



# SweetWater Health

## Professional HRV for Health Professionals



SweetWater Health™

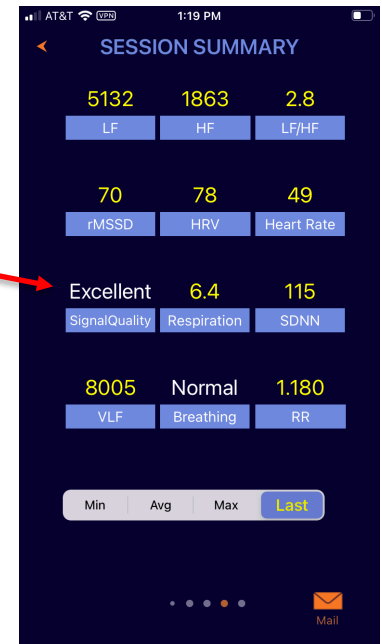
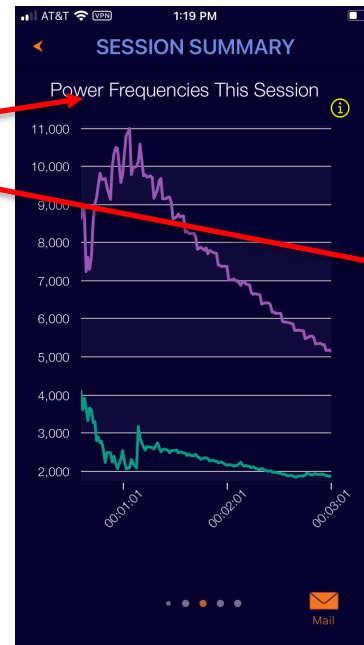
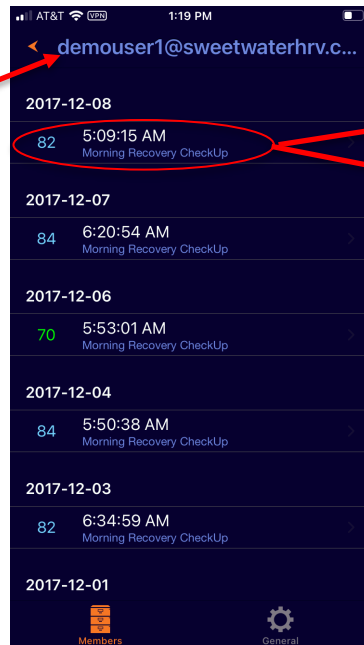
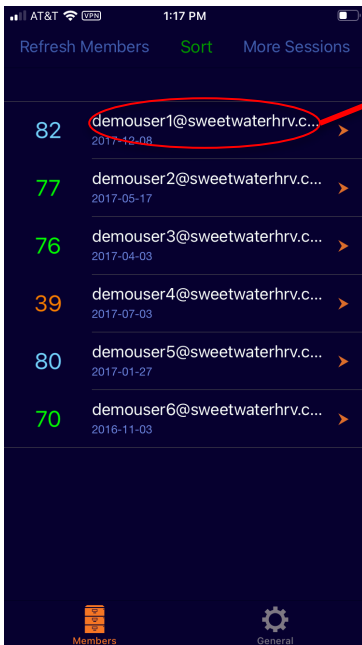
BeatHealthy™

March 8, 2023



# Introducing Professional HRV

- Securely monitor your patients and clients HRV
  - Currently only on iOS devices
- View graphs and stats from sessions
- Learn more [here](#)





# Introduction for Health Practitioners

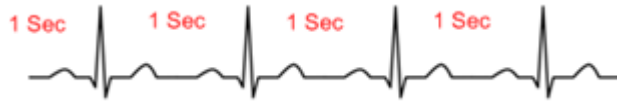
## More on the app later. What is HRV?

- Millions of people seek to improve their health using a variety of modalities
  - Self-Help books, Alternative health practitioners including Chiropractic, Acupuncture, supplements and energy work
- Treatments may do nothing or even be contraindicated for some people
  - What helps one client/patient may do nothing or even hurt another
- Standardized treatment protocols often produce well documented results however they do not take individual responses into account
  - Age, gender, race, baseline fitness level and genetic factors are known determinants of individual differences in responses to treatments
- The status of the Nervous System is an important indicator of the body's response to any type of intervention be it physical, psychological, energetic or involve supplements or other substances
  - Nervous System measures indicate individual responses
- Heart Rate Variability (HRV) is a view into the nervous system
  - HRV is reflection of vagal tone which is affected by life in general
  - HRV can be used to guide an optimal treatment program
  - HRV is non-invasive and can be measured with an off the heart rate monitor

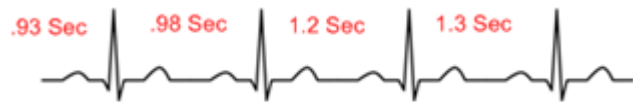


# First: What is HRV?

- What is Heart Rate Variability (HRV)?
- HRV is the variation in time between each heart beat

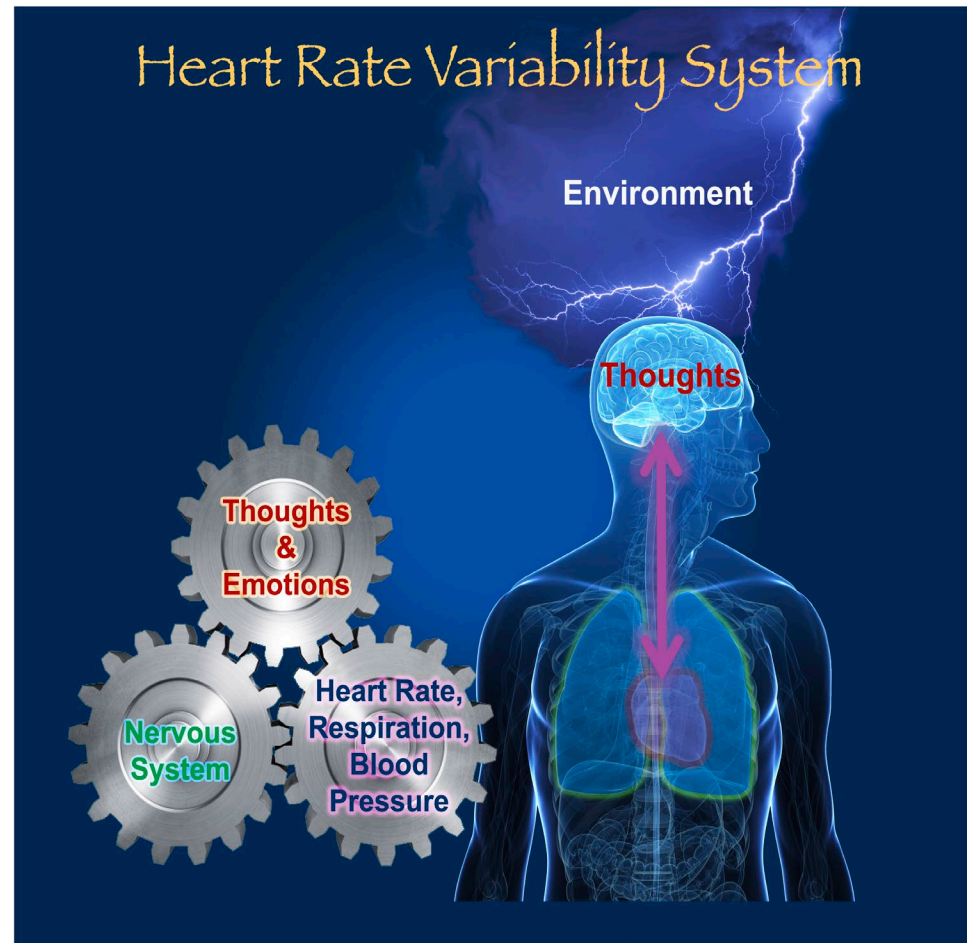


This illustration shows an unhealthy Heart Rate Variability with constant 1 sec intervals between beats



This illustration shows a healthy heart rate variability with variation between beats

- This variation in time between beats is caused by a “tug of war” between the sympathetic nervous system speeding the heart up and the parasympathetic slowing it down
- HRV has been researched for more than 30 years

