

# EEG Training User Guide: Two-phase Optimal Performance Protocol

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# 1 Introduction

This guide describes how to use the Mind-Body Training Tools (MBTT) Two-phase Optimal Performance EEG Training application.

Many of the features of this application are the same as those used in the MBTT standard-form protocol EEG training. Therefore I recommend you read the main MBTT EEG Training User Guide first, as here I will assume prior knowledge of the MBTT standard EEG training, and do not explain the common features in any great depth.

There are two versions of the application, one of which is based on one channel of data, while the other uses two channels. They are substantially the same in terms of the operation of the software. The differences are described more fully in section 1.3 below.

## 1.1 Optimal Performance Training

There is no one single brain state corresponding to optimal performance. Rather, the goal is to develop:

- **flexibility** – the brain should be able to shift state quickly and easily
- **appropriate adaptivity** – the brain should be able to access a state that's most appropriate for the task at hand.

Standard neurofeedback protocols ostensibly train the brain's ability to access just one state. In contrast, the Two-phase Optimal Performance application trains not just the ability to access two distinct states but the capacity to switch easily and rapidly from one to the other.

## 1.2 Two-phase Neurofeedback Training

I designed the application to offer two-phase training trials, each of which is relatively short in duration but trials can be repeated many times.

Phase 1 represents a concentration task. The idea is that the brain should go into a state of intense focus and alertness.

Phase 2 represents a subsequent relaxation period.

### 1.2.1 Training Trials, Phases and Feedback Parameters

Training is divided into trials, in much the same way as it is broken up into training periods in other apps, except that here a trial is typically going to be kept quite short. (There will be correspondingly more trials in a training session.) Feedback is only active during trials.

Each trial is split into phase 1 and then phase 2. The user can set the duration of each phase independently.

During phase 1, the trainee should cultivate intense alertness, focus and presence. At the end of phase 1, phase 2 begins and the user should relax all effort.

During phase 1, feedback is given that reflects effortful focus. For this purpose I selected a squash protocol – the feedback parameter is amplitude of the EEG over a broad frequency range, i.e. 1-25 Hz (this can be adjusted). This amplitude is trained down – effortful concentration flattens out the EEG particularly in the slow frequency bands, theta and alpha especially.

During phase 2, a different EEG parameter is used for feedback, one which reflects relaxation. For this purpose I selected alpha amplitude, alpha being a sort of idling rhythm, or perhaps an active not-doing rhythm. Alpha should be trained *up* during phase 2 (unlike phase 1 which involves down-training).

Trial phases are shown in the charts as different coloured bands – see section 3.1.4 below for an example.

Thus in summary, there are two independent feedback parameters, but feedback of only one is active at a time. Each feedback parameter has its own threshold control, which work like threshold controls in other applications.

### **1.3 One-Channel and Two-Channel Versions & Training Sites**

There are two versions of the application, one using a single channel of EEG data, the other using two channels of EEG data. In short, the difference is that in the two-channel version, the phase 1 feedback parameter (broad band squash) is calculated based on channel 1, while the phase 2 parameter (alpha) is calculated based on channel two.

In the brain, it's thought that activation of the Prefrontal cortex is key to effortful alertness and focus. Therefore it makes sense to base phase 1 training on data measured from the front of the head, say Fz for instance.

Conversely, the alpha rhythm that is typically generated during relaxation or “idling” is concentrated at the back of the head. It makes more sense to base phase 2 feedback on EEG measured at the back, say Pz.

The two-channel version of the application allows training of different parts of the brain in the two phases. In the one-channel version you must use the same site, which in many ways is less than ideal but more convenient in terms of set-up, especially if you have only a one-channel device.

When using the one-channel version a central site such as Cz is probably most appropriate.

In terms of the application's displays and feedback, the two versions are almost the same. The small differences are noted in the course of this document.

### **1.4 Feedback**

Alpha training is traditionally done eyes-closed. To support this, the design focuses on audio feedback. This works much like some of the feedback screens available for the standard-form protocol applications, with small differences due to the two-phase nature of the application. Essentially, a soundtrack is played whose volume varies with the feedback parameter. There are separate soundtracks for each of the two phases. Feedback is described more fully in section 3.2 below.

