HEG Neurofeedback with Breathing Software Application User Guide

Contents

1 Introduction

This guide introduces the Hemoencephalography (HEG) Neurofeedback with Breathing 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 guide has two purposes: firstly to explain what HEG actually is, and secondly 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.

HEG is a way of measuring changes in the brain's metabolic (energy-consuming) activity. The brain consumes more energy when you engage in mental activities that require focus. HEG neurofeedback is thus a means of training or exercising the brain at a physiological level, with the aim of boosting mental performance and emotional balance. Neurofeedback training seems to induce lasting change – it stimulates *neuroplasticity* in the brain.

Typically the HEG sensor is positioned over the forehead, where it monitors the Prefrontal Cortex (PFC). This region of the brain is heavily involved in *executive function* (described in section 3.2.3).

If you're new to HEG neurofeedback, I suggest the basic HEG neurofeedback application is the place to start. The HEG neurofeedback with breathing application offers some of the same capability, but I designed it to be more directly relevant to mindfulness practice by monitoring both breathing and brain state changes. The feedback is designed firstly to help you focus on the breath, and secondly to flag drops in brain activation, which I see as opportunities for distractions to arise. In other words the feedback cues you to intensify your awareness at these times, so that you don't drift towards sleepiness, dullness, agitation, etc.

Whilst training brain activity should support mindfulness practice, it is a means to an end, not an end in itself. I designed the software so that the feedback should enhance your subjective awareness rather than detract from it.

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.
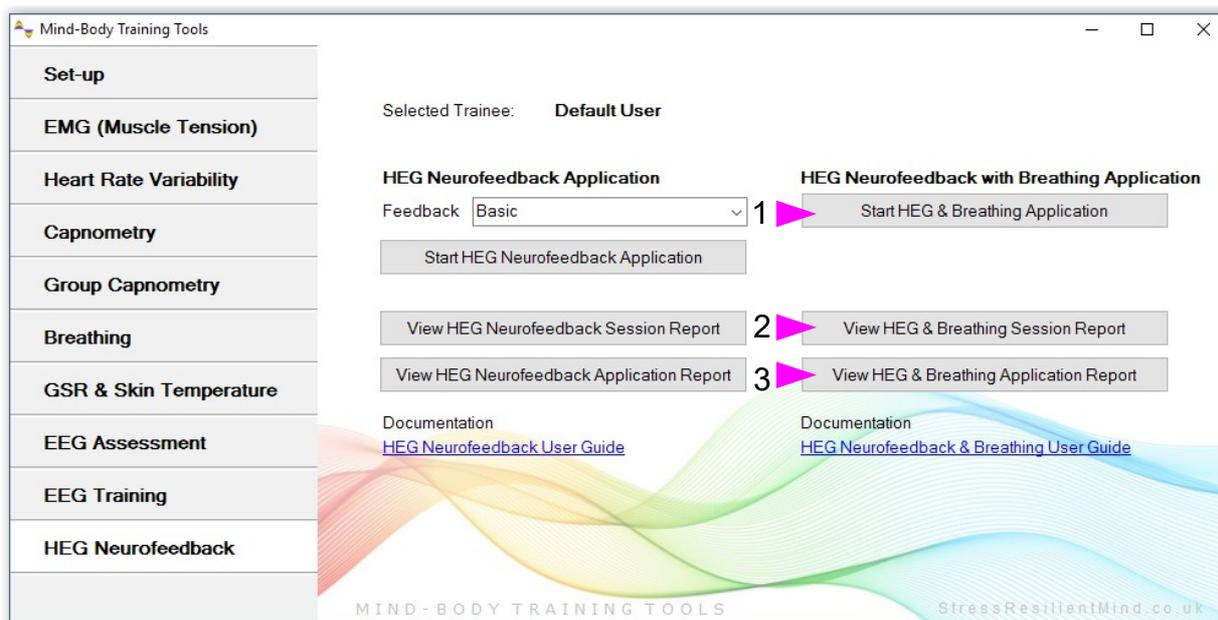
2 Launching the Application

Figure 1 – HEG Neurofeedback Tab of the Platform Application

Figure 1 above shows the HEG Neurofeedback tab of the Platform application. Press the button labelled 1 to launch the application. 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 both the **HEG** and the **Breath** source controls. 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

You may select 'Simulator' in each of the source controls. In simulator mode, you can learn how to use the software without the encumbrance of actually sampling the breath. (The application simply uses recorded data as a source.)

Once you have started the application, you should see this choice 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.
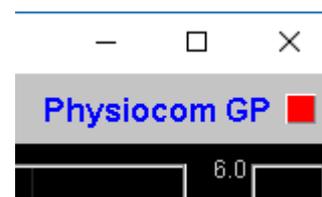
If you're using different devices for measuring HEG and breath, you'll see two buttons (labelled 'HEG' and 'B') and also two lamps. Clicking the buttons allows you to configure device settings. For some device types there are no settings to configure so the buttons are inactive. Again the lamps should turn green when the devices start (the left for the HEG device and the right for the breath device).

3 Physiological Parameters

This section describes the physiological parameters that the application measures, namely breath and HEG.

3.1 Breathing

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.