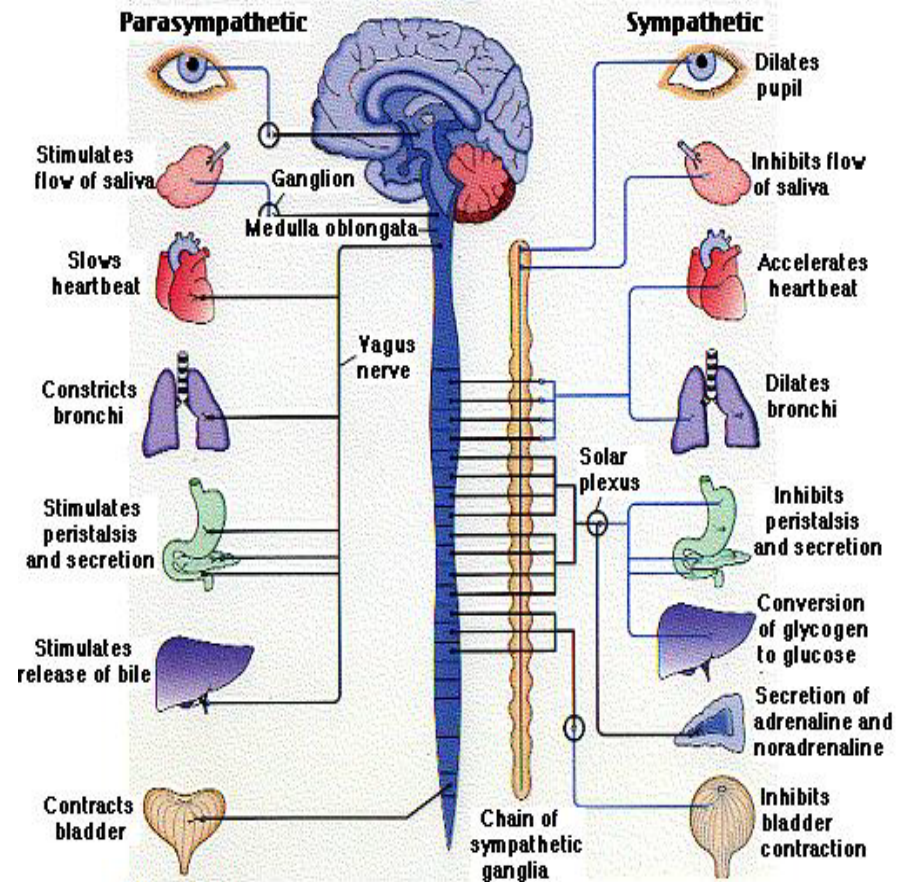






# HRV and Vagal Tone

- The Vagus Nerve is the 10<sup>th</sup> of 12 paired cranial nerves and relays information from the brain stem to most internal organs
- It controls parasympathetic innervation of the heart and acts to lower the heart rate.
- Vagal innervation is the mediator of HRV and therefore HRV is an indication of Vagal Tone
- The stronger the Vagal Tone, the higher the HRV
- Higher HRV is an indication of an individual's ability to “put the brakes on stress” by mediating the sympathetic control over the nervous system and heart rate.



# The Autonomic Nervous System



- The Autonomic Nervous System (ANS) has two main branches:
  - Sympathetic (Fight or Flight) Branch
  - Parasympathetic (Rest and Repair Branch)
- The Enteric Nervous System (ENS) is the third branch of the ANS
  - Also known as the “Gut Brain” or “Second Brain”
  - Not a known contributor to HRV

## Balance Your Nervous System



### Sympathetic Nervous System

The sympathetic nervous system is a bit like an accelerator; it controls the flight or fight response



### Parasympathetic Nervous System

The parasympathetic nervous system is more like the brake pedal; it calms us down

When sympathetic and parasympathetic systems are in balance, your body is at its optimum; ready for action, yet robust and unstressed

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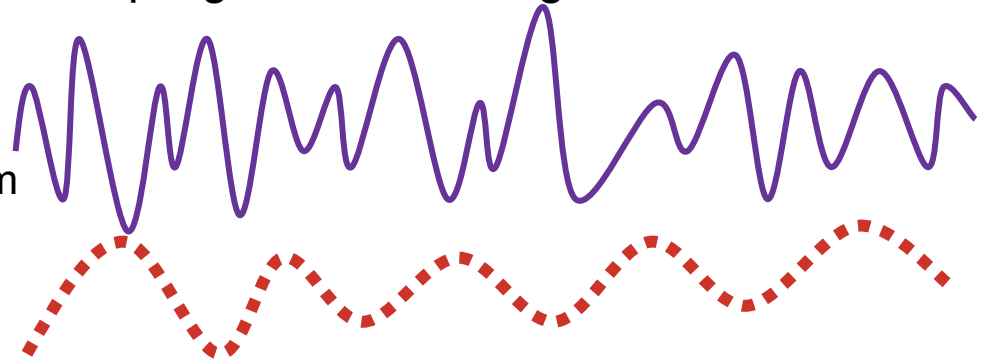


# HRV Components

- HRV is a reflection of the degree of coupling between biological oscillators

- Sinoatrial (SA) Node

- Sympathetic Nervous System
- Parasympathetic Nervous System
- Respiratory Sinus Arrhythmia
- Baroreceptors
- Chemoreceptors



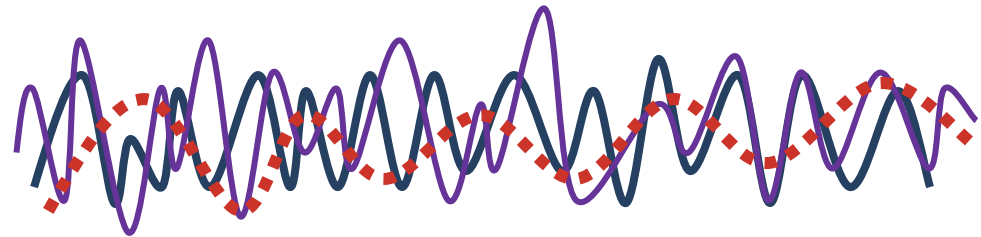
- Atrioventricular (VA) Node

- Vagus Nerve
- Minimal Contribution to HRV



- Healthy coupling -> Complexity

- Circadian Rhythm
- Deterministic Chaos
- Random Fractal
- Oscillatory
- Regular Polynomial
- 1/f noise

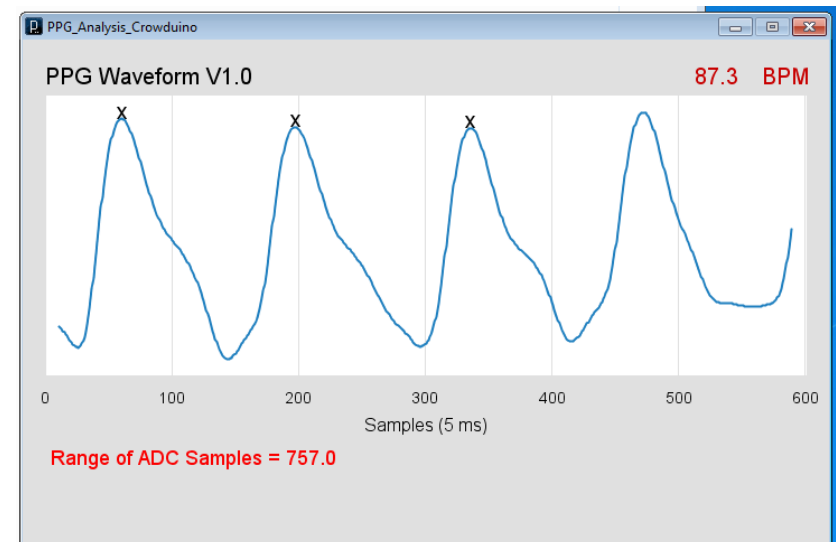
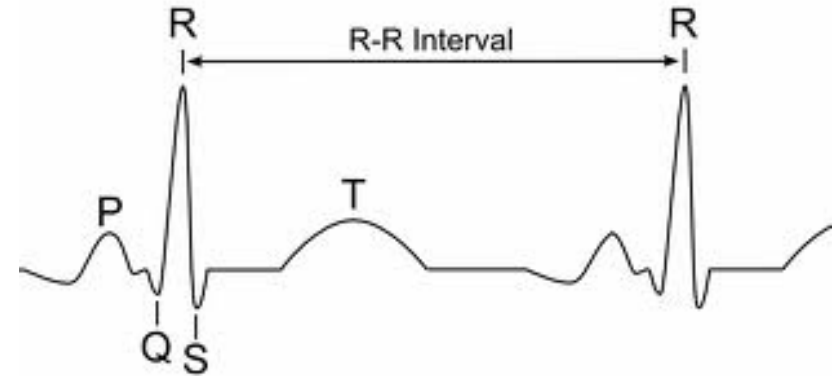




