

Emotiv

Software Development Kit

User Manual for Emotiv Xavier ControlPanel



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1. Introduction

This document is intended as a guide for Emotiv Xavier developers. It describes different aspects of the Emotiv Xavier, including:

Getting Started	Basic information about installing the Emotiv Xavier hardware and software.
Emotiv Xavier	Introduction to Emotiv Xavier, an application that configures and demonstrates the Emotiv detection suites.

If you have any queries beyond the scope of this document, please contact the Emotiv SDK support team.

1.1 Glossary

Affectiv™	The detection suite that deciphers a user's emotional state.
Insight SDK Neuroheadset	The headset worn by the user, which interprets brain signals and sends the information to Emotiv Xavier Driver.
Mental Command	The detection suite that recognizes a user's conscious thoughts.
Default Profile	A generic profile template that contains default settings for a new user. See Profile.
Detection	A high-level concept that refers to the proprietary algorithms running on the neuroheadset and in Emotiv Xavier Driver which, working together, recognize a specific type of Expressiv , emotion, or mental state. Detections are organized into four different suites: Cognitiv™s, Expressiv , Affectiv™, Inertial Sensors.
EML	XavierComposer™ Markup Language – an XML-based syntax that can be interpreted by XavierComposer to playback predefined EmoState values.
Emotiv API	Emotiv Application Programming Interface: a library of functions, provided by Emotiv to application developers, which enables them to write software applications that work with Emotiv neuroheadsets and the Emotiv detection suites.
Emotiv Xavier	The Emotiv Software Development Kit: a toolset that allows development of applications and games to interact with Emotiv EmoEngine™ and Emotiv neuroheadsets.
XavierComposer™	An Emotiv EmoEngine™ emulator designed to speed-up the development of Emotiv-compatible software applications.
Emotiv EmoEngine™	A logical abstraction exposed by the Emotiv API. EmoEngine communicates with the Emotiv neuroheadset, manages user-specific and application-specific settings, and translates the Emotiv detection results into an EmoState.

XavierEmoKey™	Tool to translate EmoStates™ into signals that emulate traditional input devices (such as keyboard).
EmoScript™	A text file containing EML, which can be interpreted by XavierComposer to automate the generation of predefined EmoStates. Also refers to the operational mode of XavierComposer in which this playback occurs.
EmoState™	A data structure containing information about the current state of all activated Emotiv detections. This data structure is generated by Emotiv EmoEngine and reported to applications that use the Emotiv API.
Expressiv™	The detection suite that identifies a user's Expressiv.
Player	Synonym for User.
Profile	A user profile contains user-specific data created and used by the EmoEngine to assist in personalizing Emotiv detection results. When created with Emotiv Xavier, all users' profiles are saved to the profile.bin file in the Emotiv program files directory.
User	A person who is wearing a neuroheadset and interacting with Emotiv-enabled software. Each user should have a unique profile.

1.2 Trademarks

The following are trademarks of Emotiv.

The absence of a product or service name or logo from this list does not constitute a waiver of Emotiv's trademark or other intellectual property rights concerning that name or logo.

Affectiv™

Cognitiv

XavierComposer

XavierEmoKey™

EmoScript™

EmoState™

Emotiv EmoEngine™

Emotiv SDK

Expressiv

2. Getting Started

2.1 Hardware Components

The Emotiv Xavier consists of one Insight SDK neuroheadsets, one USB wireless receivers, and an installation CD. The neuroheadsets capture users' brainwave (EEG) signals. After being converted to digital form, the brainwaves are processed, and the results are wirelessly transmitted to the USB receivers. A post-processing software component called Emotiv EmoEngine™ runs on the PC and exposes Emotiv detection results to applications via the Emotiv Application Programming Interface (Emotiv API).

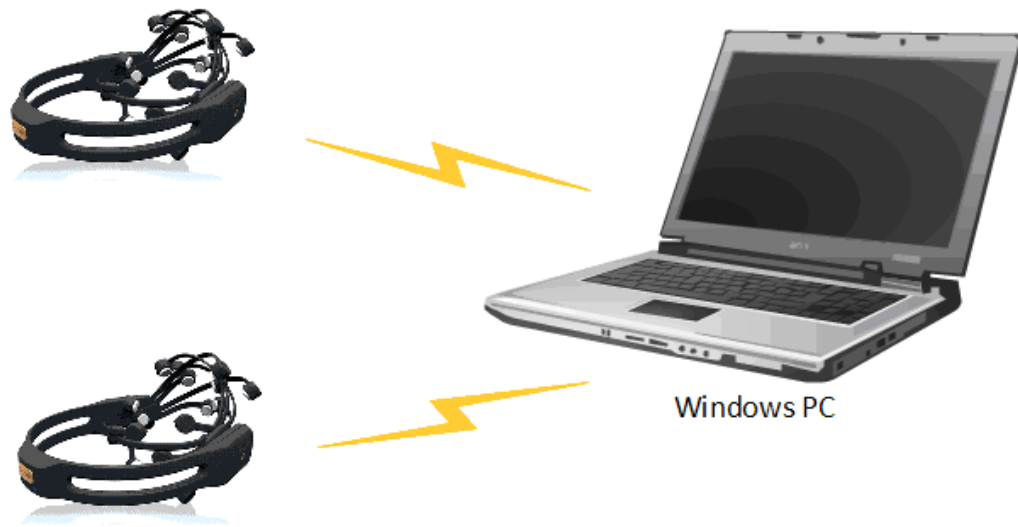


Figure 1 *Emotiv Xavier Setup*

For more detailed hardware setup and neuroheadset fitting instructions, please see the "Emotiv Xavier Hardware Setup.pdf" file shipped to SDK customers.

2.1.1 Charging the Neuroheadset Battery

The neuroheadset contains a built-in battery which is designed to run for approximately 12 hours when fully charged. To charge the neuroheadset battery, set the power switch to the "off" position, and plug the neuroheadset into the Emotiv battery charger using the mini-USB cable provided with the neuroheadset. Using the battery charger, a fully-drained battery can be recharged to 100% capacity in approximately 6 hours; charging for 30 minutes usually yields about a 10% increase in charge.

Alternatively, you may recharge the neuroheadset by connecting it directly to a USB port on your computer. Please note that this method takes the same amount of time to charge the battery.

The neuroheadset contains a status LED located next to the power switch at the back of the headband. When the power switch is set to the "on" position, the LED will illuminate

and appear blue if there is sufficient charge for correct operation. The LED will appear red during battery charging; when the battery is fully-charged, the LED will display green.

2.2 Emotiv Xavier Installation

This section guides you through the process of installing the Emotiv Software Development Kit on a Windows PC.

2.2.1 Minimum Hardware and Software requirements

- 2.4 GHz Intel Pentium 4 processor (or equivalent).
- Microsoft Windows XP with Service Pack 2 or Microsoft Windows Vista.
- 1GB RAM.
- 50 MB available disk space.
- One or two unused USB 2.0 ports (depending on the number of neuroheadsets you wish to use simultaneously)

The program displays best when the DPI setting in Windows is 100%

2.2.2 Included Emotiv Xavier software

Emotiv Xavier developers will download the compressed file Emotiv Xavier ControlPanel v3.0.0.x Installerr.exe , which contains both the Xavier SDK software and this User Manual.

Insight SDK developers will download the relevant Edition of the Insight SDK that has all software needed for Emotiv Xavier installation. Log in to your account at www.emotiv.com and navigate to My Emotiv ~> Purchases. Your Insight SDK Edition should be available for download. Please also note the installation keys available from the KEY icon next to the DOWNLOAD button.

2.2.3 USB Receiver Installation

(This section is not relevant for SDK developers).

Plug the provided Emotiv USB receiver(s) into an unused USB port on your computer. Each receiver should be recognized and installed automatically by your computer as a USB Human Interface Device. The receivers follow the USB Human Interface Device standard so no additional hardware drivers are required to be installed. Please wait for a moment until Windows indicates that the new hardware is installed and ready to use.

2.2.4 Emotiv Xavier Installation

This section explains the steps involved in installing the Emotiv Xavier software. If an older version of the Emotiv Xavier is present in your computer, we recommend that you uninstall it before proceeding.

Step 1 Using Windows Explorer, access the Emotiv Xavier ControlPanel v3.0.0.x Installer.exe downloaded from the website.

Step 2 Run the Emotiv Xavier ControlPanel v3.0.0.x Installer file. An Emotiv Xavier ControlPanel v3.0.0.x **Setup** window will appear after a few seconds.



Figure 2 *Emotiv Xavier Setup wizard*

Step 3 Click Next to start the installation process. You will be asked to enter First Name, Last Name, Email, Key Order Number and Serial Key. These numbers are available from the KEY icon next to the DOWNLOAD button at My Emotiv => Purchase. Enter these numbers and click Next.

Note: when you enter the correct Key Order Number and Serial Key, a pop-up box will appear indicating the "Serial Key is valid". Click OK and proceed to the next step.

The screenshot shows a Windows-style dialog box titled "Emotiv Xavier SDK v3.0.0.8 Setup". The main heading is "Registration" with a sub-instruction: "Please enter your personal information below:". There is a small globe icon in the top right corner of the dialog. The form contains several input fields, each preceded by a red asterisk indicating it is required:

- * First Name: [text input field]
- * Last Name: [text input field]
- * Email: [text input field]
- Organization: [text input field]

Below a horizontal line, there is another instruction: "Please refer to your software package for your order number and serial key:". This is followed by two more required input fields:

- * Key Order Number: [text input field]
- * Serial Key: [text input field]

A red asterisk with the text "(required field)" is positioned to the right of the Serial Key field. At the bottom left, the text "Nullsoft Install System v3.0a1" is visible. At the bottom right, there are three buttons: "< Back", "Next >" (which is highlighted with a blue border), and "Cancel".

Figure 3 Enter Key Order Number and Serial Key

Click **Next** to start the installation process.

Step 4 If you haven't uninstalled and older version of the Emotiv Xavier, you may be asked if you wish to uninstall the older copy before proceeding. Multiple copies of the Insight can coexist on the same machine but you must be careful not to "mix and match" components from multiple installations.

Step 5 After a few seconds, an **Installation Complete** dialog will appear.

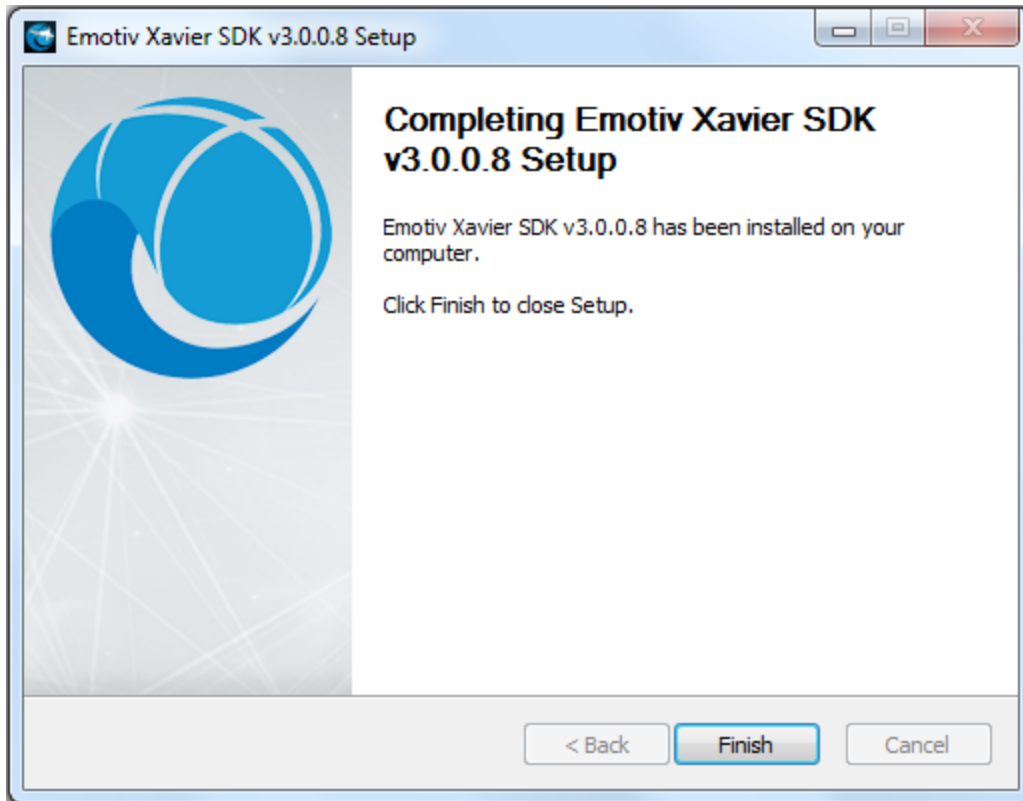


Figure 4 *Installation Complete dialog*

Step 6 Click **Finish** to complete the installation.

