QUICK START GUIDE FOR THE BCIA HRV DIDACTIC WORKSHOP

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What is heart rate?

- Heart rate (HR) refers to the number of beats per minute. HR is important because a high rate can reduce heart rate variability.

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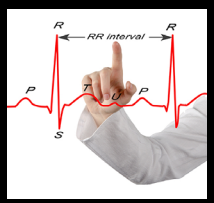
What is heart rate variability?

- Heart rate variability (HRV) refers to moment-to-moment changes in the time intervals between adjacent heartbeats (McCraty & Shaffer, 2015).



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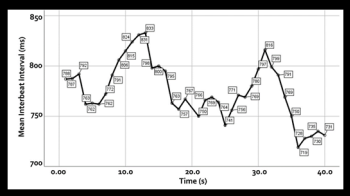
What are interbeat intervals?

- Time intervals between adjacent heartbeats are called interbeat intervals (IBIs) (McCraty & Shaffer, 2015).



Graphic courtesy of Dick Gevirtz

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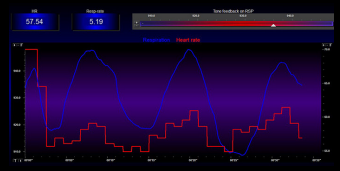
What is heart rate variability biofeedback?

- Heart rate variability biofeedback (HRVB) refers to displaying HRV to clients, often when they engage in slow-paced breathing. A typical display may include instantaneous HR (red) and their breathing pattern (blue).



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What is heart rate variability biofeedback?

- HRVB often combines HRV and breathing displays with coaching to improve self-regulation, resilience, health, and performance.

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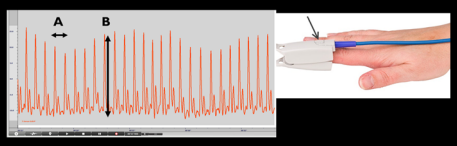
How do we detect IBIs?

- A PPG sensor detects the peak of successive pressure waves.
- Software counts the time between peaks to measure the interbeat intervals (IBIs).



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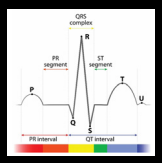
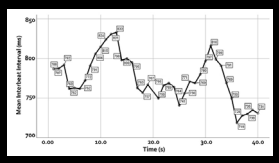
How do we detect IBIs?

- An ECG sensor detects the ECG's R-spike.
- Software measures the time between successive heartbeats.



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What does the parasympathetic branch do?

The parasympathetic nervous system (PNS) regulates activities that increase the body's energy reserves (rest, digest, and tend-and-befriend) via the vagus nerves.

When safe, we engage the PNS when we socially engage with others and self-regulate, including slow-paced breathing and HRV biofeedback.

When facing inescapable threats, the PNS produces dissociation, feigning death, and freezing.


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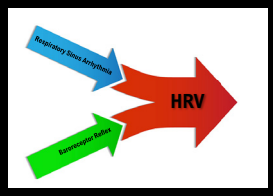
What are the parasympathetic sources of HRV?

Respiratory sinus arrhythmia and the baroreflex are the two most important sources of acute HRV, respectively (Hayano & Yuda, 2019).



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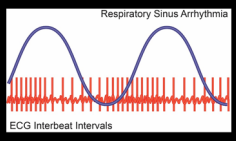
What is respiratory sinus arrhythmia?

Respiratory sinus arrhythmia (RSA), HR speeding and slowing across each breathing cycle, is the primary source of HRV (Gevirtz, 2020).



Graphic adapted from Elite Academy

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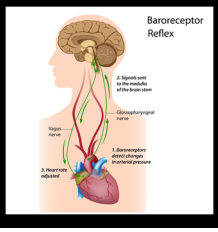
What is the baroreceptor reflex?

The baroreflex, which regulates acute blood pressure changes is the second-most-important parasympathetic source of HRV (Gevirtz, 2020).



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What is the resonance frequency?

The resonance frequency (RF) is the stimulation rate that maximizes HRV. Slow-paced breathing and rhythmical skeletal muscle tension are two well-researched methods.

Clinicians perform HRVB at the RF or around 6 breaths or muscle contractions per minute.

The first step in HRVB RF training is to identify an individual's RF. For breathing, that is done by guiding the trainee to breathe at several successive breathing rates, while monitoring the frequency distribution and amount of HRV at each breathing rate.

Once we identify the RF, biofeedback training can guide the trainee to breathe at this rate and increase the amplitude of HR oscillations.

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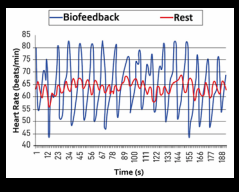
What is the resonance frequency?

