

Heart-Rate Biofeedback for Management of Stress and Chronic Pain

Neural processing of pain is complex. Stress contributes to chronic pain in several ways:

- Stress amplifies sensitivity of nerves in pathways that process pain, so stress acts to increase the 'volume' on pain.
- Chronic pain can change nerve connections (neuroplasticity) so that nerves normally involved in stress connect to nerves that normally process pain, so stress can directly increase the signal in the brain that is interpreted as pain.
- Stress affects the autonomic nervous system in ways that increase inflammation, which causes pain and increases nerve sensitivity.
- Stress makes it difficult to do things that would help you manage pain, such as breathing properly, getting sufficient sleep, exercise, and social support.

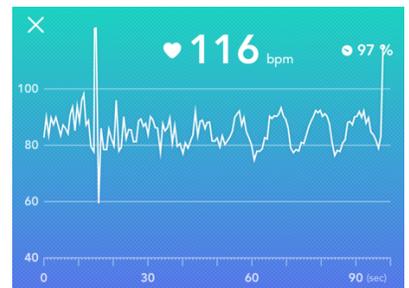
What is Heart Rate Variability? The heart rate (HR) normally varies over time. One of the things that drives this variability is breathing, where HR increases slightly when we inhale, and decreases slightly when we exhale. Higher HRV is related to improved physical and psychological health and resilience.¹ Increased HRV is sometimes referred to as 'resonance' or 'coherence'.

What is Biofeedback? Biofeedback is a method of using tools to become aware of some biological function as a means of learning to control that function. Biofeedback can be through measurements of breathing, HRV, muscle tension, skin temperature, sweating, and brain waves. Breathing and HRV biofeedback can be done at home with minimal technology. HRV biofeedback is a method for increasing HRV coherence as a tool for improving health. More information about biofeedback is available at <https://www.mayoclinic.org/tests-procedures/biofeedback/about/pac-20384664>

Medical literature reports that HRV biofeedback appears to be a promising non-pharmacological treatment for chronic pain in people with fibromyalgia² and other forms of chronic pain.³

Biofeedback devices for improving HRV

- **Free phone apps** (there are many others for purchase):
 - **StressScan:** Placing your index finger over your phone camera and flash allows the app to measure HRV. StressScan provides instantaneous feedback (shown in picture). The picture here shows low coherence (jagged line on left side) at first, but a smoother sinusoidal curve when more relaxed, breathing slowly and deeply (right side). StressScan provides a 90 second average score, giving you a simple-to-interpret score of 0-100 (100 is most stressed) and it tracks factors that may contribute to stress. But it does not have a breath cue. App is free, but you have to watch a ads to get results.
 - **Camera HRV:** Placing your index finger over your phone camera and flash allows the app to measure HRV. Has breathing cue, but no immediate feedback about performance. It provides a 60 second average. rMSSD scores reflect parasympathetic activity. Tracks factors that may contribute to stress, and records HRV values over time.
 - **Juva Migraine & Headache** (1 year free trial to beta testers: use code Apple2022 or IG2022)
 - **Welltory:** HRV through either the phone or using Apple Watch.



Biofeedback for diaphragmatic (belly) breathing. Diaphragmatic (belly) breathing is another way to calm the central nervous system. **BellyBio** is an app that teaches people how to belly breathe.

¹ Lehrer PM, Gevirtz R. Heart rate variability biofeedback: how and why does it work? *Front Psychol.* 2014;5:756.

² Reneau M. Heart Rate Variability Biofeedback to Treat Fibromyalgia: An Integrative Literature Review. *Pain Manag Nurs.* 2020;21(3):225-232.

³ Berry ME, Chapple IT, Ginsberg JP, Gleichauf KJ, Meyer JA, Nagpal ML. Non-pharmacological Intervention for Chronic Pain in Veterans: A Pilot Study of Heart Rate Variability Biofeedback. *Glob Adv Health Med.* 2014;3(2):28-33.

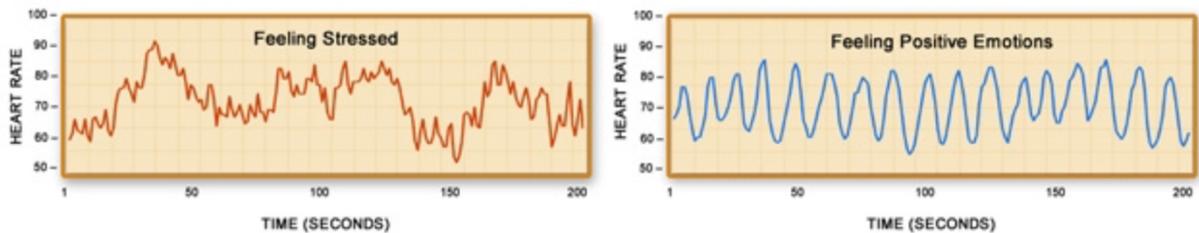
Wearable fitness devices for biofeedback:

- Fitbit: many models have HRV and other measures of stress, as well as slow breathing cues. Instructions at: https://help.fitbit.com/articles/en_US/Help_article/2077.htm
- Apple Watch provides HRV data each time you use the Breathe module: <https://support.apple.com/guide/watch/breathe-apd371dfe3d7/watchos>

Dedicated HRV biofeedback units:

- **Inner Balance** coherence sensor is an earclip that measures HRV and outputs results through a free app. The app includes a breathing cue and immediate feedback about coherence in the form of an instantaneous score (actually a moving average of 60 seconds). (about \$100). <https://store.heartmath.org/Inner-Balance-Sensor/>
- **emWave2 Heartmath** comes as either a sensor that you plug directly into your smartphone, or a sensor and portable device that can be used on its own, or plugged into a computer for more ways to interface through graphics, such as making a hot air balloon float higher in the sky. (about \$150) <https://store.heartmath.org/emWave2-Handheld/emWave2-handheld.html>

The following graphic shows output for both Inner Balance and emWave2. On the left is a recording while stressed, and on the right when more relaxed.



How to use biofeedback devices:

- Practice daily! While most people notice slight, transient improvements immediately after biofeedback practice, actually changing the nervous system requires at least 2 weeks of daily practice. Exact 'dosing' is not yet known, but 10 minutes twice a day is probably good. However, even 5 minutes once a day is better than nothing. Some people feel enough benefit to stop practicing biofeedback after a month or two, while others continue practicing for years.
- At first, find a quiet space where you won't be disturbed during your practice. Retraining the nervous system requires concentration. Once you become more skilled, practice in more distracting and stressful locations - noisier, family around, etc.

Terminology

- **Pain:** "An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage" (International Association for the Study of Pain, 2020)
- **Autonomic nervous system:** the part of the nervous system that responds automatically to control body functions. It includes sympathetic and parasympathetic portions, which are inversely related: when one increases, the other decreases.
- **The sympathetic nervous system,** commonly known as the "fight or flight" system is activated by stress. The sympathetic system normally suppresses pain and inflammation. However, the neuroplasticity of chronic pain reverses this relationship so that stress increases pain and inflammation.⁴
- **The parasympathetic nervous system,** commonly known as the "rest and digest" system, is enhanced by the relaxation response, such as slow breathing, meditation, yoga, etc..

*This handout is intended to supplement pain management with your health care provider.
It is not intended to replace medical advice.*

⁴ Schlereth T, Birklein F. The sympathetic nervous system and pain. *Neuromolecular Med.* 2008;10(3):141-147.