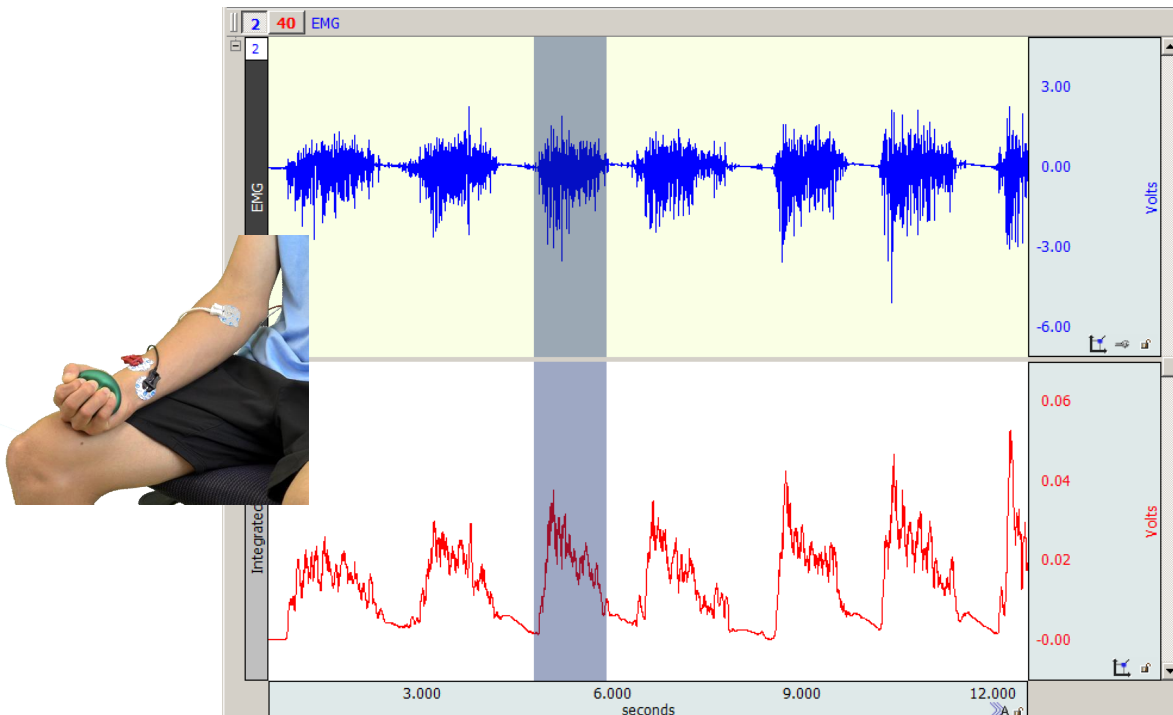


Introductory EMG Guide

Introduction to Electromyography (EMG)



Welcome to BIOPAC[®]* Introduction to electromyography, the aim of which is to offer a glimpse into concepts behind Electromyography (EMG), and demonstrate guidelines for collecting high-quality EMG data. In addition to the basic steps outlined in this guide, links to detailed instructional videos, webinars and other BIOPAC resources are included. These can be of assistance in offering an enhanced level of instructional detail about acquiring and analyzing EMG data.

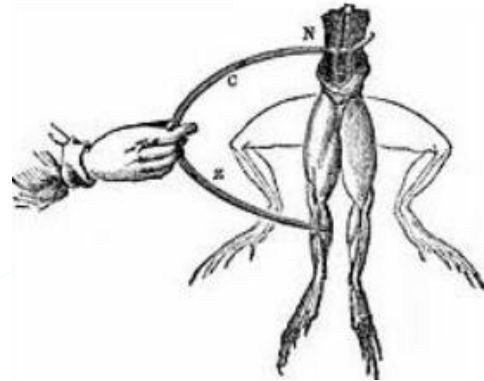
What is EMG?

EMG (Electromyography), is the electrical measurement of muscle activity. This electrical activity can be non-invasively detected and recorded by attaching leads and electrodes to the skin. The flow of electricity associated with muscle activity can then be accurately displayed as a waveform on a computer monitor or a chart recorder. Modern methods of recording EMG using life science equipment such as BIOPAC[®] array of wired or wireless data acquisition systems allows for great flexibility in viewing EMG data. In addition, the EMG wave can be easily magnified, rescaled, copied, pasted, saved and analyzed using advanced automated analysis transformations found in BIOPAC[®] AcqKnowledge and Biopac Student Lab software.

*Cited in over 33,000 peer-reviewed journal articles and trusted by the world's premier laboratories and leading researchers, BIOPAC[®] world-class life science research and education platforms provide the most advanced acquisition and analysis of ECG, EDA (GSR), EEG, EGG, EMG, EOG, and over 300 other signals and physiological measurements. Over 99% of the world's top universities use BIOPAC equipment.

A Brief History of EMG

The first documented EMG experiments were conducted by Francesco Redi in 1666, when Redi discovered that a particular muscle in electric eels generated electricity. Following further experiments in the late 1700s by Luigi Galvani using frogs, Galvani published *De Viribus Electricitatis in Motu Musculari Commentarius* in which the author demonstrated that electricity could initiate muscle contraction. Six decades later, Emil du Bois-Reymond discovered that it was also possible to record electrical activity during a voluntary muscle contraction. The first actual recording of this activity was made in 1890 by French scientist Étienne Jules Marey, who also introduced the term **electromyography (EMG)**. In 1922, researchers Gasser and Erlanger used an oscilloscope to show the electrical signals from muscles. Methods for detecting electromyographic signals improved steadily from the 1930s-1950s, and researchers began to use improved electrodes more widely for EMG studies. Clinical use of surface EMG (sEMG) for the treatment of more specific disorders began in the 1960s. Hardyck and his researchers were the first (1966) practitioners to use sEMG. In the early 1980s, Cram and Steger introduced a clinical method for scanning a variety of muscles using an EMG sensing device. By the mid-1980s, integration techniques in electrodes had sufficiently advanced to allow batch production of small and lightweight instrumentation and amplifiers.



Recent research has resulted in a better understanding of the properties of surface EMG recording. Surface electromyography is increasingly used for recording from superficial muscles in clinical or kinesiological protocols, where intramuscular electrodes are used for investigating deep muscles or localized muscle activity.

There are many applications for the use of EMG. EMG is used clinically for the diagnosis of neurological and neuromuscular problems. It is used diagnostically by gait laboratories and by clinicians trained in the use of biofeedback or ergonomic assessment. EMG is also used in many types of research laboratories, including those involved in biomechanics, motor control, gait analysis, neuromuscular physiology, movement disorders, postural control, and physical therapy.

