BioGraph® INFINITI

Reference Manual

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For use with BioGraph® INFINITI version 6.2.1 or later

CLASSIFICATION

- Type BF Equipment
- Internally powered equipment
- Continuous operation

- Read Instruction Manual

CAUTION

- US Federal Law restricts this device to sale by or on order of licensed health care practitioners.

WARNING

- Do not operate active sensor within 10 feet (3m) of an operating cellular phone, similar radio transmitting device, other powerful radio interference producing sources such as arc welders, radio thermal treatment equipment, x-ray machines or any other equipment that produces electrical sparks.
- All encoders are totally isolated from line (110 or 220VAC) power due to battery operation and fiber optic connections to computers. However, many hospitals and the FDA require that computers, printers and any other equipment used with medical devices be electrically isolated from line voltage to UL or CSA medical safety standards.
- Do not connect inputs or outputs of the encoder or sensors to line powered devices, except through the fiber optic cable.
- The PC used with the encoder must be placed outside the patient/client environment (more than 3 meters or 10 feet) or the PC must comply with EN60601-1.1 (system safety).
- After use, the disposable electrodes may be a potential biohazard. Handle and, when applicable, dispose of these materials in accordance with accepted medical practice and any applicable local, state and federal laws and regulations.
- To diminish the risk of spreading communicable diseases, always use good hygiene practices with reusable electrodes, particularly if abrasive substances are used. In all cases, refer to your facility's infection control procedure.
- Do not use in the presence of a flammable anesthetic mixture with air or with Oxygen or Nitrous Oxide.
- Not to be immersed in water.
- Take care in arranging patient and sensor cables to avoid risk of patient entanglement or strangulation.
- The operator is responsible for ensuring the safety of any devices controlled or triggered by Infiniti equipment or software, or by any software or hardware receiving data from Infiniti equipment. Infiniti equipment must not be configured or connected in such a way that failure in its data acquisition, processing or control functions can trigger patient feedback stimulus that poses an unacceptable level of risk.
- Use of any equipment in a biofeedback context should be immediately terminated upon any sign of treatment-related distress or discomfort.
- Not to be connected to a patient undergoing MRI, Electro surgery or defibrillation.

ATTENTION

- To prevent static discharge from damaging the sensor and/or encoders, use antistatic mats or sprays in your working area. A humidifier may also be used to help prevent static environments by conditioning hot, dry air.
- Not for diagnostic purposes. Not defibrillator proof. Not for critical patient monitoring.
- To prevent voiding warranty by breaking connector pins, carefully align white guiding dot on sensor plug with slot on sensor input.
- Make sure to remove electrodes from sensor snaps immediately after use.
- Apply conductive gel only to electrodes; never put gel directly on sensor snaps.

- Always use electrodes between the subject and the sensor.
- Sharp bends or winding the fiber optic cable in a loop smaller than 4 inches (10cm) may destroy the cable.
- A fiber optic cable not fully pushed into its receptacle may cause the unit not to operate; make sure that both ends of the cable are fully inserted into their receptive jacks and the nut is tightened firmly.
- Do not plug third party sensors directly into instrument inputs. Plug only Thought Technology active sensor cable connectors into instrument inputs. All electrodes and third party sensors must be connected to active sensors, either directly or through an adapter.
- Remove batteries when the device is not being used for extended period of time. Please dispose of battery following national regulations.

INTENDED PURPOSE

- Biofeedback, relaxation and muscle re-education purposes.

CONTRAINDICATIONS

- None.

NOTE

- No preventative inspections required; maintenance must be performed by qualified personnel.
- The supplier will make available, upon request, circuit diagrams, component parts lists and description or other information required for the repair of product by qualified personnel.
- If a fiber optic or patient cable is damaged or breaks, please replace it.
- Due to the essential performance and intended use of the device, testing for immunity to electromagnetic disturbances was not required and was not performed. The device may be susceptible at levels below IEC60601-1-2 immunity test levels.
- The operator must be familiar with typical characteristics of signals acquired by this equipment, and be able to detect anomalies in the acquired signal that could interfere with treatment effectiveness. Depending on the importance of signal integrity, it may be advisable to continuously monitor the raw signals, in time and/or frequency domain, while the device is being used for biofeedback or other purposes. If anomalies are observed on acquired signals, and if you suspect a problem with electromagnetic interference, contact Thought Technology for a technical note on identification and remediation.

MAINTENANCE AND CALIBRATION

- Wipe encoder with a clean cloth.
- Factory testing and calibration ensure equipment accuracy and frequency response. The user may invoke a self-calibration function that will recalibrate certain device parameters (see section in hardware manual). Contact Thought Technology for factory recalibration if necessary.

STORAGE

- Store in its original case.
- Temperature — -23 to +60C (-9.5 to 140F)
- Humidity (Non-condensing) — 10% to 90%
- Atmospheric Pressure — 70 to 106 kPa

TRANSPORTATION

- Transport in its original case.
- Temperature — -23 to +60C (-9.5 to 140F)
- Humidity (Non-condensing) — 10% to 90%
- Atmospheric Pressure — 70 to 106 kPa

Guidance and manufacturer's declaration - electromagnetic emissions		
The Infiniti system is intended for use in the electromagnetic environment specified below. The customer or the user of the Infiniti system should assure that it is used in such an environment.		
Emissions test	Compliance	Electromagnetic environment - guidance
RF emissions, CISPR 11	Group 1	The Infiniti system uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions, CISPR 11	Class B	The Infiniti system is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions, IEC 61000-3-2	Not applicable	
Voltage fluctuations/flicker emissions IEC 61000-3-3	Not applicable	

360 Suite SA8022

Manual No. SA8023 Rev. 1 (June 2019)

Contents

360 Suite Reference Manual

Introduction

Welcome to the reference manual for the 360 Suite. This manual provides information intended to help you get the most out of your system.

The 360 Suite is a set of physiological monitoring, physiological assessment and self-regulation training tools that you can use to incorporate psychophysiology techniques into your practice. It is organised by physiological system to help you select the appropriate assessment or training tool.

The suite is available for three Thought Technology encoders: ProComp Infiniti, ProComp 5 and ProComp 2. The illustrations shown in this manual are from the ProComp Infiniti package. If you are using ProComp 5 or ProComp 2, you will notice differences in some screens and on-screen instructions but the overall usage instructions are the same.

About this manual

The manual is organized into chapters as follows.

First Time Run: Explains how to start the BioGraph Infiniti software and verify its settings prior to using it for the first time. Describes how to activate the 360 Suite after it has been installed.

Hardware Set-Up: Provides general information about the encoder, sensors and accessories included with the system. It also shows how to connect the hardware elements.

Software Overview: Introduces the main functions of BioGraph Infiniti: recording, replaying, and reviewing sessions. It discusses the analytical processes of statistics calculation and report generation.

Using the 360 Suite: Describes biofeedback, explains the structural grouping of the modalities, and provides details about the 360 Suite components, including screens and Quick Starts.

Hardware Specifications, **Warranty**, **Technical Support and Contacts:** These sections provide specifications for encoders and sensors, and information about the warranty, contacting Thought Technology, and returning equipment for repair, if necessary.

About the 360 Suite

The 360 Suite was designed with a number of priorities in mind, each intended to help you integrate biofeedback and neurofeedback into your practice with ease.

Clinically relevant: The 360 Suite is designed from a clinical perspective and its biofeedback and neurofeedback tools are arranged and organised in a way that parallels clinical thinking. This makes locating the best tool for the task as intuitive as possible and greatly reduces the initial learning curve.

Easy to understand and use: The 360 Suite doesn't assume a high level of experience with physiological monitoring and biofeedback equipment and technical jargon was kept at a minimum.

Complete but efficient: The 360 Suite provides a complete set of tools to allow you to evaluate, monitor and train conscious and autonomic physiological responses. Training screens, data review screens and reports are kept simple to avoid clutter.

Broadly useful: The majority of biofeedback systems on the market only show the physiological information that is the focus of the training. The 360 Suite is designed to expand the range of monitored physiological changes to interrelated factors. When working with heart rate variability, for example, the clinician can watch how arousal and hand temperature are affected by the training.

With the various tools provided by the 360 Suite, you can perform specific clinical tasks, including:

1) **Do physiological monitoring**: Get the broadest and fullest perspective on your clients' unconscious physiological processes during therapy or while practicing relaxation exercises.
2) **Run physiological assessments**: Evaluate your client's reaction to mild stressors and ability to recuperate from them. Determine what breathing rate favors maximum heart rate variability. Get a quick view of your client's dominant brainwave frequencies over any EEG location.
3) **Train self-regulation skills**: Based on your evaluation of the presenting complaint, decide what body systems are most affected and select the most appropriate treatment protocol.
4) **Teach relaxation skills**: Select the biofeedback-assisted relaxation training session (BART) that will benefit your client most (based on the most affected body system) and have him practice as often as possible.

First Time Run

Starting the program

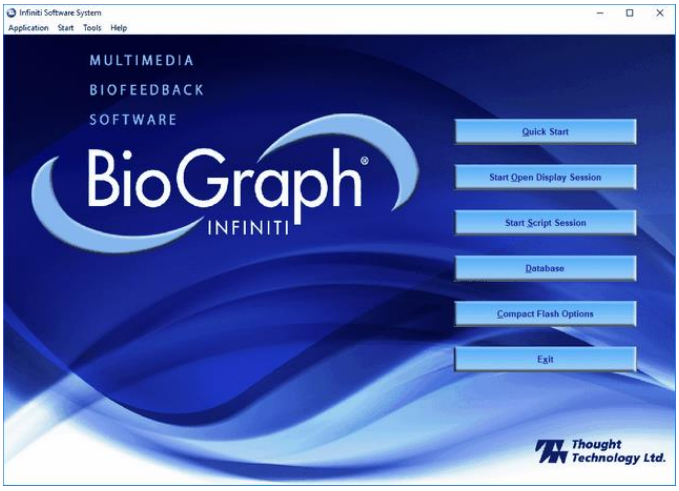
To start the program, double-click on the BioGraph Infiniti icon on the Desktop.

The program always starts by showing the Main Menu screen.

From here you can record sessions, replay or review recorded sessions, maintain session and client information, or manage session data recorded on a Compact Flash memory card.

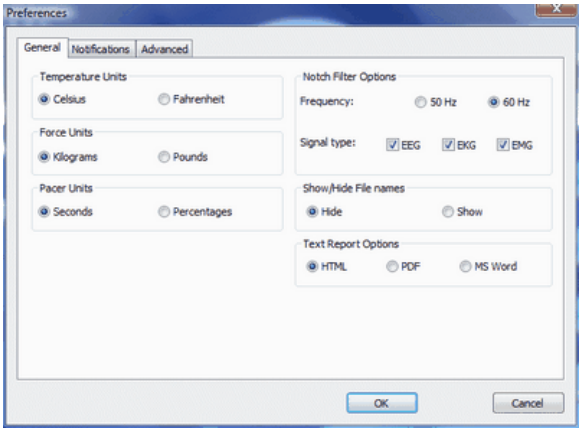
You can also set global settings that affect the performance of BioGraph Infiniti.

It takes only a few minutes to configure your system.



Setting preferences

To manage global settings for your BioGraph Infiniti system, select **Preferences** from the **Tools** menu in the Main Menu Screen.



In the **General** tab you can select values for the following global settings. These settings affect all channel sets.

Note: *Global settings remain in effect unless you change them.*

Temperature, Force, and Frequency

Default values for these settings are determined from your computer's Regional Settings at the time BioGraph Infiniti is run for the first time. If necessary, you can modify them; they are not automatically reset.

Notch filter

A notch filter removes the specific frequency caused by electrical interference from a raw signal. The signals that are susceptible to electrical interference are EEG, EKG and raw EMG. Default values are determined from your computer's Regional Settings when BioGraph Infiniti is run for the first time. If necessary, you can modify them.

Text report options

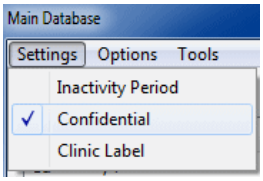
You can generate text reports in one of three different formats, **HTML**, **PDF**, or **Microsoft Word**. Select your preferred format here.

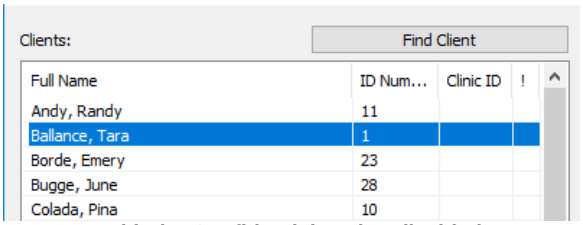
***Note**: Microsoft Word, a PDF reader, and a web browser **must** be installed on your system for these functions to work. You print and save text reports using the **Print** and **Save** functions of the appropriate software.*

Confidential setting

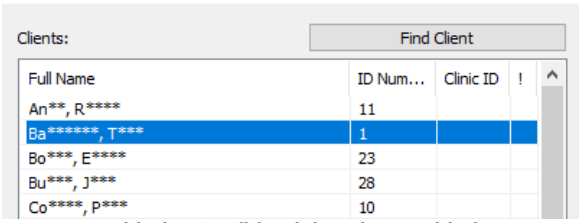
Optionally, enable the **Confidential** setting. This helps protect the privacy of your clients by masking their names in the client database.

- Click **Database** to open the Main Database window.
- From the **Settings** menu, select **Confidential**. The check mark indicates that the setting is enabled.
- If you need to disable the **Confidential** setting, repeat these steps to remove the check mark.





With the *Confidential* setting disabled

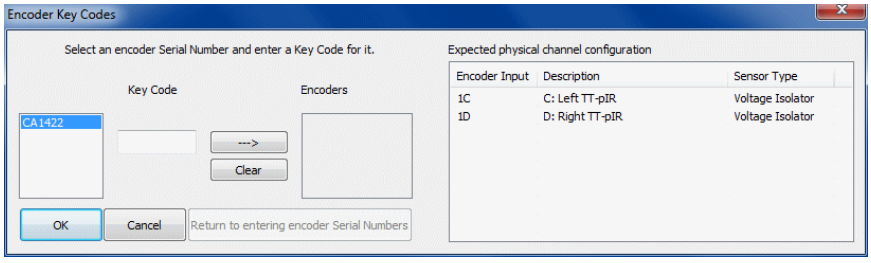


With the *Confidential* setting enabled

Entering key codes

The first time you start to record a session with BioGraph Infiniti, the software will check for the key codes and ask you to enter them. You will also be asked to enter key codes if you have uninstalled and reinstalled the software, or if this is the first time you are using your encoder with your existing installation.

1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Click **Quick Start**, select a name from the **Clients** list and a protocol from the **Favorites** list, and then click **OK** to open the **Encoder Key Codes** dialog box.
3. Click to highlight your unit's serial number in the left table (in this example, CA1422; this is the same number as on the back of the unit).

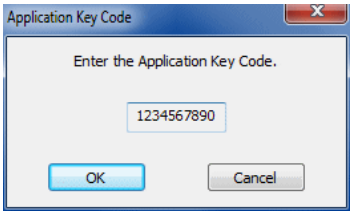


ProComp2

ProComp5 / ProComp Infiniti

4. Enter the **Encoder Key Code** (found inside the encoder battery compartment) in the **Key Code** text box.
5. Click ---> to move the serial number from the left table to the right table. The serial number should now appear in the **Configuration Table**.
6. When done, click **OK**.
7. Now the **Application Key Code** dialog box opens.
8. Enter the **Application Key Code**.

   This number is found in the battery compartment with the encoder key code.
9. When done, click **OK**.



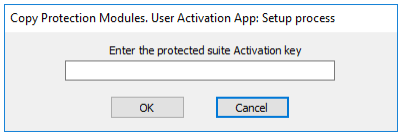
Note: *Even if you are using more than one encoder, you need to enter only one Application Key Code.*

If the key codes have been entered properly and there is no problem with your encoder setup or your sensor connections, the recording screen will open.

Activating the 360 Suite

After you have entered the key codes (as described in the previous section) for the encoder that you will use with the 360 Suite, activate the suite by following these steps:

1. Open the **BioGraph Infiniti Docs & Editors** folder.
2. Double-click the icon **1st time activation of suite**; the **User Activation App** window opens.



3. Enter the **Activation key** for the encoder and click **OK**.
4. At the acknowledgement prompt, click **OK**.

Registering additional encoders

After you activate the 360 suite for a specific encoder, you can register additional encoders for use with the suite. This is done from the User Activation App inside BioGraph Infiniti.

Note: *You must have a unique activation key for each encoder that you want to register. To get activation keys, provide Thought Technology (or your local dealer) with the serial number of each encoder to be registered.*

Before registering an encoder:

1. Obtain an activation key for the encoder from Thought Technology or from your local dealer.

2. Use the encoder to record a session with BioGraph Infiniti.

To register the encoder:

1. Open BioGraph Infiniti and from the **Tools** menu, select **Protected Suites**.

   The User Activation App window opens, listing activated protected suites and serial numbers of encoders for which the suite has been registered.

2. Select the suite from the list.
3. In the **Activation key** field enter the activation key for the encoder, and click **Activate**.

Hardware Setup

This section of the manual describes briefly how to connect the encoder and sensors, the channel configuration for each encoder type, and how to place the sensors on the client.

Note: *Illustrations in this section show the ProComp2 and ProComp5 Infiniti encoders. The ProComp5 Infiniti and ProComp Infiniti encoders are physically very similar. Detailed information about your specific encoder is provided in the device's hardware manual.*

Connecting the TT-USB to the encoder

ProComp2

Insert one end of the fiber optic cable carefully into the fiber optic port on the encoder as far as it will go. Tighten the nut gently so that the cable won't slip out.

ProComp5 / ProComp Infiniti

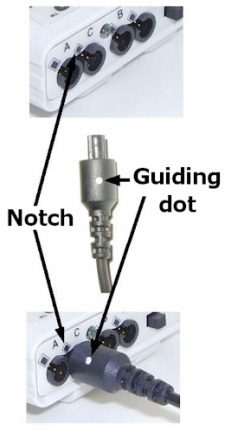
Do the same with the other end of the fiber optic cable and the fiber optic port of the TT-USB interface unit.

Insert the small connector of the USB cable into the USB port on the TT-USB interface device.

Insert the large connector of the USB cable into the USB port of your PC.

USB ports on a PC are generally located at the back of the base unit. You may also find a USB port at the front of your base unit; you can connect the other end of the USB cable to it. On a laptop, USB ports are usually located at the side or the back of the laptop. We recommend always using the same USB port for connecting the TT-USB to your computer.

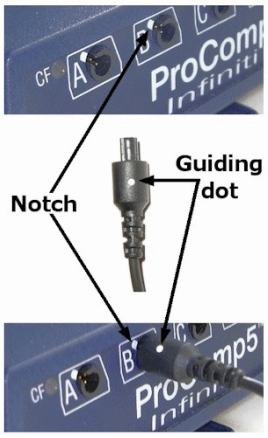
Connecting the sensors



ProComp2

Thought Technology encoders and sensors use specially designed connectors that have all metallic surfaces recessed within the plastic casing. These connectors, with protected pins, require care when you are plugging and unplugging sensor cables to the encoder or an extender cable to the sensor head.

When connecting a sensor cable to the encoder, make sure to properly line up the guiding dot on the top of the plug with the notch in the encoder input socket, as shown in the illustration. Forcing the plug into the jack in any other position may damage your equipment.



ProComp5 / ProComp Infiniti

Sensor configurations

Each encoder type has a different number of input sockets and therefore a different sensor configuration.

ProComp Infiniti encoder

When recording a session with the ProComp Infiniti encoder, use the following sensor configuration:

All body systems

- Input A: Finger pulse (BVP-Pro/Flex) or heart beat (EKG-Flex/Pro)
- Input B: Muscle tension (MyoScan)
- Input C: Brain waves (EEG-Z)
- Input D: Arousal (SC-Flex/Pro)
- Input E: Hand warming (Temperature)
- Input F: Respiration
- Input G: Forehead temperature (left TT-pIR)
- Input H: Forehead temperature (right TT-pIR)

CNS - 2 EEG

When recording a session with the ProComp Infiniti encoder and two brainwave sensors (2 EEG), connect them as follows:

- Input C: Brain waves (left EEG-Z)
- Input D: Brain waves (right EEG-Z)

ProComp5 Infiniti encoder

When recording a session with the ProComp5 Infiniti encoder, depending on the combined body systems, use either:

ANS and Cardiovascular

- Input A: Finger pulse (BVP-Pro/Flex) or heart beat (EKG-Flex/Pro)
- Input B: Muscle tension (MyoScan)
- Input C: Arousal (SC-Flex/Pro)
- Input D: Hand warming (Temperature)
- Input E: Respiration

CNS & Cardiovascular

- Input A: Finger pulse (BVP-Pro/Flex) or heart beat (EKG-Flex/Pro)
- Input B: Brain waves (EEG-Z)
- Input C: Forehead temperature (left TT-pIR)
- Input D: Forehead temperature (right TT-pIR)
- Input E: Respiration

ANS & CNS-EEG

- Input A: Brain waves (EEG-Z)
- Input B: Muscle tension (MyoScan)
- Input C: Arousal (SC-Flex/Pro)
- Input D: Hand warming (Temperature)
- Input E: Respiration

ANS & CNS-pIR

- Input A: Forehead temperature (left TT-pIR)
- Input B: Forehead temperature (right TT-pIR)
- Input C: Arousal (SC-Flex/Pro)
- Input D: Hand warming (Temperature)
- Input E: Respiration

CNS - 2 EEG

When recording a session with the ProComp5 Infiniti encoder and two brainwave sensors (2 EEG), connect them as follows:

- Input C: Brain waves (left EEG-Z)
- Input D: Brain waves (right EEG-Z)

ProComp2 encoder

When recording a session with the ProComp2 encoder, depending on the body system, use either:

CNS-EEG (1 or 2 EEG)

- Input A: Brainwaves (left: integrated EEG sensor)
- Input B: Brain waves (right EEG-Z)

CNS-pIR

- Input C: Forehead temperature (left TT-pIR)
- Input D: Forehead temperature (right TT-pIR)

Cardiovascular

- Input B: Finger pulse (BVP-Pro/Flex) or heart beat (EKG-Flex/Pro)
- Input C: Respiration

ANS

- Input C: Arousal (SC-Flex/Pro)
- Input D: Hand warming (Temperature)

***Note**: There is no option for muscle tension (EMG) for the ProComp2 encoder because the MyoScan sensor is not compatible with it.*

Sensor placement

Finger pulse

The BVP-Flex/Pro sensor measures blood volume pulse, from which we calculate heart rate and heart rate variability values.

Placement

The BVP sensor does not require skin preparation as it is placed directly in contact with the skin. Place the sensor against the fleshy part of the first joint of any finger and hold it in position using theVelcro strap.

Heart beat

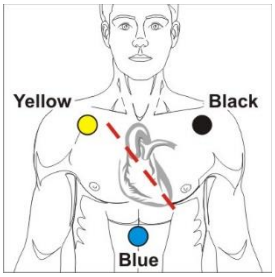
The EKG-Flex/Pro measures heart beat, from which we calculate heart rate and heart rate variability values.

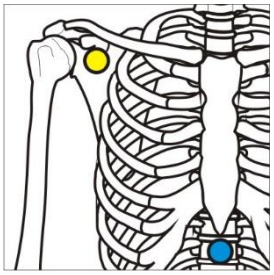
Skin preparation

For any recording where signal quality matters, good skin preparation is important to get a clean signal and avoid artifacts. Before applying the EKG electrodes, make sure the skin surface is clean and dry by rubbing it with an alcohol pad. Abrading the skin with an abrasive cream, such as NuPrep, can also help. If necessary, shaving excess body hair can be required.

Chest placement

The ideal electrode placement for detecting EKG is a triangular configuration on the chest where the yellow and blue electrodes are parallel with the heart's main axis (see illustration). The yellow and black electrodes should be placed over the right and left coracoid processes, respectively, and the blue electrode over the xiphoid process.

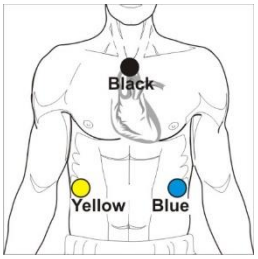




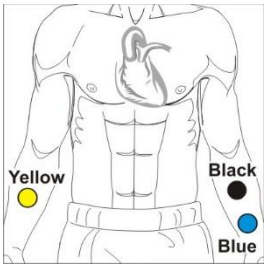
Abdominal placement

Since some clients may find the idea of exposing their chest area uncomfortable, an acceptable alternative is to place the electrodes on the abdomen.

Ask the client to lift their shirt and place the yellow electrode below the ribs on the right and the blue electrode at the same level on the left. The black electrode can go anywhere, but a good location is the upper sternum area.



Arm placement



An easier electrode placement uses the forearms, as indicated in the illustration. The yellow electrode is on the right arm and the other two are on the left arm.

Ideally, an area with little or no hair is preferred. The arm placement is more susceptible to artifacts, particularly interference caused by arm and chest muscle activity.

Wrist placement

The forearm electrode placement requires the use of an extender cable with longer leads like the one that is sold with the **EKG Wrist straps (SA9325)**. The wrist straps provide the easiest placement method for EKG signal detection.

Muscle tension

The MyoScan sensor measures electromyographic signals (EMG), which show the amount of activation or relaxation in a muscle.

Skin preparation

Proper skin preparation is important to get a good signal and avoid artifacts.

Before applying electrodes, make sure the skin surface is clean and dry:

Abrade the skin with an abrasive cream, such as NuPrep, to remove dead skin. Alternatively, you can also clean skin with an alcohol wipe and let it dry, but this is not as efficient as the abrasive cream. If necessary, shave excess body hair.

Electrode placement

Electrodes are either directly connected to the sensor, or indirectly connected via an extender cable.

If you use single electrodes with an extender cable, start by snapping the electrodes onto the cable connectors. Once the electrodes are positioned on the skin, this action may be more difficult or uncomfortable for the client.

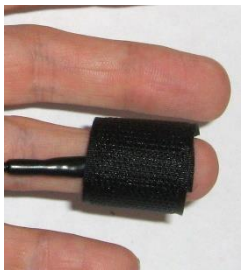
Place the active electrodes first (blue and yellow) on the examinee. The active electrodes should be placed in line with the muscle fibers, unless specified otherwise. Then place the reference electrode (black connector) anywhere on the body.

Make sure the electrodes are placed firmly on the skin and that there is good contact between the skin and electrodes.

It may be recommended to put conductive electrode paste or cream (such as Ten20) on the center of electrodes (grey area only) before applying them to the skin. Only a small amount is necessary.

Hand warming

The Temperature sensor measures finger temperature, which reflects how peripheral vasodilation is affected by stress.



Placement

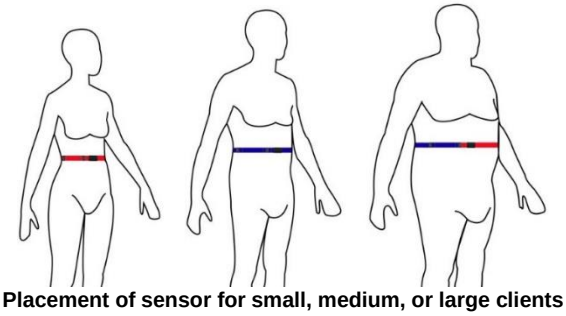
The temperature sensor can be strapped to the dorsal or palmar side of any finger or toe using the short strip of Velcro that is provided with the sensor. Remember to clean the thermistor bead with an alcohol wipe between clients.

Respiration

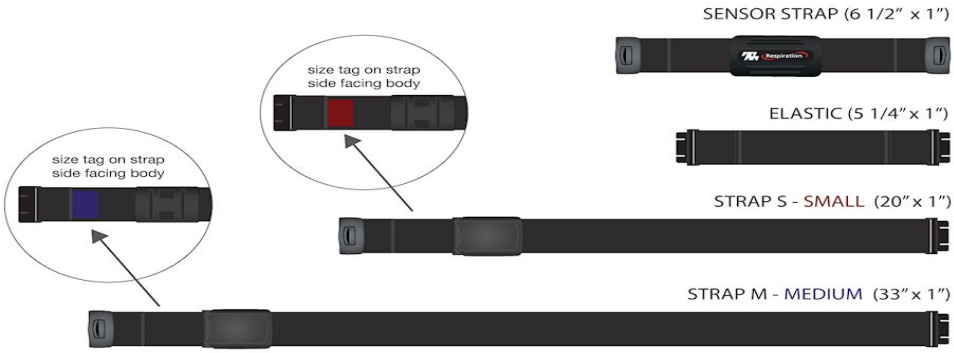
The Respiration sensor measures breathing amplitude, from which we calculate breathing rate and measure how breathing affects heart rate.

Placement

For most applications, placing one sensor around the abdomen is required. The three straps (respiration sensor strap, elastic strap, and belt strap) are buckled together, and then placed around the client's torso.



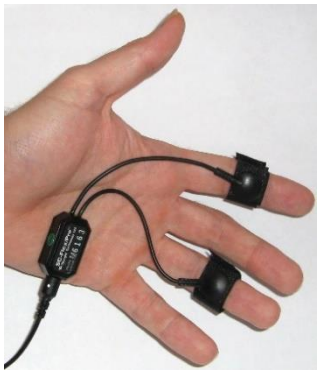
Placement of sensor for small, medium, or large clients



Select the appropriate belt strap length to fit the client. Belt straps come in small (red label) and medium (blue label) sizes. For clients who need a large or extra-large strap length, combine two belt straps.

Arousal

The SC-Flex/Pro sensor measures skin conductance, an indicator of how apocrine sweat glands are activated by stress.



Placement

The skin conductance sensor has two short leads that extend from the circuit box. At the end of each lead is an electrode snap similar to those on the extender cables. The GSR sensor uses two replaceable electrodes that are sewn inside Velcro straps. The electrode strap must be fastened around a finger tightly enough so the electrode surface is in contact with the finger pad but not so tightly that it limits blood circulation. No conductive paste should be used on the electrodes. Remember to clean the electrodes with an alcohol wipe between clients. These AG/AG/CL electrode snaps should be replaced after about 50 uses or when wear is apparent.

Forehead temperature

Two TT-pIR sensors are used to measure forehead temperature and give an indication of changes in frontal lobe activation.

Placement

The TT-pIR sensors are snapped to the inside of the TT-pIR Headgear (TT-HEG) device.

The headgear is strapped gently to the head, holding the two sensors about 1.5 inches away from the skin, on each side of the midline of the forehead. The soft strap is adjusted so that the sensors sit firmly in place while maintaining maximum comfort.

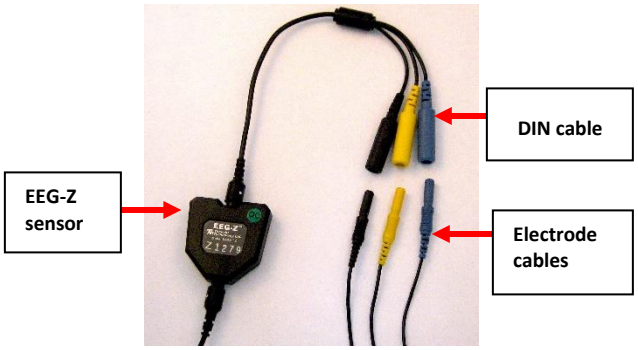
Brain waves

The EEG-Z sensor measures electroencephalographic signals (EEG) and shows how changes in dominant brainwave frequency reflect overall consciousness.

Connect the blue active electrode to the blue DIN cable input.

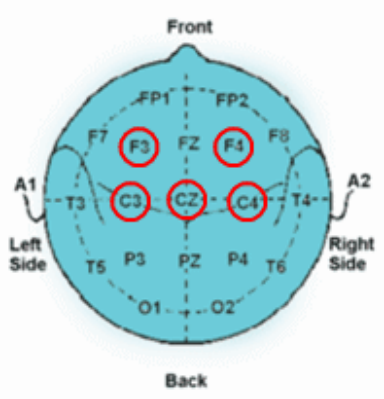
Connect the yellow ear clip to the yellow DIN cable input, and the black earclip to the black DIN cable input.

The other end of the DIN cable plugs into the input of the EEG-Z sensor.



Electrode placement

The ten–twenty (10–20) electrode system of the International Federation is the standard for electrode placement. It is used to place surface EEG electrodes in a repeatable way independent of inter-patient anatomical variability, and is called 10–20 because of the way distances between electrode sites are computed. The distances between certain anatomical landmarks are segmented at increments of 10% and 20% of their value, and electrodes are placed at these points.



Sites most frequently used for EEG are C3, CZ, C4, F3, and F4, as indicated.

To locate site CZ, do the following.

1. Locate the inion.

   On the posterior base of the skull, where the spine meets the skull, there is a small protrusion called the ***inion***. It can be found by running the finger up the spine towards the skull.

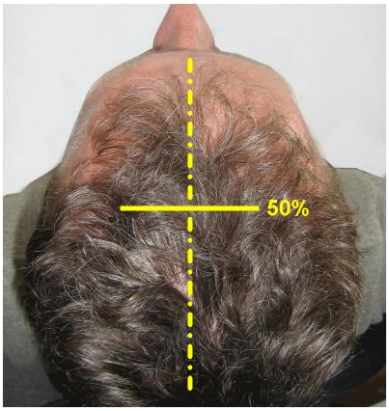
   There is a small crevice between the spine and skull in which vertebrae can no longer be felt. Just above that area is the inion of the skull.

2. Locate the nasion.

   The depression on the bridge of the nose, just below the brow and directly between both eyes, is called the ***nasion***.

   The line between these two points runs along the interhemispheric fissure of the brain (the space that separates the left and right sides of the brain, i.e. right down the middle).

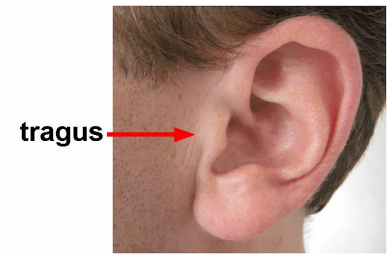
Mark a spot located at 50% of the distance between the nasion and the inion.



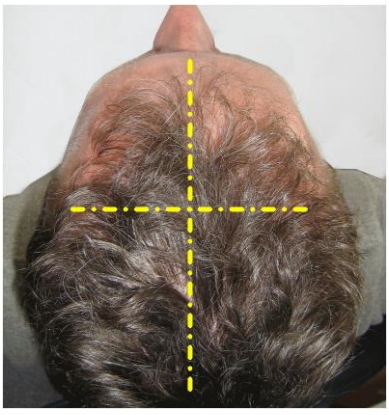
Note: *To simplify locating electrode placement sites, use a flexible tape measure to measure distances.*

3. Locate the mandibular notch on both sides of the head.

   To locate the mandibular notch, place a finger against the tragus, just anterior to the ear, and ask the subject to open their mouth. Your finger should find its way into a cavity, resting superior to the manibular notch. The line that connects the left and right mandibular notches runs along the central sulcus of the brain (the space that separates the frontal and parietal lobes).



   Mark a spot located at 50% of the distance between the left and right mandibular notches. It should intersect directly with the line made between the front and back of the head.



4. The intersection of these two lines is electrode location CZ.

   Along the line between the mandibular notches, 20% of the total distance towards the left is location C3, 20% towards the right is location C4.

Note: *If the total distance from left to right mandibular notch is 36.5 cm, 20% is 7.3 cm.*

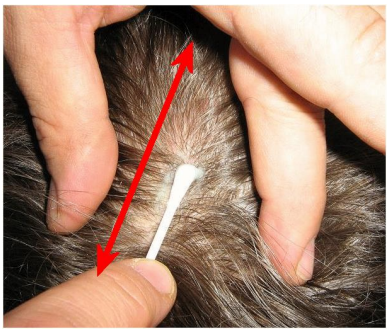
Skin preparation

1. Scoop up a small quantity of NuPrep ™ skin prepping gel on a cotton swab or tissue.

2. With the thumb and index finger of one hand, separate the hair around the electrode site that was previously found and marked.

3. Rub the gel in the direction of the natural line formed along the scalp by the split hair.

   Some light force must be used, enough to redden the scalp slightly, but not enough to break the skin.



4. Wipe away the excess prepping gel with a dry, lint-free cloth.

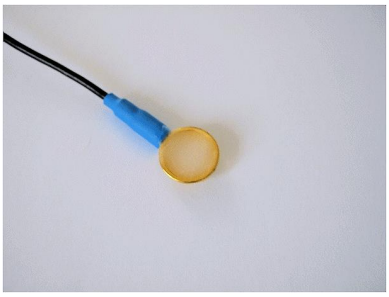
   Take care to keep the hair parted and to keep track of the site after wiping clean.

5. With the tip of your finger, smear a small amount of Ten20™ Conductive paste on the newly prepared site.

   This has the combined effect of keeping track of the site, keeping the hair neatly out of the way, and acting as a landing pad for the electrode once it is ready to fix.

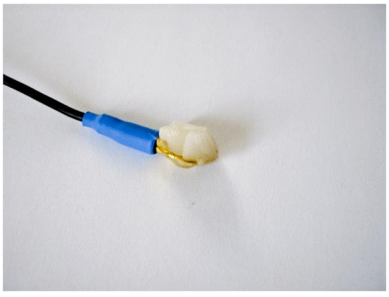
Electrode preparation

1. Fill the electrode cup with Ten20 ™ conductive paste so that no air bubbles exist in the cup.



2. Add more Ten20 paste onto the cup electrode, just enough to form a ball on the cup, not so much that it spills over the edge.

   Shown is the ideal amount of paste.

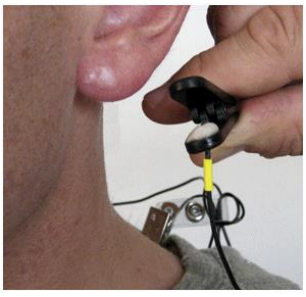


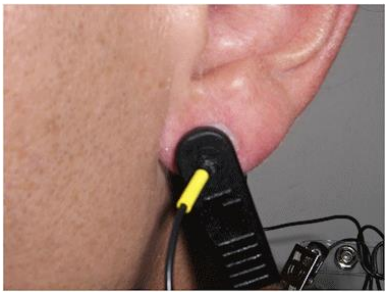
3. Place the cup face down on the landing pad previously prepared and gently push the electrode down to fix it to the scalp.

   A little bit of paste should run out along the edge of the cup to form a thin ring around it.

4. Repeat the preparation and placement steps on the ear lobes.

   Do not put too much paste on the ear clip electrode, but ensure that the gold disc is completely covered.



