

Basic Breathing Software Application User Guide

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1 Introduction

This guide introduces the Basic Breathing biofeedback application, part of the Mind-Body Training Tools suite. This set of applications is designed to develop skills in mind-body awareness and self-regulation, particularly in a context of mindfulness and meditation practice.

The purpose of the guide is to teach you how to use the software, though it is more of a reference than a tutorial. Other training material is available on the StressResilientMind.co.uk website.

The application monitors breathing via temperature of the inhaled and exhaled air. This is the only input parameter in the application – some of the other applications in the suite monitor breathing plus some other parameter – for example the EMG & Breathing application measures muscle tension in addition. These applications offer most of the capabilities of the basic breathing application and more, but the Basic Breathing application is simpler and may play a useful role in your learning process.

The Basic Breathing application offers a breath counting feature, common to several applications in the MBTT suite. This functionality is described more fully in section 5. The purpose is to support mindfulness practice and to objectively measure mindfulness performance.

In keeping with others in the suite, the Basic Breathing application was designed to support *your* aims, not to supplant them. Achieving some particular breathing state is not necessarily the only consideration – the biofeedback application is designed to enhance or expand your subjective awareness. I gave particular attention to the design of audio feedback, allowing for eyes-closed practice. You can choose how much and how often the feedback is activated, and thus how intrusive it is.

The guide assumes that you have read the Software Installation and Set-up Guide, and therefore know how to start the application.

The application works with several devices. For an up to date list of supported hardware, please see the StressResilientMind.co.uk website.

2 Launching the Application

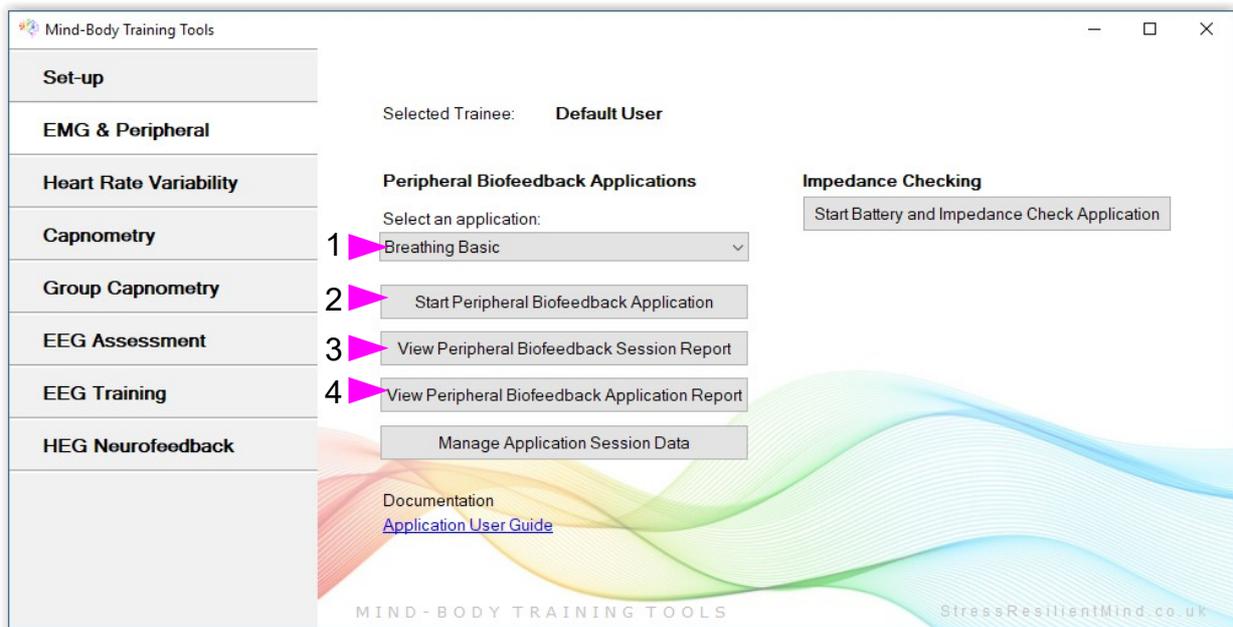


Figure 1 – EMG & Peripheral (biofeedback) Tab of the Platform Application

Figure 1 above shows the EMG & Peripheral tab of the Platform. First you need to select the “Breathing Basic” application from the drop-down list control (labelled 1). Then click the button to launch the app (labelled 2). Make sure you have your BioEra licence key (dongle) inserted into a USB socket. After a few seconds two new windows will appear on your screen.

2.1 Hardware Set-up

The physical aspects of hardware set-up (how to connect and use your sensors, etc.) are dependent upon the type of amplifier you are using, and are covered in a separate document (Hardware Set-up Guide).