# How is HRV Calculated?

## RR Intervals Defined

- HRV calculations are performed on the “RR interval time series”. What exactly is that?
  - ECG “R” point can be thought of as the beat time
  - The R-R interval is the time between beats
- The resulting “RR interval time series” looks something like this:
  - 0.978516
  - 0.982422
  - 1.06641
  - 1.06738
  - 0.974609
  - 1.05273
- Optical HR sensors such as Apple Watch, Oura Ring, Whoop and Fitbit measure expansion and contraction of capillaries
  - Very difficult to detect exact beat times
  - Very sensitive to motion

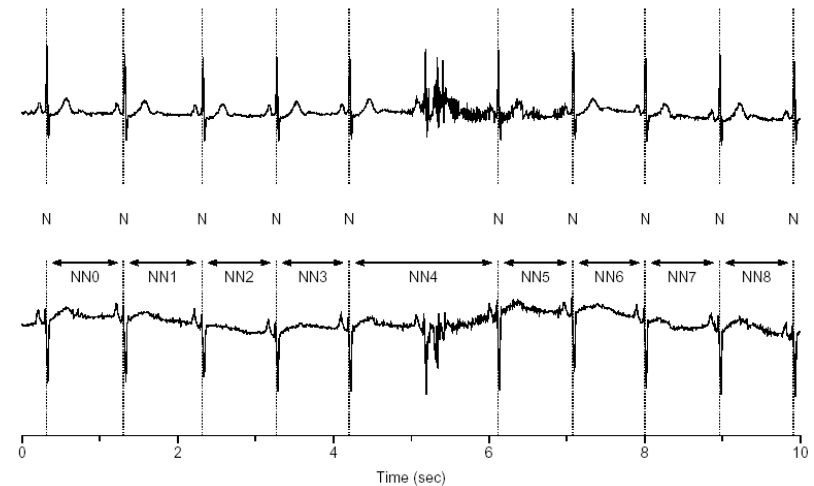






# False/Missed Normal Beat Detection

- HRV calculations are very sensitive to RR inputs including noise and missed beats
- Standard practice is to remove these “ectopic beats” and noise before performing HRV calculations
- Quality of reading is critical!
  - Will demonstrate in Kubios



Source: Time Domain Measures: From Variance to pNNx  
Joseph E. Mietus  
Beth Israel Deaconess Medical Center Harvard Medical School



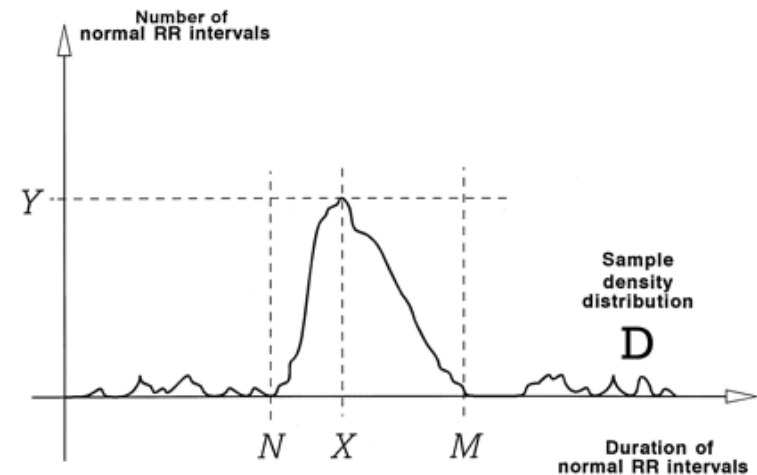
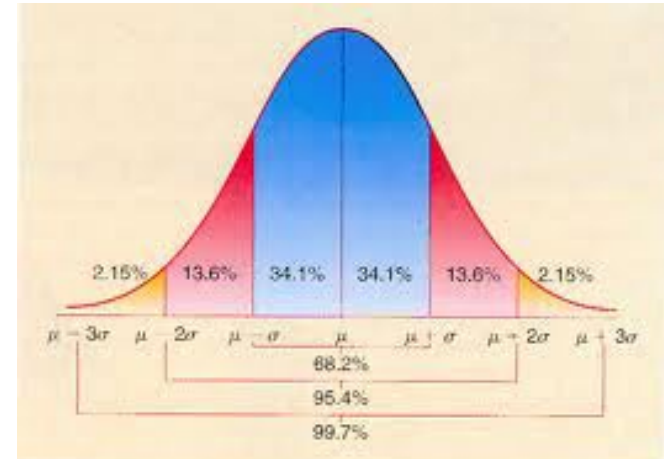
# HRV Can Be Measured in Multiple Ways

## ■ Statistical Analysis

- SDNN (ms)
  - The standard deviation of all RR intervals
    - RR intervals have also been called NN intervals which is why SDNN instead of SDRR
- rMSSD (ms)
  - Root Mean Square of Successive Differences between adjacent RR intervals
- pNN50 (%)
  - The percentage of adjacent RR intervals that differ by more than 50ms

## ■ Geometric Methods

- Triangular Index
- TINN (ms)





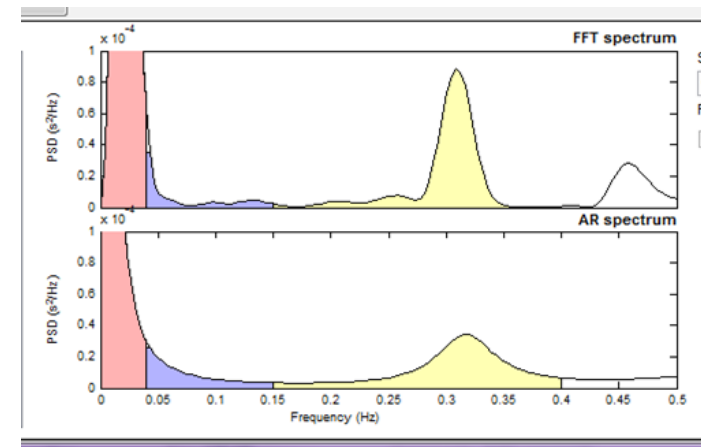
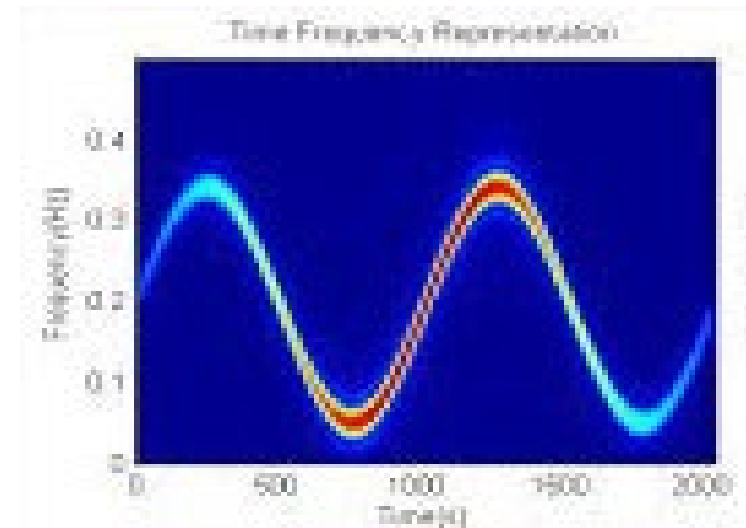
# HRV Can Be Measured in Multiple Ways

## ■ Frequency analysis

- Very Low Frequency (VLF) ( $\text{ms}^2$ )
  - Association debated
- Low Frequency (LF) ( $\text{ms}^2$ )
  - Associated with primarily sympathetic activation
  - May have some contribution from parasympathetic
- High Frequency (HF), ( $\text{ms}^2$ )
  - Associated with parasympathetic activation
- Lfnu
  - LF normalized
  - $\text{Lfnu} + \text{Hfnu} = 100$  Always
- Hfnu
  - HF normalized
- Peak Power (Hz)
  - The frequency at which the power for each region is at a maximum
  - May reflect breathing frequency during exercise or paced deep breathing