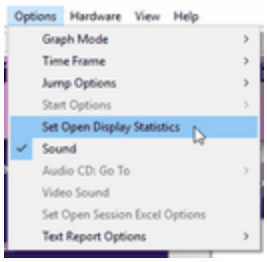


Blood pressure monitor

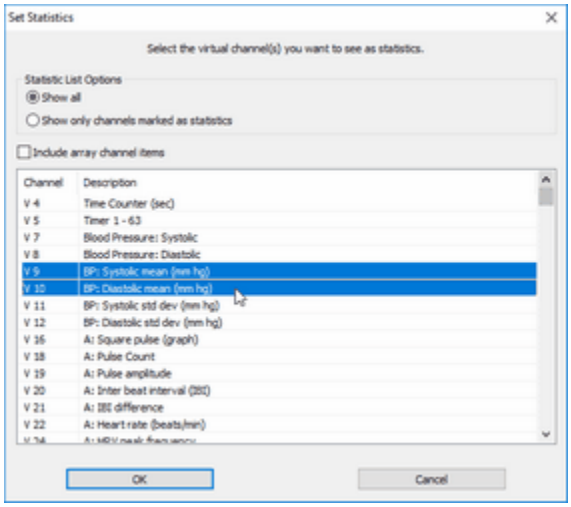
The suite is compatible with the A&D UA-767PC blood pressure monitor device. If the unit is connected to the computer with the A&D USB Smart cable and the cuff is placed on the client, you can trigger a blood pressure reading at any time during a self-regulation session by pressing F11 on your keyboard.

To add mean systolic and diastolic blood pressure values to the list of statistics of self-regulation sessions:

1. From the **Options** menu, click **Set Open Display Statistics**.



2. Press and hold the Control key on your keyboard.
3. Click on **BP: Systolic mean (mm Hg)** and **BP: Diastolic mean (mm Hg)** (channels V9 & V10).



4. Release the Control key and click **OK** to return to the recording screen.

Software Overview

This chapter provides you with an overview of the main functions of the BioGraph Infiniti software.

Although the BioGraph Infiniti software offers a wealth of features, some of them are not described in the 360 Suite manual. If you wish to explore these other features, on-line help and the **Getting Started** manual contain detailed information.

To open the on-line help, press the F1 function key, on your keyboard, from any dialog box in the program. Because the on-line help manual is designed to provide contextual information, it will automatically open at the section that discusses the dialog box from which the help was called.

Recording a session

The 360 Suite contains pre-set sessions which are accessed through the **Quick Start** button on the main BioGraph Infiniti screen. There are quick starts for most common session types, including open display and script sessions.

Quick starts allow you to run sessions with a minimum of mouse clicks. Each one contains all the information needed to run a session, including a list of recording and reviewing screens, a list of statistics and a number of other configuration elements.

1. Connect your encoder to the computer using the fiber-optic cable and the TT-USB Interface.
2. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
3. Place the sensors on the client. (See Sensor placement, starting on page 10.)
4. Launch BioGraph Infiniti.
5. Click the **Quick Start** button on the main screen.
6. If this is the first time you record a session for this client, do the following:
   a. Click **Add New Client** to open the Client Data dialog box.
   b. Type in a **First Name** and **Last Name**. Click **OK** to create the client file. The new client's name is automatically selected.

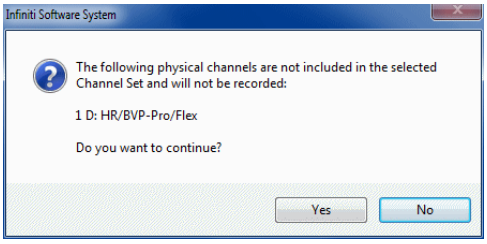
   Otherwise, select the client's name from the list.
7. Select a category from the **Categories** dropdown list.
8. Select a **Favorite** from the list on the right and click **OK**.

   ***Note**: If this is the first time you record a session, please see Entering Key Codes.*
9. Start the recording by clicking on the **Start** button  in the toolbar.

Verifying sensor connections

If there are problems with your sensor connections, the program will report those, prior to accessing the recording screen. If, for example, you have sensors that are connected but are not required for this channel set, you will get a warning message.

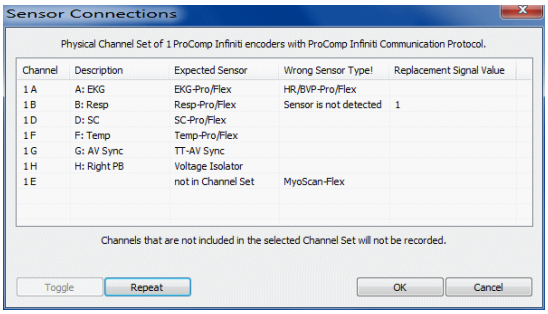
You can remove the sensor if you want, or continue recording by clicking **Yes**. Keep in mind that no data is recorded for sensors that are not defined in the channel set.



***Note**: If there are sensor connection problems in addition to extra sensors, this information won't appear as a separate message. It will display in the Sensor Connections window.*

If you have connected wrong sensor types, you will see the **Sensor Connections** window. All the sensors that are expected will be listed in the **Expected Sensor** column. The **Wrong Sensor Type** column shows which sensor type was actually detected.

You can remove the wrong sensor or replace it with the right one. Click **Repeat** to check the sensor connections again until the system no longer detects a wrong sensor type. The program will not allow you to record a session with the wrong sensors.



***Note**: If the **Wrong Sensor Type** column is empty, the correct sensor has been connected.*

If you do not connect all the sensors that are required for the selected channel set, the message ***Sensor is not detected*** appears in the **Wrong Sensor Type** column. When a sensor is not connected, the program replaces its signal value by a constant value of "1". It is possible to record a session with missing sensors but the corresponding signal will be a flat line. Any calculations based on that signal will not reflect real physiological changes.

Stopping a session

Script sessions end automatically when the script is finished. If you stop a script session before the script has finished running, no data will be saved.

1. To stop recording an open display session, click the **Stop** button: 
2. The program asks if you want to save the recorded data. You can save the session in compressed format but, unless your hard drive has very little space available or you do not need to review the saved sessions, we recommend that you always **Save**, which will use the non-compressed format. Compressed files can't be replayed, reviewed or trended until they are decompressed.
3. Then the **Session Notes** pop-up appears where you can enter, if you want, a treatment code (CPT), a session description and some notes.
4. Click **OK** to continue. Next, you are asked if you would like to review the session right away. You can switch to review mode or replay mode. Only review mode is described here.
5. If you click **No**, the program asks if you want to record another session with the same settings.
6. If you click **No**, the program reminds you to turn your encoder off.
7. Clicking **OK** takes you back to the Main Menu Screen.

Replaying sessions

Replaying a session allows you to play back a recorded session like a movie. More information about replaying sessions is provided in BioGraph Infiniti on-line help and the **Getting Started** manual.

Reviewing sessions

After recording a session you go into review mode to analyze the data. This mode allows you to scroll through graphs, examine the statistics, and create reports displaying the data in graphical and/or statistical form.

You can review the session immediately after recording it and saving the data, or open the session from the Database later by following these instructions.

1. Select **Database** from the main screen.
2. In the **Main Database** window highlight the client whose session you want to review.
3. Select the session from the right-hand table.
4. Click **Review/Report** to open the **Review/Replay Session Confirmation** window.

   When a session has been recorded from a Quick Start, review and report screens are selected by default. To use the default screens, go to Step 5.

   Otherwise, to use different screens to review the session, do the following:

   a. Click **Select Screens**.

   b. Click on the column heading for **Category** to reorder the screens into groups, and scroll down to **Report-Review** category.

   c. Select up to 5 screens and click **OK**.
5. Click **OK** in the **Review/Replay Session Confirmation** window to enter review mode.

Rejecting artifacts

Artifacts are events that are detected by the sensor but not caused by the physiology being monitored. An artifact, in the context of physiological signal recordings, is like the loud noise that is preventing you from listening to your favorite music. Artifacts create distortions in the signal and make it unrecognizable. But because artifacts have similar characteristics to the actual signal, the software can sometimes be confused by them, and either give wrong feedback or make mistakes in the statistical analysis of the signal. Clinicians with experience can minimize the probability of artifacts, but artifacts can never really be completely avoided.

There are multiple sources of artifact. Movement is a very common cause. If the client moves during a session, or the sensor is a bit loose on the client and the sensing area slides on the client's skin, for example, this can cause artificial dips or spikes in the signal. Electrical interference, sudden changes in environmental conditions (such as ambient temperature) or reusing dirty electrodes can also cause artifacts.

Some sensor types may be more susceptible to a specific type of artifact, so for each body-system related signal, the manual includes common sources of artifacts and suggests ways of minimizing them.

The software offers a number of ways of dealing with artifacts, both in real-time – as the recording is occurring – and post-recording, when you are reviewing the data and preparing to generate reports.

- **Real-time artifact rejection** detects artifacts on-the-fly, as they are happening, and temporarily stops some computational processes. Real time artifact rejection is useful, for example, when feedback is given from elaborate calculations and the artifact would cause the software to give the wrong feedback. The calculations pause until the signal becomes normal again. The real-time artifact rejection method is designed for brainwave (EEG) signals.

- **Manual artifact rejection** is used post-recording, at review time. You can scroll through the recorded data, visually inspecting it, and tell the software to ignore stretches of data by placing artifact rejection segments over the bits of signal that are distorted by artifacts. It is important to remove artifacts from recorded physiological data if you intend to generate a report and look at statistics. Statistical analysis that is performed on ***noisy*** signal is unreliable. Manual artifact rejection can be done on any signal type.
- **Review mode auto-rejection** (specifically **Physical Channel Rejection**) is also a post-recording tool. You can specify **normal** upper and lower values for any signal type and ask the software to go through the recorded data and place artifact rejection segments over any stretch of data that is outside the upper or lower thresholds that you defined. Review mode auto-rejection can be done on any signal type.

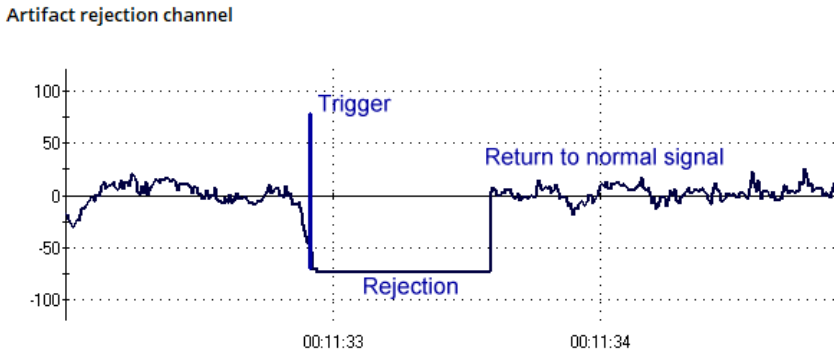
Real-time artifact rejection

The 360 Suite is built with real-time artifact rejection already pre-defined for all brainwave channels. By default, the threshold for rejection is set to +/- 20 microvolts but you can modify this value if you find that the software either doesn't reject enough artifacts or rejects even valid EEG. To modify the rejection thresholds:

1. Click the **Pause** button.
2. Select **Edit Virtual Channel Settings** from the **Edit** menu.
3. Scroll down the list of virtual channels and select virtual channel 110 **C: Eye movement threshold**.
4. Modify the **Input 2 Constant value** and click **Save Changes**.
5. Select virtual channel 113 **C: EMG noise threshold**.
6. Modify the **Input 2 Constant value** and click **Save Changes**.
7. Click **Close** and resume the session.

If you are recording a 2 EEG self-regulation session, modify these virtual channels: virtual channel 5 **Eye movement threshold** and virtual channel 8 **EMG noise threshold**.

While recording the session, if you look at the raw EEG signal that is being recorded, you will occasionally see the signal become a flat line:



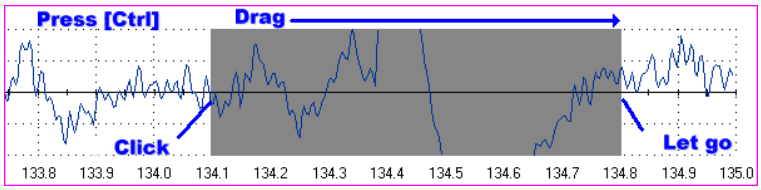
The graph shows how the real-time artifact rejection function works. The raw signal is constantly monitored. If, at some point, the signal goes over the rejection threshold, the function is triggered and the signal becomes a flat line, which tells the software to halt all following calculations. This lasts until the signal returns to normal, at which point the calculations resume.

Although the real time artifact rejection function also works in review mode, the manual artifact rejection method is a more precise way to reject artifact, post-recording.

Manual artifact rejection

Open the recorded session in review mode. First, determine where the recording is most affected by noise. Then place artifact rejection segments at these locations, by following these steps:

1. Select the line graph that contains the segment to be rejected. (Only line graphs can be used for artifact rejection. If you get an error message, select a screen containing a line graph to review the data.)
2. Press and hold the **[Control]** Key.
3. Place the cursor over one end of the rejected segment.
4. Click and hold the left mouse button. (You can release the **[Control]** key at this point.)
5. Drag the cursor across the segment to be rejected; it will be highlighted in gray.
6. Release the mouse button at the end of the segment.



Manual artifact rejection is the cleanest and most precise artifact rejection method provided by the software. It is the recommended method when you need to generate reliable session statistics.

Automatic artifact rejection

When the session is long or when there are too many artifacts to reject, a faster method is provided with the automatic artifact rejection function.

Two options are available, Boolean Rejection and Physical Channel Rejection. The Boolean Rejection method is not recommended for use with the 360 Suite, and is not described here.

Physical Channel Rejection is mostly useful for brainwave channels (EEG). For all other signal types, we recommend the manual rejection method.

Physical Channel Rejection

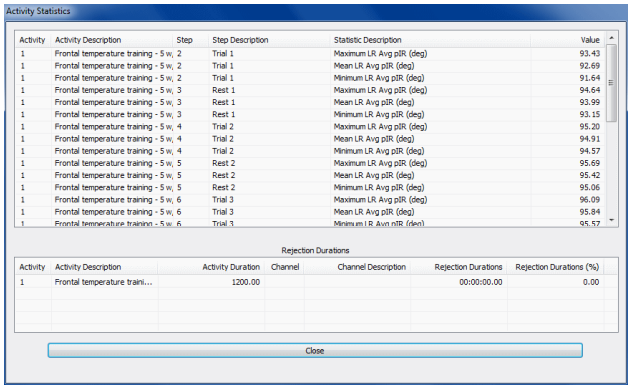
In some cases, artifacts can be rejected directly from the **raw** sensor data channel (such as the EEG signal for brainwaves) but other times, they are rejected from a processed channel (such as EMG RMS for muscle tension). The Physical Channel rejection method is designed for rejecting artifacts directly from the sensor data channel. In general, the method works well for arousal (SC) and temperature but it is most effective when used with EEG channels.

Open the recorded session in review mode.

1. From the **Tools** menu, select **Review Mode Auto-Rejection Settings**.
2. In **Rejection Type**, select **Physical Channel Rejection**. All physical channels in the channel set will be listed.
3. Select the physical channel where you want to set a rejection threshold and, in the **Rejection Threshold** text box, enter a value.
4. For bipolar signal types such as EEG, BioGraph Infiniti takes the absolute value of the rejection threshold. For other signal types, select **Above Threshold** or **Below Threshold**.
5. Click **Set**. If you want to set a rejection threshold for another physical channel, repeat these steps.
6. Click **OK**.

Calculating statistics

1. To calculate statistics for a session, click the **Calculate Statistics** button  in the tool bar. A message confirms that the program is processing session data and then the **Statistics** window opens.
2. Click **Close** to close the window.



***Note**: This is the Statistics window for a script session. The Statistics window for an open display session is similar, but does not display a list of rejection durations for individual activities.*

Generating a session report

In BioGraph Infiniti review mode, you can generate two types of session reports.

- **Excel reports** are predefined and customized to a specific assessment. The 360 Suite includes specialized Excel reports for the Full and Quick Physiological Profiles, as well as for the 2 EEG Single Hertz Bins Assessment.
- **Text reports** include general information about the session as well as optional information (session notes, statistics, markers) that you select. A text report can be generated from any screen which includes line graphs or trend graphs. Text reports can be generated in HTML, PDF, or Microsoft Word format. They can be saved or printed using the **Print** and **Save** functions of the relevant software.

***Note**: Microsoft Word and Excel, a PDF reader, and a web browser **must** be installed on your system for these reporting functions to work.*

To generate a session report, enter review mode in one of two ways.

- Immediately after recording a session (see Stopping a Session). After the session is saved, BioGraph prompts you to switch to review mode.
- From the **Database** window by selecting **Review/Report** (see Reviewing Sessions).

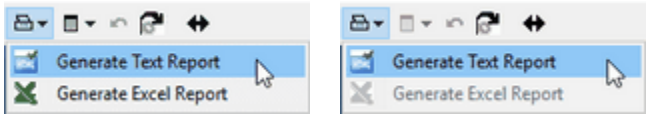
Excel report

1. Click the **Session Report** icon in the tool bar and select **Generate Excel Report**. (If no Excel report is available for the specific session type, this option is disabled.)

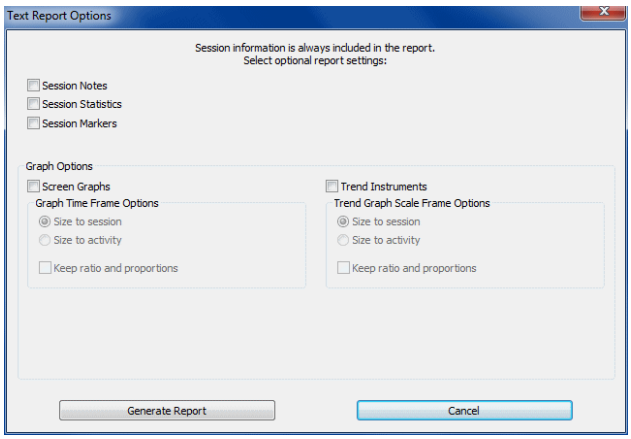
2. Microsoft Excel opens and displays your report as a workbook. You can print or save the report using Excel's **Print** and **Save** functions.

Text report

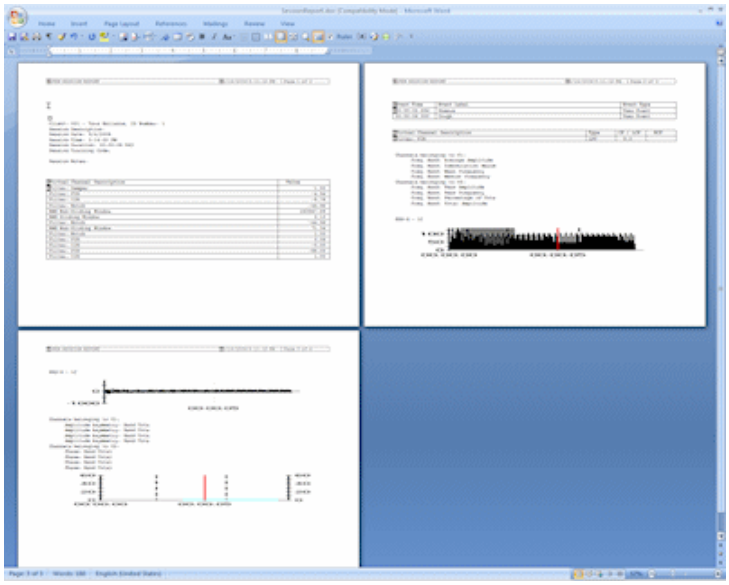
1. If more than one review screen has been loaded, open the screen from which you want to generate the report. Different screens can generate different reports.
2. Click the **Session Report** icon in the tool bar and select **Generate Text Report**. (This option is enabled for all session types.)



3. When the **Session Report** window opens, select report components by placing a check mark in the desired boxes.



4. Click **Generate Report** to generate the report.

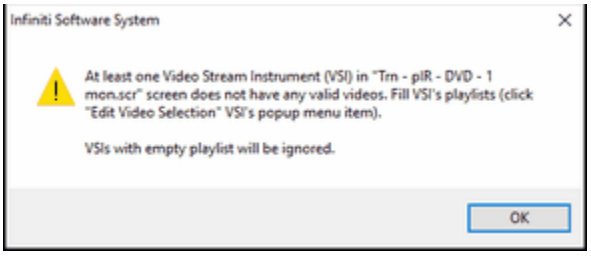


5. Your report displays as a document in HTML, PDF, or Microsoft Word format, depending upon the setting in **Preferences**. The report can be saved or printed using the **Print** and **Save** functions of the relevant software.

Video Stream instrument

The Video Stream instrument allows the user to do feedback while playing a video streamed from certain web links (currently YouTube and Vimeo) or a local file folder.

When you record or replay a session using a screen that includes the Video Stream instrument, the system will warn you if the playlist doesn't contain a video associated with the instrument.

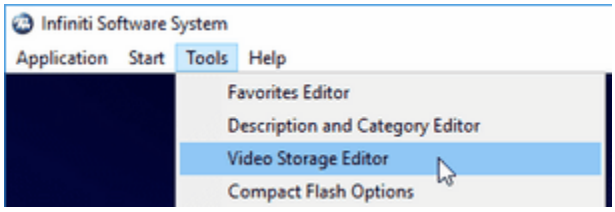


You can associate a video with the instrument or convert the Video Stream instrument to a DVD instrument.

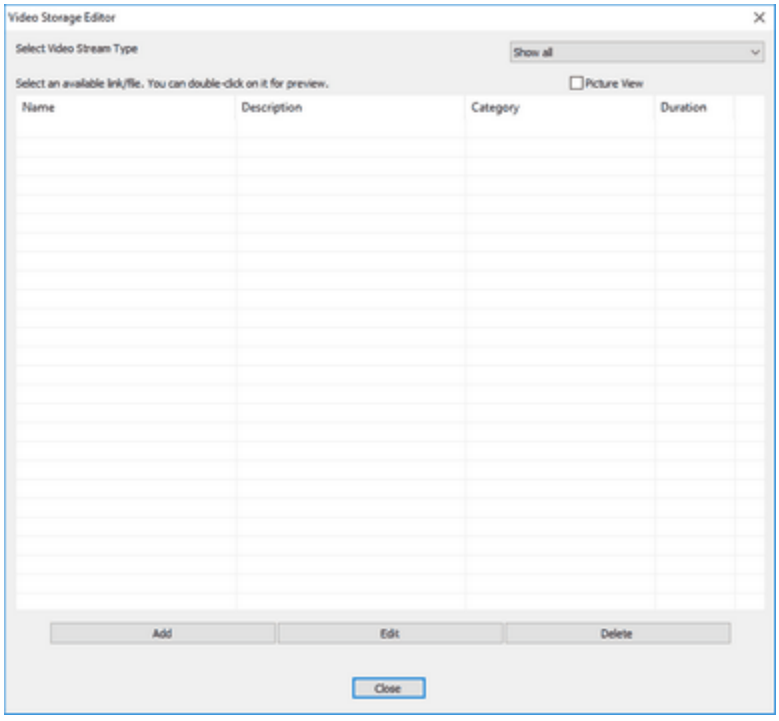
Adding a streaming video to the playlist

This is done from the BioGraph Infiniti main menu screen.

1. From the **Tools** menu, select **Video Storage Editor**.



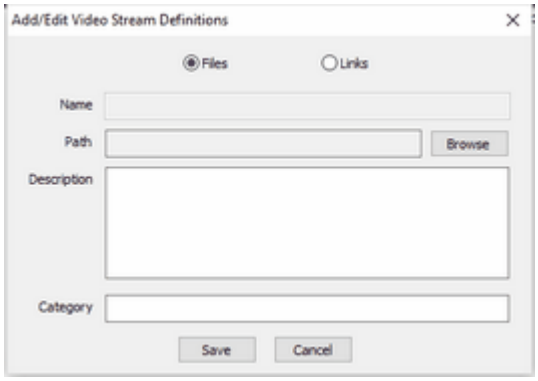
The Video Storage Editor opens.



2. Click **Add**. This opens **Add/Edit Video Stream Definitions**.

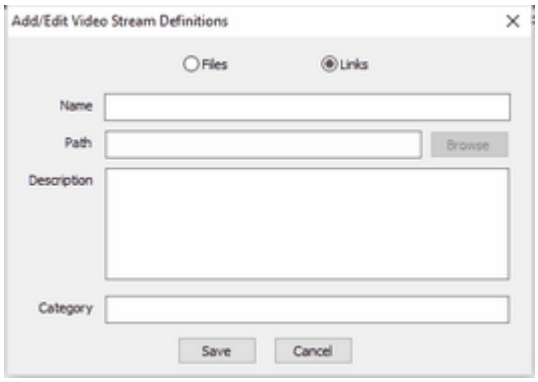
- If your streaming video is a file on your computer:
  a. Select **Files**.
  b. Click the **Browse** button to locate the file.
  c. In the browser window, select the file name and click **Open**.

     The file **Name** and **Path** to the file location are automatically entered in their respective fields.
  d. Optionally, add a **Description** and **Category**.
  e. Click **Save**.



- If your streaming video is from a link to a web site:
  a. Select **Links**.
  b. Enter a file **Name** and in **Path** enter the web address of the video.

     You can copy and paste the web address or type it in.
  c. Optionally, add a **Description** and **Category**.
  d. Click **Save**.

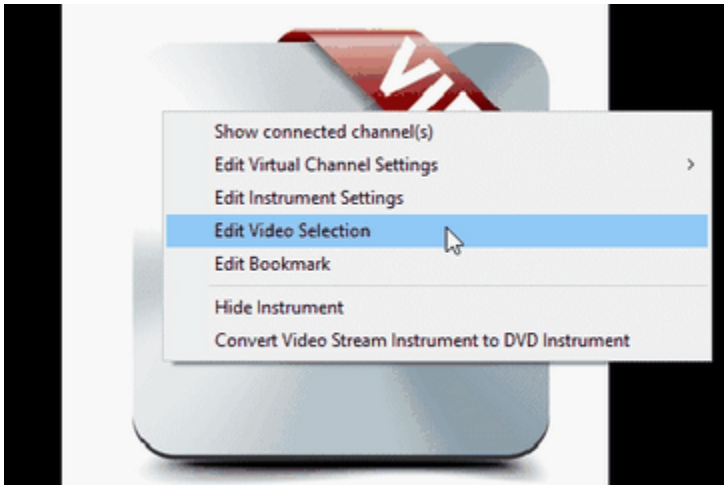


3. Click **Close** to exit the Video Storage Editor.

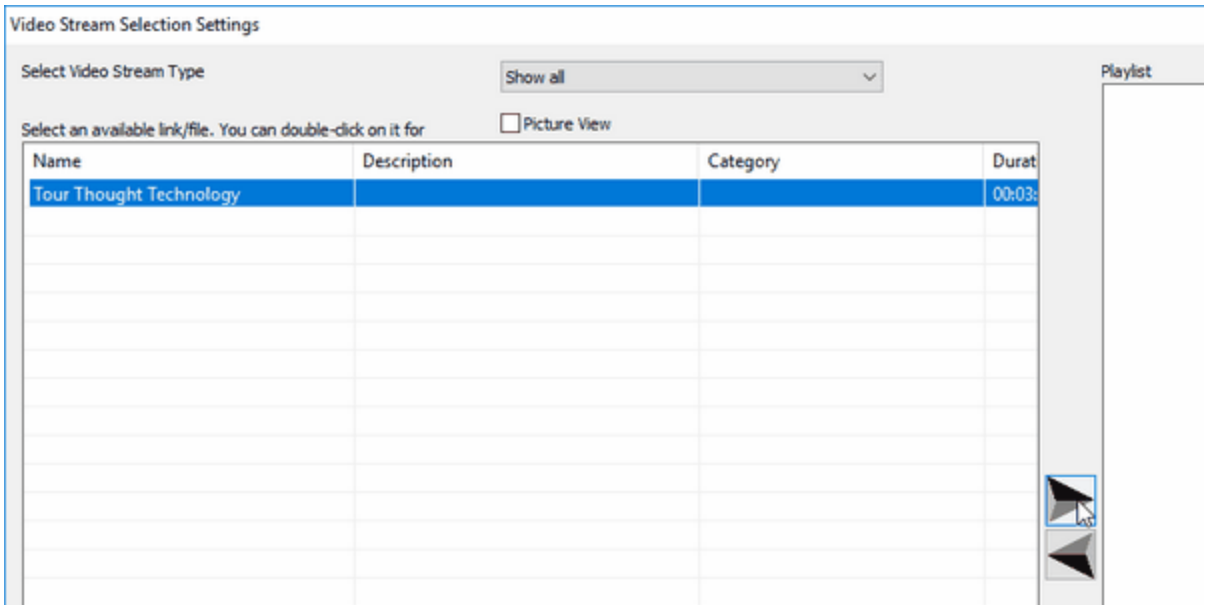
Associating a streaming video with the Video Stream instrument

This is done from the recording screen before recording a session.

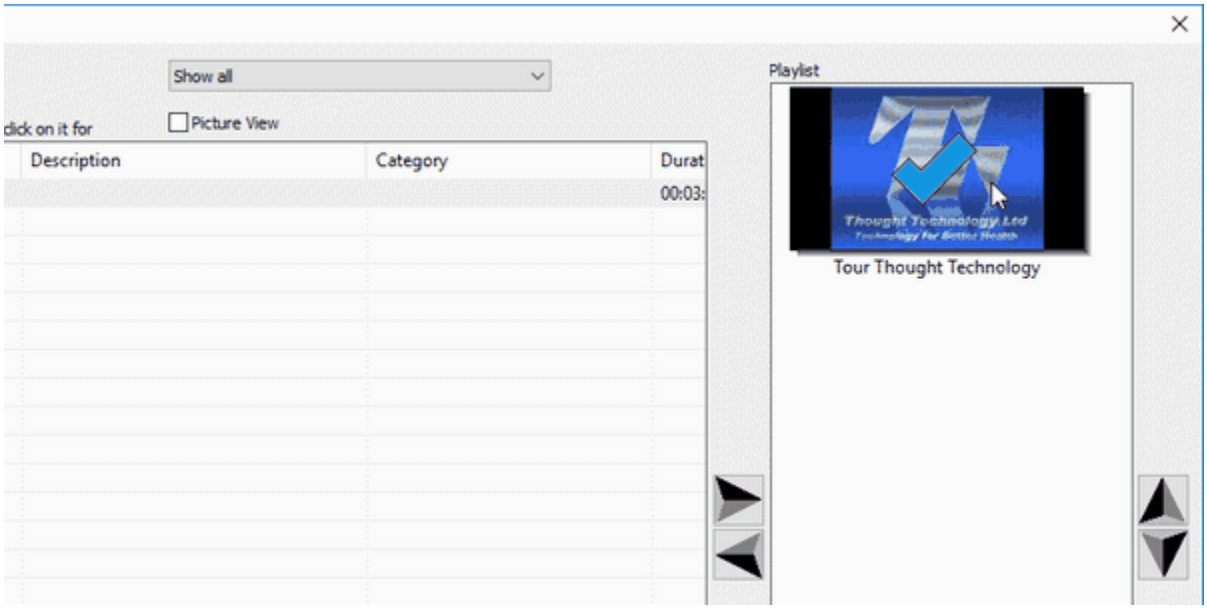
1. Place your cursor over the Video Stream instrument and click the right mouse button.



2. Select **Edit Video Selection**.
3. **Video Stream Selection Settings** opens, listing all streaming videos in the Video Stream Editor.



4. Select a streaming video and click the right arrow button to add it to the playlist.

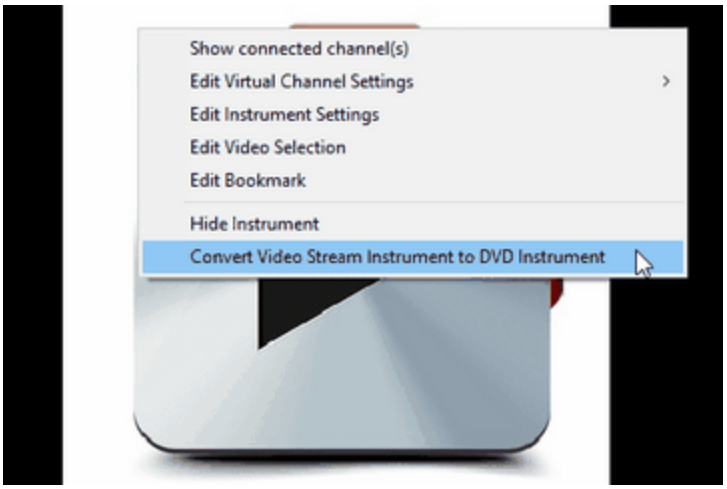


5. Click **OK** to return to the recording screen.

Converting a Video Stream Instrument to a DVD Instrument

This is done from the recording screen before recording a session. There must be a DVD in the computer's DVD drive in order for the DVD instrument to function.

1. Place your cursor over the Video Stream instrument and click the right mouse button.



2. Select **Convert Video Stream Instrument to DVD Instrument**.
3. At the confirmation prompt, click **Yes**.
4. When the system indicates that the instrument has been converted, click **OK** to return to the recording screen.

Detailed information about using the Video Stream instrument and the Video Storage Editor is provided in the BioGraph Infiniti on-line help.

Checking impedance

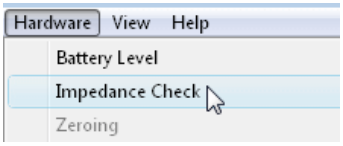
Impedance checking is done only when recording brain waves (EEG), and is performed after the electrodes have been placed on the client's head. Impedance values indicate the quality of contact between the electrodes and the skin.

If EEG is not required for a session, even if the EEG sensor is connected, it is not necessary to check impedance.

ProComp Infiniti and ProComp5 Infiniti

This is the process for checking impedance when using the ProComp5 Infiniti or ProComp Infiniti encoders.

This is done from the BioGraph Infiniti recording screen before recording a session.



1. Place electrodes on the client as described in Electrode Placement on page 14
2. From the **Hardware** menu of the Recording Screen, select **Impedance Check**. This opens the **Impedance Check** window.

3. Then, trigger impedance checking from your encoder. To do this:

   - Ensure that the encoder's **power light** is on.
   - Press and hold down the **power button** for about 3 seconds, or until the power light starts blinking.

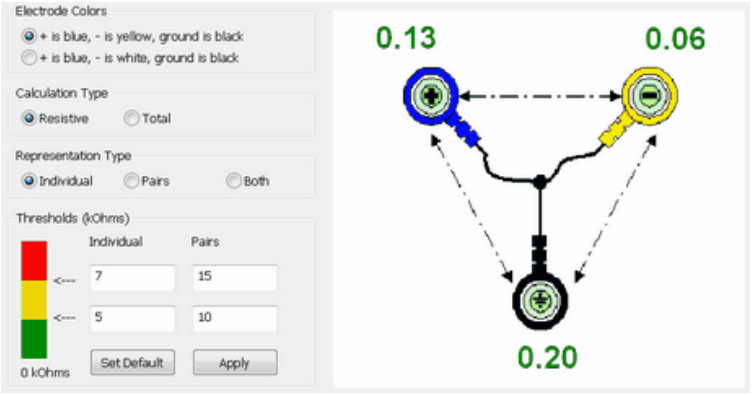
   When the power light begins to blink, impedance checking mode is active.

   The graphic display shows the impedance values of the selected sensor in green, orange or red.

   - Green indicates a low value.
   - Orange indicates a medium value.
   - Red indicates a high value.

   Ideally, all three measurements should display in green.

4. To exit impedance checking mode, press the power button down for about 3 seconds, or until the power light stops blinking.



ProComp2

This is the process for checking the impedance of the integrated EEG sensor (Input A of the ProComp2 encoder). Use the switch sensor cable and an EEG-Z sensor. This cable enables you to trigger an impedance check by the EEG-Z sensor by pressing and releasing its switch button to briefly interrupt the sensor circuit.

The EEG-Z sensor will enter impedance checking mode without requiring you to disconnect and reconnect the sensor. This reduces wear and tear on the cable connection pins.

Align the guiding dot on the top of the cable plug with the notch in the encoder input socket, and gently insert the plug into the socket.

Repeat this to connect the other end of the cable to the bottom of the sensor head.

1. Use the switch sensor cable to connect the EEG-Z sensor to Input B of the ProComp2 encoder as shown.
2. Place the electrodes on the client and connect the EEG extender cable to the EEG-Z sensor.
3. Start the software, choose the impedance checking channel set, and start a session.
4. Do not start recording. Access the impedance checking function from the **Hardware** menu.
5. Press and release the switch button on the sensor cable.

The sensor goes into impedance checking mode and the window displays impedance values.

6. If necessary, adjust the electrodes on the client and then repeat the preceding step.
7. When you are satisfied with the displayed values, close the impedance check window and end the impedance checking session.
8. Connect the EEG extender cable to Input A of the ProComp2 encoder, and remove the EEG-Z sensor.
9. Choose the appropriate channel set and start the recording session.

Using the 360 Suite

The 360 Suite is organised by physiological system to help you select the appropriate assessment or training tool. Body systems include Respiratory, Cardiovascular, Autonomic Nervous System (ANS), Central Nervous System (CNS) and Muscular. Each system group includes self-regulation tools and may include assessments and relaxation tools. The tools within each system group will focus on one or more physiological process and require appropriate signal-specific physiological sensors.

- **Respiratory**: Breathing patterns and breathing rate are measured with a respiration sensor strapped around the chest to pick up on thoracic or abdominal expansion/contraction.

Cardiovascular: Heart rate is measured with a finger pulse sensor (BVP) or electrocardiographic (EKG) sensor and electrodes placed on the client's chest. Combining heart rate with a respiration sensor allows you to monitor and train the physiological interaction between breathing and heart rate variability.

- **ANS**: The dynamics between the sympathetic and parasympathetic branches of the autonomic nervous system are best measured with changes in skin conductance (arousal) and finger temperature (peripheral circulation).
- **CNS**: Brainwave (EEG) frequency and amplitude are measured with scalp electrodes placed on specific areas of the head. Frontal lobe activation is estimated using a passive infrared (pIR) sensor detecting variations in forehead temperature.
- **Muscular**: An electromyography (EMG) sensor is placed on a client's upper or lower back to measure any increase in muscle tension associated with stress.

