

ETR556
UX RESEARCH TECHNOLOGY

Emotiv 16 Sensor Headset
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EEG INSTRUCTIONAL MANUAL

Introduction and Research Areas

An electroencephalogram (EEG) is a non-expensive and inexpensive electronic device that records electrical activity and brain waves using electrodes placed on the scalp. This type of measuring of the electrical activity from the brain is useful because it reflects how the many different neurons in the brain network communicate with each other via electrical impulses. (EEG Pocket Guide. iMotions. Biometrics Research Platform. 2017. All rights reserved.). www.imotions.com/. The first known neurophysiologic recordings were of animals and performed by Richard Caton in 1875. The advent of recording the electrical activity of human beings took another half century to occur. Hans Berger, a German psychiatrist, pioneered the EEG in humans in 1924 (St. Louis, EK, Frey, LC (Eds.), 2016). His work paved the way for present day technology in this field.

The brain is one of the most vital organs of the human body and is a collection of interconnected neurons that decide human behavior (Basker, E., 1998). Understanding functional and cognitive behavior of the human brain is not only an interesting area but important topic for medical researchers to study in order to find out a better solution for various brain related issues (Palaniappan, R., & Raveendran, P., 2001) (Caton, R., 1985). Electroencephalography (EEG) is one of the modalities which help analyze the brain and its behaviors based on the respective frequency of a signal. A significant characteristic of EEG is that it is a non-destructive and painless method to gather data. So far, there are relatively no side effects for subjects and display accurate interpretations for several different areas. An important current area of research is in medicine where researchers are studying cognitive issues and functions such as epilepsy, memory loss, Alzheimers and Autism (Ames, F., R., 1971) (Tong & Thakor, 2009) (Almejrads, A., 2010) (Trudeau, D., L., 2005) (Claassen, J., Lawrence, J., Hirsch, & Mayr, S., A., 2003).

To record electrical activity generated by the brain, EEG researchers simply record electrical data from sensors placed at the scalp surface, so-called electrodes (EEG Pocket Guide. iMotions. Biometrics Research Platform. 2017. All rights reserved.). www.imotions.com/. EEG signals are classified based on signal frequencies for different states/stimuli such as eye ball movement, eye open, eye close, finger clenching, etc. (Wang, T., & He, B., 2004) (G.,

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Pfurtscheller, F.H & Lopes da Silva, 1999). These signals are associated with specific frequency ranges from 0 Hz to 100 Hz with some signals over 100 Hz in frequency. This signal based analysis with respect to different states helps medical researchers for better understanding of functional and behavioral characteristics of complex brain structure. (Bhuvaneswari, P., Satheesh Kumar, J. (2012) Analysis of electroencephalography and its categorization – A study. *Procedia Engineering*. 38: 2525-2536).

Advantages and Disadvantages

EEG offers a good number of improved characteristics that other brain studying techniques or other behavioral observations do not offer. (Imaging Techniques)

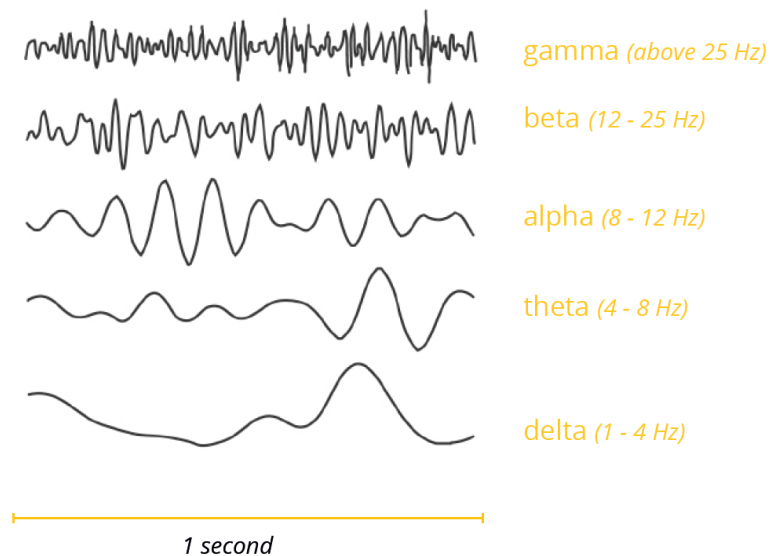
- Excellent Time Resolution: It is capable to take large numbers of electrical signals in just a second. (iMotions, 2017).
- EEG uses electrode arrays (10 to 500) electrodes that allow a larger number of measurement at the simultaneously. (iMotions, 2017).
- EEG captures and measures neural activity in real time. (iMotions, 2017).
- EEG is comprised of electrodes, conductive gel, amplifiers and Analog to Digital converter (Bhuvaneswari, P., Satheesh Kumar, J. 2012)
- EEG is inexpensive, lightweight, and portable. (iMotions, 2017).
- EEG monitors cognitive-affective processing in absence of behavioral responses. (iMotions, 2017).
- EEG uses specific frequency ranges or frequency bands to measure the brain activity. (iMotions, 2017).

With the headset being relatively inexpensive and portable, it is a great option for researchers looking to study advanced cognitive functions. There are, however, several limitations. The sensors on the headset are very sensitive, so placement and connection quality is extremely important. Connection quality can also be affected by the amount of hair a user has or natural oils on the hair and skin. There can also be limitations depending on the population a researcher wishes to study. Small children or adults with disabilities might struggle while using this headset for long periods of time because of the amount of arms and sensors and the sensation it causes around the skull. In addition, while collecting the data is relatively easy, analyzing the data can be quite

complex and tiresome. Researchers will need to be sure to have clear objectives so when the data is downloaded, they will be able to narrow down the data they needed.

EEG Parameters

The electroencephalograph is a continuous recording of waves of varying frequency and amplitude. The number of wave cycles or peaks that occurs in a EEG pattern in a set period is its frequency (iWorx Systems, 2013). Because these frequencies vary slightly depend on individual factors, stimulus properties and internal states, research classifies these frequencies based on specific frequency ranges, or frequency bands: Delta band (1 – 4 Hz), theta band (4 – 8 Hz), alpha band (8 – 12 Hz), beta band (13 – 25 Hz) and gamma band (> 25 Hz). (iMotions, 2017).



