EMG, GSR & Skin Temperature Software Application User Guide

Contents

1 Introduction

This guide introduces the EMG, GSR and Skin Temperature 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 this 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 (address above).

The EMG, GSR and Skin Temperature application combines three common peripheral biofeedback parameters into one application. Each of these parameters has a more basic application in the Mind-Body Training Tools suite offering a single parameter only (i.e. one of EMG, GSR or skin temperature). I recommend you gain experience with each of these applications before working with the combined application. Furthermore, I recommend you read the user guides for these basic applications first, because they describe their parameters in greater depth.

In keeping with others in the suite, the EMG, GSR and Skin Temperature application was designed to support *your* aims, not to supplant them. Achieving low muscle tension is not necessarily the most important thing. Biofeedback should enhance or expand 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 applications in the Mind-Body Training Tools suite work with several devices. For an up to date list of supported hardware, please see the StressResilientMind.co.uk website. However the EMG, GSR and Skin Temperature application is limited to devices that can measure all three parameters at the same time – you cannot combine different devices in the way that you can with some other applications in the suite.

2 Launching the Application

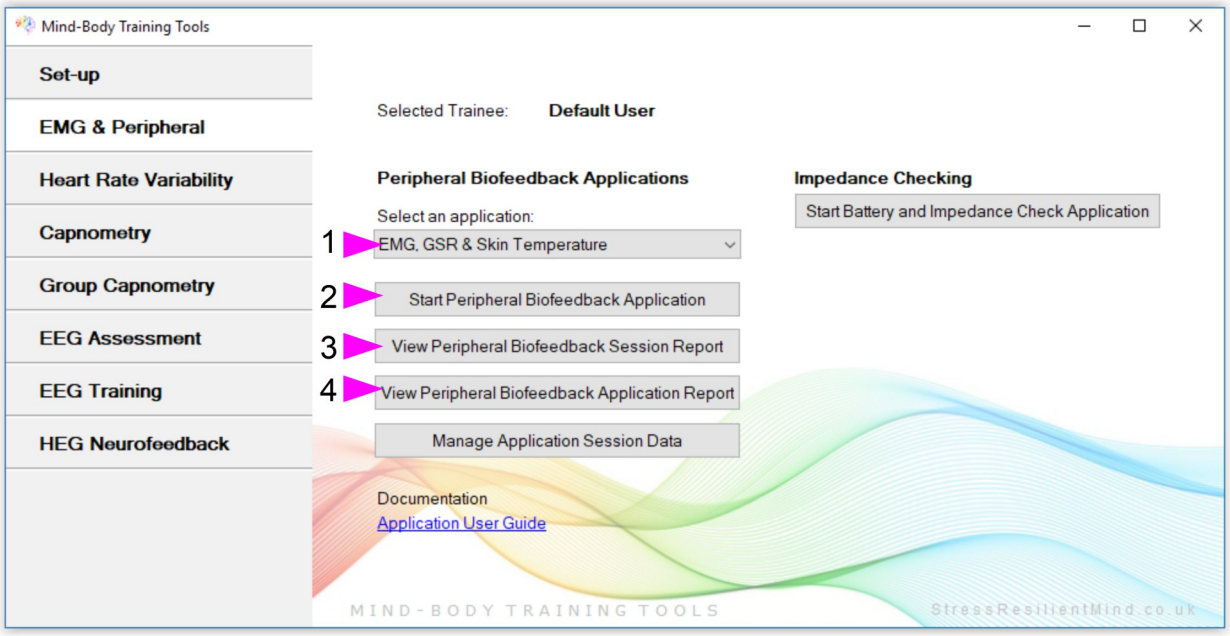


Figure 1 – EMG & Peripheral (biofeedback) Tab of the Platform Application

Figure 1 above shows the EMG & Peripheral tab of the Platform. First you need to select the "EMG, GSR & Skin Temperature" 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 a new window will appear on your screen.

