subject is in a seated, relaxed position, knees hanging off the edge of a table or seat, with enough room for full knee extension.
- Make sure the subject is not looking at the screen.
- Advise subject that he/she will go through a series of contractions with varied biofeedback.

Condition 1: Baseline

1. Instruct the subject to maximally relax (not contract) when you hit "Start." This is done to measure baseline EMG without biofeedback.

2. Click "Start" on the data screen to begin recording for 5 seconds.

3. After 5 seconds, click "Stop."

Baseline

Condition 2: Maximal Contraction Without Biofeedback

4. Instruct the subject that when you click "Start" he/she is to avoid looking at the screen and maximally contract (knee extension) and hold for 2 seconds. This is done to measure EMG during maximal contraction without any biofeedback.

5. Click "Start" on the data screen to begin recording for 5 seconds (enough time to contract and relax).

6. After the contraction is completed, click "Stop."

   - If necessary, Autoscale the waveforms in **Display>Autoscale Waveforms**.
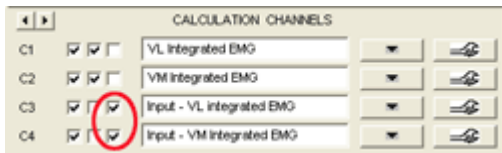
Condition 3: Maximal Contraction With Biofeedback – Trial 1

7. Instruct the subject that when you click "Start" he/she is to look at the screen and maximally contract (knee extension) and hold for 2 seconds. This is done to measure EMG during maximal contraction with visual biofeedback.

8. Click "Start" on the data screen to begin recording for 5 seconds (enough time to contract and relax).

9. After the contraction is completed, click "Stop."

   - If necessary, Autoscale the waveforms in **Display>Autoscale Waveforms**.
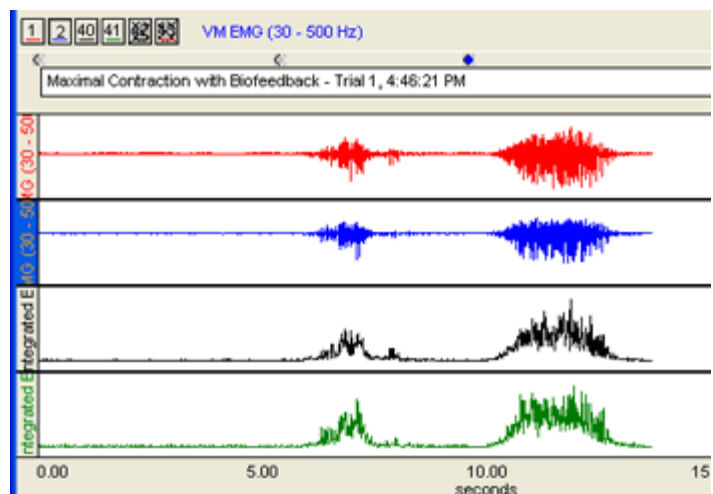
Maximal Contraction with Biofeedback – Trial 1

Option: You can display and look at incoming data in "bar chart" format in a separate **Show Input Values** window during acquisition. To set up this window, select **Enable Value Display** for C3 and C4 in **MP35>Set up Channels**.
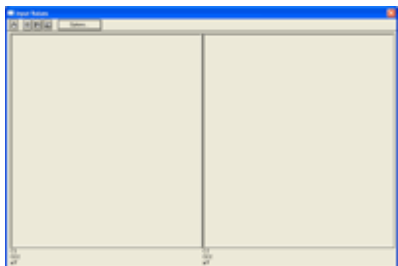