(Taken from iMotions, 2017)

Delta band (1 to 4 Hz) In sleep labs, delta band power is examined to assess the depth of sleep. The stronger the delta rhythm, the deeper the sleep. (Studies: Sleep and sleep disorders; Alcoholism and sleep)

Theta band (4 to 8 Hz) it is used to measure difficulties in mental operations and cognitive processes. (Studies: Spatial navigation; Air traffic or Vessel control; Vehicle steering or obstacle avoidance; Military scenarios)

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Alpha band (8 to 12 Hz) these frequencies are used to measure sensory, motor and memory functions. (Studies: Meditation; Biofeedback training; Attention.)

Beta band (13 to 25 Hz) these frequencies are used to measure active, busy or anxious thinking and active concentration (Studies: Motor control: Clinical population Parkinson patients and Multiple Sclerosis MS or other neurodegenerative disorders; Stimulant – Induces Alerts)

Gamma band (> 25 Hz) there is not solid evidence on what produces these Gamma frequencies and the most reliable use.

What can it do?

Electroencephalogram (EEG) is used to measure the brain potential to help the disabled people to obtain accurate diagnosis of their disease (Satheesh Kumar & Bhuvaneswari, 2012). EEG is so useful to study and analyze brain issues such as: Epilepsy, Alzheimer, seizure disorder, attention deficit disorder, learning disabilities, anxiety disorder, fetal alcohol syndrome, autism, chronic pain, insomnia, dyslexia. It can also be used to improve learning and it is also used with some relaxation treatments. EEG is likewise used to study the different kinds of memory issues such as, emotional memory, verbal memory functions, and other verbal expressions, and other kinds of cognitive disabilities. This amazing breakthrough will be, in short, an excellent alternative in the educational complex and exciting educational world.

Fields of Application

Frequency-based EEG metrics are used in commercial and academic application fields such as, General and experimental psychology; Clinical psychology; Biomedical engineering; Consumer neuroscience; Marketing research; Advertisement, trailer and media testing (iMotions, 2017).

EEG has been used with success in a good of professional fields, and medicine and psychology have been the fields where this marvelous state of the art device has been used. This device is mainly used to treat and diagnose brain diseases, but also, to treat and diagnose some human behavioral problems triggered by alcoholism issues, sleep disorder, cognitive disabilities, spatial navigation. EEG is also used for brain monitoring in operational environments in air traffic or

vessel control, vehicle steering; this marvelous device can be also applied in military industry and scenarios. There are also other studies in fields such as, meditation, relaxation and attention problems, and some studies on personality disorders. Also, clinical populations such as patients suffering from Parkinson's, Multiple Sclerosis (MS) or other neurodegenerative disorders are compared to age-matched healthy controls (iMotions, 2017). (For example, see Lainscsek et al., 2013). Additionally, another important field where EEG has been applied is the educational research field with studies on reading context, research on the presentation patterns of learning materials, research on interactive behavior, studies on edutainment, research on e-learning, research on motor skill acquisition, and research on promoting performance with EEG. (iMotions, 2017).

Safety and Regulatory Requirements

“Overall, EEG is very safe for both the technologist and patient. However, there are known risks associated with the procedure. Exposure to electrical current is the most important of injury risk and can cause injuries ranging from skin burns to induction of seizures or ventricular fibrillation. According to Ebersole and Pedley's definitive text, there are multiple potential sources that can allow harmful currents to flow through patients connected to EEG equipment, including currents from improper grounding, leakage, and double-grounding (37). Electrical grounding is very important in preventing leakage of current through the patient in case of aberrant current flow through the EEG equipment. Grounding is dependent on both the fuses within the EEG machine and the use of proper outlets to ground the machine within the room. Leakage currents can be from either stray capacitance or stray inductance and are most dangerous when combined with improper grounding. Double-grounding presents electrical risk to the EEG patient because of the existence of differences in potential the grounds. These differences in electrical potential create gradients for current flow through the double- grounded patient. Double-grounding is most likely to occur in medical settings where patients are attached to multiple (grounded) devices”. (St. Louis, EK, Frey, LC (Eds.). *Electroencephalography (EEG): An introductory text and atlas of normal and abnormal findings in adults, children and infants*. Chicago, IL: American Epilepsy Society; 2016. <http://dx.doi.org/10.5698/978-0-9979756-0-4>.)

Safety Tips to maintain and handle the EEG

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- Establish regular EEG equipment maintenance, including protection with proper fuses.
- Always use a grounding electrode, except in situations (e.g., intensive care unit, operating room). In which other electrical equipment is attached to the patient (double-grounding must be avoided).
- Always connect ground electrodes to the appropriate jack of the input jack box (never to the equipment chassis or another earth ground).
- Always use a three-prong plug. Hospital-grade power outlets should be used whenever possible. Do not use a three-prong to two-prong converter, as the converter does not provide the same protection as an actual grounded plug.
- Do not use extension for EEG machines.

Electrode handling

>> Electrodes are intricate recording devices. Due to chemical reactions, Ag/AgCl electrodes deteriorate over time (lose ions), causing noisy signals.

It is recommended to always check electrode quality before a session: As long as the electrode looks dull, you can record. However, if the electrode becomes more shiny and metallic, you should probably consider replacing it.

Also, after a recording always make sure to properly clean your electrodes, for example with a soft toothbrush and water. Once cleaned, electrodes should also be disinfected with alcohol (70% isopropanol) prior the next recording.

(Taken from iMotions, 2017)

How To Use Technology

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EmotivPRO Kit Contents:

1. EmotivPRO Neuroheadset (Rechargeable Lithium battery is pre-installed)
2. USB Transceiver Dongle Hydration Sensor Pack with 16 Felt Sensor Units
3. Saline Solution
4. Battery Charger

Hardware and Software Requirements-

EmotivPRO works with the following operating systems:

- Windows 7, 8, 10 (32 and 64-bit)
- Mac OSX 10.9 and higher

EmotivPRO currently uses CPU to render data streams. For best performance it is suggested to use a max resolution of 1920 x 1080. Downscaling the resolution on 4k, 5k displays can help improve performance.

Note: Mac 10.9 requires an EMOTIV USB dongle.