2.1 Hardware Set-up

The physical aspects of hardware set-up (how to connect and use your sensors,, how to check impedances, 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 each of three source contols (drop-down lists): **EMG; GSR and Skin Temperature**. As mentioned earlier, all three source signals must come from the same device, i.e. you must select the same device for all three controls.

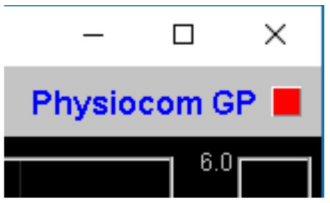


Figure 2 – Amplifier status

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.

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.) Again, you must select 'Simulator' for all three source controls.

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 About the Biofeedback Parameters

The application offers feedback for three parameters, EMG (for muscle tension), GSR (or more specifically skin conductance) and skin temperature.

These three parameters are described in more detail in the user guides for basic single-parameter applications (e.g. the Basic EMG application user guide), however, there follows a brief description.

- **EMG or electromyography** is an electrical correlate of muscle tension. It is easy to appreciate that the state of muscle tension is reflective of your subjective state of mind. The essential nature of the mind-body connection in respect of muscle tension is that we tighten up whenever we feel a sense of threat, or even just a sense of resistance towards our immediate experience. EMG biofeedback is a means of developing greater sensitivity to this mind-body relationship, and of learning to relax more fully and more consistently and reliably. EMG is measured using sensors in contact with the skin. By selecting the placement of the sensors we can choose to monitor different (sets of) muscles.
- **GSR** stands for **Galvanic Skin Response**. A more specific name for the biofeedback parameter used in this application is **skin conductance (SC)**. SC changes are triggered by the sweat response (sweat being essentially a salt water solution which is a good conductor of electricity. Sweating is in turn mediated by the Sympathetic Nervous System or SNS (which is one of the two branches of the Autonomic Nervous System or ANS). The SNS activates the body physiologically – it is the mediator of the well-known "fight or flight" response. SC is a very sensitive indicator of even subtle and brief activations of the SNS, typically associated with emotionally significant stimuli, including our own thoughts). SC changes are in large part involuntary, but SC biofeedback is useful for learning about the nature of "fight or flight" responses, and also we can learn a degree of indirect control over it.
- **Skin Temperature (ST)** is also mediated by the sympathetic branch of the ANS (i.e. it is a fight-or-flight indicator). This time the mechanism behind changes in the parameter is not sweating but changes in blood flow: sympathetic activation causes vasoconstriction in the blood vessels in the skin of the fingers (and other peripheral areas but for biofeedback we usually measure ST at the fingers). This withdrawal of blood supply causes cooling, or a fall in skin temperature. Thus skin temperature changes are also reflective of emotionally laden experiences. However it differs from SC in that it changes much more slowly and steadily. (Also, ST and SC move in opposite directions: stress causes an increase in SC and a decrease in ST, while relaxation tends to trigger falls in SC and rises in ST.

Please note that the EMG parameter is calculated on the basis of filtering the raw EMG signal over a range of 100-200 Hz – this is not controllable in the software. See the Basic EMG Application User Guide for more on what this means.