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, there is a button labelled 'Calibrate', that you simply press. 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.
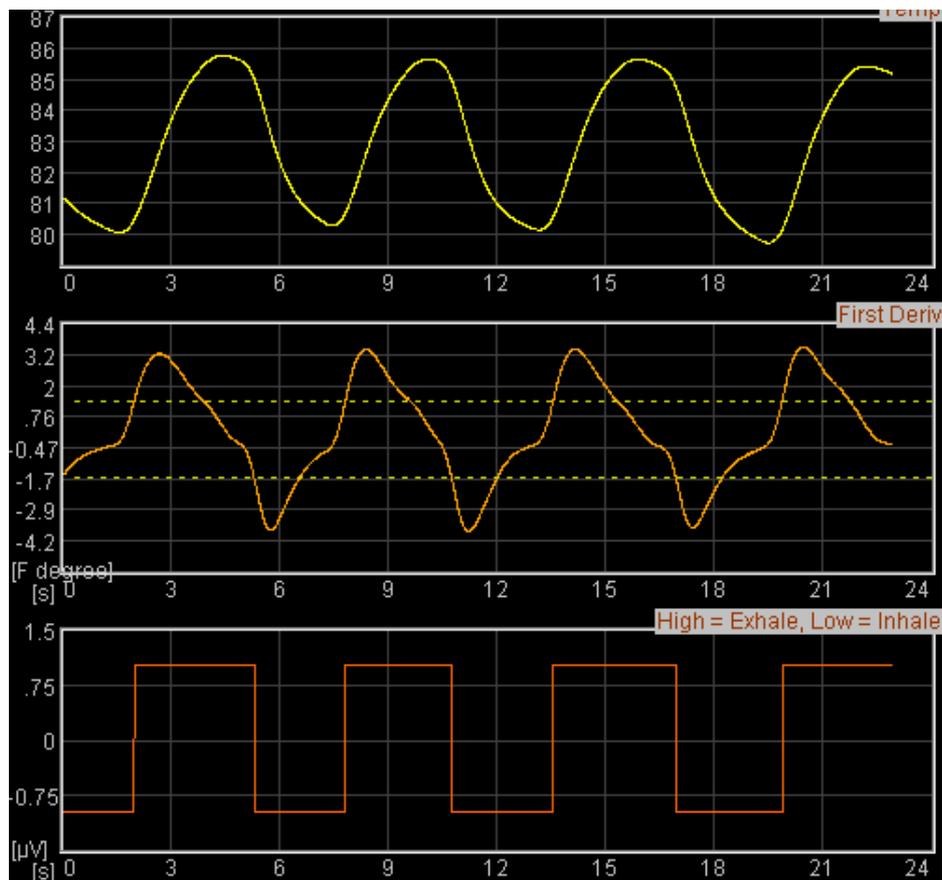
Figure 3 – A well-calibrated breathing signal

3.1.2   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 are shown in the long term display (see section 4.1.6 and figure 8), and can be used as the basis of audio feedback (section 4.1.8). They are also shown in the numeric displays (see section 4.1.4).

3.2 HEG

HEG is a way of measuring changes in the brain's metabolic activity. There are two forms of HEG sensor, known as nIR (near infra-red) and pIR (passive infra-red). The former was developed by Dr Hershel Toomim and the latter by Dr Jeffrey Carmen. For the purposes of training they seem to be largely equivalent, and the software works with both types. In either case the sensor detects changes in blood flow and metabolic activation (these two being tightly coupled in the brain). Again in either case, the sensor detects activity only in the outer region of the brain (known as the cortex), and only from an area close to the sensor.

By 'metabolic activity' I mean energy-consuming processes in brain cells. The brain consumes more energy when you engage in mental activities that require focus. HEG neurofeedback is thus a means of training or exercising the brain at a physiological level, with the aim of boosting mental performance and emotional balance. In HEG neurofeedback we train the signal upwards (not downwards).

Typically the HEG sensor is positioned over the forehead, where it monitors the Prefrontal Cortex (PFC). This region of the brain is heavily involved in *executive function* – described more fully in section 3.2.3. Thus HEG is a vehicle for training executive function.

3.2.1   HEG Rate of Change

The absolute value of the HEG signal is of little relevance – we can't infer anything about brain state from it. Rather, it is *changes* in the HEG reading that count. To repeat: when the HEG signal increases we infer the brain became more active. For this reason it is useful to calculate the *rate of change of the HEG signal*. Much of the feedback in the application is actually based on this calculation – for example see section 4.1.8 (on audio feedback) below.

The rate of change is equivalent to the slope or gradient of the HEG graph.

A zero rate of change means that the HEG reading is stable or unchanging, and that the brain is maintaining its energy level, without either increasing or decreasing it. This state doesn't tend to last very long!

When the brain is activating, the rate of change is above zero (the HEG signal is increasing) and the higher the rate of change the stronger the activation.

When the brain is becoming less energetically active, the rate of change is less than zero, or negative. (The HEG signal is falling.)

3.2.2   Sensor Placement

The standard location for the sensor is the centre of the forehead. The region of the brain behind this point is a particularly important are known as the Prefrontal Cortex (PFC). The PFC has been described as the brain's executive control centre. Its functions are discussed in the following section.

You could use any other site on the scalp for HEG neurofeedback, but I advise you to know what you are doing if you decide to move away from the centre of the forehead. It's possible that you could unwittingly train an unhelpful imbalance. Also note that hair blocks the signal – in other words the sensor cannot see through hair.

3.2.3   Executive Function

To summarise, HEG neurofeedback trains up increased activity in a key brain region, the PFC. More highly evolved in humans than in any other species, the PFC endows us with our uniquely human abilities, traits and intelligences – a set of skills known in neuroscience as executive function, and including:

- The ability to hold the mind steady in its focus.

- Body regulation – by modulating the Autonomic Nervous System (ANS) the PFC influences many of the body's automatic visceral responses.

- Emotional balance – the ability to temper over-arousal and over-stimulation, and to summon and maintain energy and clarity in the absence of external stimulation. Also the ability to modulate emotion-triggering signals coming from other brain regions such as the amygdala (which triggers fear and anger).

- Motivation and emotional drive – the ability to formulate values, goals and purposes.

- The ability to formulate a considered plan of action, and to hold to it in the face of distractions, as well as to update it appropriately. The ability to check impulsiveness.

- Empathy – the ability to appreciate the minds of other people, and to understand how our own behaviour impinges upon them. Ultimately this includes our moral awareness.

PFC functioning has been found to be compromised in several emotional and neurological disorders, including depression and ADHD. HEG neurofeedback can be used therapeutically with these disorders, but you don't have to have a disorder to benefit – HEG neurofeedback is an optimal performance training tool.

Data suggests HEG neurofeedback produces lasting benefits – it's thought that it stimulates structural change in the brain. In other words it stimulates the brain's *neuroplasticity*.

3.2.4   Working with HEG Neurofeedback

This section gives some guidelines on how to direct and apply the mind in order to increase the HEG signal (measured at the forehead).