Installation

Windows:

Login to www.emotiv.com and go to “My Account” then click on the “Downloads” option. Choose EmotivPRO Windows from the available options and click on “Download.” Open the installer and install C:\Program Files (x86) or wherever you would like to install the program then click continue. Accept the User License Agreement and continue. Wait for the installer to download required files and install them then click Close.

Mac:

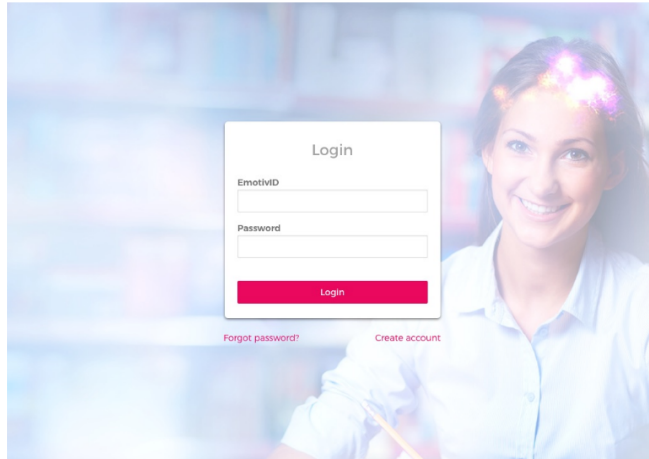
Login to www.emotiv.com and go to “My Account” then click on the “Downloads” option. Choose EmotivPRO Windows from the available options and click on “Download.” Open EmotivPRO Installer.dmg (Note: You may need to allow installing apps from unidentified developers in order to run the installer. Right click on the installer and select open. Click Open in the pop up requesting permission.) Install to the default User/Applications/EmotivPRO or wherever you would like to install the program then click continue. Accept the User License Agreement and continue. Wait for the installer to download required files and install them then click Close.

If you cannot find an EmotivPRO download available, you can purchase a license on www.emotiv.com/emotiv-pro/.

Logging In

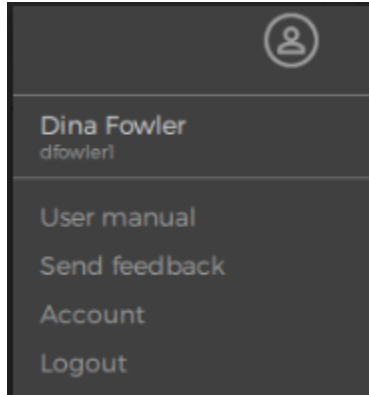
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To access EmotivPRO, you will need your Emotive or the email address used when purchasing your software license. The first time you use the program, you will need to create an account. If you are using someone else's Emotive, you can enter that license key after you log in. If the subscription has reached its device limit, you will not be able to log in.



Accessing Account

Once you login to EmotivPRO, you will see an icon on the top right corner. Click this to access your account page, the user manual, help and to log out.



Program Information

You can use EmotivPRO on up to three computers along with using a different set of devices each month. The number of seats available can be seen through the website in the Subscriptions section on your Account Page. If you need a different device once the month has started, contact Customer Support to deactivate one of your preexisting devices.

All features are available for use offline; however, the data collected will not be synced to your other devices.

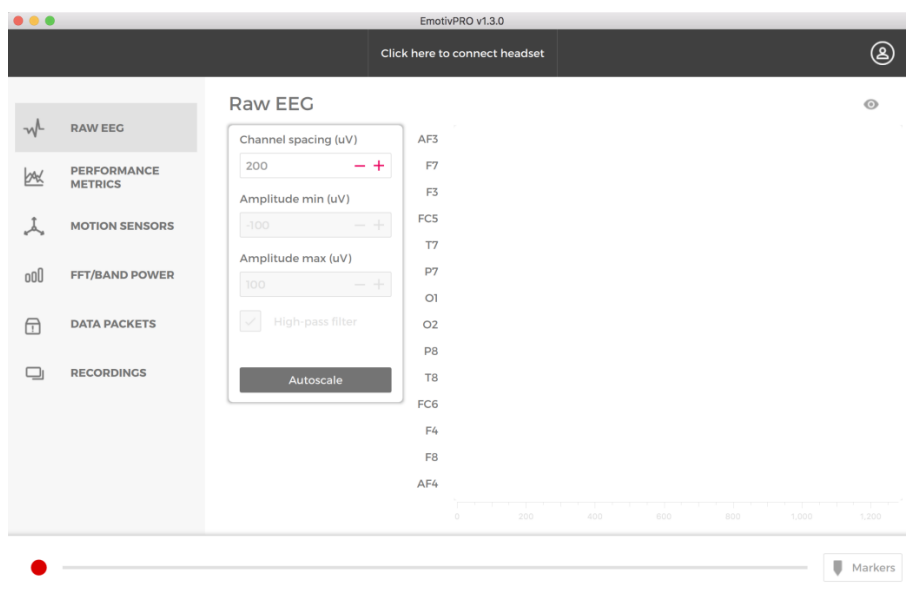
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At the end of the monthly subscription, the program will check your subscription status and reauthorize your license. If you would like to cancel your subscription, go to the website and access your account, click on Subscriptions then cancel and follow the instructions.

EmotivPRO Navigation

Once in EmotivPRO, you will see a menu on the left side of the main screen where you can access these features:

- **Raw EEG:** A data stream from the sensors presented live or recorded (14 for Epoc, Epoc+; 5 for Insight and up to 32 for Epoc flex, depending on your configuration)
- **Performance Metrics:** Stress, Engagement, Interest, Excitement, Focus and Relaxation
- **Motion Sensors:** Information from the 9-axis motion sensors
- **FFT/Band Power:** Frequency analysis on one channel of EEG data
- **Data packets:** Packet loss and capture from your headset to your computer
- **Recordings:** Access or download recordings of previous sessions



See Data Stream Views for more detailed information about the data streams.

Preparing the Headset

Charging Headset Battery

The Emotiv headset has a built in and rechargeable battery. A fully charged battery takes approximately 6 hours and power can generally last for 12 hours (Note: 30 minutes of charging produces around 10% increase of battery power).