2.3 Start Menu Options

Once you have installed the Emotiv Xavier, you will find the following in

Start > All Programs:

- 📁 Emotiv Xavier ControlPanel v3.0.0.x
 - 📄 Emotiv Xavier ControlPanel A program to test and tune detection suites available in the Emotiv Xavier.
 - 📄 Uninstall To uninstall the Emotiv Xavier

3. Emotiv Xavier

This section explains how to use Emotiv Xavier to explore the Emotiv detection suites.

Launch Emotiv Xavier by selecting **Windows Start** → **Programs** → **Emotiv Xavier ControlPanel v3.0.0.x** → **Emotiv Xavier ControlPanel** . When the Emotiv Xavier is launched for the first time, your firewall software (if installed on your computer) may notify you that the Insight is trying to accept connections from the network (port 3008). The notification message may be similar to the dialog shown in Figure 4. For proper operation, you must allow Emotiv Xavier to use this port by selecting **Allow access** (or a similar option, depending on your firewall software).

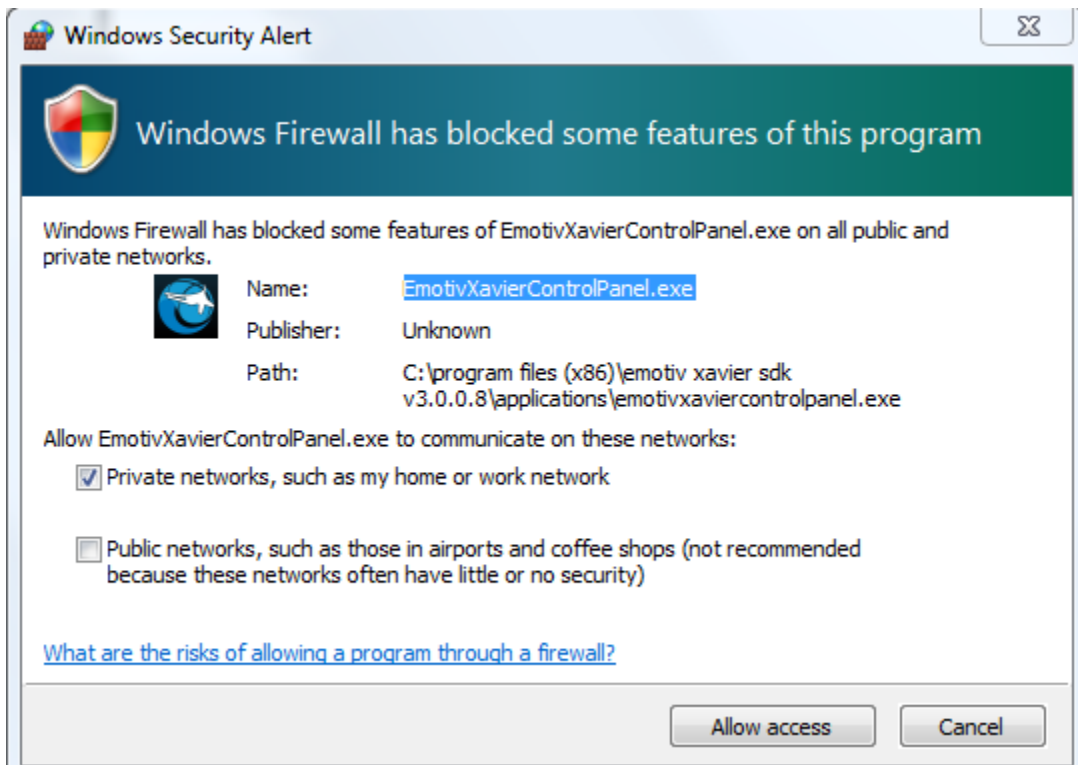


Figure 5 Windows Firewall warning about Emotiv Xavier – select Allow access

Emotiv delivers the Emotiv API in the form of a dynamically linked library named InsightEDK.dll. Emotiv Xavier provides a GUI (graphical user interface) that interfaces with Emotiv EmoEngine through the Emotiv API. The Xavier user interface showcases the EmoEngine's capabilities to decipher brain signals and present them in useful forms using Emotiv's detection suites.

3.1 EMOENGINE Status Pane

The top pane of Emotiv Xavier is known as the Xavier Status Pane. This pane displays indicators that provide real-time information about Xavier status and neuroheadset sensor contact quality. It also exposes user profile management controls.



Figure 6 *Xavier Status Pane*

3.1.1 Xavier Status

In this Xavier version will automatically detect EPOC or Insight neuroheadset using to open EPOC or Insight suitable. By default, the Xavier will automatically connect to the Insight or EPOC Driver when launched. In this mode, it will automatically discover attached USB receivers and Emotiv neuroheadset. Alternatively, you may choose to connect to Insight or EPOC Composer, Emotiv's Insight or EPOC emulator tool, from the **Connect** Tab. **Please note that Xavier Composer should be launched prior to selecting this option in Emotiv Xavier.**

There are three status indicators:

- **System up time:** The timestamp (in seconds) attached to the most recently received EmoState event. Generally, this corresponds to the length of time that the Insight or EPOC have been running with a neuroheadset connected to the USB receiver
- **Wireless Signal:** This displays the quality of the connection between the neuroheadset and the Emotiv wireless USB receiver connected to your machine. If you have not yet connected, the display will show a black waves. If the wireless signal strength drops too low then no detection results will be transmitted and the Insight or EPOC will disable its detection suite UI controls.
- **Battery Power:** Displays an approximation of the remaining charge in the neuroheadset's built-in battery.

3.1.2 User Status

Use the controls in this section to manage user profiles and assign a specific user (via their profile) to a specific attached neuroheadset. Although the Insight or EPOC Driver supports up to two simultaneously connected neuroheadsets, Emotiv Xavier only displays status information and detection results for a single neuroheadset at a time. The **HEADSET** combo box allows you to specify the neuroheadset that has the current "focus."

Note: headset numbering begins with 0 and not 1 as you might expect.

Other operations that are supported include adding, saving, removing, and switching between user profiles. Note: Emotiv Xavier will automatically save user profile data to disk when it exits so it is generally not necessary to use the Save Profile button.

Addition you can set background for Emotiv Xavier by using THEME. The program supported many theme to use.

3.1.3 Sensor Contact Quality Display

Accurate detection results depend on good sensor contact and EEG signal quality. This display is a visual representation of the current contact quality of the individual neuroheadset sensors. The display is a smaller copy of the contact quality visualization found on the Xavier's **Set Up** tab. Please see Section **Set Up** below for more information about fitting the neuroheadset and achieving good EEG signal quality.

3.1.4 Xavier connect

Every you attach dongle to computer, program automatically check Epoc or Insight neuroheadset attached to set interface suitable. Emotiv Xavier allows you to use both old Epoc and new Insight neuroheadset. With every neuroheadset will display Epoc or Insight corresponding.

You click  of program will display detail tabs of Emotiv Xavier as follow:

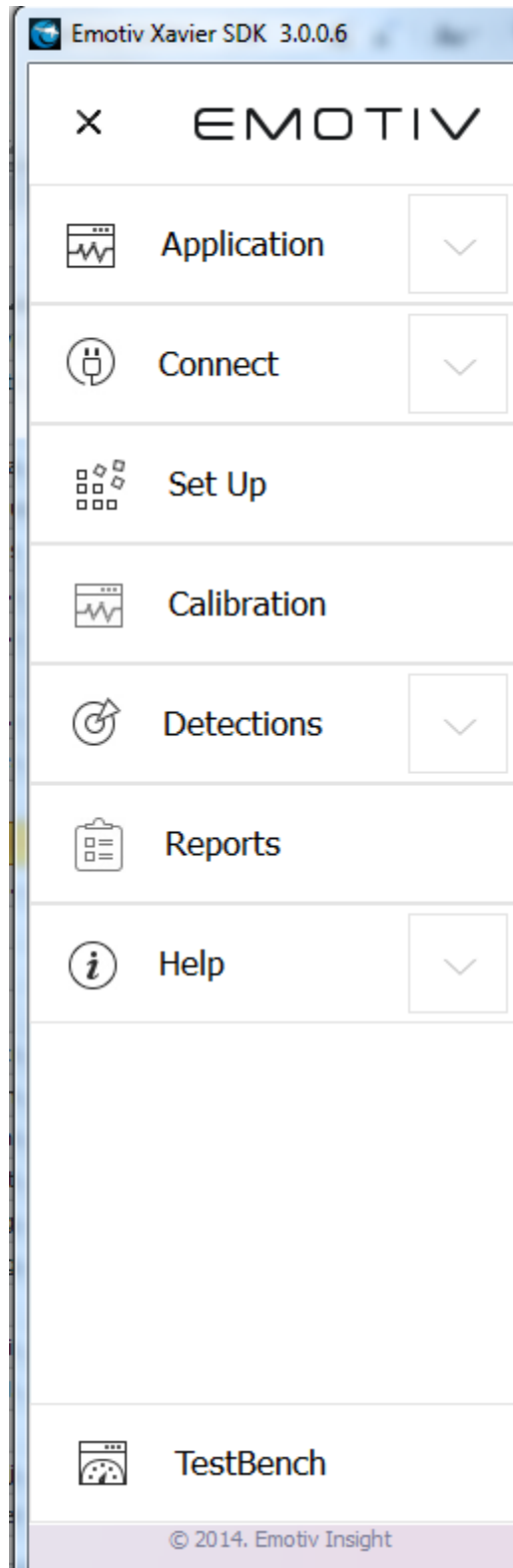


Figure 7 *Xavier tabs detail*

After drop-down menu is opened, you can select a tab which you want. You can click X on the top to close drop-down menu. There are six sub tabs in drop-down menu:

Application, Connect, Set Up, Calibration, Detections, Reports, Help and TestBench is a shortcut to connect to TestBench.

3.2 Application

You click  of program will display detail tabs of Emotiv Xavier, then you select **Application** tab. You click **X** to close .

3.2.1 Enable Debug Logging

If you select this section, a name file is EDK-Debug-Log.txt will be generated in your folder running. EDK-Debug-Log.txt display informations of program in real time.

To use this tab you click Enable Debug Logging, then Reconnect program. The data for each time debugging will write continuous to EDK-Debug-Log.txt file.

3.2.2 Save Current Screenshot

When you click this item a screenshot is taken and a path window opens so you may type a filename to save the screenshot. After you click the Save button on this window it is closed.

3.3 Connect

You click  of program will display detail tabs of Emotiv Xavier, then you select **Connect** tab. You click **X** to close .

You need click to Connect Tab to see detail this tab

By default when you start program will connect to Insight or Epoc Driver and allows the user to select his profile, configure the detection suite settings, and get contact quality feedback through the Xavier SDK user interface.

Xavier SDK can also be connected to Xavier Composer . This is useful when creating and testing a new action since the user can easily generate EmoState update events that satisfy the conditions for rules defined in Xavier SDK. Refer to Section below for more information about Insight Composer .

If this occurs, then run the desired application (either Connect Driver or Connect Composer) and then select **Reconnect** from the **Connect** Tab.

3.4 Set Up

You click  of program will display detail tabs of Emotiv Xavier, then you select **Set Up** tab. You click **X** to close .

The **Set Up** tab is displayed by default when starting Emotiv Xavier. The main function of this panel is to display contact quality feedback for the neuroheadset's EEG sensors and

provide guidance to the user in fitting the neuroheadset correctly. It is extremely important for the user to achieve the best possible contact quality before proceeding to the other Emotiv Xavier tabs. Poor contact quality will result in poor Emotiv detection results.