## 2 The MBTT Platform Application

As stated in other guides, Mind-Body Training Tools consists of a set of applications built using BioEra, plus the Platform application, which manages and launches the training applications, and the data they generate. So the Platform application is the starting point.

Each MBTT module has its own tab in the Platform app, and EEG Training is no exception. The EEG training tab is shown in figure 3 below.

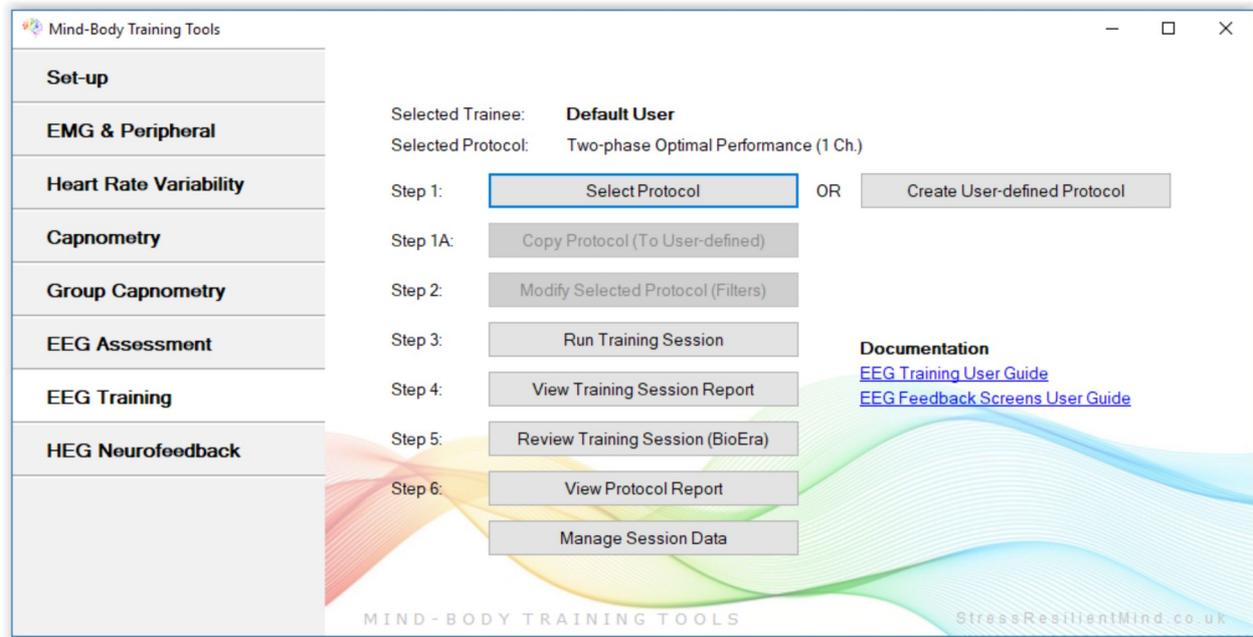


Figure 3 – EEG Training tab of the Mind-Body Training Tools Platform application

To run a session with the Two-phase Optimal Performance app, first you need to select the protocol, by clicking on the button “Select Protocol” (Step 1, in figure 3 above). This opens up a dialog window showing lists of protocols organised under three tabs. The two-phase protocols are listed under the “non-standard” tab (see figure 4 below).