To charge the battery, turn the power switch on the back of the headband OFF, and plug the headset into the battery charger using the mini-USB cable that was included with the kit. When

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the headset is ON and there is enough battery power, the light next to the power switch will turn blue. The light will turn red while the battery is charging and green when the battery is fully charged.

Preparing and Using Saline Hydration Sensor Pack

The hydration pack contains 14 sensors (felt inserts) and a white felt pad, all of which need to be completely saturated, but not dripping wet, by the saline solution before adding the inserts to the headset. Wetting these before using the headset will make sure the headset is connecting properly with the skull.

Add about 8 drops to each sensor and make sure the white pad is fully wet. Close the hydration pack and let sit for approximately five minutes (you can gently shake the pack to disseminate the solution around).

Once the sensors are wet, you can remove each sensor and add them to the headset. Positioning does not matter, just be sure to firmly add the sensor in place. To remove the sensor, twist the plastic piece under the felt insert and lift up. Then, twist the sensor into any headset arm until the piece clicks into position. Be careful not to be too rough and that all sensors are locked in place before use. Be aware that there are two sensor locations that are fitted with a soft rubber comfort pad and do not require felt pads. You will have a total of 16 sensors. Sensors should be put back in hydration pack after every use to keep moist.

Once all sensors are set in place, the headset should look like this:



Headset Connection to Computer

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Be sure your battery is charged before starting.

Bluetooth

Turn on your headset and Bluetooth on MacOS on a Mac or in “Bluetooth and other devices” in Windows.

USB Dongle Connection

Plug the USB into the computer and the headset and turn on the power.

Connecting Set

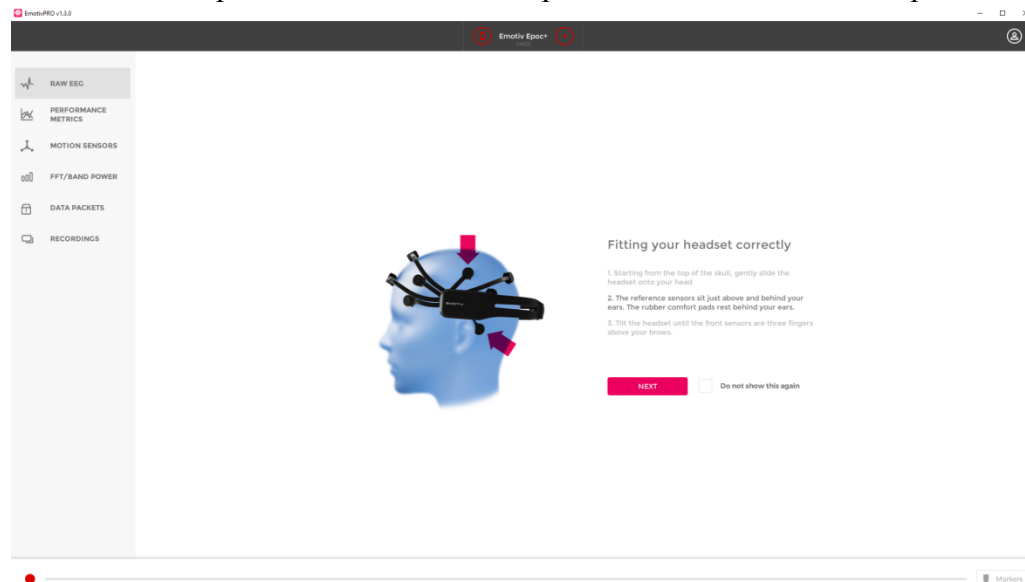
Once you have plugged in the USB or turned on the Bluetooth, open the Emotiv Pro app and click on the button on the middle top of your screen labeled, “Click here to connect headset” and you will see your headset appear. Once you see your headset, click “Connect.”

Disconnecting Set

To disconnect your headset, unplug the dongle or press the power button. Disconnecting the headset from EmotivPro make take approximately 30 seconds.

Headset Placement

Once the headset is fully connected to the computer and the EmotivPro program is opened on the desktop, a prompt will be displayed on the computer that shows you how to properly place the headset. The steps below are the same steps that will show on the computer.



Carefully slide the headset down onto the subject’s head using both hands and ensuring that the arms and sensors are properly placed around the skull. Never force or bend the headset’s arms

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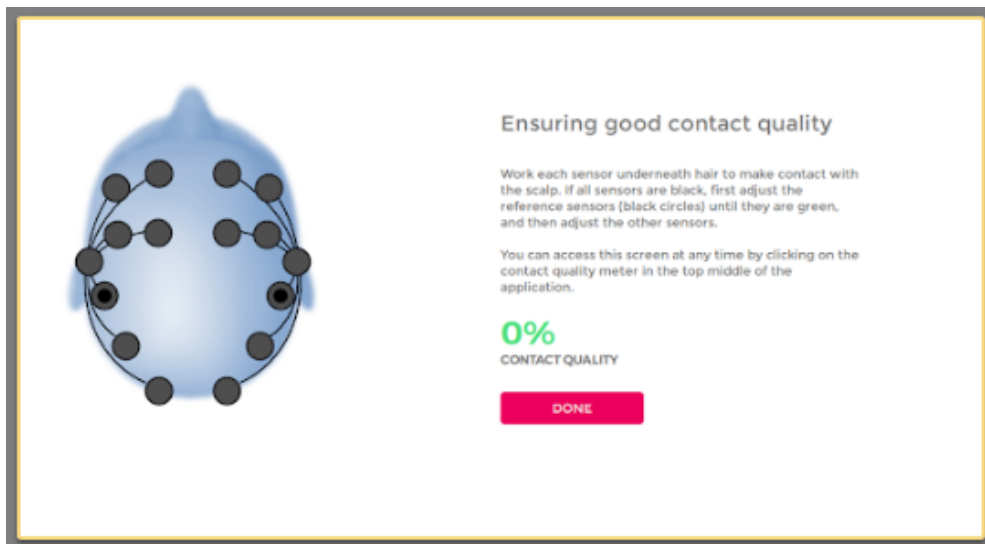
around the skull and gently move the arms around to fit around the head. The rubber sensors should lie on the bone just behind each ear lobe. The front sensors should be 2 – 2.5 inches (50-60mm or about three finger widths) above the eyebrows

The headset will not work properly if all sensors are not placed correctly. If any of the sensors fall out during placement, just twist the sensors back into place until you hear a click.