Aim to feel intensely awake, alert and present. Imagine that something very significant is about to happen, something that you'll want to remember all your life. The mind is rapt, poised, expectant, with all the senses "peeled", and yet calm and still.

Your intent is to move the graph upwards. Imagine that you could move it by the power of your intent, as though you had a psychic power. A useful metaphor can be found in the "Star Wars" series of films, in which Jedi knights such as Luke Skywalker learn to to channel the mystical "force".

You need some emotional commitment behind your intent. You have to really want that graph to move upwards. And yet this motivation must remain positive – if it tips over into frustration or self-criticism or "performance anxiety" then this will work against you. Don't be overly attached to the outcome of your exertions. Appreciate that your brain has limitations. The graph will not always head upwards – at times your brain will tire. Take mini-breaks when you need to, then re-engage your intent.

On the other hand, the occasions at which the graph drops are your working ground, or your learning ground. With practice you'll learn to turn them around so that the HEG signal quickly returns to increase.

What kind of influences cause the HEG signal to drop? In my experience there are two main ones:

- The mind becomes bored or fatigued, and drifts into a slothful, low-energy or even sleepy state.

- Negative emotion, perhaps triggered by a passing thought or memory, or perhaps by a negative judgement of your own performance.

In either case, the practice is to rebalance the brain as quickly as possible.

Sometimes the signal begins to fall, but you're not consciously aware of any reason for it (neither of the above two seem to apply). I think it's best to understand these occasions as openings for distraction – if you let the trend continue unchecked for long, the mind will drift into some form of distraction, but if you respond and turn the signal round, no problem.

Responding to mild boredom often isn't easy. Looking at a line on a computer screen is inherently a pretty boring situation. I think this is an important part of the context for training. You have to generate the arousal internally, not rely on the external stimulation. If you were watching a really interesting film, it might be a lot easier to maintain brain activation, but you're probably already good at that and don't need to practise. On the other hand you don't need to focus exclusively on the graph – you can broaden your focus out to include your environment, and other sensory channels besides vision, as long as you can maintain your intent.

Be careful not to over-train. As with physical exercise, there is a window of opportunity for change – not enough effort, and nothing really changes in the longer term, but over-do it and you risk fatiguing the brain and perhaps giving yourself a headache. However there is no reason to think that over-training can cause lasting problems.

In the very early days of training, I suggest no more than five minutes of active training at a time,

but you can probably quite quickly build up to 20 minute sessions or longer, though it is reasonable to take rests during this time.

Remember that HEG neurofeedback sessions are about exercising the brain. If brain activation increases but then falls back again – well you've still exercised the brain. Compare it to lifting dumbells – you have to lower them back again. In other words, achieving a net increase over the course of a HEG training sessions is not the important thing. Don't get overly focused on the numbers. You can assume that if you practise (exercise) regularly, neuroplastic changes will happen in the brain automatically in the longer term.

My design intent has been to support *mind training* (not simply brain training), by enhancing and augmenting your subjective awareness, rather than detracting from it. This is another reason not to get overly focused on the feedback or overly goal-oriented with respect to the feedback. Instead find a way for the feedback to enhance your subjective awareness. In practice this means letting the feedback be more in the background of your broad awareness. Audio feedback is useful in this regard as it allows you to practise without watching the screen.

Keep emotionally positive as much as you can, or at least avoid falling into negative emotions. Getting frustrated when the signal doesn't go up, and getting anxious if it doesn't go up or you think you can't make it go up, are two traps that can cause drops in the signal.

Another point worth making is that, in the context of training it is sometimes enough just to maintain the brain's energy level, without needing to increase metabolic activity. (Of course there is ultimately a ceiling to the HEG signal – it can't keep on increasing for ever more.) In other words, training is about avoiding drops rather than achieving gains.

4 User Interface

When you first start the application from the Platform, you will see two windows. The main window is shown in figure 4 below, while the support window is shown later (figure 10).

The support window allows you to check that breath detection is working properly (see the discussion of breath calibration in section 3.1.1). I expect that most users will rarely need to make reference to it.
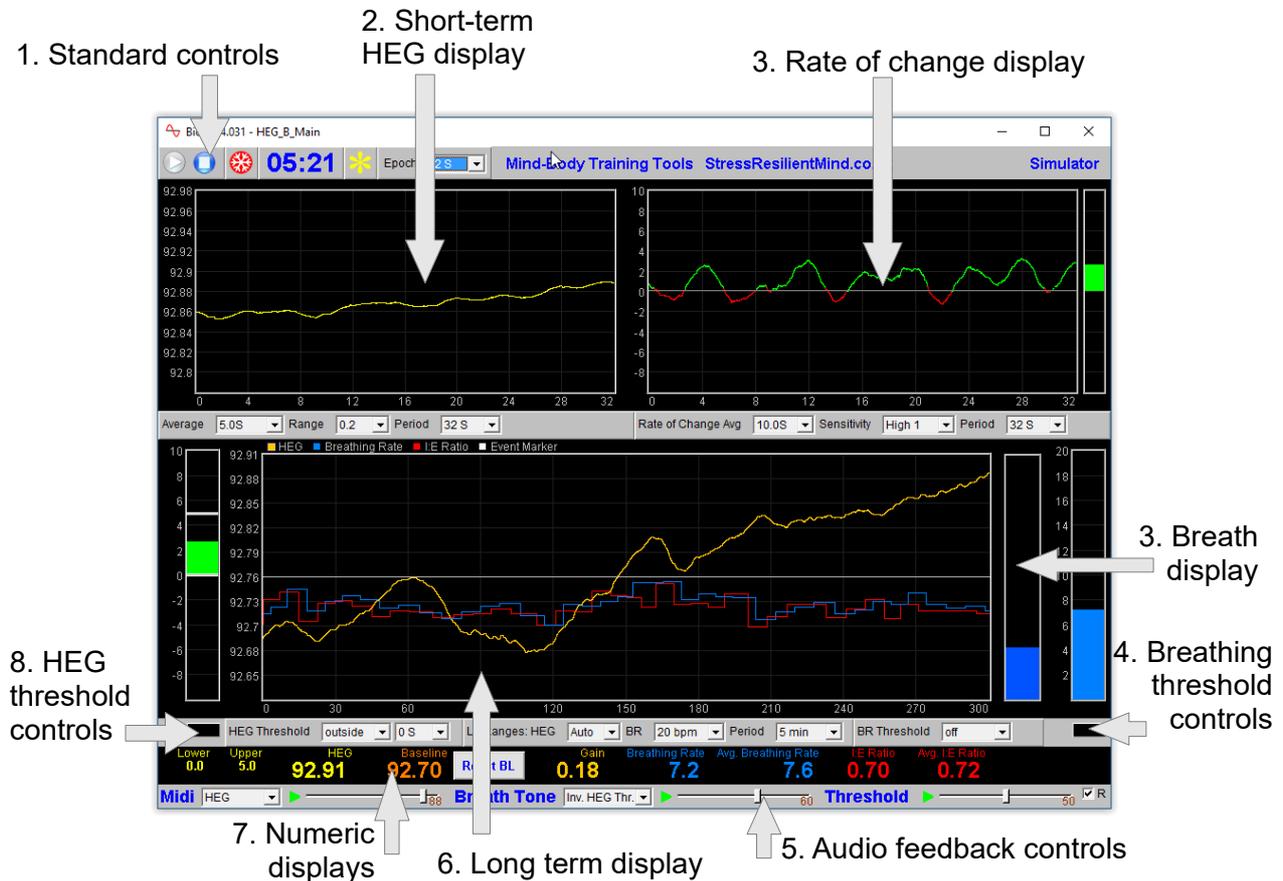