4 User Interface

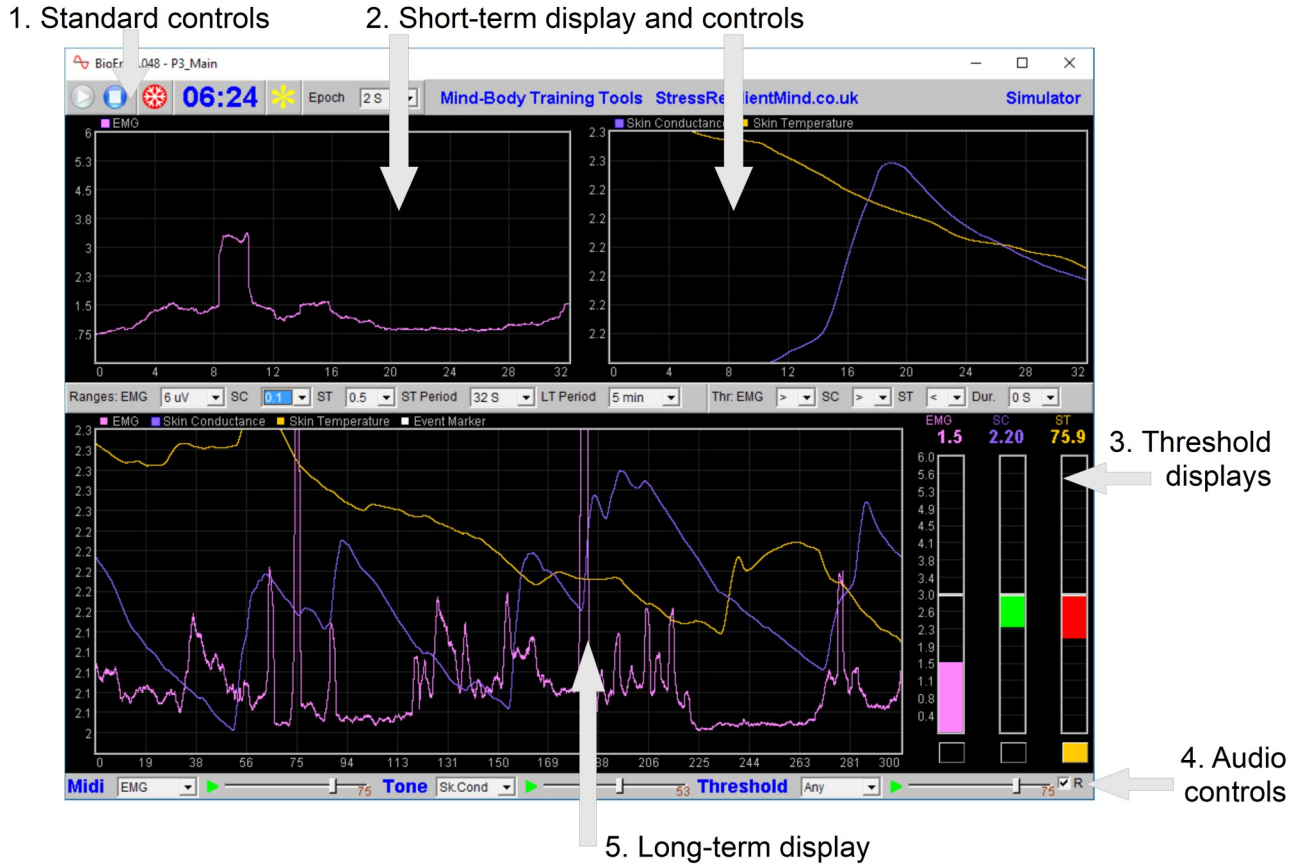


Figure 3 – User Interface

Figure 3 above shows the user interface for the EMG, GSR and ST application.

4.1 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 6 below. For the EMG, GSR and ST application, data is written for each of the three parameters. Choosing a lower time period generates more data. The setting also controls the level of averaging of the recorded data. For example, if you select 2 seconds, then the application will write to the session data file once every two seconds, the average EMG, etc. over that two second period.

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. 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).