How does EMG work?

The human body contains three kinds of muscle tissue and each performs specific tasks to maintain homeostasis: **Cardiac muscle**, **Smooth muscle**, and **Skeletal muscle**.

- **Cardiac muscle** is found only in the heart. When it contracts, blood circulates, delivering nutrients to cells and removing cell waste.
- **Smooth muscle** is located in the walls of hollow organs, such as the intestines, blood vessels or lungs. Contraction of smooth muscle changes the internal diameter of hollow organs, and is thereby used to regulate the passage of material through the digestive tract, control blood pressure and flow, or regulate airflow during the respiratory cycle.

- **Skeletal muscle** derives its name from the fact that it is usually attached to the skeleton. Contraction of skeletal muscle moves one part of the body with respect to another part, as in flexing the forearm. Contraction of several skeletal muscles in a coordinated manner moves the entire body in its environment, as in walking or swimming.

The primary function of muscle, regardless of the kind, is to *convert chemical energy to mechanical work*, and in so doing, the muscle shortens or contracts.

Human skeletal muscle consists of hundreds of individual cylindrically shaped cells (called **fibers**) bound together by connective tissue. In the body, skeletal muscles are stimulated to contract by somatic motor nerves that carry signals in the form of nerve impulses from the brain or spinal cord to the skeletal muscles (Fig. 1). **Axons** (or nerve fibers) are long cylindrical extensions of the neurons. Axons leave the spinal cord via spinal nerves and the brain via cranial nerves, and are distributed to appropriate skeletal muscles in the form of a peripheral nerve, which is a cable-like collection of individual nerve fibers. Upon reaching the muscle, each nerve fiber branches and innervates several individual muscle fibers.

Although a single motor neuron can innervate several muscle fibers, each muscle fiber is innervated by only one motor neuron. The combination of a single motor neuron and all of the muscle fibers it controls is called a **motor unit** (Fig. 1).

When a somatic motor neuron is activated, all of the muscle fibers it innervates respond to the neuron's impulses by generating their own electrical signals that lead to contraction of the activated muscle fibers.

Physiologically, the degree of skeletal muscle contraction is controlled by:

1. Activating a desired number of motor units within the muscle, and
2. Controlling the frequency of motor neuron impulses in each motor unit.

When an increase in the strength of a muscle's contraction is necessary to perform a task, the brain increases the number of simultaneously active motor units within the muscle. This process is known as **motor unit recruitment**.

Resting skeletal muscles *in vivo* exhibit a phenomenon known as **tonus**, a constant state of slight tension that serves to maintain the muscle in a state of readiness. Tonus is due to alternate periodic activation of a small number of motor units within the muscle by motor centers in the brain and spinal cord. Smooth controlled movements of the body (such as walking, swimming or jogging) are produced by graded contractions of skeletal muscle. **Grading** means changing the strength of muscle contraction or the extent of shortening in proportion to the load placed on the muscle.

Skeletal muscles are thus able to react to different loads accordingly. For example, the effort of muscles used in walking on level ground is less than the effort those same muscles expend in climbing stairs.

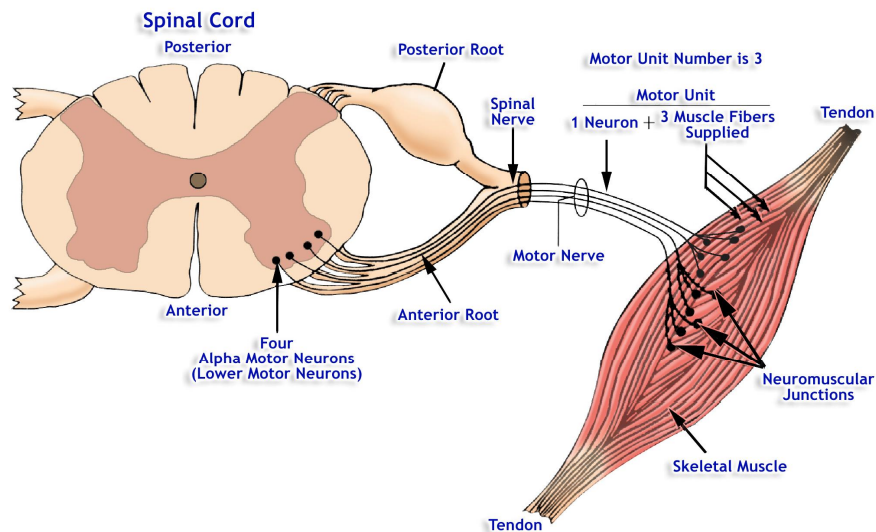


Fig. 1 Example of Motor Units

When a motor unit is activated, the component muscle fibers generate and conduct their own electrical impulses that ultimately result in contraction of the fibers. Although the electrical impulse generated and conducted by each fiber is very weak (less than 100 microvolts,) many fibers conducting simultaneously induce voltage differences in the overlying skin that are large enough to be detected by a pair of surface electrodes. The detection, amplification, and recording of changes in skin voltage produced by underlying skeletal muscle contraction is called **electromyography**. The recording thus obtained is called an **electromyogram (EMG)**.

The **EMG signal** is the recorded consequence of two principal bioelectric activities: 1) propagation of motor nerve impulses and their transmission at the neuromuscular junctions of a motor unit, and 2) propagation of muscle impulses by the sarcolemma and the T-tubular systems resulting in excitation-contraction coupling. The magnitudes of the action potentials of active motor units are not all the same nor are they in phase with one another. Furthermore, the timing sequence of motor unit activation is variable. The net result of these and other factors is a complex EMG signal. Remember we are recording all of this activity as it is detected by surface electrodes, and propagation of muscle and nerve impulses involves both depolarization and repolarization phenomena. The "spikes" therefore, will have a negative and a positive component and the amplitudes will be influenced by the location of the recording electrodes with respect to the number of active underlying skeletal muscle and motor nerve fibers.

