



## Teaching Notes

# BioCapture™ : Acquiring EEG data

The BioRadio™ is intended for use in education and research applications only. The BioRadio has not yet been reviewed, certified, or approved by the FDA or similar organization for use with patients or clinical purposes. In no case should the BioRadio be used for any diagnosis, treatment or other medical decision-making purposes. All use of the BioRadio must be in compliance with 45 CFR 46 and appropriate human subjects' procedures as they exist within your institution.

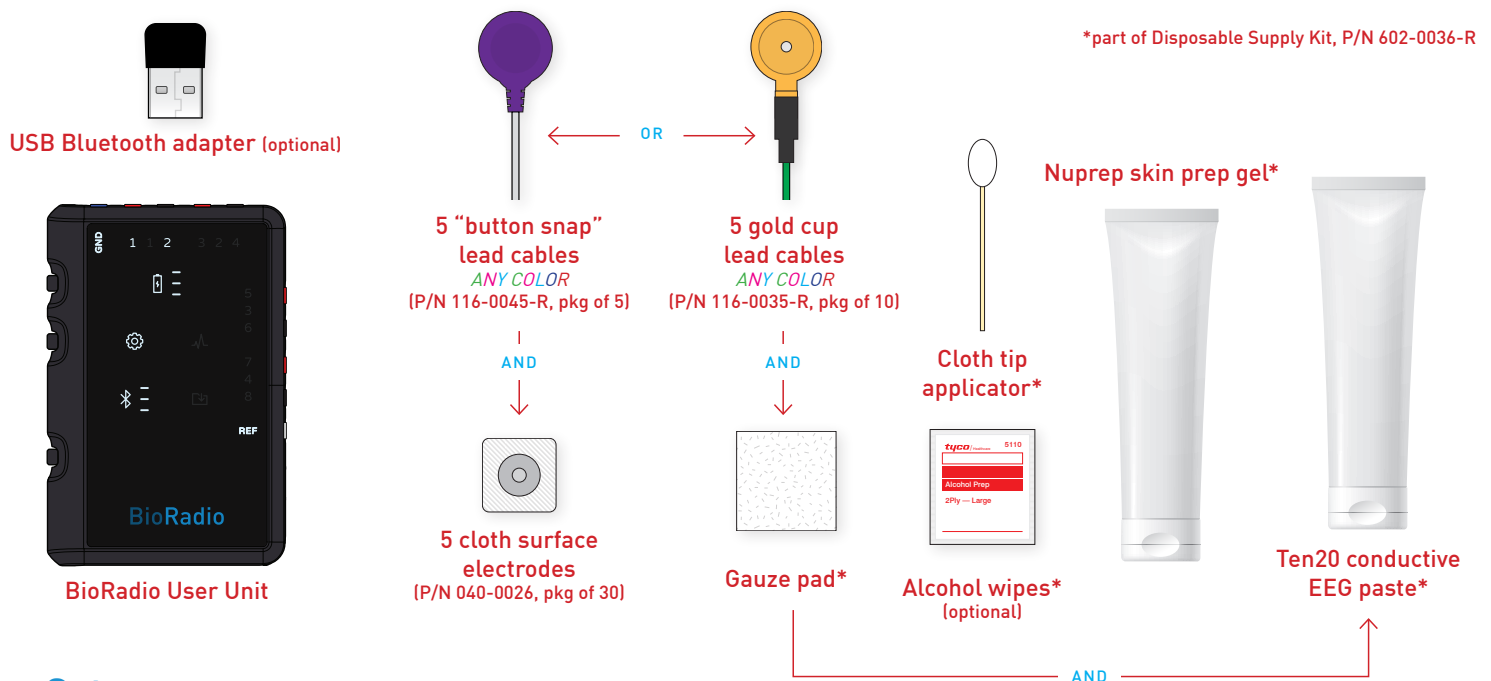
**E**lectroencephalography (EEG) is a recording used to measure the synaptic electrical activity of the brain. The BioCapture system uses electrodes on the scalp and forehead to monitor the average behavior of millions of brain cells or neurons. There are several practiced ways of acquiring an EEG signal. This Quick Note will demonstrate a basic 2-channel EEG recording of the brain's frontal poles (Fp1 and Fp2), on the frontal lobe of the cerebrum—the largest part of the brain, based on a common method for recording EEG.



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## What you will need



## Setup

Before applying electrodes to the subject, it is important to properly prepare and clean the electrode sites. The sensitivity of an EEG signal display suggests using a gentle exfoliant (skin prep gel) to remove dirt, oils and any dead skin cells. Using skin prep gel and alcohol wipes to remove oil and dirt from the skin. After which, make sure the skin of the forehead (frontal lobe) and the lower bone behind both ears (mastoids) is clean and dry.