Biofeedback

As a therapeutic method, biofeedback is generally considered an adjunctive therapy, and it is most often used in conjunction with other clinical methods. Because the technology makes usually unconscious processes visible and generates concrete measurements that can be used to document progress and validate treatment, combining physiological monitoring and biofeedback techniques with other methods frequently helps achieve better and faster results than using the other methods alone.

Historically, biofeedback has been primarily known for its ability to help train people to do basic self-regulation methods which (1) facilitate relaxation and (2) reduce the effects of stress on the body. A significant number of conditions that can upset one's health have stress-related symptoms which can be powerfully alleviated using BFB & NFB methods.

In 2016, the Association for Applied Psychophysiology and Biofeedback (www.AAPB.org) published a review of research in the field of biofeedback and neurofeedback (BFB & NFB) which (1) looks at the various conditions that have been treated using BFB & NFB protocols, (2) evaluates published research evidence to assess the clinical efficacy of each protocol and (3) gives a rating for the treatment's clinical efficacy, based on the scientific validity of the compiled research data. The book provides excellent guidance to clinicians who are looking for reliable resources when selecting the right protocol to use for a given condition. (***Evidence-Based Practice in Biofeedback and Neurofeedback*** (3rd ed.). Gabriel Tan, Fredric Shaffer, Randall Lyle and Irene Teo. 2016. Association for Applied Psychophysiology and Biofeedback.)

We recommend the following process when using the 360 Suite:

1) **Evaluate the condition**: When a client comes into your office for an initial visit, your intake history and the client's presenting complaint allow you to identify one or more condition(s) which may be the cause of his/her symptoms.
2) **Validate treatment options**: Based on published research, clinical experience and expert recommendations, define whether biofeedback or neurofeedback are an appropriate treatment option for the client's condition.

Note: *Because of the risks involved in treating some of the more severe conditions and the possibility of abreactions to some treatment protocols, clinicians who want to do this work should seek the help of expert clinicians in the field until they acquire enough experience to work alone. A number of clinical biofeedback and neurofeedback training workshops are available through professional clinical associations. Contact* www.aapb.org*,* www.bfe.org *and* www.isnr.org *for more information on specialized training.*

3) **Identify body system(s)**: Once you've determined a primary condition for the client's presenting complaint and decided to use biofeedback/neurofeedback to treat it, identify the body system(s) most affected by it, to determine what type of training protocol is appropriate.

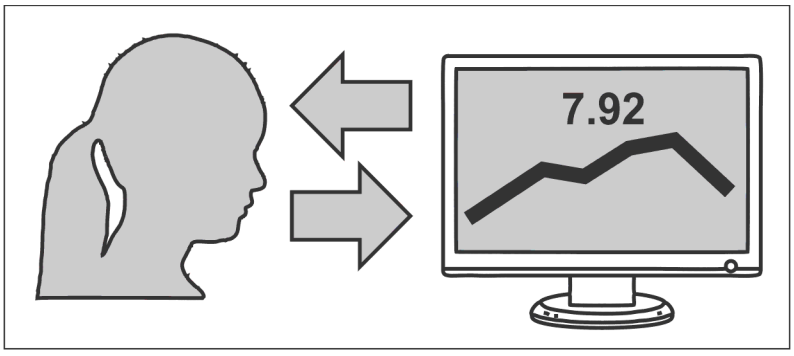
4) **Assess physiological responses**: Running a physiological assessment at the beginning of a therapeutic plan and then following up at regular intervals during the therapy gives you an instantaneous view of the client's physiology and allows you to document progress and demonstrate efficacy.

5) **Teach self-regulation**: As part of your therapy regimen, use body system specific training screens to help the client learn self-regulation skills that will improve his overall health and physiological adaptability.

6) **Teach relaxation**: Because stress is a pervasive component of many conditions, teaching physical and mental relaxation techniques to your client improves his ability to become aware of - and disengage from - stress related physiological responses when they occur in daily life.

How biofeedback works

Biofeedback is a therapeutic method which has been around since the early 1960s. It consists of placing one or more physiological sensor on a person's body and showing how the person's physiology changes, in real time, on a computer monitor or via an audio tone.



The feedback loop created by this process allows the person to:

- Become aware of unconscious behaviors and automatic reactions to stress, triggered by external or internal stimuli.
- Associate the observed physiological responses with specific internal physical and mental processes and feelings.
- Learn to control internal states using various mental strategies in order to influence physiological change.
- Gain the ability to recognise automatic and undesirable physiological reactions to stressful situations and override them with practiced self-regulation skills.

When considering biofeedback or neurofeedback therapy for a given condition, keep in mind that the therapy can affect the client's symptoms directly or indirectly.

Many conditions can directly benefit from self-regulation training if the training specifically counteracts, mitigates or rehabilitates dysfunctionality immediately caused by the condition itself. Teaching your client to become aware of increased shoulder muscle tension and voluntarily relax his upper-body muscles will have a fairly rapid effect on tension-related head and neck pain, for example.

A number of other conditions can be helped indirectly, using biofeedback or neurofeedback training, because they have a strong stress-related component. Teaching HRV biofeedback methods to a client suffering from anxiety or sleeplessness can help him learn to voluntarily shift his physiological responses from sympathetic to parasympathetic dominance, thus triggering the relaxation response and allowing his body to engage in restorative processes.

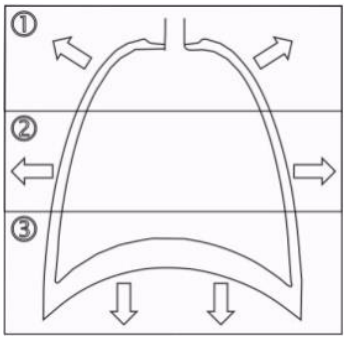
Respiratory system

Breathing is a fundamental life supporting function. We can go without food, water or even sleep for a few days but we cannot stop breathing for more than a couple of minutes without experiencing catastrophic health problems. Most of the time, breathing happens automatically without having to think about it. When we are stressed or when we exercise, our body breathes faster. When we are relaxed, our body breathes slower. When we fall asleep, breathing slows down even more. If our body feels the need for more oxygen, we sigh. When paying attention to something, we may hold our breath. Breathing is mostly under the control of the autonomic nervous system but the central nervous system can easily take control and override automatic breathing: Go ahead, take a deep breath…

Most of us never learned how to breathe, we just breathe. Traditional health care systems, like Ayurvedic medicine, put enormous value on the ability to breathe correctly: Prana, the vital energy that is present in all living things, moves in and out of your body through breathing. Physiologically, there are certain aspects of breathing which have direct influence on a person's health which can be improved by learning a few self-regulation skills.

Abdominal breathing

The next time you are sitting in front of a client, spend a bit of time observing their breathing. Most people breathe shallowly and mainly use their upper body, raising and lowering their shoulders with each breath (1). Sometimes the rib cage expands and contracts (2). The lower lobes don't get much air unless the diaphragm contracts and the abdomen expands (3).



Shallow breathing only fills up a portion of the lungs, which leads to less effective blood oxygenation. Teaching clients to breathe abdominally (or diaphragmatically) is a powerful way to help them breathe in more oxygen and breathe carbon dioxide out more effectively. Maintaining an optimum balance between oxygen and carbon monoxide helps enhance blood oxygenation and improves health in general.

Paced breathing

When a person is experiencing stress, many physiological reactions start happening, including an increase in breathing rate. This is all controlled by the sympathetic branch of the autonomic nervous system. When facing serious danger, the fight or flight response can be useful to help a person survive a threat, but when the stress response is triggered by everyday events – such as needing to give a presentation to coworkers or having a heated discussion with a police officer – fighting or flying may not be valid options. In such cases, the stress response can have negative effects on health because the physiological load of stress is maintained without release for long periods of time.

Paced breathing teaches the client to breathe in and out following a slow, regular metronome-like visual guide and progressively takes the person from his normal breathing rate, which can be fairly high, to a much slower and more desirable resting breathing rate. Slow, regular breathing engages the relaxation response and helps the parasympathetic nervous system take over.

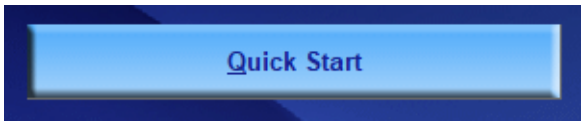
Assessment tools

Normal breathing baseline

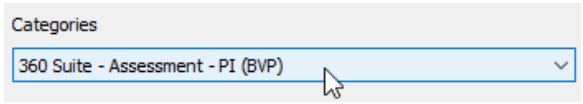
The purpose of this short assessment is to give you a way to see a client's natural breathing patterns. You can run this assessment as one of the first things you do with a client because it's an easy way to introduce the technology and explain how it works.

Running the assessment

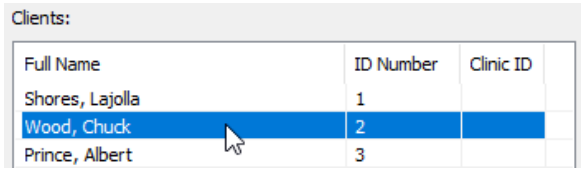
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



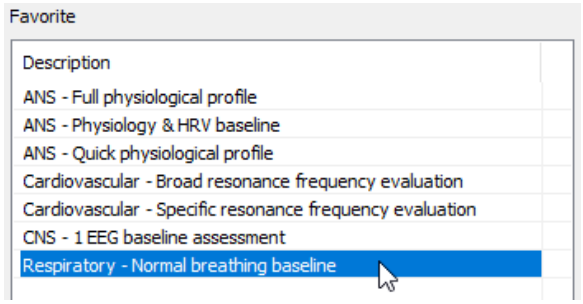
4. From **Categories**, select the **360 Suite - Assessment** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



6. From **Favorite**, select **Respiratory - Normal breathing baseline**.
7. Click **OK**.



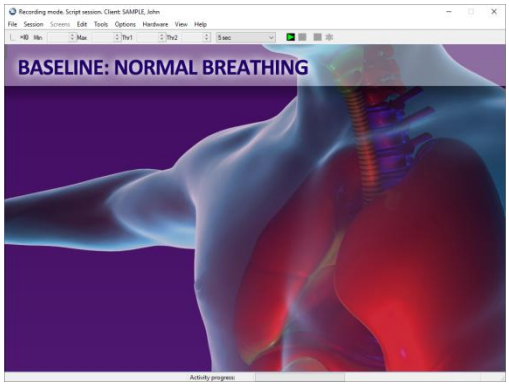
Assessment screens

The following is the series of screens, in chronological order, that the script displays during the assessment.

Introduction screen

When you launch the assessment, after selecting a client and clicking OK, the introduction screen appears.

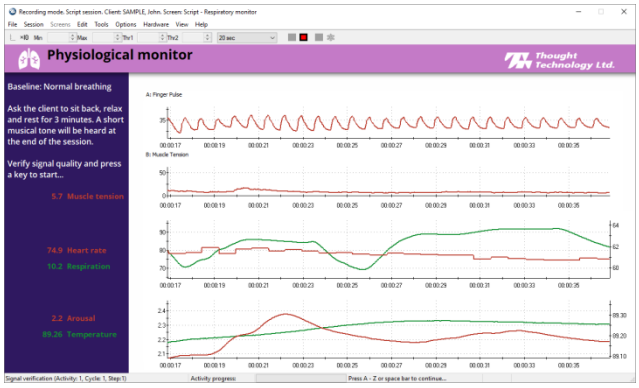
Describe what the assessment is about to your client and click the **Start** button when your client is ready to go.



Instructions & signal verification

This screen displays instructions and allows you to verify that the physiological signals are good.

Press a key on the keyboard to start the assessment.



Baseline recording

While the baseline is being recorded, make sure the signals stay as clean as possible throughout.

The client should be relaxed without moving or falling asleep.

End of session

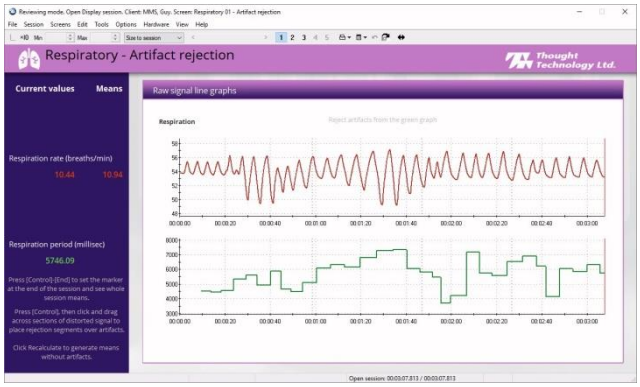
At the end of the baseline recording, a short musical chime is heard and the session is paused.

Press a key on the keyboard to save the session.

Review screens

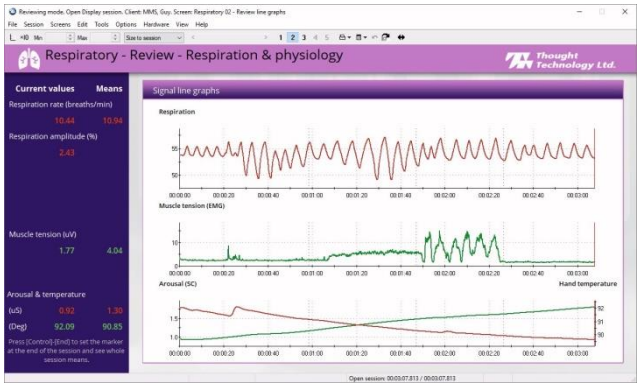
Respiratory 01 –Artifact rejection

The screen shows a line graph of the respiration signal with corresponding respiration period (green). Use this screen to review the recorded respiration signal and reject artifacts from the green respiration period graph.



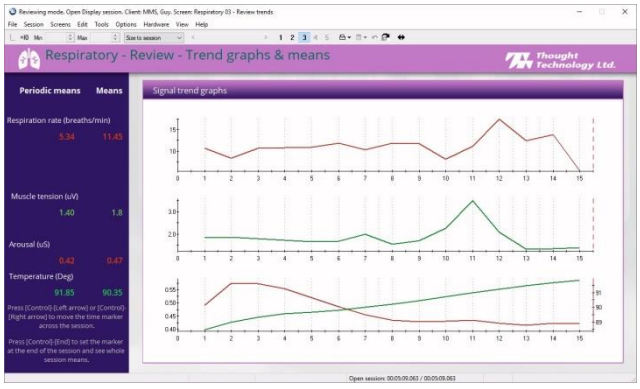
Respiratory 02 –Respiration & physiology

The screen shows line graphs of the respiration signal with muscle tension, arousal and finger temperature. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.



Respiratory 03 –Trend graphs and means

The screen shows trend graphs of the respiration rate, muscle tension, arousal and finger temperature. Use this screen to look for tendencies in the signal directions and confirm that self-regulation training is generating the desired change in physiology.



Reviewing the session

At the end of a session, you can save the data and switch to the review mode where you can scroll through what was recorded and assess your client's physiological responses. Look for normal breathing patterns as well as any evidence of stress-related events, such as breath holding or shallow breathing.

Artifact rejection

Physiological sensors are designed to detect and amplify physiological processes that are sometimes very tenuous. A number of factors can prevent sensors from recording good physiological data, including bad sensor placement, sensor or client movement and electrical interference from nearby sources (neon lighting, electric fan, cell phones, etc.). One of the best ways of limiting the amount of artifact in a physiological recording is to develop good sensor placement techniques. Although some information on sensor placement is included starting on page 10 of this manual, learning the tricks of the trade requires professional guidance and training.

As previously mentioned, artifacts are events that are detected by the sensor but not caused by the physiology being monitored. The ability to recognise artifacts and distinguish between good and bad data is an important skill to develop. This is also experience that is developed over time, and requires professional guidance and training.

Even the most experienced biofeedback practitioner will encounter some artifacts in recorded data. The next line of defence against artifacts consists of reviewing the recorded physiology and ***normalizing*** the data by removing artifacts. This is particularly important if you intend to analyse the data and generate reliable reports. BioGraph offers a few artifact rejection methods which are covered further starting on page 21 of this manual. Artifact rejection is particularly important if you want to be able to evaluate your client's progress and assess the clinical effectiveness of your work by comparing session means.

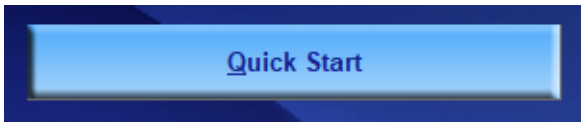
Self-regulation training tools

The main clinical purpose of the respiration screens is to help clients focus on breathing mostly from the abdomen - by contracting and relaxing the diaphragm - while minimizing the use of the shoulders and rib cage. On screen practice consists of making smooth regular breathing "mountains" without getting dizzy or air hungry – i.e. breathing deeply enough but not too deep.

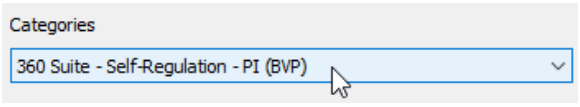
The self-regulation tools include feedback screens to practice abdominal breathing, paced breathing and paced breathing with accessory movement control (to decrease shoulder or upper rib cage movement).

Running a self-regulation training session

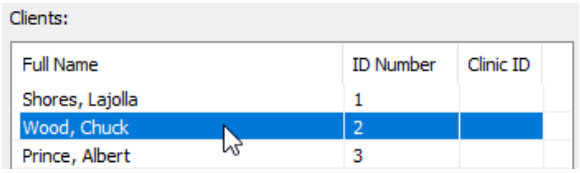
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



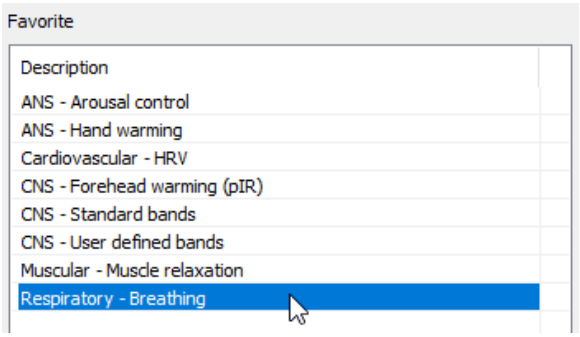
4. From **Categories**, select the **360 Suite - Self-Regulation** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.

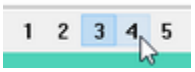


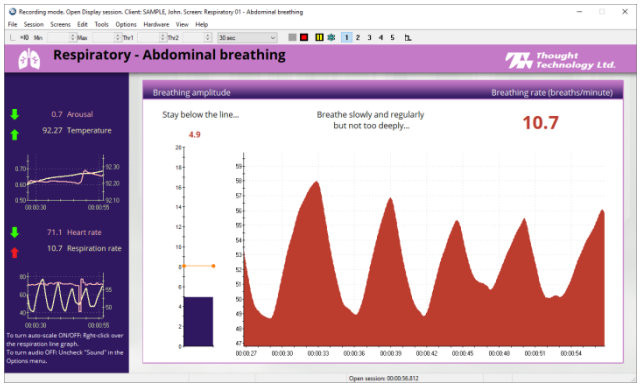
6. From **Favorite**, select **Respiratory - Breathing**.
7. Click **OK**.



Self-regulation screens

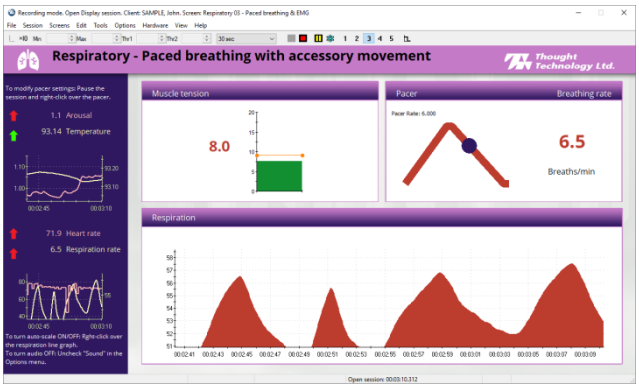
Each Quick Start is associated with a group of up to 5 relevant recording screens, and self-regulation training can be conducted from any one of them. To switch from one screen to another, place the cursor over the desired screen number in the Tool Bar and click the left mouse button. Switching can be done at any time before or during recording.



01 – Abdominal breathing Simple breathing feedback showing the respiration waveform on a filled line graph. A number showing the breathing rate helps the client become aware of his natural breathing rate. A bar graph shows the breathing amplitude. You can set a threshold to keep the client from breathing too deeply. Music plays at full volume when the signal is in condition and at low volume when it is out of condition.	
02 – Paced breathing This screen is similar to the previous screen with the addition of a breathing pacer which you can set at any breathing rate.	

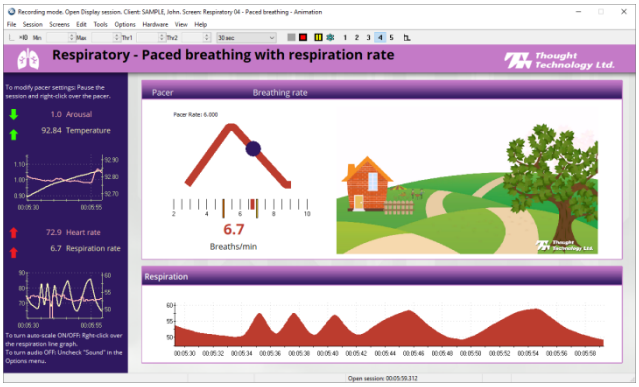
03 – Paced breathing with accessory movement

On this screen, the breathing amplitude is replaced by a bar graph showing accessory muscle activity. With the muscle tension (EMG) sensor electrodes on the client's shoulders, you can train the client to inhibit moving his shoulders while breathing. Set the threshold lower and lower and instruct the client to stay below the line. Music plays at full volume when the signal is in condition and at low volume when it is out of condition.



04 – Paced breathing with rate & animation

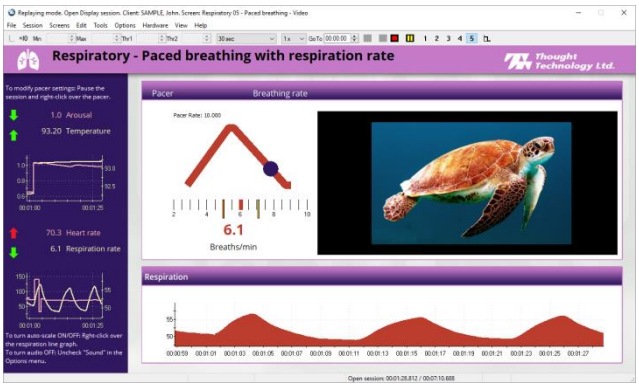
This screen helps you train regularity of breathing. The scale and number below the pacer shows the breath by breath breathing rate. You can adjust the low and high thresholds and instruct the client to stay within the lines. The animation plays and music is at full volume when the signal is in condition. The animation pauses and music is at low volume when it is out of condition.



05 – Paced breathing with rate & video

This is the same screen with a video stream instrument. The video image enlarges when the client is keeping his breathing rate between the lines.

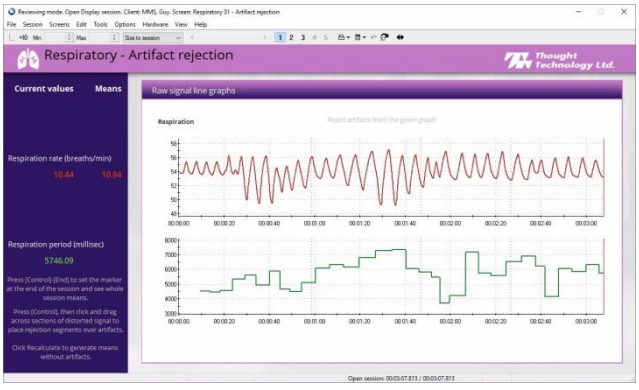
Information about the Video Stream Instrument is provided on page 26.

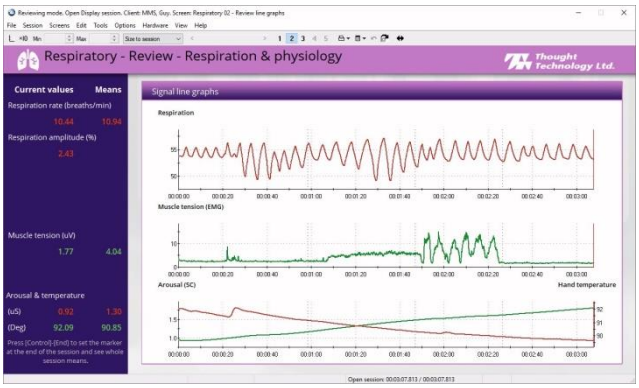
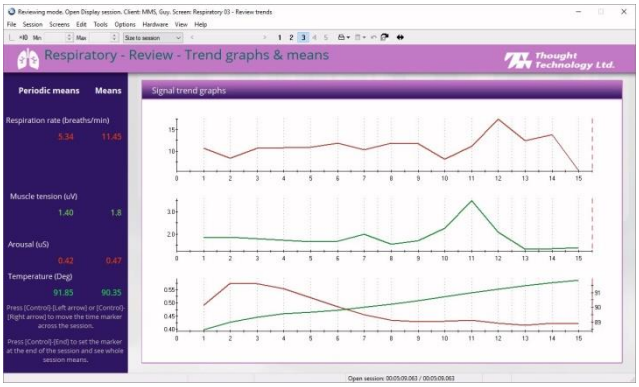


Review screens

Respiratory 01 –Artifact rejection

The screen shows a line graph of the respiration signal with corresponding respiration period (green). Use this screen to review the recorded respiration signal and reject artifacts from the green respiration period graph.



Respiratory 02 –Respiration & physiology The screen shows line graphs of the respiration signal with muscle tension, arousal and finger temperature. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.	
Respiratory 03 –Trend graphs and means The screen shows trend graphs of the respiration rate, muscle tension, arousal and finger temperature. Use this screen to look for tendencies in the signal directions and confirm that self-regulation training is generating the desired change in physiology.	

Note: *The review screens for a given body system may include statistical information and show signal graphs on physiological processes that belong to other body systems because body systems work together and interact with each other all the time. Sessions can be reviewed with screens from different body systems as long as the appropriate physiological sensor(s) were connected and on the client when the session was recorded.*

Cardiovascular system

The cardiovascular system circulates blood throughout the body, distributes oxygen and nutrients to the organs and carries cellular waste to the kidneys and liver for filtering and elimination. The heart is the organ that makes it all happen by pumping the blood around. It beats normally between 60 and 80 beats a minute and only rests for the fractions of a second between beats. A normal healthy heart doesn't beat regularly like a clock. Its rhythm is constantly accelerated and slowed down by multiple physiological factors, including breathing, baroreceptors, sympathetic and parasympathetic activity, varying levels of hormones in the blood, etc. Research suggests that a cardiovascular system with more variability is healthier than one with less variability. Training your clients to become aware of, and learn to voluntarily increase, heart rate variability (HRV) helps improve the overall health of his cardiovascular system.

The 360 Suite includes self-regulation training screens which allow you to train HRV using various key metrics and explore different physiological aspects of cardiovascular dynamics.

Respiratory sinus arrhythmia

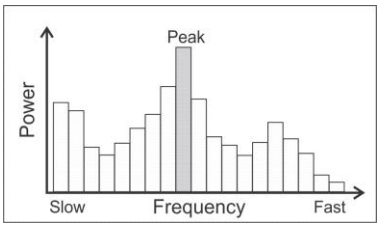
The cardiovascular and respiratory systems are physiologically and functionally intertwined. Physiologically, the respiratory system brings oxygen into the lungs while the cardiovascular system

delivers oxygenated blood to the various organs. Functionally, breathing entrains the heart to beat faster (heart rate increases) during the in breath and slower (heart rate decreases) during the out breath. This phenomenon -- respiratory sinus arrhythmia (RSA) -- helps optimize gas exchanges between the lungs and the blood and allows the heart to do less work during part of the breathing cycle. The breath by breath difference between the maximum and minimum heart rate values (HR max-min) is a documented measure of HRV.

Teaching your clients to maximize HR max-min with RSA biofeedback is a powerful way to increase the cardiovascular system's range of adaptability. Biological adaptability is an important factor of health and survival.

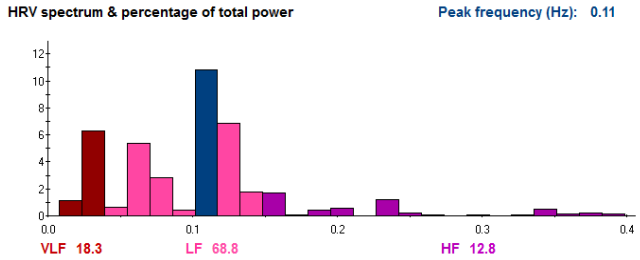
HRV resonance frequency

Running a frequency analysis over about a minute (64 seconds) of inter-beat intervals (IBI) will reveal information about the frequency range where the dominant influencer of HRV is during that period of time. Frequency ranges within which a strong influencer is acting will have more **power** than others. The **peak** frequency – i.e. the frequency that has the most power – is shown as the tallest bar on a frequency distribution graph.



For the purpose of doing HRV analysis, the frequency spectrum is generally divided in three zones, or frequency bands. Very low frequency (VLF, 0.016-0.04 Hz), low frequency (LF, 0.04-0.15 Hz) and high frequency (HF, 0.15-0.4 Hz). Broadly speaking, when a person is breathing normally, VLF reflects activity of the slower sympathetic processes (thermoregulatory, renin-angiotensin). LF is generally seen to be influenced by both sympathetic and parasympathetic activity while HF tends to be influenced mostly by the parasympathetic nervous system.

When breathing normally (ex. 10-12 breaths/min), respiratory sinus arrhythmia's influence will be in the HF band. When practicing breathing exercises at around 6 breaths/min, the influence of RSA shifts power towards the LF band and generates a visibly taller spike in the spectrum at 0.1 Hertz. Most HRV self-regulation protocols involve teaching clients to breathe at 6 breaths/min or at their resonance frequency breathing rate.



Resonance frequency training is a way to use the relationship between breathing and heart rate in order to strengthen the cardiovascular system. According to research, each person has a specific **resonance frequency**. At that frequency, the effects of two or more heart rate influencers combine (resonate with one another) to significantly increase the power in the HRV spectrum beyond what either influencer would have had on its own, thus maximizing the effect of the training.

The 360 Suite includes a **Broad** and a **Specific** resonance frequency assessment that will help you identify your clients' resonance frequency.

Assessment tools

Broad / specific resonance frequency assessment

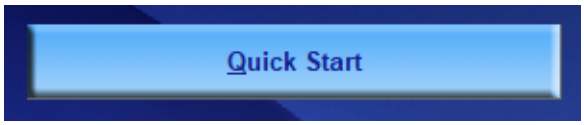
Essentially, the process of identifying someone's resonance frequency is simple: Use a breathing pacer and have the client breathe for a couple of minutes at various breathing rates while watching the peak frequency bar and paying attention to how high its power goes (the amplitude of the bar). For the purpose of this assessment, the breathing rate that engenders the highest power in the low frequency (LF) band is the **resonance frequency** breathing rate. Once that rate has been identified for a given client, just set the breathing pacer appropriately when doing HRV self-regulation with him.

The broad resonance frequency assessment takes about 15-20 minutes (including set up time) and takes the client through seven breathing rate levels: 7.5, 7.0, 6.5, 6.0, 5.5, 5.0 and 4.5 breaths/min. During the assessment, you can coach the client to follow the pacer as closely as possible. If dizziness occurs, instruct the client to breathe less deeply. If lack of air is felt, instruct the client to breathe a bit more deeply.

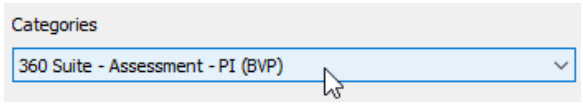
The broad resonance frequency assessment checks seven different breathing rates, at 0.5 breath/minute intervals. Because human bodies are not all the same and can vary greatly on many factors, a person's actual resonance frequency is rarely precisely at one of the breathing rates tested by the assessment. A little like what happens when setting an FM radio's frequency dial between two stations, when you hear faint music, you're not sure if the signal is from the lower or the higher station. The specific resonance frequency assessment takes a bit longer to run (20-25 min, including setup time) but makes smaller jumps between breathing rate levels: 6.8, 6.6, 6.4, 6.2, 6.0, 5.8, 5.6, 5.4 and 5.2 breaths/minute. Those shorter gaps can help you identify the resonance frequency with more precision.

Running the assessment

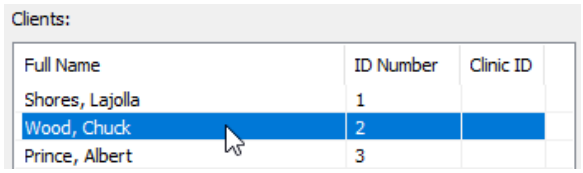
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



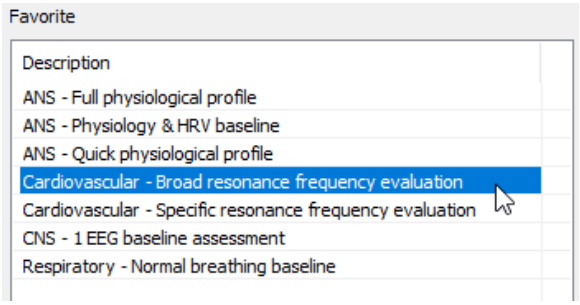
4. From **Categories**, select the **360 Suite - Assessment** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



6. From **Favorite**, select one of the following, as appropriate.
   - **Cardiovascular - Broad resonance frequency evaluation**
   - **Cardiovascular - Specific resonance frequency evaluation**
7. Click **OK**.



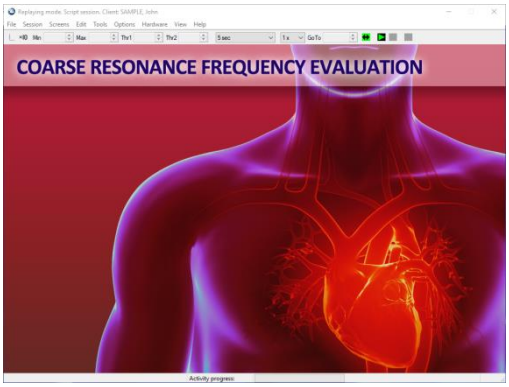
Assessment screens

The following is the series of screens, in chronological order, that the script displays during the assessment.

Introduction screen

When you launch the assessment, after selecting a client and clicking OK, the introduction screen appears.

Click the **Start** button when your client is ready to go.

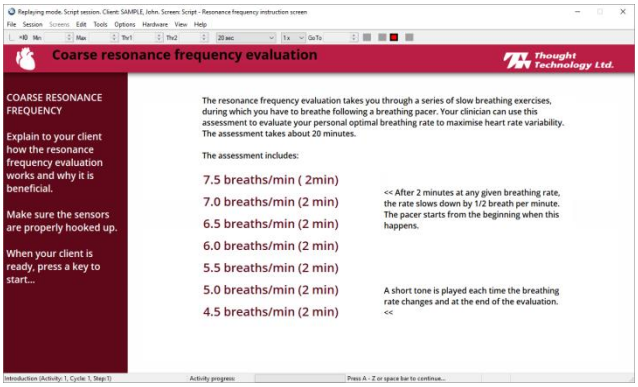


Instructions

This screen displays instructions.

Describe what the assessment is about to your client and explain how the breathing pacer works.

Press a key on the keyboard to start the assessment.

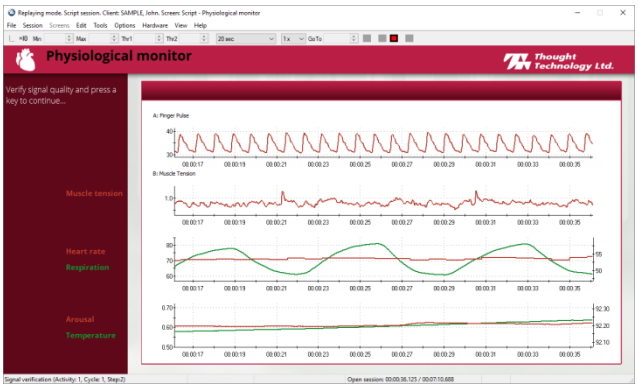


Signal verification

This step allows you to verify that the physiological signals are good.

Check each sensor to make sure it is placed on the client properly and picking up good signals.

Press a key on the keyboard when the client is ready to continue.



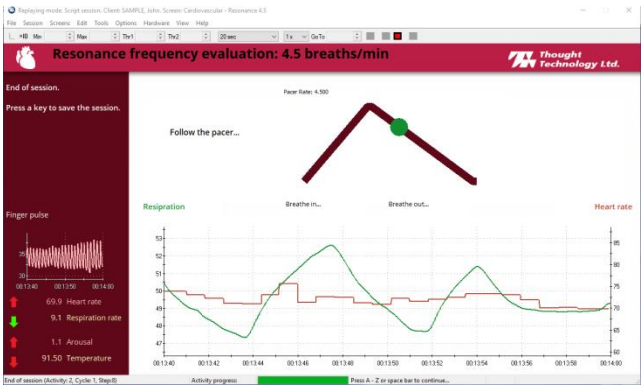
Paced breathing

The assessment starts at 7.5 breaths/minute and decrements the breathing rate by 0.5 breath/min every two minutes. Each time the breathing rate is changed, a short musical chime is heard but the recording is NOT paused.

End of session

After the last breathing rate (4.4 br/min), the short musical chime is heard once more and the session is paused.

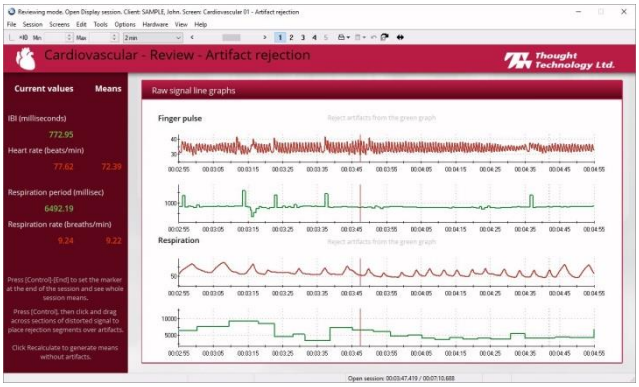
Press a key on the keyboard to save the session.



