

ETR556
UX RESEARCH TECHNOLOGY

Brain Wave Monitoring System
Emotive with 5 Channels

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Introduction

The purpose of the paper aims to introduce an EEG product referred to as EmotivPRO v1.3.0 from the perspective of its potential application in educational research, advantages and disadvantages, and data collection, exporting and analysis through an exploratory step-by step procedure.

The product is the Emotiv Insight model 1.0

The software used in the manual is EmotivPRO v1.3.0



[Emotiv](#) was founded in 2011, and has quickly become one of the biggest EEG hardware companies around. They currently offer two headsets that can detect various emotional states,

and can be used for brain-computer interfaces. We will be looking at the 5 sensor EmotivPRO v1.3.0 The company's goal was to “empower individuals to understand their own brain and accelerate brain research globally”, they certainly seem to be on track.

Some suggested uses for this type of technology

- Biomedical Engineering
- Studying brain waves for moving robotic limbs
- Consumer neuroscience to investigate an users engagement and motivation in real world applications
- Market research testing product and brand effectiveness
- Website usability testing
- Measuring cognitive load during training or instruction
- Medical diagnosis
- Neurobiological research

Literature Review

Research shows the significance and challenges of applying Electroencephalography (EEG) in educational research in regards to the remarkable value of neuroscience to learning, instruction, and performance (Antonenko & Keil, in press; Antonenko, van Gog, & Pass, 2014; Xu & Zhong, 2018). EEG provides a physiological monitoring method to record the electrical activity generated by the brain from electrodes attached to the scalp (Hughes, 1994). These electrodes are held tightly via a fitting headpiece to the head and skin to measure the brain waves in Hertz units designated *alpha*, *beta*, *delta* and *theta* (Hughes, 1994). Lawrence (1972) elaborated on these four types of brain waves respectively: the slowest but the most prominent *delta* brain waves occur in states of deep and dreamless sleep; *theta* brain waves occur in states of drowsiness, creativity, and the dream portion of the sleep cycle; *alpha* brain waves occur in relaxed yet alert mental states; and the fastest waves, which are *beta*, occur to the moments of attending, orienting, and coping skills as well as states of anxiety. In addition, EEG measures the amplitude of brain waves with regard to *absolute power*, which indicates the cumulative amount of recorded brain activity and *relative power*, which specifies how much brain activity is shown in the bands connected to each electrode location (Belkofer & Konopka, 2008).

EEG has been considered as one of the fastest imaging techniques and an innovative tool for conducting research in various educational contexts such as language and reading, presentation patterns, interactive behavior, e-learning , motor skills acquisition, and art therapy (Antonenko & Keil, in press; Antonenko, van Gog, & Pass, 2014; Belkofer and Konopka, 2008; iMotions, 2016; Xu & Zhong, 2018). For example, Belkofer and Konopka (2008) conducted a study of using EEG to measure the pattern of electrical activity of one art therapy student’s brain during an experimental period of one hour of painting and drawing using paired sample *t*-tests. Findings showed a statistically significant difference of the neurobiological activity between pre- and

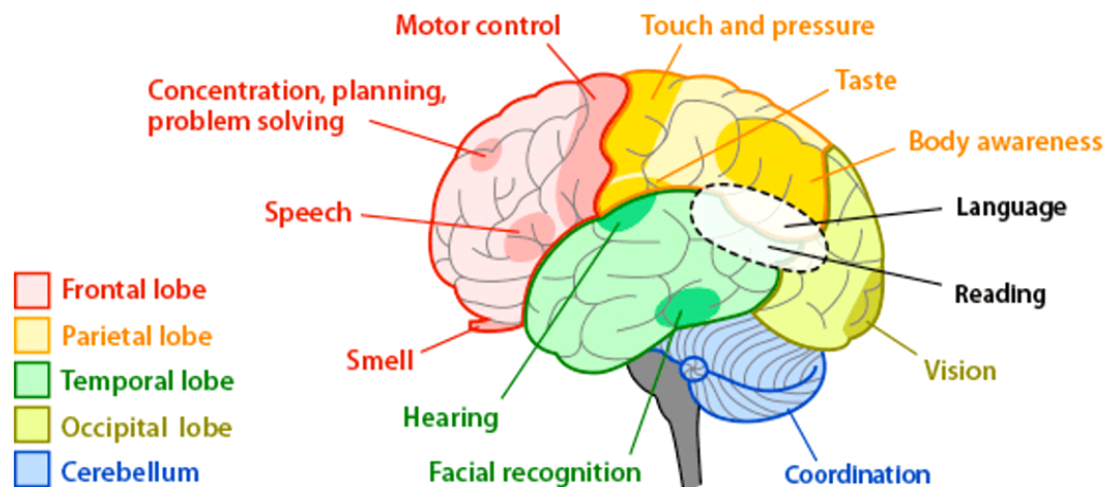
post-art making EEG data. Ayvaz, Yaman, Mersin, Yilmaz, and Durmus (2017) operated an EEG device named Neuron-Spectrum 4 to examine the primary mathematics teacher candidates' perceptions about the equal sign. The reported EEG data revealed different cognitive activity in the parietal lobe when solving different types of questions. Comparing EEG with functional magnetic resonance imaging and functional near-infrared spectroscopy, Antonenko and Keil (in press) addressed the uniqueness of employing EEG as a measurement of working memory dynamics in authentic educational contexts because EEG identifies temporal and spontaneous types of cognitive load. Antonenko and Keil also pointed out the weaknesses of using EEG in educational research, including “relatively poor spatial resolution, high susceptibility to a variety of artifacts, and the necessity to collect multiple trials to isolate the brain activity of interest from noise” (p. 11).