Before you start the application you configure the device set-up options, accessible by clicking a button in the Set-up tab of the Platform. In the dialog, select the type of amplifier (biofeedback device) you are using, in the **breath source control**. Note, all the source settings are remembered the next time you start the Platform. (See the Installation and Set-up Guide for further details of device set-up.)



Figure 2 – Amplifier status

One of the device options is 'Simulator'. In simulator mode, you can learn how to use the software without the encumbrance of sensors, leads etc. (The application simply uses recorded data as a source.)

Once you have started the application, you should see your device selection reflected in the device status display in the top right corner of the main window (see figure 2). The lamp (shown as a red square in figure 2) should change to green when you press the play button. If you do not see this happen, it means that the application has not been able to establish a connection with your device. Check it is plugged in and that the batteries are not flat.

For some devices, you'll see a button rather than just text. Pressing this button opens up a dialog that allows you to adjust settings related to the device, such as COM port. The specifics depend on the device – see the Hardware Set-up Guide for more details.

3 Measuring the Breath

3.1 Breath Detection

The breath sensor is actually a temperature sensor placed just below the nostril. From the changing temperature of inhaled and exhaled air, the system is able to detect the turning points of the breath and therefore derive breathing rate. This method depends on a reasonable current of air coming through the nostril. It should still work if you breathe with your mouth open as long as your nose is not completely blocked. Speech will disrupt the normal air current, and will give rise to unreliable breathing calculations.

3.1.1 Breathing Calibration

The breath detection method requires a short period of time to calibrate to your breath. This happens automatically during the first 20 seconds of any session (i.e. after you press 'play'). It's important that you breathe naturally and evenly, and not too slowly, through the nose, during this time. Note that the breath signal will not display properly until proper calibration is established. If the initial automatic calibration does not work, you can recover either by pressing stop and then start again, or by following the procedure described in the following section.

3.1.2 Manual Re-calibration

If for any reason you lose reliable breath detection during a session (e.g. you have to remove and reattach the sensor) there is a way to recover: in the support window, you can press a button labelled 'Calibrate'. You should breathe naturally and evenly and not too slowly for a few breaths prior to pressing. If this doesn't work you can stop and restart the application. Generally the breath detection once established is very reliable and you should not need to re-calibrate during normal use.

Figure 3 shows you what a well-calibrated breath signal looks like (in the support window). The upper trace is the temperature of inhaled / exhaled air, while the middle trace is its first derivative or gradient. The yellow dotted lines are thresholds used for the detection of the breath turning points. They should be reasonably far apart, but close enough to the centre that the trace will easily and consistently cross to register a turning point.