Figure 4 – User interface

4.1 Main Window

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

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 'Epoch' control sets the time period at which data is written to the session data file. This data file is used to generate session reports, which are described in section 5 below. For the HEG application, only HEG data is written. Choosing a lower time period generates more data. For example, if you select 2 seconds, then the application will write HEG readings to the session data file once every two seconds.

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 4.4 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 5).

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).
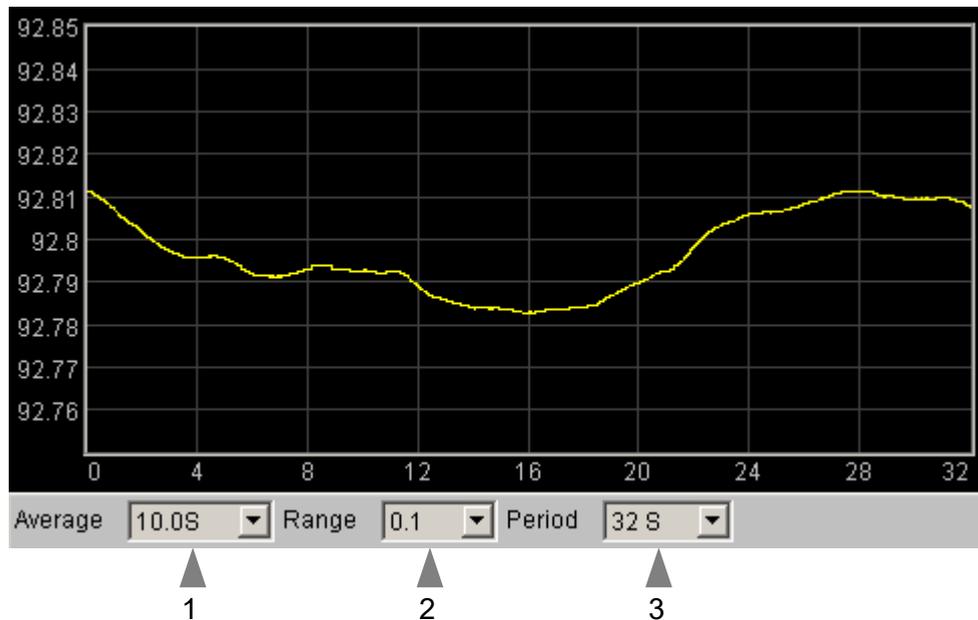
4.1.2　　　**Short-term HEG Display**

Figure 5 – Short-term HEG display

The chart in figure 5 above shows the progression of the HEG signal over the short term. Note this chart operates in auto-centre mode. The trace will be continually adjusted so that it's (most recent) right hand section displays in the middle of the vertical range.

The three (sometimes four) drop-down list controls, positioned below the chart and described in the following table, can be used to configure this chart.

Average	Controls the level of smoothing of the HEG signal. With a shorter average you will see all the fine-grained changes. With a longer average these are smoothed out, but the signal will be slower in responding to change.
Range	Controls the vertical scale of the display, or the difference between the upper and lower limits of the vertical axis. Note that in auto-centre mode, the scale is fixed but the actual upper and lower limits are constantly changing. Selecting 'Auto' produces a different behaviour: the system will automatically calculate the best range to best fit the chart based on the variation over the period of the chart. In this case the range will not stay fixed but will vary over the session.
Period	This controls the length of time it takes for the traces to traverse the whole chart from right to left – or in other words the horizontal range.

Note that *increasing* the period after processing has started can have unpredictable consequences, so I recommend you make your selection before pressing play.