Introduction to EMG

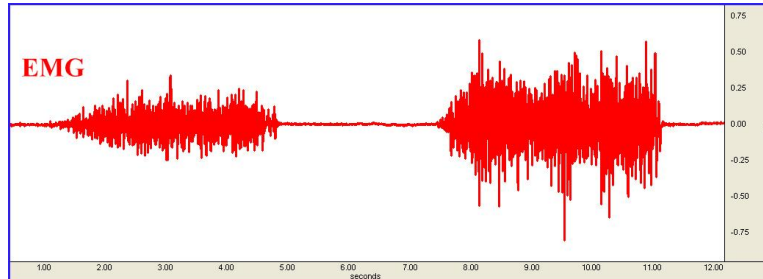


Fig. 2 EMG Signal

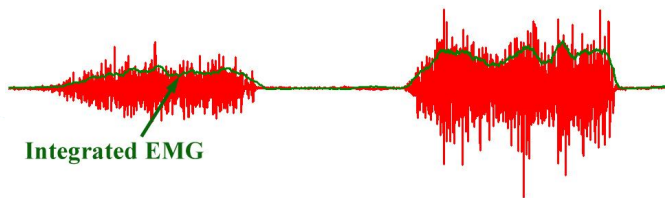


Fig. 3 Integrated EMG

Integrated EMG is an alternative view of the EMG signal that clearly shows the pattern of muscle activity. Integrated EMG averages out noise spikes in the raw EMG data to provide a more accurate indication of the EMG output level. Integrated EMG calculates a moving average (mean) of the EMG data by first rectifying each point in the sample range (inverting all negative values) and then computing the mean. In this lesson, each data point of Integrated EMG is calculated using 100 samples of data from the EMG source, so the first 100 sample points should be ignored since they reflect the number of zero values being averaged in with the first few samples of data.

What is Required to Measure EMG?

Most commonly, electrodes are applied to the skin surface near the muscle group to be measured and connected to leads or EMG transducers. The electrode types vary depending on the area from which the EMG data is to be acquired. To measure gripping strength, a hand dynamometer is used in combination with skin electrodes.

For more information about recording EMG, [click here](#)

BIOPAC products are quoted in over [8300 EMG Citations](#) and counting.

Common Applications for EMG Measurement

Biomechanics

Biomechanics is the study of movement as it relates to the muscular and skeletal systems. Sport and Exercise Biomechanics encompasses the area of science concerned with analysis of the mechanics of human movement.

Gait Analysis

Gait analysis is a method used to assess the way we walk or run to highlight biomechanical abnormalities. The major focus of gait analysis is to measure the degree of pronation. Pronation is the natural inward roll of the foot as the outside part of the heel strikes the ground. This roll acts as a shock absorber for the leg and body, optimally distributing the force of the impact of the heel hitting the ground.

Facial EMG

Human facial expressions are of interest to both psychologists and psychophysicologists. Facial electromyography (EMG) is one of the methods for measuring emotional expressions such as fear, surprise, happiness, disgust, sadness, and anger. There are differences in facial behavior on an individual level, based on subjective response.

Facial EMG can be distinguished based on the activity across specific facial muscles. Activities in the zygomaticus major muscle tend to correspond with positive emotions (happiness, surprise), and the corrugator supercilii muscle tends to correspond with negative emotions (anger, fear, disgust).

Muscular Biofeedback

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 psychophysicologists can use electrophysiological instrumentation to measure, process, and provide feedback to the subject (client, patient, athlete).

Preparing for an EMG Recording

An initial step is to decide which type of EMG electrodes to use. There are two types of BIOPAC EMG electrodes, **reusable** and **disposable**. Whichever type is used, proper preparation and application of electrodes/leads is vital for obtaining great EMG data.

Reusable EMG Electrodes such as [BIOPAC EL250 Series](#).

Disposable EMG Electrodes such as [BIOPAC EL500 Series](#).

Electrode leads are cables that attach to the skin electrodes in various arrangements depending on the muscle group to be recorded. Electrode leads, such as BIOPAC's SS2LB and BioNomadix Lead-3 series are color coded red (positive), white (negative), and black (ground.)



Figure 4: SS2LB Lead Set

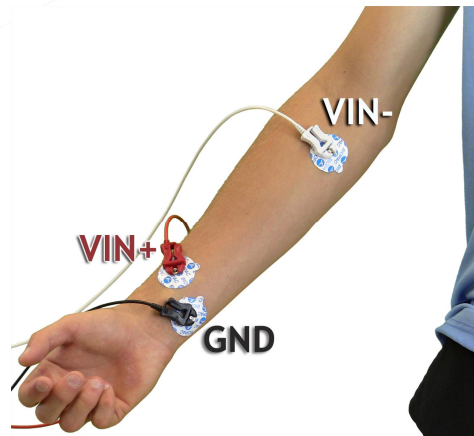


Figure 5: Example EMG Electrode Placement

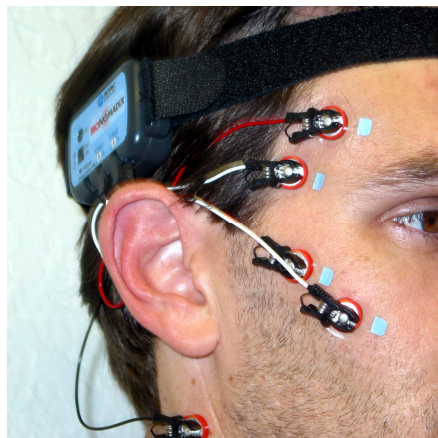


Figure 6: Leads/Electrodes for Recording Facial EMG

Tips for Preparing Subject prior to Recording EMG

- Clean skin with alcohol or BIOPAC ELPREP skin prep gel.
- Gently abrade the skin where electrodes are to be placed.
- Remove any jewelry on or near the electrode sites
- Always apply a drop of electrode gel (GEL1) to the sponge portion of electrodes before attaching
- Place electrodes at least 5 minutes in advance of recording.
- Once electrodes are placed on the skin, an impedance check (also called a %resistance+check) should be made to determine the resistance between all the applied electrodes. Resistance checking, with BIOPAC's [ELCHECK](#), should be performed between Vin+ and GND, Vin- and GND and Vin+ to Vin-. For best electrode-based measurement performance, resistance levels should be 5 K ohms or less.

Tips for Ensuring Great Data

- Make sure electrodes, leads or transducers are properly attached and cables secured.
- Participant should breathe slowly and regularly.
- Participant should keep movement to a minimum to avoid introducing unwanted artifact into the data.
- Participant should sit comfortably in a natural position with feet supported.
- If the data appears distorted or as a flat line, check to make sure the connections are in place and that the electrodes have not lost adhesion.

[Click to watch a Webinar about recording EMG data](#)

Hardware Setup - Hardware required to record EMG

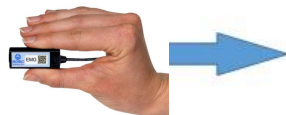
BIOPAC hardware provides three basic methods for acquiring EMG data. Wired, wireless, and cabled in the MRI environment.

