iTHRVE HRV + Craniosacral Training App

0.1Hz Coherence Breath Training Option in iTHRVE app

ithrve.com

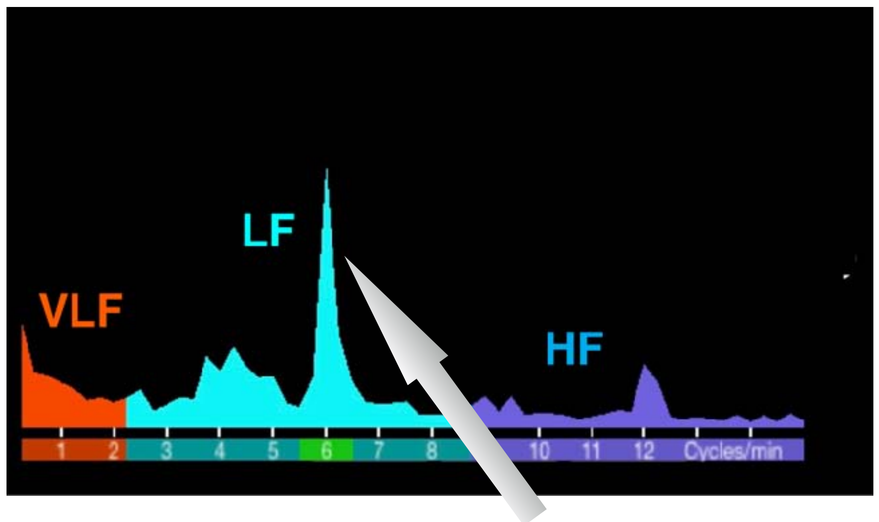
HRV spectrum bands & single peak coherence

Heart **Coherence** was originally extracted from the analysis of HRV (Heart Rate Variability which is variations of number of heart beats/minute) spectrum. This **Coherence** was defined as the size of the biggest LF HRV peak compared to the amplitude of the broad HRV spectra (VLF+LF+HF).
VLF (very low frequency), **LF** (low frequency),
HF (high frequency)

This way of analysis assumes you are breathing at a constant and fixed frequency (using a pacer around 0.1 Hz - 6 cycles/minute) during the breathing session.

If the frequency of your breathing is changing during the session, the LF peak will be larger (or there will be more than one peak) and the size of the LF biggest peak will be affected, resulting a lower coherence value.

3 bands are usually described in HRV spectrum:
The VLF band (up to 2.4 cycles per minute)
The LF band (2.5 to 9 cycles per minute)
The HF band (9 to 24 cycles per minute)



Biggest LF peak

Physiological body rhythm…

When you are sitting or lying down, in a calm and safe environment, your breath should automatically go to a slow and deep breathing pattern, according to a pressure wave we have inside our body.

Unfortunately, most of the time due to stressful lifestyles, this is not the case.

For a calm and healthy person, this pressure wave presents a good amplitude and its rhythm is around 5-7 cycles/minutes. Craniosacral Osteopaths can sense this pressure wave and interact with it in their therapeutic sessions.

Blood pressure PPG (Photoplethysmogram) pulses

This pressure variation can be detected with light plethysmograph sensors like the BERRY sensor we are using or like the flash & camera sensor of your iPhone (which is less stable and less accurate).

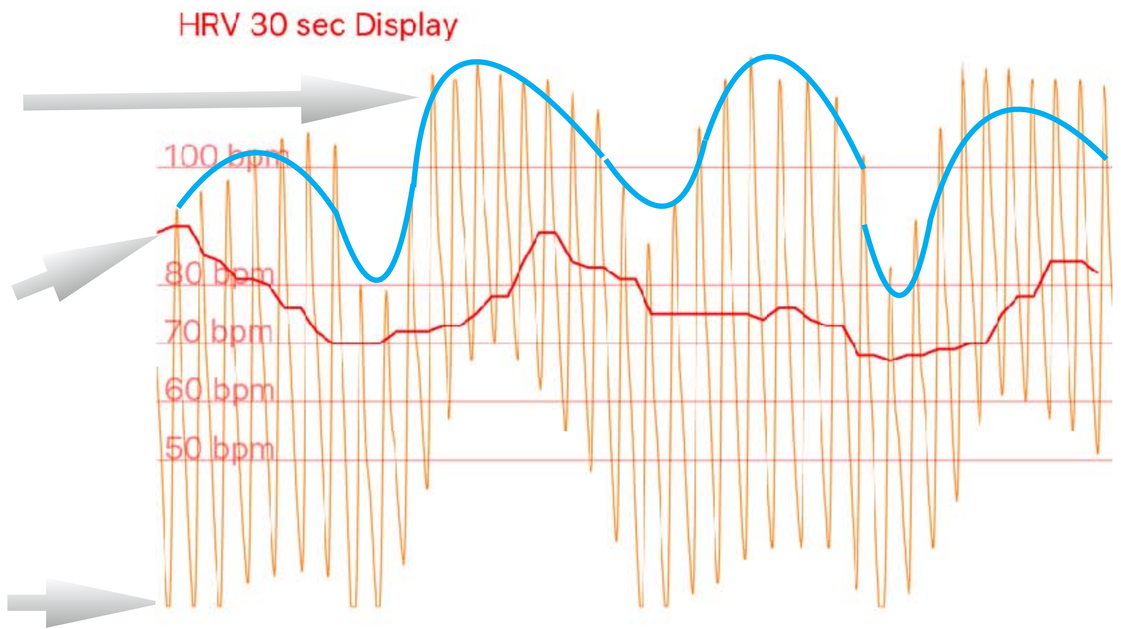
…Physiological body rhythm

This pressure wave is closely related to HRV. When heart coherence was originally defined, it was much easier to detect HRV than blood pressure variation, heart coherence was extracted from HRV spectrum analysis.

Pressure wave (cycles/minute)

HRV (beats/minute)