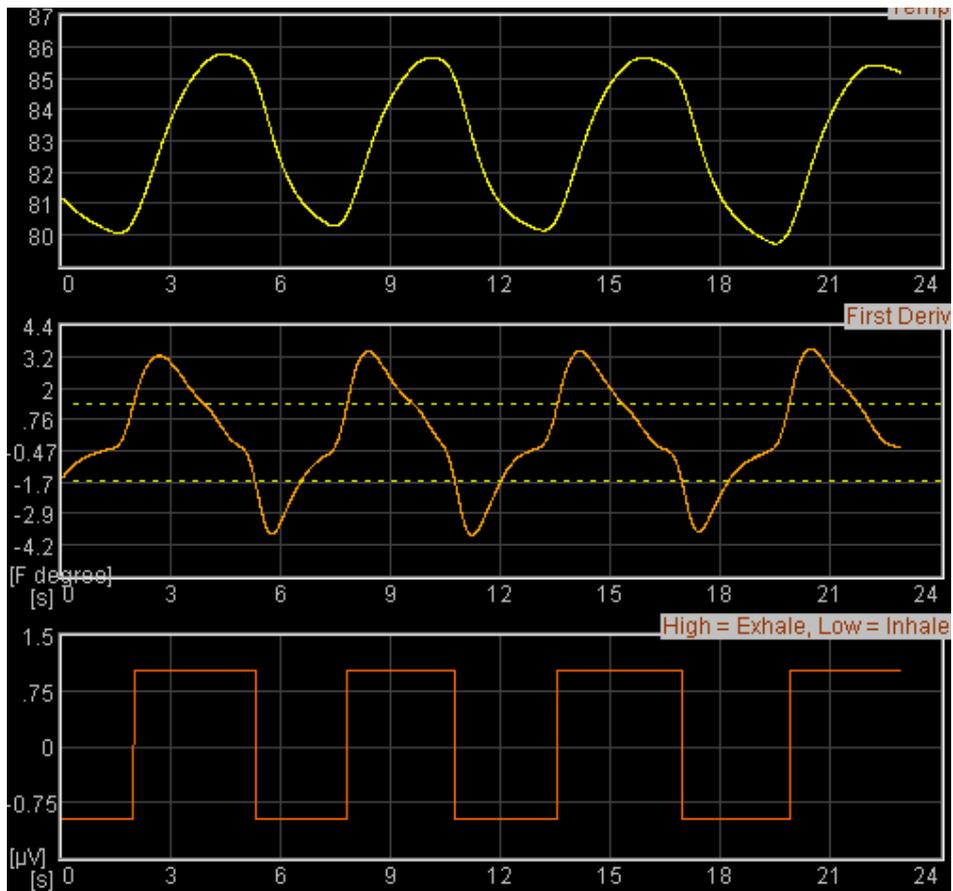


Figure 3 – A well-calibrated breathing signal

3.2 Derived Breathing Parameters

From the detection of the breath turning points, the software calculates:

- breathing rate, and average breathing rate (the averaging period is 1 minute)
- the ratio between the (durations of the) inhalation phase and exhalation phase of the breath. This is shortened to 'I:E Ratio' (or simply 'I:E'). A 1-minute average is also calculated.

These two parameters are shown in the long term displays (figure 6), and can be used as the basis of audio feedback (section 4.1.6).

4 User Interface

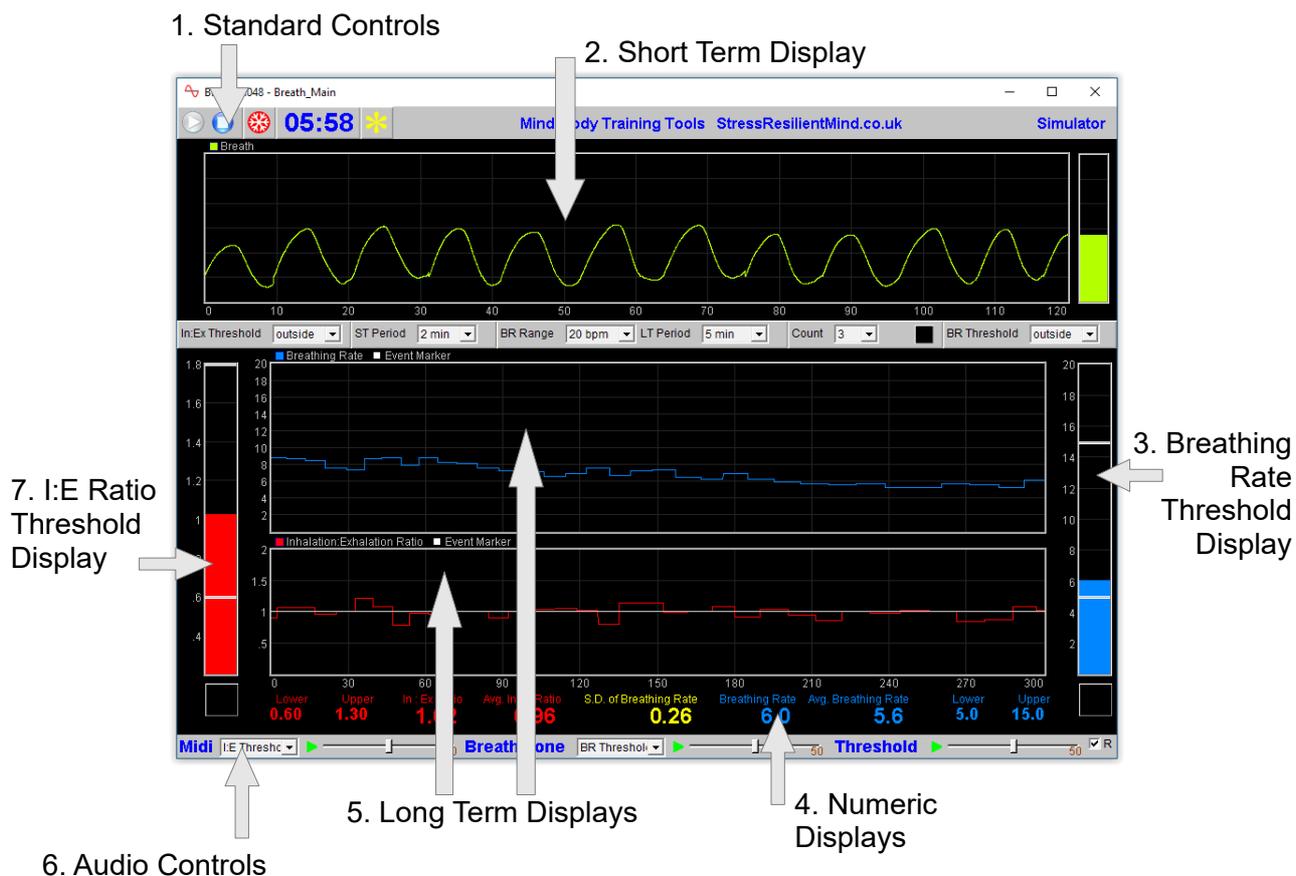


Figure 4 – Main window

When you first start the application from the Platform, you will see two windows. The main window is shown in figure 4 above, while the support window is shown later (figure 9).