Review screens

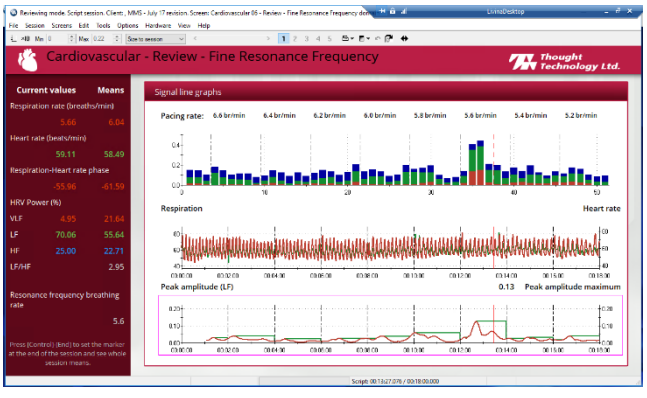
01 – Artifact rejection

The screen shows line graphs of the finger pulse (BVP) or EKG and respiration signals (red) with corresponding inter-beat interval and respiration period signals (green). Use this screen to review the recorded signals and reject artifacts from the green IBI and respiration period graphs.



05 – Broad/specific Resonance frequency

The screen shows VLF, LF & HF total power values on stacked bar graphs on the top as well as the peak amplitude and peak amplitude maximum values on the bottom graph. Use these graphs to find the breathing rate that generated the most power in the LF band (i.e. the section with the tallest power bars and highest peak. The breathing rate that corresponds to the highest LF power is indicated as **Resonance frequency**



breathing rate in the lower left area of the screen.	

Reviewing the session

When reviewing the session with the Resonance frequency assessment review screen (broad or specific), look for the breathing rate where the power in the low frequency (LF) band is highest. This will show on the top bar graph as one or more bars within one of the pacing rate sections being significantly taller than the bars in other sections. This will also appear on the bottom peak amplitude line graph as the section with the highest maximum. In the lower left corner of the screen, you can see what breathing rate triggered this localised increase in power.

Things to keep in mind

These assessments are difficult to perform with anyone who has little or no practice with doing paced breathing because:

1. Not everyone is able to breathe slowly without feeling either air hungry or dizzy. Your client may have to stop mid assessment.
2. Keeping up with the pacer with sufficient precision takes practice. Throughout the assessment, the larger the difference between the target and the actual breathing rate, the less accurate the resonance frequency assessment will be.
3. The task makes some clients fall asleep. When this happens, their breathing desynchronizes from the pacer and precision is lost.

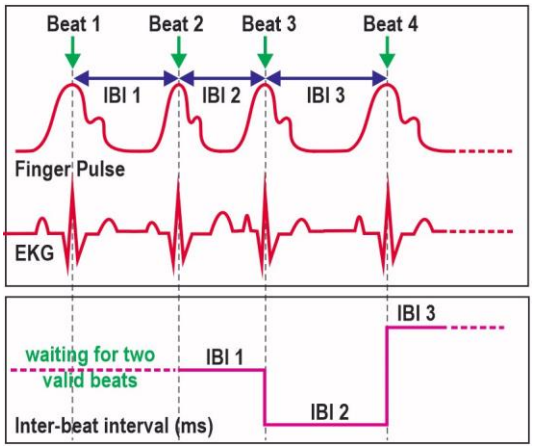
All of which can lead to a wrong assessment of the resonance frequency. Having your client practice paced breathing for a few sessions prior to attempting the resonance frequency assessment helps ensure better results.

Artifact rejection

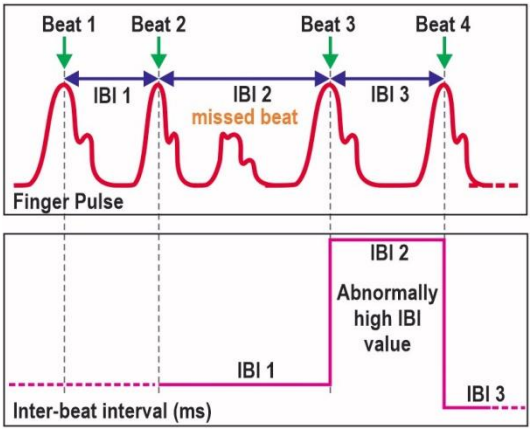
When reviewing resonance frequency sessions, it is particularly important to be careful about artifacts because they distort computations and can lead to mistakes in the resonance frequency value. The 360 Suite provides you with methods for mitigating the effects of artifacts. For HRV, the preferred method for rejecting artifacts is manual artifact rejection, described further starting on page 23 of this manual.

Overview

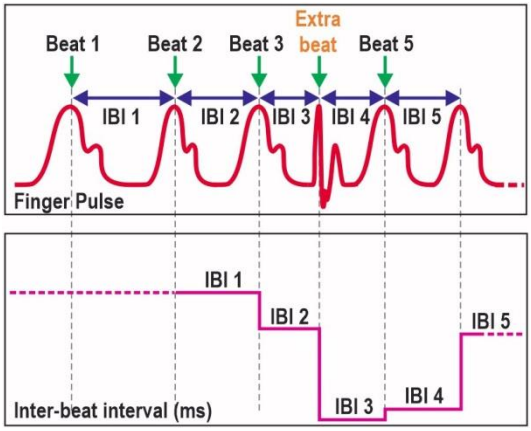
When processing finger pulse or EKG sensor data, the software scans the streaming data and looks for recognisable patterns which it can identify as beats. When a session starts, it waits for the first beat. Then it waits for the second beat and calculates the first inter-beat interval (IBI) value and corresponding heart rate. Beat after beat, the various time domain metrics are calculated and shown on the screen. After gathering about a minute of IBI data (64 seconds), the software generates a power spectrum and calculates power values for VLF, LF and HF.



If the signal is of a good quality, this is done fairly reliably but occasionally, artifacts occur. In terms of IBI data processing two types of artifacts are of concern: Missed beats and extra beats. Missed beats happen when the signal loses its pattern (i.e., becomes too weak or becomes distorted) and the software cannot recognise the beat anymore. When this happens, the software sees an abnormally long IBI value.



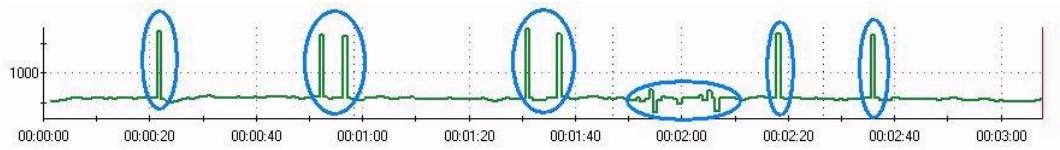
Extra beats happen when something else (such as a distortion caused by movement) is picked up by the sensor and mistaken for a beat. When this happens, the software calculates two very short IBI values. Either way, these artifacts cause errors in the HRV metric calculations which can then lead you to make the wrong clinical choice.



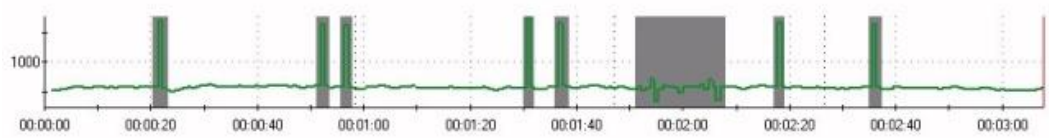
Note: *A third type of problem can occur when the client's heart has an ectopic beat. Similarly to palpitations or heart flutters, ectopic beats appear "out of place" in the IBI sequence and looks like one low and one high IBI value, side by side. Although these are natural physiological events, not caused by distortions in the signal, it is often better to remove those as well.*

Procedure

The first review screen (**Cardiovascular 01 – Artifact rejection**) allows you to find and eliminate artifacts from the data so calculations can be redone with better reliability. When looking at the IBI graph on the screen (top green graph), look for abnormally high or low points:



Place a rejection segment over each upward or downward spike, along the signal. You may also decide to remove ectopic beats if there are many of them:



There may also be artifacts in the respiration period graph (bottom green graph). Visually review the green respiration period graph and reject any value which seems abnormal.

When you are done, click the **Recalculate** button  in the tool bar, and return to the Resonance frequency review screen. Once you have a good idea of a client's optimal breathing rate, you can set the breath pacer on any self-regulation screen to that breathing rate in order to maximize heart rate variability training. You can repeat the specific resonance frequency assessment after a few visits to see if you can achieve more precision.

Self-regulation training tools

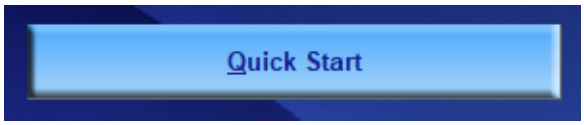
The main clinical purpose of the Cardiovascular self-regulation tools is to help clients maximize their heart rate variability through breathing exercises. HRV can be measured in a number of ways and many HRV metrics can be used for biofeedback.

Practicing slow and regular breathing -- with and without a breathing pacer -- helps clients understand the relationship between breathing and heart rate (RSA). Practicing to increase the amplitude of the minimum

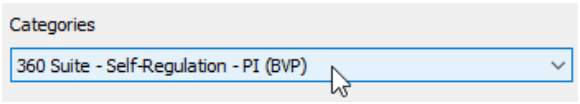
to maximum heart rate difference and learning to minimise the phase between the respiration and heart rate waves improves control over HRV. Doing slow regular breathing exercises at or around 6 breaths/minute shifts the RSA effect within the LF frequency range but when breathing at the resonance frequency breathing rate, HRV is maximised even further.

Running a self-regulation training session

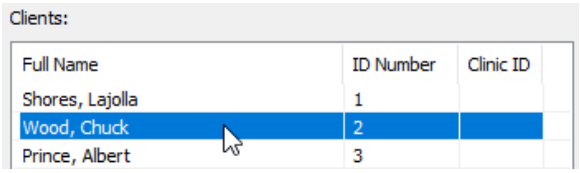
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



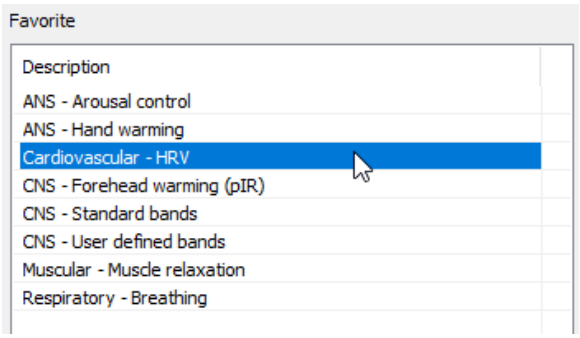
4. From **Categories**, select the **360 Suite - Self-Regulation** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



6. From **Favorite**, select **Cardiovascular - HRV**.
7. Click **OK**.



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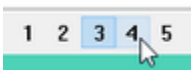
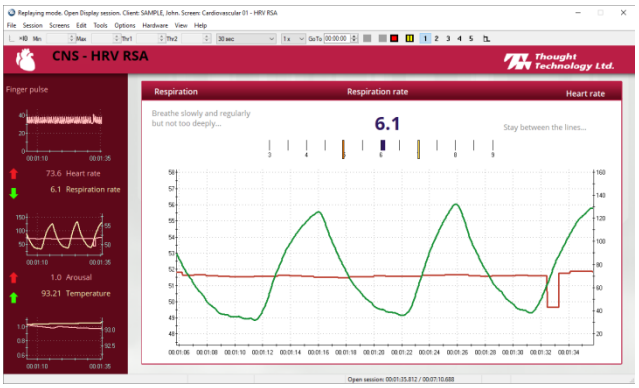


In general, Cardiovascular - HRV screens are listed in order of difficulty. That is, Screen 01 is most suitable for a new client, while Screens 04 and 05 should be used by an experienced client.

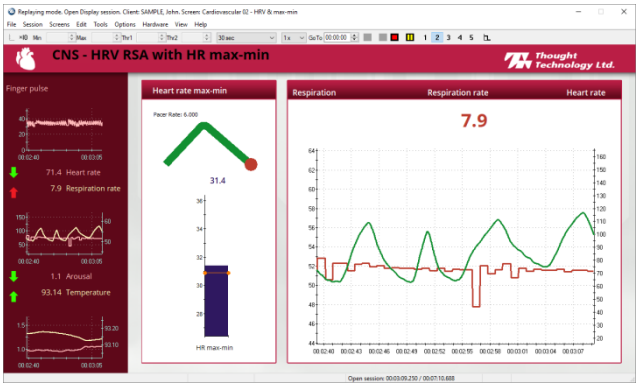
01 – HRV RSA

This classic respiratory sinus arrhythmia (RSA) training screen shows respiration and heart rate on a large line graph. The training goal is to breathe slowly and regularly in order to encourage heart rate to increase with the in breath and decrease with the out breath. You can adjust the two thresholds on the top horizontal graph to train the client to breathe within a specific range of breathing rates. Positive feedback is given when the client is able to breathe within the target range.



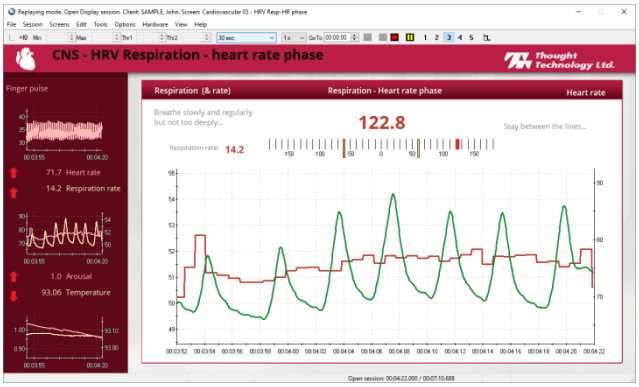
02 – HRV RSA with HR max-min

This screen is similar to the previous screen with the addition of a breathing pacer which you can set at any breathing rate. The bar graph on the left shows the breath by breath difference between the maximum and minimum heart rate achieved during a breath cycle (from one full in-breath to the next). The training goal is to achieve higher values of HR max-min. Feedback is given when the HR max-min is above the threshold.



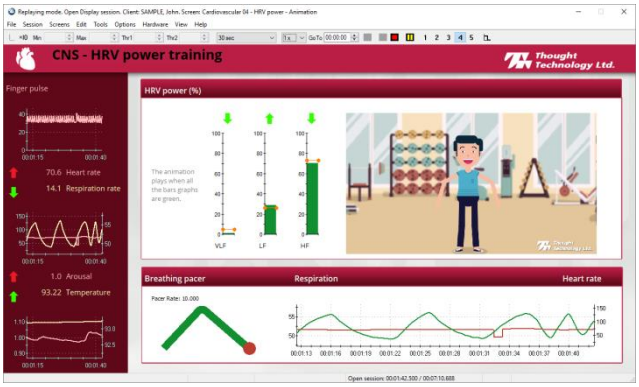
03 – HRV with respiration – heart rate phase

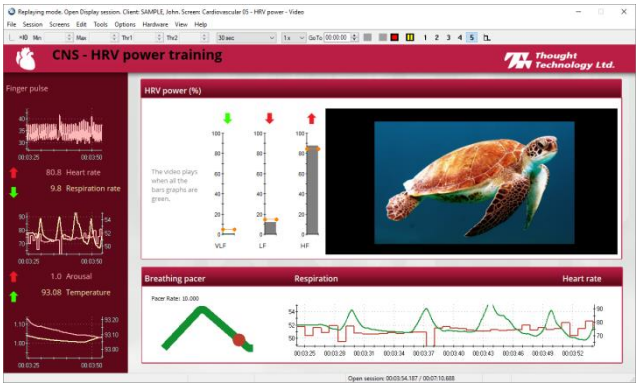
Using this screen you can train another aspect of respiratory sinus arrhythmia, which is the phase between the two signals. When both signals go up and down together, they are in phase and the phase value is close to 0. The training goal is to keep the phase value as small as possible. You can adjust the two thresholds on the top horizontal graph to train the client to breathe within a specific range of phase. Positive feedback is given when the client is able to breathe within the target range.



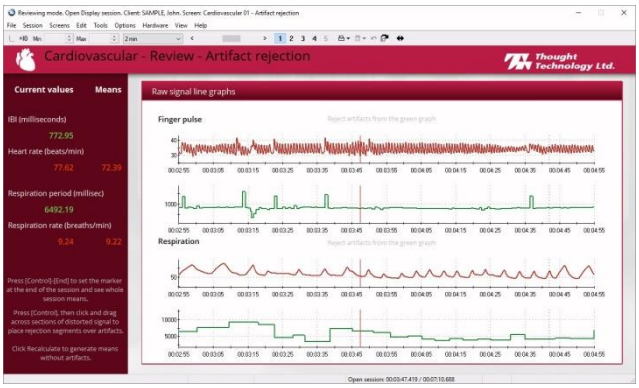
04 – HRV with power

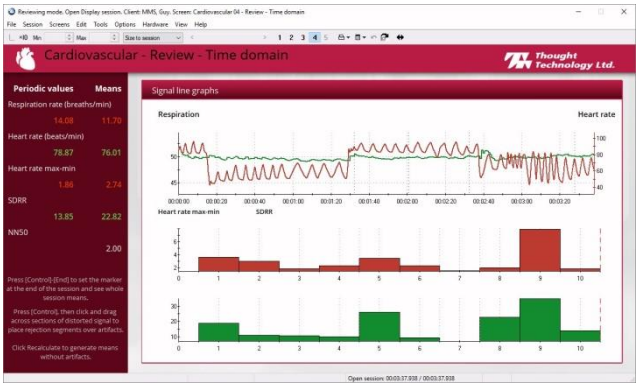
Using this screen you can train HRV with VLF, LF and HF percentage of power. You can set the breathing pacer's target rate to 6 breaths/min or to the client's resonance frequency breathing rate. Positive feedback is given when the client is able to increase the power in the LF frequency band while decreasing power in the VLF and HF bands. The animation and music play when the client is successful.



Note: *Because of the need to accumulate 64 seconds of IBI data, feedback starts only after 64 seconds.*	
05 – HRV with power This screen is similar to the previous one and is used to train HRV with VLF, LF and HF percentage of power but feedback is given with a Video Stream instrument. The video image enlarges when the client is keeping his breathing rate between the lines. Information about the Video Stream Instrument is provided on page 26.	

Review screens

01 – Artifact rejection The screen shows line graphs of the finger pulse and respiration signals (in red) with corresponding inter-beat interval and respiration period signals (in green). Use this screen to review the recorded signals and reject artifacts from the green IBI and respiration period graphs.	
02 – Review line graphs The screen shows respiration and heart rate on the top graph, VLF, LF & HF % power on the middle graph as well as arousal and temperature on the bottom graph. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.	

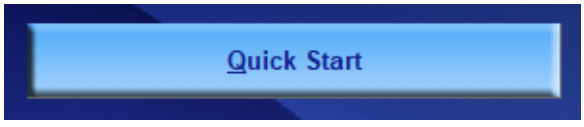
03 – Frequency domain The screen shows respiration and heart rate on the top graph and VLF, LF & HF % power on stacked bars on the bottom graph. Using this screen, you can correlate changes in breathing patterns and heart rate with shift in percentage of power between the VLF, LF and HF frequency bands.	
04 – Time domain The screen shows respiration and heart rate on the top graph with trend graphs of heart-rate max-min and SDRR. Using this screen, you can correlate changes in breathing patterns and heart rate with changes in periodic means for HR max-min and SDRR. The NN50 count appears in the statistics section on the left.	

Biofeedback-assisted relaxation training tools

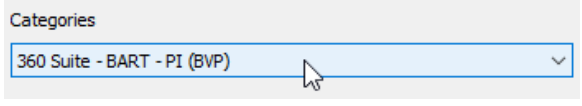
Biofeedback-assisted relaxation training (BART) tools provide you with an efficient way to teach relaxation skills to your client. The Paced Breathing relaxation training session goes beyond self-regulation training and teaches your client to use slow breathing to access a state of deep relaxation. The session takes about a half-hour to run, including preparation time. After practicing this relaxation technique a few times, the client should be able to start slow breathing on his own, without the help of the biofeedback equipment. Slow breathing relaxation is a useful tool for people who have difficulty falling asleep because it quickly engages the relaxation response.

Running a session

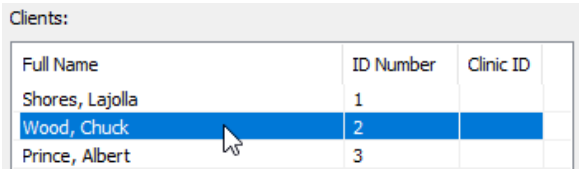
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



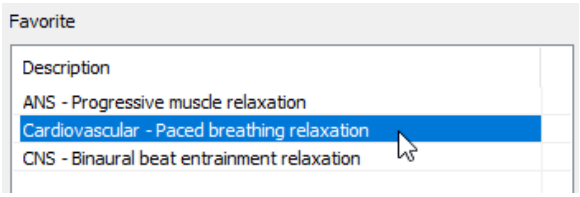
4. From **Categories**, select the **360 Suite - BART** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



6. From **Favorite**, select **Cardiovascular - Paced breathing relaxation**.
7. Click **OK**.

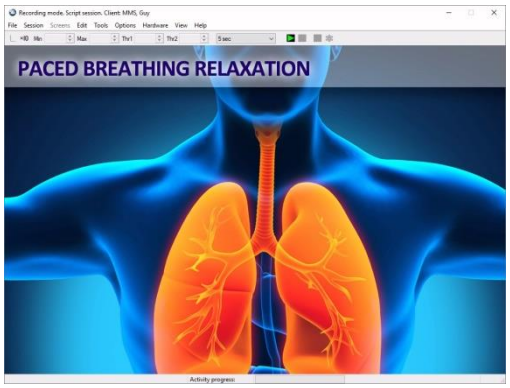


Session screens

Introduction screen

When you launch the assessment, after selecting a client and clicking OK, the introduction screen appears.

Click the **Start** button when your client is ready to go.

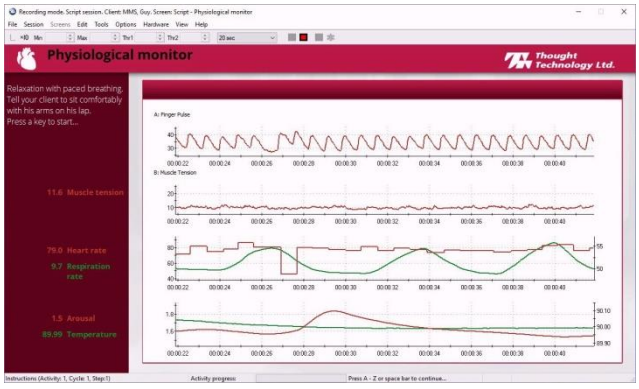


Instructions & signal verification

This screen displays instructions and allows you to make sure that the sensors are properly placed on the client and the recorded signals are valid.

Describe what the relaxation session is about to your client and explain how the breathing pacer works.

Press a key on the keyboard to start the session.



Paced breathing

The main screen shows signal graphs and a breathing pacer, set to progressively slow down, from 10 to 6 breaths/minute and then stay at 6 breaths/min for the rest of the session.

The relaxation exercise can be done with eyes slightly open, if the client wants to watch the pacer, or closed, if he prefers to listen to the **In** and **Out** guiding sounds.

Session ending Quiet music plays for the last two minutes, to let the client know that the exercise is ending and allow him a slow waking up period.	
Saving the session At the end of the relaxation session, you are given the opportunity to save the data if you want to be able to review it.	

Review screens

The review screens are the same as for the self-regulation training sessions.

Autonomic nervous system

The autonomic nervous system manages a lot of our body's physiological activities without requiring any conscious effort from us. Blood pressure, digestion, body temperature, metabolism and a slew of other processes are controlled automatically by the ANS and we generally have little or no awareness of it. This control is achieved through the interaction between the two divisions of the ANS, the sympathetic nervous system (SNS) and parasympathetic nervous system (PNS). Generally, the SNS activates processes while the PNS deactivates processes. Repeated or chronic activations of the SNS can be damageable to health because it inhibits the restorative capacity of the PNS and impedes physiological recovery. For this reason, the ANS biofeedback protocols included in the 360 Suite aim at making the client learn to engage the PNS.

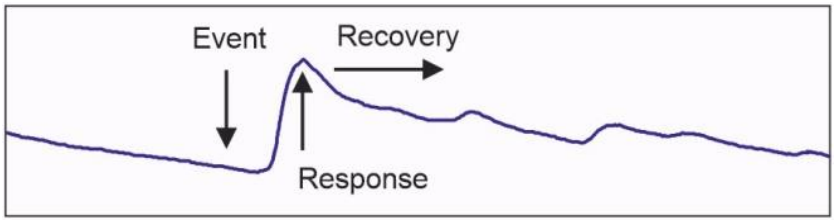
The 360 Suite includes **Physiological profile** assessments (full and quick) which help you make periodic evaluations of your clients' ability to deal with stress and see how well they can recuperate after being stressed. The **Physiological & HRV baseline** assessment takes just a few minutes to run and provides a quick way to get pre- and post-training views on your client's physiology. Running pre- and/or post-training baseline assessments over the course of a treatment plan is an easy way to document progress and demonstrate positive change over time.

The 360 Suite also includes self-regulation screens which use arousal and hand temperature biofeedback to help clients become aware of - and learn to control - their usually unconscious reactions to stress.

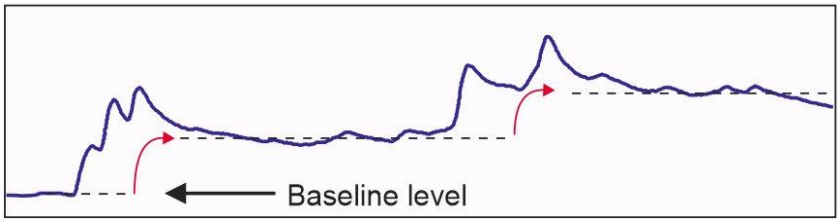
Arousal and hand temperature

Self-regulation protocols for the ANS mostly involve two physiological processes: arousal and peripheral temperature. When the stress response kicks in, a number of physiological reactions occur, preparing us to either fight or flee. Along with increasing heart rate and breathing rate, people frequently get cold and clammy hands. The cold is caused by a shunting of the blood circulation from the periphery (hands and feet) to the core (trunk and leg muscles), bringing more blood to the larger muscles of the body. The clamminess is caused by an increase in sweatiness on the palm of the hands.

Arousal biofeedback is done using a skin conductance sensor which detects tiny changes in sweatiness caused by activation or deactivation of eccrine glands. When a person is challenged by an external event (stimulus), such as a loud noise or being asked to perform a demanding task, a stress reaction occurs and this translates into a rise in skin conductance. Arousal reactions can also be triggered by internal events, such as remembering recent stressful moments or worrying.

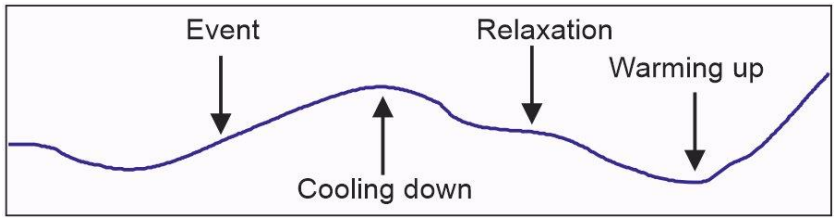


A skin conductance response normally comes from 1 to 3 seconds after the stimulus event. The response is a quick rise, followed by a slower recovery period. In normal circumstances, the arousal level lowers back to its original resting value within a few minutes when the stressor event is over but some people have a hard time relaxing after getting stressed and their base arousal level slowly rises, instead.



Arousal biofeedback can help retrain their physiological responses so they can become aware of changes in arousal and voluntarily ***let go*** when they feel stressed out.

Peripheral temperature is a slow signal. A change in peripheral temperature can take a minute or two to become noticeable after a stressful event happens. Because of this slowness, measuring hand temperature is a good method for monitoring the long term effects of stress. While a short stress event may not have much effect on hand temperature, any long lasting challenge, such as having to perform in front of a crowd, being audited by the revenue agency or doing end of semester exams, will definitely affect the circulation in hands and feet.

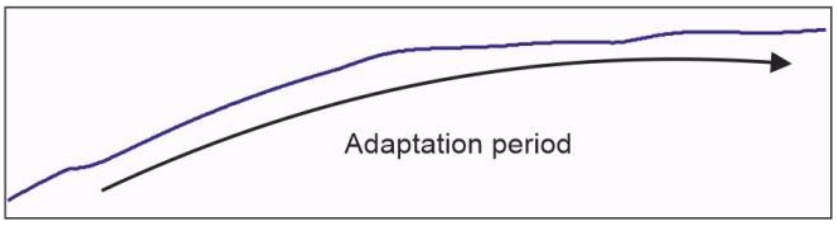


People who chronically have cold extremities can benefit from hand warming self-regulation training.

Things to keep in mind

The temperature sensor has a long adaptation time. If you start a session just after having placed the sensor on your client, you might notice that the signal shows a very slow but constant increase in

temperature. This is more probably due to the sensor warming up, than to the client's self-regulation efforts. If time allows, place the temperature sensor on the client a few minutes before starting the training. Check for the signal leveling off before you start training or running a physiological profile.



Muscle tension

Although the 360 Suite includes a group of tools for the Muscular body system, muscle tension is frequently recorded along with ANS physiology because unconscious tensing up of body muscles is a key element of sympathetic nervous system activation and a large component of the fight or flight response to stress. A lot of common musculoskeletal problems, such as back pain, headaches, strains and sprains, etc., are associated with chronic muscle tension linked to long term stress.

Assessment tools

Physiological profile

The physiological profile is your main tool for evaluating how your clients handle stress. Essentially, the assessment puts your client through a sequence of mildly stressing periods, immediately followed by resting periods. The rapid changes between stress and rest forces the person's physiology to shift from state to state at a fast pace. During the stress periods, you can observe how your client's body responds to being challenged and how much of a physiological response is triggered. During the rest periods, you can find out how long it takes your client to recuperate and whether his physiology is able to return to baseline levels. The assessment ends with 3 minutes of relaxation, which gives you an idea of how well the person is able to voluntarily relax and let go even further.

The physiological profile assessment gives you the concrete information you need to make informed self-regulation training choices. Two versions are provided:

Full physiological profile: The full physiological profile assessment takes about 30 minutes to run, from placing the sensors on the client to generating a report, and consists of eight states:

- Baseline (2 min)
- Loud noise (2 min)
- Rest (2 min)
- Math task (2 min)
- Rest (2 min)
- Stressful memory (2 min)
- Rest (2 min)
- Relaxation (3 min)

Quick physiological profile: The quick version of the profile can be run within 15 minutes. It includes five states:

- Baseline (2 min)
- Math task (2 min)
- Rest (2 min)

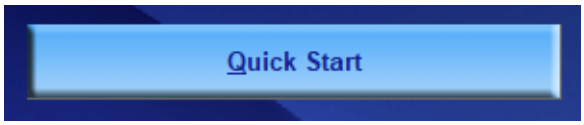
- Stressful memory (2 min)
- Rest (2 min)

As a general rule, the long version gives you the best overview of your client's physiological adaptability but the short one can be used when time is restricted. Running the full assessment during the first visit and then the quick assessment, once or twice during the duration of the therapy, is a good way to document client progress. The Quick assessment has similar screens.

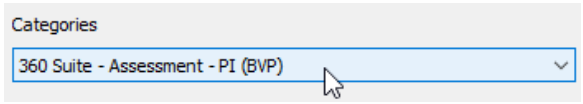
When using an encoder device with multiple sensor inputs, you have the opportunity to record physiological data that spans across three body systems: ANS (arousal and temperature), cardiovascular (finger pulse/EKG and respiration) as well as CNS (brainwaves). You do not have to connect all sensors to run the assessment but, as a general rule, more data is better than not enough. If time allows, we recommend recording physiological profile assessments with as many sensor types as possible.

Running the assessment

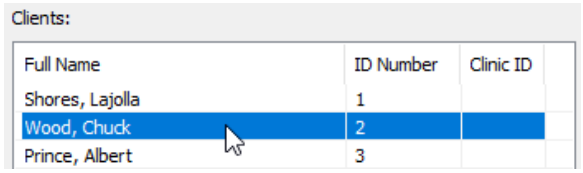
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



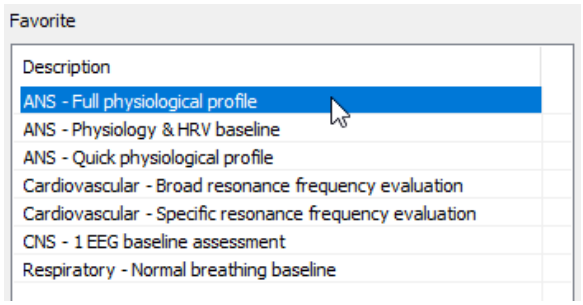
4. From **Categories**, select the **360 Suite - Assessment** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



6. From **Favorite**, select one of the following, as appropriate.
   - **ANS - Full physiological profile**
   - **ANS - Quick physiological profile**
7. Click **OK**.



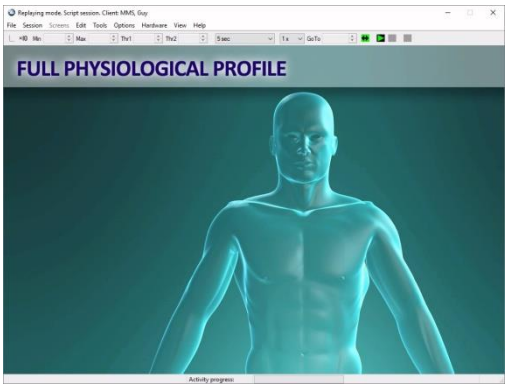
Assessment screens

The following is the series of screens, in chronological order, that the script displays during the assessment.

Introduction screen

When you launch the assessment, after selecting a client and clicking OK, the introduction screen appears.

Click the **Start** button when your client is ready to go.

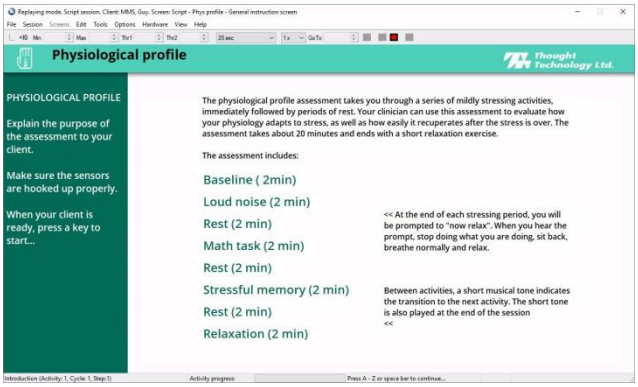


Instructions

This screen displays instructions.

Describe what the assessment is about to your client and make sure he understands that he should stop and ***let go*** at the end of each stress period when he hears the "Now relax" audio prompt.

Press a key on the keyboard to start the assessment.

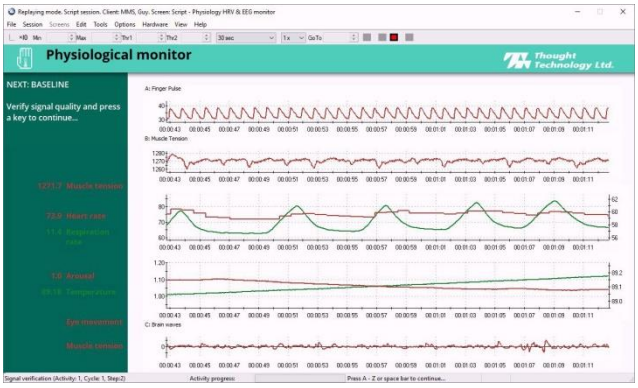


Signal verification

This screen displays the physiological signals without recording them.

Make sure that the sensors are working correctly and that you are seeing valid data.

When you and your client are ready, press a key on the keyboard to start the assessment.

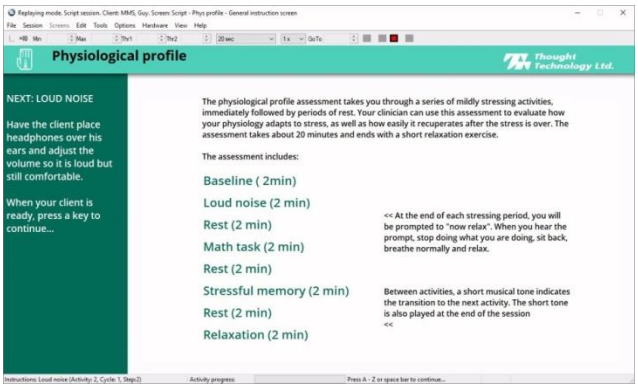
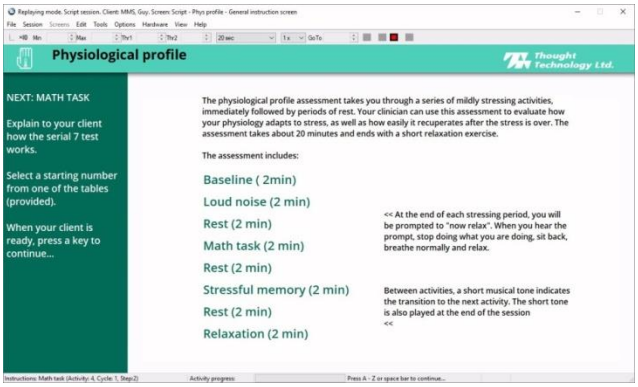


Baseline: Recording

This screen displays the physiological signals as they are being recorded.

Monitor the data and remind the client to stay quiet until the end of the baseline period.

The recording will be paused at the end of this step and music will play to help you set up the next activity.

Instructions: Loud noise During the next activity, the client will hear an audio track with a lot of unpleasant sounds (alarms, jackhammers, car horns, dentist drills, etc.). Help your client adjust the headphones comfortably and set the volume so it is loud, but not too loud. When you and your client are ready, press a key on the keyboard to continue.	
Loud noise: Recording This screen displays the physiological signals as they are being recorded. Watch the client for signs of distress. Stop or pause the recording if you notice anything wrong. At the end of the stress step, a voice prompts the client to "Now relax".	
Rest: Recording There is no pause at this point because the transition between a stress and a rest period can reveal a lot of information. Quietly encourage the client to just let go and relax the best he can for the next few minutes. Do not talk or respond to questions. At the end of the rest step, a short musical tone is played.	
Instructions: Math task The next stress activity is a serial 7 challenge. Use one of the tables of numbers that are provided at the end of the Reference manual to help you administer the challenge. Give the client a starting number (ex 1081), ask him to subtract 7 from that number and say the number out loud. If he is right, say "Right!" and tell him to keep at it as quickly as possible. If he is wrong, say "Wrong!", give him the right number and tell him to keep at it as fast as possible.	

At the end of the stress step, a voice prompts the client to "Now relax".	