## ■ Non-Linear:

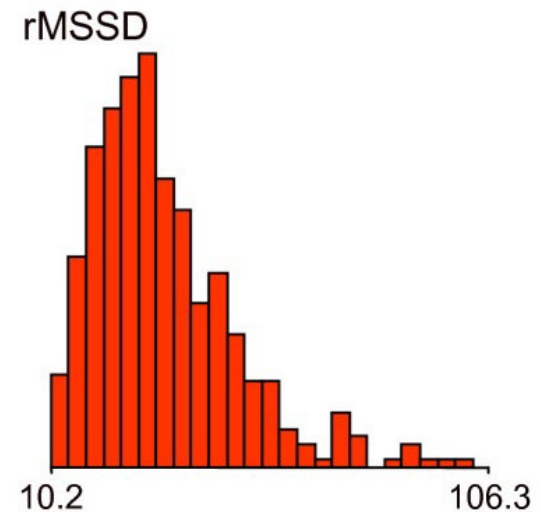
- SD1/SD2, ApEn, SampEN, DFA



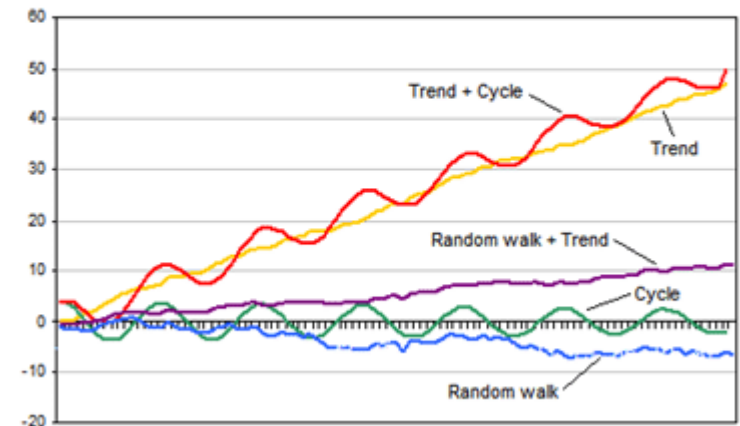


# HRV Parameters of Interest: rMSSD

- rMSSD is a reflection of Vagal Tone
  - rMSSD is non-stationary and varies +/- 10 ms at rest
  - Average rMSSD ranges from ~20ms to ~80ms depending on age and state of health
  - Generally calculated on 5 minute window
    - 3 minute window is offered as an option
  - Used (along with HF) in clinical research to assess Vagal Tone
- The “HRV” value in the app is rMSSD scaled to a value from 0-100 for ease of use
  - Each application uses a slightly different scaling algorithm so it is important to choose one and stick with it
- A high HRV (rMSSD) is an indication of strong vagal tone and stress recovery



**Table 1 Non-stationary behavior**

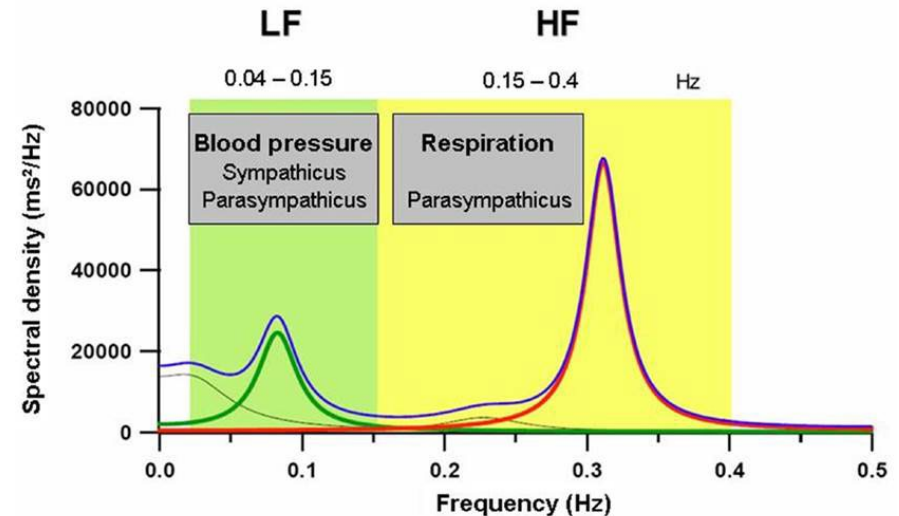






# HRV Parameters of Interest: LF, HF

- LF is associated with sympathetic nervous system
- HF associated with parasympathetic nervous system
- There are industry standards for LF and HF frequency ranges
  - LF = 0.04hz - 0.15Hz
  - HF = 0.15hz – 0.4hz
- LF and HF Ratio is another standard of measure
  - Represents a measure of sympatho-vagal balance
  - LF/HF < 2 is indication healthy \*resting\* ANS balance



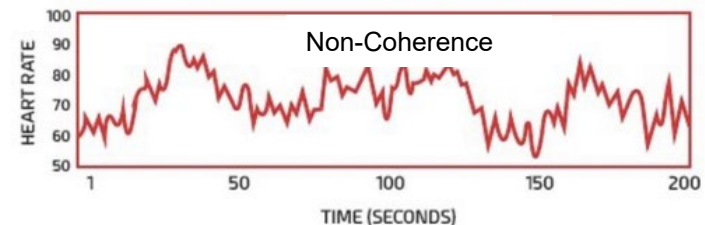
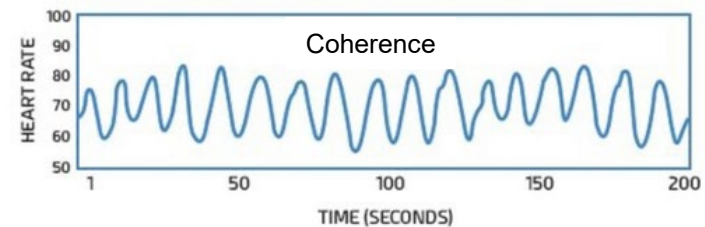
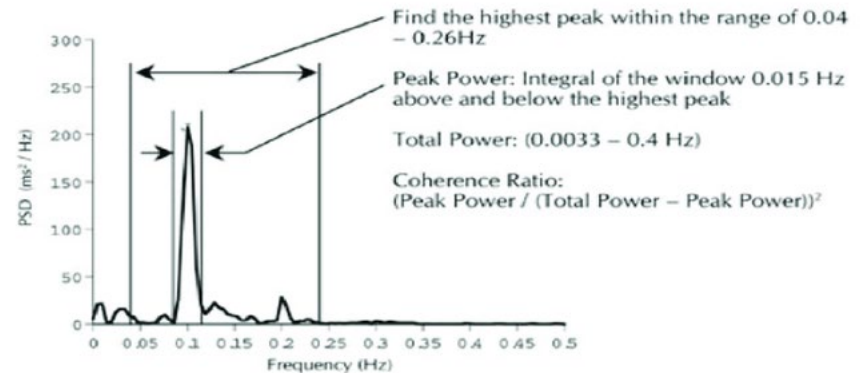


# Rhythmic Breathing Power

Also known as Coherence

- When breathing is paced and rhythmic, the power levels will be focused around the frequency of the breathing as shown.
- This is primarily due to what is called Respiratory Sinus Arrhythmia
  - Respiration influences ANS
- HeartMath Coherence is an example with power spike at around 0.15Hz
  - Induced through deep regular breathing
  - Feeling of love, gratitude, appreciation
- Example shows real time heart rate in Coherent and Non-Coherent state.
  - We are mostly non-coherent as our nervous system reacts and responds to life