4.2 Short Term Displays and Controls

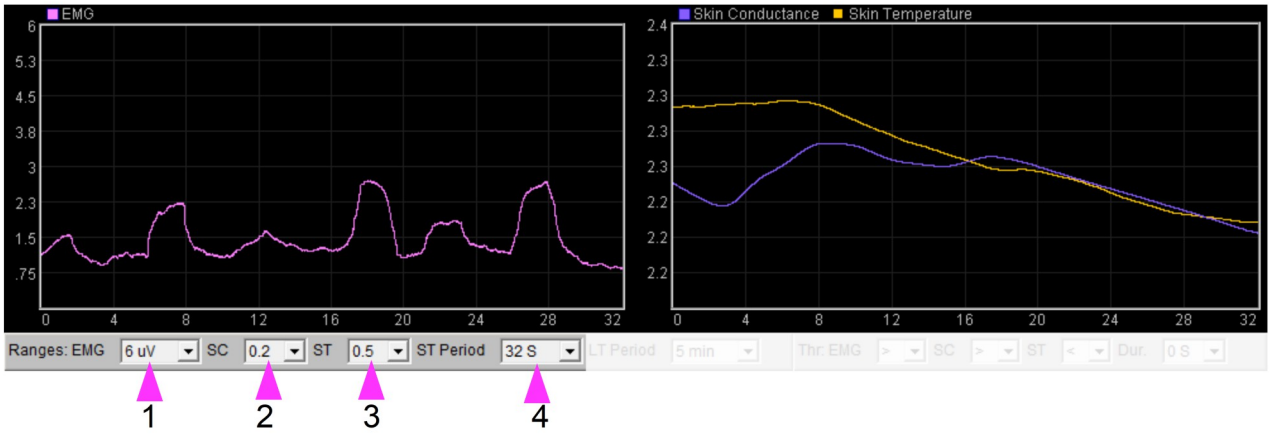


Figure 4 – Short term displays and controls

The two charts shown in figure 4 above show the variations of the three parameters over the short term (e.g. 32 seconds shown here). The left chart shows EMG while the right chart shows both SC and ST.

The drop-down list controls shown below the EMG chart can configure these displays. The first three set the vertical ranges, the first (1 in figure 4) for EMG in the left chart, the second for SC in the right-hand chart, and the third for ST also in the right-hand chart.

Please note that for SC and ST, even though the controls set the scale, the actual window shown by the chart is automatically adjusted upwards or downwards so as to fit the signals to the display. Also note for SC and ST, only one vertical scale is shown at a time (i.e. either SC or ST) you can switch which is shown by clicking the coloured squares at the top of the chart.

The fourth drop-down sets the time range or horizontal scale for both the short-term charts.