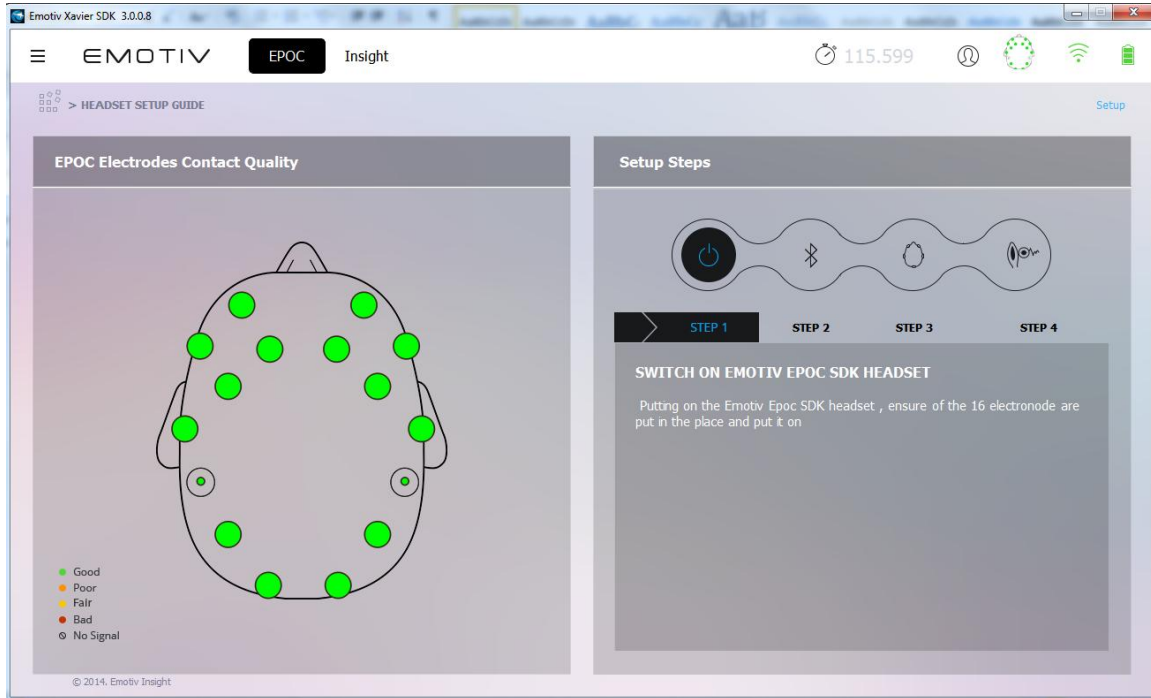


Figure 8 SETUP Tab

The image on the left is a representation of the sensor locations when looking down from above onto the user's head. Each circle represents one sensor and its approximate location when wearing the Insight SDK headset. The color of the sensor circle is a representation of the contact quality. To achieve the best possible contact quality, all of the sensors should show as **green**. Other sensor colors indicate:

- Black** No signal
- Red** Bad signal
- Orange** Poor signal
- Yellow** Fair Signal
- Green** Good signal

The setup procedure used to achieve good contact quality is outlined below. Only after the neuroheadset sensor contact quality has been verified, should you move on to other Emotiv Xavier tabs.

3.4.1 Achieving Good Signal Quality

Note to SDK Developers: This section is not required, but it may be useful to understand how contact quality information may need to be conveyed to the user for standalone, Emotiv-enabled applications.

Step 1 Putting on the Epoc neuroheadset into the headset.

Step 2 Switch on the neuroheadset, and verify that the built-in battery is charged and is providing power by looking for the blue LED located near the power switch at the back of the headset. If the headset battery needs charging, then set the power switch to the off position, and plug the headset into the Emotiv battery charger using the mini-USB cable provided with the neuroheadset. Allow the neuroheadset battery to charge for at least 15 minutes before trying again.

Step 3 Verify that the **WIRELESS SIGNAL** reception is reported as “Good” by looking at the **EPOC STATUS** area in the EPOC Status Pane (described in Section **Error! Reference source not found.**). If the **WIRELESS SIGNAL** status is reported as “Bad” or “No Signal”, then make sure that the Emotiv Wireless USB Receiver is inserted into a USB port on your computer and that the single LED on the top half of the receiver is on continuously or flickering very rapidly. If the LED is blinking slowly or is not illuminated, then remove the receiver from the computer, reinsert it, and try again. Remove any metallic or dense physical obstructions located near the receiver or the neuroheadset, and move away from any powerful sources of electromagnetic interference, such as microwave ovens, large motors, or high-powered radio transmitters.

Step 4 Put on the neuroheadset by gently pulling apart the headband and lowering the sensor arms onto your head from the top down, near the rear of the skull. Next, slide the headset forward until the sensors closest to the headset pivot points are located directly above your ears and as close to your hairline as possible. Adjust the fit so that the rectangular compartments at the front ends of the headband sit comfortably just above and behind your ears. Tilt the headset so that the two lowest, frontmost sensors are symmetric on your forehead and positioned 2 to 2.5 inches above your Raise Brows. Finally, check that all sensors are touching your head and, if not, then fine tune the headset fit by gently sliding the headset in small increments until an ideal fit has been achieved.

Step 5 Repeat for each of the remaining sensors until all of the sensors have adequate contact quality (i.e. are predominantly showing green).

If at any time the reference sensors (located just above and behind your ears) no longer have a good connection (i.e. are not showing green), immediately restore these sensors to green before proceeding further.

3.5 Calibration

You click  of program will display detail tabs of Emotiv Xavier, then you select **Calibration** tab. You click **X** to close .

This part allows users to record their own most accurate feelings via two states: Eyes Open and Eyes Closed. To perform this part well, it is recommended that users go through two steps: **Calibration Step** and **Live Metrics**. By default there are only two main

windows and the title appears at the beginning of the line. Every you want to use this tab to record , the first you need to pass Step1 and Step2 in Calibration Step.

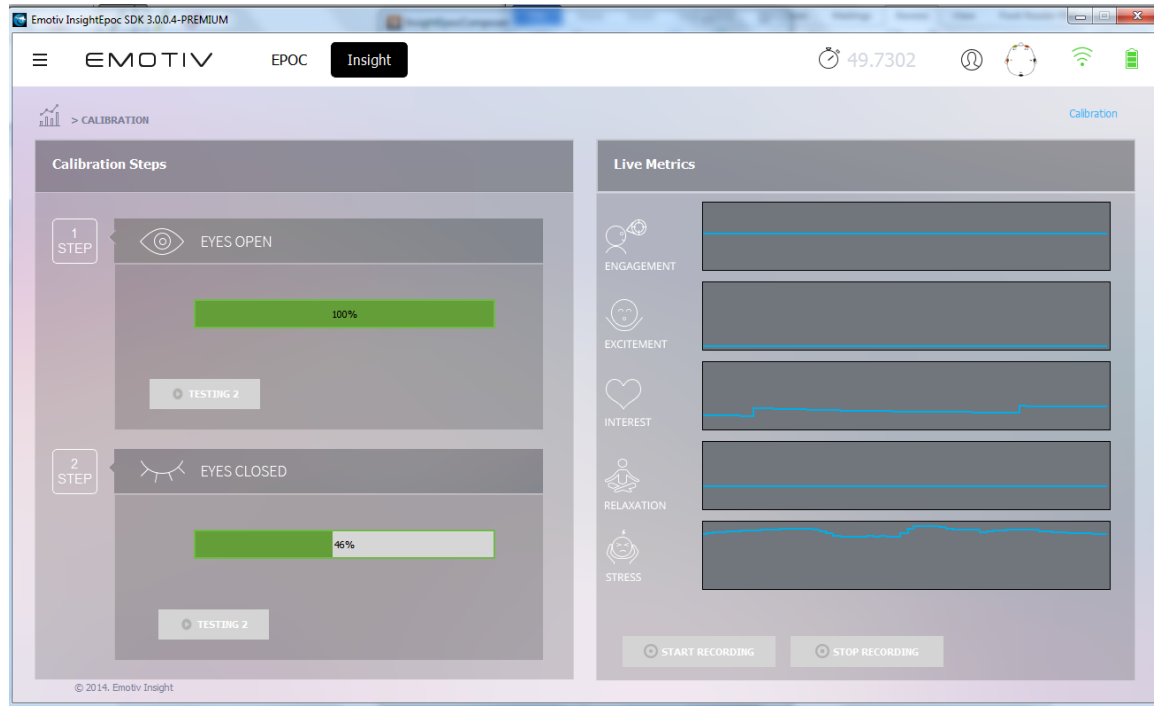


Figure 1 CALIBRATION Tab

3.5.1 CALIBRATION STEPS

You click **1 STEP** to begin using this part. Order implementing this section should follow: Step1, Step2, Record and you can not reverse this order of execution.

In Calibration step, you should go through two steps, each step takes 30 seconds.

Step 1: Eyes Open

Users click **1 STEP** to expand this tab, click **BEGIN TEST 1** and open their eyes within about 30 seconds until the slider runs out and hearing the sound "bing". At the end of this process, the amount of per cent will be displayed.

After finishing the step 1, you turn to the step 2.

Step 2: Eyes Closed

To start with Step 2, user should click **2 STEP** to expand this tab, click **BEGIN TEST 2**, then close their eyes within about 30 seconds until hearing the sound "bing".

Note: If you are not satisfied with the data in Eyes Open and Eyes Closed step, you can click **BEGIN TEST 1** to collect data again. You need to focus your mind to have the data collected is the best

3.5.2 LIVE METRICS

This process allows users to record their own feelings via two steps above.

To start recording, Start Recording button should be clicked. There are waves of five detected emotional states that are displayed above the button including Engagement, Focus, Interest, Relaxation, and Stress.

After a sufficient amount of time, users should click Stop Record to stop the process of recording. After Stop Record is clicked, the program will turn to REPORTS tab automatically. Please take a look at details in REPORTS Tab.

3.6 Detections

You click  of program will display detail tabs of Emotiv Xavier, then you select **Detections** tab. You click **X** to close .

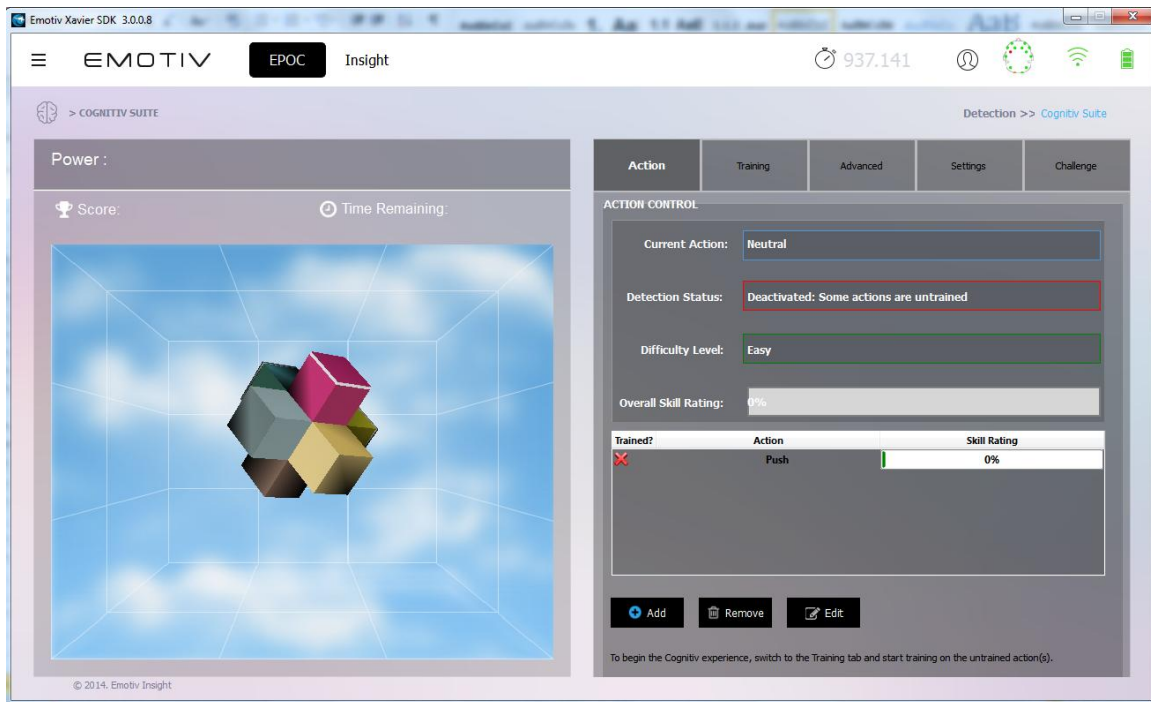


Figure 2 DETECTIONS Tab

The DETECTIONS Tab contains activities relating to Cognitiv™, Expressiv , Affectiv™ and Inertial Sensors

3.6.1 Cognitiv™

a. Cognitiv™ Introduction

The Cognitiv detection suite evaluates a user's real time brainwave activity to discern the user's conscious intent to perform distinct physical actions on a real or virtual object. The detection is designed to work with up to 13 different actions: 6 directional movements (push, pull, left, right, up and down) and 6 rotations (clockwise, counter-clockwise, left, right, forward and backward) plus one additional action that exists only in the realm of the user's imagination: disappear.