Sensor Contact Quality Display

To ensure accurate data is collected, the sensors must be placed properly with a strong established connection to the skull. An image will be available to show the contact quality of the sensors. You should not move on to the next step until you have at least 85% contact quality and most of the sensors are green. The color information below shows the status of each sensor:

- Green: Good
- Orange: Moderate
- Red: Poor
- Black: Very Poor



EmotivPro Indicators

At the top of the EmotivPro App, you will see several icons. These icons provide live information about your headset and connection.

Contact Quality Indicator: Shows overall quality of contact across all sensors on entire headset



(Taken from EmotivPRO, 2018)

Battery Indicator: Shows remaining battery power in your headset.

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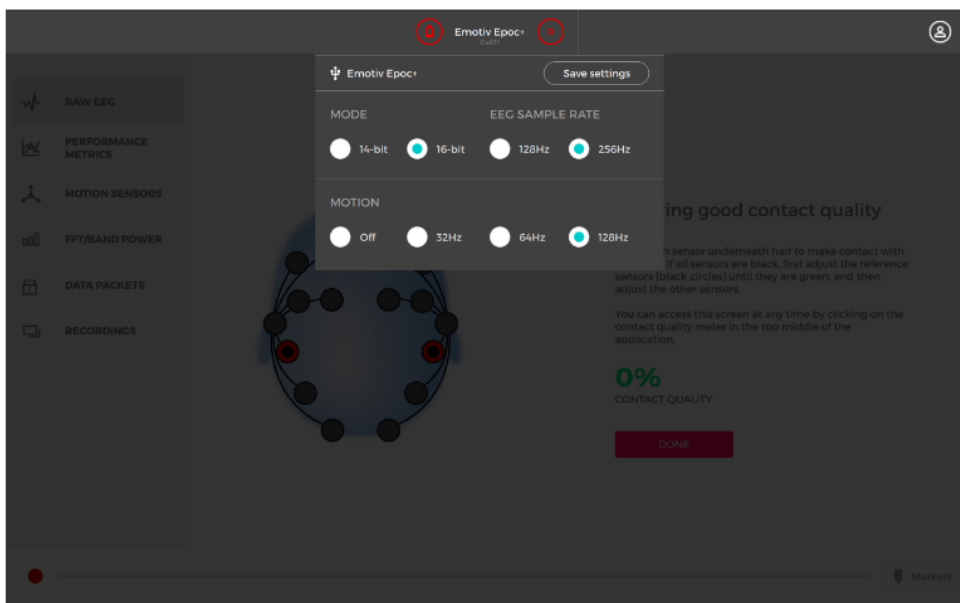


(Taken from EmotivPRO, 2018)

Headset Configurations

The EmotivPRO program allows you to configure your headset's EEG resolution and sample rate as well as the motion data resolution and sample rate.

To configure your headset, plug it in to your computer using the USB cord. Click the headset name on the top center of the main screen in EmotivPRO and open the configuration settings. As you select your configurations, your headset will update.



(Taken from EmotivPRO, 2018)

Recording Data

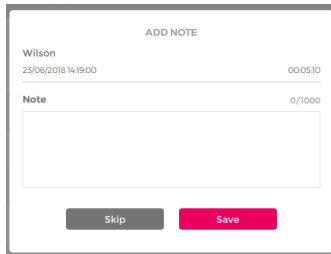
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You are able to view, record and download data collected from the headset.

To record press the red record button on the bottom right corner of the program. You will need to name your recording and SubjectID and then click save. If you wish to stop recording, hit the grey stop button on the bottom right corner.

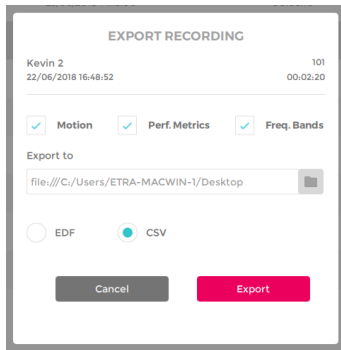
Record  Stop 

After you have finished recording, you are able to add a note about the data for future reference. You can also edit these notes later.



All of your recordings are available in the Recordings tab on the left side. They are also saved to your PC for offline use as well as to the EmotivPRO cloud. You can delete any recordings from one device without deleting from all devices.

To export a recording, hover over the desired recording and click the Export icon. Choose all of the EEG data you wish to record and download as a CSV or EDF file.



To playback a recording, click on the Play button on the bottom left. You can also review specific sections of the data by moving the pink circle (scrubber) left or right along the timeline. You can also add markers for sections that you think are important.



(Taken from EmotivPRO, 2018)

Data Stream Views:

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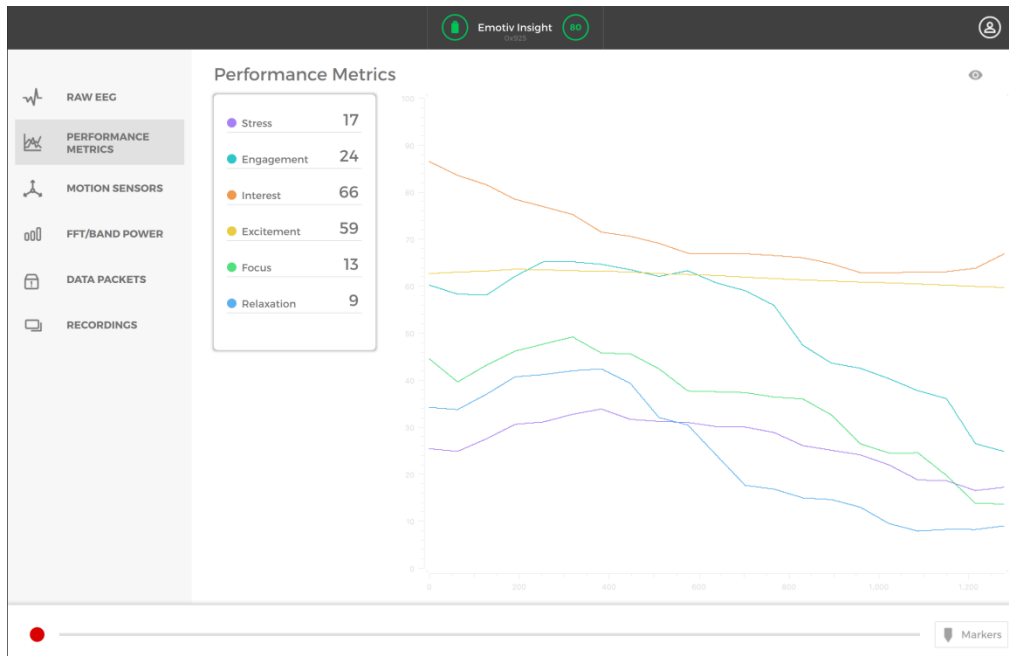
You can record data from the following Data Stream views:

RAW EEG: Shows the voltage fluctuations detected from the sensors and are shown as uV per sample. There are 14 channels- one for each channel on the headset.