Research Areas

The EmotivPRO v1.3.0 is used typically for medical diagnosis and neurobiological research.

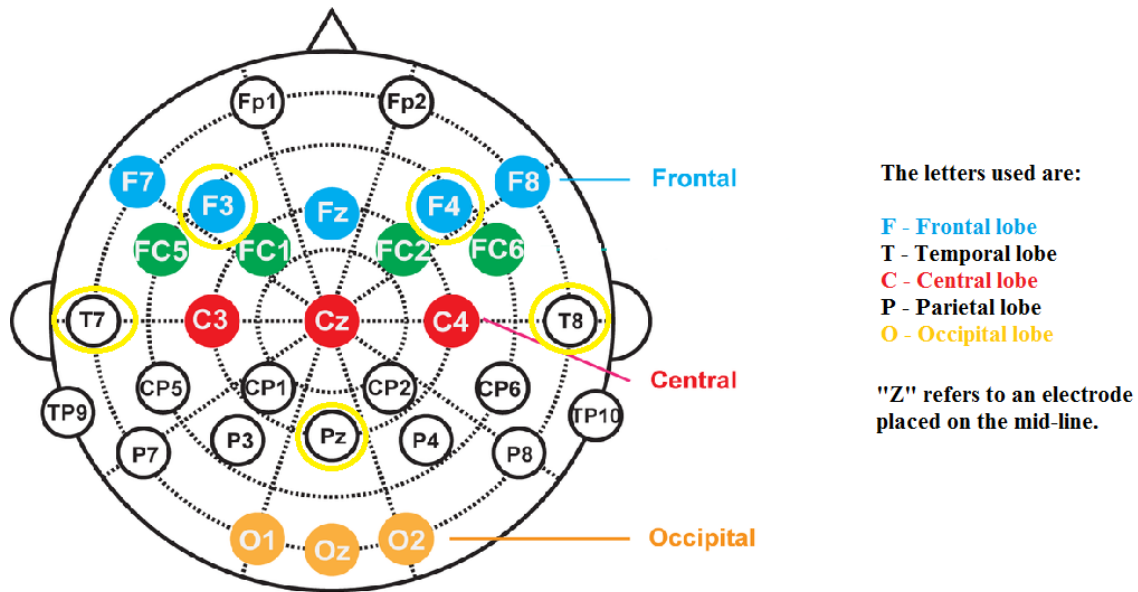
EEG brain waves:

Formal standard is called the 10/20 System. This standard gives the approximate locations of where to place the electrodes.



Brain Structures and Their Functions. (2013)

(Fp = frontopolar; F = frontal; C = central; P = parietal; O = occipital; T = temporal).



Researchgate.net Jul, 2018

Odd numbers are used in the left hemisphere and even numbers in the right hemisphere. Larger numbers indicate greater distances from the midline. Electrodes placed at the midline are labeled with a "z" for zero. The 5 sensors on the EMOTIV Insight are:

(highlighted with yellow circles above)

- AF3 - Attention
- T7 – Verbal Memory
- Pz- Ground / Reference
- T8 – Emotional memory
- AF4 – Judgment

Bands:

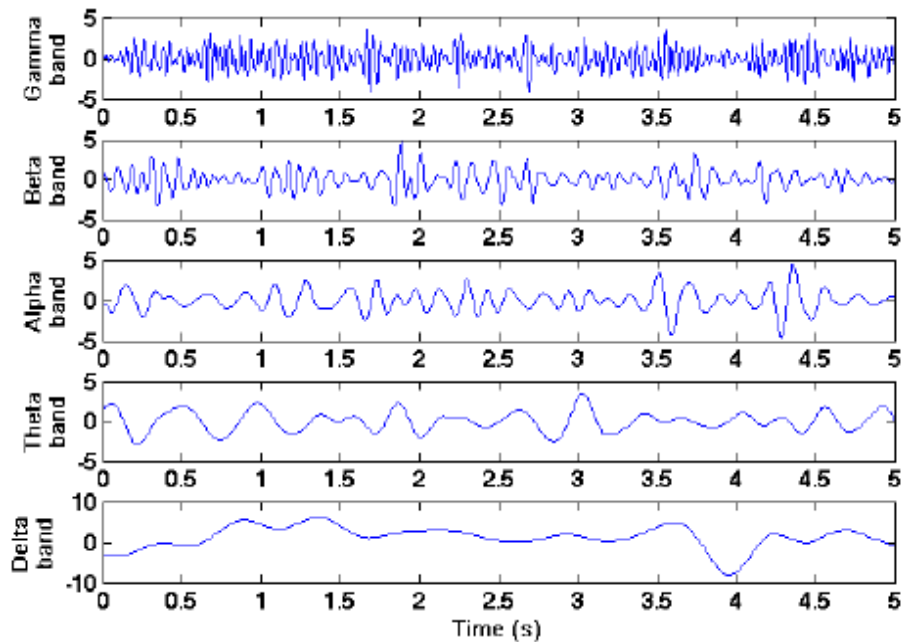
Delta band (1 - 4 Hz) – Deep Sleep

Theta band (4 - 8 Hz) – Creativity, Emotion

Alpha band (8 - 12 Hz) – Relaxation

Beta band (12- 25 Hz) – Memory, Focus, Problem Solving,

Gamma band (above 25 Hz) - High Level Thinking, Learning, Perception



Zahhad et, al. 2015

Advantages and Disadvantages

Advantages:

- Fairly affordable
- Captures cognitive processes in real time
- Mobile
- Minimal set up
- 5 channels; Whole Brain Sensing
- Wirelessly connects; PC and Mobile Devices
- Raw EEG, Mental Commands, Performance Metrics, and facial expression detections available

Disadvantages:

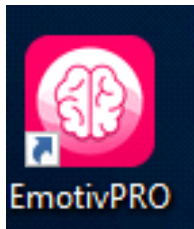
- Many researchers are questioning its effectiveness
- Poor reviews online / customers saying that Emotiv Tech Support wasn't helpful
- Limited channels
- Our team had many problems with the headset turning off / disconnecting during use
- The markers were misleading, you need to know where your markers are to put them in vs going back and trying to guess where they would go
- The facial expressions and movements were not accurate, even when adjusting the sensitivity

- The program is not easy to understand, we as a team struggled with how to use the program, the included manual was not very user friendly

Step by step Guide on how to use the program

Once the program is installed* select the EmotivPRO icon.

*It is important to make sure all of the needed drivers are set up properly prior to installation to avoid having other issues.



Once you open the program,

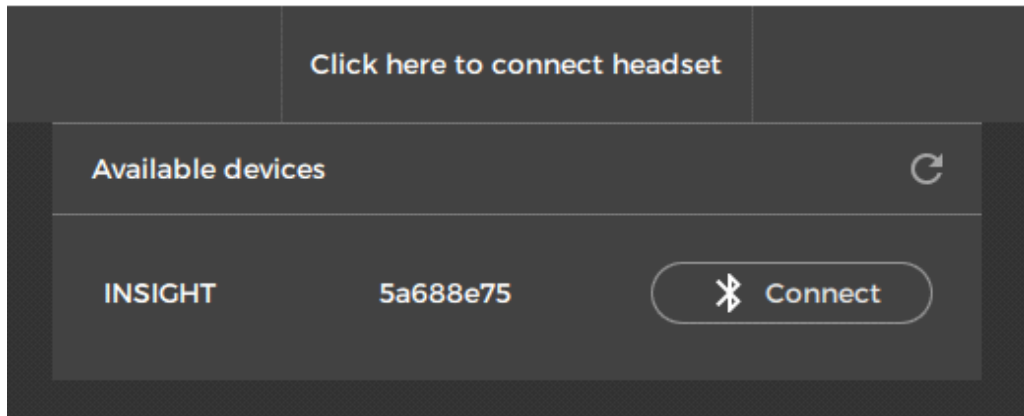
The first thing you will need to do is connect the headset device using the Bluetooth connection.



Click the [Click here to connect the headset](#) in the top center of the page.

[Click here to connect headset](#)

It will show if your device has been identified.



Click Connect to connect the device to the computer.