Cognitiv™ allows the user to choose up to 4 actions that can be recognized at any given time. The detection reports a single action or neutral (i.e. no action) at a time,

along with an action power which represents the detection's certainty that the user has entered the Cognitiv™ state associated with that action.

Increasing the number of concurrent actions increases the difficulty in maintaining conscious control over the Cognitiv detection results. Almost all new users readily gain control over a single action quite quickly. Learning to control multiple actions typically requires practice and becomes progressively harder as additional actions are added. Although Emotiv Xavier allows a user to select up to 4 actions at a time, it is important that each user masters the use of the Cognitiv detection one action at a time, only increasing the number of concurrent actions after he has first gained confidence and accuracy with a lower number of actions.

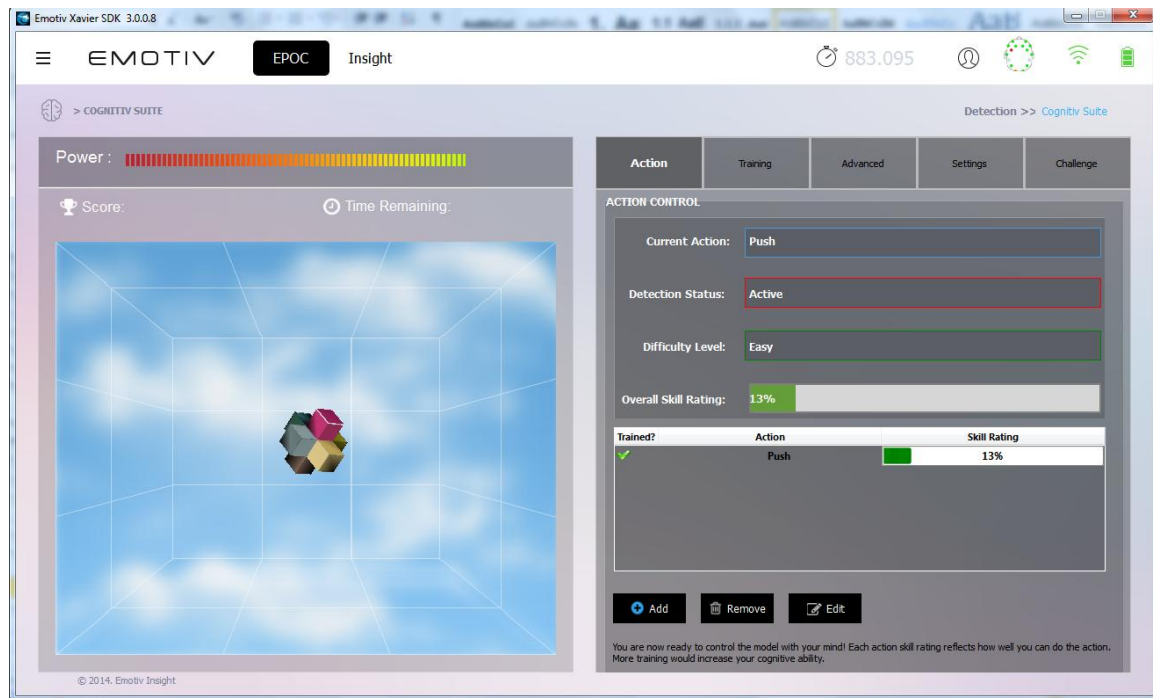


Figure 3 Cognitiv Tab

b. Understanding the Cognitiv Tab Display

The **Cognitiv** Tab uses a virtual 3D cube to display an animated representation of the Mental detection output. This 3D cube is also used to assist the user in visualizing the intended action during the training process. The **Power** gauge on the top of the 3D display is an indicator of the “action power”, or relative certainty that the user is consciously visualizing the current action.

The default tab on the Cognitiv Tab is the **Action** tab. This tab displays information about the current state of the Mental detection and allows the user to define the current set of actions.

In order to enable the Cognitiv detection, each chosen action, plus the Neutral action, must first be trained. Alongside each currently selected action is another gauge displaying a **Skill Rating**. This skill rating is calculated during the training process and provides a measure of how consistently the user can mentally perform the intended action. It is necessary to train the same action at least two times before the action skill is updated. The **Overall Skill Rating** is simply the average of all the individual action skills

and can be used as a general measure of the user's skill with the selected set of actions and existing training data.

A green checkmark is used to indicate that the corresponding action has been trained; a red X indicates a lack of training data. Remember, in order for the Cognitiv detection to be activated, all actions, plus Neutral (the user's background Cognitiv state) must be trained.

Use the **Add**, **Remove**, and **Edit** push buttons to modify the number and type of enabled actions.

c. Cognitiv Training

The Cognitiv training process enables the Epoc to analyze your brainwaves and develop a personalized signature which corresponds to each particular action, as well as the background state, or "neutral". As the Insight learns and refines the signatures for each of the actions, as well as neutral, detections become more precise and easier to perform.

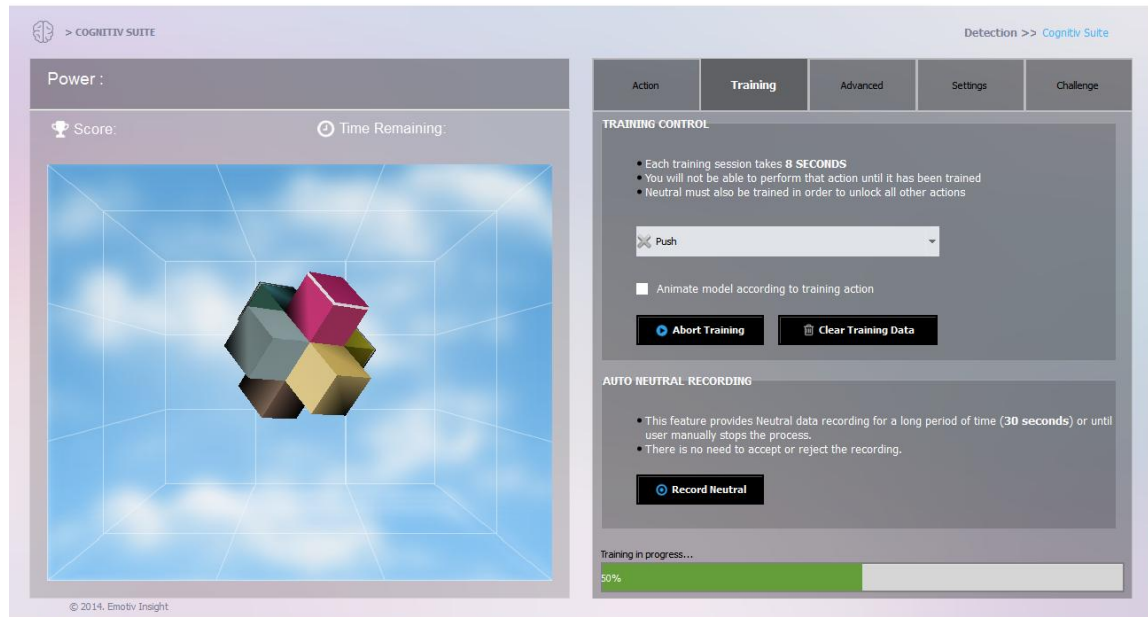


Figure 4 Cognitiv training in action

The **Training** tab contains the user interface controls that support the Cognitiv training process. The training process consists of three steps:

First, select an action from the dropdown list. Actions that have already been trained are paired with a green checkmark; actions with no training data are paired with a red X. Only actions that have been selected on the **Action** tab are available for training. The default action is one without training data; otherwise the default action is "Neutral."

Next, when you are ready to begin imagining or visualizing the action you wish to train, press the **Start Training** button. During the training process it is very important to maintain your Cognitiv focus for the duration of the training period (currently 8 seconds). Physical gestures, such as pushing an imaginary object with one hand, may be used to heighten your focus on the intended action, but are not required. You should also refrain from

making substantial head movements or dramatic Expressiv™ during the training period, as these actions can interfere with the recorded EEG signal.

Initially, the cube on screen will not move, as the system has not yet acquired the training data necessary to construct a personalized signature for the current set of actions. After Neutral and each enabled action have been trained at least once, the Cognitiv detection is activated and the cube will respond to the Cognitiv detection, and your Cognitiv control, in real time.

Some users will find it easier to maintain the necessary Cognitiv focus if the cube is automatically animated to perform the intended action as a visualization aid during training. If you think you will benefit from this, then you may select the **Animate model according to training action** checkbox. Otherwise, the cube will remain stationary or, if you have already supplied training data and the detection is active, will be animated by the current detection results for the action being trained, while you supply new training data.

Finally, you are prompted to accept or reject the training recording. Ideal Cognitiv detection performance is typically achieved by supplying consistent training data (i.e. a consistent Cognitiv visualization on the part of the user) across several training sessions for each enabled action. The ability to reject the last training recording allows you to decide whether you were able to remain mentally focused on the appropriate action during the last training session. Alternatively, you may press the **Abort Training** button to abort the training recording if you are interrupted, become distracted, or notice problems with the neuroheadset contact quality indicators during the recording.

A training session is automatically discarded if the wireless signal strength or EEG signal quality is poor for a significant portion of the training period. A notification will be displayed to the user if this has occurred.