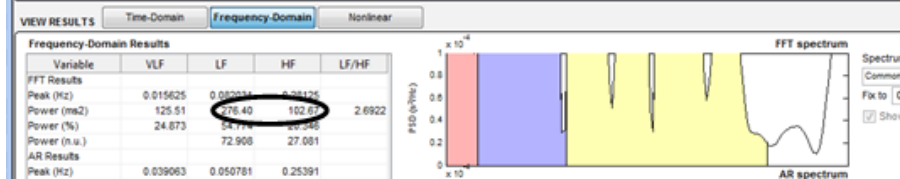
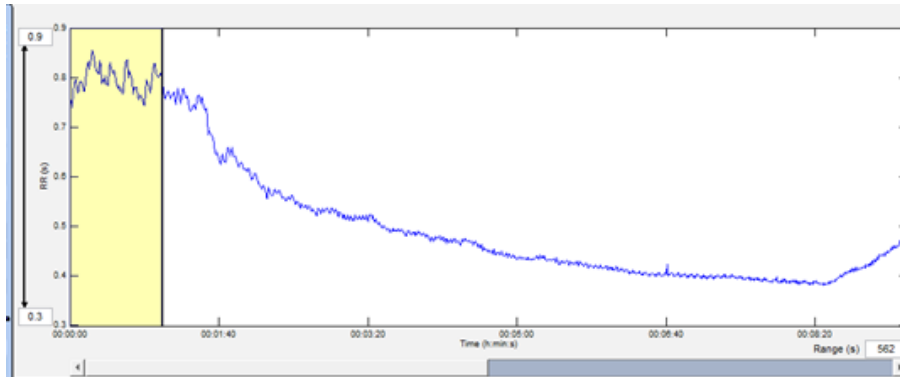
## Heart Rhythm Coherence Ratio Calculation



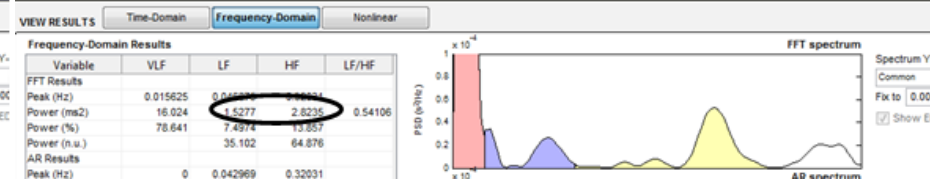
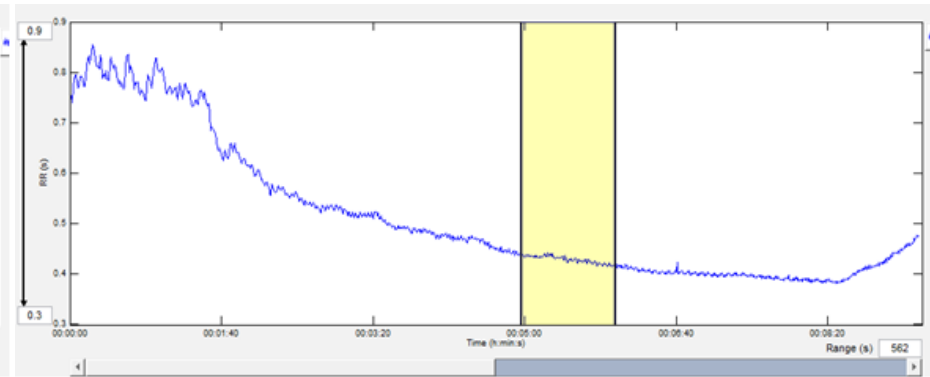


# Deeper Dive into Power Levels

- LF and HF units are Power
  - Technically called Power Spectral Density or PSD
  - Power represents “Power Level” of Nervous System



LF = 276, HF = 102  
Lfnu = 72, Hfnu = 27



LF = 1.5, HF = 2.8  
Lfnu = 35, Hfnu = 64



# HRV Additional Information

- HRV is an indication of your resilience – the ability of the nervous system to **respond** and **recover** from physical or psychological stressors
- IMPORTANT: HRV values depend on length of measurement
  - 5 Minutes = Short term HRV
  - 24 Hour = Long term HRV
- IMPORTANT: HRV is age and gender dependent
- HRV has a circadian rhythm
- HRV may change day to day with your biorhythm or due to emotional or physical stress
  - Jo Beth Dow discovered a yearly rhythm in her Quantified Self analysis
- Chronic low HRV is an indication of systemic health (psychological or physical) issues





# Data Analysis

- There are 4 major HRV metrics to consider
  - rMSSD/HRV
    - “HRV” is derived from rMSSD -> 0-100 values easier to understand than raw rMSSD
  - Stress level -> derived from LF/HF and represents the balance of the nervous system
  - LF Power -> represents the sympathetic or “fight or flight” response
  - HF Power -> represents the parasympathetic or “rest and repair” response
- IMPORTANT – In order to meet the accepted definition for “Short Term HRV”, SweetBeatLife algorithms operate on a 5 minute window. While rMSSD/HRV settle down in 3 minutes, LF and HF do not!
  - **When evaluating LF and HF, a minimum of 5 minutes is required**



# HRV Interpretation

This includes HRV, rMSSD, LF, HF

- HRV can vary greatly from person to person depending on health and fitness
- HRV can vary greatly for an individual from day to day and even hour to hour
- While there are “average HRV values” determined through clinical research, HRV is dynamic and individuals will tend to have their own range
- Some athletes have HRV values that are magnitudes higher than average persons
- Some healthy and fit individuals may have values at the high end of average

Gender	Age	Average SweetBeat HRV
Male	10-29	72.29827
Female		67.68875
Male	30-49	62.51162
Female		60.47521
Male	50-69	52.91486
Female		55.733
Male	70-99	52.91486
Female		52.91486

		Age 20's	Age 30's	Age 40+
Average LF	Male	1480	678	212
	Female	804	336	330
Average HF	Male	925	314	131
	Female	528	311	156

- Source:
- [http://www.anti-aging.gr.jp/english/pdf/2010/7\\_94.pdf](http://www.anti-aging.gr.jp/english/pdf/2010/7_94.pdf)
- Values based on 5 minute measurements