Now you will need to place the headset correctly to get good connectivity.

The program will show you how to fit the headset correctly.



Fitting your headset correctly

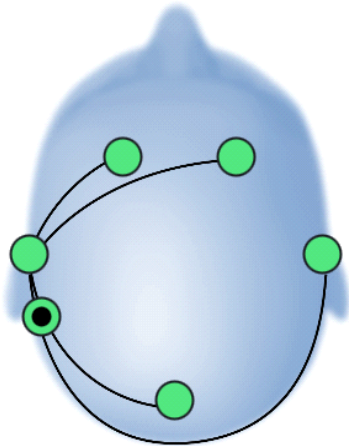
1. Starting from the top of the skull, gently slide the headset onto your head
2. The reference sensors sit just above and behind your ears. The rubber comfort pads rest behind your ears.
3. Tilt the headset until the front sensors are three fingers above your brows.

NEXT

Do not show this again

Once you have all of the set points positioned correctly they will turn green and show 100% contact quality. The goal is to get the sensors to become all green for the most accurate fit.

If the sensors are not turning green and you cannot obtain 100% connectivity, try putting a dab of gel on the sensors. Even if they are dry connect sensors this could help.



Ensuring good contact quality

Work each sensor underneath hair to make contact with the scalp. If all sensors are black, first adjust the reference sensors (black circles) until they are green, and then adjust the other sensors.

You can access this screen at any time by clicking on the contact quality meter in the top middle of the application.

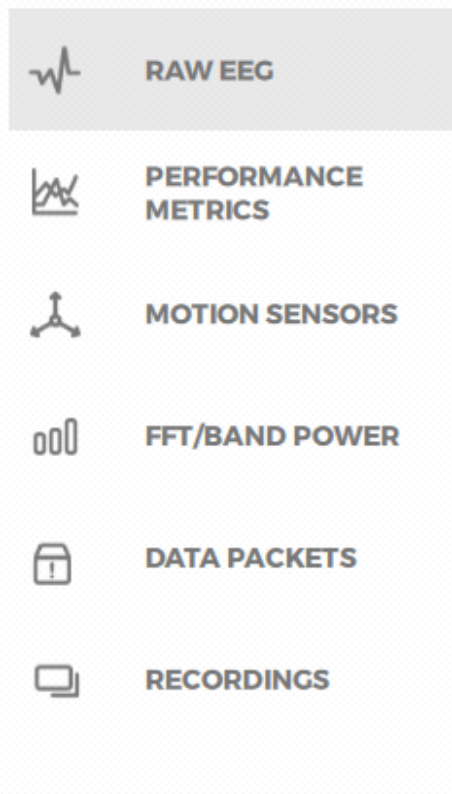
100%
CONTACT QUALITY

DONE

Click DONE

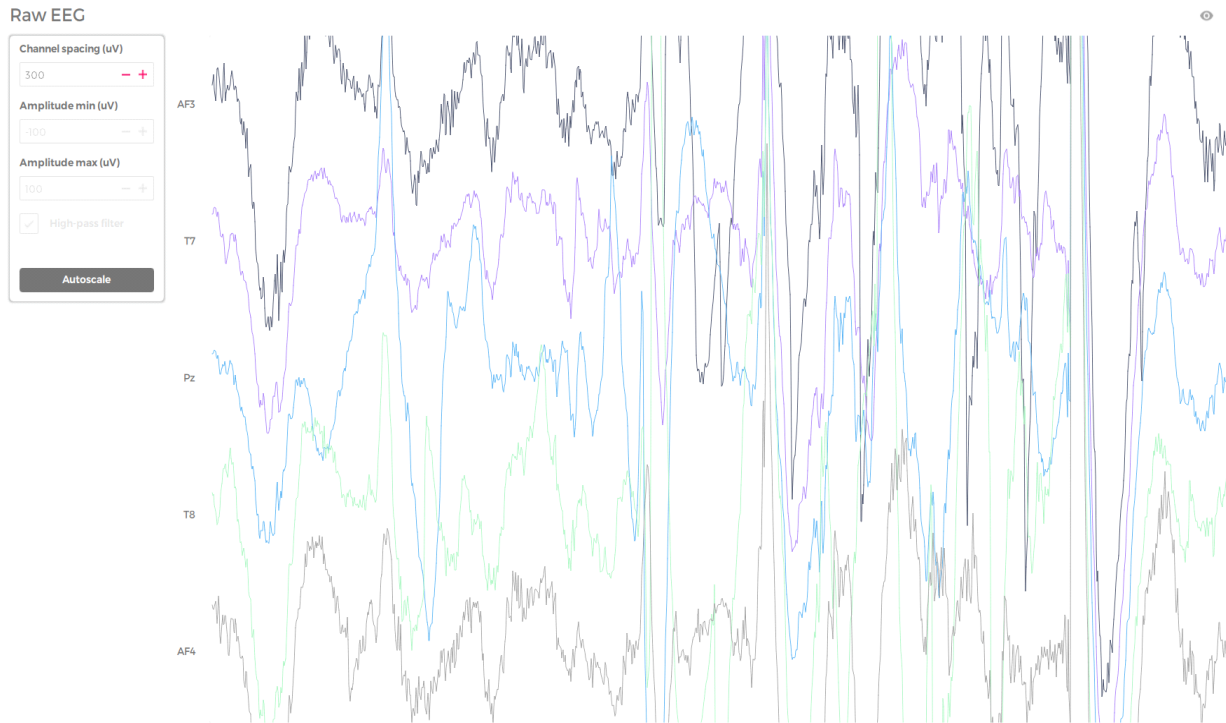
The brain waves will start displaying when everything is connected properly.