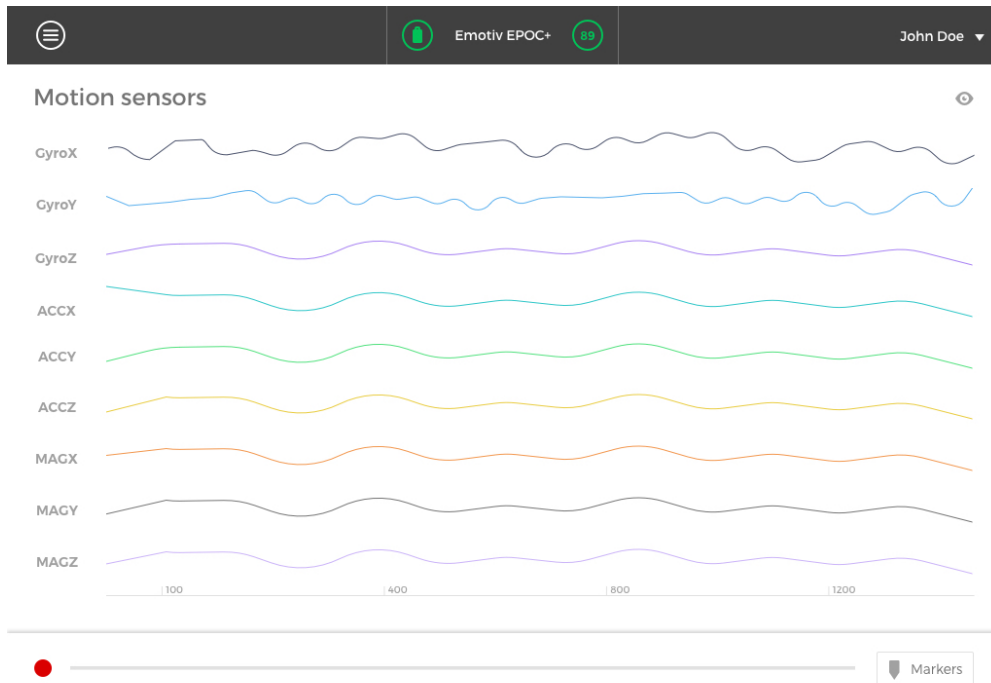
(Taken from EmotivPRO, 2018)

Performance Metrics: Shows the results of the EMOTIC Performance algorithms for cognitive states and is shown on an axis scaled from 0-100. You are able to download these files with scaled and non-scaled data.



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Motion Sensors: Shows the position and orientation using relative orientation (gyroscope), acceleration (accelerometer) and absolute orientation (magnetometer) measurements.



(Taken from EmotivPRO, 2018)

Frequency Analyses (FFT/Band Power): Shows data on the frequency of a single EEG channel.

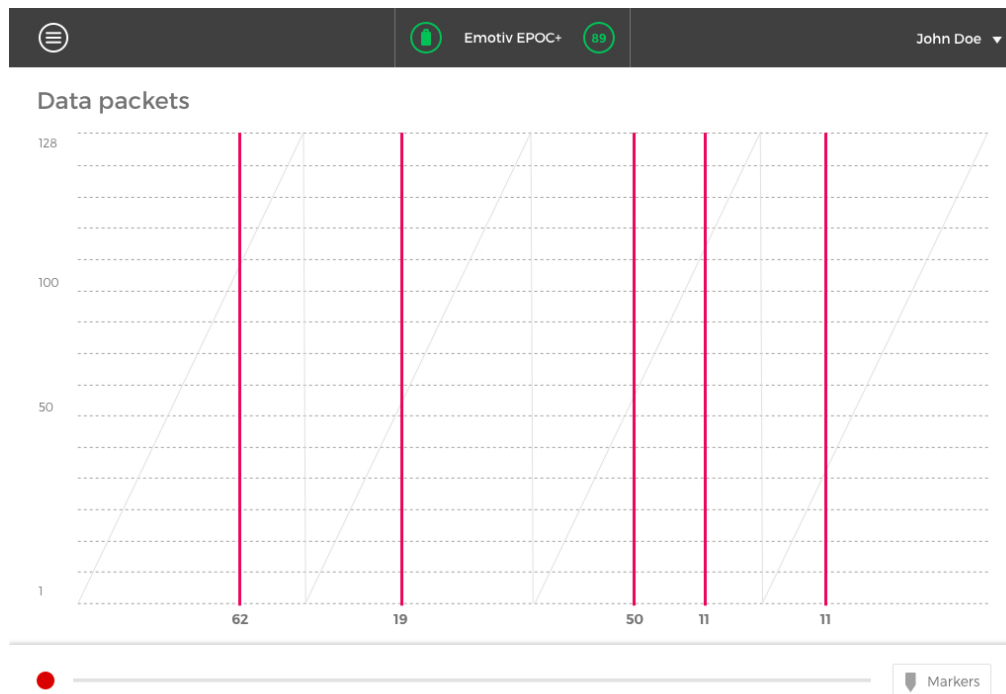


Data Packets: Shows how many data packets are successfully downloaded from the headset to the computer and those that are not. The gray line shows a 128 or 356 Hz revolution that is

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repeated every second. An even line shows solid usable data while a shifted graph shows spotty data. The pink lines show the quantities of the data that are not transferred.