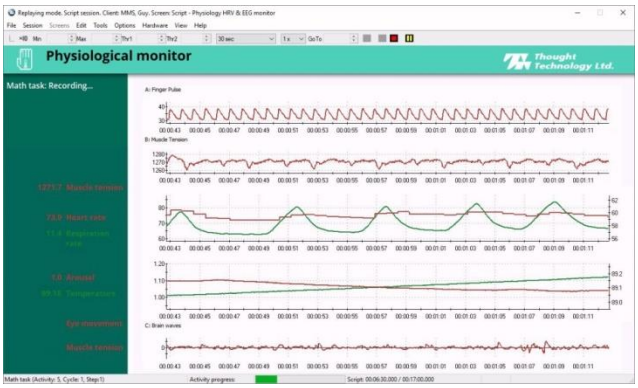
1081	941	801	661	521	381	241	101
1074	934	794	654	514	374	234	94
1067	927	787	647	507	367	227	87
1060	920	780	640	500	360	220	80
1053	913	773	633	493	353	213	73
1046	906	766	626	486	346	206	66
1039	899	759	619	479	339	199	59
1032	892	752	612	472	332	192	52
1025	885	745	605	465	325	185	45
1018	878	738	598	458	318	178	38
1011	871	731	591	451	311	171	31
1004	864	724	584	444	304	164	24
997	857	717	577	437	297	157	17
990	850	710	570	430	290	150	10
983	843	703	563	423	283	143	3
976	836	696	556	416	276	136	
969	829	689	549	409	269	129	
962	822	682	542	402	262	122	
955	815	675	535	395	255	115	
948	808	668	528	388	248	108	

Math task: Recording

This screen displays the physiological signals as they are being recorded.

As you are challenging the client, watch him carefully for signs of distress. Stop or pause the recording if you notice anything wrong.

At the end of the stress step, a voice prompts the client to "Now relax".



Rest: Recording

There is no pause at this point because the transition between a stress and a rest period can reveal a lot of information.

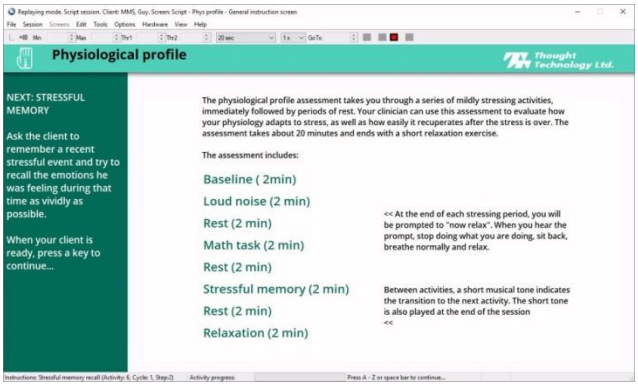
Quietly encourage the client to just let go and relax the best he can for the next few minutes. Do not talk or respond to questions.

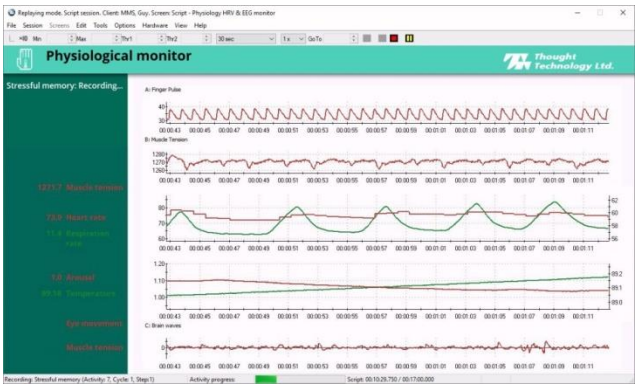
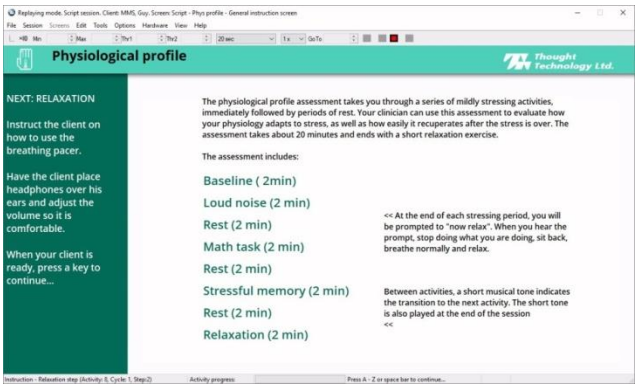
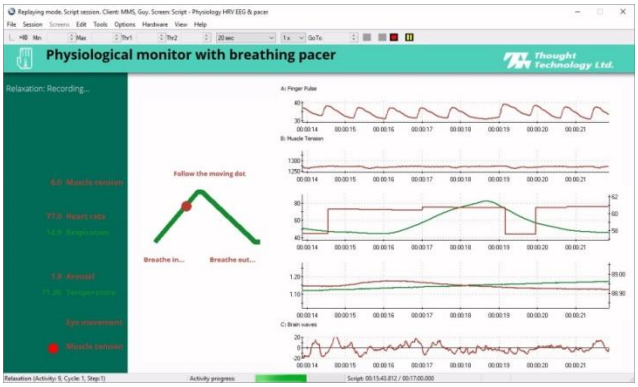
At the end of the rest step, a short musical tone is played.

Instructions: Stressful memory

Ask the client to remember a recent stressful event. Instruct him to visualize the moment as vividly as possible and try to recall how it made him feel at the time. Tell him he can either speak to you about it or just imagine it in his mind.

When you and your client are ready, press a key on the keyboard to continue.

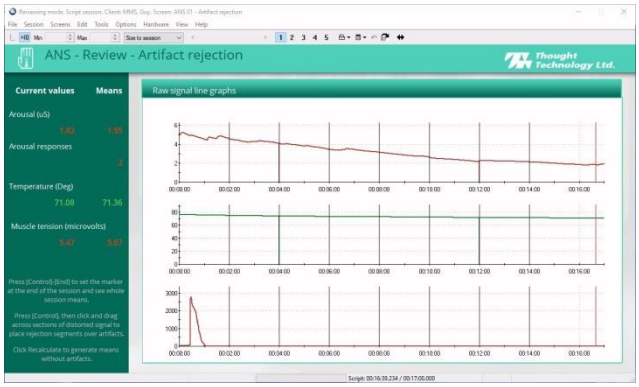


Stressful memory: Recording This screen displays the physiological signals as they are being recorded. Encourage the client to feel the event as he felt it when it was happening but watch him carefully for signs of distress. Stop or pause the recording if you notice anything wrong. At the end of the stress step, a voice prompts the client to "Now relax".	
Rest: Recording There is no pause at this point because the transition between a stress and a rest period can reveal a lot of information. Quietly encourage the client to just let go and relax the best he can for the next few minutes. Do not talk or respond to questions. At the end of the rest step, a short musical tone is played.	
Instructions: Relaxation The next activity is a 3 minute relaxation exercise with slow regular breathing. Help the client place headphones over his ears and adjust the volume so it is not too loud. When you and your client are ready, press a key on the keyboard to continue.	
Relaxation: Recording This screen displays the physiological signals as they are being recorded. Watch the client for signs of sleepiness and gently touch his arm to keep him awake. At the end of the relaxation period, a short musical tone is heard to indicate that the assessment is completed. Press a key to save the session.	

Review screens

01 – ANS artifact rejection

The screen shows line graphs of arousal, temperature and muscle tension. Use this screen to review the recorded signals and reject artifacts.



01 – Cardiovascular artifact rejection

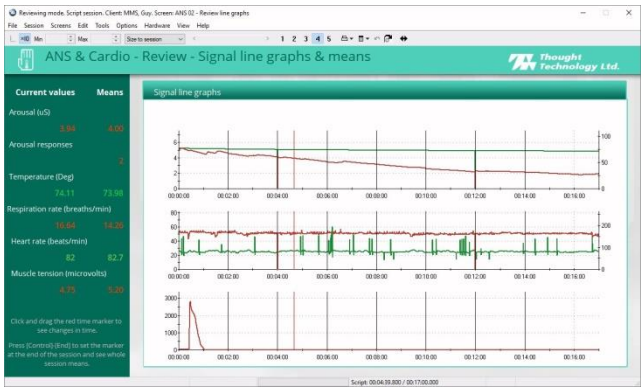
The screen shows line graphs of the finger pulse (BVP) or EKG and respiration signals (red) with corresponding inter-beat interval and respiration period signals (green). Use this screen to review the recorded signals and reject artifacts from the green IBI and respiration period graphs.

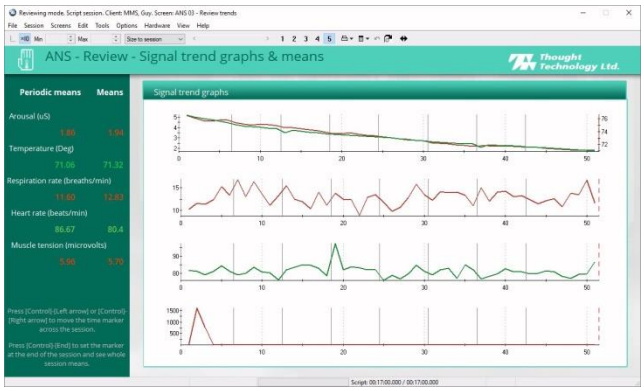
01 – CNS artifact rejection

The screen shows line graphs of EEG signal, on the top, and peak to peak amplitude of the various standard and user bands. Use this screen to review the recorded EEG signal and reject artifacts.

02 – ANS line graphs

The screen shows line graphs of the autonomic nervous system physiology. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.



03 – ANS trend graphs The screen shows trend graphs of the autonomic nervous system physiology. Use this screen to look for tendencies in the signal directions and confirm that self-regulation training is generating the desired change in physiology.	

Reviewing the session

At the end of a session, you can save the data and switch to the review mode where you can scroll through what was recorded and assess your client's physiological responses during the assessment. Look for normal and abnormal stress responses.

Artifact rejection

Reviewing the recorded data also includes looking for – and rejecting – artifacts. Since it is possible to record data from multiple physiological sensors at the same time, the review screens include artifact rejection screens for three body systems (ANS, Cardiovascular and CNS).

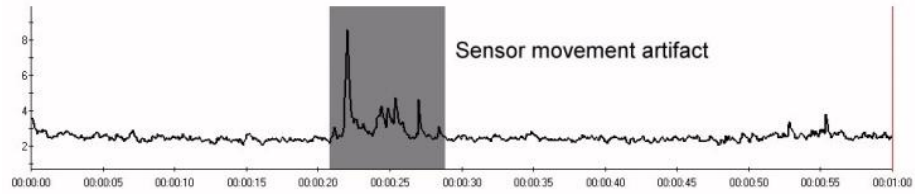
- The procedure for IBI data artifact rejection is described in the Cardiovascular system section of this manual.
- The procedure for brainwave artifact rejection is described in the CNS section of this manual.

Overview

ANS signals are fairly stable and much less prone to artifacts than other signal types. The two main types of artifacts that can occur are sensor movement and sensor detachment (falling off). The best way to minimise artifacts when recording arousal, temperature and muscle tension is to optimize your sensor placement methods and always instruct the client to reduce arm and hand movement to a minimum.

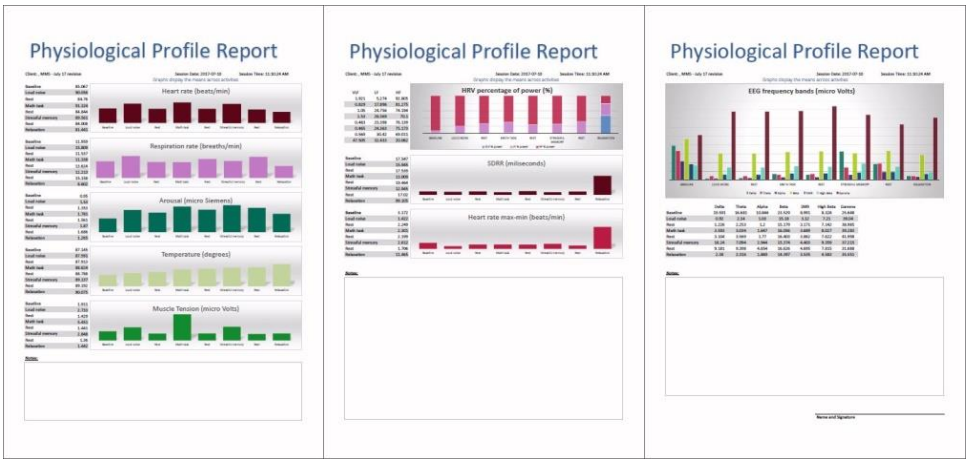
Procedure

If movement artifacts are detected, place a rejection segment over the affected sections to reject any signal distortion from the data analysis.



Generating a report

Both Physiological Profile assessments include a specialized report which can be printed from the review mode. The three page report compares means across all activities, to show how the client's physiology adapts to stress and how well it is able to recover during the resting periods. The report also provides a powerful visual tool to help you explain the goals of the self-regulation therapy.



Physiological & HRV baseline

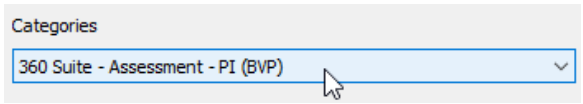
Baseline assessments are a quick way to get a snapshot view of your client's physiological state, any time during a visit. Most often, baseline assessments are recorded at the beginning (pre-training) or at the end (post-training) of a visit to see how your client's physiology is responding to the treatment.

- By comparing pre-training baseline means across multiple sessions, you can get an idea of your client's retention abilities and see if the skills, learned during self-regulation training, stick when he is away from your office and back into his everyday life conditions.
    - An upward trend shows that retention is occurring and the client is able to apply learned skills to his day to day routine.
    - A flat line indicates that the client has not managed to introduce his newly acquired skills into his life, yet. Homework exercises can be prescribed.
- By comparing post-training baseline means across multiple sessions, you can get an idea of how much learning is achieved during each session. At the beginning of a training plan, learning tends to be minimal. It increases over time until the task becomes too easy and no more learning occurs.
    - An increasing trend would indicate that the training sessions are having an immediate effect and learning is happening.
    - A flat line would show that the client is not able to learn the self-regulation skills. Many factors can come into play. Review your client's personal motivation to go through the therapy, your coaching methods as well as the challenge level settings on your self-regulation screens (too easy or too difficult are both inhibitors to learning).

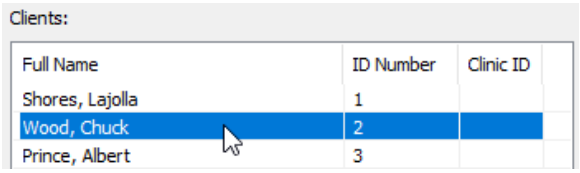
Running a session

1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.

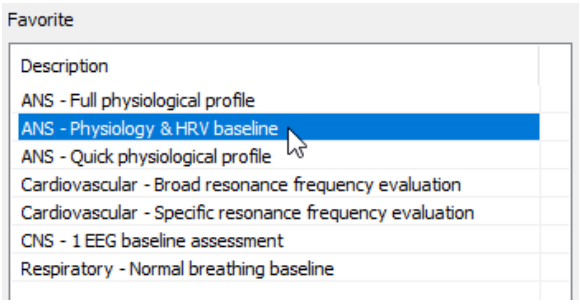
4. From **Categories**, select the **360 Suite - Assessment** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



6. From **Favorite**, select **ANS - Physiology & HRV baseline**.
7. Click **OK**.



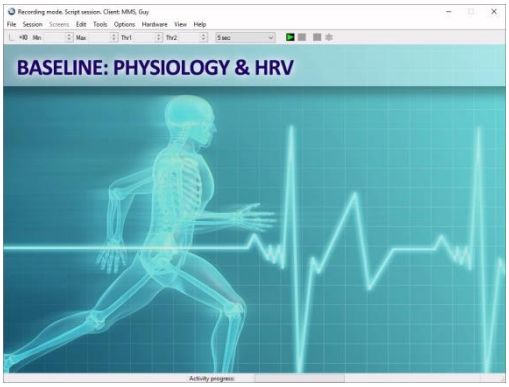
Assessment screens

The following is the series of screens, in chronological order, that the script displays during the assessment.

Introduction screen

When you launch the assessment, after selecting a client and clicking OK, the introduction screen appears.

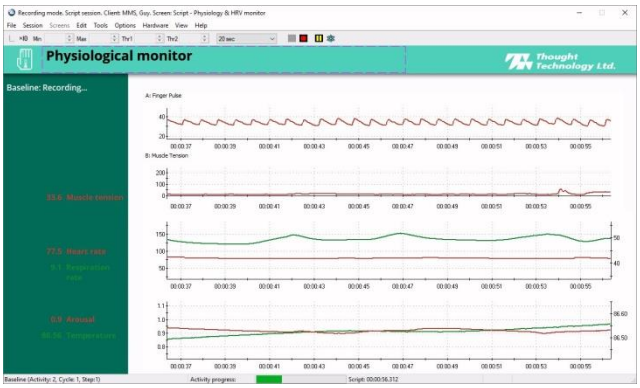
Describe what the assessment is about to your client and click the **Start** button when your client is ready to go.



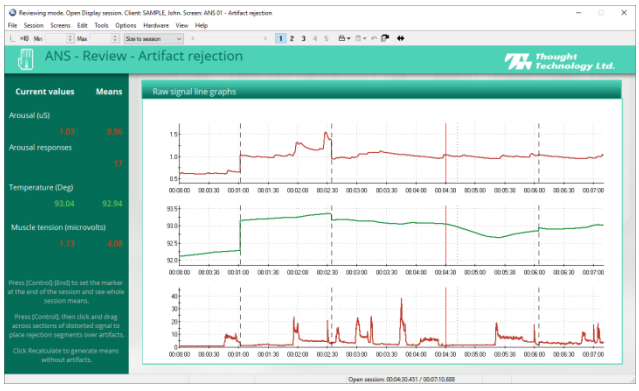
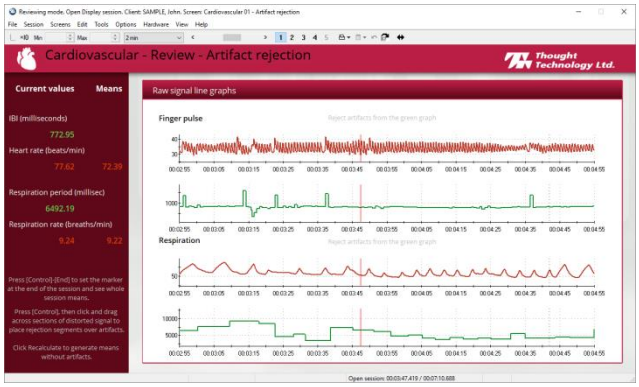
Instructions & signal verification

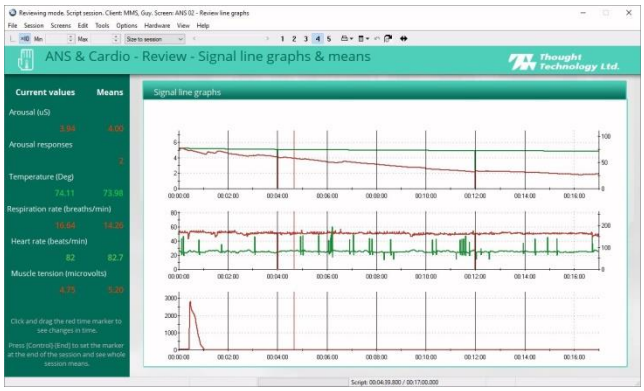
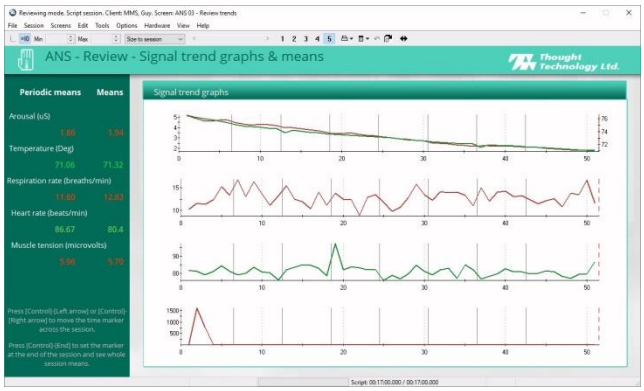
This screen displays instructions and allows you to verify that the physiological signals are good.

Press a key on the keyboard to start the assessment.

Baseline recording While the baseline is being recorded, make sure the signals stay as clean as possible throughout. The client should be relaxed without moving or falling asleep.	
End of session At the end of the baseline recording, a short musical chime is heard and the session is paused. Press a key on the keyboard to save the session.	

Review screens

01 – ANS artifact rejection The screen shows line graphs of arousal, temperature and muscle tension. Use this screen to review the recorded signals and reject artifacts.	
01 – Cardiovascular artifact rejection The screen shows line graphs of the finger pulse (BVP) or EKG and respiration signals (red) with corresponding inter-beat interval and respiration period signals (green). Use this screen to review the recorded signals and reject artifacts from the green IBI and respiration period graphs.	

02 – ANS line graphs The screen shows line graphs of the autonomic nervous system physiology. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.	
03 – ANS trend graphs The screen shows trend graphs of the autonomic nervous system physiology. Use this screen to look for tendencies in the signal directions and confirm that self-regulation training is generating the desired change in physiology.	
02 – Review line graphs The screen shows respiration and heart rate on the top graph, VLF, LF & HF % power on the middle graph as well as arousal and temperature on the bottom graph. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.	

Self-regulation training tools

Self-regulation training with arousal involves lowering the overall level of the signal and reducing the frequency of arousal responses. Training usually happens in two stages. During the first stage, the client's task is to just watch the screen and be aware of his internal ***chatter***. Every so often, the client will see sudden rises in the signal. Each time this happens, he should try to detect what the internal event was that triggered the rise. After a while, the link between an internal event and the signal rise on the screen will become easier to make. The second stage of training consists of learning to ***defuse*** the response to a detected internal trigger. This generally involves thoughts of ***letting go*** or ***detaching one's emotions from the event***. With practice, high responders can learn to reduce the magnitude of their emotional responses.

Self-regulation training with hand warming consists mainly of trying to increase the temperature in the hands and fingers. Since this is a slow changing signal, training is most effectively achieved by focussing on relaxation. Coaching the client through simple relaxation techniques, such as slowing down his

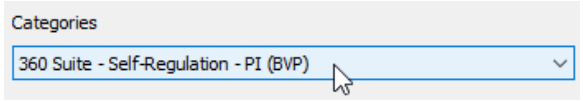
breathing, letting his upper body or low back muscles relax or just closing his eyes and imagining that he is in a warm comfortable place can help. Having him actively visualizing that he is extending his hands towards a crackling fireplace or rubbing his hands together can also trigger an increase in peripheral blood circulation.

A difficult aspect of thermal biofeedback is that the more the client forces effort and ***tries*** to warm their hands, the lower their finger temperature will fall. This is because "trying" is sympathetically activating. The key to raising finger temperature is relaxation – completely ***letting go***.

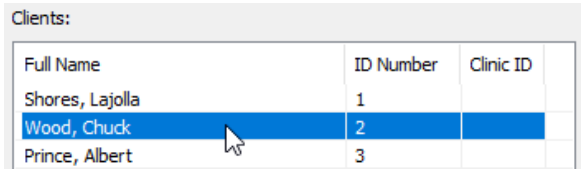
Running a session

1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.

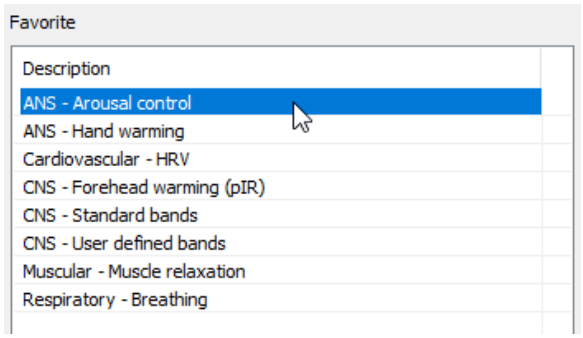
4. From **Categories**, select the **360 Suite - Self-Regulation** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



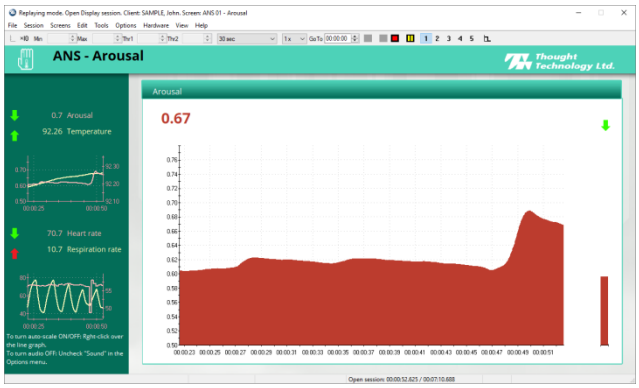
6. From **Favorite**, select one of the following, as appropriate.
   - **ANS - Arousal control**
   - **ANS - Hand warming**
7. Click **OK**.



Self-regulation screens - Arousal

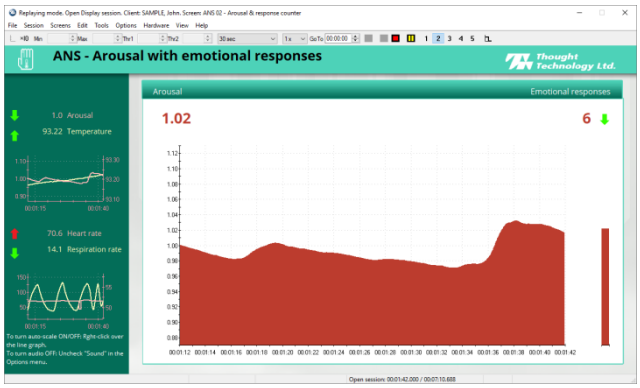
01 – ANS Arousal

This classic skin conductance biofeedback screen shows a filled graph of the arousal level. As stress goes up, arousal increases and the line moves upward. As stress goes down, arousal decreases and the signal moves downward. A small bar on the right reflects the signal's direction by getting taller when arousal increases and shorter when it decreases. A proportional periodic tone is also played, so the client can close his eyes to do biofeedback training. The training goal is to let the tone get as low as possible. When the tone reaches the lowest point, it stops to allow the client to become aware of his internal mental and emotional processes.



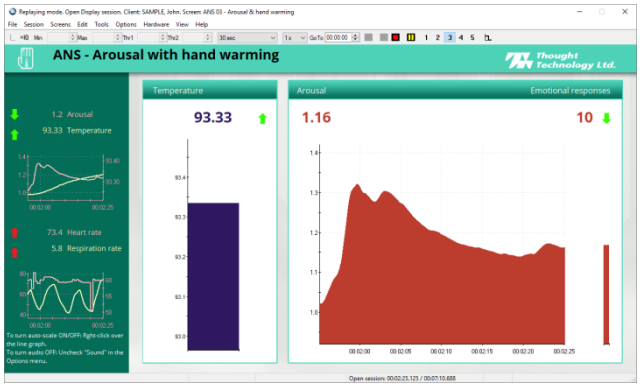
02 – ANS Arousal & response counter

This screen is similar to the previous screen with the addition of a response counter. The counter keeps track of how many arousal events happen during the session. The training goal is the same as for the previous screen with the additional task of trying to keep the number of reactions as low as possible.



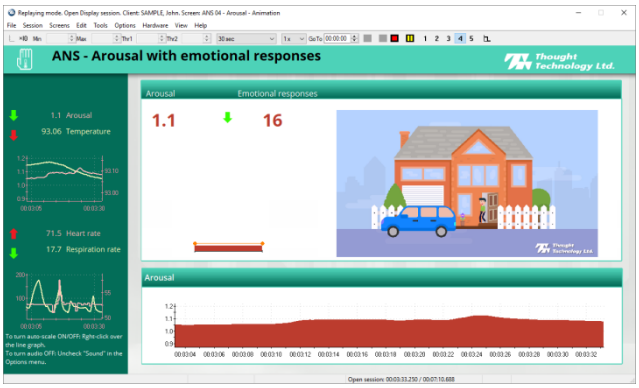
03 – ANS Arousal and hand warming

This screen combines arousal training with hand temperature monitoring. Feedback is similar to the previous screen with the addition of music, which plays quietly if the temperature decreases and at full volume when it increases. The training goal is the same as for the previous screen with the additional task of trying to keep the music playing loudly (i.e. temperature not going down).



04 – ANS Arousal & animation

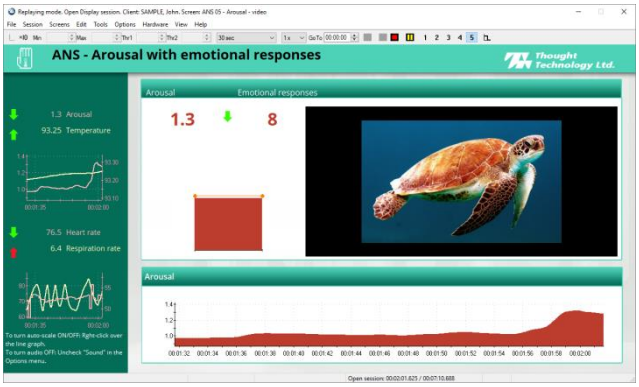
This screen is similar to the Arousal & response counter training screen. When arousal goes down, the animation moves forward and music plays at full volume. When arousal goes up, the animation reverses and music plays quietly. The training goal is to keep the arousal level and response counter as low as possible.



05 – ANS Arousal & video

This screen is similar to the previous one but feedback is given with a Video Stream instrument. The video image enlarges when the client's arousal level is going down and shrinks when it is going up.

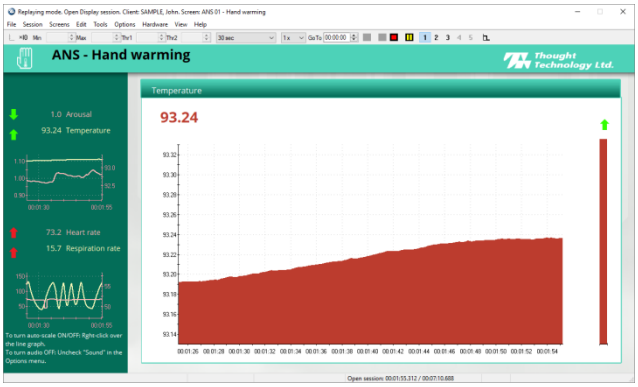
Information about the Video Stream Instrument is provided on page 26.



Self-regulation screens – Hand warming

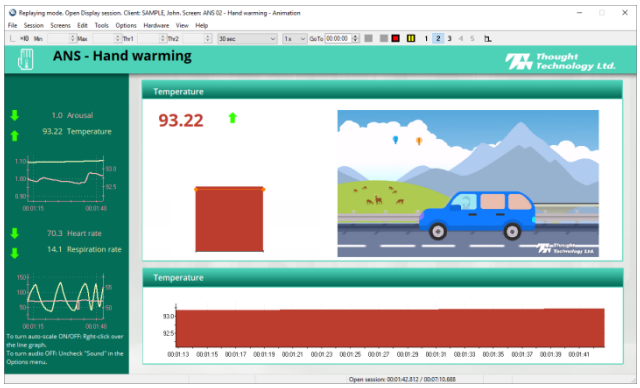
01 – ANS Hand warming

This classic hand warming biofeedback screen shows a filled graph of the temperature signal. As stress goes up, vasoconstriction reduces the amount of blood in the hand and fingers get colder, making the signal go down. As the person relaxes, blood flow is slowly restored and temperature goes up. A small bar on the right reflects the signal's direction by getting taller when temperature increases and shorter when it decreases. An inverse-proportional periodic tone is played, so the client can close his eyes to do biofeedback training. The training goal is to let the tone get as low as possible.



02 – ANS Hand warming & animation

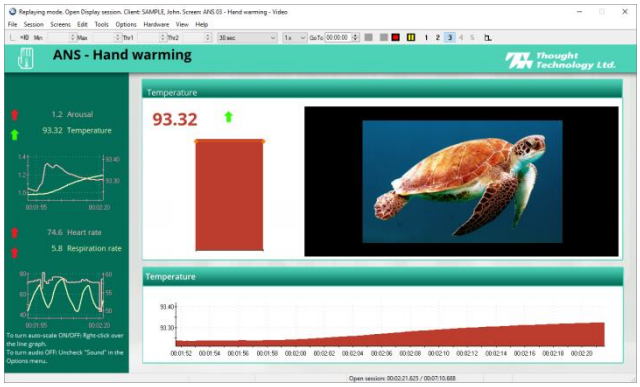
This screen is similar to the previous screen. When the temperature goes up, the animation moves forward and music plays at full volume. When it goes down, the animation pauses and music plays quietly. The training goal is to keep the temperature as high as possible.



03 – ANS Hand warming & video

This screen is similar to the previous one but feedback is given with a Video Stream instrument. The video image enlarges when the client's temperature is going up and shrinks when it is going down.

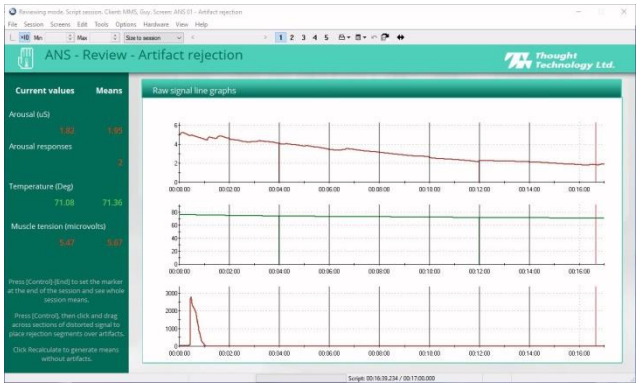
Information about the Video Stream Instrument is provided on page 26.



Review screens

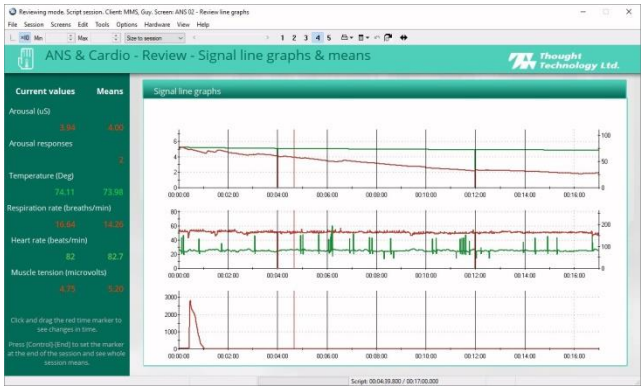
01 – ANS artifact rejection

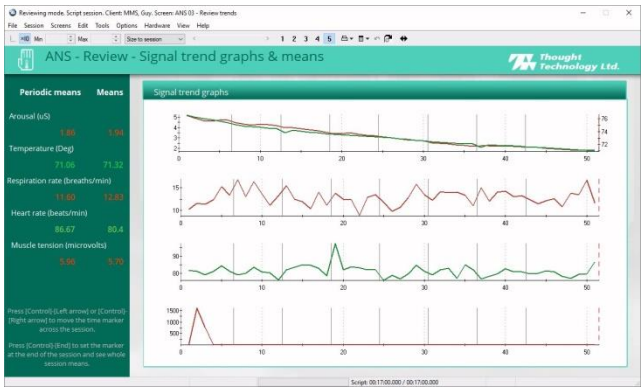
The screen shows line graphs of arousal, temperature and muscle tension. Use this screen to review the recorded signals and reject artifacts.



02 – ANS line graphs

The screen shows line graphs of the autonomic nervous system physiology. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.



03 – ANS trend graphs The screen shows trend graphs of the autonomic nervous system physiology. Use this screen to look for tendencies in the signal directions and confirm that self-regulation training is generating the desired change in physiology.	

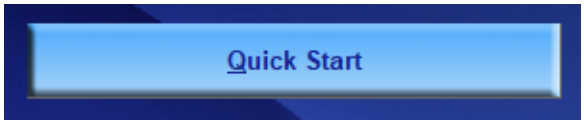
Biofeedback-assisted relaxation training tools

The progressive muscle relaxation training session uses a professionally recorded guided relaxation exercise to help your client access a deep physical and mental relaxation state. The session takes about a half-hour to run, including preparation time. After practicing this relaxation technique a few times, the client should be more conscious of muscle tension in his body and learn how to voluntarily decontract selective muscle groups and activate the relaxation response.

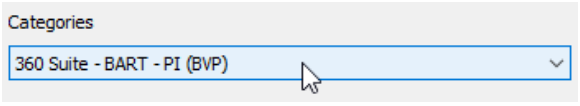
Note: *The progressive muscle relaxation training session is part of the ANS tool set because, although muscle activity is under the control of the central nervous system, progressive relaxation uses voluntary conscious intention to trigger the relaxation response and favor the sympathetic nervous system.*

Running a session

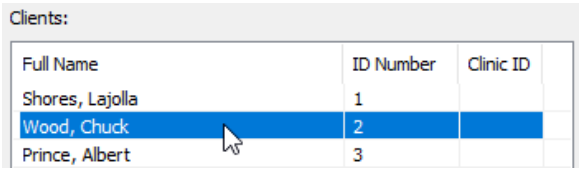
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



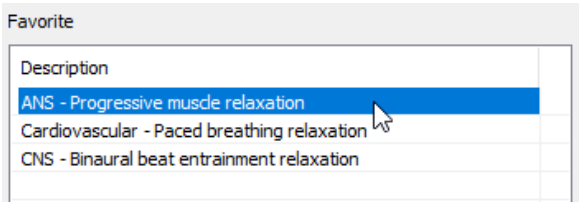
4. From **Categories**, select the **360 Suite - BART** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



6. From **Favorite**, select **ANS - Progressive muscle relaxation**.
7. Click **OK**.

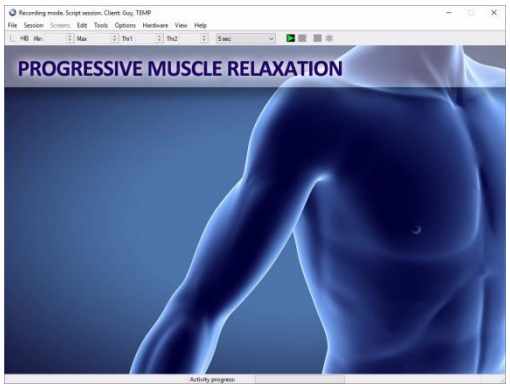


Session screens

Introduction screen

When you launch the assessment, after selecting a client and clicking OK, the introduction screen appears.