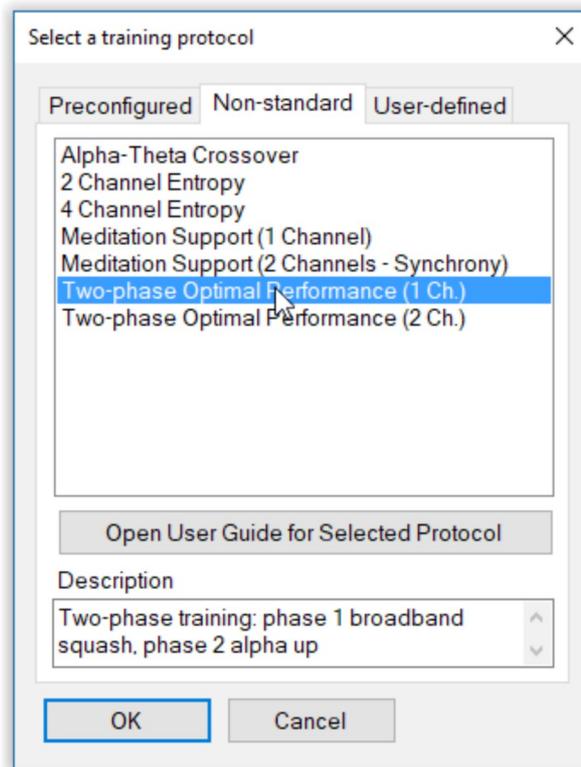


Figure 4 – Select protocol dialog

As explained earlier, there are two versions, based on one and two-channel EEG. Select one of them from the main box in the dialog, then click OK to close the dialog.

At this point, you can either run a new session (step 3 in the main EEG Training tab) or view data from previous sessions (i.e. create reports). The buttons for steps 4 onwards are for report generation and data management, and these functions are covered in section 4 below.

You can't edit the protocol in the same way as for standard-form protocols (i.e. outside of training sessions), but you can adjust the filters used in the protocols (see section 3.1.3 below).

## 2.1 Running A Live Training Session

To launch a live training session, click the button “Run Training Session” (step 3). This opens another dialog window, shown below in figure 5.

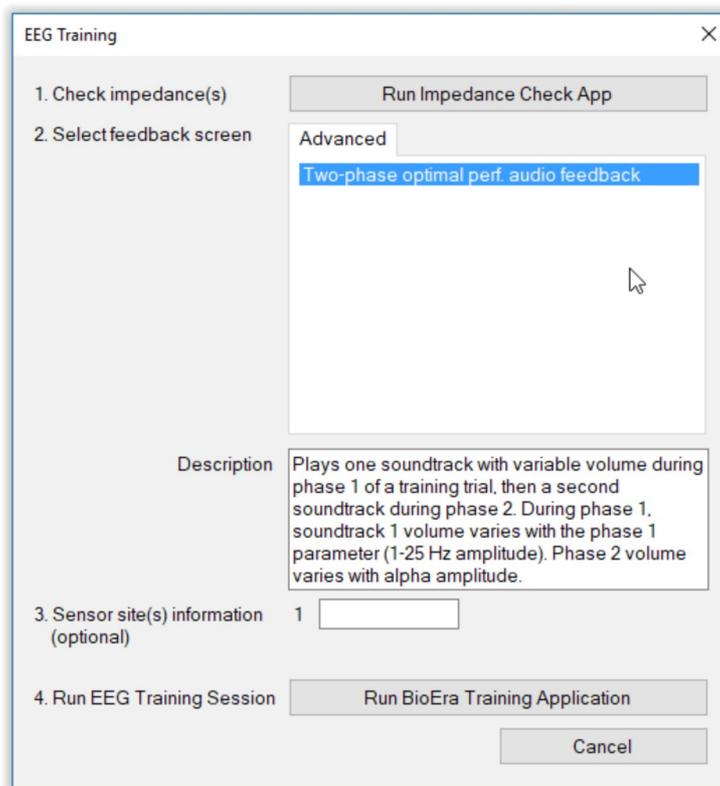


Figure 5 – Run training session dialog

It is strongly recommended that you check the quality of your EEG hook-up by testing impedance – click the button “Run Impedance Check App” at the top of the dialog, step 1.

Explaining impedance checking is beyond the scope of this guide, but it should be said that this function in MBTT is dependent on what type of amplifier you are using. Not every amplifier has an impedance checking tool built into MBTT, but you should still check impedance using another means.

There is currently only one feedback screen available for the Two-phase Optimal Performance application, so accept this default at step 2 in the dialog.

You can optionally record the site(s) on the scalp you're recording from (step 3 in the dialog). This does not affect the software operation, but it is recorded and shown in reports.

Click the button “Run BioEra Training Application” (step 4) to launch the live training session. This opens a BioEra app, which is described in detail in the following section.