4.3 Long Term Display and Controls

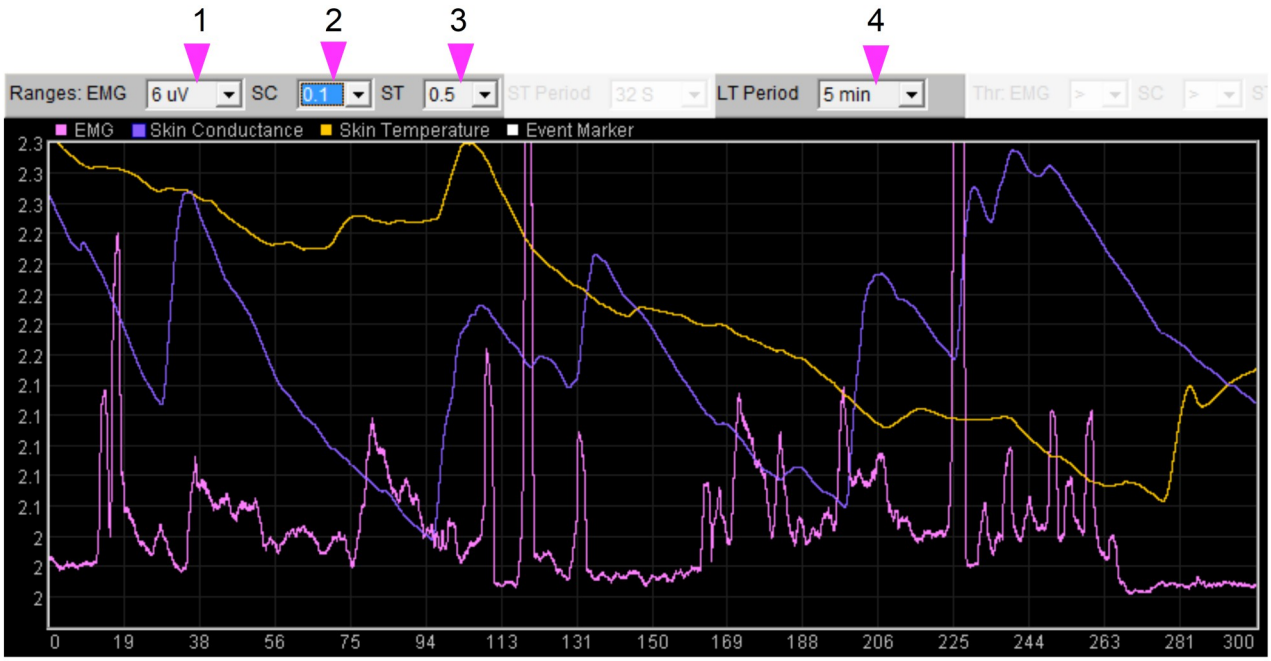


Figure 5 – Long term display and controls

The long-term display (figure 5) shows the variation of the all three parameters over a longer time scale (up to 20 minutes). The four highlighted drop-down controls set the ranges for the chart. The first three (1, 2 and 3 in figure 5) are in fact the same controls that set the ranges in the short-term chart (for simplicity, I stuck to one set of range controls for both charts). In fact the ranges used in the long-term chart are larger (for SC and ST), but the controls still step it up or down.

As with the short-term display, the actual range for both of SC and ST can (automatically) shift up or down to fit the display, even though the scale is fixed by the drop-down controls.

Again, you can click the coloured squares at the top to set which of the three numerical ranges is displayed at the left side of the chart.

The fourth drop-down (4 in figure 5) sets the time range or horizontal scale.

4.4 Threshold Display 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 4.5 below.)

There are three separate thresholds in the EMG, GSR and ST application, and all shown in figure 6. Each is a simple one, offering just two conditions ("above" and "below"). These conditions are set using the drop-down controls (1 to 3 in figure 6).

Each threshold has its associated bar chart with movable threshold level. In figure 6, the EMG level is labelled 5. The range of this EMG bar chart is set to be the same as the both the short-term and long-term displays, i.e. using the drop-down control labelled 1 in figure 4.

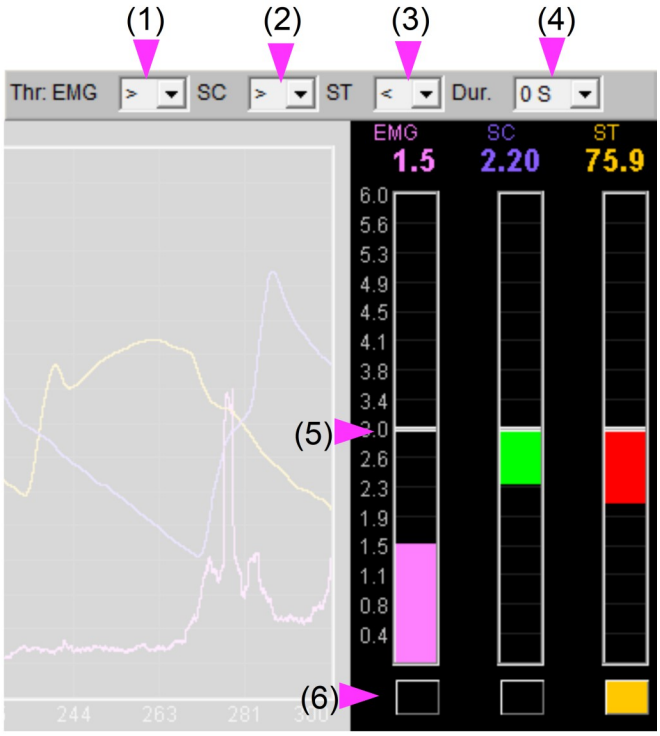


Figure 6 – Threshold controls

The SC and ST thresholds are different in that they are based on the parameter rate of change rather than the parameter itself. In this respect they are like the basic GSR and basic ST applications. See the user guides for those apps for a discussion of rate of change. The ranges of the SC and ST rate-of-change bar charts is automatically adjusted when you change the SC and ST ranges (using drop-down controls 2 and 3 in figure 4).