Click the **Start** button when your client is ready to go.



Instructions & signal verification

This screen displays instructions and allows you to make sure that the sensors are properly placed on the client and the recorded signals are valid.

Describe what the relaxation session is about to your client and explain the three parts of the exercise.

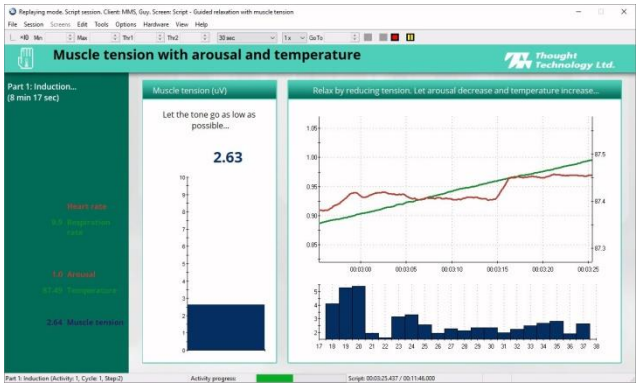
Press a key on the keyboard to start the session.

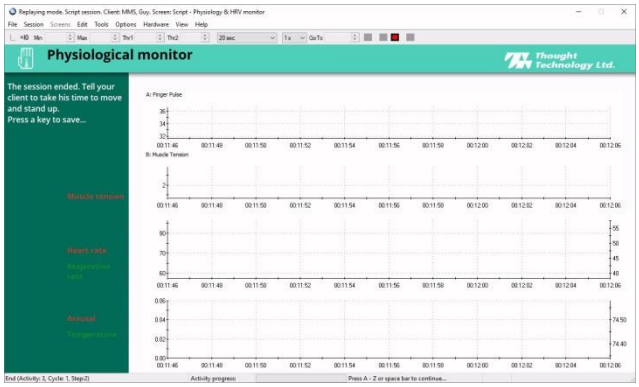
Guided relaxation

The main screen shows signal graphs for arousal and temperature and a trend graph of muscle tension. The same screen is used for **Part 1: Induction**, **Part 2: Quiet relaxation** and **Part 3: Wake up**.

Note: *You can modify the duration of Part 2, but Part 1 and Part 3 are of fixed duration.*

The relaxation exercise should be done with eyes closed lying down or reclining in a comfortable chair.



Session ending Near the end of the session, quiet music starts playing for the last two minutes. This helps the client know that the exercise is ending and allows him a slow waking up period.	
Saving the session At the end of the relaxation session, you are given the opportunity to save the data if you want to be able to review it. Press a key on the keyboard to save the session.	

Central nervous system

The central nervous system includes the brain and the spinal cord but CNS self-regulation tools generally focus on brain activity. In broad terms, the CNS controls such things as how we *integrate* sensory information, *interpret* what we perceive, *decide* how to respond and *act* on our decision. Significant changes in CNS activity can be observed from brainwaves (EEG), measured from the surface of the head or from changes in temperature detected over specific areas of the head, like the forehead.

Brainwaves

Brainwaves, recorded from the surface of the scalp, are generally understood to broadly reflect a person's consciousness level. Beta waves are associated with being alert, thinking and problem solving, but beta waves are also present when a person is worrying and overthinking. When a person is sitting down and not doing anything in particular, alpha waves appear. Alpha waves are associated with relaxation, daydreaming and visualizing. When recording over the sensory motor cortex, specifically, a specialised sub-group of frequencies between beta and alpha waves -- the sensory motor rhythm (SMR) -- reflects a relaxed state with awareness of one's body. As theta waves become dominant, the person's state shifts toward inattentiveness or daydreaming (eyes open), or drowsiness (eyes closed) but not quite asleep. When the person falls asleep, delta waves take over.

A number of health conditions are associated with atypical brainwave patterns. People with attention deficit disorders, for example, can display a lot of theta activity when they are trying to focus or pay attention. Anxious people have difficulty falling asleep because their brain frequently can't let go. They stay in beta instead of shifting to alpha, theta and into delta. Brainwave self-regulation can help a person

become aware of any atypical brainwave patterns and can teach him to voluntarily activate or inhibit selective brainwave frequencies to alter his overall state of consciousness.

While beginner biofeedback practitioners can add ANS or Cardiovascular self-regulation training to their practice with just a few hours of professional training, learning the skills required for doing neurofeedback with clinical success and without putting your client at risk takes a lot of time and practice. We do not recommend doing brainwave self-regulation training without professional clinical guidance and many hours of supervised practice. You can find information on expert mentoring and clinical training by contacting the International Society for Neurofeedback and Research (www.ISNR.org).

Forehead temperature

Passive infrared (thermal) biofeedback can also be used to indirectly measure gross changes in brain activation by detecting and feeding back on temperature changes on the forehead. When a person's attention is raised – ex. in order to perform a mental task -- blood circulation in the frontal lobes increases. This increase in blood flow generates a rise in local temperature which, as it slowly propagates to the surface of the skull, can be detected by the passive infrared sensors.

Training your clients with passive infrared biofeedback on the forehead teaches them to voluntarily increase their forehead temperature and indirectly, the blood flow to their frontal lobe. This increase in blood flow may have beneficial effects on your client's executive functions.

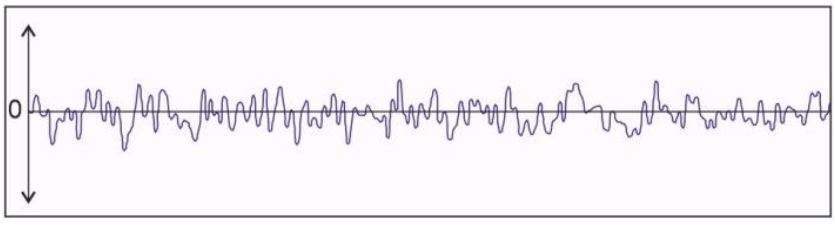
Amplitude and frequency biofeedback

The raw electroencephalography (EEG) signal is measured in microvolts (µV) and picked up from the surface of the head using small electrodes held on the scalp with conductive paste. Most of the brainwave self-regulation protocols in the 360 Suite require one channel. A few specialized protocols require two channels. Each channel uses three electrodes, positive (blue), reference (yellow) and ground (black).

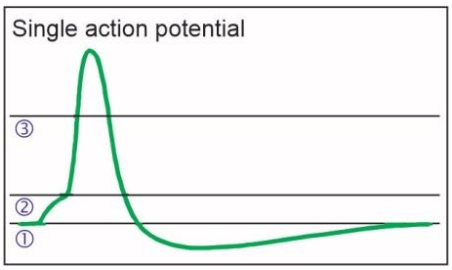
Electrodes are placed on the head following the 10-20 EEG electrode placement system. The ***signal*** electrode is the positive one and it is placed on the desired electrode location (ex. CZ). Most of the time, the reference electrode is placed on a spot on the body where no EEG is expected to occur, such as the earlobe. The ground electrode is often placed on the earlobe on the other side of the head.

Teaching EEG electrode montage techniques is not within the scope of this document, but we recommend learning about electrode montage to any clinician who wants to do neurofeedback. To this end, a brief description of the 10-20 electrode placement system is provided on page 14.

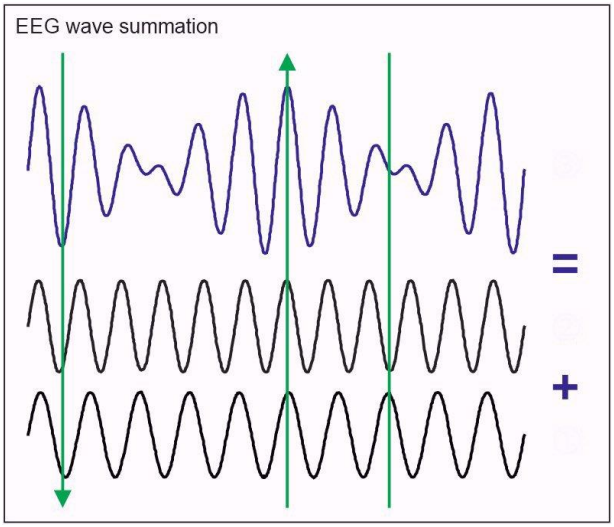
Physiologically, the ***raw*** EEG signal (as it comes directly from the sensor) is the summation of many tiny electrical impulses generated by the neurones within a small area under the positive electrode. The equipment filters out very slow drifts within the signal to prevent upward or downward changes in the baseline. The resulting signal is an oscillatory (wavy) line that moves up and down around the zero line of a graph. The average peak to peak amplitude of the raw EEG signal is between 10 and 100 µV.



The EEG signal that is perceived at the signal electrode results from multiple electrical impulses, generated by nearby neurones (action potentials).



A single action potential starts from a resting potential level (1) and occurs when the neurone is stimulated by another neurone. If the stimulus is sufficiently strong to trigger a response, i.e. it goes over the response threshold (2), the action potential occurs and a rapid depolarization and repolarization process takes place, which creates a single wave. The amplitude of each action potential (3) and the frequency of firing of a neurone are fairly constant and determined by the physiology of that particular type of nerve cell.



The raw EEG signal we collect is the summation of the hundreds of thousands of neurons firing at their respective intensities.

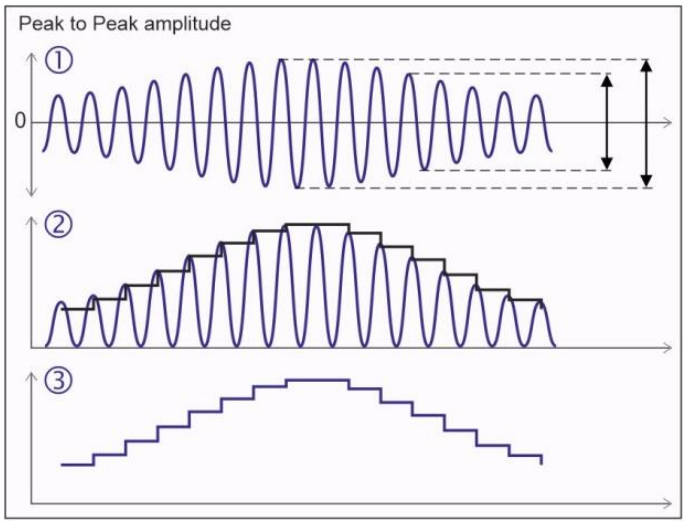
If two sine waves of slightly differing frequencies are summed together, the resulting signal illustrates how raw EEG is created: A low point is created when the troughs of both source waves occur at the same time. A high point is created when the peaks of both source waves occur at the same time. The signal stays near zero when the peak of one wave is summed to the trough of the other. By observing the raw signal moving across the graph, an expert EEG clinician can detect brainwaves as they occur but it is not possible without more powerful equipment to assess the activity of single neurones or even individual brain structures.

For the purpose of doing neurofeedback, the software uses various mathematical algorithms to process the raw EEG signal and extract clinically useful information from it. Generally, the EEG is composed of waves of various frequencies, from 1 Hertz (1 oscillation per second) to about 40 Hertz (Hz). A series of digital filters cut out the wave activity for each standard band. The default frequency cut-off values used for the 360 Suite are:

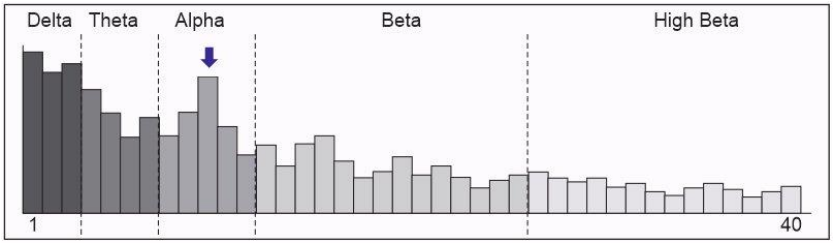
- Delta, 1-3 Hertz
- Theta, 4-8 Hertz
- Alpha, 8-12 Hertz
- Beta, 13-21 Hertz
- SMR, 12-15 Hertz

- High beta, 21-35 Hertz
- Gamma, 35-64 Hertz

The wavy signal from each filter is then converted to an amplitude value by calculating the difference between the lowest and the highest value for each wave. The peak to peak amplitude calculation is what is used for brainwave biofeedback.



Another commonly used processing method for analysing brainwaves is similar to what the software does to calculate frequency domain heart rate variability metrics (VLF, LF & HF). By processing 1 or 2 seconds worth of raw EEG signal through a Fast Fourier Transform (FFT), the time domain ***raw*** signal is converted to a frequency domain spectrum of frequencies, from 1 to 40 Hz.



The software uses the FFT to calculate the alpha ***peak*** frequency value. This is the frequency of the tallest bar within the alpha band (ex. 10 Hz).

Assessment tools

CNS baseline assessments

The 1 EEG baseline assessment provides a quick way to get an overall snapshot of your client's resting brainwave activity. The assessment is usually performed with the positive electrode on the topmost central 10-20 location, CZ, and records 2 minutes with eyes open and 2 minutes with eyes closed. By comparing the mean amplitude values for the standard bands in the two conditions, you can identify typical and atypical shifts in brainwave power.

When the client's eyes are open (EO), his mind is naturally trying to process visual information, so we expect to see some beta activity. Because the client is in a relaxed state and was prompted to "think about nothing specific", his mind will be wandering and some alpha, theta or delta waves can be present. Essentially, fast brainwaves should be dominating.

When your client closes his eyes (EC), his mind naturally shifts into an alpha dominant state. Eyes closed resting EEG tends to show more alpha, more theta - possibly more delta if the client becomes sleepy -

and less beta than eyes open resting EEG. The overall power should shift towards the slower brainwaves.

Things to keep in mind

The central nervous system is a very intricate network of neurones and brain structures in constant interaction. Trying to assess the brain's function with one electrode on one 10-20 location is a bit like trying to understand the conversations in a conference room by placing a glass against the door and putting your ear against the bottom of the glass: At best, you'll be able to make out the tone of the closest conversationalist and detect when the room goes silent or explodes in applause. The 1 EEG baseline assessment is a coarse tool which will reveal very large and long lasting shifts in brainwave activity.

The awake brain is constantly generating waves of multiple frequencies. While going from eyes open to eyes closed creates a significant and observable shift in the frequency spectrum's power distribution, it will not completely stop the production of specific frequencies. You will still see beta waves during the EC stage and alpha during the EO stage.

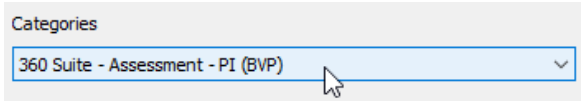
Running the assessment

Before you begin:

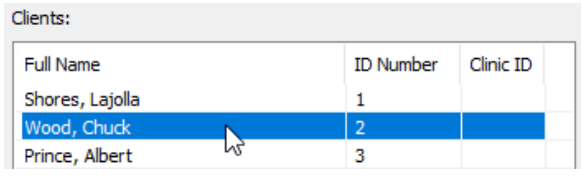
- Plug the sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
- Prepare the client's skin for electrode placement. (See page 16 for more information about skin preparation.)
- Ensure that electrodes are well-placed on the client. (See page 14 for more information about EEG electrode placement.)
- Check the impedance of the EEG sensors. (See page 29 for more information about impedance checking.)

1. Click **Quick Start**.

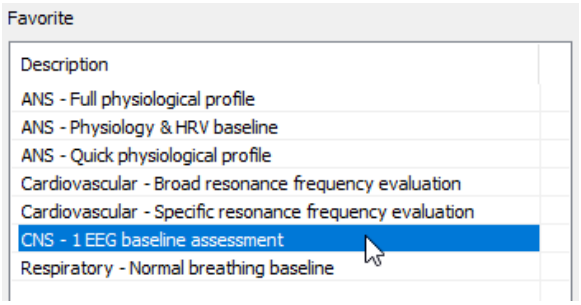
2. From **Categories**, select the **360 Suite - Assessment** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



3. From **Clients**, select a name.

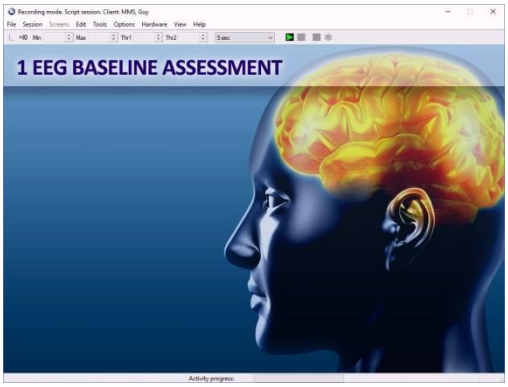
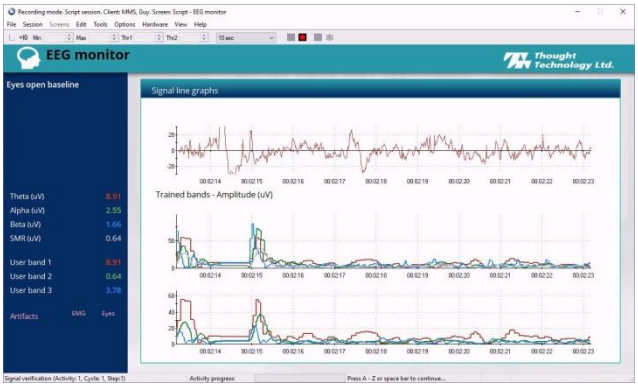


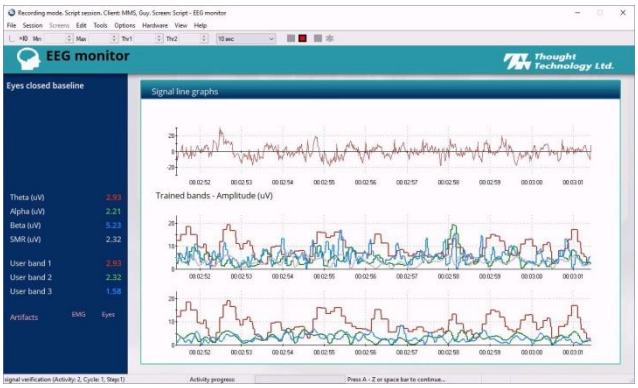
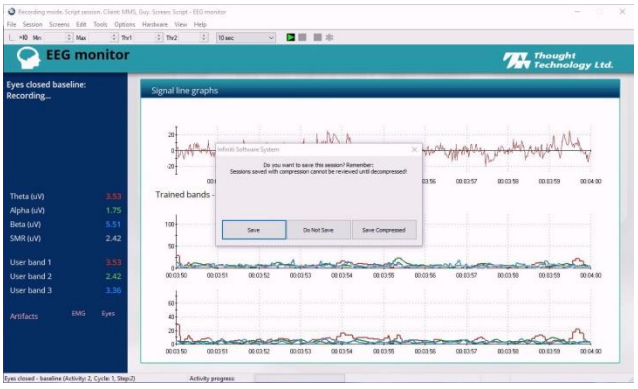
4. From **Favorite**, select **CNS - 1 EEG baseline assessment**.
5. Click **OK**.



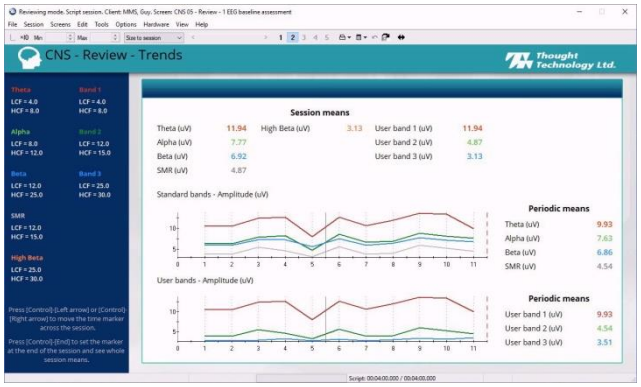
Assessment screens

The following is the series of screens, in chronological order, that the script displays during the assessment.

Introduction screen When you launch the assessment, after selecting a client and clicking OK, the introduction screen appears. Click the **Start** button when your client is ready to go. 	
Signal verification This screen shows the raw EEG signal to allow you to make sure that the electrodes are properly placed on the client and the recorded signals are valid. It is recommended to check electrode impedance, at this step of the assessment. Describe what the baseline session is about to your client and explain how he should relax and avoid moving his eyes or clenching his teeth during the recording. Prompt him to think about nothing specific and look straight ahead of him, focusing on point on the wall or an object on your desk. Press a key on the keyboard to start the EO baseline recording.	

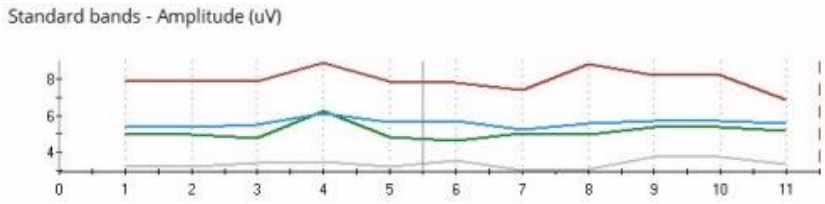
Eyes open baseline recording While the baseline is being recorded, make sure the signal stays as clean as possible throughout. Gently coach the client to stay relaxed without moving or falling asleep.	
Baseline pause Recording is paused after the eyes open baseline stage to allow you to instruct the client to close his eyes, let his eyes rest in a natural position, maybe looking inside at the tip of his nose. Remind him to minimise movement and eye blinks. Press a key on the keyboard to start the EC baseline recording.	
Eyes closed baseline recording While the baseline is being recorded, make sure the signals stay as clean as possible throughout. Gently coach the client to stay relaxed without moving or falling asleep.	
End of session At the end of the baseline recording, the recording stops and you are prompted to save the data. Press a key on the keyboard to save the session.	

Review screens

01 – CNS artifact rejection The screen shows a line graph of the raw EEG at the top and the peak to peak signals for the standard and user bands below. Use this screen to review the recorded signals and reject artifacts.	
05 – CNS Review - 1 EEG baseline assessment The screen shows line graphs of the standard and user bands. The corresponding cut-off frequencies are shown on the left. Use this screen, once artifacts have been rejected, to identify upward or downward shifts in mean amplitude values. A vertical line, in the middle of the graphs, shows when the client went from EO to EC.	

Reviewing the session

At the end of the baseline recording, you can save the data and switch to the review mode where you can scroll through what was recorded and observe changes in your client's brainwave activity during both phases of the baseline assessment. Look for normal and abnormal shifts in dominant frequencies, which, in the trend graphs, would appear as clear upward or downward slopes during EO or EC or significantly different mean levels between EO and EC states.



Artifacts

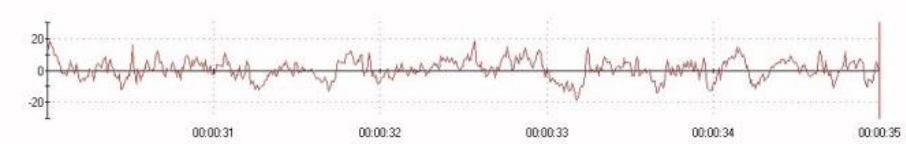
The EEG signal is particularly susceptible to artifacts and any statistical analysis of an EEG recording is highly unreliable if you do not do any artifact rejection. There are three major sources of artifacts to be aware of: Muscle tension, eye blinks/movement and electrical interference.

Proper coaching can help a client reduce his level of muscle tension and of eye movement. In addition, the 360 Suite provides three methods of removing artifacts from recorded EEG signals. These are:

- Real-time artifact rejection. (See page 22 for more information about real-time artifact rejection.)
- Automatic artifact rejection. (See page 23 for more information about automatic artifact rejection.)
- Manual artifact rejection. (See page 23 for more information about manual artifact rejection.)

Normal EEG

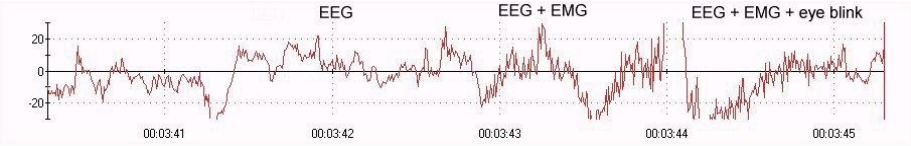
As previously described, normal EEG is a blend of fast and slow waves of varying amplitudes. Short fast waves ride on top of tall slow waves.



In general, the amplitude of normal EEG is within plus or minus 40 microvolts (+/- 40 µV) but this can vary between people. Always check the scale setting on the raw EEG line graph to assess the ***normal*** amplitude for a given client. Teaching how to recognise and identify normal brainwaves in the EEG signal is not in the scope of this document but learning this skill would be a worthwhile exercise for any clinician who wants to do neurofeedback.

Muscle tension

Muscle tension artifacts occur when upper body muscles are contracting during the recording. Because the electromyographic (EMG) signal is similar in type to the EEG signal, it can easily be picked up by the EEG sensor. EMG gets mixed up with – and completely distorts – the EEG signal. Be particularly watchful for clenching teeth, frowning or tight shoulders. Chewing gum is also a frequent source of muscle tension artifacts. Muscle tension artifact generally appears as high frequency and high amplitude EEG. Even a slight frown can distort the normal EEG signal significantly.



Encourage the client to relax his muscles if you notice fretfulness or impatience during the recording. It may help to have him contract and relax shoulder and face muscles a few times before running the assessment. Taking a few slow deep breaths can also help.

Eye blinks

Eye movement (looking around) and eye blinks look like very large slow waves that completely overpower the EEG. Sometimes you can see a few of them in a row if the client is really nervous. While looking around can be minimised with a bit of coaching before the assessment starts, blinking is more difficult to avoid because telling the client to stop blinking can make him blink even more.

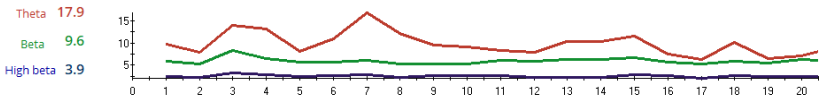
At the beginning of the session, during the signal verification step, tell the client to watch the signal while moving his eyes around a bit and voluntarily blinking a few times. Explaining how artifacts distort the good EEG signal and make the assessment less useful can help as well. During the eyes open phase, have the client look at a specific point on the wall in front of him or at an object on a table or desk placed in front of him (not on a side). During the eyes closed phase, tell the client to let his eyes relax in their natural position inside his head. If he is not sure about where that is, tell him to gently look inside (no straining) towards the tip of his nose. Allow a few seconds before continuing with the recording.

Self-regulation training tools

The main clinical purpose of the central nervous system (CNS) self-regulation tools is to help clients become aware of the changes that can occur in their mind states (anxiety, overthinking, lack of focus,

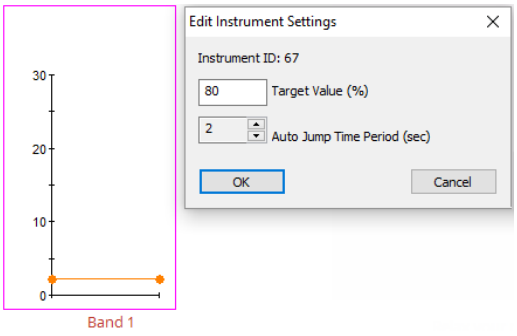
sleepiness, etc.) and learn to voluntarily shift their dominant brain activity up or down the spectrum to favor preferred mind states.

Brainwaves are, by nature, very labile. While arousal or hand temperature are slow and steady signals, EEG brainwave amplitude goes up and down constantly and rapidly. When doing EEG training, trends are more important than single up or down changes. Most CNS self-regulation screens display a trend graph which plots periodic means to make increasing or decreasing tendencies more obvious.



Classical neurofeedback training consists of setting a fixed threshold at a value defined by the clinician (clinical target) and then telling the client to try to get his EEG amplitude over or under the threshold as often as possible. If the client is able to learn the task, he becomes able to achieve the goal more often and sustain the state over a longer period of time each time.

Proper threshold setting is important but requires a good deal of clinical experience to be able to do it right. If the threshold is set to a position where the task is too easy, the client doesn't learn because he gets feedback without effort. If the threshold is set to a position where the task is too difficult, the client doesn't learn because he rarely gets feedback and cannot tell when his internal strategy is working. On screens that use threshold controlled feedback, the thresholds are set to adjust themselves automatically to follow the 80/20% rule. By default, thresholds are maintained in a position where feedback is given about 80 % of the time, so the client has to make an effort about 20 % of the time. You can adjust the target percentage value before starting a session by right-clicking over each bar and selecting **Edit Instrument Settings**:



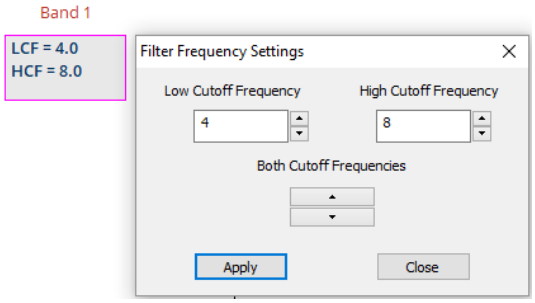
Make the task easier by increasing the target value. Make the task more difficult by lowering it. The settings also allow you to define how often the thresholds should be adjusted. By default, they ***jump*** every 2 seconds. By increasing the auto-jump time period, you give the client more opportunity to try succeeding before the software adjusts the threshold.

Some clients don't like the automatic threshold because it keeps moving around and they don't understand what they have to do to get positive feedback. You can toggle any bar graph's threshold mode between automatic and manual by right-clicking over the bar and selecting **Threshold Mode**, then selecting either **Automatic** or **Manual**.

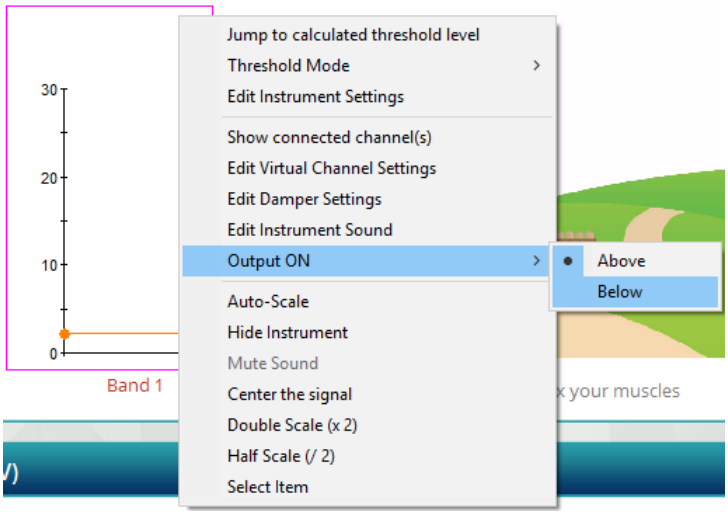
Very often, neurofeedback is done with up to three EEG bands. In general, one frequency range is desired (rewarded) while the others are undesired (inhibited). The client has to learn to produce more activity within the ***reward*** band and less activity within the ***inhibit*** bands. On a neurofeedback screen, a band is displayed as a colored bar which becomes taller or shorter, following the band's amplitude changes. The training goal (success) is defined as three conditions: Get the reward bar over its threshold and keep the inhibit bars under their thresholds. The reward and inhibit frequency bands can vary across protocols but the strategy is generally the same. If the client is able to learn the task, he becomes able to achieve the goal more often and sustain the state over a longer period of time each time.

The 360 Suite includes two sets of EEG-based self-regulation screens. The ***Standard bands*** screens are based on existing protocols. The reward and inhibit bands are determined by the protocol and should not

be changed unless there is a valid clinical reason for doing so. The ***User bands*** screens are designed to be modified to your client's specific needs. Each screen displays the cut-off frequencies for Band 1 to 3 in a light grey box on the left side. Right-click over the desired band's grey box to edit the cut-off frequencies for that band:



Similarly, you can define if each band should be a reward (train to increase amplitude) or an inhibit (train to decrease amplitude) by right-clicking over the bar and selecting **Output ON - Above** or **Output ON - Below**. On a 3 band screen, feedback will be given when all 3 bars are in their Output ON condition. By default, Band 2 is the reward and bands 1 and 3 are inhibits.



Alpha wave training protocols are slightly different from other EEG protocols as they are generally designed to work with closed eyes. Because of this, feedback tends to be auditory. Alpha amplitude training helps the client enter an alpha state of relaxation at will. Alpha peak frequency helps the client generate more of the higher frequencies of alpha (10-12 Hz) than of the lower ones (8-10 Hz). Higher alpha frequencies, especially in the posterior areas of the brain, have been associated with improved working memory.

Alpha-theta training takes the client into a deep meditative state, hovering between drowsiness and sleepiness. As the client's consciousness is maintained between alpha, where daydreaming frequently occurs, and theta, at the doorstep of sleep, alpha-theta training can help your client's unconscious memories bubble up. For this reason, you may want to stay with the client during the exercise and talk about his feelings and observations when the exercise is over.

Passive infrared (pIR) training screens are included in the 360 Suite. Passive infrared is not EEG but forehead temperature is seen to correlate with activity in the frontal cortex. The working principle underlying pIR training is that an increase in activity in the frontal lobes of the brain (involved with executive functions, such as thinking, decision making, and planning) will trigger both an increase in blood flow (supplying the oxygen, sugars, and nutrients for functioning) and an increase in temperature from the metabolic burning of energy. Although homeostatic processes of the body will regulate brain temperature to minimize changes, a general warming up of the whole forehead will occur in response to this increased activity and the body's efforts to keep the brain cool.

The pIR headgear's left and right sensors are tiny cameras that pick up changes in temperature by measuring radiated heat (infrared radiation). The left and right signals are averaged to output the feedback signal used for feedback.

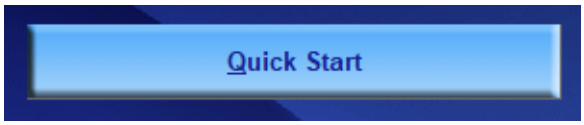
Passive infrared training is simpler to do than EEG and provides a good way to introduce the concept of changing brain activity with biofeedback to a client who might feel resistant to the idea of having electrodes placed on his head. The training goal for pIR biofeedback is to sequentially increase and then decrease the amplitude of the signal by ***paying attention*** for a few minutes, and then letting go, resting, for a few minutes.

There are three categories of CNS self-regulation training screens:

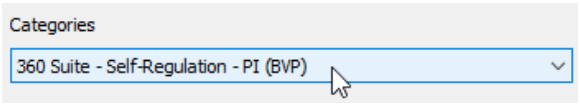
- Standard bands: This category includes frequently used training protocols, such as alpha amplitude, alpha peak frequency, alpha-theta, theta-beta and theta-SMR.
- User bands: This category includes screens that allow customizable training protocols for a single band, two bands and three bands.
- Passive infrared (pIR): This category includes basic screens to train forehead temperature biofeedback.

Running a session

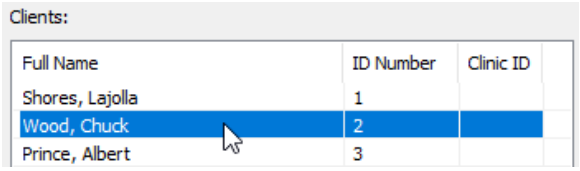
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



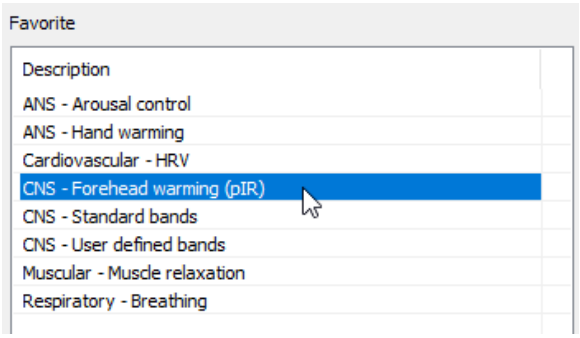
4. From **Categories**, select the **360 Suite - Self-Regulation** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



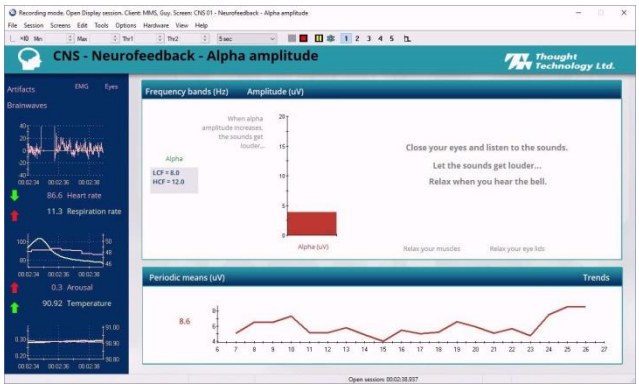
6. From **Favorite**, select one of the following, as appropriate.
   - **CNS - Forehead warming (pIR)**
   - **CNS - Standard bands**
   - **CNS - User defined bands**
7. Click **OK**.



Self-regulation screens – CNS EEG – Standard bands

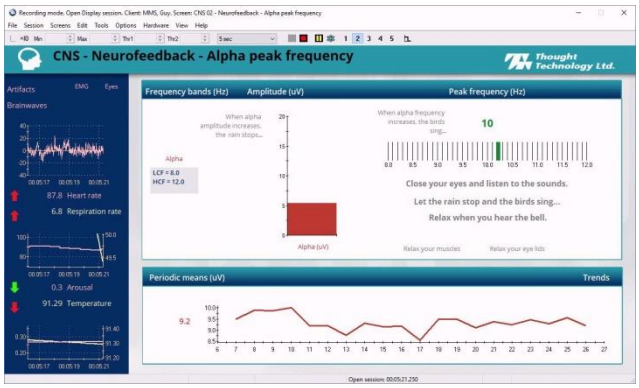
01 – CNS Alpha amplitude

This screen helps you train the ability to produce alpha brainwaves and increase their amplitude. The signal electrode can be placed at Cz or Pz. Training should be done with eyes closed, wearing headphones. A nature soundtrack plays louder when the alpha bar gets taller and quieter when it gets shorter. The training goal is to let the sounds play as loud as possible. A bell sounds when artifacts occur. Prompt the client to relax his muscles and eyelids if this happens too frequently.



02 – CNS Alpha peak frequency

This screen encourages the production of higher frequency alpha. The signal electrode can be placed at Cz or Pz. Training should be done with eyes closed, wearing headphones. The sound of rain falling plays quieter when the alpha bar gets tall. The sound of birds chirping plays louder when the frequency indicator moves towards higher values (right) and quieter when it moves towards lower values (left). The training goal is to let the rain stop and the birds sing. A bell sounds when artifacts occur. Prompt the client to relax his muscles and eyelids if this happens too frequently.