Blood pressure PPG pulses

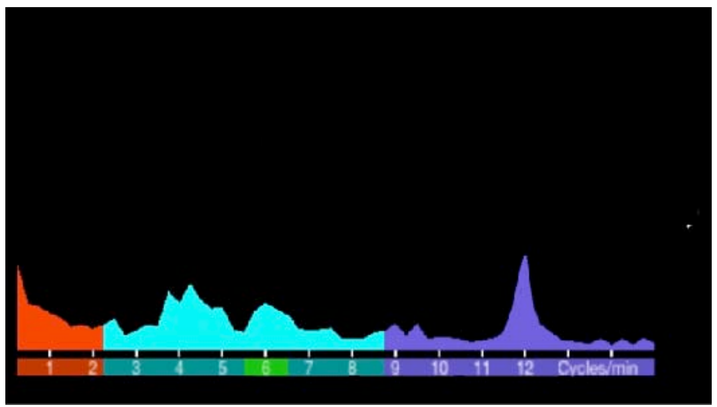


HRV spectrum bands & stress & HF band

HF band

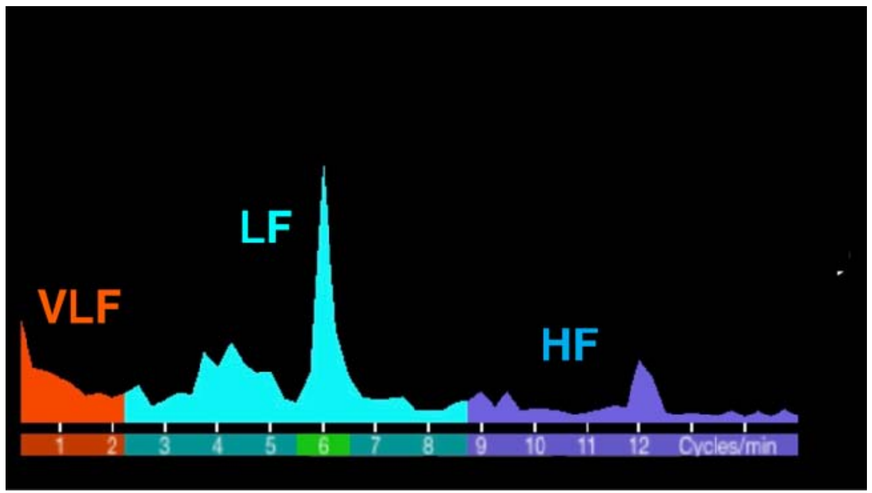
When you are sitting and working at your desk, your breathing rhythm will be above 9 cycles/ minutes.

The main peak in the spectrum will be in HF band.



Main peak in HF band

3 bands are usually described in HRV spectrum:
The VLF band (up to 2.4 cycles per minute)
The LF band (2.5 to 9 cycles per minute)
The HF band (9 to 24 cycles per minute)



Main peak in LF band during 0.1 Hz practice

HRV spectrum bands & stress & LF band

The LF band

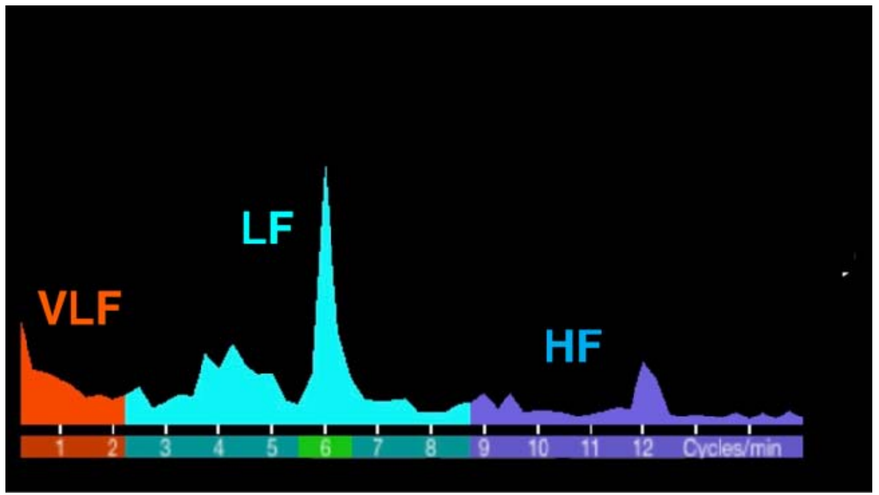
When you are sitting or lying down, in a calm and safe environment, your breath should automatically go to a slow and deep breath pattern between 3 and 6 cycles/minute.

Unfortunately, due to stress, it is most of the time, not the case!

That is the reason why slow and deep breathing practice is so powerful for your health and for your buffer to stress.

You can watch this video explaining more about this buffer:
https://www.youtube.com/watch?time_continue=550&v=8u-W0ro7Mfw

3 bands are usually described in HRV spectrum:
The VLF band (up to 2.4 cycles per minute)
The LF band (2.5 to 9 cycles per minute)
The HF band (9 to 24 cycles per minute)



HRV spectrum bands & stress & VLF band

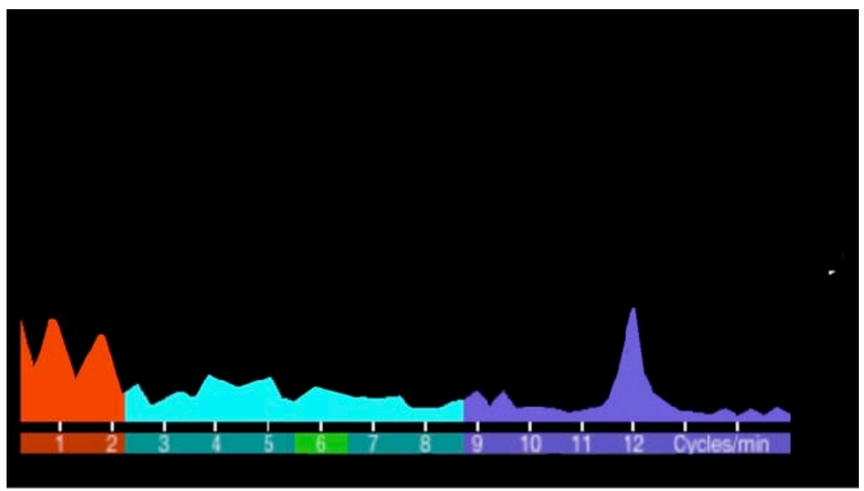
The VLF band

When you are sitting or lying down, in a calm and secure environment, the VLF band should be low.

The more you will free your mind, the more the VLF band will be low.

When you are sitting or lying down, the VLF band will increase each time you will be disturbed by something (or if you begin to think about something).

3 bands are usually described in HRV spectrum:
The VLF band (up to 2.4 cycles per minute)
The LF band (2.5 to 9 cycles per minute)
The HF band (9 to 24 cycles per minute)



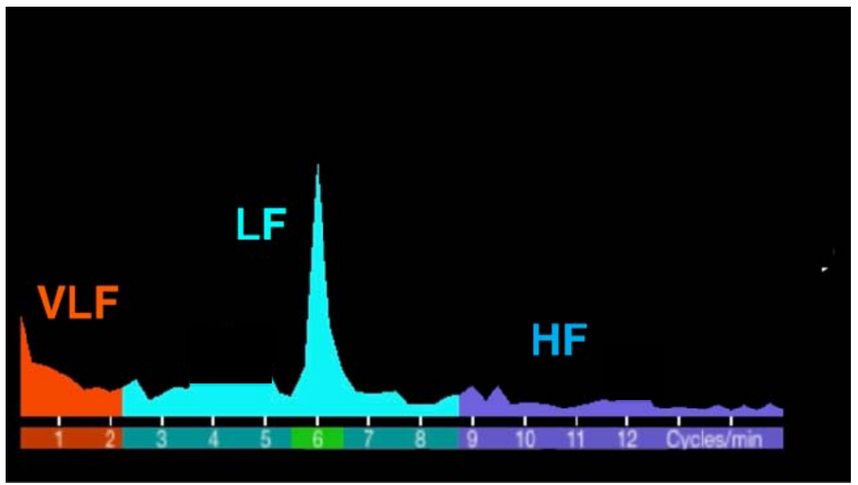
HRV spectrum band ratios & stress

When you are sitting or lying down in a calm and secure environment, making a 0.1Hz breath training practice, you should get a beautiful peak in the LF part of the HRV spectrum.

But according to how your body feels during the practice you can get different kind of results in the different bands of the spectrum.

If you are really calm and relax, and your mind is completely free of worrying, VLF and HF bands will be low and a beautiful single big peak will appear in the LF band.