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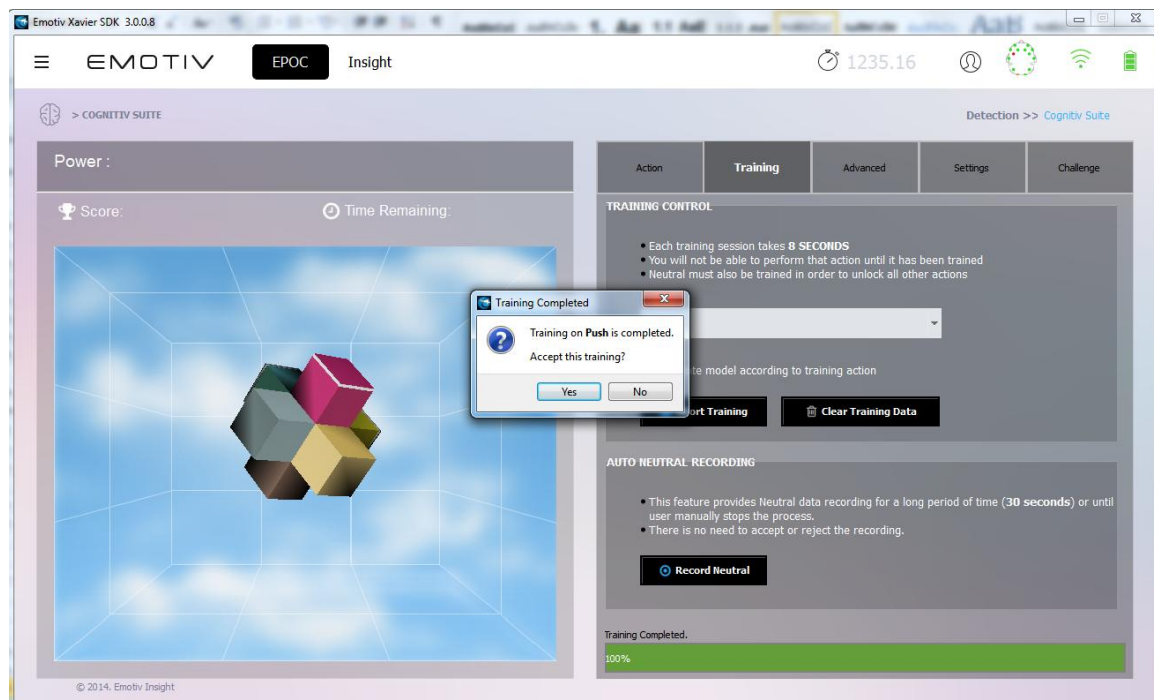


Figure 5 Accepting or Rejecting a Cognitiv Training Session

d. *Training Neutral*

The Neutral “action” refers to the user's passive Cognitiv state; one that isn't associated with any of the selected Cognitiv actions. While training Neutral, you should enter a Cognitiv state that doesn't involve the other Cognitiv actions. Typically this means engaging in passive Cognitiv activities such as reading or just relaxing. However, to minimize “false-positive” Cognitiv action results (i.e. incorrect reporting of unintended actions), it may also be helpful to emulate other Cognitiv states and Expressiv™ that are likely to be encountered in the application context and environment in which you'll be using Mental. For many users, providing more Neutral training data will result in better overall Mental performance. In order to facilitate the acquisition of this data, and because most users have an easier time maintaining a relaxed mental state for longer periods of time, the Training tab provides a second method for training Neutral.

The **Record Neutral** button allows you to record up to 30 seconds of Neutral training data. The recording will automatically finish, and the Mental signature will be rebuilt, after 30 seconds, or you may press the **Stop Recording** button at any time you feel sufficient data has been collected. Note: at least 6 seconds of recorded data will be required to update the signature with data collected using the **Record Neutral** button.

e. *Clear Training Data Button*

Occasionally, you may find that a particular trained action doesn't work as well as it once did. This may indicate that the training data used to construct your personalized Mental signature was “contaminated” by a more recent, inconsistent training session or that some characteristics of your brainwaves have changed over time. It may also happen that you wish to change the mental imagery or technique that you associate with a particular action. In either situation, you can use the **Clear Training Data** button to delete the training data for the selected action. Keep in mind that doing so will disable the Cognitiv detection until new training data has been recorded for this action.

f. *Advanced Cognitiv Options*

The **Advanced** tab exposes settings and controls that allow you to customize the behavior of the Cognitiv detection. By default, the Cognitiv detection is pre-configured in a manner that produces the best results for the largest population of users and environments. It is strongly recommended that you only change these settings with the guidance of Emotiv personnel who are better acquainted with the internal details of the Emotiv EmoEngine.

g. *Cognitiv Tips*

Cognitiv dexterity with the Cognitiv is a skill that will improve over time. As you learn to train distinct, reproducible Cognitiv states for each action, the detection becomes increasingly precise. Most users typically achieve their best results after training each action several times. Overtraining can sometimes produce a decrease in accuracy – although this may also indicate a lack of consistency and Cognitiv fatigue. Practice and experience will help determine the ideal amount of training required for each individual user.

If it becomes hard for you to return to neutral (i.e. to stop the cube from moving) you should try refreshing your Cognitiv state by momentarily shifting your focus away from the screen and relaxing. It is easy to become immersed in the experience and to have the Cognitiv actions at the “front of your mind” while trying to be neutral.

Successful training relies on consistency and focus. For best results, you must perform the intended action continuously for the full training period. It is common for novice users to become distracted at some point during the training period and then Cognitivly restart an action, but this practice will result in poorer results than training with a Cognitiv focus that spans the entire training period.

A short latency, of up to two seconds, in the initiation and cessation of the cube's animated action on screen is typical.

h. Cognitiv Settings

Settings Tab is a new feature of Emotiv Xavier. You can use your Epoc headset to customize and control imported 3D Objects.

First you have to Import your model, edit the scale to suit, and arrange the background to create custom context. Then you can use the Epoc Cognitiv to control any 3D Object in the Epoc SDK window.

MODEL CONTROL

The MODEL CONTROL tab allows you to set the Background, Set Frame for the usual Cube. You can click Set Default button to reset default state. The window on the right allow you preview settings relate to display, then you click Apply button to display on Cube on the left window.

There are two types display for cube: 2D and 3D cube. You just need to click back and forth between 2D and 3D will look clearer of the differences between 2D and 3D picture.

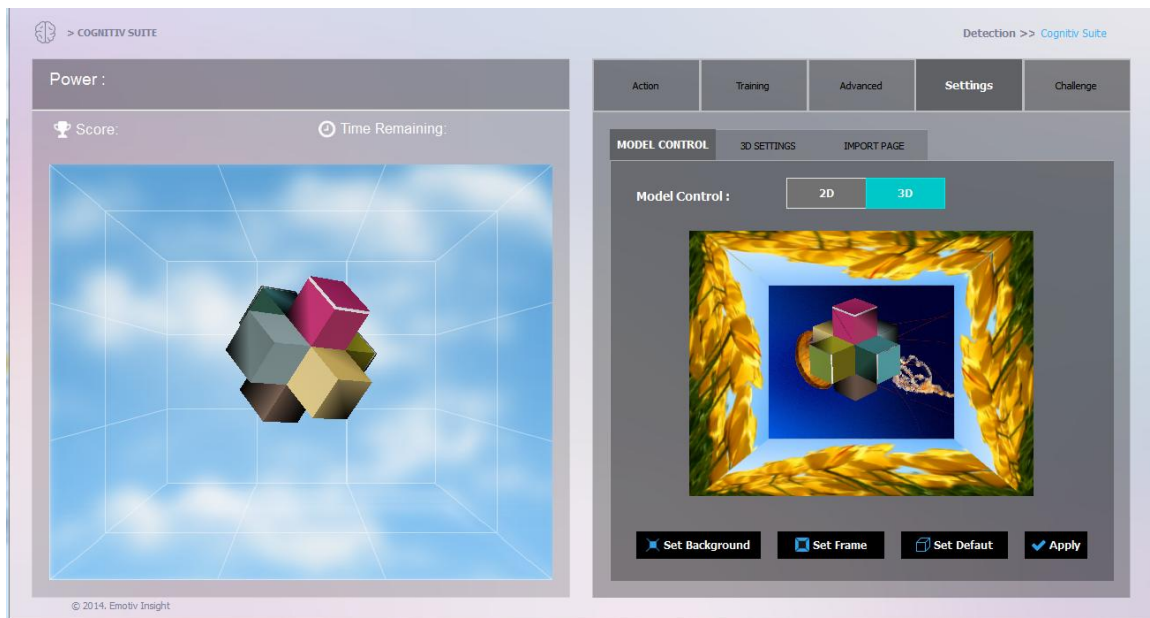


Figure 6 Model Control

3D SETTINGS

Emotiv Xavier preset for you some model 3D to use. There are two 3D Models: Car and Box in this program for you may be selected.

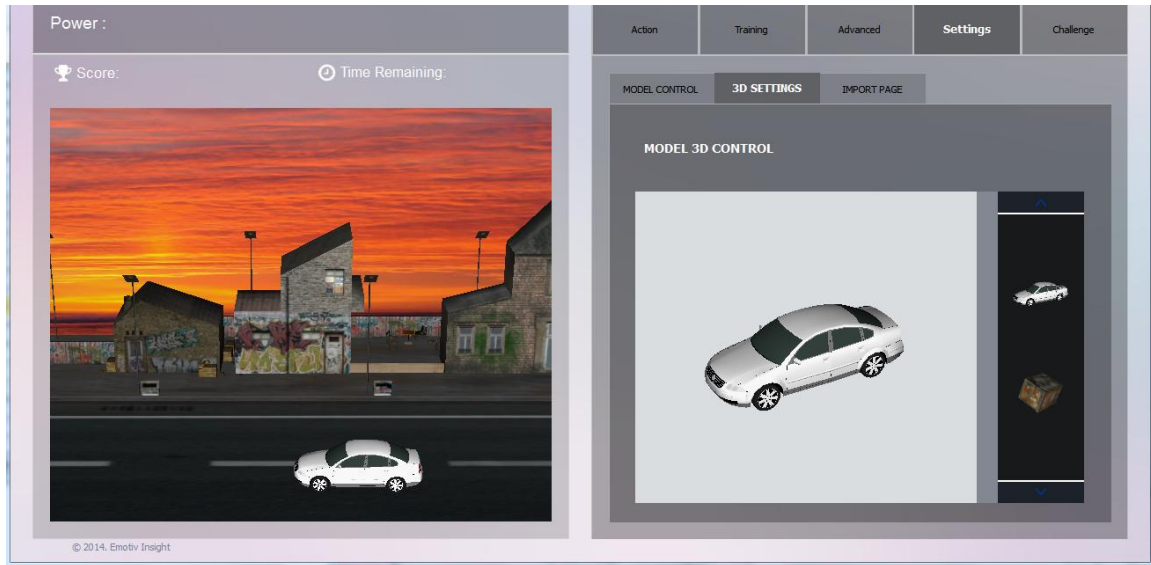


Figure 7 Set 3D Model

Select the 3D Object from the Option tab and use the Epoc headset to control them in Cognitiv .



Figure 8 Demo actions for model

You can combine multiple actions to control the model (Rotate Clockwise and Left/Right) or (Rotate Reverse vs Left/Right).

IMPORT PAGE:

IMPORT PAGE allows the user to set up the context with your own 3D models which can be manipulated using your Cognitiv. This tab allows you to experience some of the other models with the default interface of the program. Here you can test the ability to sort, decoration ... model

Step 1: Import model

Click Import Model button, then you navigate to the folder where you stored 3DS Model (.3ds) file or Emotiv Model Setting (.EMS) file if it is available.

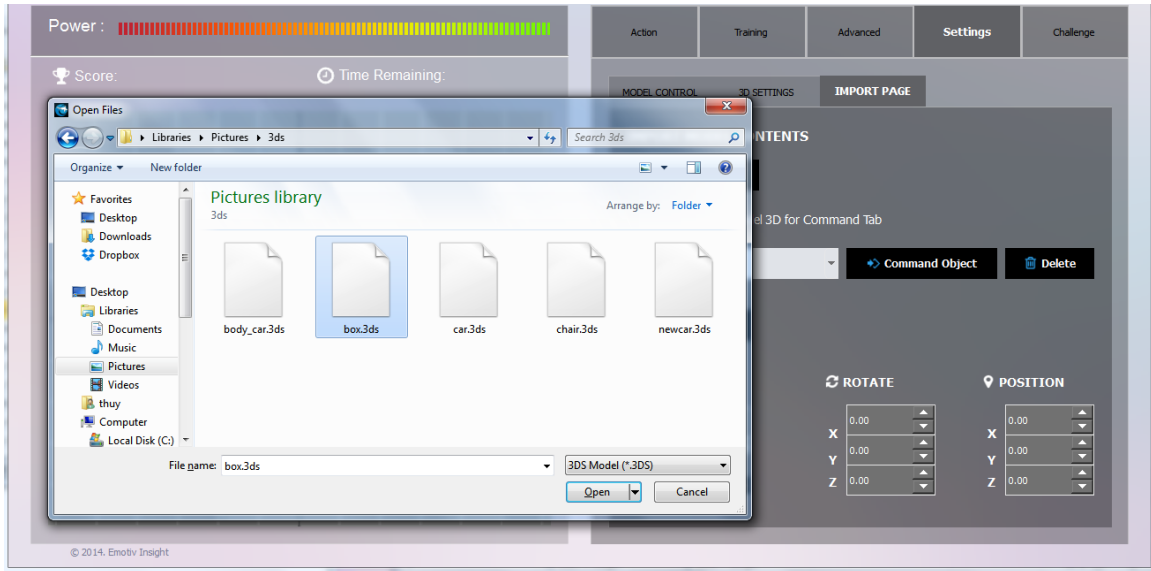


Figure 9 *IMPORT MODEL*

Step 2: Place the models in your desired position then add Texture for Model, edit Scale, Rotate and Position for it.