## 3 The BioEra Training Application

As stated in other documentation, live biofeedback and neurofeedback work is done using a third-party software called BioEra. The Two-phase Optimal Performance app is built as a BioEra design. This app has two windows, much as the standard-form protocol apps do. One is the control screen, the other the feedback screen.

### 3.1 Control Screen

Figure 6 below shows the control screen window (in this case the two-channel version).

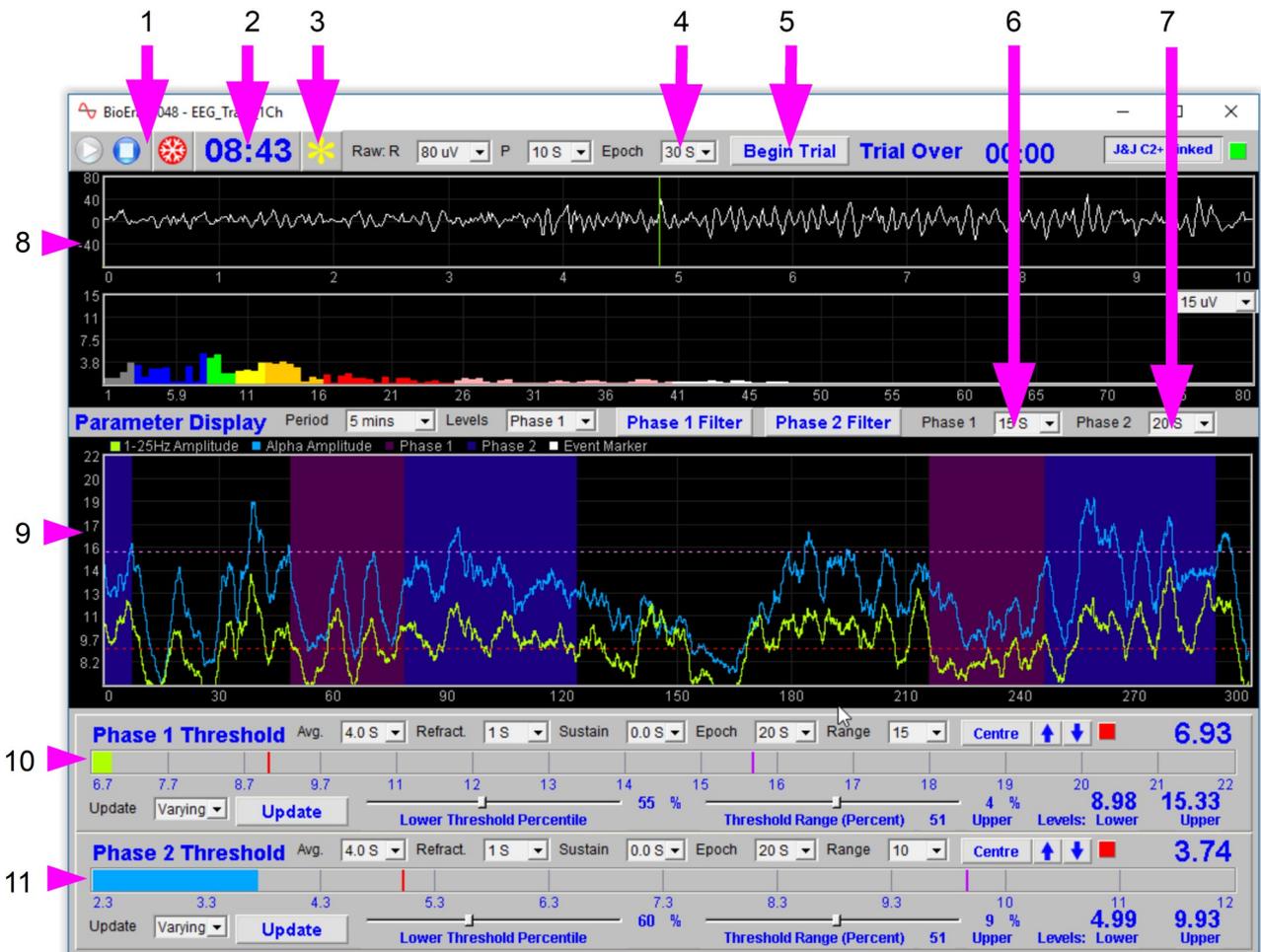


Figure 6 – Control screen of the two-phase optimal performance training application

#### 3.1.1 Controls Common To Standard-form EEG Training

The following controls are explained more fully in the main EEG Training User Guide:

- Start, stop, freeze buttons (1 in figure 6)
- Session time display (2 in figure 6)
- Event marker (3 in figure 6)
- Data epoch (drop down list – 4 in figure 6) – sets how often data is written for the session summary report.