You will have 6 different selections to choose from.



Once you are connected, you will be on the raw EEG screen.

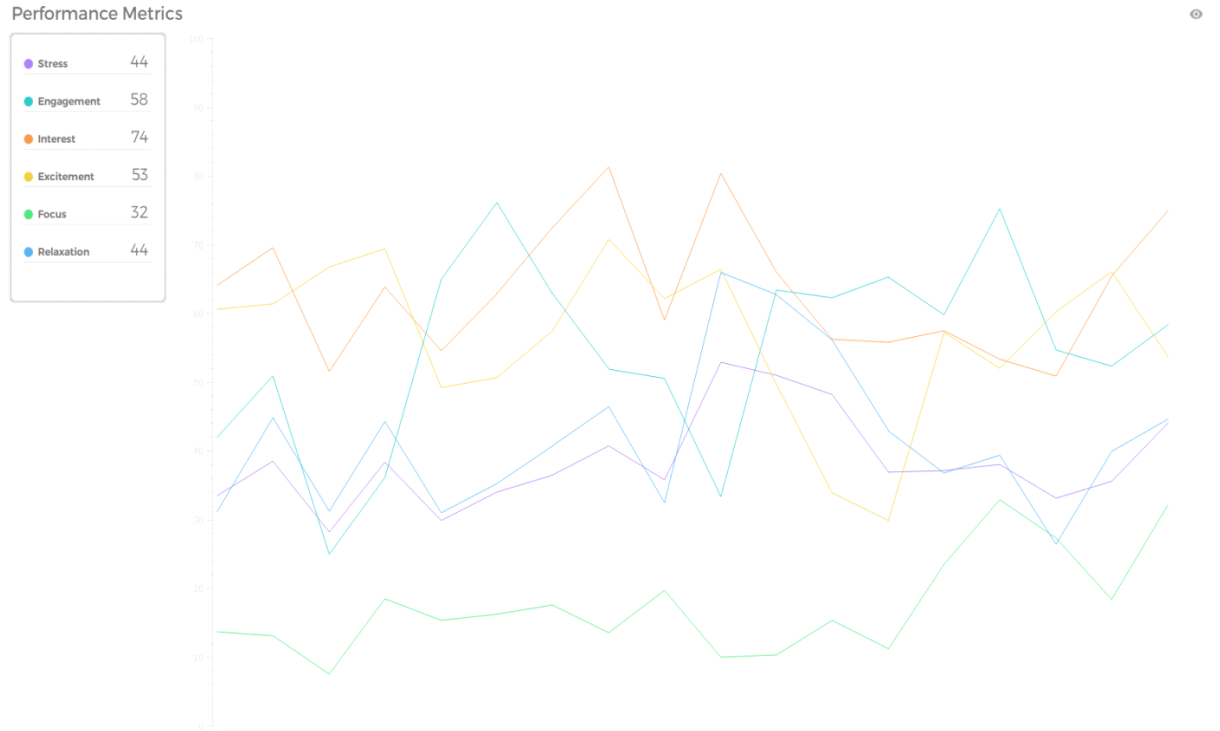
Raw EEG



Raw EEG data refers to a complex wave form when an electrode captures the neuron activity taking place in its proximity. It is the electrical activity of nearby muscles, electrode motion interferences, and “ambient noise” caused by electrical supplies and appliances in the room.