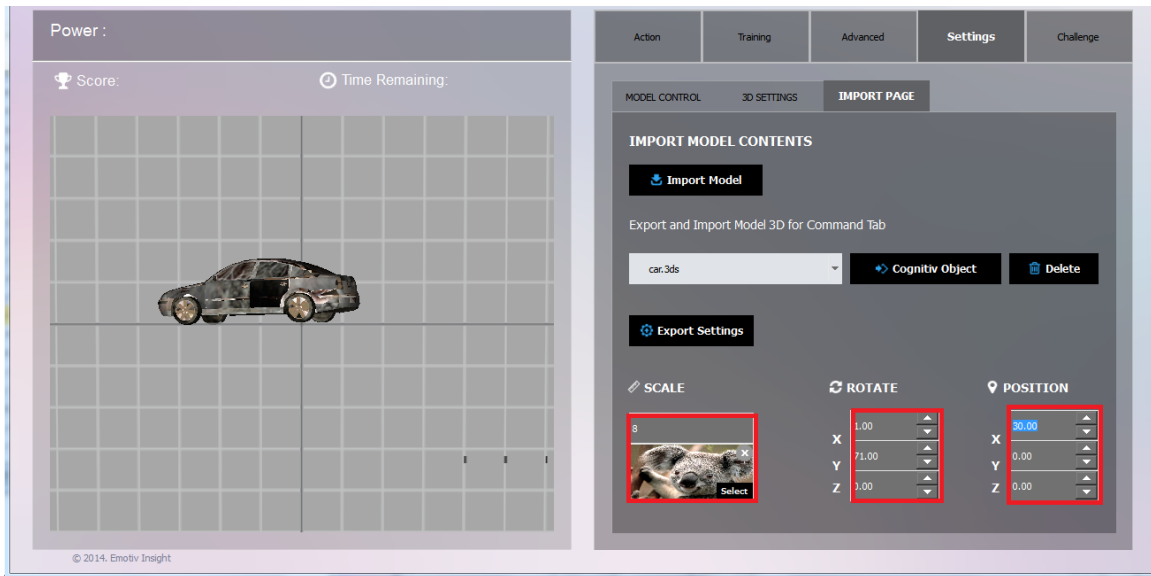


Figure 10 *EDIT SCALE, POSITION, ROTATE for model*

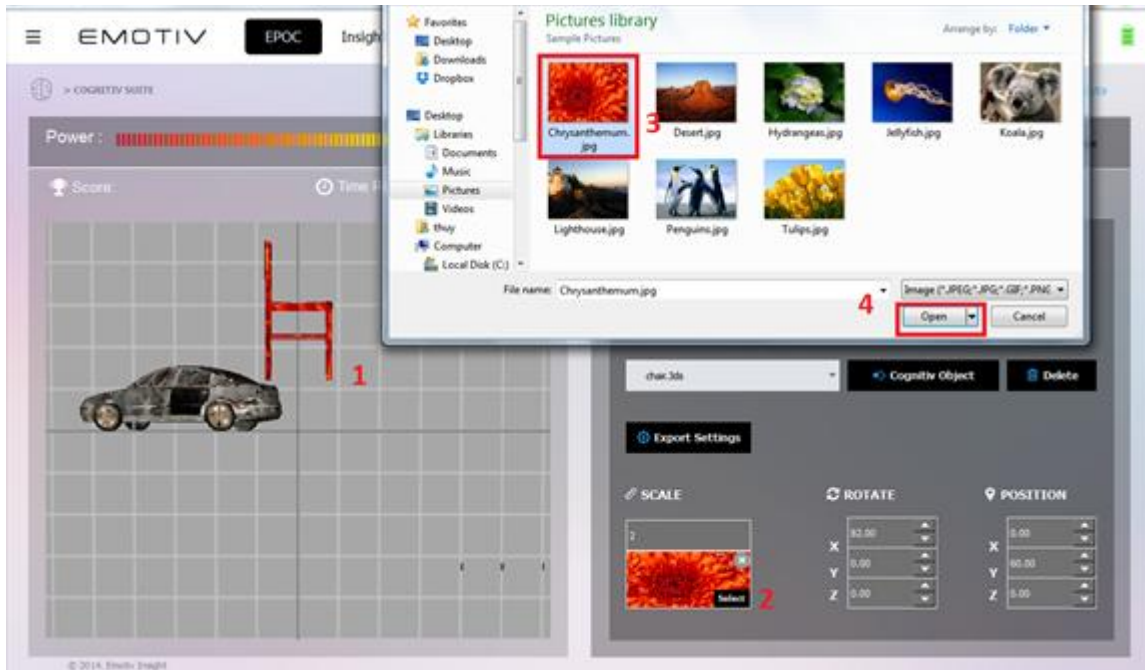


Figure 11 Add texture for model

Step 3: Repeat step 1 and step 2 until your context is completed. You can add some model for context. If you are not satisfied with any models, you can remove it by choosing Delete button, then all data that you set for that model would be disappeared.

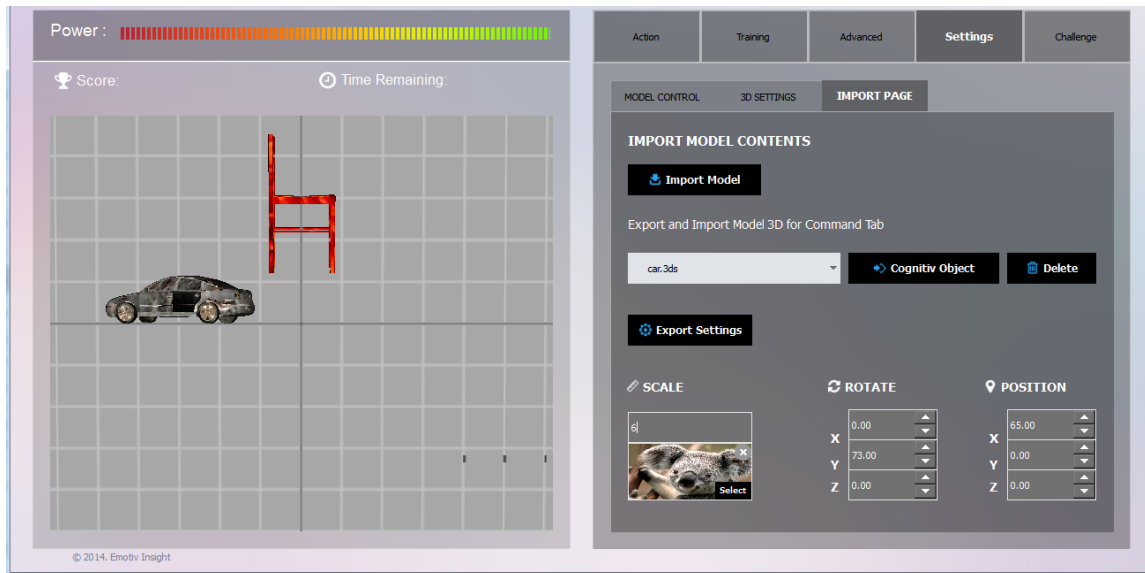


Figure 12 Model after add texture

Step 4: Select any model in that context. You can use the Epoc headset to control model. You need to click **Command Object** button to start. Model which choiced. The chosen Model is transferred the respective action in Action Tab. You could click the window to the left of the desktop, then drag the mouse to see the change of rotation angle of the Model, which helps you have a new view of your chosen model.

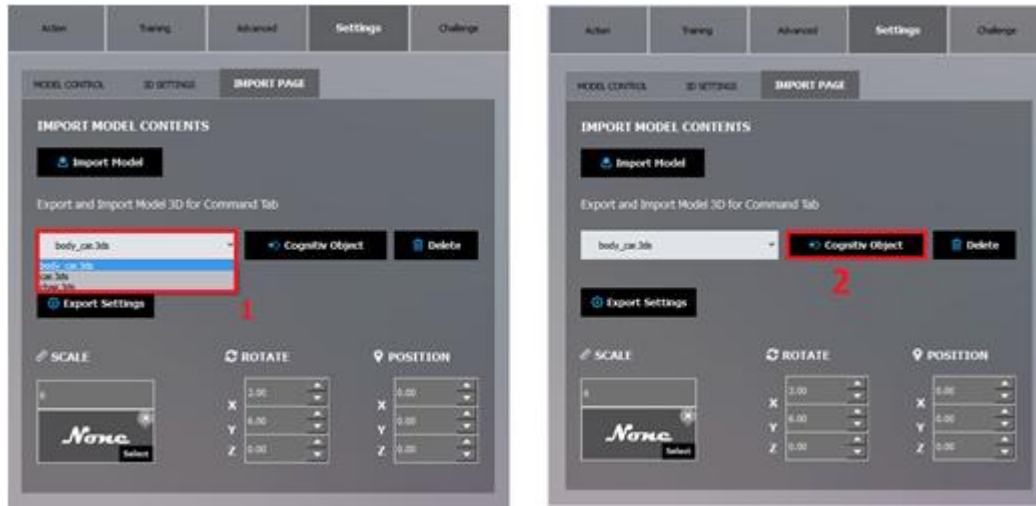


Figure 13 Select model for Cognitiv

Step 5: Import Model and Export Setting

Export Setting: After you have created a context you like and want to save it to be able to use it again next time you can use the Export Settings. This file is saved in the format of .ems file. With a certain context you have created, Emotiv Xavier allows you to keep still the Position, Texture, Scale... of the model so that you could be reloaded later.

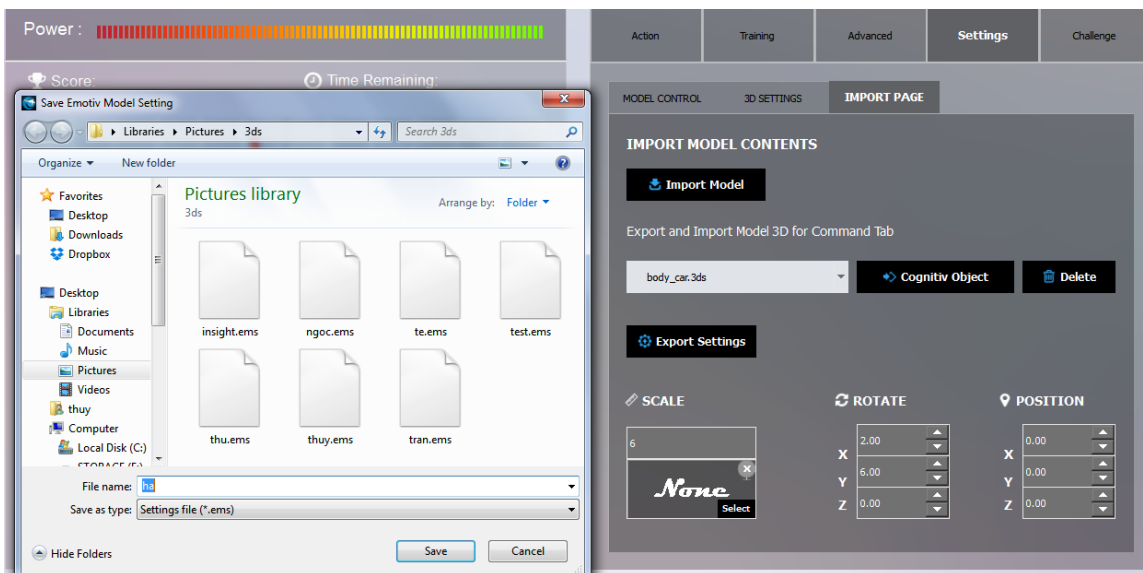


Figure 14 EXPORT MODEL

IMPORT MODEL: If you want to reload a context which you have saved the previous use, you can reload it from .ems. Then the whole context of the file will be will be reloaded to the program.

The file idea1.ems is provided as an example.