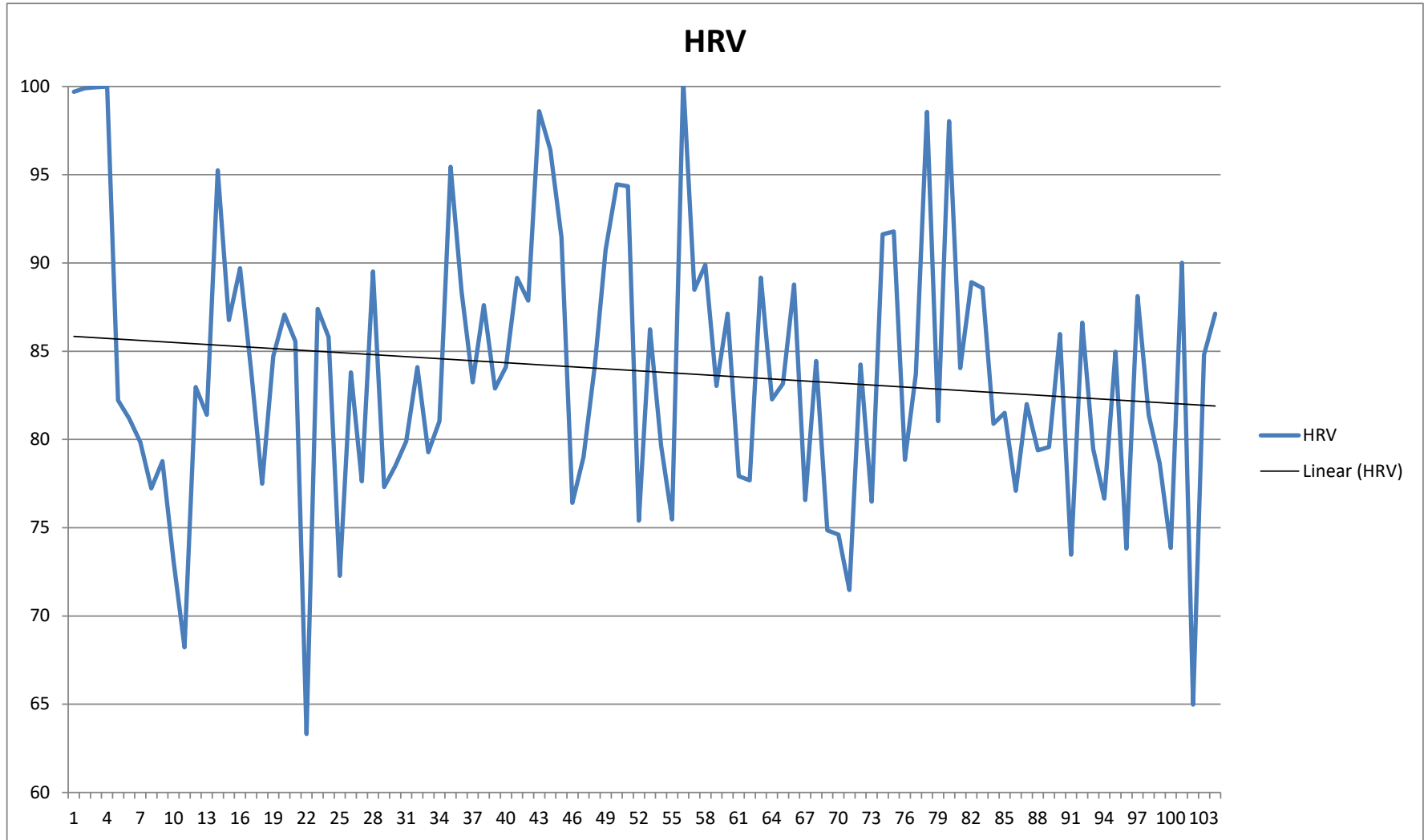


# Healthy vs Un-Healthy Variations

- Through time you will start to see the individual range for each client
    - The following graphs indicate healthy and expected variations of HRV
    - This range may trend down by 10% during heavy exercise or high stress
    - Average stress is “yellow” with sensitivity setting = 5 (LF/HF avg <1.5)
  - Red Flag Warnings
    - Established normal range drops more than 30% and becomes the new norm
    - HRV < 50 (rMSSD < 20) consistently
    - LF, HF < 100 – consistently \*
    - LF/HF > 10 consistently \* = chronic stress, lack of sleep or other
    - NOTE: Sessions are run while supine or sitting, NOT during exercise
- \* Minimum session length = 5 minutes