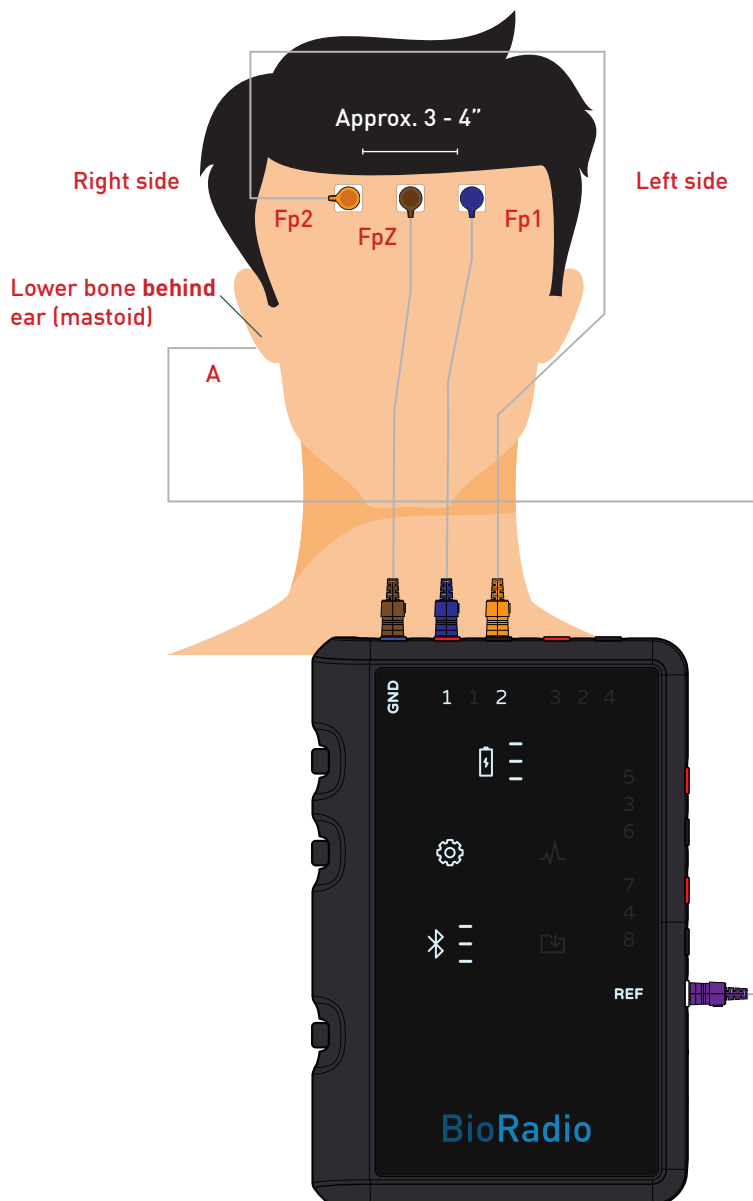
**i** If sweating occurs, the electrode contact will diminish and you may have to repeat this process in order to ensure sufficient skin/electrode contact.

With you or a subject sitting and relaxed, place cloth surface electrodes:

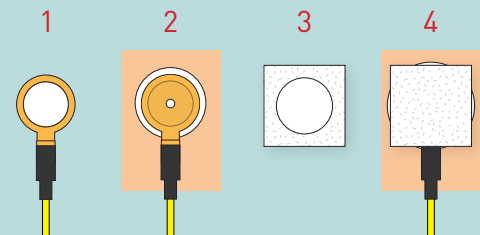
- Two cloth surface electrodes (Fp1 and Fp2) on the forehead.
- One cloth surface electrode (A) on the bone (mastoid) behind an ear.
- One cloth surface electrode (FpZ) in between the two electrodes on the forehead.  
*This is the Ground electrode.*

Connect **ANY COLOR** lead cable to each cloth surface electrode.

## 2-Channel EEG hook up



For EEG signal display from the scalp, **gauze, conductive EEG paste,** and **gold cup electrode cables** are required. Gold cup electrode cables and conductive paste are designed to work in tandem when recording EEG signals from the scalp in the presence of parted hair. Below are steps for setting up gold cup electrode cables.