Hardware Components – Wired Methods

Wired methods for collecting EMG data are appropriate for experiments where participants remain in close proximity to the data acquisition system.

MP160 System

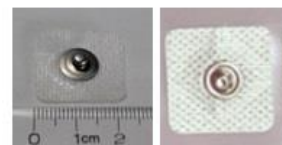
The MP160 System is a 16-channel Data Acquisition System with *AcqKnowledge* software specifically designed for the Research market. New small-form 100D Series [Smart Amplifiers](#) provide the same advanced functionality as the proven BIOPAC 100C Series modules and support 11 biopotential and transducer signals.



Reusable:
EL250 Series



Disposable:
EL500 Series



LEAD110 Series



MP160

EMG100C, EMG100D or fEMG100D

BIOPAC MP160 Research System with EMG100C or EMG100D Amplifier Module, plus EMG Leads/Electrodes
[Click to learn more about the BIOPAC MP160 System.](#)

Introduction to EMG

MP36/36R Systems

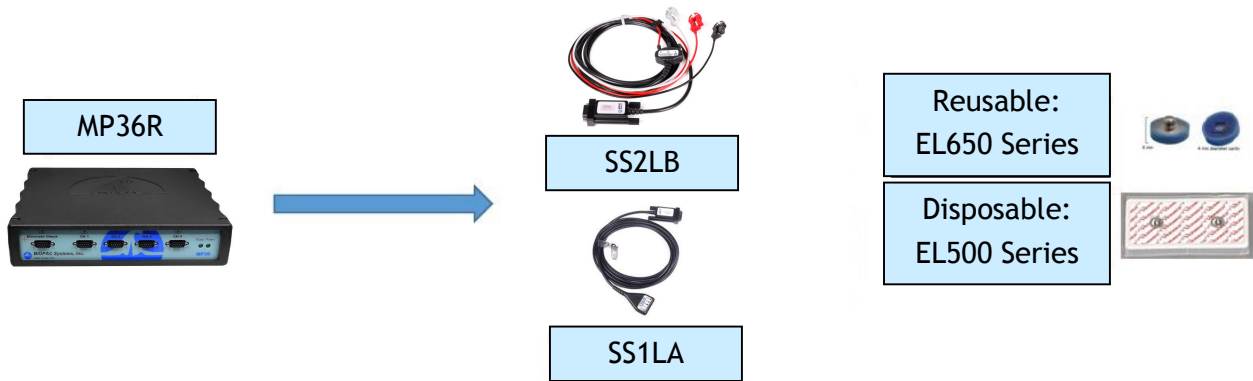
BIOPAC's 4-channel Data Acquisition System is available for



Educators: MP36 unit for Biopac Student Lab software



Researchers: MP36R unit for AcqKnowledge software



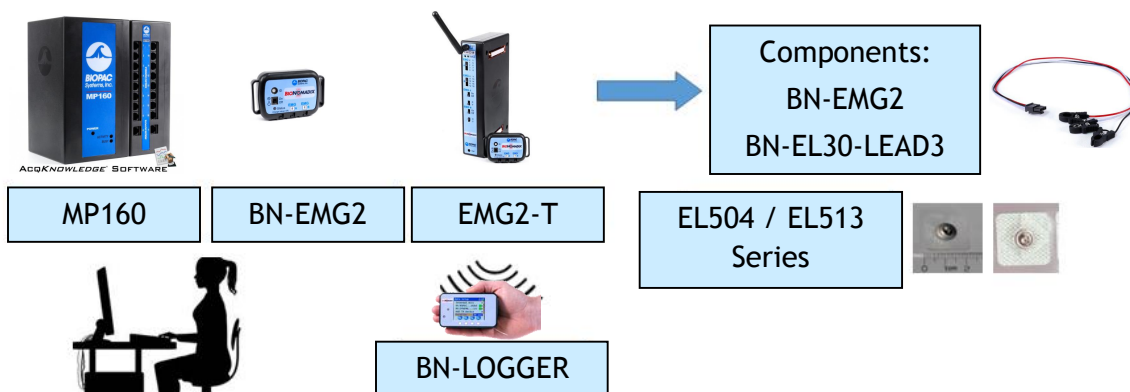
BIOPAC MP36/36R System, plus EMG Leads/Electrodes

[Click to learn more about the BIOPAC MP36R System.](#)

Hardware Components - Wireless Methods

BioNomadix

The BioNomadix System allows EMG data to be collected from ambulatory or untethered participants. The Transmitter is attached to the participant with a Velcro strap or placed in a pocket, and the data wirelessly streamed to an EMG receiver unit attached to the MP160 System. The dual-channel BioNomadix EMG Transmitter wirelessly measures electromyography (EMG) data on one or two channels.



BIOPAC MP160 Research System with BioNomadix Receiver, Transmitter, or BioNomadix Logger

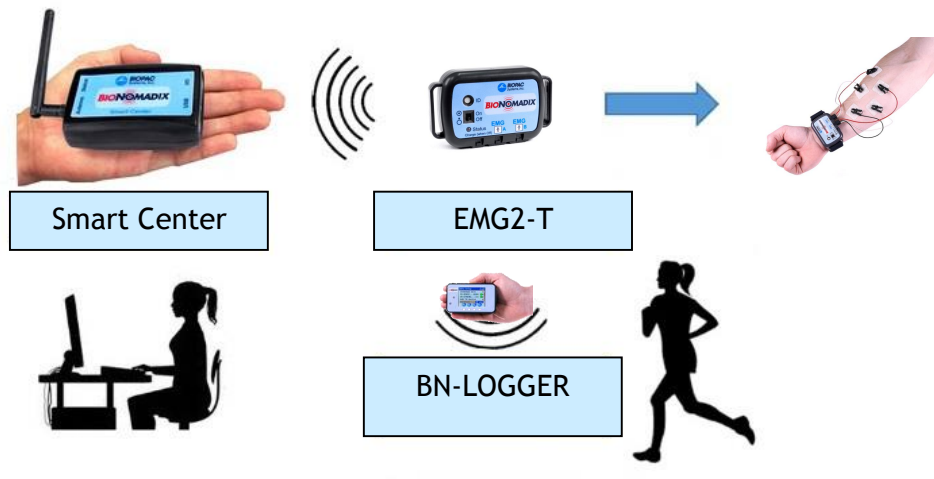
[Click to learn more about the BIOPAC BioNomadix EMG System.](#)

Introduction to EMG

BioNomadix Smart Center and BioNomadix Logger

BioNomadix Smart Center (lower left) is a portable small-form data acquisition system that allows EMG data to be collected from ambulatory or untethered participants. The EMG Transmitter is attached to the participant with a Velcro strap, and the data wirelessly streamed to the Smart Center unit.