# HRV\* Example # 1

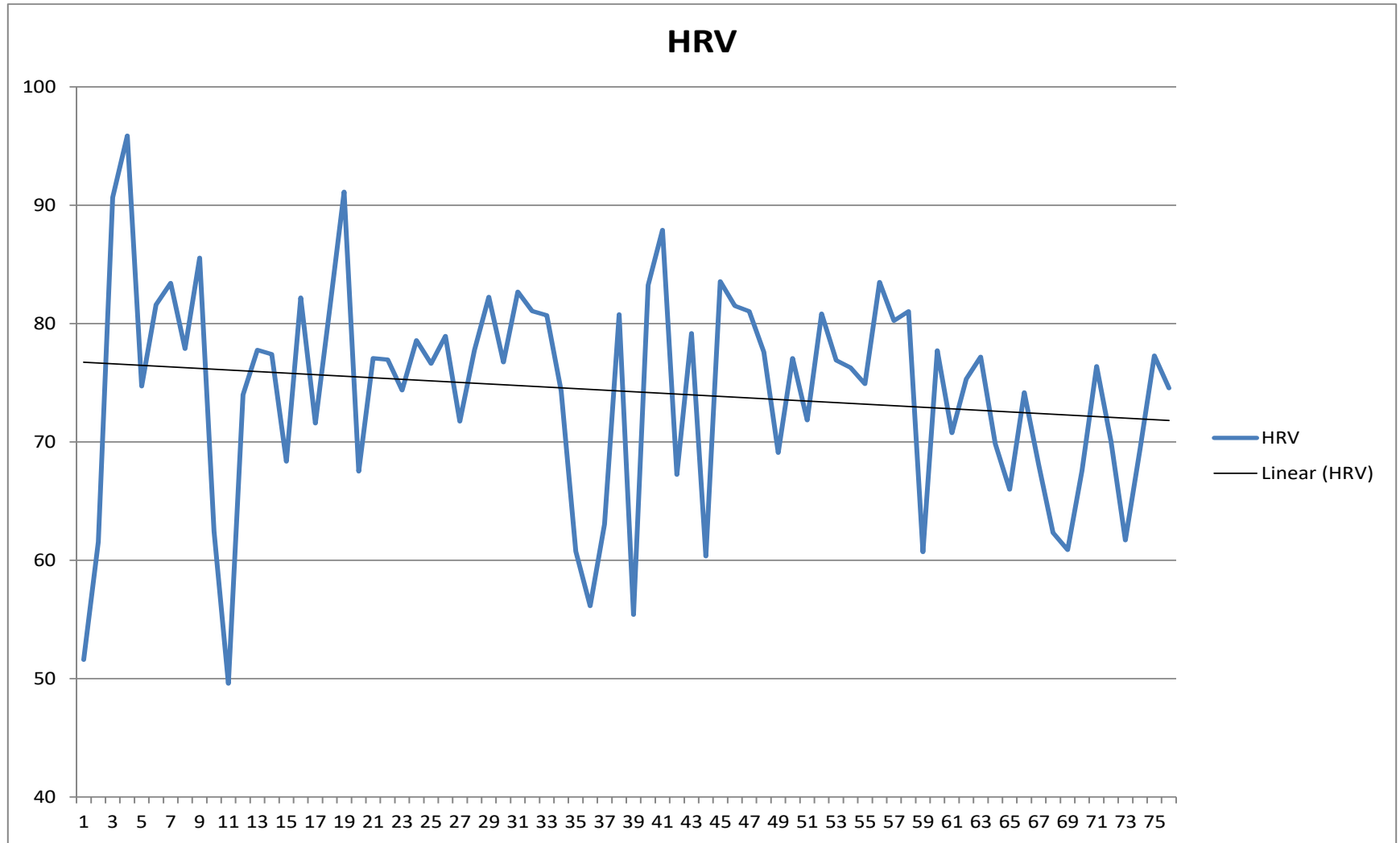


\*HRV measured using SweetBeat





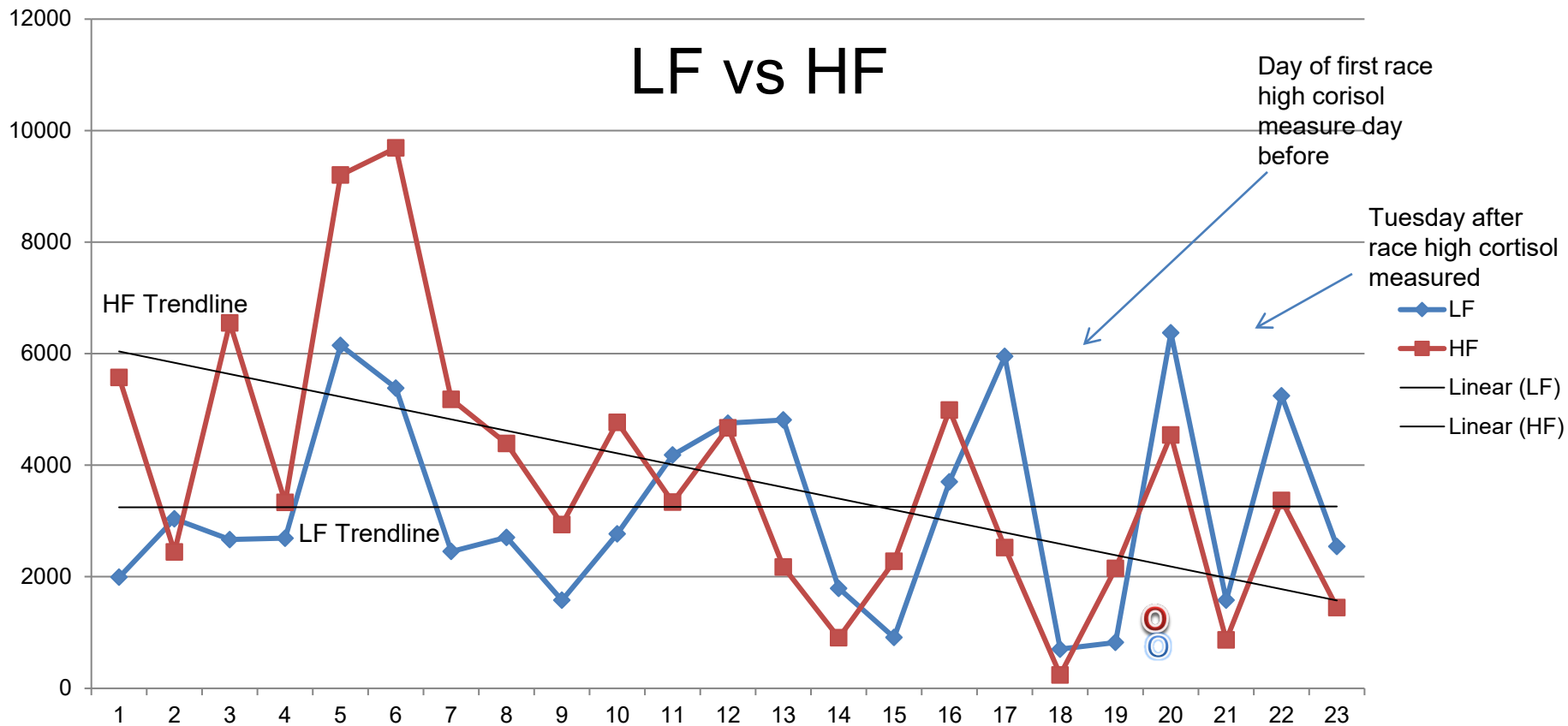
# HRV\* Example #2



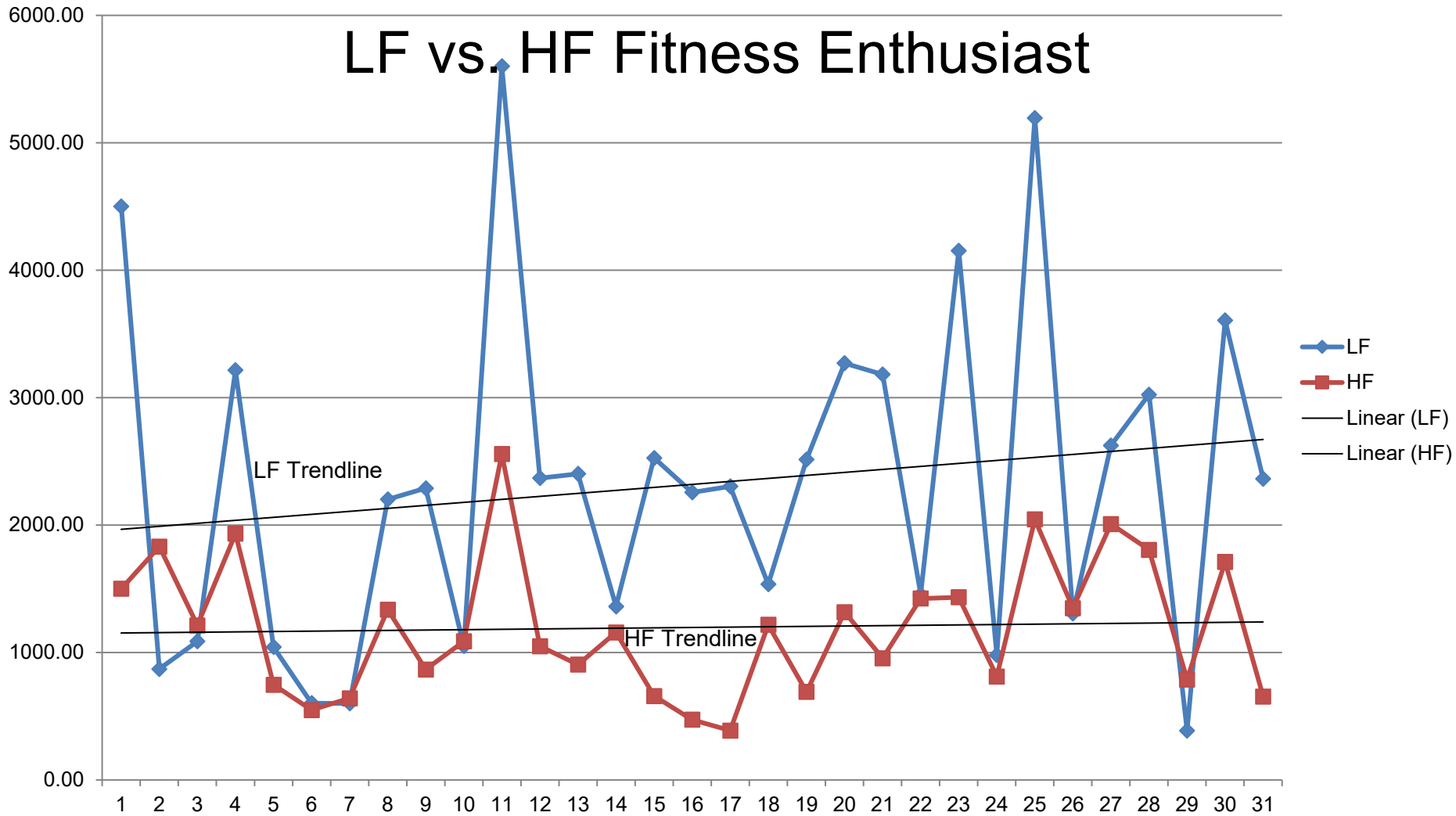
\*HRV measured using SweetBeat



# LF, HF Power, Elite Athlete



# LF, HF Power, Fitness Enthusiast





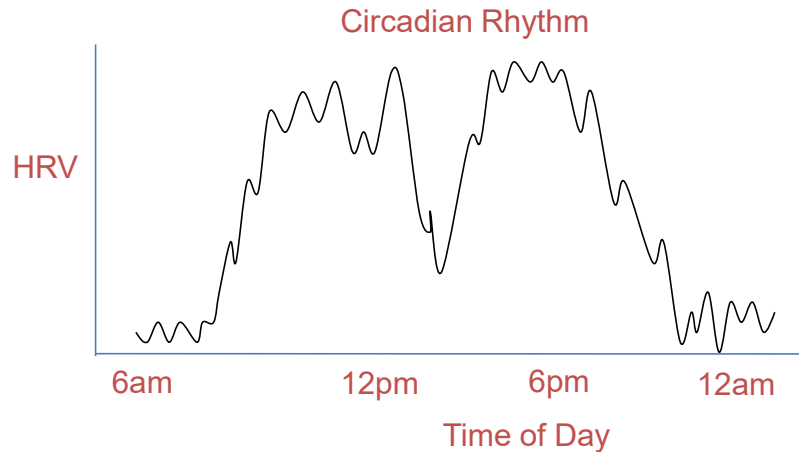
# Use Models for Coaches and Trainers

- SweetBeatLife features used by coaches and trainers
  - HRV for Training Feature
    - Coach provides specific Instructions of how and when to take reading
  - Stress Monitoring
    - Daily stressors also affect performance
    - Usually includes stress awareness and reduction techniques
      - Breath work
      - Meditation/Yoga
  - Heart Rate Recovery
    - Another measure of ANS flexibility
  - Food Sensitivity
    - Nutrition and inflammation interact negatively with cortisol and adrenaline