The threshold levels for SC and ST by default are set at zero, so that the threshold feedback indicates when the parameter changes from rising to falling or vice versa. (The colour of the bar chart likewise changes between red and green.)

Three lamp displays light up when the threshold condition is met, but the main medium for threshold feedback is audio – see section 4.5 below.

There is a duration control available for the three thresholds. (See the Guide to Audio and Threshold-based Feedback for a discussion of what this means). The same duration setting (4 in figure 6) is applied to all three thresholds.

4.5 Audio Feedback Controls

Again, please read the Guide to Audio and Threshold-based Feedback to gain a fuller understanding of the audio feedback controls, which are shown in figure 7 below. These controls work as you would expect based on the Guide to Audio & Threshold-based Feedback. The only notable point is that you can select the parameter on which to base threshold feedback, using drop-down control 7 in figure 7. This can be any single one of the three thresholds, or you can select "Any" which means the feedback will sound when any one of the three threshold conditions is met.

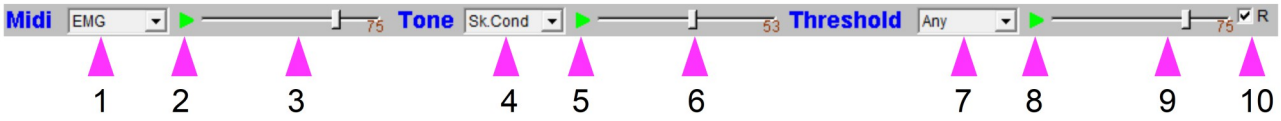


Figure 7 – Audio feedback controls

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 parameter over the whole session.

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 8).

The software creates the report in html format. It will be opened using your computer's default web browser, e.g. chrome or firefox. (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.

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

Setting a maximum EMG amplitude is a basic way of excluding “artefacts”, for example if you changed your posture during the session. Data points exceeding the maximum value 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.

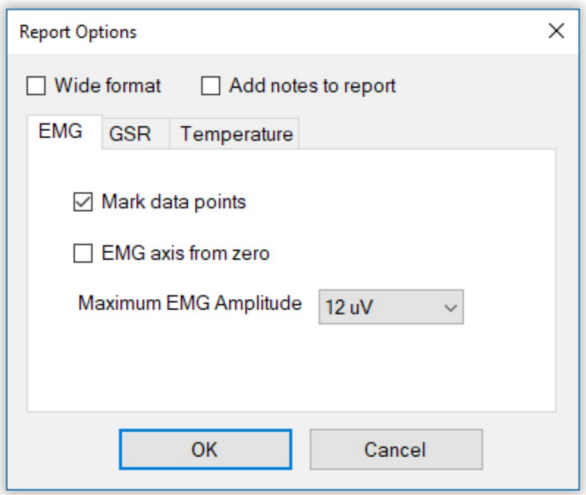
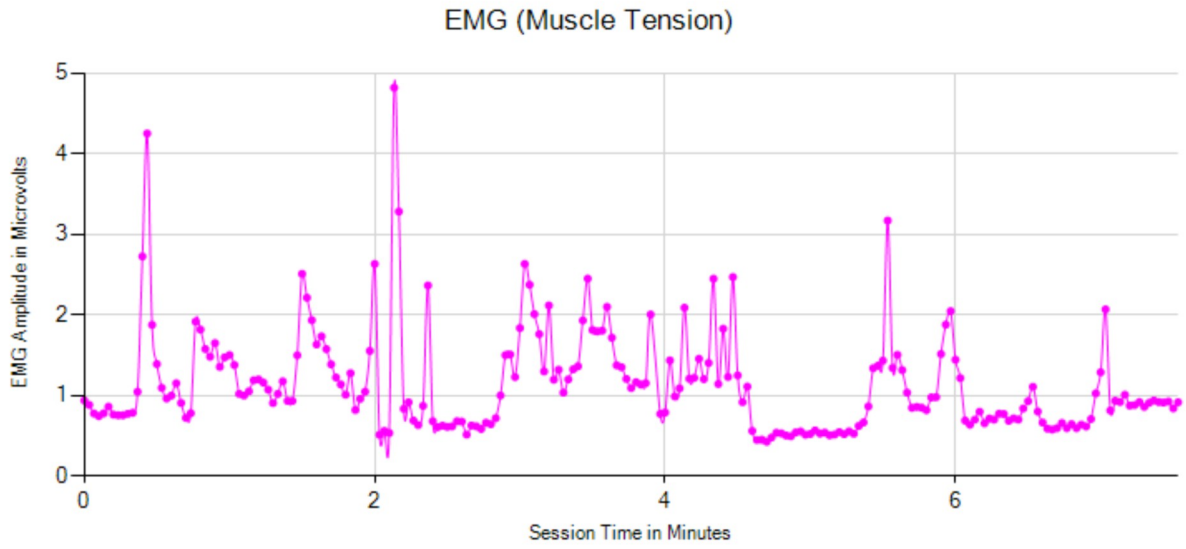