1. With a gold cup electrode cable face up, fill inside with conductive EEG paste
2. Apply gold cup electrode cable face down to skin
3. Add a dime size amount of electrode paste to gauze
4. Apply gauze—side with electrode paste face down—on top of gold cup electrode cable

## Connecting electrode cables to BioRadio User Unit

Connect the electrode cables to the BioRadio User Unit in the following manner:

- Fp1 → Ch1
- Fp2 → Ch2
- A → REF
- FpZ → GND

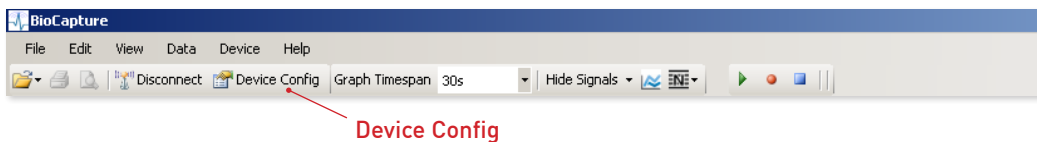


To prevent interference from affecting EEG signal data, twist or bundle together any dangling cables, or tape any dangling cables to the skin with medical tape.

Connect the FpZ ('Ground') electrode cable to the GND input of the User Unit.

## Configuring your BioCapture system

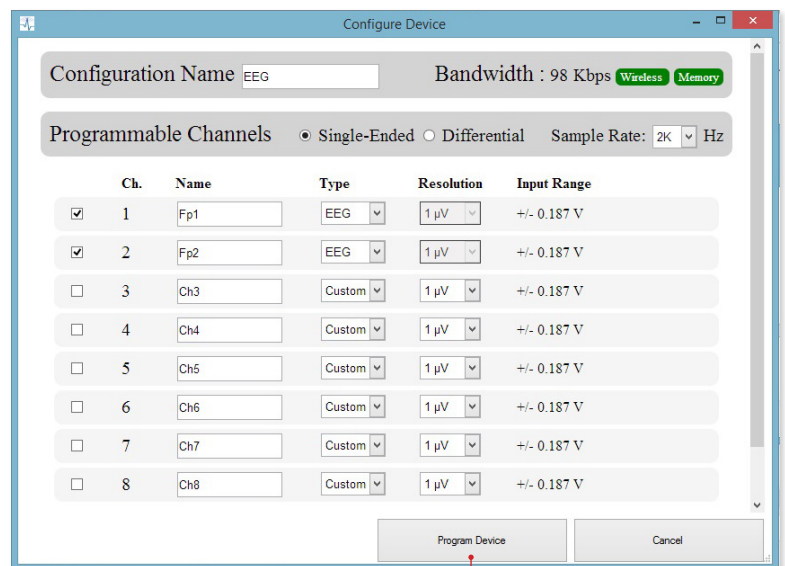
With BioCapture launched and your BioRadio turned on, connected and ready for use, press Device Config, from the tool bar to configure the BioRadio for two channels of EEG.



From the Configure Device window, select Single-Ended, enable Channel 1 ('Ch1') and Channel 2 ('Ch2'), type in Fp1 and Fp2, respectively, for custom names, and select EEG, under the Type drop down box.

Ensure that all other inputs are disabled. For this demonstration, Sampling Rate can remain as-is.

**i** For further reading on Sampling Rate and Resolution, please refer to the BioCapture Owner's Manual.



Program Device

Press Program Device to program your BioRadio.

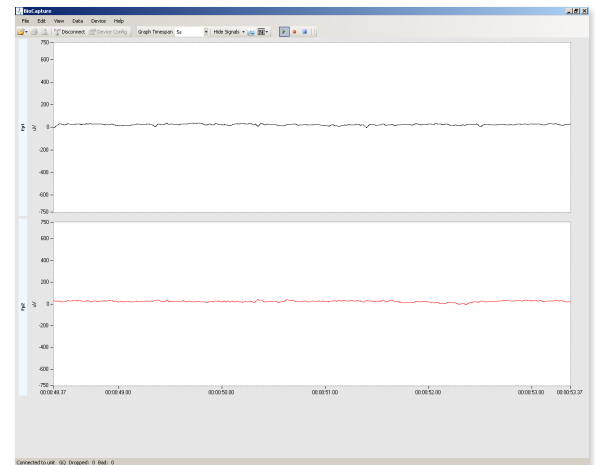
## Acquiring EEG data

Your BioCapture system should now be ready to collect two channels of EEG. Please note that the EEG configuration option presets the following display properties: y-axis max/min, custom filters, gain and offset.

With the arms at rest and relaxed, press Start Acquisition from the tool bar, to begin acquiring data. Two small data traces will appear.