### 3.1.2 Raw EEG Display

The uppermost chart(s) (8 in figure 6) shows the raw EEG – it is always useful to see this, in part to know that you have a clean EEG.

The two-channel version of the protocol shows two traces, one for each channel, while the one-channel version shows a spectral display in place of the second channel raw trace. In this respect it's the same as the standard-form protocols.

Drop-down list controls, situated above the chart, set the range (vertical scale) and the time period (horizontal scale) of this chart (or charts).

### 3.1.3 Filter Settings

You can set the properties for the filters used to calculate the phase 1 and phase 2 feedback parameters. Filters are described in more detail in the main EEG Training User Guide. The main settings are the upper and lower frequency cut-offs, but there are others besides.

There are buttons which open up a filter properties dialog. These are positioned just above the main parameter display, see figure 7 below where the buttons are labelled 3 and 4.

I anticipate most users will won't need to take advantage of this feature, but it is there for those who wish to experiment. For example you could limit the broad frequency range of the phase 1 (squash) parameter to a narrower range.

### 3.1.4 Main Trend Display

The largest chart, in the centre of the control screen, (9 in figure 6) shows the variation of the phase 1 and phase 2 feedback parameters over time.



Figure 7 – Parameter display and controls

You can easily see the training trials in this display as coloured blocks. Phase 1 is shown in a dark red colour while phase 2 is dark blue.

Each parameter has an independent range (vertical scale) although only one is displayed at a time. Click the coloured squares just above the chart to switch which one is active.

Each range is exactly the same as the bar chart which is part of the thresholds (see section 3.1.5 below). The thresholds have controls for adjusting the range (and of course each of the two parameters is controlled independently).

The chart shows threshold levels as dotted lines – you can select to show either phase 1 or phase 2 levels using the drop-down list, 2 in figure 7.

### 3.1.5 Threshold Controls

To recap, thresholds are used to precisely control how and when feedback is delivered, or more specifically, over what range of the EEG parameters the feedback varies.

The Two-phase Optimal Performance app uses two thresholds, one for each of the feedback parameters (i.e the phase 1 and phase 2 parameters). They work in much the same way as the main parameter threshold in the standard-form training applications. The only difference is that there is no control setting the direction of training, since this is pre-set (down-training in phase 1, up-training in phase 2). The phase 1 threshold is shown in figure 8 below. The phase 2 threshold is identical except for having a different colour trace in the bar graph.

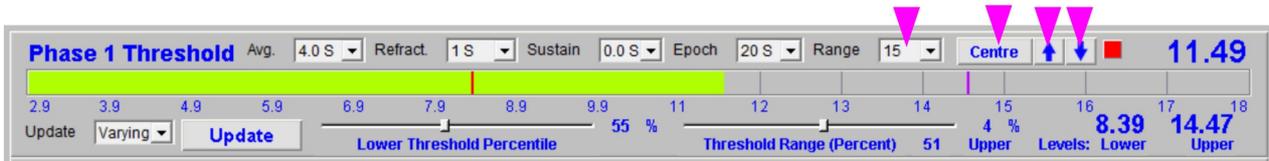


Figure 8 – Phase 1 threshold and controls

There are several controls for setting the behaviour of the threshold (and threshold-based feedback) plus the display of the feedback parameters. I refer you to the main EEG Training User Guide for detailed description of these controls. If you're familiar with training using the standard-form protocols, then you'll already know how to use them.

The arrows in figure 8 indicate the controls used to adjust the parameter trace in the main parameter display (section 3.1.4).