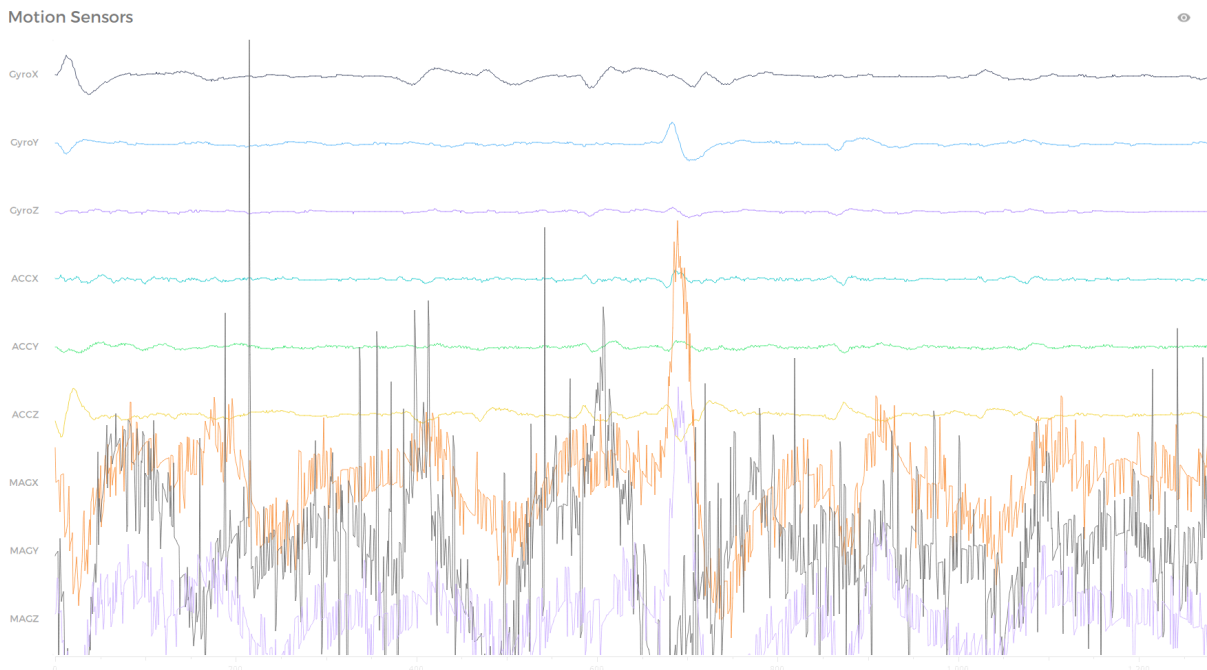
In this area is where you will want to record your base line levels so that you have starting point measurements. You will need to do both an eyes open and eyes closed measurement for a baseline sample.

Performance Metrics



A **performance metric** measures an organization's behavior, activities, and **performance**. This program measures Stress, Engagement, Interest, Excitement, Focus, and Relaxation.

Motion Sensors



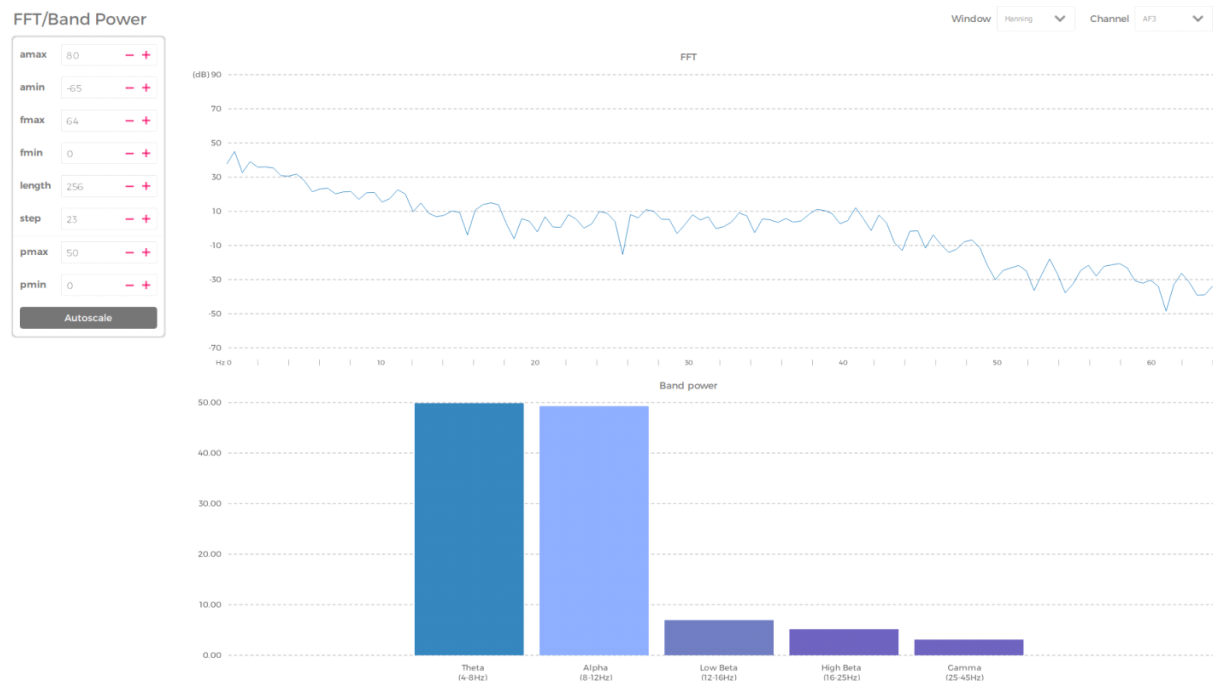
A **motion sensor** can use one or multiple technologies to detect movement in an area. This program measures:

Gyroscope (rotational motion) GyroX GyroY and GyroZ

Acceleration forces Accx Accy and Accz

Magnetism (the average of the amplitude of each EEG signal) Magx, Magy and Magz

FFT/Band Power



Bandpower returns the average power in the frequency range. This program measures these bands: Delta, Theta, Alpha, Beta, Gamma.

Data Packets

Data Packets

256

128

0

The data packet stream displays the number of data packets that are successfully transferred from the headset to the PC and how many are dropped. Select “DATA PACKETS” in the left side menu to access this view.

Recordings

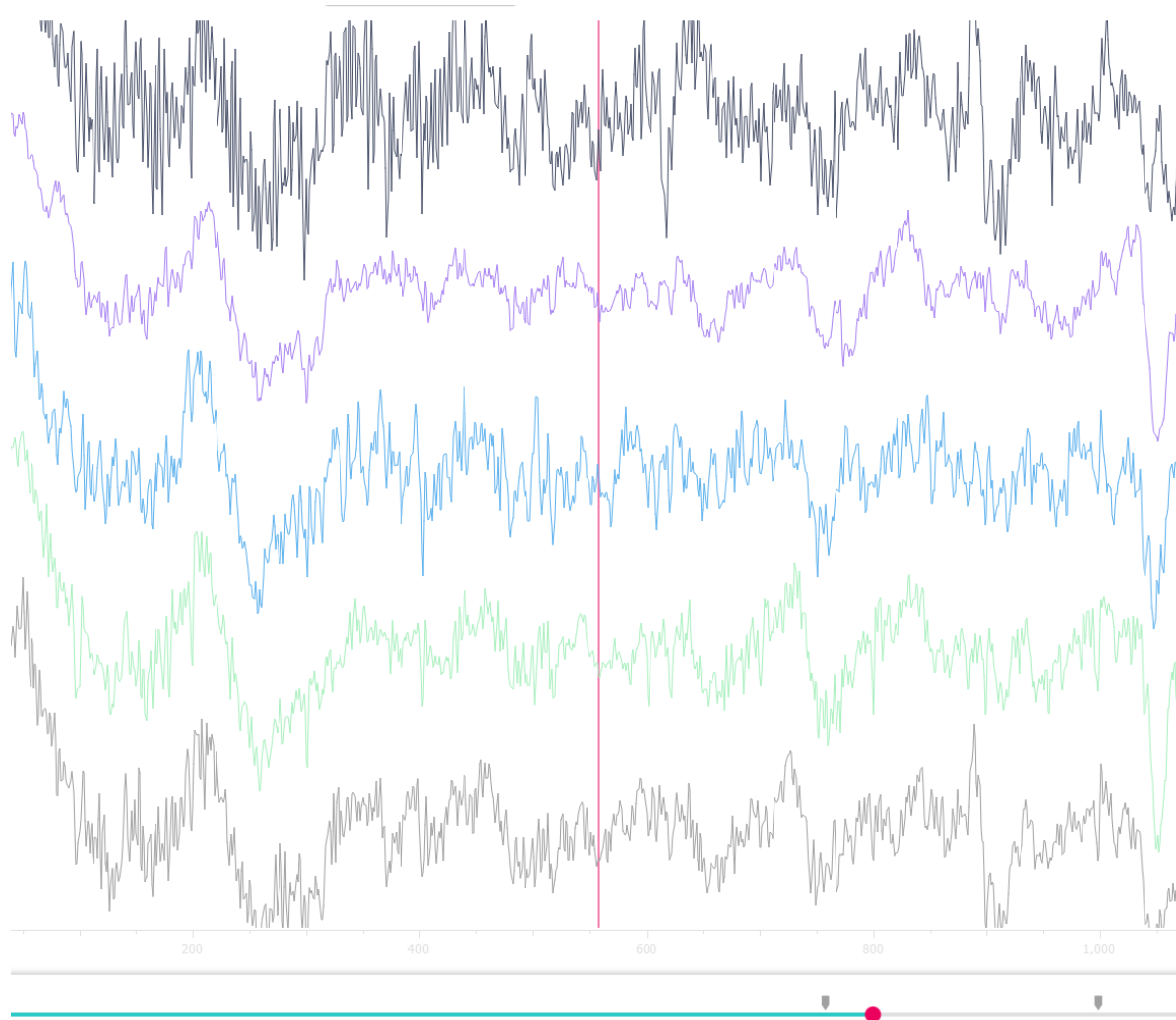
Recordings



Name	Subject	Date	Duration	Note
Wilson 3		23/06/2018 15:53:38	00:05:30	
Wilson 2		23/06/2018 15:34:55	00:04:13	
Wilson		23/06/2018 14:19:00	00:05:10	
Kevin 2	101	22/06/2018 16:48:52	00:02:20	First test
Kevin 1st recording	100	22/06/2018 16:00:29	00:00:00	
Kevin	1	22/06/2018 15:36:18	00:01:24	Kevin Baseline recording 6/22/18
Chris		13/06/2018 20:14:30	00:21:56	Slight moving, a lot of reading and searching. Still very strong theta and reasonable strong average alphas.
test1	test	24/05/2018 13:35:57	00:00:19	
a	a	22/05/2018 14:43:58	00:02:59	Test
test	2	24/04/2018 15:03:07	00:01:28	
test	1	24/04/2018 14:56:08	00:04:37	