Unit   Only available for some device types. Select either Fahrenheit or Celcius as the unit (of infra-red temperature). This applies to all the displays, not just the short-term HEG chart.
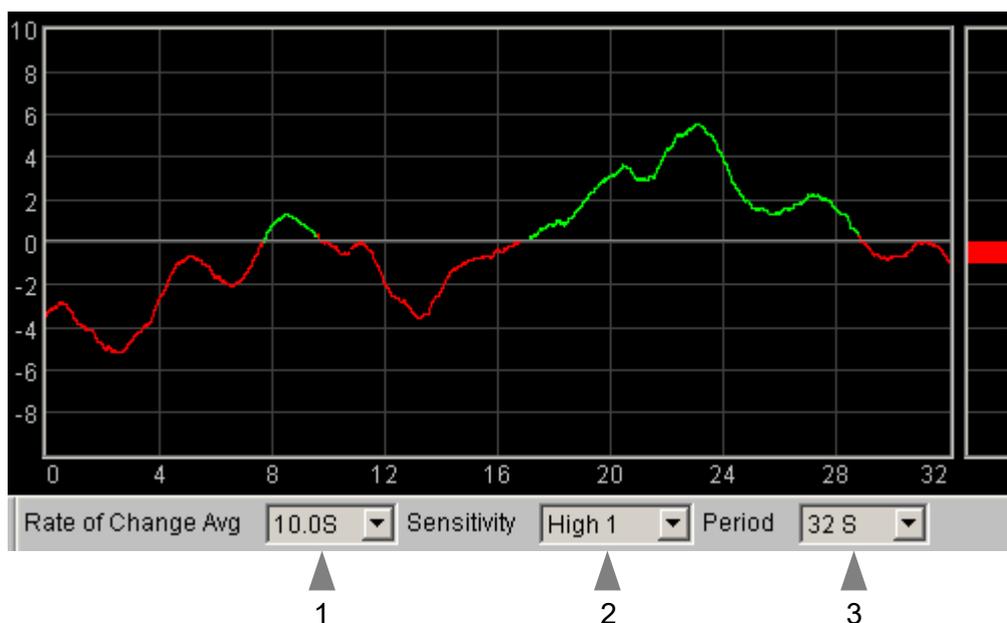
4.1.3   Rate of Change Display

Figure 6 – HEG rate of change display

This chart (figure 6) shows the HEG rate of change, or in other words the gradient or slope of the HEG trace shown in the short-term HEG chart (section 4.1.2 above). The central horizontal line is zero. When the trace goes above this line, it means the HEG signal is increasing and its colour is green. When the trace falls below the line it means the HEG signal is falling and its colour changes to red. The further away from the zero line, the faster the HEG signal is changing.

Since the goal of training is to increase or at least maintain the HEG reading, you should aim to keep this graph "in the green" as much as possible.

The bar graph at the right of the display shows the current rate of change – this chart always has the same scale as the adjacent chart.

The three drop-down list controls, positioned below the chart and described in the following table, can be used to configure this chart.

Rate of Change Avg   Controls the level of smoothing of the signal. With a shorter average you will see all the fine-grained changes. With a longer average these are smoothed out, but the signal will be slower in responding to change.

I suggest a setting of 10 seconds as a starting point.

Sensitivity   Controls the vertical scale or range of the display. With a higher sensitivity setting,

the range will be smaller, so changes will appear more prominently.

The zero line is always fixed in the centre of the chart.

If the trace tends to disappear off the top or bottom of the chart, choose a lower sensitivity. Conversely if the trace is bunched tightly around the zero line, choose a higher sensitivity.

Period   This controls the length of time it takes for the traces to traverse the whole chart from right to left – or in other words the horizontal range.

Note that *increasing* the period after processing has started can have unpredictable consequences, so I recommend you make your selection before pressing play.

4.1.4   Numeric Displays

Figure 7 – Numeric displays and associated controls

The numeric displays (figure 7) are situated at the bottom of the main window above the audio feedback controls. They should be mostly self-explanatory except for these:

Baseline   The HEG reading at the beginning of the session, or more precisely 30 seconds into the session (to allow a settling period).

Reset BL   Pressing this button resets the baseline to the current HEG reading.

Gain   Current HEG reading minus the baseline. This allows you to assess the overall change achieved in your session. (Note the overall gain does not necessarily reflect the worth of the training session. If it is low it doesn't mean you didn't do useful work.)

Averages are calculated over 60 seconds.

4.1.5   Breath Display

This is simply shows a bar graph of the breath (see 3 in figure 4 above). The bar increases in height during inhalation and drops back again during exhalation. The signal is automatically calibrated so it will fit to the chart; each breath begins at the same place. During the initial calibration phase (see section 3.1.1) the chart will not display properly. If it doesn't look right after this, the system may not have calibrated to your breath properly (you can recalibrate the breath signal – see section 3.1.1).
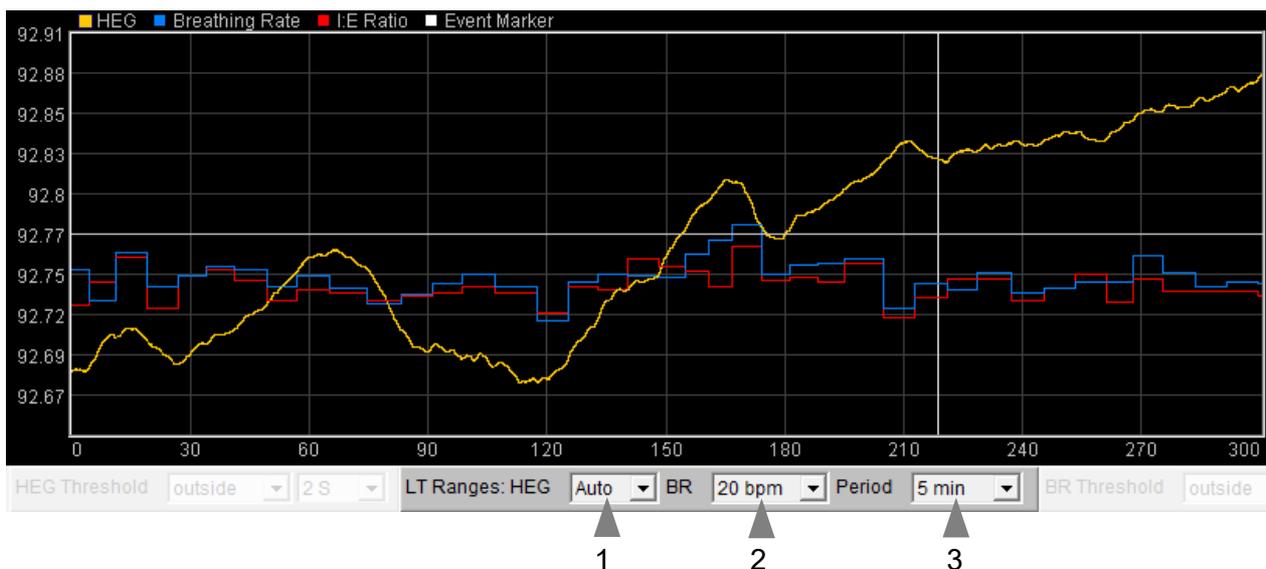
4.1.6 Long-term Display

Figure 8 – Long-term displays

Figure 8 shows the variation of the parameters (HEG, breathing rate and I:E ratio) in the longer term (five minutes and upwards). Like the short-term display this chart operates in auto-centre mode. The trace will be continually adjusted so that it's (most recent) right hand section displays in the middle of the vertical range. Click on the coloured squares (top left) to select which parameter scale is displayed. There are three associated drop-down list controls (labelled 1 to 3 in figure 8).