The support window allows you to check that breath detection is working properly (see the discussion of breath calibration in section 3.1). I expect that most users will rarely need to make reference to it.

4.1 Main Window

This section explains how to configure the controls in the main window.

4.1.1 Standard Controls (Start / Stop, etc.)

A set of buttons – Play, Stop and Pause – are the same in all the applications in the suite. They should be self-explanatory.

The button marked with a red asterisk is a simple event marker. You can use it to mark adventitious happenings and changes in session conditions (e.g. you turn on or off breath pacing). It is particularly useful for coaches and therapists. Events thus marked are represented in the long term chart (see section 4.1.4 below) by a vertical white line. They are also recorded in the session data file and are shown in session report charts (as dotted vertical lines) (see section 6).

Note that pressing the escape key during a session has the same effect as pressing the red asterisk with your mouse (i.e. it is an alternative).

4.1.2 (Short Term) Breath Display

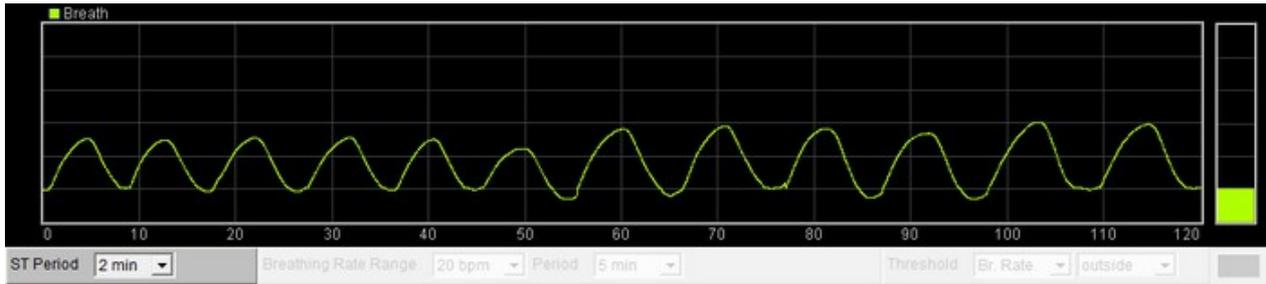


Figure 5 – Short term display and controls

The chart (figure 5 above, and 2 in figure 4) shows the breath trace in green-yellow – it rises on the inhalation and falls on the exhalation.

Note there is no vertical range control for the breath signal. This should automatically be adjusted to fit the display, during the calibration process. (If it goes off the top or bottom, it means recalibration is needed. Use the recalibrate button in the support window, as described section 3.1.) Each breath starts from the same point on the vertical axis – sometimes you see this as jumps in the signal.

There is a single control connected with this display – you can see it below the chart at the left. It sets the horizontal scale or time range – the length of time it takes the trace to traverse the whole chart.

4.1.3 Numeric Displays

These are positioned at the bottom of the main window, just above the audio feedback controls (6 in figure 4 above) and should be self-explanatory.

Averages are calculated over a 60 second interval.