If there are large amounts of data being lost, try using the USB instead of Bluetooth and move away all other electronics. You can also try to reduce how many devices are connected to your Bluetooth or changing the configurations to reduce the frequency rate and/or resolution on the headset.



(Taken from EmotivPRO, 2018)

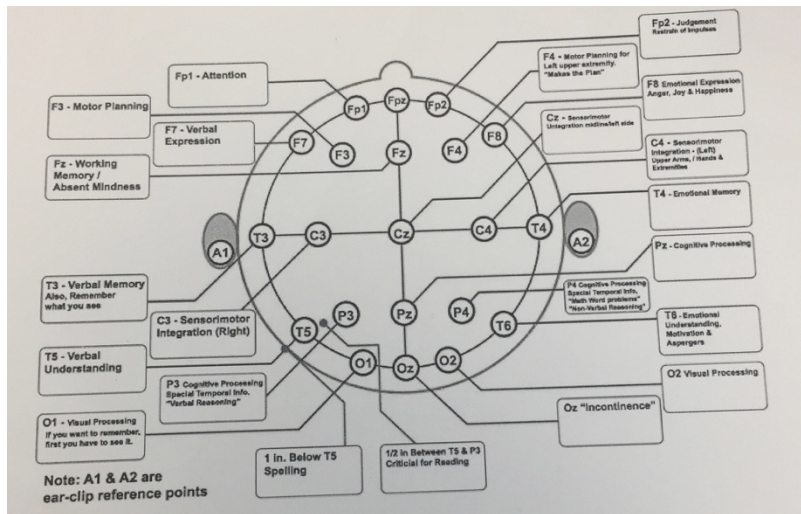
Collecting Data

Here one experiment trial from a students' group in NIU which illustrates how Emotiv headset beginners collect data presented. The example here is comparing the same user's brain signal changes after several stimuli. Experiments about exploring the correlations between different subjects' brain signals can be also implemented by using Emotiv headset.

Decide the variables that you want to examine

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First time users in this field will find the map below helpful:



(http://www.edontonneurotherapy.com/i//10-20_locations_brain_functions_map.gif)

After group discussion, four students in this group decided to test the following variables:

1. Fp1-Attention
2. F3- Motor Planning
3. T3-Verbal memory, also remember what you see
4. T5- Verbal understanding
5. F7- Verbal Expression
6. T4- Emotional Memory
7. P3- Cognitive processing

Design stimuli activities

Activity1: Where do I have the paper? (Fp1- Attention)

One group member hides a piece of paper in left hand and then passed the paper to right hand. The passing speed increased gradually as the experiment developed. Participant wearing Emotiv headset was required to watch and tell where the paper is after this performance.

Activity2: Describe your cellphone. (T3- Verbal memory, also remember what you see)

Without seeing his cellphone, participant was asked to describe the cellphone's details. For example, cellphone's appearance, colors and functions.

Activity3: Can you explain how you use cellphone? (P3-cognitive processing)

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Cognitive process involves different tasks that brain operates continuously such as receiving information, processing information and storage information from the outside world. In this activities, participant recalled how to use cellphone and provide a step by step verbal instruction.

Activity4: Can you tell us your families? (T4- Emotional Memory)

Family is an effective stimulus to trigger participant's emotional response. Here, participant was given enough autonomy to tell anything related to his families including family members, pets, traveling experience and house decoration style.

Activity5: Speak out loudly a series of number and repeat them in a reversed order. (multi-variables involved)

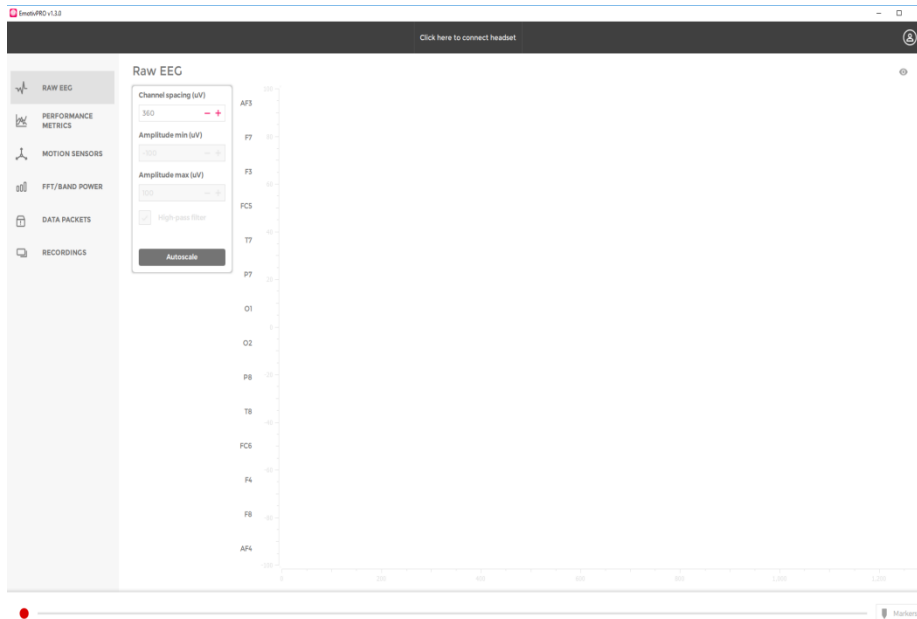
Participant is a Spanish native speaker and is fluent in English. Another group member who is a Chinese native speaker taught him how to speak these numbers in mandarin. Hence, participant used three languages in this activity.

Activity 6: Wave hands and snap fingers (F3- Motor Planning)

In this activity, participant followed another group member to do some activities such as hands up, snap fingers and wave hands.

Carrying out Experiments

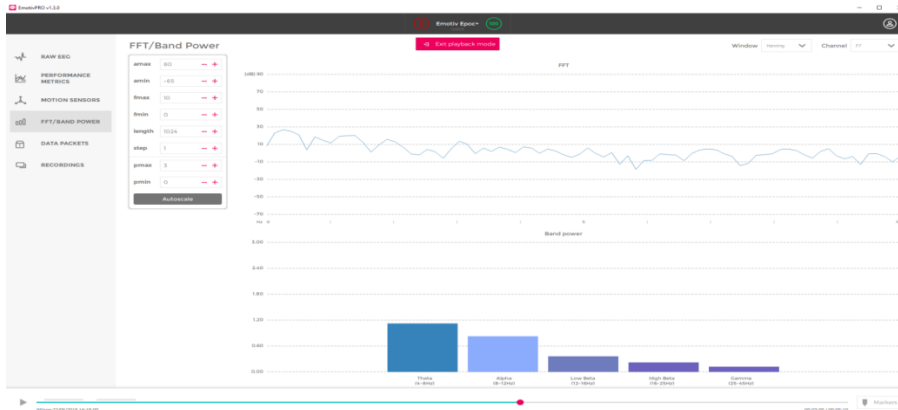
Before the experiment, remember to click red button and record your data.