HEG   Controls the vertical scale of the (upper) HEG chart, or the difference between the upper and lower limits of the vertical axis. Click the orange square (upper left of chart) to see this scale displayed on the chart's vertical axis.

      In auto-centre mode the scale is fixed, but the actual upper and lower limits are constantly changing.

      Selecting 'Auto' produces a different behaviour: the system will automatically calculate the range to best fit the chart based on the variation over the period of the chart. In this case the range will not stay fixed but will vary over the session.

BR Range Controls the vertical range of the blue breathing rate trace in the lower chart.

      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.

Period Controls the horizontal (time) range – in other words how long it takes the trace to traverse from right to left.

      Note that *increasing* the period after processing has started can have unpredictable consequences, so I recommend you make your selection before pressing play.

The red I:E ratio trace has a fixed range of 0 to 2. The bold line in the centre of the chart is at 1.0, meaning that when the red trace is below the line, the exhalation phase lasts longer than the inhalation phase (usually desirable).

4.1.7   Threshold Displays and 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 4.1.8 below.)

In the HEG Neurofeedback with Breathing application there are two threshold displays, one for HEG and one for breathing rate. They are situated at either side of the long term display (HEG to the left, 8 in figure 4, and breathing rate to the right, 4 in figure 4). The HEG threshold display and controls are shown in figure 9 – the other threshold is functionally similar.

The HEG threshold is based on the rate of change, as in the Basic HEG application. The control settings for the HEG Rate of Change

Figure 9 – Threshold displays and controls

display (see section 4.1.3 above) apply to the threshold signal too – the averaging is the same and the range of the bar graph (sensitivity) is the same as the rate of change chart.

For the breathing rate threshold, the range of the bar graph is the same as that of the long term display (set using drop-down list 2 in figure 8).

The HEG threshold has an additional control (7 in figure 9) which is a duration control. It works as described in the Guide to Audio & Threshold-based Feedback, i.e. it allows you to in effect filter out events of short duration.

As an example of how you might use threshold-based feedback, suppose you wish to maintain a steady breathing rate of around 6 breaths per minute, while at the same time keeping a steady level or increase in the HEG signal. First, set the HEG threshold to warn you if the HEG signal starts to decrease – set the condition to 'below' and drag the (single) level to around zero. Second, set the breathing rate threshold feedback (right side) to inform you if the breath is either too fast or too slow – set the condition to 'outside', then drag the threshold levels so that the upper is say around 7 bpm and the lower is say around 5 bpm.
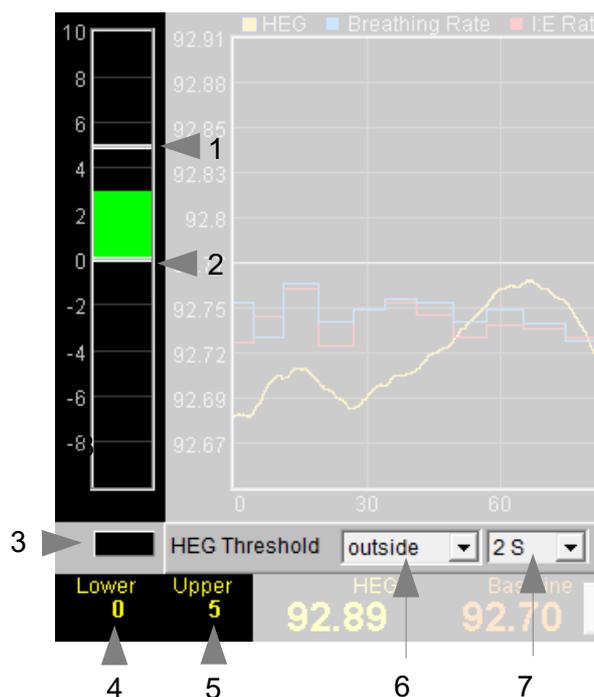
4.1.8   Audio Feedback

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.

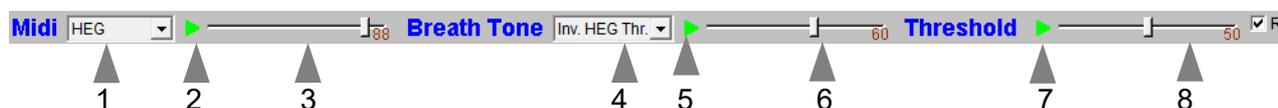Figure 16 below shows the controls available for audio feedback.

Figure 10 – Audio feedback controls

Midi

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

Drop-down list control (1) in figure 9 above sets the parameter for midi feedback. The options are:

HEG; breathing rate; breathing rate threshold (ratio).

Please note: changing the selected feedback parameter forces the application to have to restart, and you will lose your earlier session data. If session data is important to you, it's better to make your selection at the start of your session, and then stick with it.

Breath Tone

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

Control 4 in figure 9 allows you to choose which parameter to use as the basis of feedback. The options are:

HEG threshold (ratio); inverse HEG threshold (ratio); breathing rate; breathing rate threshold (ratio).

Please note: changing the selected feedback parameter forces the application to have to restart, and you will lose your earlier session data. If session data is important to you, it's better to make your selection at the start of your session, and then stick with it.

Please note also, for the HEG threshold ratio selections (including inverse), the behaviour is different to other parameters: the HEG (rate of change) ratio is averaged over the cycle of the previous breath, then this value is used to calculate the pitch for the next breath.