Offering the industry's only system that delivers a comprehensive, 24-hour data logging solution in an easy-to-use, easy-to-wear package, the BioNomadix Logger (lower right) truly delivers % physiology anywhere. The BioNomadix Logger is the perfect tool for applications that demand greater degrees of subject freedom and complex experimental design.

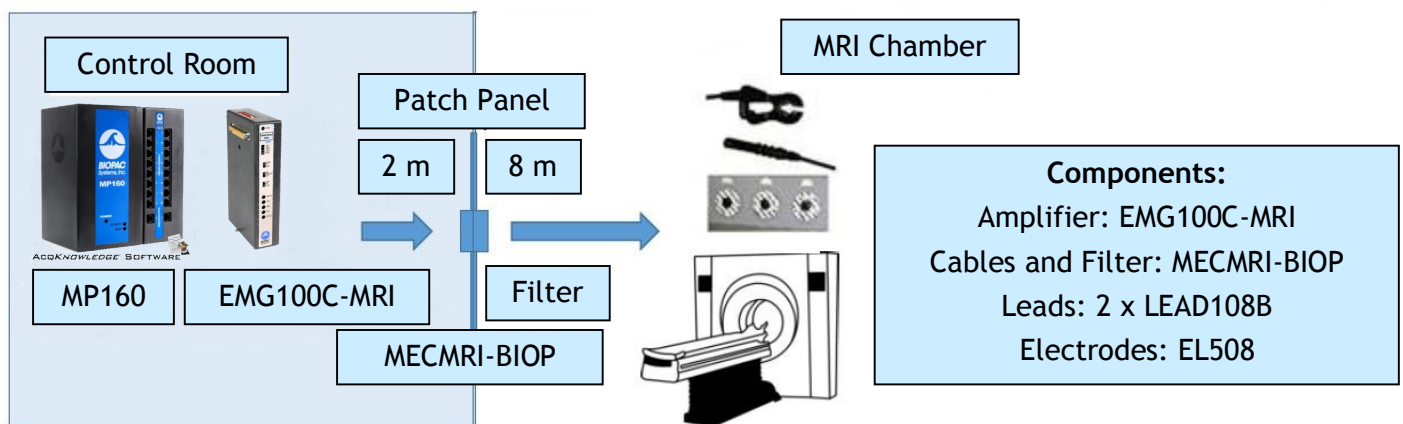


BioNomadix Smart Center and BioNomadix Logger

Hardware Components – MRI Environment

Special cabling, filters, and a BIOPAC EMG100C-MRI Smart Amplifier module is required for acquiring EMG data in the MRI chamber. BIOPAC MRI Smart Amplifiers incorporate advanced signal processing to remove signal artifacts introduced by the MRI environment. Only components rated **MR Safe+** are used inside the chamber with non-MRI components isolated outside the chamber.

The following figure depicts the BIOPAC MP160 System with components necessary for recording in the MRI.



BIOPAC MP160 Research System with EMG100C-MRI Amplifier Module cabled for MRI environment

[Click to learn more about recording in the MRI environment.](#)

Software Setup

BIOPAC Data Acquisition and Analysis Software

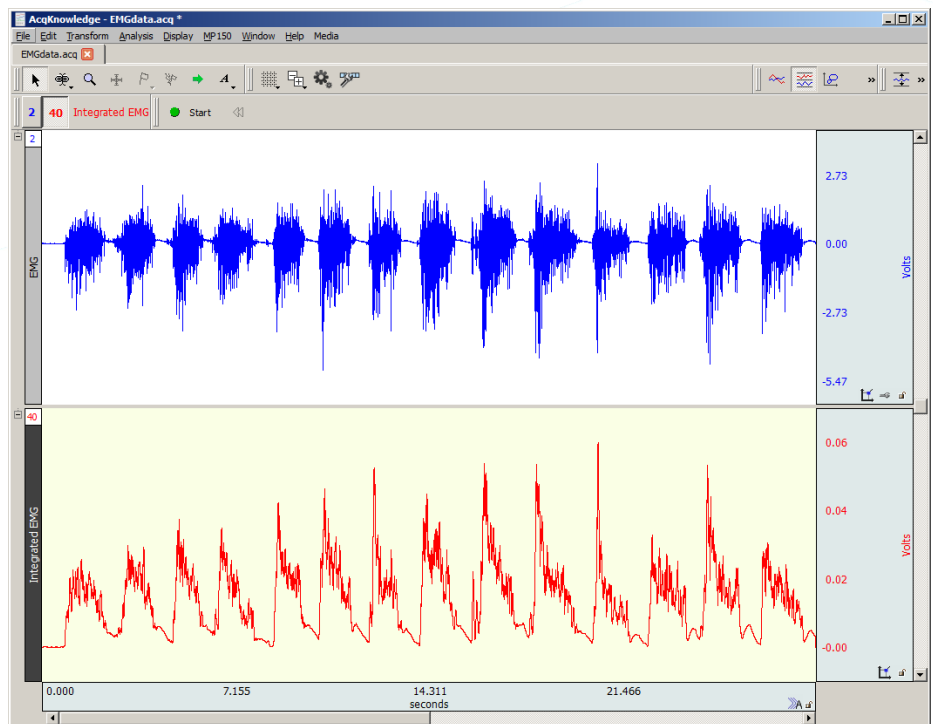
AcqKnowledge Research software or Biopac Student Lab Educational software is used to record, view and analyze EMG data.

AcqKnowledge Research Software

AcqKnowledge is used by thousands of research labs around the world and has been cited in thousands of peer reviewed publications. AcqKnowledge is included with each MP160, MP36R, BioNomadix Smart Center System, and BioNomadix Logger.

AcqKnowledge is an interactive, intuitive program that allows you instantly view, measure, transform, replay, and analyze data.

With the wired or wireless MP160 Systems, up to 16 channels of physiological data can be recorded simultaneously, ECG, EMG, EEG, EDA, EEG, EOG, Respiration, and more. Additionally, up to 16 digital and 16 online calculation channels are available.



With the MP36R System, up to 4 channels of physiological data, 8 digital channels, and 16 online calculation channels are available. Pre-configured software presets assist in simplifying setup.