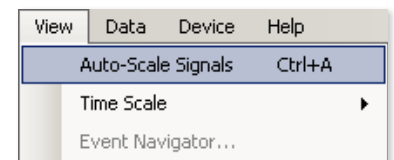


Start Acquisition



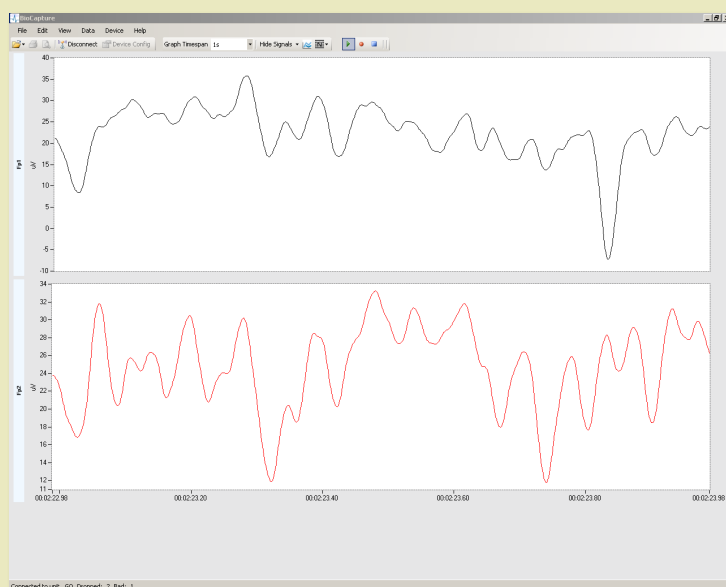
▲ Referential EEG signal display of Fp1 and Fp2, with default display settings

**i** You may need to access the Y-Axis Set Max/Min option for a more interpretable EEG signal display. The EEG hardware configuration option sets a display range of  $\pm 750 \mu\text{V}$  (microvolts). You can also auto-scale all signals by pressing Ctrl + A or by selecting View > Auto-Scale Signals.



▲ Auto-Scale Signals

## EEG signal display: A network of electrically excitable neurons



▲ Referential EEG signal display of Fp1 and Fp2, auto-scaled.

Like muscle cells, all neurons, or brain cells, are electrically excitable, meaning that the voltages recorded in BioCapture are the neurons reacting to an electrochemical imbalance due to external stimuli. The change in EEG signal display reflects an average change in the net voltage of brain cells. Voltage-dependent ion channels and pumps within the cells create an “all-or-none” electrochemical pulse called an action potential. This pulse, which travels rapidly along the cell’s body, activates synaptic connections of other brain cells. As a result, the signal display reveals a network of brain cells working together in unison.

## EEG, delta waves and the Stroop Test

EEG activity shows wave patterns at a variety of oscillations or waves—delta, theta, alpha, beta etc. These patterns have particular frequency ranges and are associated with different states of brain function (e.g., waking and various levels of sleep). These patterns represent synchronized activity over a network of neurons.

Delta waves are the slowest of the known EEG frequencies—no faster than 4 Hz or about  $\frac{1}{4}$  second between each delta wave. Delta waves can be seen in the cerebral cortex of the frontal lobe.

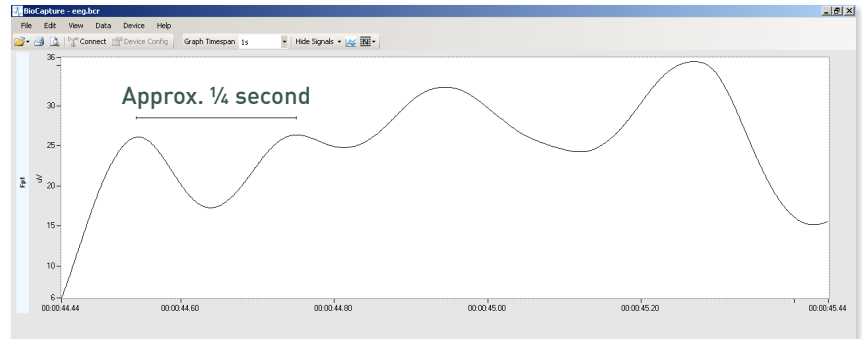


EEG and functional neuroimaging studies of the Stroop Effect have consistently revealed activation, as your brain is “tricked” by having the subject name the color of the font rather than the color name that is typed.

**GREEN   RED   YELLOW**  
**BLUE   YELLOW   GREEN**  
**RED   GREEN   BLUE**

A Stroop Test is considered to measure selective attention, cognitive flexibility, and processing speed, and it is used as a tool in the evaluation of executive control.