I have personally used breathing tone with the the inverse HEG threshold option selected, and the threshold levels positioned with the upper limit at zero, and the lower one somewhere below. Then, the breathing tone is deep in pitch when the HEG signal is increasing (i.e. the rate of change is above zero) – this is my target because I find a deep tone more aesthetically pleasing. When the HEG signal drops, the breathing tone goes higher in pitch and warns me to increase my attention, etc.

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 4.1.7 above.

4.2 Support Window

Figure 10 shows the support window. It displays the breath's (air) temperature signal together with various aspects of the breath detection method (see section 3.1.1).

The two lamp displays at the bottom (black squares in the figure as they are turned off) will flash briefly whenever the application detects (i) beginning of the exhalation (left lamp), and (ii) beginning of the inhalation (right lamp).

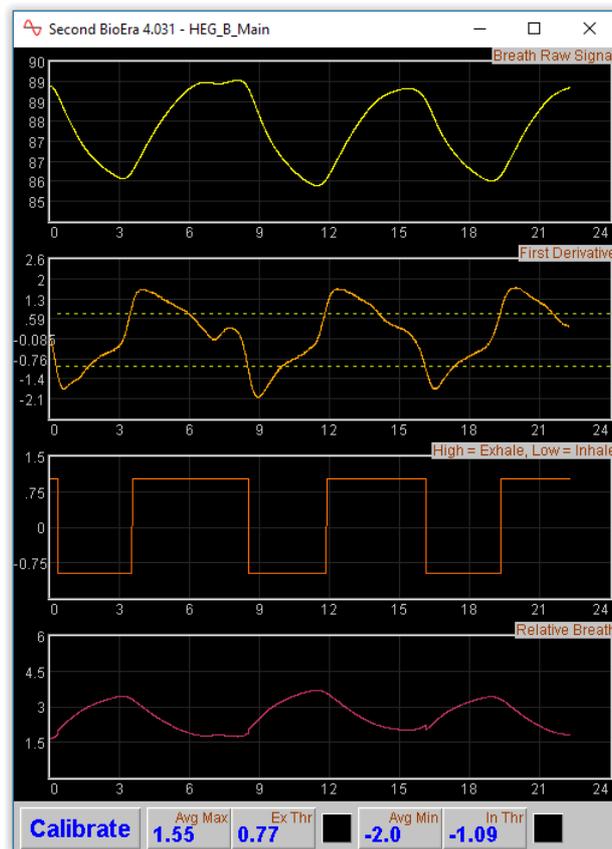Press the 'Calibrate' button to recalibrate the breath as described in section 3.1.1.

Figure 11 – 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 3.1.1).

5 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 the HEG data in the session data file is averaged according to the setting of the short-term HEG display (control 1 in figure 5).

To generate and open a session report, click the button labelled 2 in figure 1. A dialog window opens in which you can select various options (see figure 11 below).

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.
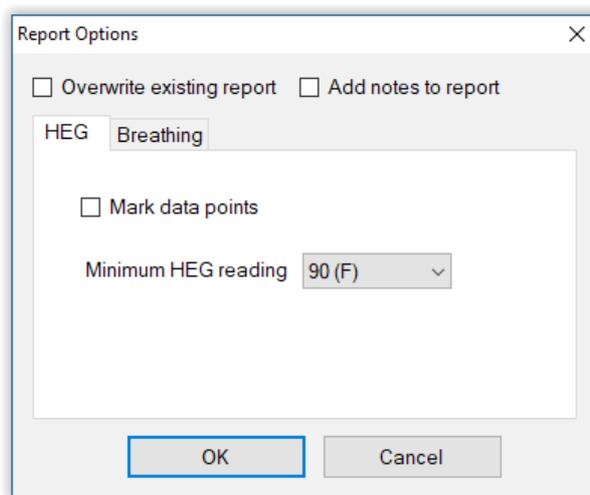

Figure 12 – Report options

5.1 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 (2 in figure 1), then checking 'Overwrite existing report'.

Options relating to either HEG data or breathing data are found under separate tabs.

Drop-down list controls allow you to set maximum or minimum values for several of the parameters. Setting these limits is a basic way of excluding "artefacts", for example if you moved during the session, so that the flow of air over the HEG sensor caused cooling. Data points outside these limits are excluded.