4.1.4 Long Term Displays and Controls

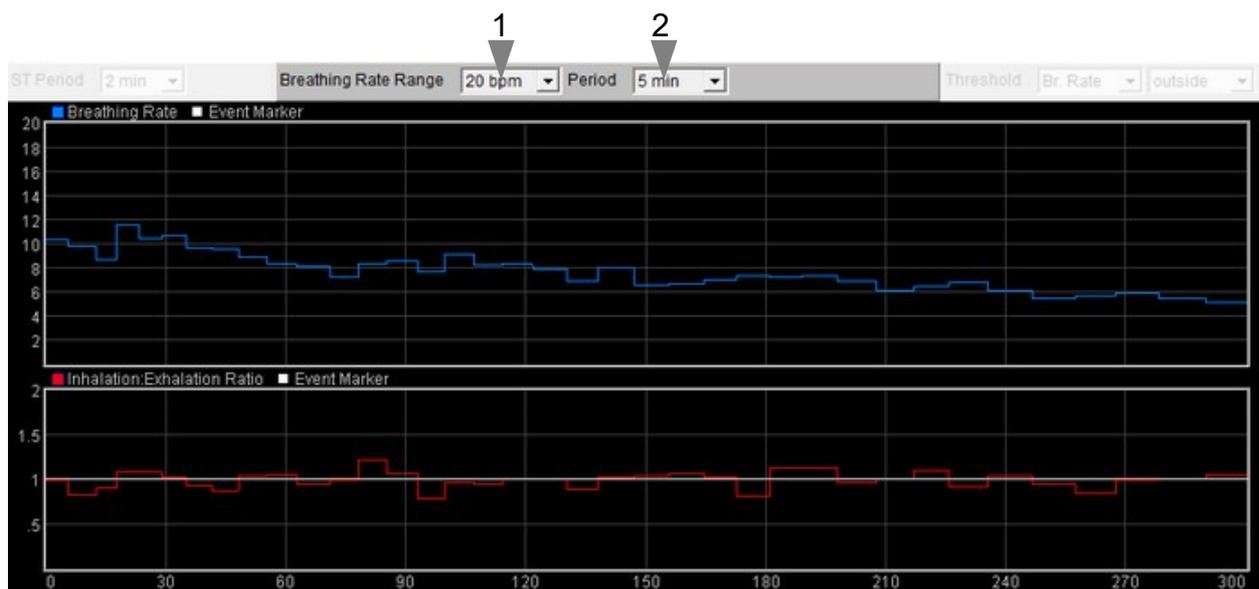


Figure 6 – Long term displays and controls

There are two long-term charts, shown in figure 6 (and labelled 5 in figure 4), displaying breathing rate (blue trace) and inhalation-exhalation (I:E) ratio (red trace). Two drop-down lists positioned above the charts (1 and 2 in figure 6) control the display of the traces.

LT Period Controls the horizontal (time) range of both charts.

Breathing Controls the vertical range of the blue breathing rate trace.

Rate Range Make this range larger if the blue trace appears to be off the top of the chart. You can reduce it for greater sensitivity, as your breathing slows down.

The I:E ratio trace (middle chart) has a fixed scale of 0 to 2. The bold line in the centre of the chart represents 1.0, at which point the inhalation and exhalation are equal in length. When the trace is above this line it means that the inhalation is longer than the exhalation, and when it drops below it means the exhalation is longer. The exhalation is usually longer in relaxed breathing.

4.1.5 Threshold Display & Controls

Threshold-based feedback is designed to follow a consistent pattern throughout all the applications, and therefore it made sense to describe threshold functionality in a single place, viz. The Guide to Audio and Threshold-based Feedback (a separate document). I recommend you read that before trying to make sense of this section.

(Controls for threshold-based audio feedback are covered in section 4.1.6 below.)

In the Basic Breathing application, there are two thresholds, found at left and right sides of the application's main window, labelled 3 and 7 in figure 4 above.

Threshold 1 (left) applies to I:E ratio, while threshold 2 applies to breathing rate, and is shown in figure 7.

Each has the standard four conditions, i.e. “above”, “below”, “outside” and “off”.

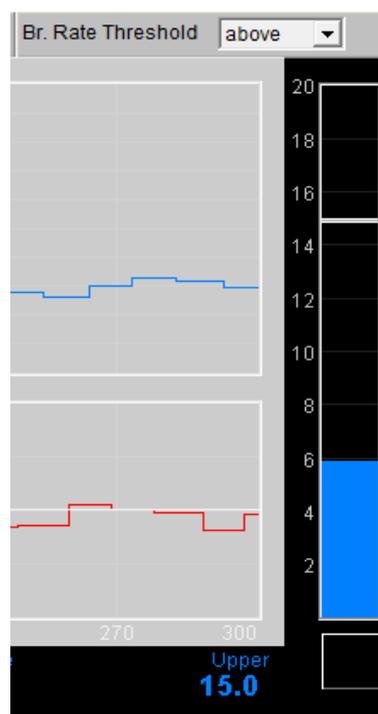


Figure 7 – Threshold display & controls

4.1.6 Audio Feedback Controls

Again, audio feedback functionality is consistent between applications and so is described in one place, i.e. The Guide to Audio and Threshold-based Feedback, which you should read before trying to make sense of this section.

Figure 8 below shows the controls available for audio feedback.

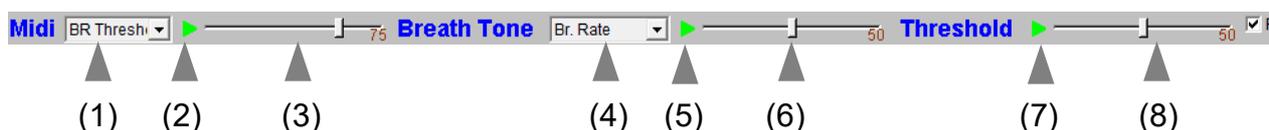


Figure 8 – Audio feedback controls

4.1.6.1 Midi Feedback

When activated, a musical note is played once per breath whose pitch reflects the chosen feedback parameter.