The threshold levels can be updated in exactly the same ways as in the standard-form training application. In the Two-phase application there is one difference: when you set the threshold levels to vary automatically and continuously, the variation is suspended at the beginning of each trial (i.e. all threshold levels, both upper and lower and for both parameters, are held fixed for the duration of the training trial. This change was made because it is not appropriate to calculate the phase 2 parameter thresholds based on the phase 1 time, when the trainee is cultivating a quite different brain state.

### 3.1.6 Training Trial Controls

There is a button to launch a training trial – this is labelled 5 in figure 6. This works much like the button to begin training periods in other applications – after clicking it, the feedback becomes active, first phase 1, then phase 2.

There are two drop-down list controls for setting the durations of each phase. These are positioned just above the main parameter display, see figure 7 above where they are labelled 5 and 6.

## 3.2 Feedback Screen

The feedback screen is the second of the application's two windows, and is shown in figure 9 below.

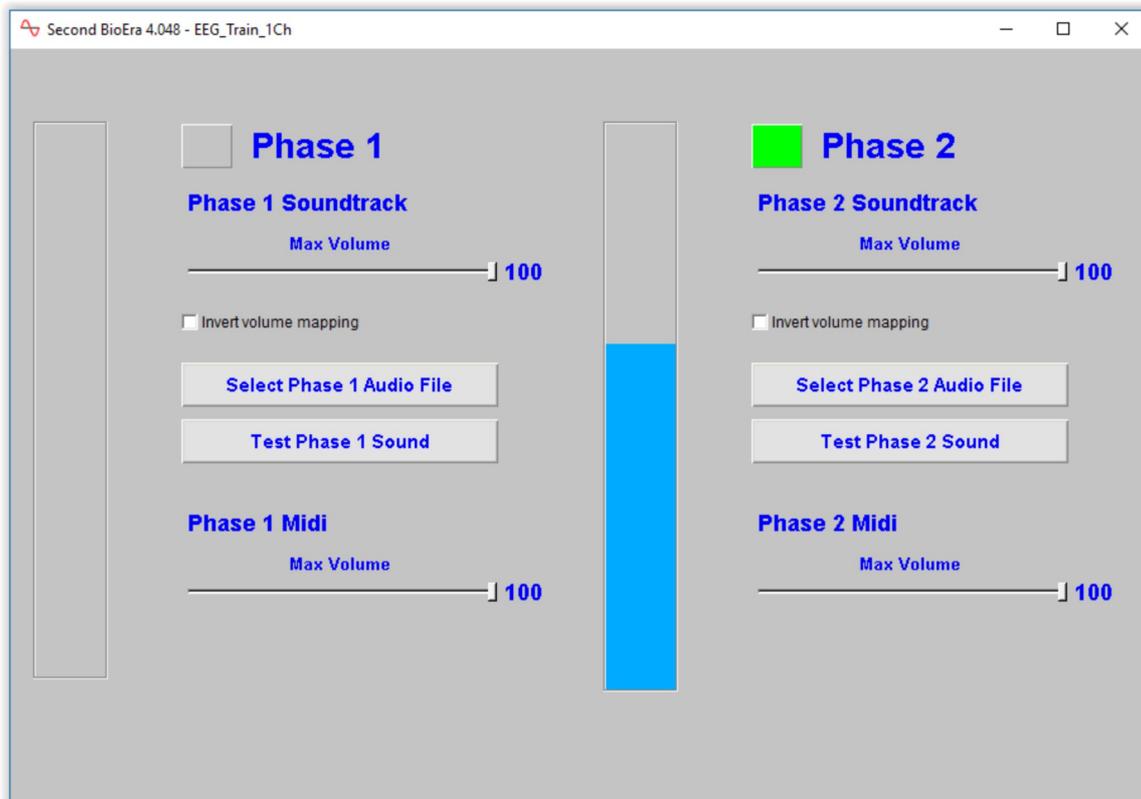


Figure 9 – Feedback screen

The feedback screen is similar to some of those available in the standard-form application. There are controls for configuring each of the two feedback parameters. The left side of the screen is devoted to phase 1 feedback while the right side is devoted to phase 2 feedback. The two-phase design of the application means that only one feedback parameter is active at a time.

Again the application is designed for eyes-closed training / practice, so the primary form of feedback is auditory. Both soundtrack and midi feedback are available.