5.2 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 (2 in figure 1) again, and check the Add notes option. This will regenerate the report with your added notes.
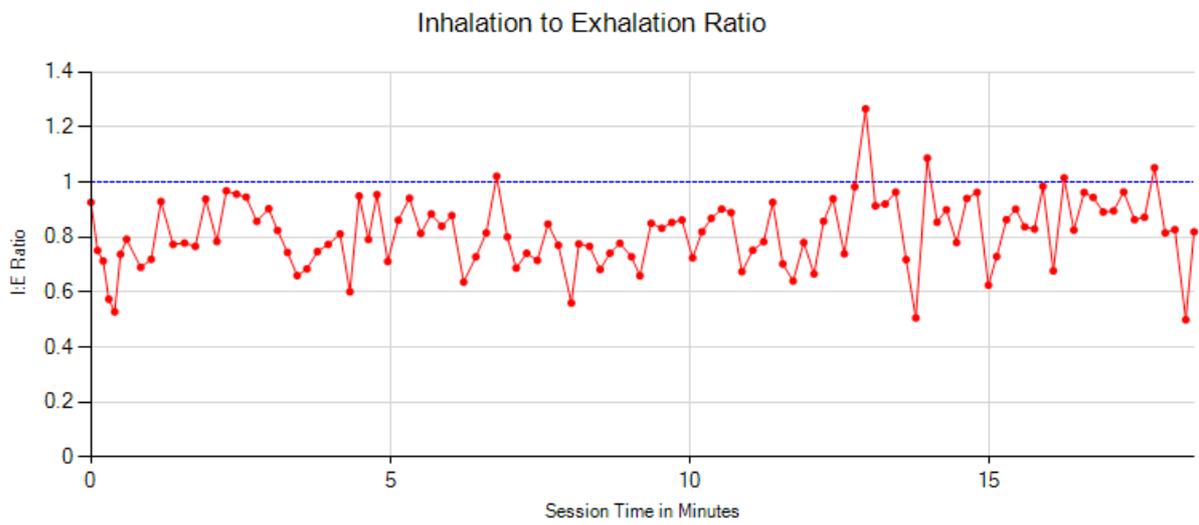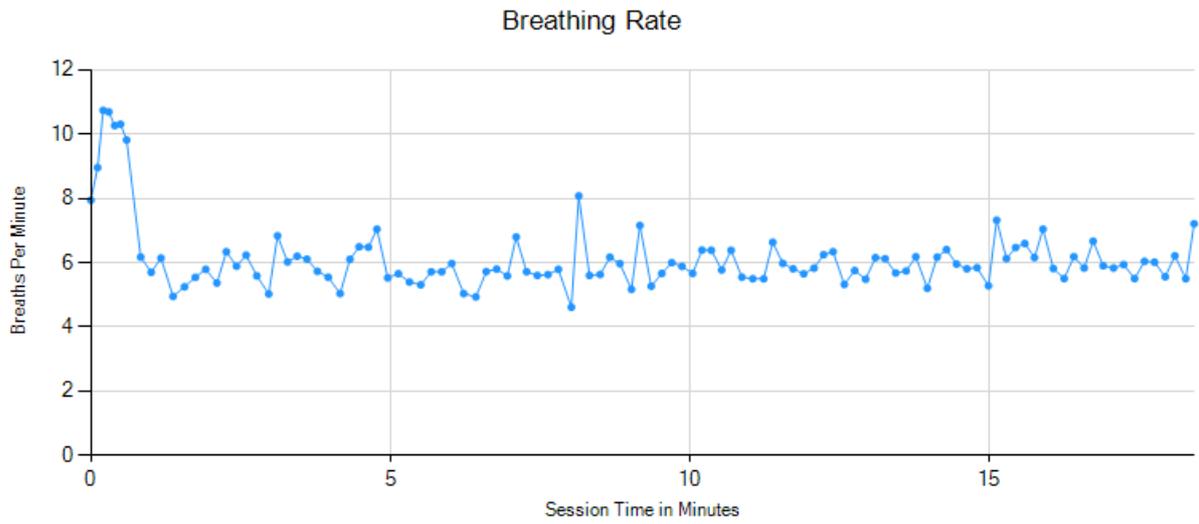
5.3 Sample Session Report

Training Session Report

Training Application	HEG Neurofeedback with Breathing
User Name	Default User
Session Date	28/03/12 22:01
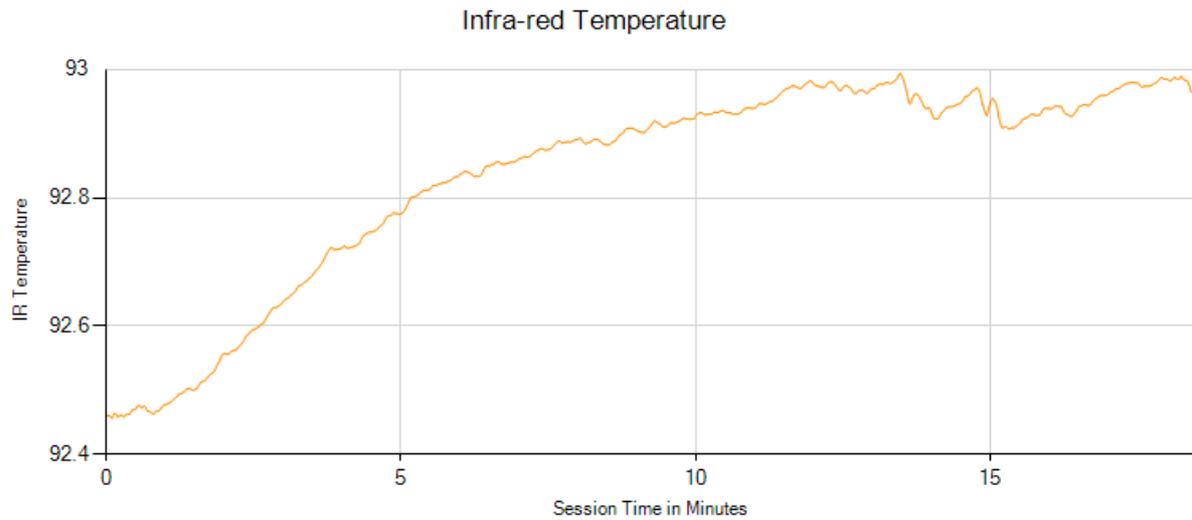
HEG Summary Data

Parameter	Value
Starting Reading	92.46
End Reading	92.96
Max Reading	92.99
Net Change	0.51

Breathing Rate

Inhalation to Exhalation Ratio

Breathing Summary Data

Parameter	Mean	Max	Min	S.D.
Breathing Rate	6.2 bpm	10.7 bpm	4.6 bpm	1.1 bpm
I:E Ratio	0.82	1.27	0.50	0.13

6 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 3 in figure 1. A dialog window opens in which you can select various options (see figure 11).

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.
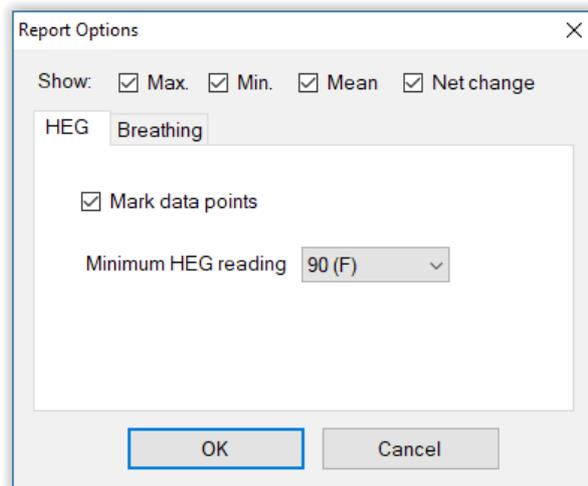
Figure 13 – Report options

6.1 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 5.1 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 HEG & Breathing application that means HEG score, breathing rate and inhalation to exhalation ratio. For each chart you can opt for line graphs for the maximum, minimum, mean and net change. The line graphs have one point per session.