Drop-down list control (1) in figure 8 above sets the parameter for midi feedback. The options available are:

Breathing rate; I:E ratio; breathing rate threshold (ratio); I:E threshold (ratio).

4.1.6.2 Breath Tone

To recap, a tone is played which follows the breath, and whose pitch reflects the selected feedback parameter.

Control 4 in figure 8 allows you to choose which parameter to use as the basis of feedback.

The options are exactly the same as for midi feedback, and listed above.

4.1.6.3 Threshold

To recap, a sound is played whenever one of the threshold parameters goes out of range (or comes back within range). Function depends on the settings of the threshold controls covered in section 4.1.5 above.

4.2 Support Window

Figure 9 shows the support window. It displays the raw temperature signal together with various aspects of the breath detection method (see section 3.1). The support window allows you to check the breathing calibration is ok, but for the most part you shouldn't need it.

The two lamp displays at the bottom (shown turned off) will flash briefly whenever the application detects (i) beginning of the exhalation (left), and (ii) beginning of the inhalation (right).

Press the 'Calibrate' button to recalibrate the breath as described in section 3.1.

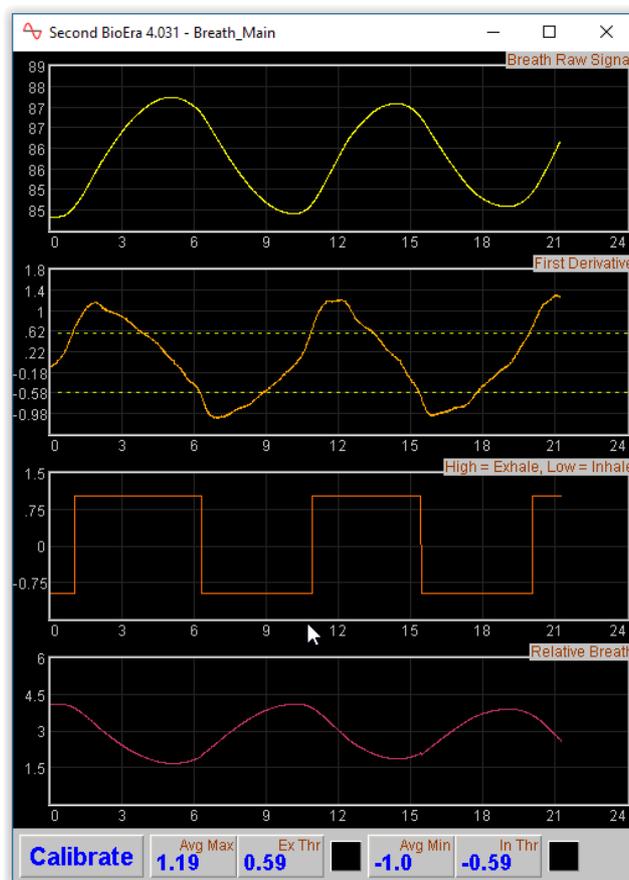


Figure 9 – support window. The charts show aspects of the calculation of the breath's turning points. In the bottom left is the button used to recalibrate the breath (see section 3.1).

5 Breath Counting Functionality

The Basic Breathing application offers a breath counting function aimed at supporting mindfulness practice. This enables users to test the accuracy of their own breath counting. This is useful in a context of mindfulness of breathing meditation practice, where the meditator counts breaths up to a target of say, ten. Distraction and mind-wandering cause the meditator to lose count, and perhaps to lose awareness of the breath completely. However, with greater engagement in the practice, better focus or concentration, and greater skill in meditation, this is less likely to happen. The breath counting function thus offers an objective assessment of performance in mindfulness meditation. Such a method of tracking mindfulness is discussed in the book “The Science of Meditation” by Daniel Goleman and Richard Davidson. Professor Davidson developed such an assessment to aid his group's research into meditation (please note, they did not use Mind-Body Training Tools).

5.1 Steps To Using Breath Counting Functionality

- The trainee should set the target count, e.g. 10, using the drop-down list control (see below).
- To begin a counting trial, the trainee should press the space bar once.
- The trainee then counts breaths, counting after each exhalation (the software also counts number of exhalations).
- When the trainee reaches the target count e.g. 10, he/she should press the space bar again (once). If the count is accurate (i.e. if the software agrees with the trainee) a bell sound indicates success. If the trainee has lost count or is inaccurate, another sound indicates this.
- With each press of the space bar, whether accurate or not, a new counting trial begins – the trainee should begin counting exhalations at once, again, and the software will do likewise.

The results of each trial are written to the session data file, and are included in the session report. The overall accuracy is given, e.g. if the trainee performs ten trials and accurately counts for six of these, the overall rate is given as 60%.