Select "Enable Value Display"
for C3 and C4 in Setup Channels

Note: In the **Integrated EMG** Calculation Channels, the Samples have changed to 500 to see smooth increment of the input values.
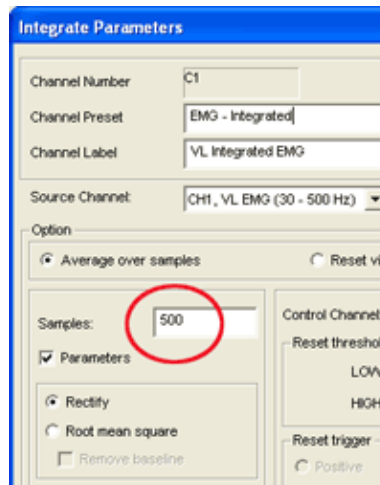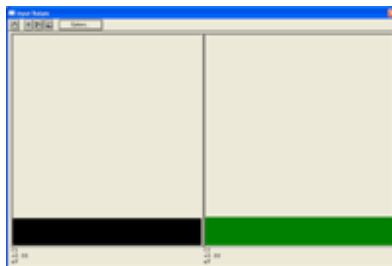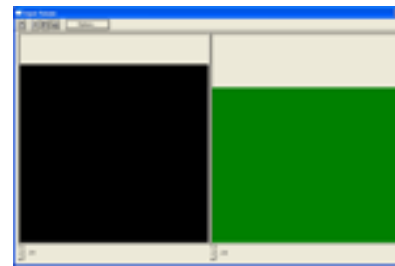
Integrated EMG for C3 and C4

Condition 4: Maximal Contraction With Biofeedback – Trial 2


Open the "Input Values" display

Click "Start"

Hold for two (2) seconds

10. Instruct the subject that when you click "Start" he/she is to look at the screen and maximally contract (knee extension) and hold for 2 seconds. This is done to measure EMG during maximal contraction with visual biofeedback, and to see if any improvement can be made over Trial 1.

11. Click "Start" on the data screen to begin recording for 5 seconds (enough time to contract and relax).

12. After the contraction is completed, click "Stop."

Data Analysis:
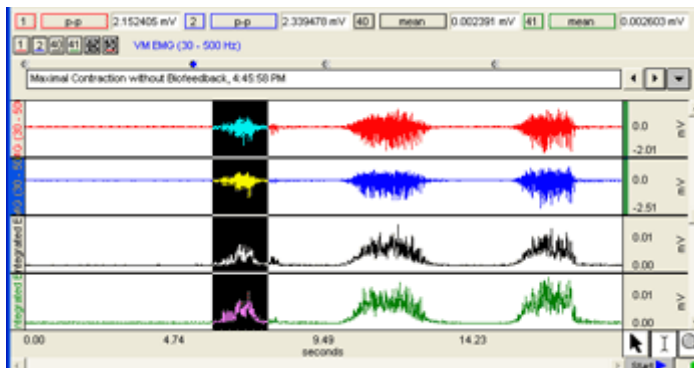
Example Data File

13. To compare measures of EMG and determine if any significant change was detected between any of the variables.
    a. Set the measurement boxes to record the following measures
        i. Channel 1: p-p
        ii. Channel 40: mean
        iii. Channel 2: p-p
        iv. Channel 41: mean
    b. Highlight various segments of EMG data.
    c. Compare values obtained during each type of activity.

Active Learning

Have students form groups, develop hypotheses, and test the effects of a stimulus on EMG.

ACTIVE LEARNING SUGGESTIONS:

- Perform the same series of activities listed above while incorporating auditory biofeedback and combination of auditory and visual biofeedback with the use of the headphones (OUT1) or an integrated speaker.

OUT1 plug into back of MP35 unit
for auditory biofeedback

- Perform the same series of activities listed above while the subject touches the muscle, or the therapist touches the muscle, based on the theory that touch may cause improvements in healing and or therapy.

- Perform the same series of activities while external verbal motivation/encouragement is provided.

- Perform the same series of activities while simultaneously contracting the bi-lateral limb muscle. This exercise is based on the Bilateral Deficit (BLD) theory, that contracting both limbs simultaneously may alter motor unit recruitment patterns.