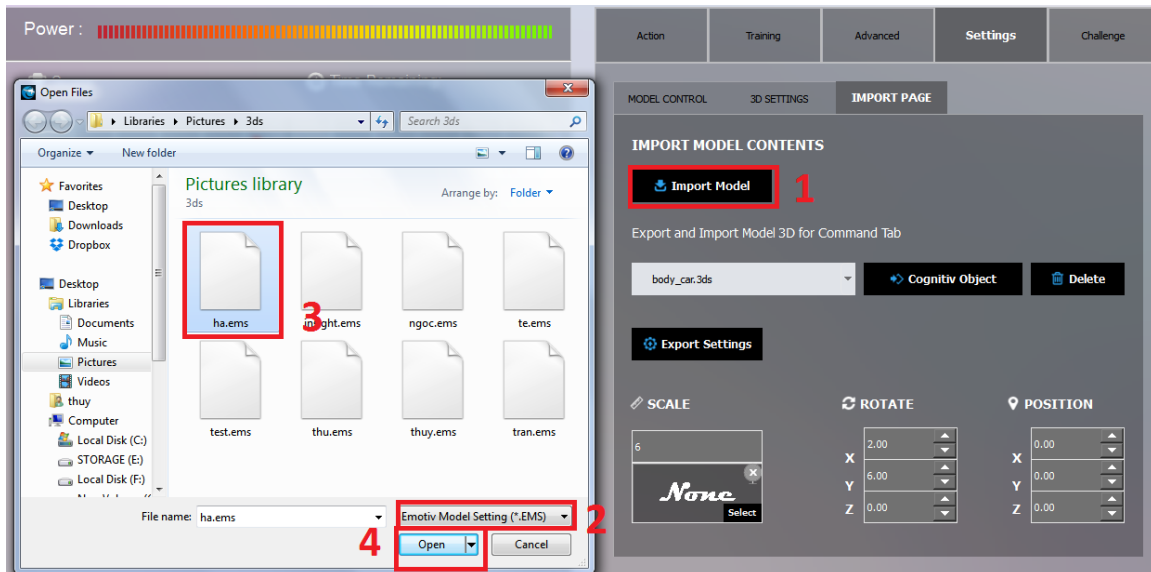


Figure 15 IMPORT MODEL from .ems file

The program also supports tools for manipulating the design:

Key G: enable/disable Grid

Key V: show camera Viewport

Key S: Pause/Run Action

i. *Cognitiv Challenge*

The Challenge tab allows you to challenge with cube model and submit your score to Emotiv's website. You need to select at least one trained action to begin challenge.

You can only challenge when there are at least a half number of sensors is green because this makes sure that the data are collected accurately. If there is no trained action, you are necessary to choose one action, then train it. Only when the Power bar above the Cube to the left of the window changes, you get some scores. **Score** displays your current score, **Time Remaining** presents the remaining time in your challenge session. The maximum of time duration for each session is 60 seconds. You could also challenge within a shorter time by choosing "END NOW" button.

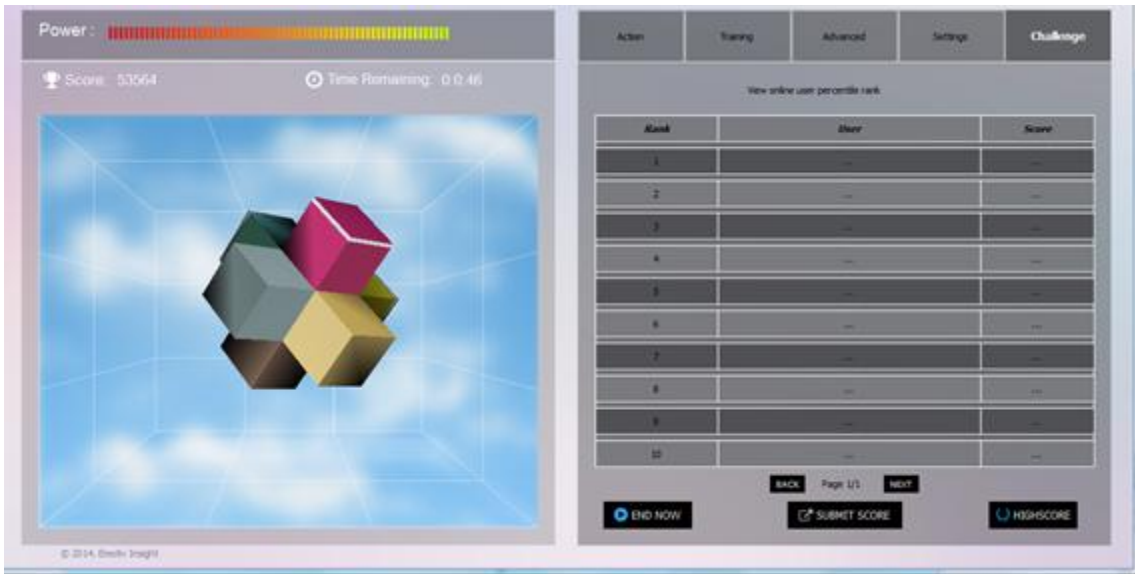


Figure 16 The Challenge tab

Click the START button to begin playing. You can click Esc keyboard to disable fullscreen, END NOW button to finish challenge. After you finish playing, click SUBMIT SCORE button to submit your score to Emotiv's website under the name you are using in program. The HIGHSCORE button displays the highest score online. To view your Score online, you can click View Online Leaderboard in HighScore or View online user percentile rank above Score table.

The right-hand table displays Scores recorded only on your local machine

3.6.2 Expressiv

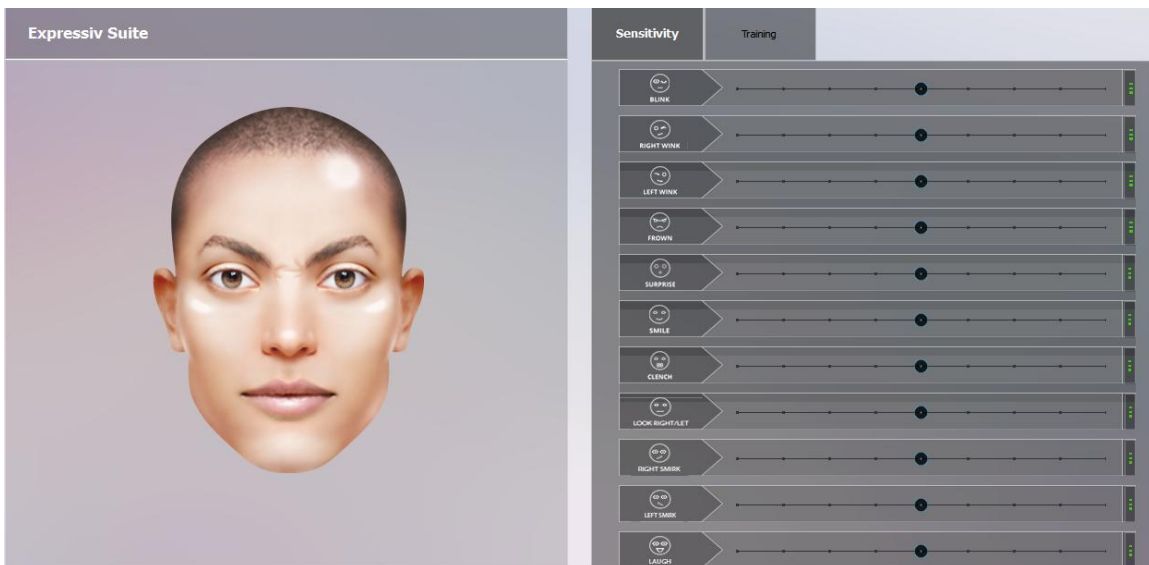


Figure 17 EXPRESSIV Sensitivity Adjustment Panel

Understanding the EXPRESSIV Panel Display

On the left-hand side of the **EXPRESSIV** Tab is a simple avatar. The avatar will mimic your Expressiv , in camera view (i.e. not mirrored).

In the center of the panel is a series of graphs, indicating the various expression detection event signals. These graphs show a short history of the detections listed. The graphs should be interpreted as follows:

- **BLINK**: low level indicates a non-blink state, while a high level indicates a blink.
- **RIGHT WINK / LEFT WINK**: these two detections share a common graph line. A center level indicates no wink, low level indicates a left wink and high level indicates a right wink.
- **LOOK RIGHT / LEFT**: these two detections share a common graph line and a single sensitivity slider control. A center level indicates eyes looking straight ahead, while a low level indicates eyes looking left, and a high level indicates eyes looking right.
- **RAISE BROW**: low level indicates no expression has been detected, high level indicates a maximum level of expression detected. The graph level will increase or decrease depending on the level of expression detected.
- **FURROW BROW**: low level indicates no expression has been detected, high level indicates a maximum level of expression detected. The graph level will increase or decrease depending on the level of expression detected.
- **SMILE**: low level indicates no expression has been detected, high level indicates a maximum level of expression detected. The graph level will increase or decrease depending on the level of expression detected.
- **CLENCH**: low level indicates no expression has been detected, high level indicates a maximum level of expression detected. The graph level will increase or decrease depending on the level of expression detected.
- **RIGHT SMIRK / LEFT SMIRK**: these two detections share a common graph line. A center level indicates no smirk, low level indicates a left smirk and high level indicates a right smirk.
- **LAUGH**: low level indicates no expression has been detected, high level indicates a maximum level of expression detected. The graph level will increase or decrease depending on the level of expression detected.

On the right-hand side of the panel are two additional panels: **Sensitivity** and **Training**. These panels are explained further in the following two sections.

a. Sensitivity Adjustment Panel

The Xavier SDK offers sensitivity adjustments for the Expressiv detections. This is controlled through sliders to the right of corresponding graph.

For each Expressiv , check the performance of the detection. If you feel that the Expressiv detection is not responding readily to a particular expression, then increase the sensitivity for that expression. If you feel that it is too easy to trigger a particular expression, or you are seeing "false positive" expressions, then decrease the sensitivity for that expression. Sensitivity can be increased or decreased by moving the sensitivity slider to the right or left, respectively.

Expressiv supports two types of "signatures" that are used to classify input from the neuroheadset as indicating a particular Expressiv . The icon to the right of the sliders is an indicator of whether the *Universal Signature* or *Trained Signature* is being used. A circle with three dots is shown when the Universal Signature is active, while a circle with one dot inside indicates that a Trained Signature is active. An empty circle indicates that a Trained Signature has been selected, but that no training data has been collected for

this action, and so it is currently disabled. The default signature, the Universal Signature, is designed to work well for a large population of users for the supported Expressiv .

If the application or user requires more accuracy or customization, then you may decide to use a Trained Signature as described below.

b. Training Panel

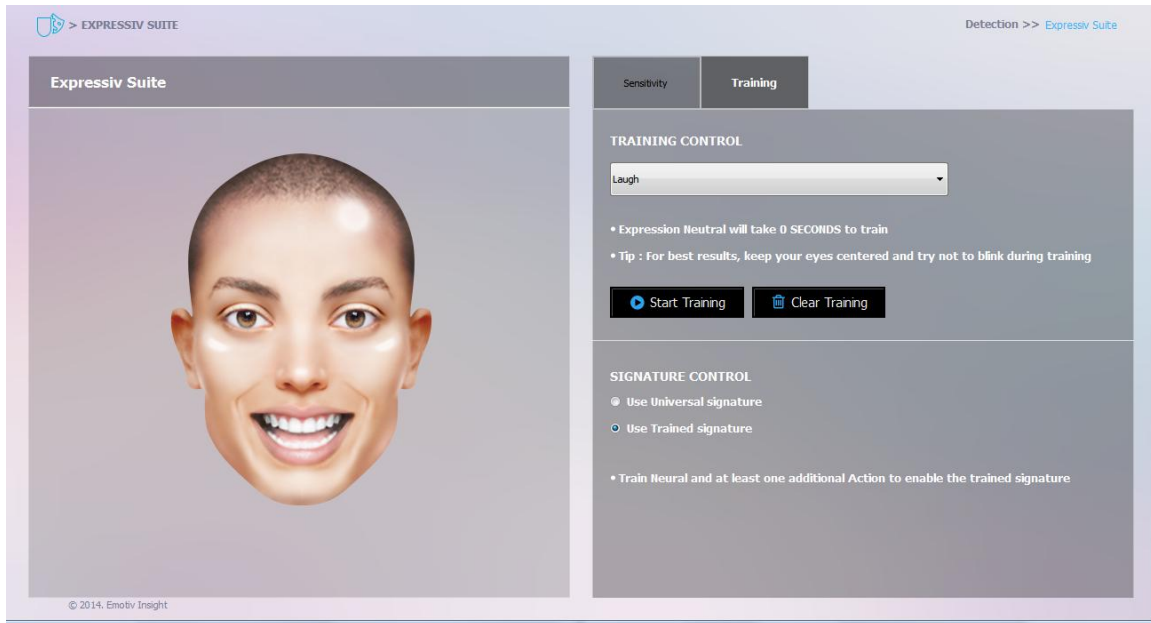


Figure 18 EXPRESSIV Training Panel

In this mode, Expressiv requires the user to train the system by performing the desired action before it can be detected. As the user supplies more training data, the accuracy of the Expressiv detection typically improves. If you elect to use a Trained Signature, the system will only detect actions for which the user has supplied training data. The user must provide training data for a neutral expression and at least one other supported expression before the Trained Signature can be activated with the **Use Trained Signature** checkbox. Important note: not all Expressiv expressions can be trained. In particular, eye and eyelid-related expressions (i.e. “blink”, “wink”,) can not be trained and always rely on the Universal Signature.