3 bands are usually described in HRV spectrum:
The VLF band (up to 2.4 cycles per minute)
The LF band (2.5 to 9 cycles per minute)
The HF band (9 to 24 cycles per minute)



HRV spectrum band ratios & stress

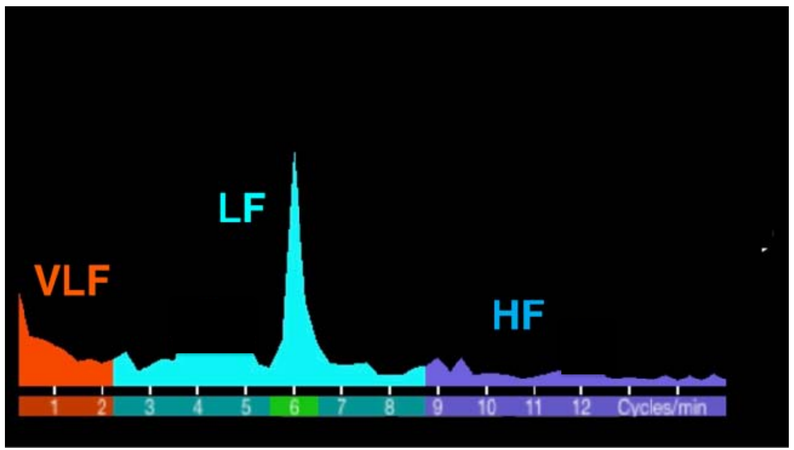
If you are not quite relax, your body will not allow to stay at the fixed 0.1Hz frequency and will turn around it. You will then get a large and lower peak around 6 cycles/minutes.

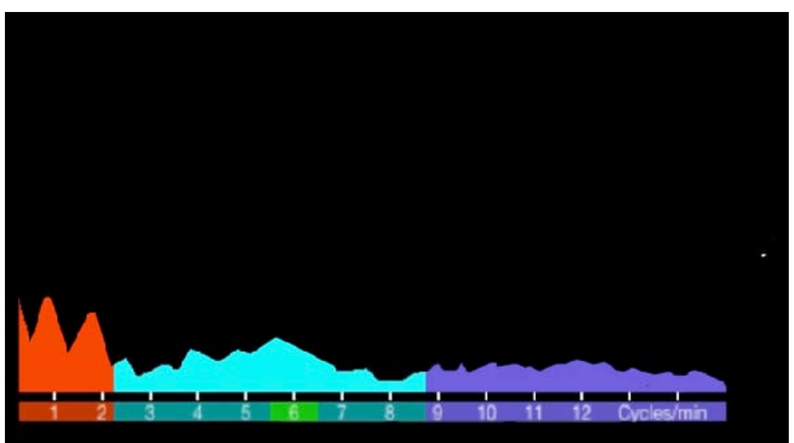
If your mind is not free and you are too much thinking… VLF will tend to increase.

If your are very stressed, you will get a higher amplitude of HF band.

In 0.1Hz breath training practice, the most important band to watch is the LF band. But the two other bands are also quite interesting.

This is the reason why we will make ratios between the different bands.





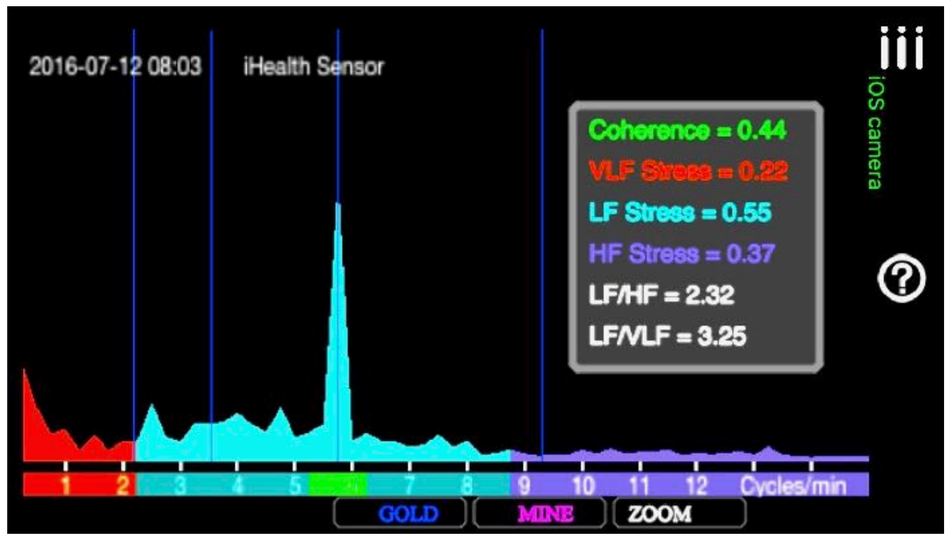
HRV spectrum band ratios & stress

LF/VLF will make the relationship between your relaxing state (LF band) and the state of your thinkings - mind free (VLF band).

The LF/VLF ratio will be higher when your are quite relax and have your mind free of thinkings.

LF/HF will make the relationship between your relaxing state (LF band) and a stress state you are living (bigger amplitude in the HF band).

The LF/VLF ratio will be higher when your are quite relax and not having stress.

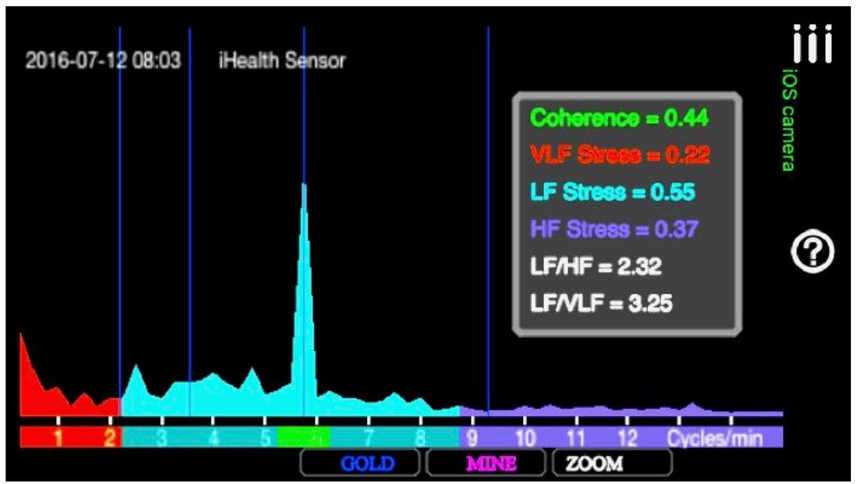


HRV spectrum band ratios & stress

We have already mentioned that stress is influencing the size and the shape of the peak, but also the size and the shape of the different parts of the spectrum: the lower the stress, the bigger the peak and the lower all the parts of the spectrum.