Since breathing rate is probably a factor in accuracy (losing count is more likely if you're breathing slowly) the software also reports mistakes per minute.

5.2 Controls

There is only one control, a drop down list to set the target breath count. This is found just below the short term breath display, and is shown in figure 10 below.

The lamp display next to this control lights up whenever the space bar is pressed.



Figure 10 – Breath counting control

5.3 Software Reliability

Clearly the software's ability to accurately count breaths depends upon its correctly and reliably detecting each exhalation within the raw breath signal (temperature). From time to time the software may lose track of the breath – in my experience this happens rarely, but can happen when the nostril where the temperature probe is placed becomes blocked or partially blocked. If this happens the software will recalibrate, and usually it does recover, but it means that the result of the counting trial during which this happens will be invalid.

The software's count is shown at the bottom of the support window.

6 Session Reports

The application records data so that you can generate a report for your sessions. The report contains summary data and graphs showing the progression of the feedback parameters over the whole session. (Note that during the first 25 seconds of the session, data are not written – it is likely to be inaccurate anyway due to the breath calibration process.)

To generate and open a session report, click the button labelled 3 in figure 1. A dialog window opens in which you can select various options (see figure 11).

The software creates the report in html format. It will be opened using your computer's default web browser, e.g. Google Chrome. (Note that a live internet connection is not needed.) The html file is saved, so you can for example email it to someone. See the Installation and Set-up Guide for details of file storage.

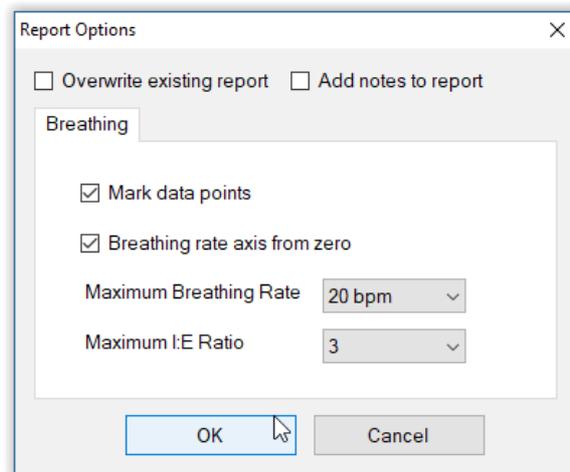


Figure 11 – Report options

6.1 Report Options

Most of the options should be self-explanatory.

If you change your mind about options on seeing your report, you can regenerate the report by clicking the report button (3 in figure 1), then checking 'Overwrite existing report' (top left in the dialog).

Drop-down list controls allow you to set maximum values for breathing rate and I:E ratio. Setting a maximum is a basic way of excluding “artefacts”, for example if you sniffed causing a breathing rate calculation much higher than baseline.