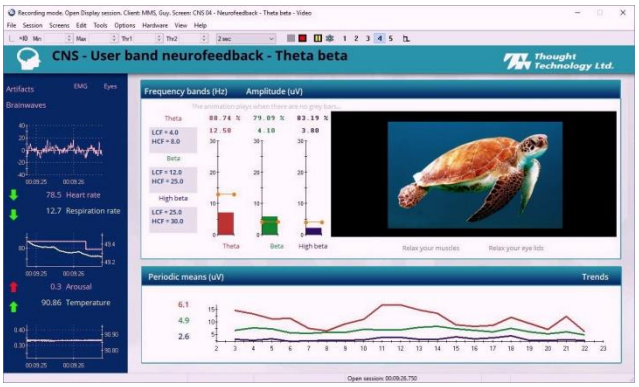


03 – CNS Alpha theta

This screen is used to train alpha-theta relaxation. The signal electrode can be placed at Cz or Pz. Training should be done with eyes closed, wearing headphones. Very slow, quiet music plays in the background. The sound of ocean waves gets louder when theta becomes dominant and the sound of a babbling brook gets louder when alpha becomes dominant. The training goal is to listen to the sounds and either relax deeper when the brook noise becomes louder or focus on awareness when the ocean sound becomes louder. The sound of crickets is heard when delta waves become stronger and the client might be falling asleep. Quietly prompt the client to stay awake when this occurs. You can adjust the threshold on the delta bar.

04 & 05 – CNS Theta-beta (& theta-SMR)

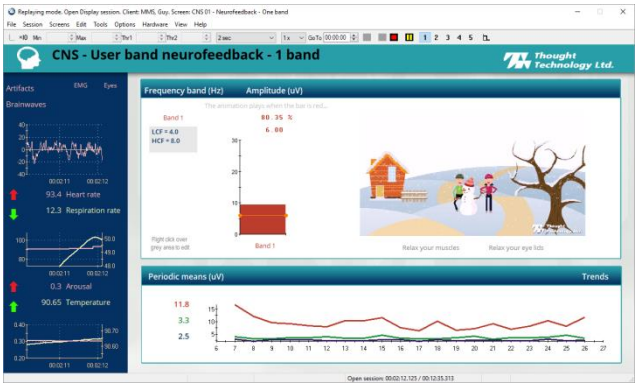
Theta-beta and theta-SMR training is classic attention and awareness training. The signal electrode is placed at Cz and training is done with eyes opened. The video image enlarges when the client is able to increase the amplitude of the reward bar (beta or SMR) while decreasing the amplitude of the inhibit bars (theta and high beta). The automatic thresholds are designed to keep the instruments in feedback condition about 80 % of the time.



Self-regulation screens – CNS EEG – User bands

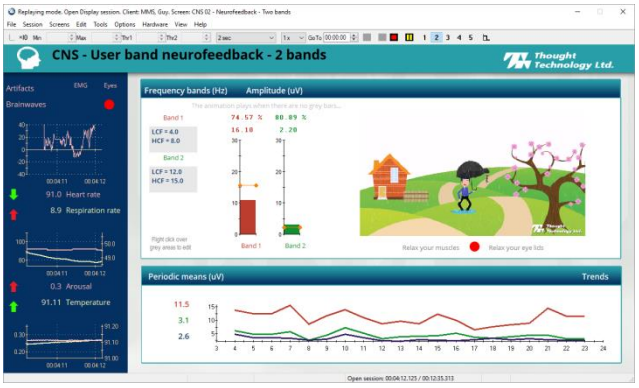
01 – CNS One band

This screen is used to train one EEG band. Adjust the cut-off frequencies and Output ON direction prior to starting the session. When the bar is in condition, the animation moves forward and music plays at full volume. When it is out of condition, the animation stops and music plays quietly. Muscle tension (EMG) or eye movement artifacts stop all feedback.



02 – CNS Two bands

This screen is used to train two EEG bands. Adjust the cut-off frequencies and Output ON directions prior to starting the session. When both bars are in condition, the animation moves forward and music plays at full volume. When one of them becomes out of condition, the animation stops and music plays quietly. Muscle tension (EMG) or eye movement artifacts stop all feedback.

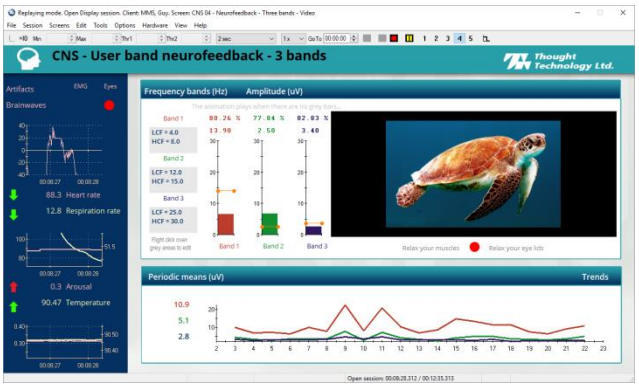


03 – CNS Three bands

This screen is used to train three EEG bands. Adjust the cut-off frequencies and Output ON directions prior to starting the session. When the three bars are in condition, the animation moves forward and music plays at full volume. When one of them becomes out of condition, the animation stops and music plays quietly. Muscle tension (EMG) or eye movement artifacts stop all feedback.

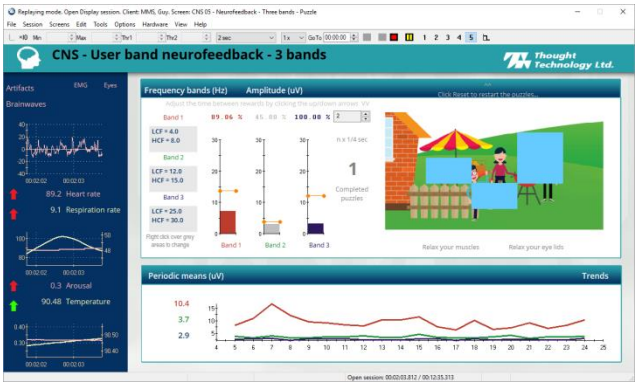
04 – CNS Three bands - Video

This screen is used to train three EEG bands. Adjust the cut-off frequencies and Output ON directions prior to starting the session. When the three bars are in condition, the video image enlarges. Muscle tension (EMG) or eye movement artifacts stop all feedback.



04 – CNS Three bands - Puzzle

This screen is used to train three EEG bands. Adjust the cut-off frequencies and Output ON directions prior to starting the session. When the three bars are in condition for a specified duration, a piece of the puzzle is revealed and a tone is heard. You can adjust how long the condition has to be sustained by clicking the small up/down arrows above the counter. Muscle tension (EMG) or eye movement artifacts stop all feedback.



Review screens – CNS EEG

01 – CNS artifact rejection

The screen shows a line graph of the raw EEG at the top and the peak to peak signals for the standard and user bands below. Use this screen to review the recorded signals and reject artifacts.

02 – CNS trend graphs – Standard and user bands

The screen shows trend graphs of the standard and user bands. Use this screen, once artifacts have been rejected, to identify upward or downward shifts in EEG band dominance.

03 – CNS Alpha training (trends)

This review screen is specifically designed for alpha, alpha amplitude and alpha-theta training sessions. It shows trend graphs of the alpha and theta amplitudes. Use this screen, once artifacts have been rejected, to identify upward or downward shifts in alpha or theta dominance. The bottom graph shows trends in alpha peak frequency. The overall percentage of time alpha is over 10 Hertz is indicated.

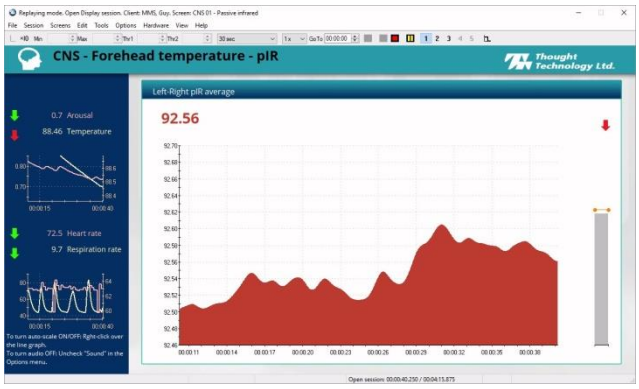
04 – CNS Theta beta SMR training (trends)

This review screen is specifically designed for theta-beta or theta-SMR training sessions. It shows trend graphs of theta beta and SMR amplitudes on the top graph. High beta trends are shown on the bottom graph. Use this screen, once artifacts have been rejected, to identify upward or downward shifts in theta or SMR/beta dominance.

Self-regulation screens – CNS pIR

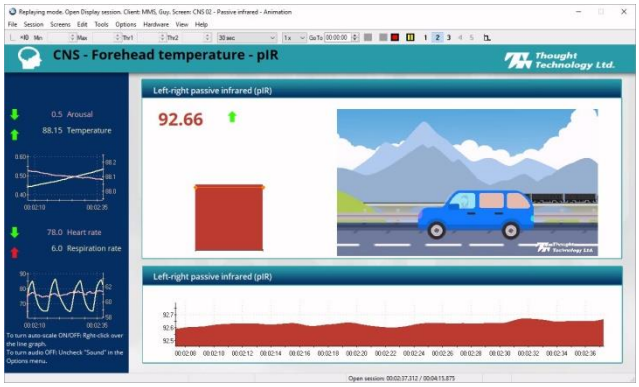
01 – CNS pIR

This screen is used to train forehead temperature. As the forehead temperature increases, the line moves upward. As it decreases, the line goes down. A small bar on the right reflects the signal's direction by getting taller when pIR signal increases and shorter when it decreases. Music plays quietly if the temperature decreases and at full volume when it increases. The training goal is to keep the temperature as high as possible.



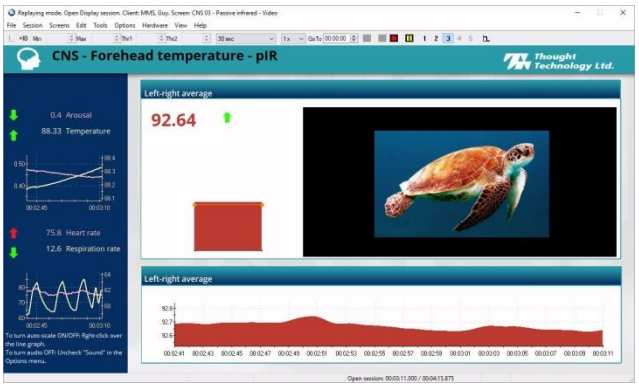
02 – CNS pIR

This screen is similar to the previous screen. When the forehead temperature goes up, the animation moves forward and music plays at full volume. When it goes down, the animation stops and music plays quietly. The training goal is to keep the temperature as high as possible.



03 – CNS pIR & video

This screen is similar to the previous screen. When the forehead temperature goes up, the video image enlarges. The training goal is to keep the temperature as high as possible.



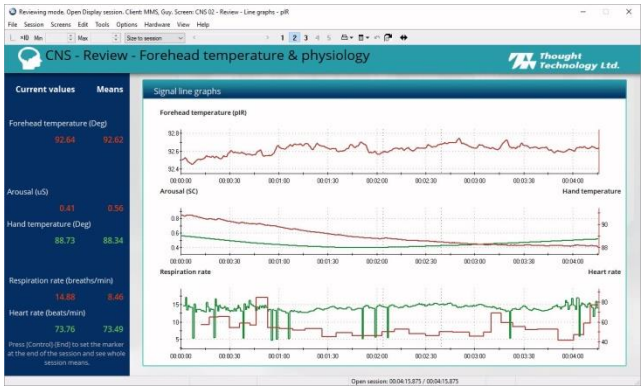
Review screens – CNS pIR

01 – CNS pIR artifact rejection

The screen shows a line graph of the smoothed left-right average pIR signal at the top and the non-smoothed average below, in green. Use this screen to review the recorded signals and reject artifacts.

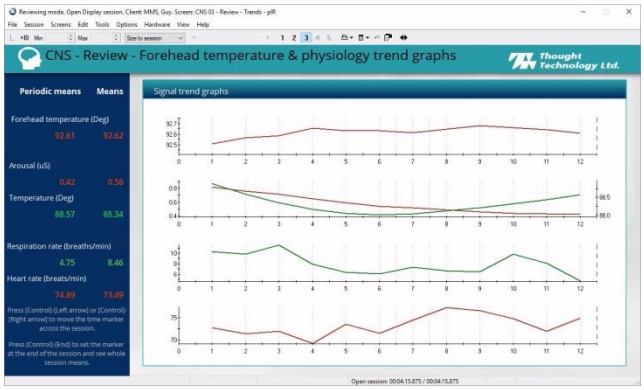
02 – CNS pIR line graphs

The screen shows line graphs of the smoothed left-right average pIR signal with autonomic nervous system physiology. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.



03 – CNS pIR trends

The screen shows trend graphs of the forehead temperature signal, at the top and some autonomic physiology below. Use this screen to look for tendencies in the signal directions and confirm that pIR self-regulation training is generating the desired change in physiology.



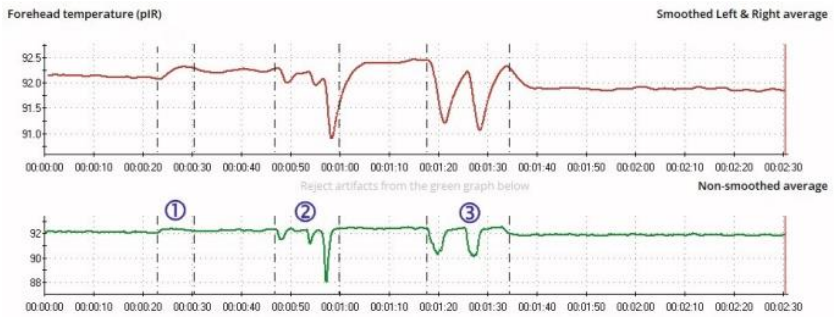
Artifact rejection

Because it involves the slow propagation of temperature through soft tissue and bone, the actual forehead temperature is very slow to change but if you look at the raw pIR sensor signal (non-smoothed left-right average), you will see a lot of variability. This high variability is caused by the sensitivity of the sensors, which pick up on events, such as changes in ambient light reflecting on the client's skin, fluctuations of skin temperature caused by from wind cooling, and so on. The clinically relevant information is not in the small fluctuations but in the long term tendencies. For this reason, the feedback signal is heavily smoothed. When reviewing the pIR signal for artifact rejection, look at the smoothed (red) signal to see its overall direction but place rejection segments over the non-smoothed signal because it shows all the variability.

Things to keep in mind

The pIR signal is very sensitive to:

1. Environmental changes: Cold drafts and turning on and off bright lights (especially with incandescent bulbs) can cause low amplitude transient changes in the signal. Try to keep the room in stable environmental conditions.
2. Sensor movement: If the client needs to scratch his head or adjust the headgear, you will see significant artifacts. Press the Space bar to place event markers in the session when this happens and when it stops so you can find and reject the artifact(s) in review.
3. Changes in reflective area: Putting fingers between the sensor and the skin or raising eyebrows will cause artifacts because it changes the surface of the skin that is under the IR sensors. Press the Space bar to place event markers in the session when this happens so you can find and reject the artifact(s) in review.



Artifacts will generally have much greater amplitudes than regular physiological events, so they are fairly easy to locate. Place artifact rejection segments over the greater distortions of the signal and click the **Recalculate** button  in the tool bar.

Biofeedback-assisted relaxation training tools

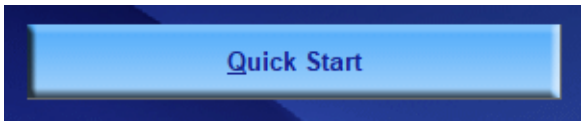
Biofeedback-assisted relaxation training (BART) tools provide you with an efficient way to teach relaxation skills to your client. The Binaural beat entrainment relaxation session uses sensory stimulation (binaural beat audio) to trigger changes in the client's brainwaves and generate deep relaxation.

Binaural beat entrainment requires the use of headphones. Two pure sine wave tones of slightly different frequencies (ex. 250 and 259 Hertz) are played through the left and right audio channels. Because of the phase shift between the two tones, the brain perceives a fluctuating rhythm of a frequency equal to the difference between the tones (9 Hertz). The working principle underlying binaural beat entrainment is that organized, repetitive sensory stimulation -- including touch, photic and auditory -- can be used to influence brain activity. The exact neurophysiological process involved is outside of the scope of this document but, the end result is that listening to binaural beat sounds at a frequency within the alpha or theta ranges ***excites*** the brain, which then starts generating waves of the same frequency.

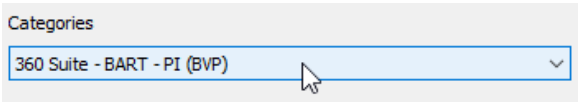
The Binaural beat entrainment screen includes a Binaural Beat Pacer, which is set to dynamically generate appropriate left and right sine wave tones with a frequency difference that goes from 18 Hertz to 9 Hertz for 5 minutes, then stay at 9 Hertz for 9 minutes and increase the frequency up to 15 Hertz for the last 4 minutes. The whole session takes 20-30 minutes, including set up time.

Running a session

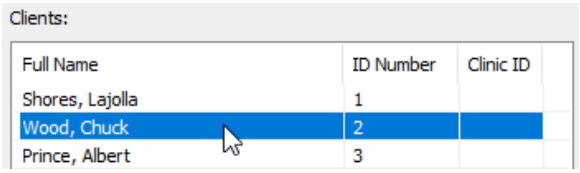
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



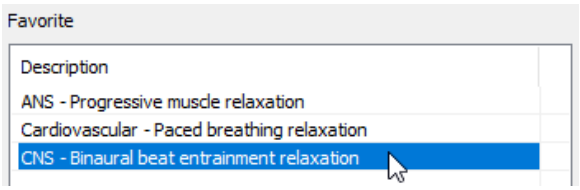
4. From **Categories**, select the **360 Suite - BART** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



6. From **Favorite**, select **CNS - Binaural beat entrainment relaxation**.
7. Click **OK**.



Session screens

Introduction screen

When you launch a Binaural beat entrainment session, after selecting a client and clicking OK, the introduction screen appears.

Click the Start button when your client is ready to go.

Instructions & signal verification

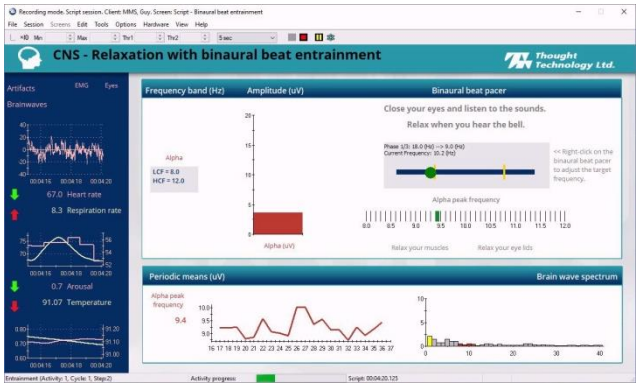
This screen displays instructions and allows you to make sure that the sensors are properly placed on the client and the recorded signals are valid. Help your client adjust the headphones comfortably and set the volume so it is loud, but not too loud.

Press a key on the keyboard to start the session

Binaural beat pacing

The main screen shows signal graphs and a binaural beat pacer, set to progressively slow down, from 18 to 9 Hertz and then back up to 15 Hertz. The relaxation exercise should be done with eyes closed.

The screen shows related physiological information on the screen, so you can monitor the client's progress.



Session ending

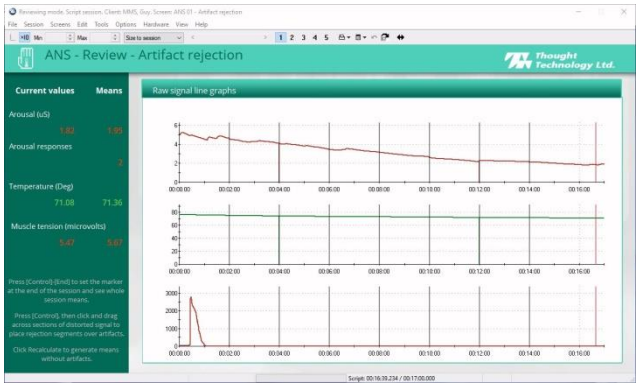
Near the end of the session, quiet music starts playing for the last 4 minutes. This helps the client know that the exercise is ending and allows him a slow waking up period.

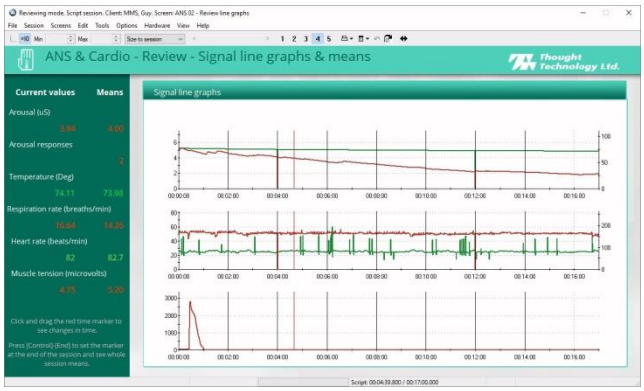
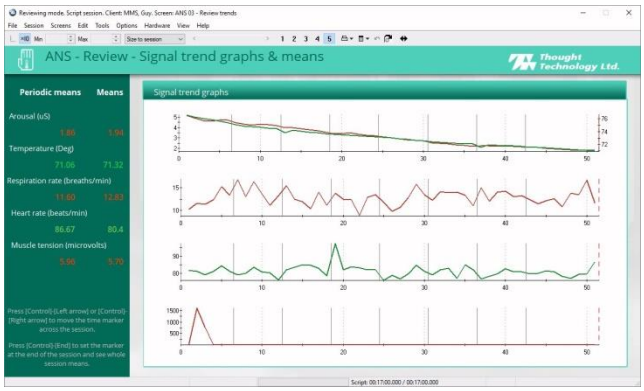
Saving the session

At the end of the relaxation session, you are given the opportunity to save the data if you want to be able to review it.

Review screens

Because you can watch changes in breathing, heart rate, arousal and hand temperature during your client's binaural beat entrainment relaxation training session, the review screens include the CNS and ANS artifact rejection signal graphs and trend graphs.

01 – CNS artifact rejection The screen shows a line graph of the raw EEG at the top and the peak to peak signals for the standard and user bands below. Use this screen to review the recorded signals and reject artifacts.	
02 – CNS trend graphs – Standard and user bands The screen shows trend graphs of the standard and user bands. Use this screen, once artifacts have been rejected, to identify upward or downward shifts in EEG band dominance.	
01 – ANS artifact rejection The screen shows line graphs of arousal, temperature and muscle tension. Use this screen to review the recorded signals and reject artifacts.	

02 – ANS line graphs The screen shows line graphs of the autonomic nervous system physiology. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.	
03 – ANS trend graphs The screen shows trend graphs of the autonomic nervous system physiology. Use this screen to look for tendencies in the signal directions and confirm that self-regulation training is generating the desired change in physiology.	

Two-channel protocols

While a majority of basic neurofeedback self-regulation training protocols involve only one channel of brainwaves, some specialized applications require two. The suite includes a bilateral baseline assessment and a set of specialized self-regulation screens that use two EEG sensors.

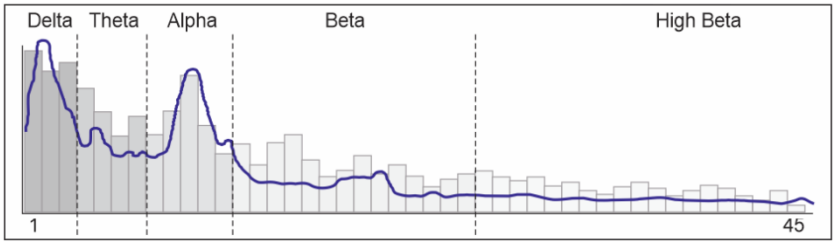
Assessment tools

CNS 2 EEG Single Hertz bins assessment

The 2 EEG baseline assessment is similar to the single channel baseline assessment but provides a breakdown view of the whole spectrum, cut into single Hertz slices (bins), to show how amplitude is distributed across frequencies from 1 to 45 Hertz. This provides a quick way to get an overall snapshot of your client's resting brainwave levels and allows you to see how frequencies are activated, bilaterally, by opening or closing his eyes. The assessment should be performed with the two active EEG electrodes placed on the same location, left and right (ex. C3/C4, F3/F4, P3/P4, etc).

EEG power distribution

The EEG amplitude distribution of a normal individual at rest shows more power (amplitude) in the low frequency range than in the high frequency range. As frequency increases, power decreases. If the electrodes are placed towards the back of the head, and especially if the eyes are closed, the power in the alpha band will also be high.

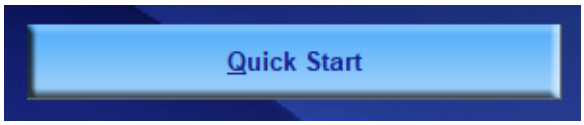


Running the assessment

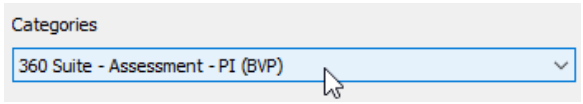
Before you begin:

- Plug the sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
- Prepare the client's skin for electrode placement. (See page 16 for more information about skin preparation.)
- Ensure that electrodes are well-placed on the client. (See page 14 for more information about EEG electrode placement.)
- Check the impedance of the EEG sensors. (See page 29 for more information about impedance checking.)

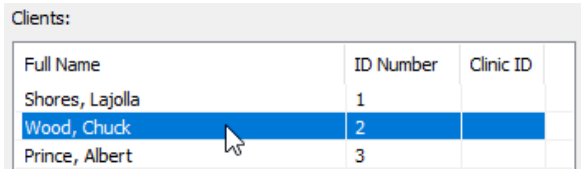
1. Click **Quick Start**.



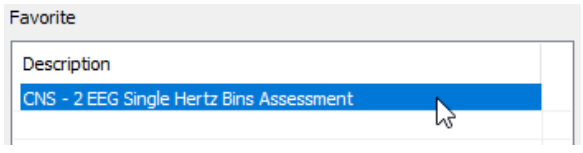
2. From **Categories**, select the **360 Suite - Assessment** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



3. From **Clients**, select a name.



4. From **Favorite**, select **CNS - 2 EEG Single Hertz Bins Assessment**.
5. Click **OK**.



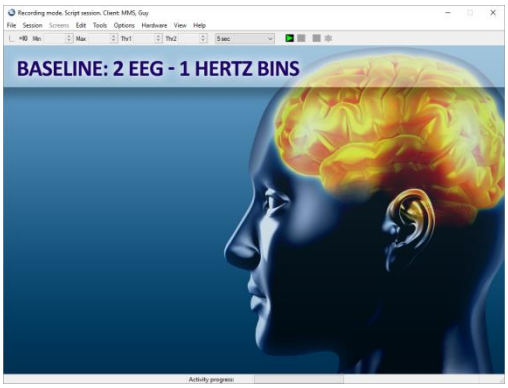
Assessment screens

The following is the series of screens, in chronological order, that the script displays during the assessment.

Introduction screen

When you launch the assessment, after selecting a client and clicking OK, the introduction screen appears.

Click the **Start** button when your client is ready to go.

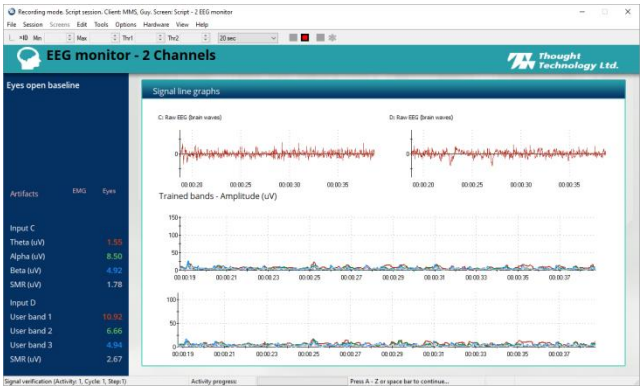


Signal verification

This screen shows the raw EEG signal to allow you to make sure that the electrodes are properly placed on the client and the recorded signals are valid. It is recommended to check electrode impedance, at this step of the assessment.

Describe what the baseline session is about to your client and explain how he should relax and avoid moving his eyes or clenching his teeth during the recording. Prompt him to think about nothing specific and look straight ahead of him, focusing on point on the wall or an object on your desk.

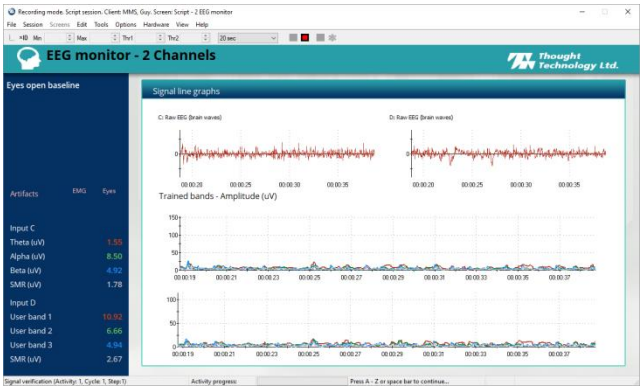
Press a key on the keyboard to start the assessment.



Baseline recording

The assessment goes through 4 steps, eyes open baseline (pause), eyes open baseline (recording), eyes closed baseline (pause) and eyes closed baseline (recording). While the baseline is being recorded, make sure the signal stays as clean as possible throughout.

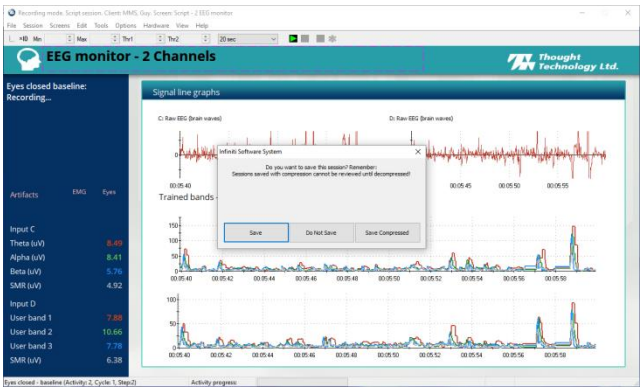
Gently coach the client to stay relaxed without moving or falling asleep.



End of session

At the end of the assessment, the recording stops and you are prompted to save the data.

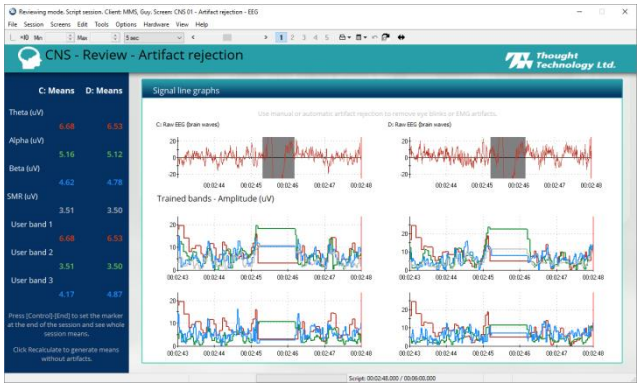
Press a key on the keyboard to save the session.



Review screens

01 – CNS artifact rejection

The screen shows line graphs of the raw EEG for each channel at the top and the peak to peak signals for the standard and user bands below. Use this screen to review the recorded signals and reject artifacts.



Generating a report

The 2 EEG Single Hertz Bins assessment includes an Excel report which shows the average amplitude for single Hertz bins and standard bands for both locations and in both conditions (eyes open or closed). Below the graphs, tables show the mean for standard bands as well as key ratios.

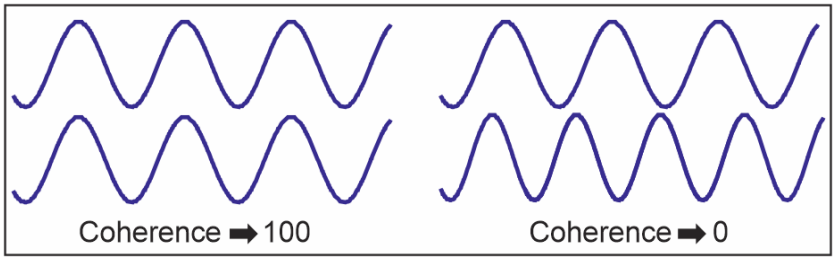
Self-regulation training tools

Specialized self-regulation protocols offer the ability to compare the activity of the same frequency bands from side to side or between two locations that are functionally related.

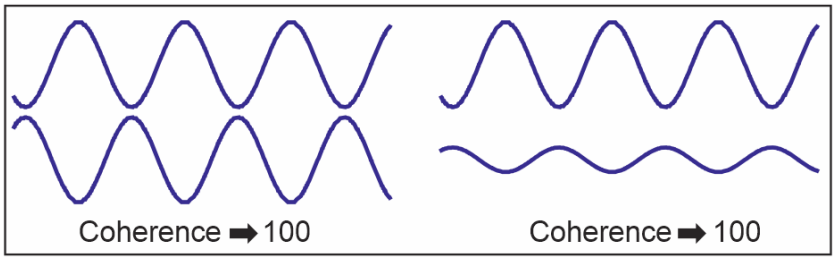
Focus and attention can be enhanced by facilitating the production of beta waves over the sensory-motor areas on either side or on both sides together. Generally, beta is up-trained over C3 (left) and SMR is up-trained over C4 (right). Theta and high beta are also down-trained on both sides. A similar screen allows you to specify user-defined bands and whether you want to up- or down-train each band. This is mostly useful when you need to implement customized protocols for your clients, based on multi-channel brain mapping assessments (QEEG).

Research suggests that frontal EEG asymmetry can be used as an indicator of approach or avoidance motivation (desire to move toward or away from a stimulus). Left side activation is associated with more positive approach related behavior whereas right side activation (comparatively) is more often associated with withdrawal type tendencies. Because alpha is the frequency of ***a brain at rest***, down-training alpha on the left (favoring activation) and up-training alpha on the right (favoring idleness) can be used to encourage more positive feelings in a client.

Coherence is a measure of ***togetherness*** between two sinusoidal signals. When two signals move up and down together, their coherence tends towards 100. If they move completely independently from one another, their coherence tends towards 0.



Two out-of-phase signals can be coherent if the phase (delay) between them is constant. Coherence is independent of amplitude. A strong signal can be coherent with a weak signal.

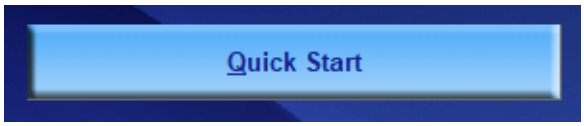


Clinically, coherence within a given frequency range between two EEG locations is a measure of connectivity. Two sites are connected when nearby brain structures work together. Generally, you would know to up-train or down-train coherence from a QEEG assessment report. The suite includes coherence training screens for theta, alpha, beta and SMR.

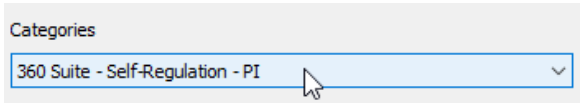
Running a session

1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)

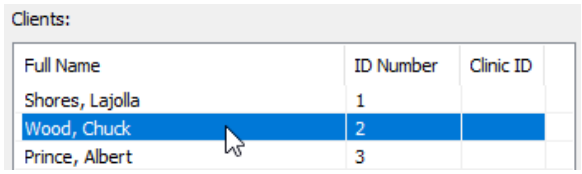
3. Click **Quick Start**.



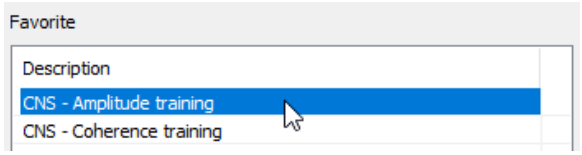
4. From **Categories**, select the **360 Suite - Self-Regulation** corresponding to your encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



6. From **Favorite**, select one of the following, as appropriate.
   - **CNS - Amplitude training**
   - **CNS - Coherence training**
7. Click **OK**.

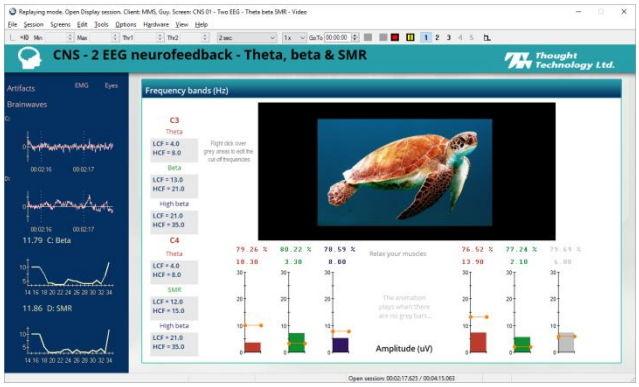


Self-regulation screens

Note: *When switching from screen to screen during a session, the video will start anew or continue from wherever it was interrupted the last time that the screen was selected. Videos played from an Internet source will always restart from the beginning.*

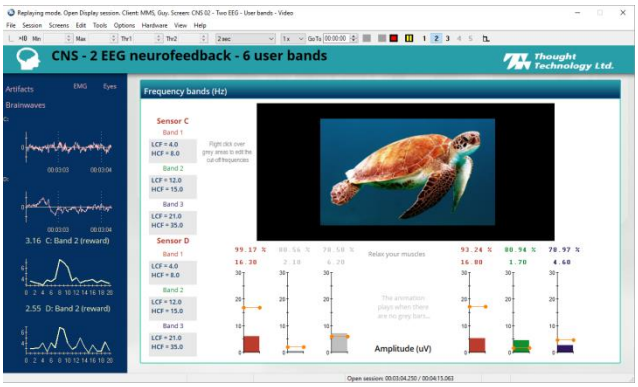
01 – CNS Theta-beta-SMR - Video

This screen combines theta-beta and theta-SMR training in one exercise to train attention and awareness. The signal electrodes are placed at C3 and C4 and training is done with eyes opened. The video image enlarges when the client is able to increase the amplitude of both reward bars (beta and SMR) while decreasing the amplitude of the inhibit bars (R & L theta and high beta). The automatic thresholds are designed to keep the instruments in feedback condition about 80 % of the time.