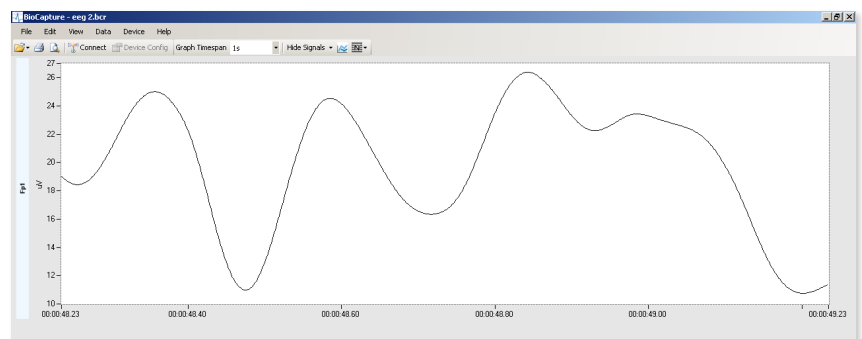
Try an interactive Stroop Test at <http://faculty.washington.edu/chudler/java/ready.html>



▲ EEG delta waves (bandpass filter with cutoffs at .5 Hz and 4 Hz applied)

According to clinical research, delta waves correlate to executive control, which includes the brain’s ability to focus, problem solve as well perform verbal reasoning, inhibition, mental flexibility and multi-tasking. These cognitive processes put millions and billions of frontal neurons to work. The more cognition required, the greater the delta wave’s amplitude.

A **Stroop Test** (see sidebar) is a demonstration of the reaction time of a task. When the name of a color (e.g., “blue,” “green,” or “red”) is printed in a color not denoted by the name (e.g., the word “red” displayed in blue instead of red), naming the color of the word takes longer and is more prone to errors than when the color of the word matches the name of the color.

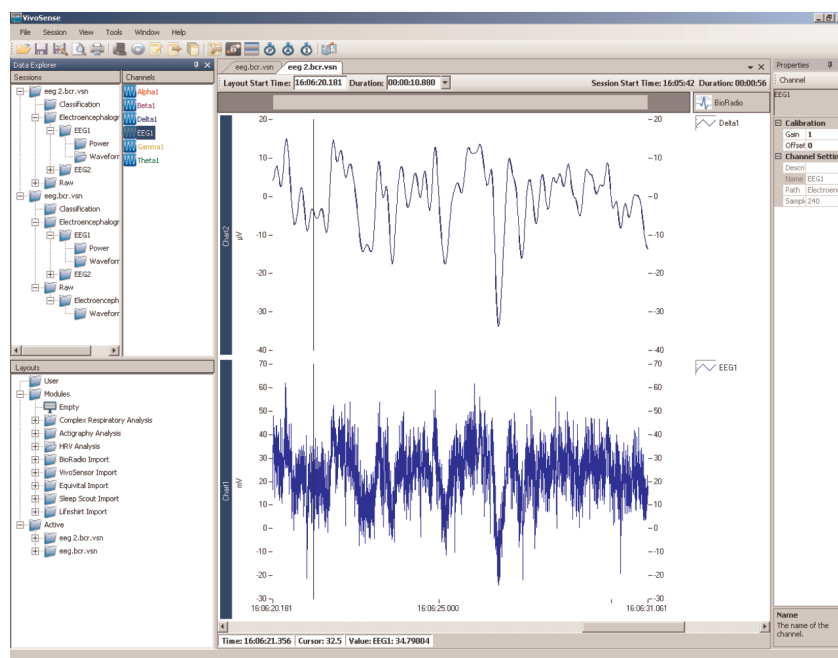


▲ EEG delta waves during Stroop testing

## Ready. Set. Go!

You are now familiar with an essential 2-Channel EEG recording. For further reading on EEG, please refer to the BioCapture Owner's Manual and/or the following references:

- Guyton and Hall. Textbook of Medical Physiology, 9 Edition, Saunders, Philadelphia, 1996.
- Kandel ER, Schwartz JH, Jessel, TM. Essentials of Neuroscience and Behavior, 1995.
- Kooi, Kenneth A. Fundamentals of Electroencephalography, Harper & Row, Hagerstown, MD. 2nd Ed., 1978.



▲ EEG data may be difficult to visually interpret without the aquisiton and interpretation of other parameters, such as ECG or EMG. As such, signal analysis programs are necessary for proper interpretation.

BioCapture and BioRadio are trademarks of Great Lakes NeuroTechnologies Inc., Independence, OH. Acknowledgments: This work utilizes technologies supported by Small Business Innovation Research grants from the National Institutes of Health (NINDS, NHLBI, NIMH) and the Department of Defense.

## HAVE QUESTIONS? NEED TECHNICAL SUPPORT? WE'RE HERE TO HELP.

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