The red waveform shows HR oscillations while resting with no breathing instructions or feedback. The blue waveform shows HR oscillations with HRV biofeedback and breathing from 4.5-6.5 bpm. Graphic adapted from Gevirtz et al., 2016.



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What determines the resonance frequency for each individual?

Slow-paced breathing increases RSA by stimulating the baroreceptor system at its unique RF, which is ~ 0.1 Hz). 0.1 Hz corresponds to breathing around 6 times per minute.

The exact RF is caused by the delay in the baroreflex. The source of this delay is the inertia of blood in the vascular tree. More blood, longer delay, and lower RF (Lehrer et al., 2004).

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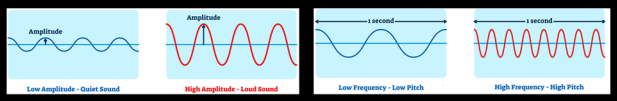
How do we measure HRV?

- Amplitude is signal strength, measured in ms^2, and is analogous to loudness.
- Frequency is the number of completed cycles per second, measured in hertz (Hz), is analogous to pitch.



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How do we measure HRV?

- We measure HRV over short (~5 minute) and long (24 hour) periods.
- We cannot compare short-term with long-term values.
- Likewise, we cannot compare measurements from resting baselines with values obtained during HRVB.
  - Paced breathing at a controlled rate, as in HRVB, momentarily increases HRV.
- We characterize HRV using time- and frequency-domain measurements.

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What are HRV time-domain measurements?

- Time-domain measurements quantify the amount of HRV observed during monitoring periods that may range from 60 seconds to over 24 hours.
- Three widely-used metrics are the RMSSD, SDNN, and pNN50.

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What are HRV time-domain measurements?

- The RMSSD is the root mean square of successive differences between normal heartbeats in milliseconds. It is the best overall measure of short-term HRV because it is less affected by outliers and artifact than SDNN (Gevirtz, 2020).
- The SDNN is the standard deviation of the IBIs of normal sinus beats, also expressed in milliseconds. RSA is its main source, especially during slow-paced breathing.
- The pNN50 is the percentage of adjacent NN intervals that differ from each other by more than 50 milliseconds. The RMSSD better assesses RSA than the pNN50.

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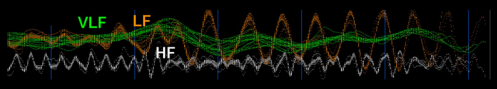
What are HRV frequency-domain measurements?

- Frequency-domain measurements reveal the sources of physiological changes (Gevirtz, 2020).
- The processes that contribute to HRV operate at different speeds and therefore generate different frequencies.
- Frequency-domain measurements quantify the amount of HRV signal power within each of three relevant frequency bands (very-low-frequency, low-frequency, and high-frequency).



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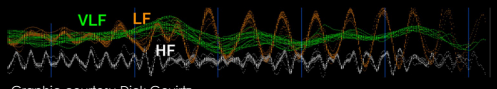
What are HRV frequency-domain measurements?

- The very-low-frequency (VLF) band (0.0033-0.04 Hz) may involve the heart's intrinsic nervous system. The SNS influences the amplitude and frequency of its oscillations (Shaffer, McCraty, & Zerr, 2014; Task Force, 1996).
- In short-term recordings, VLF elevations may signal chronic SNS activation or vagal withdrawal (parasympathetic suppression) due to chronic worry or excessive effort (Gevirtz, 2017).



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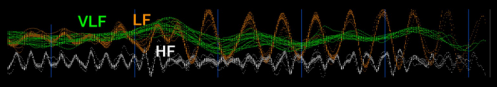
What are HRV frequency-domain measurements?

- The low-frequency (LF) band (0.04-0.15 Hz) reflects PNS (but NOT SNS) and baroreceptor activity and is affected by breathing from ~3-9 bpm (Task Force, 1996).
- Use LF band power to assess the success of HRVB while your adult client is breathing from 4.5-7.5 bpm (Shaffer & Ginsberg, 2017).



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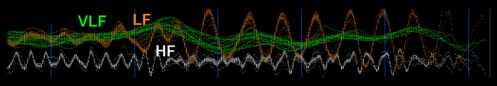
What are HRV frequency-domain measurements?

- The high-frequency (HF) or respiratory band (0.15-.40 Hz) is influenced by breathing from 9-24 bpm (Task Force, 1996).
- The HF band reflects parasympathetic activity.
- Use HF band power to assess HRV biofeedback training success during resting baselines, when breathing at normal rates (12-14 bpm) without feedback (Shaffer & Ginsberg, 2017).



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