



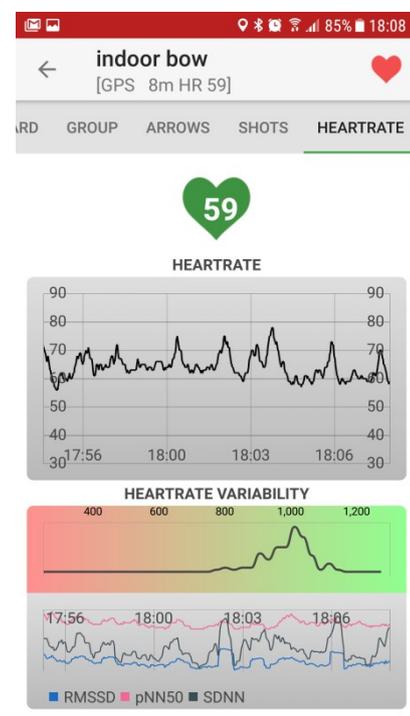
Heartrate and Stress monitoring

Introducing a new feature of Artemis; the heartrate monitor. A recent study from the Medical Informatics R&D centre in Hungary¹ showed that stress can be detected using low cost heart rate sensors. This study triggered me to implement a stress detection function in Artemis.

Stress can be detected in laboratory environments with special and expensive equipment; skin conductivity, skin temperature, EMG, eye-pupil diameter, blink rate and ECG to name a few. But the main goal of the Hungarian study was the development of a reliable, robust, **low price** stress detection method suitable for mobile health applications.

What do you need?

This is an *ArtemisCoached* feature, so you need to upgrade to Coached. There are many heartrate sensors on the market. The wristband types are very popular nowadays, but it has been shown that they are wildly inaccurate and cannot be used for stress detection. This feature was tested with the chest worn heartrate sensor that **is accurate enough** for these types of measurements; the Polar H7.



How does it work?

When setup, the Polar H7 measures two variables; the time between two heartbeats in milliseconds, and from that it derives the (average) heartrate in beats per minute. When a



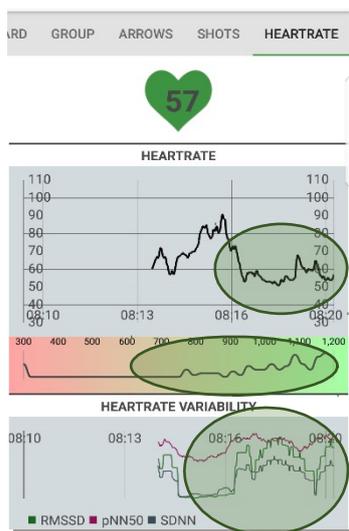
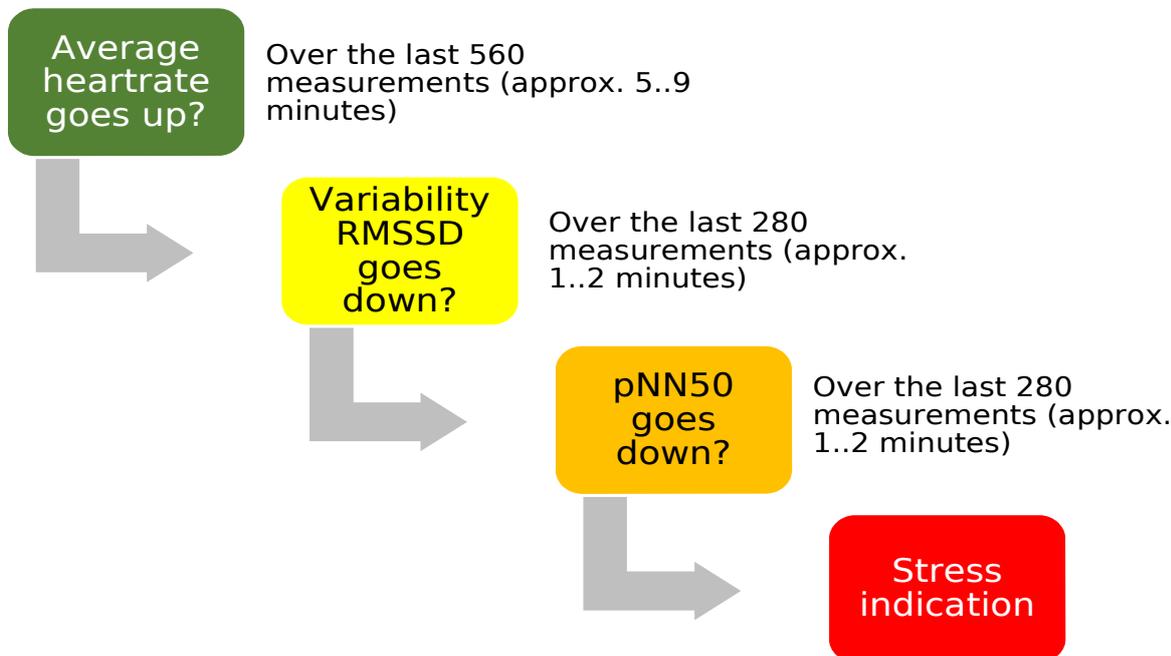
person is in a relaxed state, the heartrate is low and the timing between two beats differs a lot (the variability of the time between heartbeats is high). In very simple words; the heart beats when it feels like it,