[Click for more information about AcqKnowledge Software.](#)

[Click to watch a Webinar about recording EMG data](#)

[Click to view or download a full EMG Product Resource Sheet](#)



Introduction to EMG

The Smart Center System supports up to 9 channels of physiological data from up to three BioNomadix transmitters at a time. Online calculation channels are available for many transmitters, easily selectable by checking a box. The full range of 14 BioNomadix transmitter types are supported. Guided prompts in *AcqKnowledge* for Smart Center software assist with setup and pairing to have you recording data within minutes.

The BioNomadix Logger wirelessly records physiological data as subjects freely and naturally live their lives. Connect up to three transmitters to the Logger for data logging or use with BioNomadix receivers operating in the lab and view data in *AcqKnowledge*. Or sync the BioNomadix Logger with GPS for a correlation between physiological and location data.

So, regardless of which system you choose, EMG data can be easily and accurately recorded in conjunction with other body signals.

With *AcqKnowledge*, perform complex data acquisition, stimulation, triggering and analyses using simple pull-down menus and dialogs- no need to learn a programming language or new protocol.

Online analysis settings, filters, and transformations provide real-time feedback, or choose from a wide variety of off-line analysis tools. Multiple display options are available during and after acquisition- click an icon to flip between Chart, Scope, X/Y, Overlapped segments. Histograms, FFTs, and other essential transformations are easily applied, offering enhanced data analysis.



Biopac Student Lab Educational System

The Biopac Student Lab system is an integrated life science teaching solution that includes MP36 hardware, BSL 4 software and [curriculum materials](#) that students use in undergraduate laboratories to record data from their own bodies, animals or tissue preparations. The system includes over sixty-five complete lessons that educators use as part of undergraduate lab courses.

Use BSL Lessons for lab curriculum or powerful BSL *PRO* for advanced lessons, custom experiments and analysis. Both applications are included in the BSL 4 software.



EMG Lessons for Education include:

[Lesson 1 . Electromyography I](#)

[H27 . Facial EMG](#)

[Lesson 2 . Electromyography II](#)

[H34 - Electrogastrogram](#)

[H06 . Finger Twitch](#)

[H35 . ROM Sit and Reach](#)

And more!

With the MP36 System, up to 4 channels of physiological data, 8 digital channels, and 16 online calculation channels are available. Pre-configured software presets assist in simplifying setup.

[Click to review the Biopac Student Lab Curriculum page.](#)

[Click for more information about the Biopac Student Lab Educational Systems.](#)

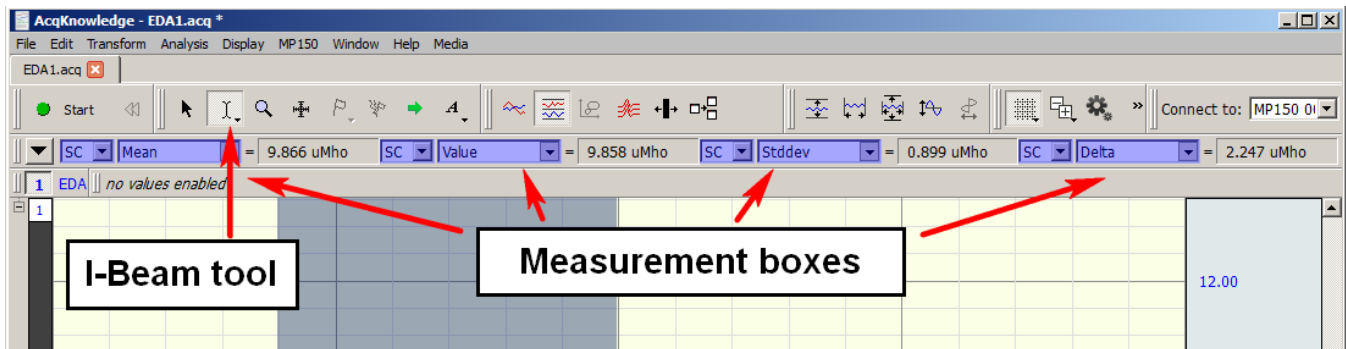
EMG Data Analysis

In *AcqKnowledge* Research and Biopac Student Lab Educational software, powerful viewing tools allow for the selection, editing, and zooming of data. More than 40 measurement types can be extracted, and over 20 transformations and filters can be applied to clean the data.

There are three main ways to approach, explore and analyze EMG data.

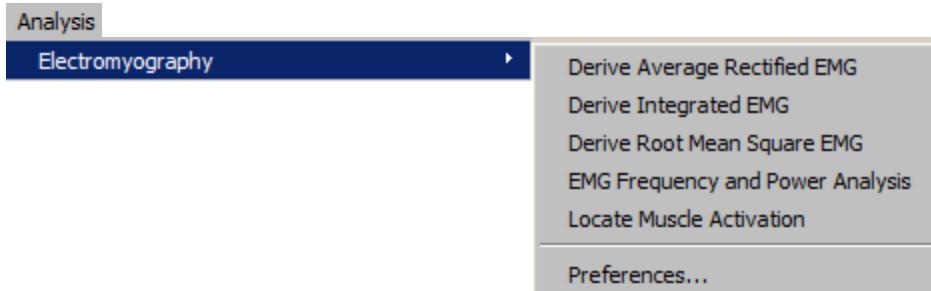
1. Manually, by using the software's I-Beam selection tool in conjunction with selected measurements.
2. Via a series of EMG automated analysis routines included in *AcqKnowledge* software.
3. Using the software's Analysis > Find Cycle routine.

The I-Beam tool in BIOPAC software allows highlighting of specific regions of the signal for analysis. This tool works in conjunction with the measurement boxes (which provide the output from the region highlighted by the I-Beam tool), which can be configured to provide specific mathematical information via individual pop-up menus.



Measurements useful for analyzing EMG data

- Mean: returns the arithmetic mean for the whole area highlighted by the I-Beam (averaged across peaks, troughs, etc).
- Value: returns the exact value (level of the signal) at the point where the mouse button was last released.
- Peak-to-Peak: Subtracts the minimum value from the maximum value found in the selected area.
- Delta: provides the difference between the values at the left and right edges of the selected data. Particularly useful when used in conjunction with the %Find Cycle+ routine.
- Delta T: provides an accurate time period of the area being highlighted.
- Min / Max: provides values for the minimum and maximum values encountered in the highlighted areas and is useful for calculating the range of values.
- Additionally in *AcqKnowledge* software, the following fully automated analysis routines are available.



EMG Automated Analysis in AcqKnowledge Software

Derive Average Rectified EMG

Derive Average rectified EMG (ARV) is defined as a time windowed mean of the absolute value of the signal. ARV is one of the various processing methods used to construct derived signals from raw EMG data that can be useful for further analysis.