Another way to analyse is then to compare the power of the different parts of the spectrum:

- the power of the peak
- the power of LF band around the peak
- the power of VLF band
- the power of HF band



Coherence will compare the shape of the peak regarding to the other parts of the spectrum.
VLF stress will indicate the way your mind is free
LF stress indicates the way your body is free to accept the single breathing peak resonance.
HF stress will indicate the power of the stress your are related to

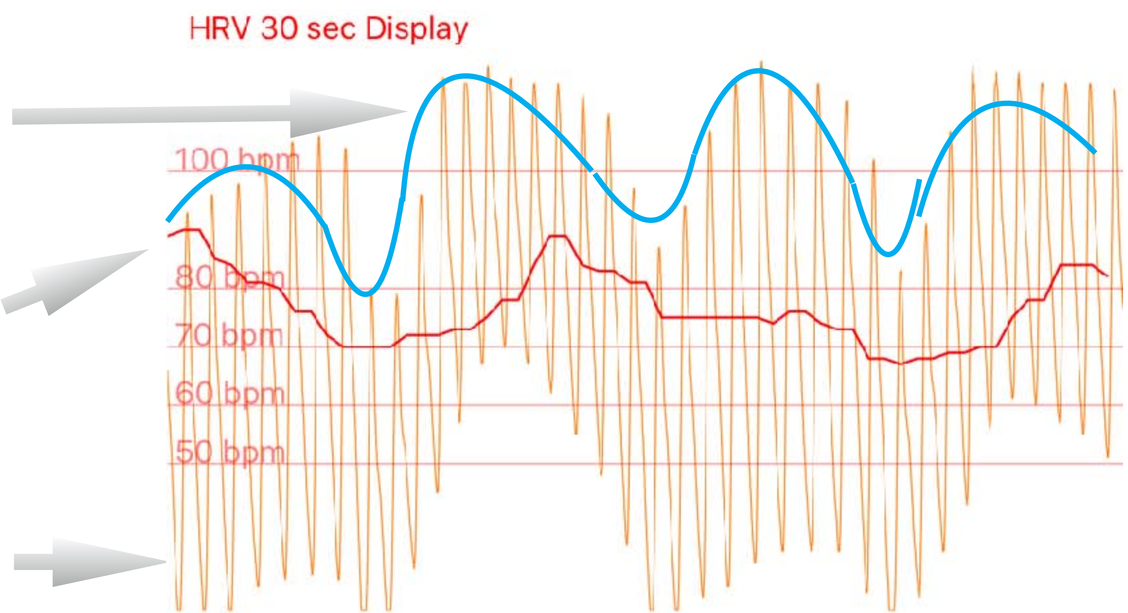
Our new ways of heart coherence analysis

Heart coherence was originally defined from HRV spectrum analysis. The first part of our coherence analysis is extracted from HRV data. PPG blood pressure data are also important. The Pressure wave (Mayer wave) is also a good indicator of the coherent state. And we will see that comparison of HRV LF wave with PPG LF wave is a very interesting indicator of stress.

Pressure wave (cycles/minute)

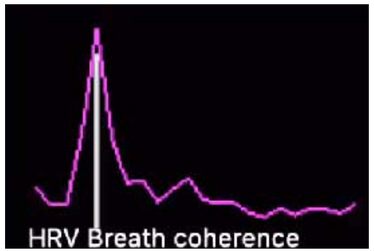
HRV (beats/minute)

Blood pressure PPG pulses

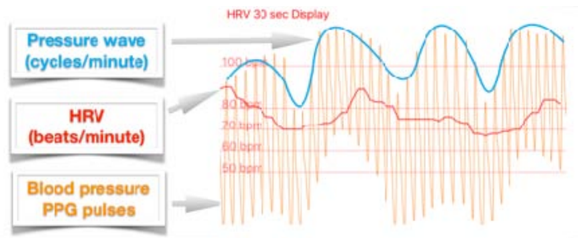


Our 3 new ways of heart coherence analysis

Broad spectra
Coherence
(FFT3)

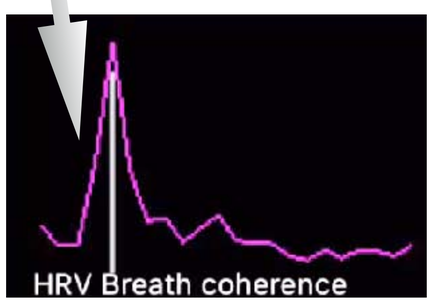


Coherence
of PPG waves



HRV & PPG waves
comparison
(power factor)

Broad spectra coherence (FFT3)

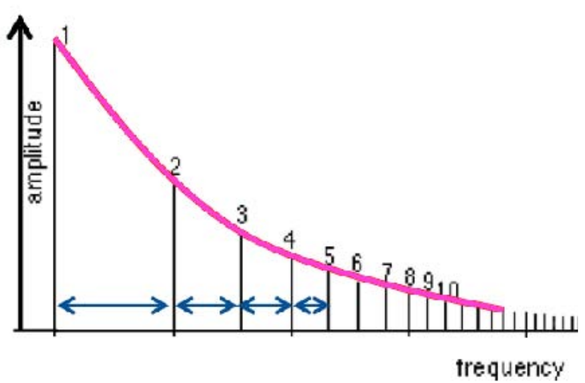


Another way to analyse the coherence from the heart HRV spectrum, is to analyse the relationship between all the peaks present in the spectrum. The more these peaks will be related to musical (or golden) ratios, the more your HRV will be coherent (harmonic inclusiveness, fractal).

We have developed a new kind of mathematical analysis of 3rd order FFT (Fast Fourier Transform) of the broad HRV spectra.

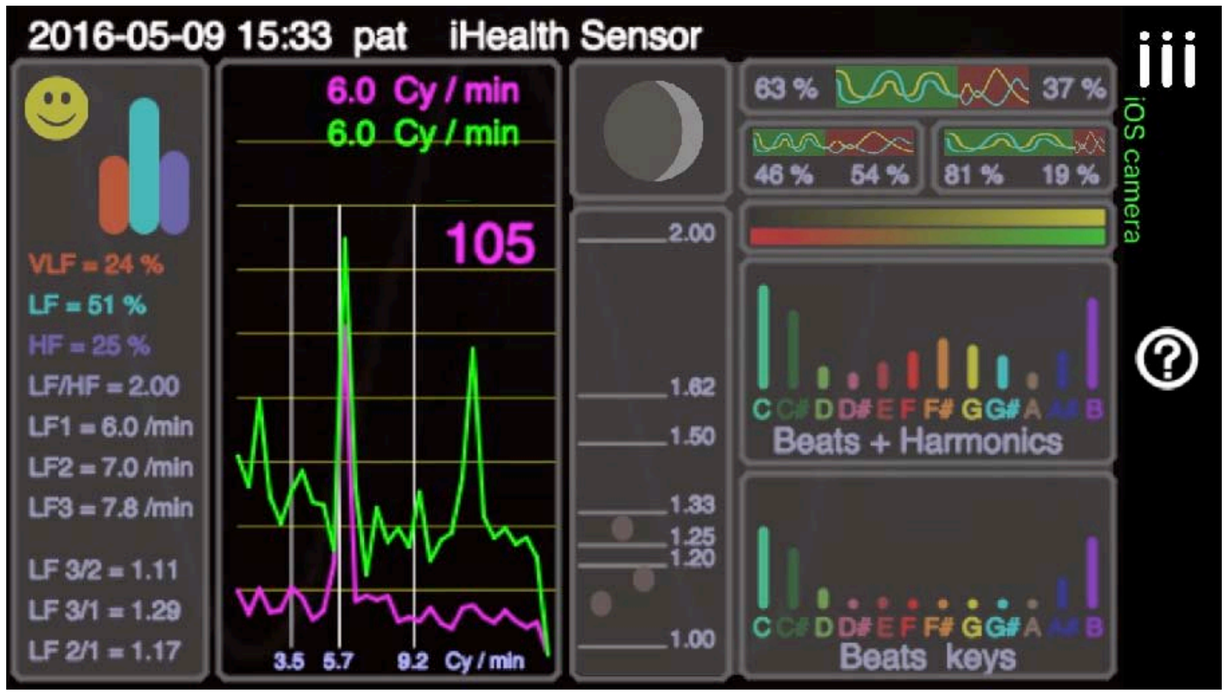
The musical relationship between the peaks is defined by musical (or golden) ratios. These ratios are related by the respective sizes of the peaks and their relative position in the spectrum.

