Pulse Rate Variability (PRV)

Background

Heart rate variability (HRV) is the variability in the time intervals between successive heartbeats. The heart rate is regulated by opposing forces of the nervous system: one wants to increase the heart rate in response to certain factors ("fight or flight") and the other wants to lower the heart rate ("rest and ruminate"). Thus, the heart does not always beat at a consistent rhythm. The variability in the beat-to-beat time intervals is a result of the interaction between these opposing forces. HRV corresponds to the body's ability to adapt to different physiological or environmental stimuli and, as a result, has become a useful tool in understanding the athlete's adaption to training load and recovery.[1]

HRV & PRV

Ember measures the time variation of the heartbeat by examining the PPG (photoplethysmograph) waveform obtained at the fingertip; whereas ECG and ECG-based chest-strap devices compute HRV based on the variation of the heartbeat in response to electrical impulses from the heart. Because Ember measures the pulse rate at the fingertip vs. the heart rate, we use the term PRV instead of HRV.

How does our approach compare to other methods?

Traditionally, HRV has been measured by analyzing the variation in time between heartbeats by examining what's called the "R-R" (inter-beat) time. Simply, this is a measure derived from analysis of an ECG or EKG, which examines the electrical activity of the heart. Ember measures PRV by looking at the time variation between heartbeats via examining the plethysmograph waveform. Figure 1 shows an example of a synchronized ECG and PPG waveform, and the time intervals of the instantaneous beats measured from them. The similarity between the inter-beat time intervals obtained from these waveforms results in a close similarity between the PRV and HRV measurements. External and internal studies have shown a high degree of statistical equivalence between PRV, determined from the plethysmograph, and HRV measurements from ECG based systems[2,3,4]. The results of an internal study which compared PRV from Ember to HRV computed from a multi-lead ECG system is shown in Figure 2.

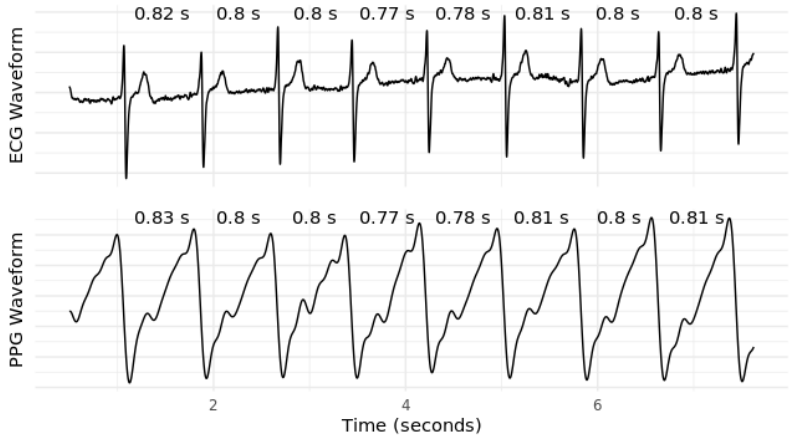

Figure1: Comparison of synchronized ECG and PPG waveforms of a subject also showing the duration of the individual beats measured in seconds.

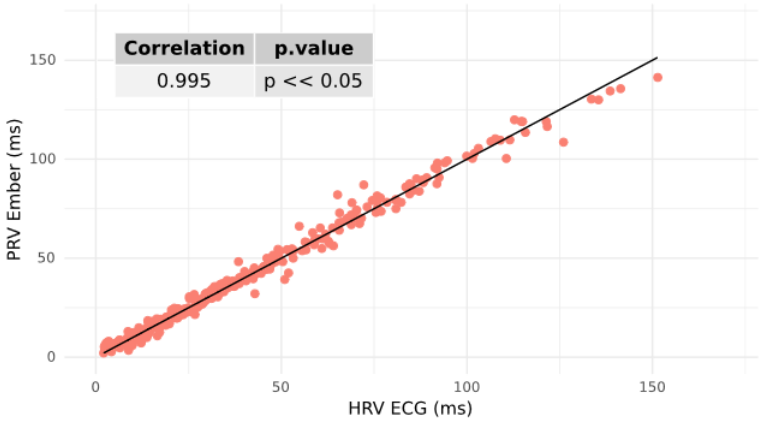

Figure 2: PRV from Ember compared to HRV from ECG device.

What factors influence PRV (& HRV)?

PRV (& HRV) is affected by many factors, including: demographics such as: age, sex and race; lifestyle factors, such as: level of physical activity and fitness, and alcohol and tobacco consumption; and psychological factors, such as: stress, depression and negative emotions.[5]

Values in the range of 20-70[6] are considered normal for healthy adults; and values trending upwards are generally considered a good measure of improving fitness and the body's ability to adapt to external stimuli. The time of day when the measurement is taken and the body posture can also impact PRV & HRV. As such, like the other Ember parameters, the first-of-day measurement before getting out of bed is the best time to take a PRV measurement.

How does tracking PRV and emotions help the athlete?

While studies have shown that PRV can track improving cardiovascular fitness, there is also evidence that emotions can impact HRV (& PRV). Studies have shown that negative emotions such as sadness, anger, or fear cause irregular heart rates and a reduced HRV.[5]

In addition, studies have shown that positive emotions can have a positive impact on sports performance, whereas negative emotions can have a negative impact on sports performance.[7] By tracking and trending emotions with PRV with the other Ember parameters, users will now be better equipped to understand when their bodies respond to external factors to help them better understand their physiology, response to training, readiness and more.

References:

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