Derive Integrated EMG

Integrated EMG (iEMG) is defined as the area under the curve of the rectified EMG signal, that is, the mathematical integral of the absolute value of the raw EMG signal.

Root Means Square EMG

Root Mean Square EMG (RMS EMG) is defined as the time windowed RMS value of the raw EMG. RMS is one of a number of methods used to produce waveforms that are more easily analyzable than the raw EMG.

EMG Frequency & Power Analysis

Several frequency domain techniques may be used for data reduction of EMG signals. The EMG Frequency & Power Analysis script extracts several measures derived from the power spectrum of an EMG signal. The EMG signal is split up into a fixed number of time periods; within each window, the power spectrum is computed using the Power Spectral Density transformation. For each time period, the following measures are extracted: Median Frequency, Mean Frequency, Peak Frequency, Mean Power, and Total Power.

Locate Muscle Activation

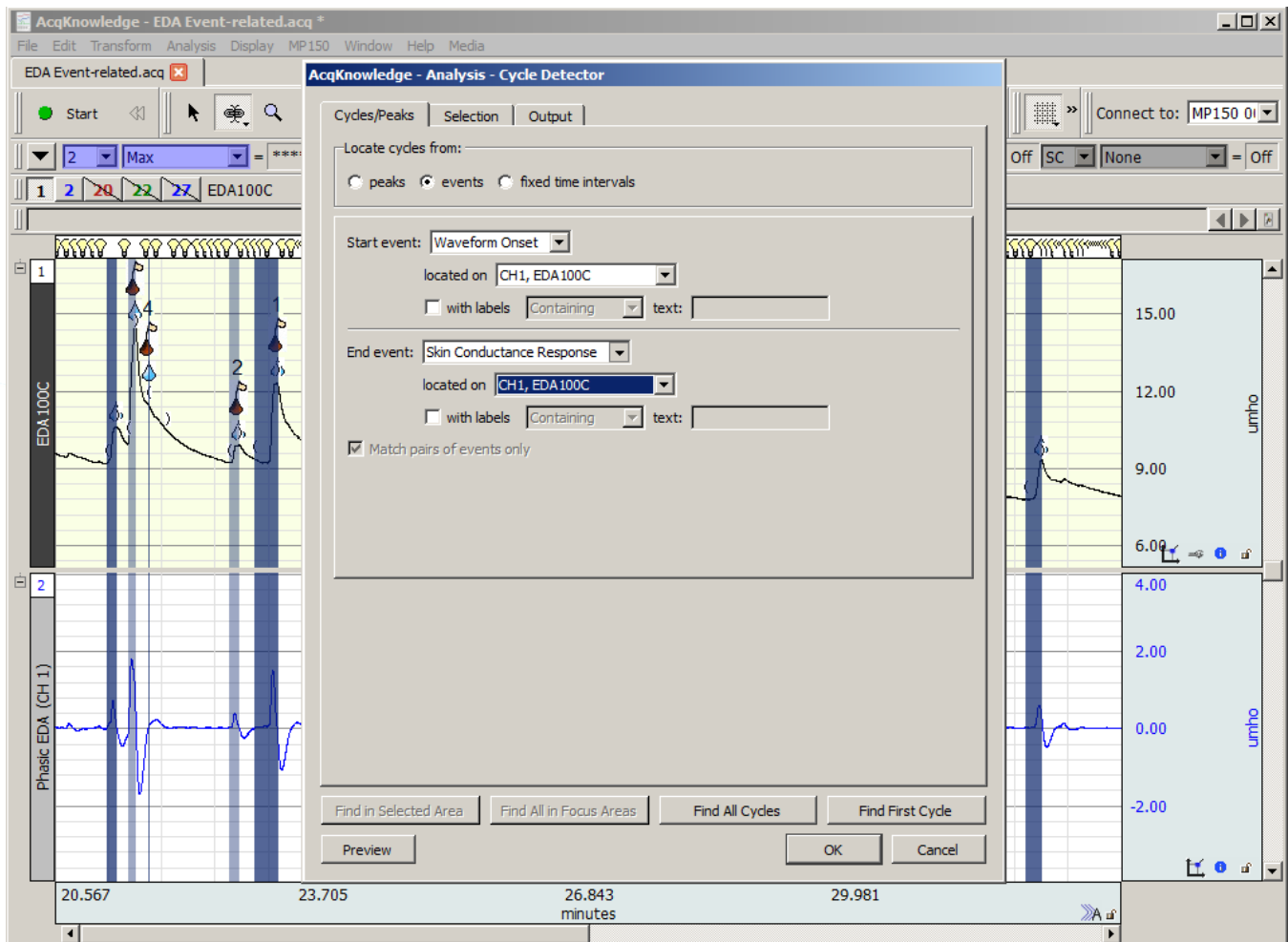
When performing gait analysis, exercise physiology, startle response, or other research, identification of periods where the muscle is active can allow for correlation of external factors to muscle activity. Locate Muscle Activation attempts to identify various periods of muscle activity using statistical methods. The transformation requires a raw, unfiltered surface EMG channel. It is important that the muscle being examined is relaxed for the first 0.25 seconds of the recording to provide an estimate of the "background noise" during areas of muscle relaxation. This quarter-second period is used to estimate baseline parameters that affect the entire process.

[Click to find out more about Automated EMG Analysis](#)

Introduction to EMG

A third method for extracting amplitudes and other variables from all significant events in data is by using the Find Cycle Analysis routine. This feature can provide a spreadsheet or Journal output of values corresponding to selected events and measurements.

[Click to watch Find Cycle feature tutorials.](#)



[Click to watch a webinar about how to get great EMG data](#)

[Click to watch a webinar about how to analyze EMG data](#)

We also encourage you to review the linked EMG resources on the following pages.