very irregularly. When a person perceives stress, two things happen: The heartrate goes up, and the body starts to take more control of the heartbeat, by sending very regular signals to beat, which means that the variability goes down.

¹ "Stress detection using low cost heart rate sensors", Salai M., Vassanyí I, Kosá I., Journal of Healthcare Engineering, Volume 2016, Article ID 5136705, 13 pages



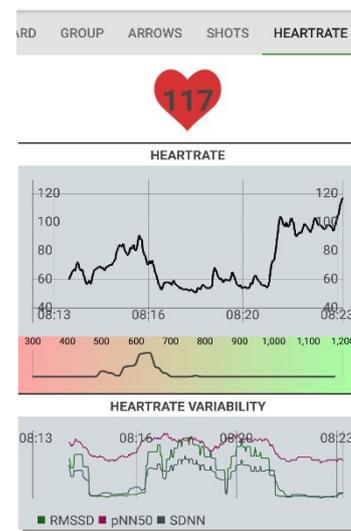
To detect stress, the algorithm developed in the study, and implemented in *ArtemisCoached*, measures the average heartrate and some variability numbers called RMSSD, SDNN and pNN50 and derives a stress level as shown in the diagram below.



Rest situation; heartrate is low and there is a high variability of timing between beats.



Heartrate goes up, average timing between heartbeats moves to the left and variability goes down.

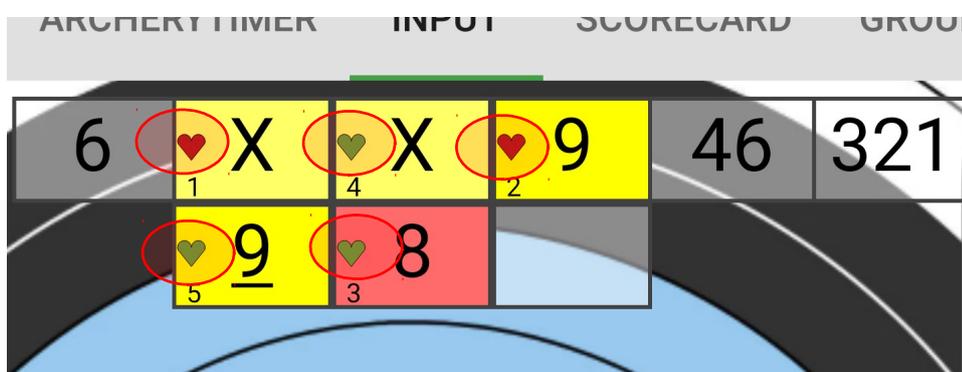


Situation with perceived stress; the heartrate went up and the variability went down.



Setting things up

1. Strap the Polar H7 onto your chest.
2. Start plotting a match, go to the tab 'Heartrate'. If you don't have this tab, your Android version might be too low (this feature needs Android 5.0+) or your device does not support Bluetooth LE.
3. In the tab, click the small heart-shaped button in the menubar. Artemis will start scanning for Bluetooth devices. When the Polar H7 is found, click on it to connect. Next time it will start this process automatically and scan for the last known H7.
4. If there is a connection and a heartrate signal, the title bar of the Match-input will show the heartrate.
5. When plotting arrows, the measured heartrate, the heartrate variability metrics; RMSSD, SDNN and pNN50 and the derived stress level are saved for each arrow and indicated on the scorecard.
6. Obviously, you (or your coach) should plot arrows as you shoot, not when you're



done, at the target.

7. In the analysis section of Artemis, there is a filter for these stress related values.

Note that the success rate of measuring mental stress even in laboratory conditions may vary a lot and that this (although scientifically supported) simple algorithm has not undergone much testing in real-life stress situations. It does not claim to be correct and individual results may vary.