In addition to audio feedback there is a simple bar chart for each parameter. The range of each bar is set by the upper and lower threshold levels in the control screen.

### 3.2.1 Soundtrack Feedback

Each feedback parameter has a soundtrack whose volume varies with the parameter. Only one soundtrack plays at a time – one during phase 1, another during phase 2.

The soundtrack feedback can be configured in different ways. You can either have the sound play as a reward for attaining the desired state, or as a warning that you are drifting out of it. If the latter, then you can consider silence as the reward. For example, since phase 1 is about intense focus and alertness, my personal preference is to have silence as a reward, and the sound as a warning that I need to tighten my focus.

Depending on this choice, you can opt to invert the soundtrack feedback using the checkbox

control, “invert volume mapping” (there is one for each soundtrack). Checking this option means that the soundtrack plays louder, the lower the feedback parameter falls (otherwise volume increases proportionally to the parameter).

You also need to consider the direction of training when setting this control. In my example of phase 1 training being rewarded with silence, remember that phase 1 is down-training (i.e. a squash protocol) so that means I would uncheck the box, so that the soundtrack goes silent when the parameter drops low.

Phase 2 involves up-training alpha. Suppose I want to reward alpha with the playing of a pleasant sound: in this case I would also uncheck the phase 2 box.

### 3.2.1.1 Media Files

Audio files are not included with MBTT software for reasons of copyright. You need to obtain suitable material for yourself. You can purchase this easily from online retailers such as Amazon or Apple (iTunes).

I have found that nature sounds work well with neurofeedback. For example, I've used a “dawn chorus” soundtrack for reward feedback, and a rain storm soundtrack for aversive (warning) feedback.

The software requires audio files to be in .wav format. However, downloadable audio files are typically provided in .mp3 format, in which case you will need to convert them. Software for conversion is readily available, including some online converters (just google something like “convert mp3 to wav”). Personally I've used a freeware product called *Audacity*, which I have found very helpful, not just for conversion but for sound editing more generally.

Downloaded soundtracks typically have a fade-in and fade-out at the start and end, which is unhelpful for neurofeedback. I recommend using Audacity to edit these out.

### 3.2.2 **Midi Feedback**

Discrete midi feedback is available in each phase of training. A note is played whenever the feedback parameter crosses a threshold limit. During phase 1 notes are played when the parameter drops below the lower level, since phase 1 involves down-training. In phase 2 we are up-training so the note plays when the signal goes above the upper limit.

As with points-based feedback in the standard-form applications, there is a refractory period after each “point” is scored. (Note that in this application a points tally is not kept.) Also you can set a sustain period for each parameter. There are controls for each of these options within the threshold control (see section 3.1.5 above).

By default you have both continuous soundtrack feedback, and discrete midi feedback, but if you wish you can turn either one off, by setting the volume to zero (using the volume slider controls you see in figure 9).

## **4 Reports & Data Management**

As with the standard-form protocols, MBTT software allows you to manage the data generated by training sessions over time. The report and data management functionality is almost exactly the same, for the Two-phase Optimal Performance application, and I again refer you to the main EEG Training User Guide. Here I will give a very brief summary and comment on the minor differences.

### **4.1 Reports**

You can view reports for individual session, or all sessions over time for the currently selected user.

There are two types of individual session reports: html summary reports (based on a text data file written by the training application) and BioEra-viewable reports based on a .xdf session file.

The html report tracks both the phase 1 and phase 2 parameters, and can show each training trial, divided into the two phases.

The BioEra report shows the standard EEG bands – delta, theta, alpha and beta. It has a simple way of highlighting the training trials but has the limitation that it cannot distinguish phases 1 and 2. However it has at least a couple of advantages: first, you can zoom in to particular areas of the chart (by dragging your mouse over areas of interest) and second, you can show or hide individual traces such as delta.

#### **4.1.1 Protocol Report**

The protocol report is not available for the Two-phase Optimal Performance application, because the report functionality cannot distinguish between phases 1 and 2.

### **4.2 Data Management**

You can use the data management functions to delete or archive training sessions, and to email reports to other people, e.g. if you are a coach or therapist working with clients.