3.6.3 Affectiv™



Figure 19 Affectiv™ Tab

a. AFFECTIV™ Introduction

The Affectiv™ reports real time changes in the subjective emotions experienced by the user. Emotiv currently offers six distinct Affectiv™ detections: Valence, Engagement Boredom, Instantaneous Excitement, Frustration, Meditation and Long-Term Excitement. See section below for a description of these detections. The Affectiv™ detections look for brainwave characteristics that are universal in nature and don't require an explicit training or signature-building step on the part of the user. However, individual data is collected for each user and is saved in the user's profile while the Affectiv™ runs. This data is used to rescale the Affectiv™ results and improve the detection accuracy over time. For this reason, it is very important that a new user profile is selected when a new user puts on the neuroheadset.

b. Understanding the Affectiv™ Tab Display

The Affectiv™ Tab contains two graphs which can be customized to display different combinations of detections and time scales. By default, the top chart is configured to plot 30 seconds of data for the **Valence, Engagement, Frustration, Meditation** and **Instantaneous Excitement** detections. The bottom chart defaults to display 5 minutes worth of data for the **Long-Term Excitement** detection. The values that are plotted on the graphs are the output scores returned by the Affectiv™ detections.

The controls to the right of the charts can be used to select the detection output to be plotted and to customize the color of each plot. The **DISPLAY LENGTH** edit box allows you to customize the time scale for the associated chart.

c. Affectiv™ Detection Details

Instantaneous Excitement is experienced as an awareness or feeling of physiological arousal with a positive value. Excitement is characterized by activation in the sympathetic nervous system which results in a range of physiological responses including pupil dilation, eye widening, sweat gland stimulation, heart rate and muscle tension increases, blood diversion, and digestive inhibition.

Related emotions: titillation, nervousness, agitation

Scoring behavior: In general, the greater the increase in physiological arousal the greater the output score for the detection. The Instantaneous Excitement detection is tuned to provide output scores that more accurately reflect short-term changes in excitement over time periods as short as several seconds.

Long-Term Excitement is experienced and defined in the same way as Instantaneous Excitement, but the detection is designed and tuned to be more accurate when measuring changes in excitement over longer time periods, typically measured in minutes.

Engagement is experienced as alertness and the conscious direction of attention towards task-relevant stimuli. It is characterized by increased physiological arousal and beta waves (a well-known type of EEG waveform) along with attenuated alpha waves (another type of EEG waveform). The opposite pole of this detection is referred to as "Boredom" in Emotiv Xavier and the Emotiv API; however, please note that this does not always correspond to a subjective emotional experience that all users describe as boredom.

Related emotions: alertness, vigilance, concentration, stimulation, interest

Scoring behavior: The greater the attention, focus and Cognitive workload, the greater the output score reported by the detection. We need to point out that the Interest level is centred on 0.5. Numbers close to zero mean that the subject really wants to avoid the situation, close to 0.5 is 'don't care' and close to 1 is very strongly interested. Examples of engaging video game events that result in a peak in the detection are difficult tasks requiring concentration, discovering something new, and entering a new area. Deaths in a game often result in bell-shaped transient responses. Shooting or sniping targets also produce similar transient responses. Writing something on paper or typing typically increase the engagement score, while closing the eyes almost always rapidly decreases the score.

3.6.4 Inertial Sensor

The Emotiv Xavier neuroheadset comes with a built-in 2-axis gyroscope which enables a range of additional functions. One possible use is mouse cursor control

a. Understanding the Inertial Sensor Tab

The Inertial Sensor Tab in the Emotiv Xavier allows you to activate the neuroheadset's gyroscope and link it to the control of your computer's mouse cursor.

The left side of the Inertial Sensor Tab display is a visual representation of the current contact quality of the individual neuroheadset sensors. The display is a smaller copy of the contact quality visualization found on the Insight SDK's **SET UP** tab

The right side of the Inertial Sensor Tab provides a visual representation of the gyroscope's relative position and the controls to activate and deactivate this feature along with a slider bar to make sensitivity adjustments.

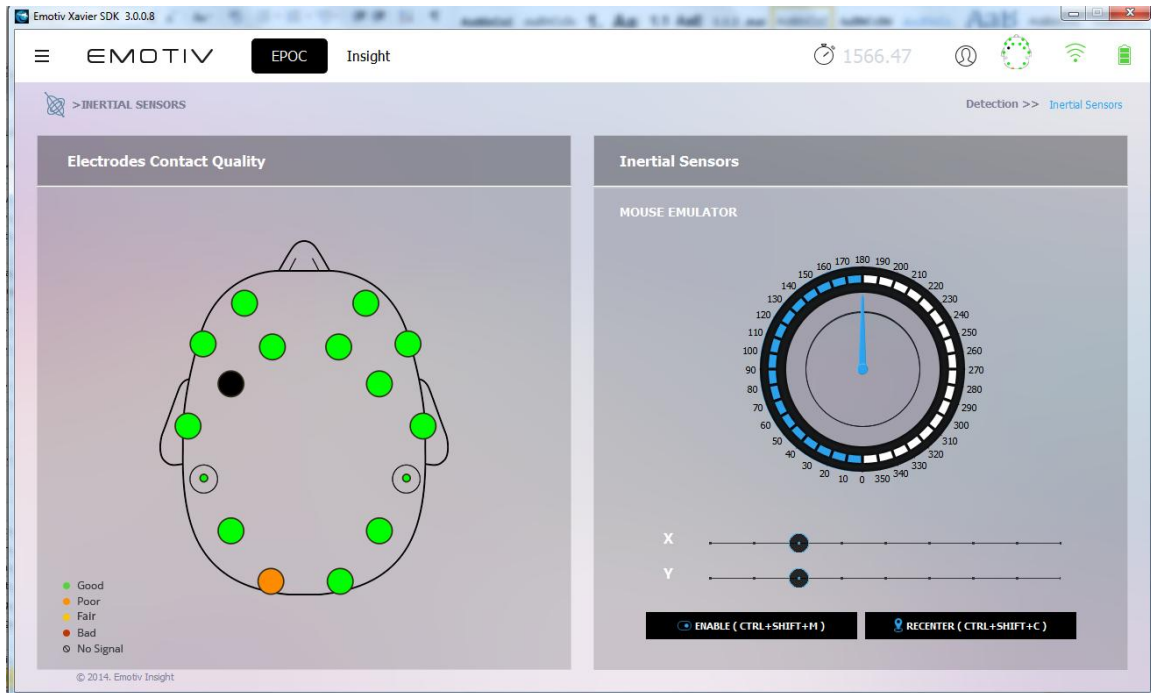


Figure 20 Inertial Sensor Tab

b. Inertial Sensor Controls

To enable this feature, click on the ENABLE (CTRL+SHIFT+M) button or shortcut CTRL+SHIFT+M. Your mouse will immediately respond based on the movement of your head. Simply turn your head from left to right, up and down. You will also notice the black indicator dot move in accordance with the movement of your head/gyroscope.

The Mouse Sensitivity slider allows you to adjust the sensitivity of the gyroscope when controlling your mouse cursor. The RECENTER(CTRL+SHIFT+C) button or shortcut CTRL+SHIFT+C allows you to re-centre your position.

To deactivate this feature, use your head movement to move your cursor to the Deactivate button and left mouse click, or Press CTRL+SHIFT+M

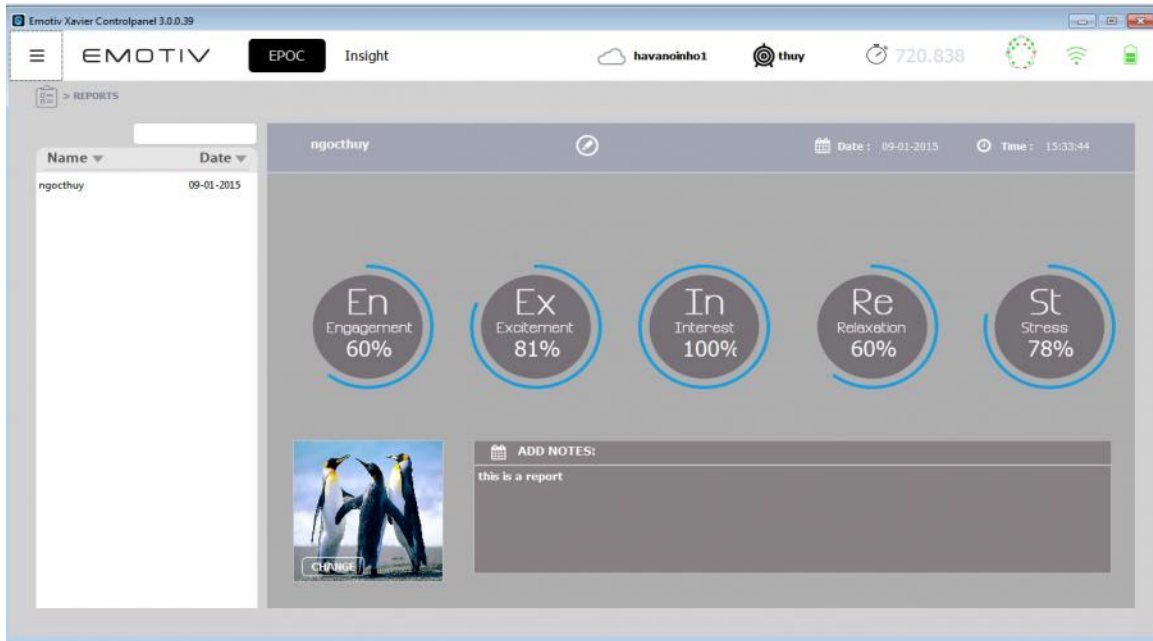
3.7 Reports

You click  of program will display detail tabs of Emotiv Xavier, then you select Reports tab. You click X to close .

As mentioned above, Calibration tab will turn to Reports tab automatically when Stop Record is clicked. This tab contains the reports that users recorded in Calibration tab, the number of reports will increase automatically in accordance with the number of times users use Record.

Each report consists of date and time when users implement recording. Below the report, there are five parameters: Engagement, Excitement, Relaxation, Interest and Stress which are calculated based on users' EmoState in each report.

Besides you can Add photo to your record this make more lively, Add Notes to note some text for record, change name of report. All this photo and notes will store in your profile and you may be review in time after.



3.8 Help

You click  of program will display detail tabs of Emotiv Xavier, then you select **Help** tab. You click **X** to close .

3.8.1 Epoc SDK API Reference

This section allows you to connect with Emotiv Application Programming Interface: a library of functions, provided by Emotiv to application developers, which enables them to write software applications that work with Emotiv neuroheadsets and the Emotiv detection suites.

3.8.2 About Xavier Control Panel

Some Information in this part of the version name , version number, website address... will be displayed.