Check recorded data and export data:

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Next screenshot is about playing a recorded video:



Choose preferred data type and export data:

The 'EXPORT RECORDING' dialog box shows the following details: Name: Kevin 2, ID: 101, Date: 22/06/2018 16:48:52, Time: 00:02:20. It has three checked checkboxes: Motion, Perf. Metrics, and Freq. Bands. The 'Export to' field contains the path: file:///C:/Users/ETRA-MACWIN-1/Desktop. There are two radio buttons: EDF (unselected) and CSV (selected). At the bottom, there are 'Cancel' and 'Export' buttons.

Data Analysis

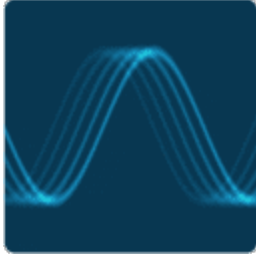
WHAT ARE BRAINWAVES?

Brainwaves are communication between neurons within our brains. Brainwaves are produced by electrical pulses from masses of neurons communicating with each other. Brainwaves are detected using sensors placed on the scalp. They are divided into bandwidths to describe their function (Brainworksneurotherapy) .

1. Thoughts, emotion communication between the neurons effect brain waves pattern.
2. Make sure the device is connected at 85 percent or better.
3. The person wearing device should relax.
4. Ask the person who wearing the device to do an activity, for example raise your arm watch your screen to see if there are any change in the brain pattern. You can use the brain function map to target different parts of the brain.
5. Understanding Brainwaves: Theta, Alpha, Beta, and Gamma

THETA WAVES (3 TO 8 HZ)

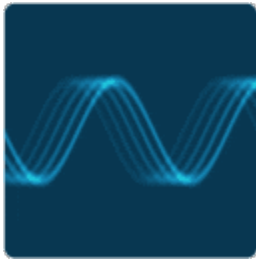
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Problem Solving

Theta brainwaves occur most often in sleep but are also dominant in deep meditation. Theta is our gateway to learning, memory, and intuition. In theta, our senses are withdrawn from the external world and focused on signals originating from within. It is that twilight state which we normally only experience fleetingly as we wake or drift off to sleep. In theta we are in a dream; vivid imagery, intuition and information beyond our normal conscious awareness. It's where we hold our 'stuff', our fears, troubled history, and nightmares.

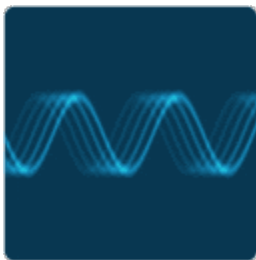
ALPHA WAVES (8 TO 12 HZ)



Relaxing, Calm

Alpha brainwaves are dominant during quietly flowing thoughts, and in some meditative states. Alpha is 'the power of now', being here, in the present. Alpha is the resting state for the brain. Alpha waves aid overall mental coordination, calmness, alertness, mind/body integration and learning.

BETA WAVES (12 TO 38 HZ)



Awake, Normal Alert

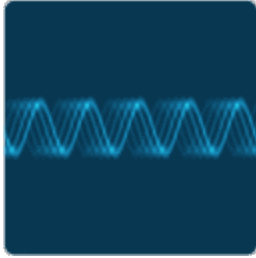
Beta brainwaves dominate our normal waking state of consciousness when attention is directed towards cognitive tasks and the outside world. Beta is a 'fast' activity, present when we are alert, attentive, engaged in problem solving, judgment, decision making, or focused mental activity.

Beta brainwaves are further divided into three bands; Lo-Beta (Beta1, 12-15Hz) can be thought of as a 'fast idle', or musing. Beta (Beta2, 15-22Hz) is high engagement or actively figuring something out. Hi-Beta (Beta3, 22-38Hz) is highly complex thought, integrating new experiences, high

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anxiety, or excitement. Continual high frequency processing is not a very efficient way to run the brain, as it takes a tremendous amount of energy.

GAMMA WAVES (38 TO 42 HZ)



Gamma brainwaves are the fastest of brain waves (high frequency, like a flute), and relate to simultaneous processing of information from different brain areas. Gamma brainwaves pass information rapidly and quietly. The subtlest of the brainwave frequencies, the mind has to be quiet to access gamma.

Gamma was dismissed as 'spare brain noise' until researchers discovered it was highly active when in states of universal love, altruism, and the 'higher virtues'. Gamma is also above the frequency of neuronal firing, so how it is generated remains a mystery. It is speculated that gamma rhythms modulate perception and consciousness, and that a greater presence of gamma relates to expanded consciousness and spiritual emergence.

6. When analyzing brain wave we are looking on the screen to see if there any change in the brain wave pattern.
7. The FFT/Band powder helps breaks down the information from the brainwave pattern to the screen.

Be sure to detect the brainwave signal then process and determine useful information from the input signal. Did you see a change in the brainwave pattern?

8. Sample of raw data:

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The image shows a screenshot of a Microsoft Excel spreadsheet. The ribbon at the top includes 'Home', 'Insert', 'Page Layout', 'Formulas', 'Data', 'Review', and 'View'. The 'Home' ribbon is active, showing options for font (Calibri, size 12), paragraph (bullet, indent), styles (background color, borders), and cells (wrap text, merge & center). The spreadsheet contains a large table with columns labeled A through V and rows numbered 1 through 37. The data consists of numerical values, likely representing measurements or scores. The status bar at the bottom indicates the active cell is 'Wilson 3 .jbp'.

Researchers will need to be sure to narrow down the exact data they want to study so they are not overwhelmed. SPSS or similar statistical software can be used to analyze the data.

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