This could be visualised as an analysis for regularly spaced patterns in the shape of the purple line linking all the peaks of the spectrum.

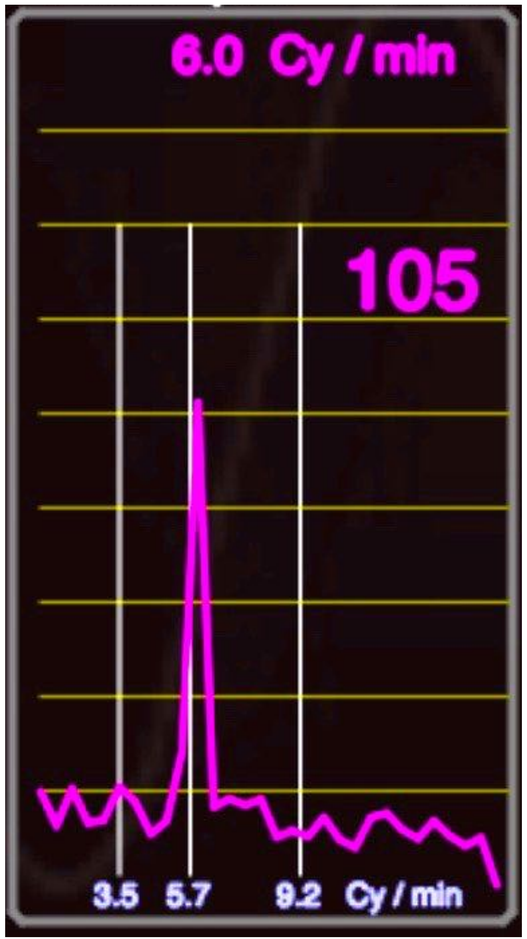


Dashboard of a 0.1Hz training breathing recording on iTHRVE app

Broad spectra coherence (FFT3)



Broad spectra coherence (FFT3)



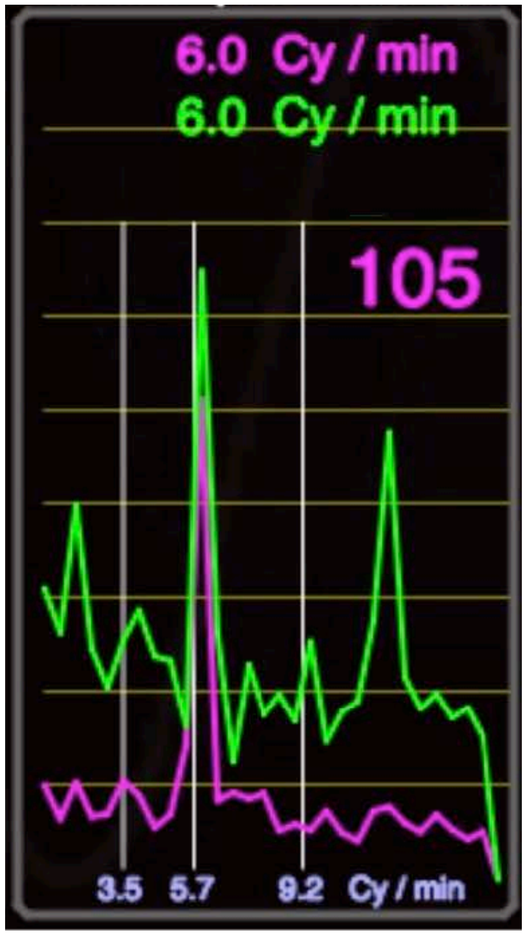
Third order spectrum analysis related to the coherence of the breathing.

HRV analysis is in pink.

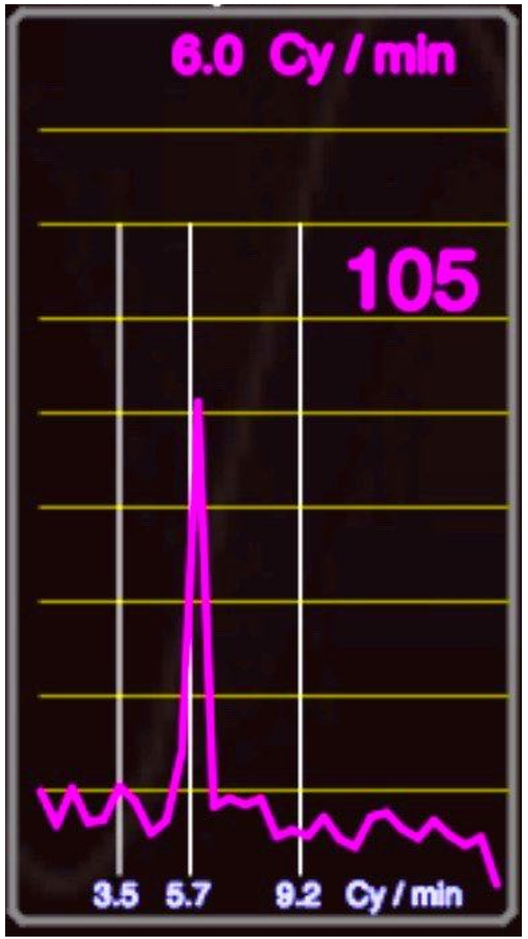
PPG/blood pressure wave analysis in green (only available with light sensors).

The coherence is related to the amplitude of the peak.

The pink number is an indicator of the size of **broad spectra HRV coherence**.



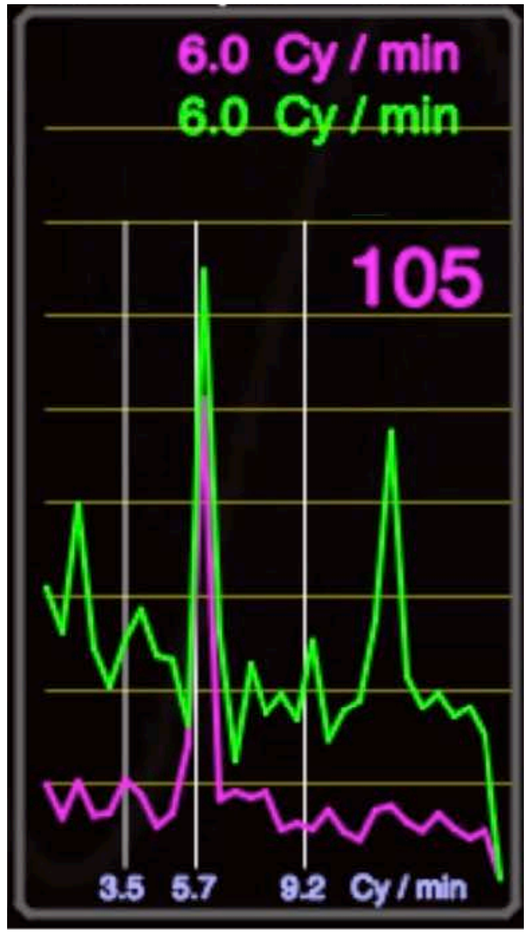
Broad spectra coherence (FFT3)



This graph also displays the average rhythms of HRV LF and PPG LF waves.