6.2 Adding Notes to a Report

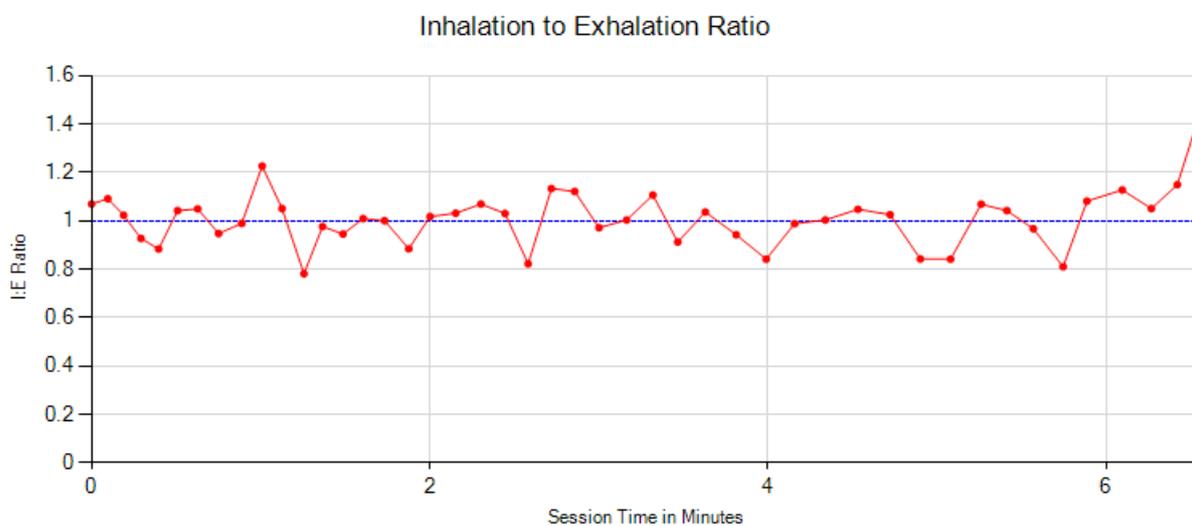
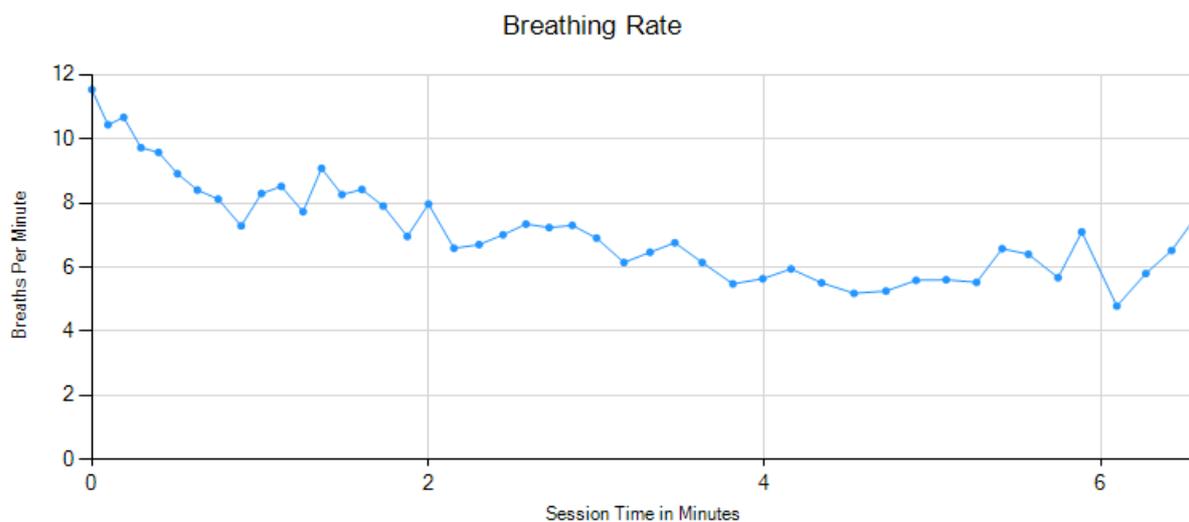
You can choose to write some notes for your session report. Checking 'Add notes to report' (top right of the dialog) allows you to do this.

You may wish to add notes after having first seen the report. In this case, simply click the button (3 in figure 1) again, and check the Add notes option. This will regenerate the report with your added notes.

6.3 Sample Session Report

Training Session Report

| | |
|----------------------|----------------|
| Training Application | Breathing |
| User Name | Default User |
| Session Date | 31/03/12 14:02 |



Breathing Summary Data

| Parameter | Mean | Max | Min | S.D. |
|----------------|---------|----------|---------|---------|
| Breathing Rate | 7.2 bpm | 11.5 bpm | 4.8 bpm | 1.5 bpm |
| I:E Ratio | 1.01 | 1.44 | 0.78 | 0.12 |

7 Application Report

An application report summarises all the sessions for the currently selected user, in charts and a table.

To generate and open an application report, click the button labelled 4 in figure 1. A dialog window opens in which you can select various options (see figure 12).

As with session reports, the software creates the application report in html format. It will be opened using your computer's default web browser, e.g. Google Chrome. (Note that a live internet connection is not needed.) The html file is saved, so you can for example email it to someone. See the Installation and Set-up Guide for details of file storage.

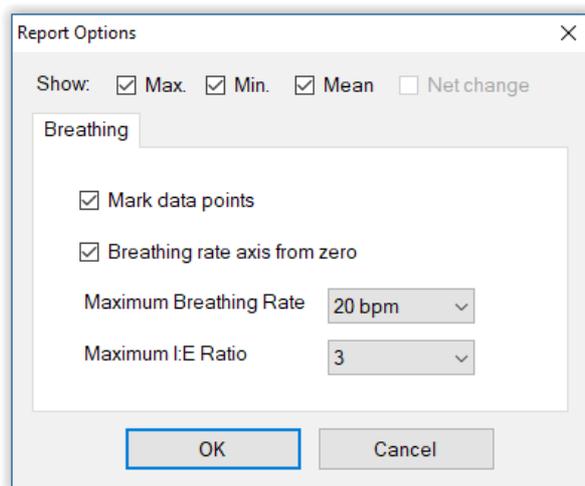


Figure 12 – Report options

7.1 Report Options

The application report options dialog is an adapted version of the session report options dialog. Many of the options are the same, and should be self-explanatory. See section 6.1 above.

As with all of the application reports in the suite, there is a chart for each of the main parameters tracked in the application – in the case of the breathing application that means breathing rate and inhalation to exhalation ratio. For each chart you can opt for line graphs for the maximum, minimum and mean. The line graphs have one point per session.