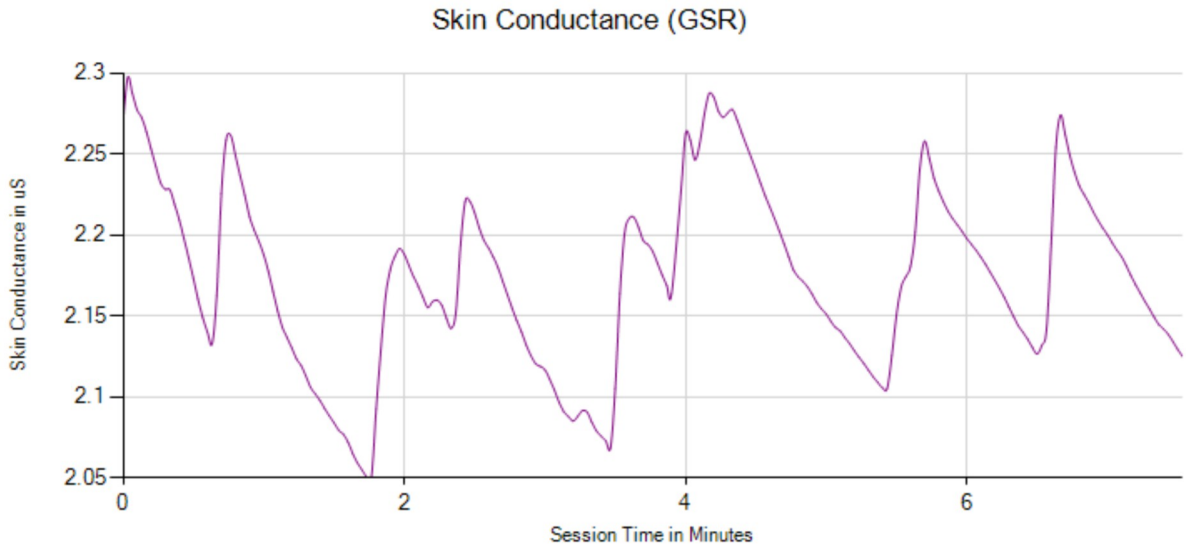
Figure 8 – Report options

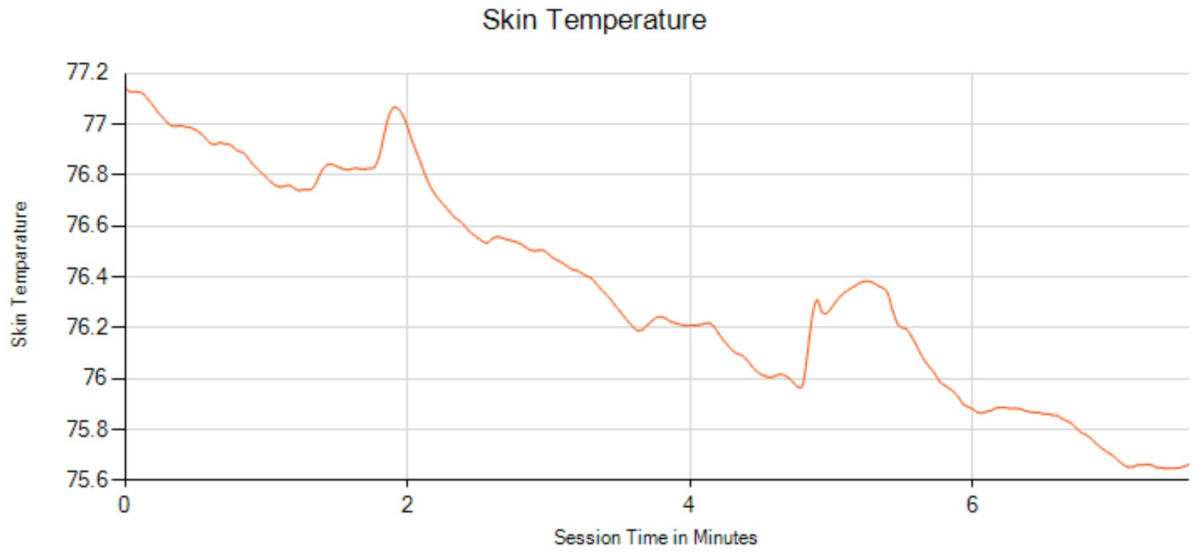
5.3 Sample Session Report

Training Session Report

Training Application	EMG, GSR & Skin Temperature
User Name	Default User
Session Date	29/08/18 16:08







EMG, GSR & ST Summary Data

Parameter	Mean	Start	End	Max	Min	Change
EMG	1.14	0.94	0.92	4.82	0.43	-0.02
Skin Conductance	2.17	2.27	2.13	2.3	2.05	-0.14
Skin Temperature	76.36	77.14	75.66	77.14	75.65	-1.48