Introduction to EMG

Video Tutorials for Analysis

[EMG Frequency and Power Analysis](#)
[EMG Locate Muscle Activation](#)
[EMG Derive Average Rectified](#)
[EMG Derive Integrated](#)
[EMG Derive Root Mean Square](#)
[EMG Cleaning Data EMG Example](#)
[Wireless Neuro Controlled Prosthesis](#)
[Horse EMG Running on Treadmill and Data](#)
[EL- CHECK Portable Impedance Checker from BIOPAC](#)

Knowledge Base

[EMG Underwater Measures](#)
[EMG Artifact in EMG Signal](#)

Hardware Options for EMG



WIRED

[EMG100C](#) Advanced Amplifier for Research
[MP36RWSW](#) 4-Channel Data Acquisition System
[MP160WSW](#) 16-Channel Data Acquisition System
[EL503](#) General Purpose Electrodes
[EL504](#) Cloth Based Electrodes
[EL258S](#) AG-AGCL Electrodes
[SS2LB](#) Lead Set BSL
[TSD150A](#) Designed for Multiple Channel Surface EMG (sEMG)
[EL513](#) Disposable Cloth Facial Electrodes
[LEAD110](#) Lead Wire with Clip for EL500 Series



WIRELESS

[BN-EMG2](#) 2 CH Wireless EMG Amplifier
[BN-EMG2-T](#) 2 CH Wireless EMG Transmitter
[BN-EL15-LEAD3](#) Electrode Leads BioNomadix Wireless
[BN-EL15-LEAD2](#) Electrode Leads BioNomadix Wireless
[BN-CLENCH-XDCR](#) Transducer for Wireless Wearable Physiology
[BN-LOGGER-1](#) Logger supports complex experimental design
[BN Smart Center](#) Essentials System includes BioNomadix EMG, Enhanced System includes extra transmitters and BN-Logger



MRI

[EMG100C-MRI](#) Wired MRI EMG
[MECMRI-BIOP](#) MRI Filtered Cable Sets
[EL510](#) Disposable Electrodes

Application Notes

214 - [EMG Startle Scoring for Prepulse Inhibition Studies](#)
118 - [EMG Signal Analysis](#)
165 - [Integrated EMG](#)
232 - [EMG Normalized to Maximum Voluntary Contraction](#)
235 - [Zygomaticus Measures](#)
233 - [Heart Rate Variability- Preparing Data for Analysis](#)
241 - [Recording EMG Data in an FMRI](#)



Introduction to EMG

Automated Analysis with AcqKnowledge

[Active Electrodes and Fine Wire EMG](#)

[Automated EMG Analysis](#)

[Automatic Spike](#)

[EMG and Force](#)

[EMG Power Spectrum Analysis](#)

[Facial EMG and Startle Response](#)

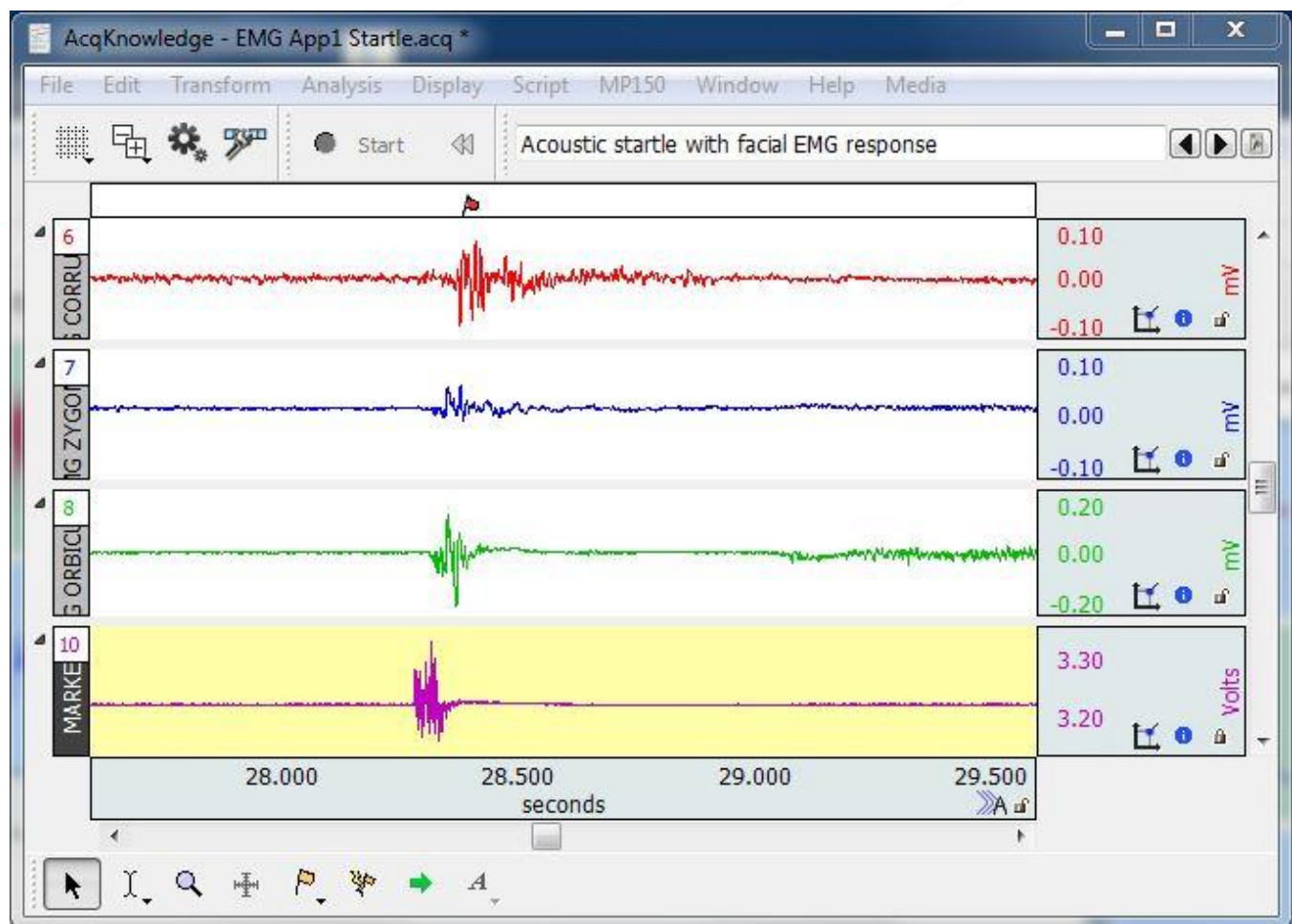
[H-Reflex Methodology](#)

[Histogram Analysis](#)

[Subject Mobility](#)

[Interface with Imaging Equipment](#)

[Synchronize with Video Capture](#)



Research Citations

Selected citations below- [search online](#) for more than 8,300 BIOPAC Citations for EMG.

[Effect of Yelling on Maximal Aerobic Power during an Incremental Test of Cycling Performance](#)

C.L. Chen, et al. (2015). *Journal of Sport and Health Science*.

[Evaluation of Electromyographic Frequency Domain Changes during a Three-Minute Maximal Effort Cycling Test](#)

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