02 – CNS Six user bands - Video

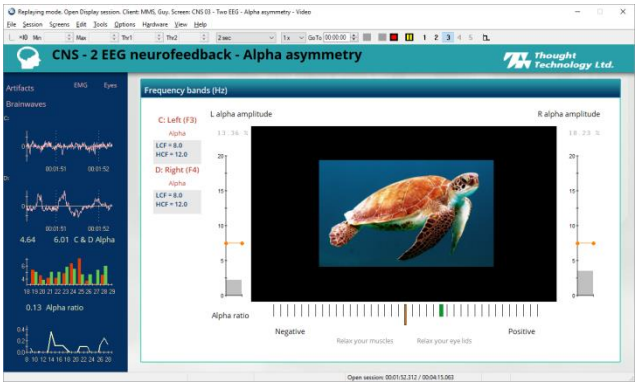
This screen is used to train six EEG bands. Adjust the cut-off frequencies and Output ON directions prior to starting the session. When the six bars are in condition, the video image enlarges. Muscle tension (EMG) or eye movement artifacts stop all feedback.



03 – CNS Alpha amplitude asymmetry - Video

The alpha amplitude asymmetry training screen allows you to look at alpha amplitude on both sides of the head. It is important to place the signal electrode connected to input C at F3 (left side) and the one connected to input D at F4 (right side). Training is done with eyes open.

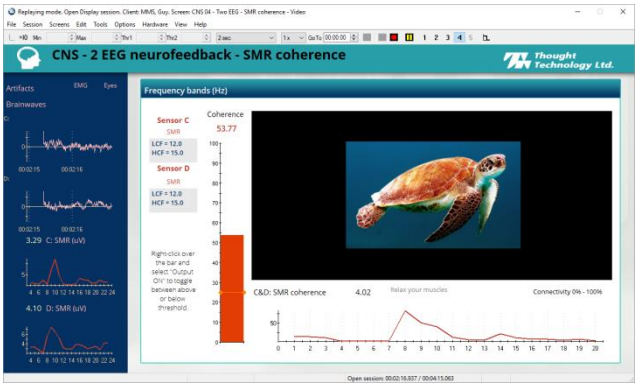
The feedback rewards having higher alpha amplitude on the right than on the left. When this happens, the video image enlarges. Muscle tension (EMG) or eye movement artifacts stop the video.



Self-regulation screens - Coherence

01-04 – CNS Coherence

The coherence training screens can be used to up-train or down-train coherence for theta, alpha, beta or SMR. A manual threshold allows you to set the target coherence value. The video image enlarges when the client's coherence value is in the **Output ON** condition, above or below threshold.

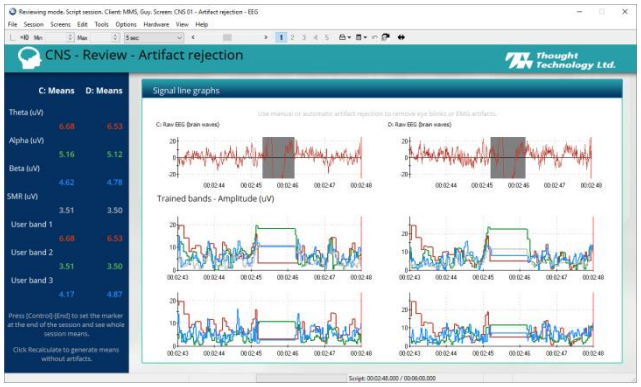


Note: *When switching from screen to screen during a session, the video will start anew or continue from wherever it was interrupted the last time that the screen was selected. Videos played from an Internet source will always restart from the beginning.*

Review screens

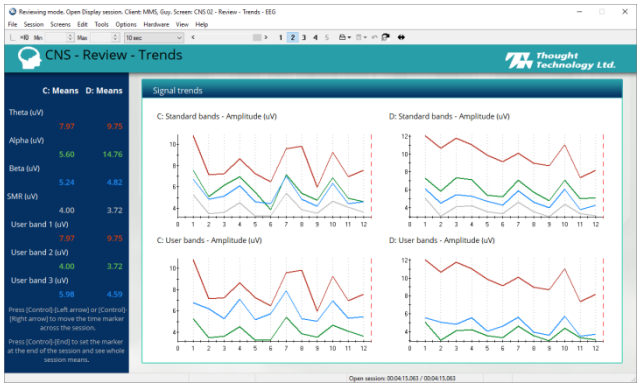
01 – CNS artifact rejection

The screen shows line graphs of the raw EEG for each channel at the top and the peak to peak signals for the standard and user bands below. Use this screen to review the recorded signals and reject artifacts.



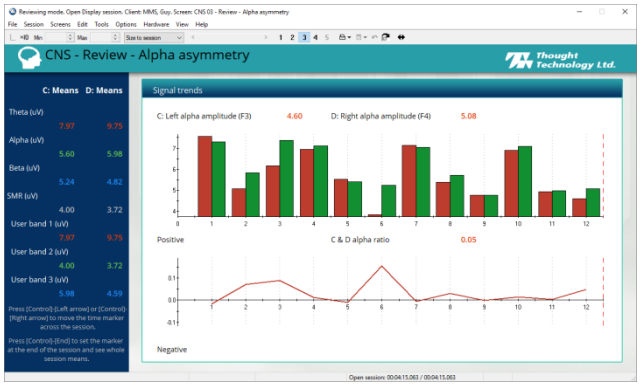
02 – CNS trend graphs – Standard and user bands

The screen shows trend graphs of the standard and user bands. Use this screen, once artifacts have been rejected, to identify upward or downward shifts in EEG band dominance.



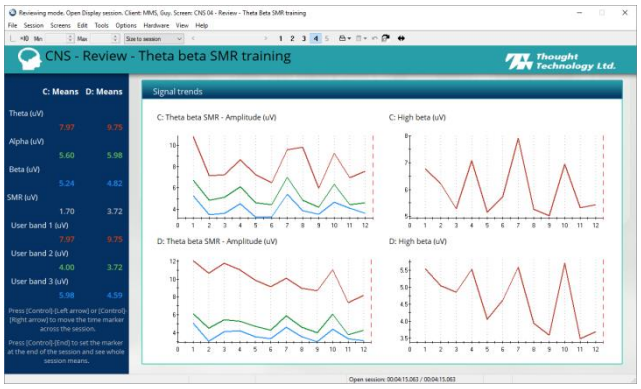
03 – CNS trend graphs – Alpha asymmetry

The screen shows trend graphs of the mean left and right alpha amplitude and the alpha ratio, on the bottom graph. Use this screen, once artifacts have been rejected, to identify upward or downward shifts in left or right alpha asymmetry.

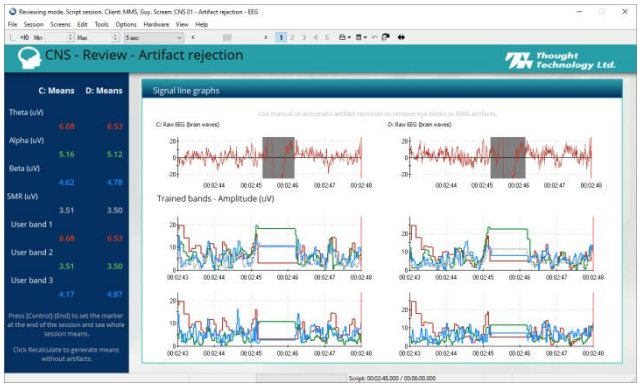
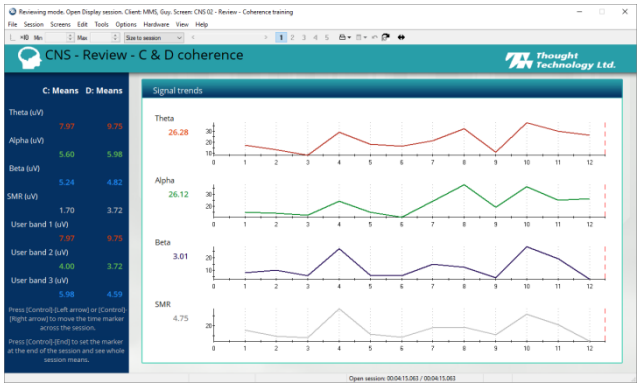


04 – CNS trend graphs – Theta- beta-SMR

The screen shows trend graphs of the theta, beta and SMR bands as well as high beta, on the right. Use this screen, once artifacts have been rejected, to identify upward or downward shifts in EEG band dominance.



Review screens - Coherence

01 – CNS artifact rejection The screen shows line graphs of the raw EEG for each channel at the top and the peak to peak signals for the standard and user bands below. Use this screen to review the recorded signals and reject artifacts.	
02 – CNS Coherence The screen shows line graphs of the theta, alpha, beta and SMR coherence over time. Use this screen, once artifacts have been rejected, to identify increases or decreases in coherence within each of the bands.	

Muscular system

Increased muscle tension is a common sign of stress in many people. In magazines and television, the prevalence of advertisements for low back, shoulder and neck pain medication is a reflection of how common musculoskeletal troubles caused by chronic muscle tension are. Although muscle activity is under the direct control of the central nervous system, stress related tension is mostly unconscious. Long lasting muscle tension reduces blood flow, prevents healing and leads to various aches and pains.

Muscle tension biofeedback training (EMG) consists of teaching clients to become aware of the tension they feel in their body and to voluntarily regain control over specific muscle groups, allowing them to relax. Relaxing muscle tension restores normal blood flow and favors healing.

Muscle tension control

Muscles, at rest, always exhibit small amount of tension. This base muscle tone is useful for maintaining posture and to allow your body to respond when a sudden pull or stretch happens. Unconsciously, over time, the base muscle tone can increase when under stress for long periods of time. Because this happens very slowly and over many weeks or months, we are rarely aware of how much tension is present in our bodies. We only become aware that something is wrong when we develop chronic pain syndromes, such as tension headaches or low back pain. Muscle tension can also cause acute pain syndromes (strains and sprains) when we bend down too fast, to tie our shoe laces, for example, or pick up a fallen pen. Muscle tension can also reduce blood flow to the soft tissues in the injured area and prevent or slow down healing.

Muscle tension control biofeedback is done by affixing an EMG (electromyography) sensor over the fleshy part of a tense muscle and asking the client to watch the signal on the screen. You can then ask him to adjust his posture, sitting straight and letting the chair support his back. You can ask the client to gently contract the muscle and then let go. You can ask the client to do breathing exercises and ***feel*** the tension ease out of his body each time he breathes out. While he doing that, instruct him to try to get the signal lower and lower at each breath.

After a bit of practice, the client should develop an awareness of how the tension feels in his body and learn how to voluntarily make the signal go up or down. Muscle tension control biofeedback is a good tool for teaching selective muscle relaxation, where the client tries to isolate the muscles in one area of his body and willingly relax those muscles only. The long term goal of muscle tension self-regulation is for the client to develop a broader ***body awareness*** and be able to feel when tension is developing again. Then, to voluntarily let go of it and know how to relax his muscles, even when he is not connected to the equipment.

Assessment tools

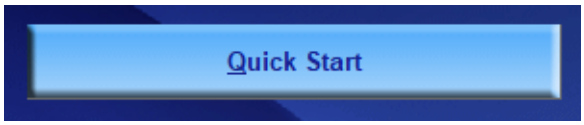
The 360 Suite does not include an assessment tool specific to the muscular system but includes muscle tension data in the full and quick physiological profile and physiological baseline assessments.

Self-regulation training tools

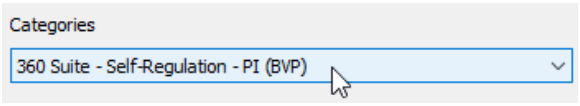
Self-regulation training with muscle tension involves lowering the overall level of the signal and learning to voluntarily make the signal increase or decrease.

Running a session

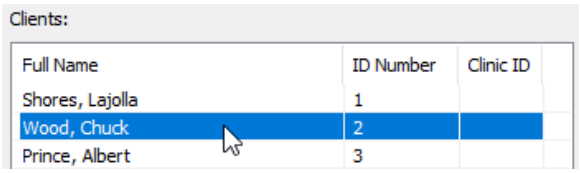
1. Plug your sensors into the appropriate inputs of the encoder. (See Sensor configuration, starting on page 8.)
2. Place the sensors on the client. (See Sensor placement, starting on page 10.)
3. Click **Quick Start**.



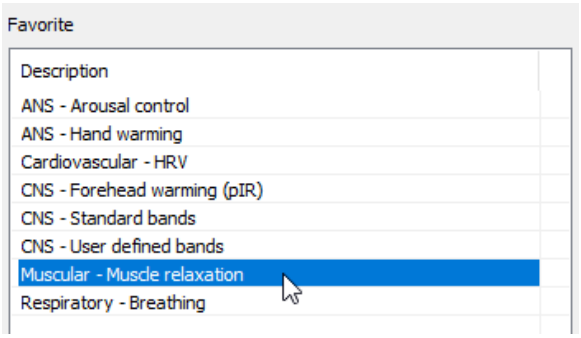
4. From **Categories**, select the **360 Suite - Self-Regulation** corresponding to your channel set (BVP or EKG) and encoder (ProComp2, ProComp5 Infiniti, or ProComp Infiniti).



5. From **Clients**, select a name.



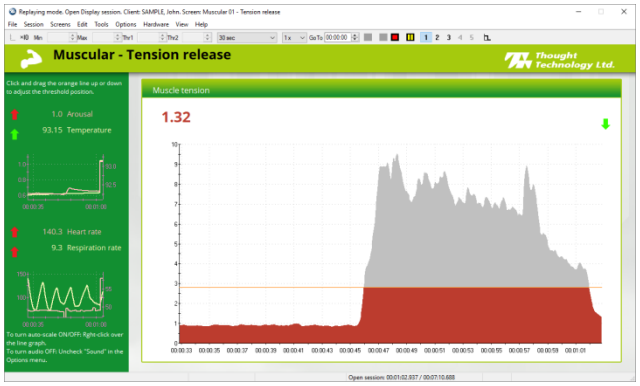
6. From **Favorite**, select **Muscular - Muscle relaxation**.
7. Click **OK**.



Self-regulation screens - Muscular Tension

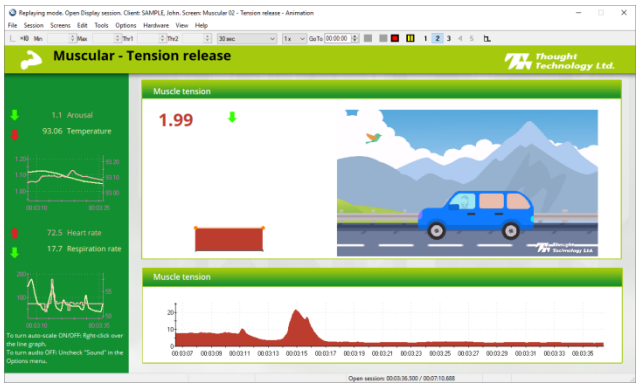
01 – Muscular – Tension release

The screen shows a large graph of the muscle tension signal (EMG). A manual threshold can be adjusted up or down with the mouse. When the tension level is above the threshold, music plays quietly and the signal turns grey. When it lowers below the threshold, music plays at full volume and the signal becomes red. The training goal is to keep the signal below threshold.



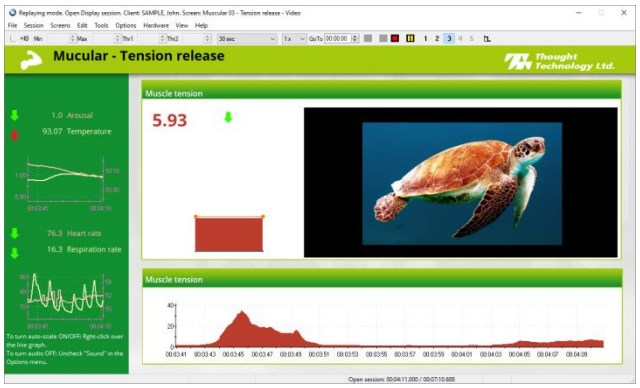
02 – Muscular – Tension release & animation

The screen shows a bar graph on the left and an animation on the right. The threshold is set to automatically follow the signal, so you do not have to adjust it. When the tension level is above the threshold, the animation pauses and music plays quietly. When it goes below the threshold, music plays at full volume and the animation advances. The training goal is to keep the signal below threshold.

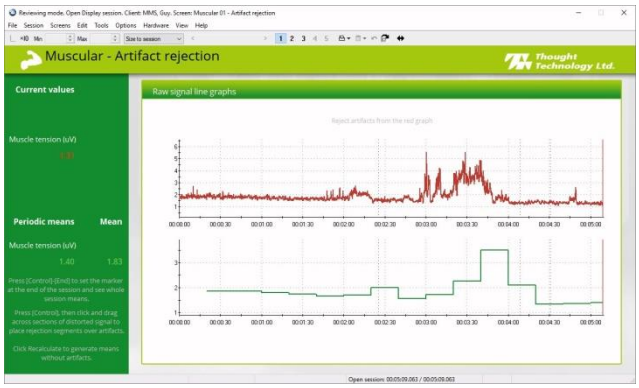
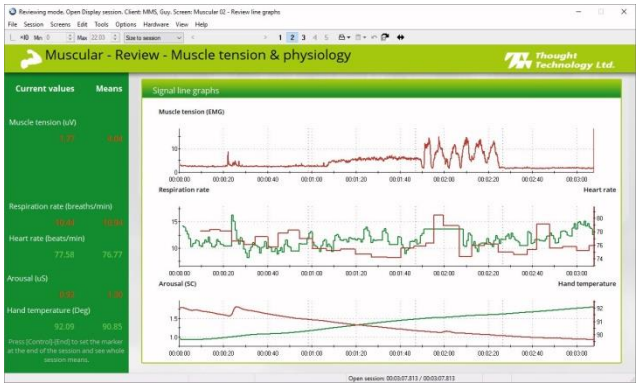
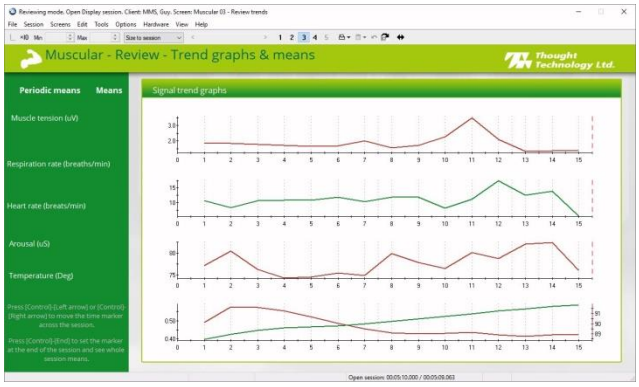


03 – Muscular – Tension release & video

This screen is similar to the previous one but feedback is given with a Video Stream instrument. The video image enlarges when the client's tension level is going down and shrinks when it is going up.



Review screens

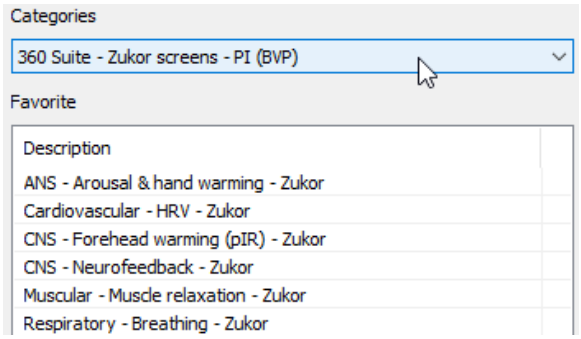
01 – Muscular artifact rejection The screen shows a line graph of muscle tension, above, and the periodic mean of muscle tension below. Use this screen to review the recorded signals and reject artifacts.	
02 – Muscular line graphs The screen shows line graphs of muscle tension with ANS and Cardiovascular physiology. Use this screen to review the data that was recorded and identify normal and abnormal physiological events.	
03 – Muscular trends The screen shows trend graphs of muscle tension with ANS and Cardiovascular physiology. Use this screen to look for tendencies in the signal directions and confirm that self-regulation training is generating the desired change in physiology.	

Biofeedback-assisted relaxation training tools

The 360 Suite does not include a biofeedback-assisted relaxation training tool specific to the muscular system but includes muscle tension data in the Progressive muscle relaxation training session.

Add-on for Zukor Interactive products

A set of self-regulation screens, compatible with the Zukor Interactive games and Media Player, is included with the suite and can be installed optionally. The Zukor screens are similar to the self-regulation screens described in previous sections of this manual but feedback is given by altering various game actions.



The optional files include a Zukor category of favorites, allowing you to quickly start sessions with the following screens.

ANS - Arousal & handwarming - Zukor

ANS 01 - Arousal - Zukor

ANS 02 - Hand warming - Zukor

ANS 03 - Arousal & hand warming - Zukor

Cardiovascular - HRV - Zukor

Cardiovascular 01 - HR max-min - Zukor

Cardiovascular 02 - Resp-HR phase - Zukor

Cardiovascular 03 - HRV power - Zukor

CNS - Forehead warming-(pIR) - Zukor

CNS 01 - Passive infrared - Zukor

CNS-Neurofeedback (EEG) - Zukor

CNS 01 - Neurofeedback - One band - Zukor

CNS 02 - Neurofeedback - Two bands - Zukor

CNS 03 - Neurofeedback - Three bands - Zukor

CNS 04 - Neurofeedback - Theta beta - Zukor

CNS 05 - Neurofeedback - Theta SMR - Zukor

Muscular - Muscle relaxation - Zukor

Muscular 01 - Tension release - Zukor

Respiratory - Breathing - Zukor

Respiratory 01 - Abdominal breathing - Zukor

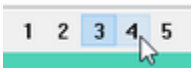
Respiratory 02 - Paced breathing - Zukor

Respiratory 03 - Breathing & EMG - Zukor

Running a self-regulation training session

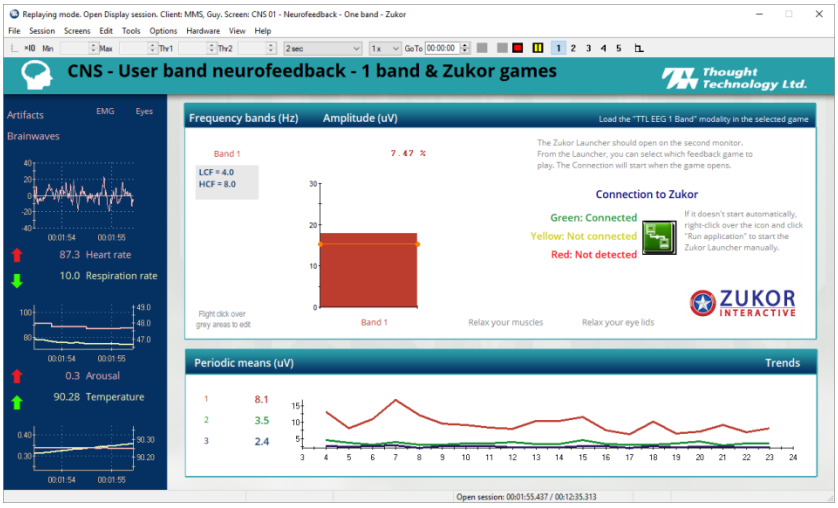
When you start a self-regulation session with a Zukor screen, the Zukor Launcher appears as soon as the screen is loaded.

At this point, if more than one screen is loaded in BioGraph, select the screen you want to use by clicking on a number button at the top of the screen (1-5).



Changing screens during a session will disconnect the Zukor game from BioGraph and you will have to close the game manually (select **Quit**) and restart the launcher by right-clicking on the yellow connection instrument icon and selecting **Run target application**.

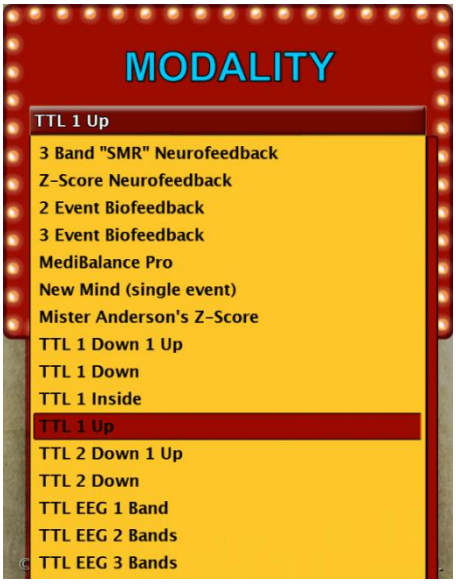
In the Zukor Launcher, select the game you want to play by clicking on the game image or the button **Click to start**. When the game opens, notice the connection instrument on the self-regulation screen goes from yellow to green.



When the main screen appears, be sure to check that the game is set to load the modality that the self-regulation screen expects. The game may not play properly if the wrong modality is loaded.

The expected modality, in this example **TTL 1 Up**, is shown in the upper right area of the self-regulation screen.

If the wrong modality is shown, click on the button to see a drop-down list of available modalities and select the proper modality before starting the game (click **OK**).



Refer to the Zukor game's instructions for more information on modalities.

Appendix

The following pages contain four math task tables for use with the 360 Suite.

1081	941	801	661	521	381	241	101
1074	934	794	654	514	374	234	94
1067	927	787	647	507	367	227	87
1060	920	780	640	500	360	220	80
1053	913	773	633	493	353	213	73
1046	906	766	626	486	346	206	66
1039	899	759	619	479	339	199	59
1032	892	752	612	472	332	192	52
1025	885	745	605	465	325	185	45
1018	878	738	598	458	318	178	38
1011	871	731	591	451	311	171	31
1004	864	724	584	444	304	164	24
997	857	717	577	437	297	157	17
990	850	710	570	430	290	150	10
983	843	703	563	423	283	143	3
976	836	696	556	416	276	136	
969	829	689	549	409	269	129	
962	822	682	542	402	262	122	
955	815	675	535	395	255	115	
948	808	668	528	388	248	108	

2048	1908	1768	1628	1488	1348	1208	1068
2041	1901	1761	1621	1481	1341	1201	1061
2034	1894	1754	1614	1474	1334	1194	1054
2027	1887	1747	1607	1467	1327	1187	1047
2020	1880	1740	1600	1460	1320	1180	1040
2013	1873	1733	1593	1453	1313	1173	1033
2006	1866	1726	1586	1446	1306	1166	1026
1999	1859	1719	1579	1439	1299	1159	1019
1992	1852	1712	1572	1432	1292	1152	1012
1985	1845	1705	1565	1425	1285	1145	1005
1978	1838	1698	1558	1418	1278	1138	998
1971	1831	1691	1551	1411	1271	1131	991
1964	1824	1684	1544	1404	1264	1124	984
1957	1817	1677	1537	1397	1257	1117	977
1950	1810	1670	1530	1390	1250	1110	970
1943	1803	1663	1523	1383	1243	1103	
1936	1796	1656	1516	1376	1236	1096	
1929	1789	1649	1509	1369	1229	1089	
1922	1782	1642	1502	1362	1222	1082	
1915	1775	1635	1495	1355	1215	1075	

2001	1861	1721	1581	1441	1301	1161	1021
1994	1854	1714	1574	1434	1294	1154	1014
1987	1847	1707	1567	1427	1287	1147	1007
1980	1840	1700	1560	1420	1280	1140	1000
1973	1833	1693	1553	1413	1273	1133	993
1966	1826	1686	1546	1406	1266	1126	986
1959	1819	1679	1539	1399	1259	1119	979
1952	1812	1672	1532	1392	1252	1112	972
1945	1805	1665	1525	1385	1245	1105	965
1938	1798	1658	1518	1378	1238	1098	958
1931	1791	1651	1511	1371	1231	1091	951
1924	1784	1644	1504	1364	1224	1084	944
1917	1777	1637	1497	1357	1217	1077	937
1910	1770	1630	1490	1350	1210	1070	930
1903	1763	1623	1483	1343	1203	1063	923
1896	1756	1616	1476	1336	1196	1056	
1889	1749	1609	1469	1329	1189	1049	
1882	1742	1602	1462	1322	1182	1042	
1875	1735	1595	1455	1315	1175	1035	
1868	1728	1588	1448	1308	1168	1028	

1098	958	818	678	538	398	258	118
1091	951	811	671	531	391	251	111
1084	944	804	664	524	384	244	104
1077	937	797	657	517	377	237	97
1070	930	790	650	510	370	230	90
1063	923	783	643	503	363	223	83
1056	916	776	636	496	356	216	76
1049	909	769	629	489	349	209	69
1042	902	762	622	482	342	202	62
1035	895	755	615	475	335	195	55
1028	888	748	608	468	328	188	48
1021	881	741	601	461	321	181	41
1014	874	734	594	454	314	174	34
1007	867	727	587	447	307	167	27
1000	860	720	580	440	300	160	20
993	853	713	573	433	293	153	
986	846	706	566	426	286	146	
979	839	699	559	419	279	139	
972	832	692	552	412	272	132	
965	825	685	545	405	265	125	

Hardware Specifications

HR/BVP Sensor (SA9308M)

Length (approx.)	20mm x 34mm x 10mm (0.72" x 1.33" x 0.41")
Weight	20g (0.66 oz)
Input range	Unit less quantity displayed as 0% – 100%
Accuracy	±5%

EKG Sensor (SA9306M)

Size (approx.)	37mm x 37mm x 12mm (1.45" x 1.45" x 0.45")
Weight (approx.)	25g (1oz)
Input Impedance	1,000,000MΩ in parallel with 10pF
Signal Input Range	0 –12mVRMS
Sensitivity	<1µVRMS
CMRR	>130dB
Channel Bandwidth	0.05Hz – 1kHz
Signal Output Range	0 – 600mVRMS
Input/Output Gain	50
Supply Voltage	7.26V (± 0.05V)
Current Consumption	<1.5mA
Accuracy	±3µVRMS, ±5% of reading @25°C to 30°C

MyoScan EMG Sensor (SA9503M)

Size (approx.)	37mm x 37mm x 12mm (1.45" x 1.45" x 0.45")
Weight	15g (0.5 oz)
Input impedance	≥10GΩ in parallel with 10pF
Input range	0 – 2000µVRMS
Sensitivity	<0.1µVRMS
CMRR	>130dB
Channel bandwidth	10Hz – 1kHz
Signal output range	0 – 1.0VRMS
Input / output gain	500
Supply voltage	7.26V (± 0.02V)
Current consumption	0.7mA (± 0.25mA)
Accuracy	±0.3µVRMS ±4% of reading @25°C to 30°C

Skin Temperature Sensor (SA9310M)

Length (approx.)	152cm (60")
Weight	10g (0.33oz)
Temperature range	10°C - 45°C (50°F – 115°F)
Accuracy	±1.0°C (±1.8°F) 20°C – 40°C (68°F – 104°F)

Respiration Sensor (SA9311M)

Size of sensor (approx.)	33mm x 33mm x 11mm (1.28" x 1.28" x 0.44")
Weight (approx.)	90g (3.3 oz)
Input range	0 – 9cm (0 – 3.55")
Supply voltage	7.26V (± 0.05V)
Current consumption	≤ 0.5mA
Straps:	
Length, sensor strap (approx.)	18cm (7")
Length, elastic strap (approx.)	14cm (5.5")
Max. length, small extender strap (approx.)	51cm (20")
Max. length, medium extender strap (approx.)	84cm (33")

Skin Conductance Flex/Pro Sensor (SA9309M)

Size without electrode leads (approx.)	3.5 cm (1.4")
Size with electrode leads (approx.)	15 cm (6.0")
Cable length (approx.)	127 cm (50")
Weight (approx.)	25 g (1 oz)
Signal input range	0 – 30.0 μS
Accuracy	±5% and ±0.2 μS

TT-pIR Sensor (SA2600)

Size (approx.)	37mm x 37mm x 12mm (1.45" x 1.45" x 0.45")
Weight (approx.)	25g (1oz)
Absolute measurement accuracy	±5°C
Measurement resolution	0.02°C
Measurement range	19.76°C - 40.24°C
Operating temperature (ambient)	20°C - 30°C
Target emissivity	98.0%
Sensor warm-up time	60 seconds
Supply voltage	7.26V
Maximum supply current	2.5mA

EEG-Z Sensor (SA9305Z)

Size (approx.)	37mm x 37mm x 12mm (1.45" x 1.45" x 0.45")
Weight (approx.)	25g (1oz)
Input impedance	10GΩ in parallel with 10pF
Signal input range	0 –200μV
Sensitivity	<0.1μVRMS
CMRR	>130dB
Channel bandwidth	2Hz – 1kHz
Accuracy	±0.3μVRMS, ±5% of reading @10°C to 40°C

ProComp Infiniti Encoder (SA7500)

Size (approx.)	130mm x 95mm x 37mm (5.1" x 3.7" x 1.5")
Weight (approx.)	200g (7oz)
Power source	4AA batteries, single use alkaline or NiMH rechargeable
Supply voltage	3.6V – 6.5V (fiber optic), minimum 4.0V (Compact Flash)
Battery life, Alkaline cells	30h typical, 20h minimum
Low-battery warning	20 – 30 minutes of battery life remaining
Sensor supply voltage	7.260V ± 2mV
ADC output	14bits
Full-scale input range, DC	2.8V±1.696V
LSB magnitude	207µV
Encoder channel bandwidth (3dB) and sample rate	DC – 512Hz @ 2048 samples/second DC – 64Hz @ 256 samples/second DC – 64Hz @ 200 samples/second DC – 8Hz @ 32 samples/second DC – 8Hz @ 20 samples/second
Anti-aliasing filter	5th order Butterworth
Alias rejection	30dB typical
DC gain accuracy	±0.5% (initial, or after self-calibration)
DC offset	±3LSB (initial, or after self-calibration)
Overall system accuracy	5%
Offset drift, calibration temperature ±10C	±5 LSB
Encoder noise	150µVRMS, 1mV p-p typical, offset removed

ProComp5 Infiniti Encoder (SA7525)

Size (approx.)	130mm x 95mm x 37mm (5.1" x 3.7" x 1.5")
Weight (approx.)	200g (7oz)
Power source	4AA batteries, single use alkaline or NiMH rechargeable
Supply voltage	3.6V – 6.5V (fiber optic), minimum 4.0V (Compact Flash)
Battery life, Alkaline cells	30h typical, 20h minimum
Low-battery warning	20 – 30 minutes of battery life remaining
Sensor supply voltage	7.260V ± 2mV
ADC output	14bits
Full-scale input range, DC	2.8V±1.696V
LSB magnitude	207µV
Encoder channel bandwidth (3dB) and sample rate	DC – 512Hz @ 2048 samples/second DC – 64Hz @ 256 samples/second DC – 64Hz @ 200 samples/second DC – 8Hz @ 32 samples/second DC – 8Hz @ 20 samples/second
Anti-aliasing filter	5th order Butterworth
Alias rejection	30dB typical
DC gain accuracy	±0.5% (initial, or after self-calibration)
DC offset	±3LSB (initial, or after self-calibration)
Overall system accuracy	5%
Offset drift, calibration temperature ±10C	±5 LSB
Encoder noise	150µVRMS, 1mV p-p typical, offset removed

ProComp2 Encoder (SA7400)

Size (approx.)	2 ½ " x 2 3/16" x 5/8" (64mm x 56mm x 16mm)
Weight (approx., without batteries)	40 g
Input impedance (Input A)	1,000,000 mΩ
Input impedance (Input B, C, D)	2 mΩ
Resolution (Input A only)	0.1 µV RMS
Signal input range (Input A)	0-200 µV RMS
Signal input range (Input B, C, D)	2.0V – 3.6V
CM RR (Input A)	-130 @ 2 Hz to 45 Hz
Channel bandwidth	0 Hz – 45 Hz
Sample rate /channel (A, B)	200 or 256 samples/second
Sample rate /channel (C, D)	20 or 32 samples/second
Supply voltage	1.0V – 1.6V
Current consumption	75 mA - 150 mA @ 1.5 V
Battery life (Alkaline)	10 Hours (minimum)
Low battery warning	1.1 V ± 0.2 V
Data output protocol	19.2 or 38.4 Kbaud, 8 Bits, 1 Stop, No Parity
Analog to digital conversion	13 bits
System accuracy	+/- 5%

Warranty

The hardware (encoder and sensors) is guaranteed to be free from defects in material and workmanship for 1 year from the date of purchase.

In the unlikely event that repair is necessary, contact Thought Technology Ltd. to receive a Return Authorization number. Then send the unit back by a traceable method. Thought Technology will not be responsible for items not received. We will repair or replace your unit(s) that are still under warranty free of charge.

This warranty does not apply to damage incurred through accident, alteration, or abuse.

This warranty does not cover damage to the Infiniti encoder or sensors caused by obvious mechanical mistreatment of the system.

Technical Support and Contacts

Placing orders

- Outside USA

  Tel: 1-514-489-8251
  Fax: 1-514-489-8255

- In USA Toll-Free

  Tel: 1-800-361-3651

- E-Mail: mail@thoughttechnology.com

  Or contact your local authorized distributor.

Technical support

For technical support please refer to the Thought Technology Ltd. website at www.thoughttechnology.com for frequently asked questions. If your support issue is not covered please e-mail or telephone at the number below.

- Outside USA

  Tel: 1-514-489-8251
  Fax: 1-514-489-8255

- In USA Toll-Free

  Tel: 1-800-361-3651

- E-Mail: techsupport@thoughttechnology.com

  Or contact your local authorized distributor.

Returning equipment

Be sure to call for an authorization number (RA) before returning any equipment!

Send the unit(s) postage prepaid and insured, with proof of purchase to one of the addresses below.

If you are shipping from outside Canada or the USA to Canada, mark the package **Goods to be repaired – Made in Canada** to avoid unnecessary customs charges.

All customs and duties charges will be billed to you if incurred by sending the unit to the wrong address.

Provide a detailed description of the problem you are experiencing, and your telephone/fax number and email (see form on the next page of this manual).

- **In the USA**, ship insured to:

  Thought Technology Ltd.
  Cimetra LLC
  8396 State Route 9
  West Chazy, New York
  12992, USA

- **In Canada and all other countries**, contact your dealer or ship insured to:

  Thought Technology Ltd.
  5250 Ferrier, Suite 812,
  Montréal, Québec
  H4P 1L3 Canada

  Broker: Livingston International – 133461

Repair return form

Name: _____

Company: _____

Address: _____

_____

_____

Telephone Number: _____

Fax Number: _____

Date Purchased: _____

From: _____

Model Name: _____

Serial Number: _____

Problem: _____

_____

_____

_____

_____

_____