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 4 in figure 1. A dialog window opens in which you can select various options (see figure 9).

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. chrome or firefox. (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.

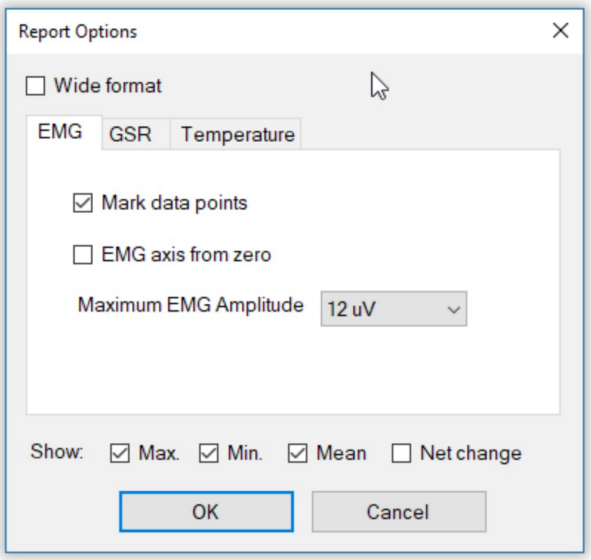


Figure 9 – Report options

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 EMG, GSR & ST application that means three charts, one for each parameter. For each chart you can opt for line graphs for the maximum, minimum, mean and standard deviation. The line graphs have one point per session.