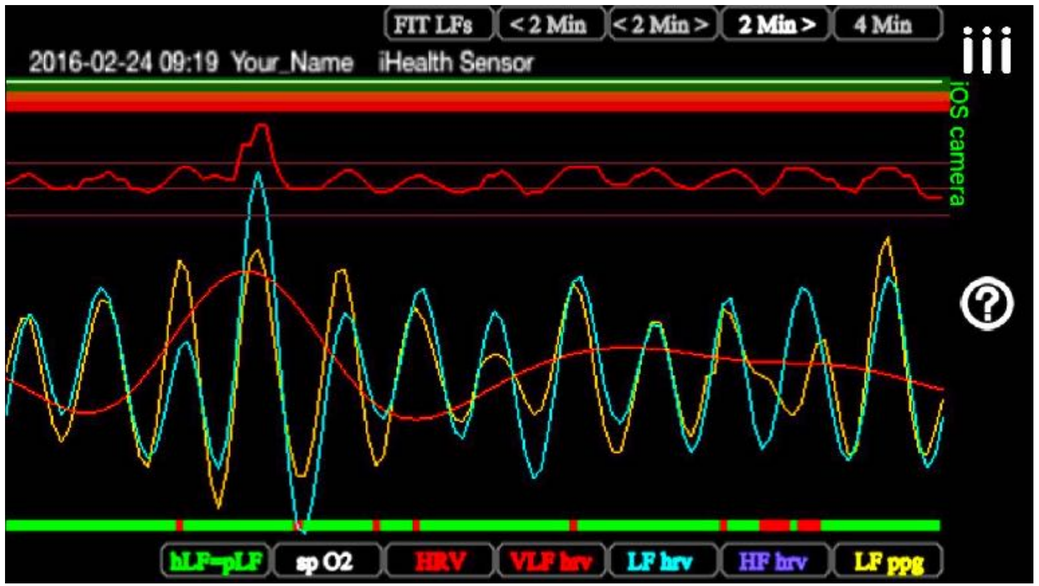
The better when LF HRV & LF PPG waves are phase locked

Sometimes a second peak (second rhythm) could appear in PPG spectrum



Phase lock between HRV & PPG

4 last minutes of HRV VLF, LF, HF and blood pressure waves



It is useful to note the phase lock (where the peaks line up), between the yellow LFppg (Mayer blood pressure wave) versus the light blue (HRV LF wave) period.

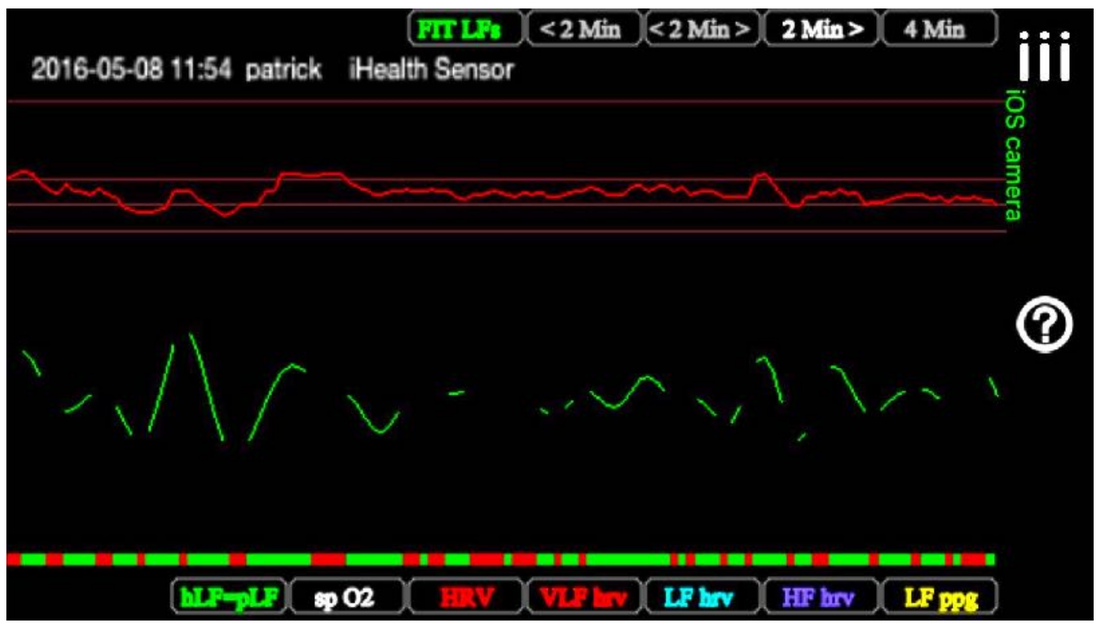
This efficient entrainment of the bodies blood pressure resonance synchronise with the LF from the HRV electrical peak - can be a profound indicator of relaxation vs stress.

0.1 Hz breathing records
LF HRV & LF PPG waves phase lock

An example of an **efficient, relaxed, resonant entrainment**, showing the green wave summation of the constructive combination of HRV LF wave and PPG LF wave (clicking on the FFT LFs button enables this display).

0.1 Hz breathing records
LF HRV & LF PPG waves phase lock

An example of a **less** efficient, relaxed, resonant entrainment, showing the green wave summation of the constructive combination of HRV LF wave and PPG LF wave (clicking on the FFT LFs button enables this display).

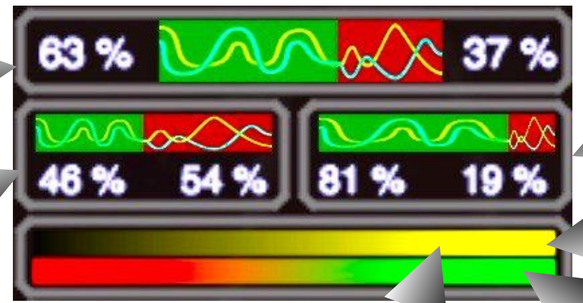


Stress vs Relaxation indicator:

% Fit between HRV and PPG (blood pressure) LF waves
(only available with light sensors)