The recording area contains a list of the name, subject, date, duration and notes. The recording is done in the EEG area. The recording can be done at any needed length. The recording is done in real time, however you want to make sure that you complete your baseline recording first. This will insure that you have a good starting point when collecting your data. In this area you can also set markers in the data collection process. Using this playback option gives you an excellent opportunity to analyze the data.

Analyzing Data

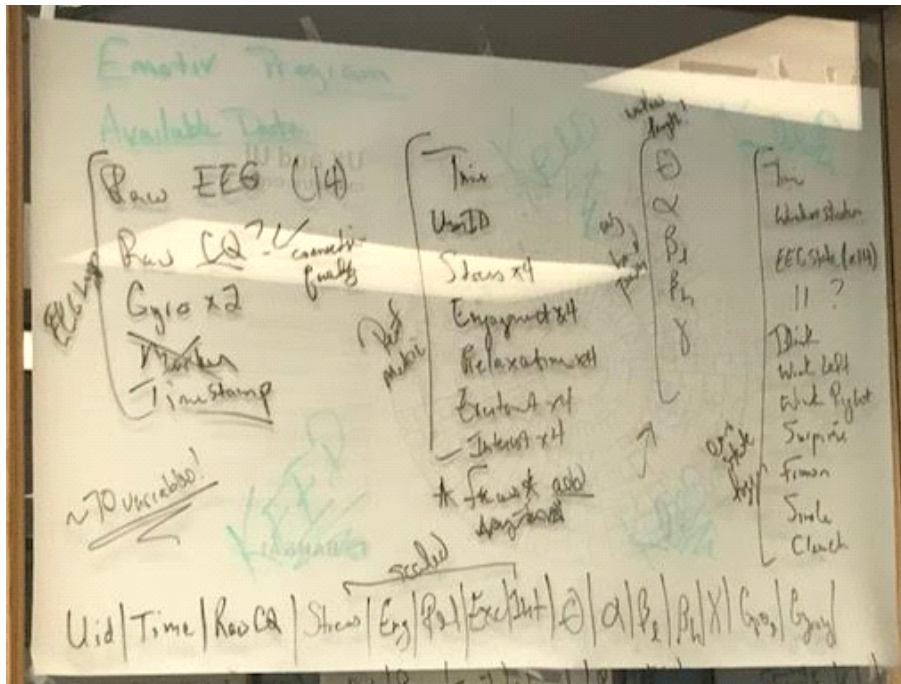


Once you have done your baselines you can compare various tasks against the baseline by placing markers at the point of the scheduled task. This will show the differences between the two set points.

To analyze the data more, use the recording area to play back the information that was generated. There you can make the comparisons to the baseline recordings that were done at the beginning of the recording process.

When analyzing an EEG experiment, it is recommendable to base your procedures on known material. You will find it easier to explain the observed effects, if you are able to link your results to comparable statistical procedures has been used previously.

These are some of the variables that can be used with the EmotivPRO.



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