Last
4 minutes

Previous
2 minutes



Last
2 minutes

Evolution during
4 minutes

Comparison
2 first minutes
2 last minutes

COLOURS

< 50%

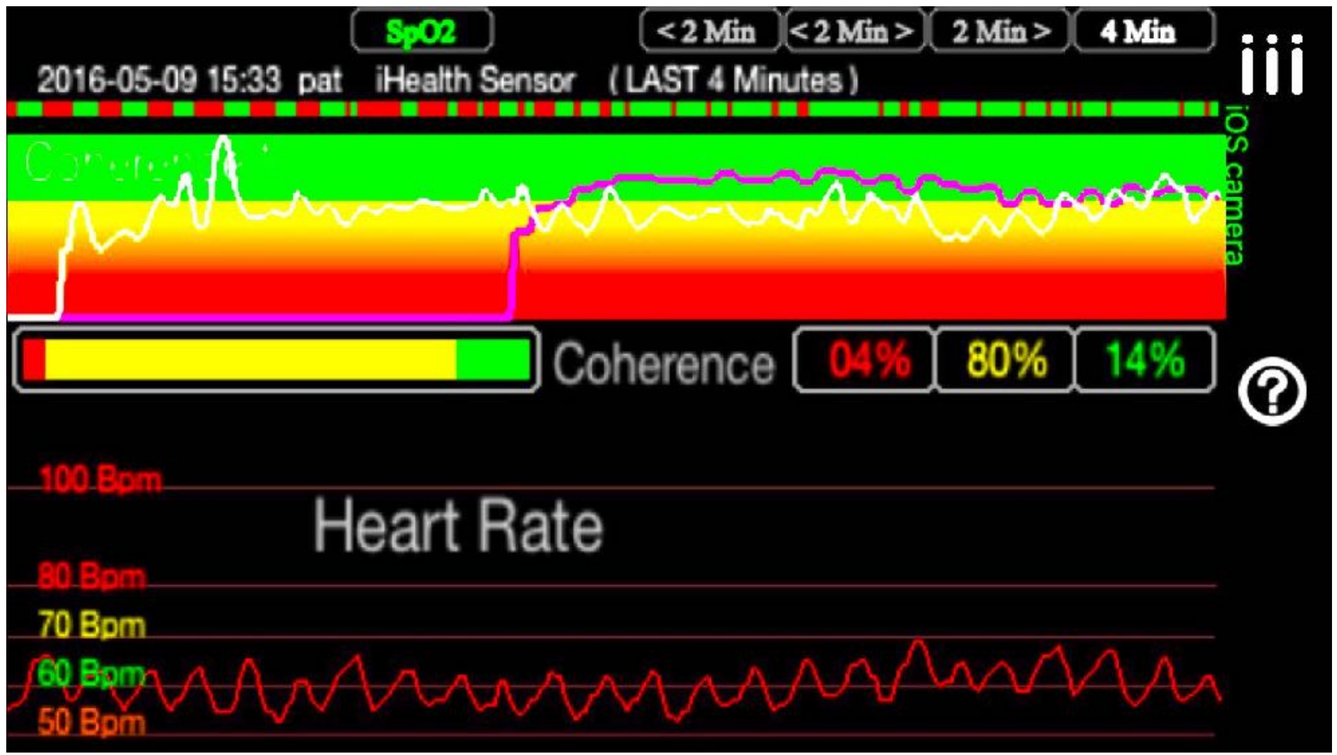
>=50% & < 60%

>=60% & < 70%

>= 70%

Last 4 minutes averaging

Coherence display options:
Full FFT3 coherence vs simple dominant harmonic amplitude coherence



HRV % Coherence evolution over time

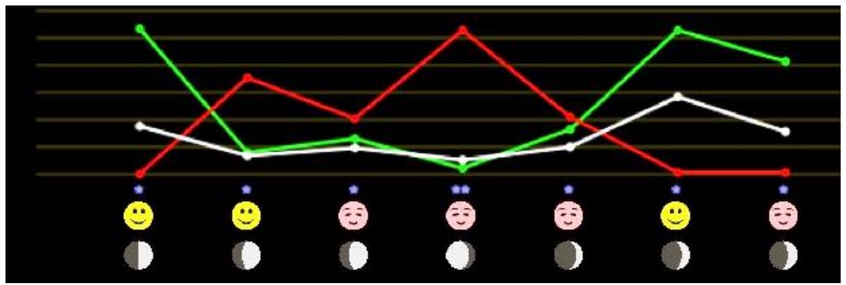
Options to display graphs:

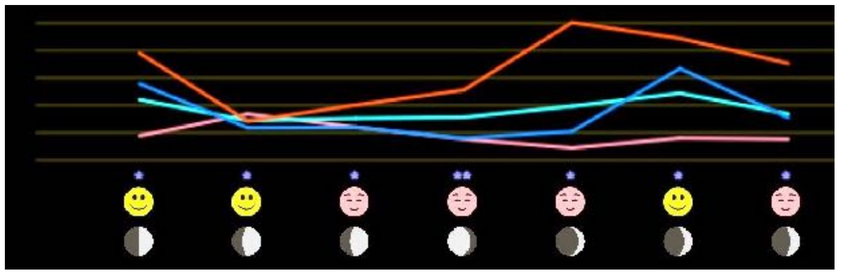
- Long Term Stress Level
- Short Term Stress Level
- LF/HF
- FFT3: heart/breath Coherence (by third order spectrum analysis)
- Coherence curve by simple single dominant harmonic amplitude

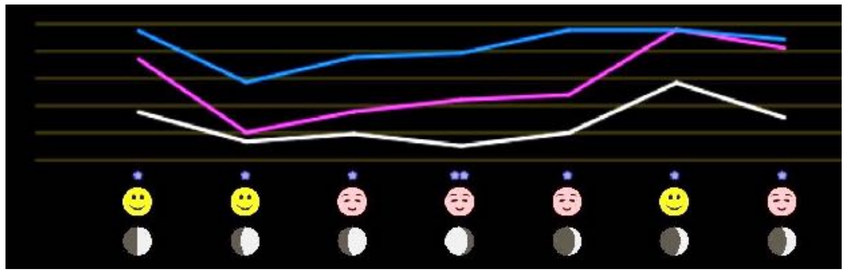
Evolution & History

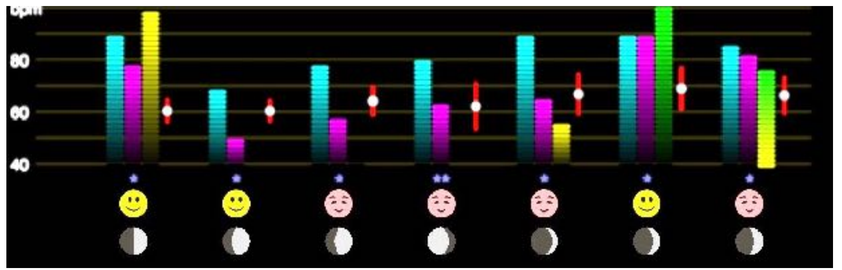
Coherence Breath Training

4 kinds of graphs









Breathing practice history

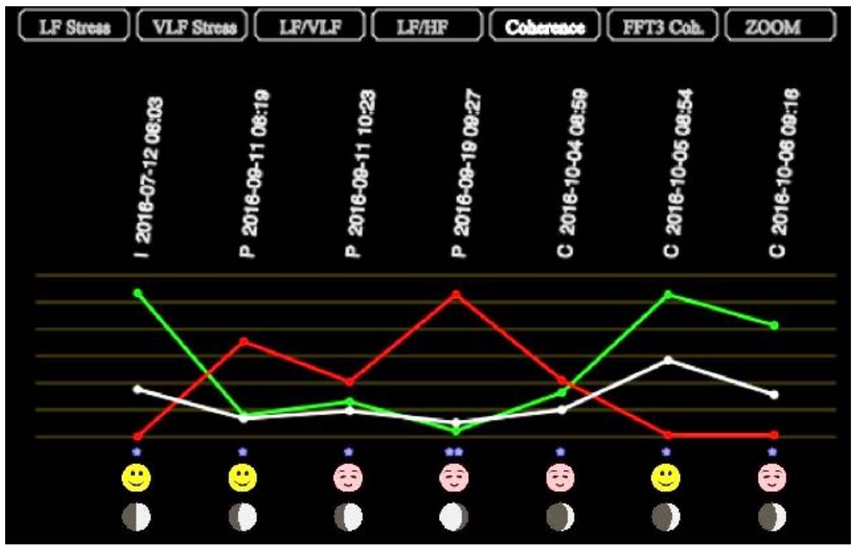
HISTORY displays 3 main curves:

• white curve is the size of the coherence peak (computed by single peak analysis)

- the red curve is the percentage of the worst part of the coherence graph

- the green curve is the percentage of the best part of the coherence graph

The progress should show an increase of the white and green curves and a decrease of the red curve.

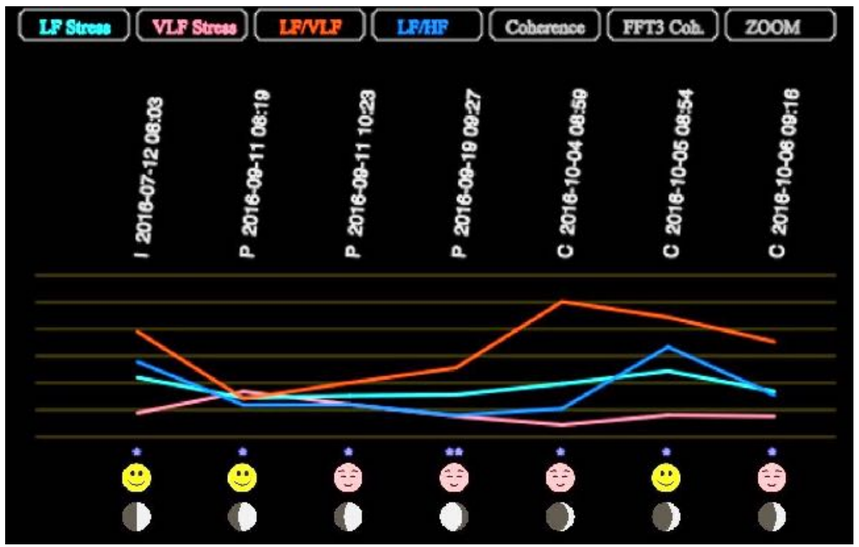


[ZOOM] will display more or less data on the screen
The lower little stars are related to the level you selected for the practice (beginner/ expert).

Breathing practice history

All buttons can be used together or separately to compare all these parameters

VLF Stress is related to short term stress
LF Stress is related to long term stress
HF Stress is related to emotional ‘baggage’.

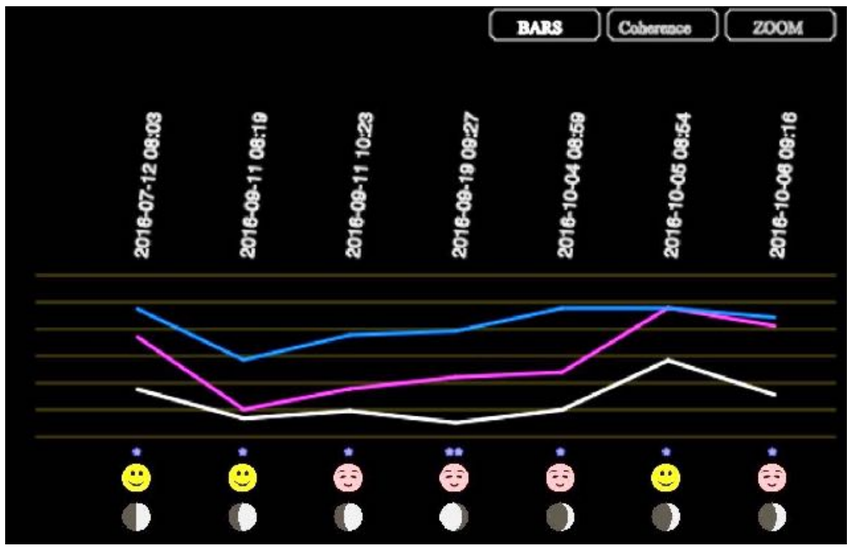


[ZOOM] will display more or less data on the screen
The lower little stars are related to the level you selected for the practice (beginner/ expert).

Breathing practice history

HISTORY displays 3 curves:

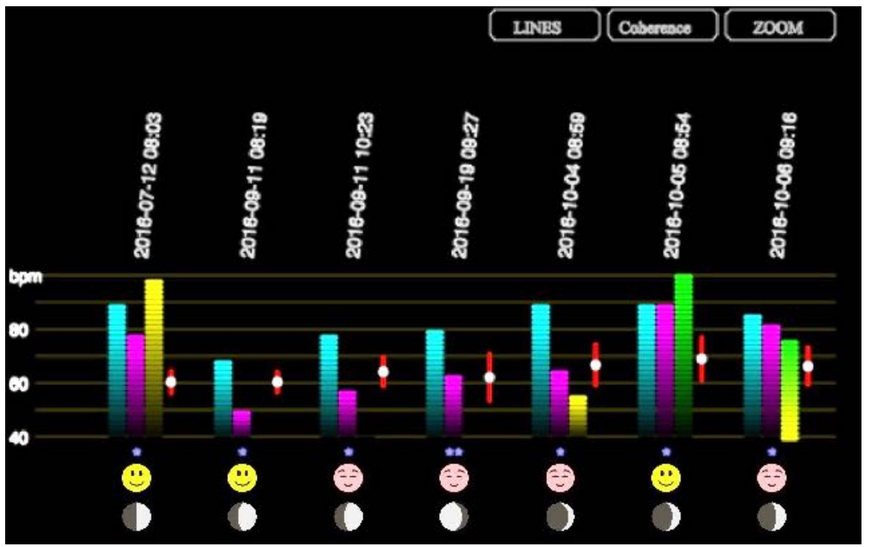
- white curve is the size of the coherence peak - computed by single peak analysis (as in the previous graph)
- pink curve is the coherence of the whole HRV spectrum (using a third order FFT of the HRV spectrum, allowing to compute the whole HRV spectrum coherence - not only a single peak as in the previous analysis)
- blue curve is the LF/HF ratio



[ZOOM] will display more or less data on the screen
The lower little stars are related to the level you selected for the practice (beginner/ expert).

Breathing practice history

- light blue = LF/HF ratio
- pink = coherence (FFT3) of the whole HRV spectrum
- yellow/green = single peak coherence (from yellow to green)
- white dots = average heart rate (bpm)
- red bars = HRV amplitude



[ZOOM] will display more or less data on the screen
The lower little stars are related to the level you selected for the practice (beginner/ expert).

iTHRVE HRV + Craniosacral Training App

For more info visit ithrve.com