# HRV for Training/Willpower: When and How to Measure

- HRV has a circadian rhythm



- HRV is dependent on body position

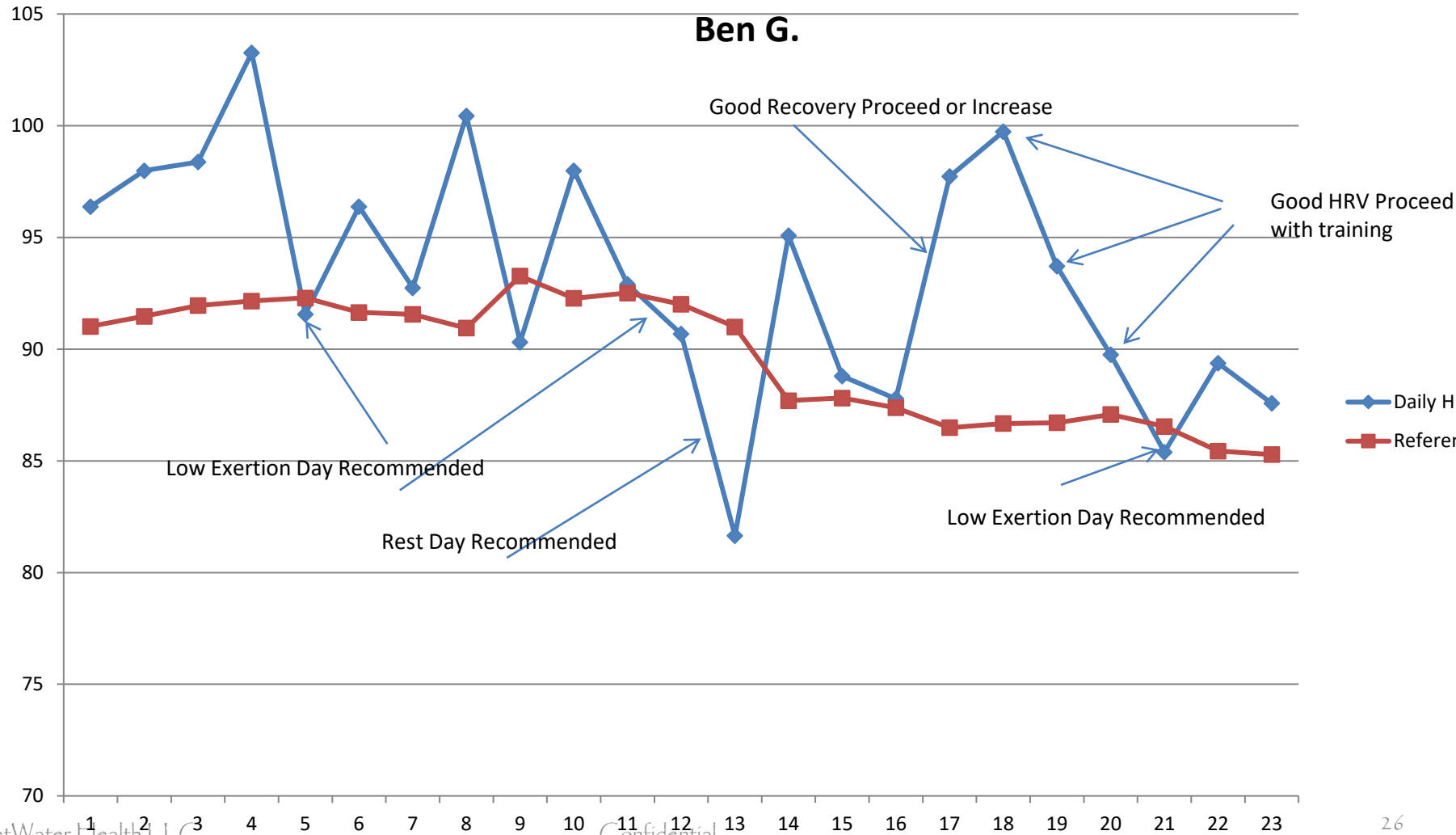


- HRV value is dependent on length of measurement
- HRV taken at same time each day
  - First thing in the morning while lying in bed is recommended
  - Try to keep a blank mind. Thoughts about a busy day can effect the reading
  - Don't surf the web on you phone!!!
- In same position
  - Lying down
  - Sitting
  - Standing
- Timed measurement (3-5minutes)





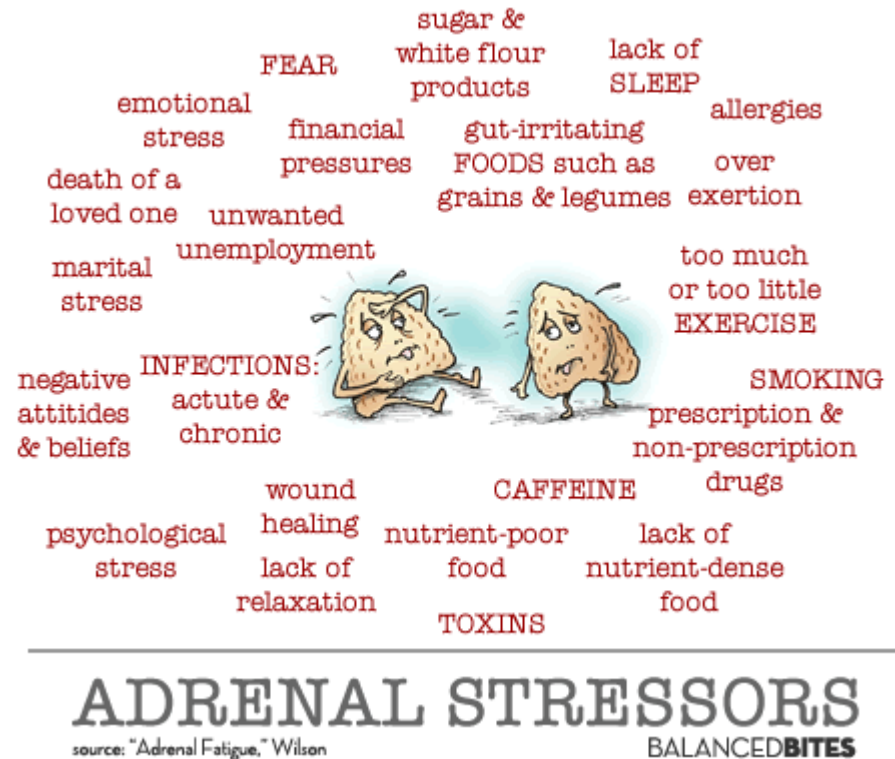
# HRV for Training Example



# Stress, Food, HRV and Optimal Performance



- Inflammation is a common reaction to a hardcore work out and is part of the recovery process
- Inflammation is an innate response to stress, illness, poor gut function or eating toxic foods
  - Stress increases cortisol which contributes to inflammation
- What causes stress for one person will not cause stress for another
  - Same thing goes for food
  - Individuals need to track what works and doesn't for them
- Interdependence of our body functions make it complicated

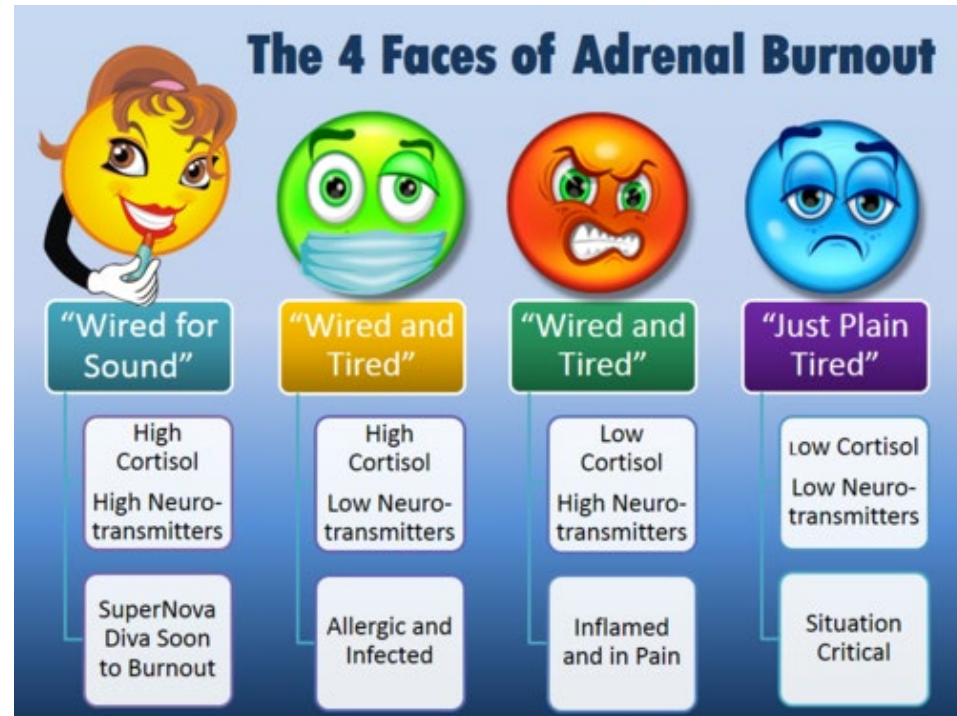


Source: <http://robbwolf.com/2012/04/09/real-deal-adrenal-fatigue/>



# “It’s Complicated”

- When this response becomes the norm for your body, whether it is from workouts, stress or food, it becomes a low-level feature in your physiology
  - Mild, chronic, inflammation produces few symptoms and subtle changes on blood tests, though has a very different effect on your metabolism
  - Chronic low-grade inflammation makes your brain and body resistant to the normal regulatory effects of hormones, including insulin and cortisol
  - It interferes with recovery and thus optimal performance
- It is recommended that stress and diet be monitored in addition to HRV for optimal performance



Source: [http://www.integrativepsychiatry.net/adrenal\\_fatigue.html](http://www.integrativepsychiatry.net/adrenal_fatigue.html)



# HRV, HPA and Sleep

- Though 'adrenal fatigue' is not an accepted term in the medical community, malfunctions of the stress response system are a very real phenomenon. The sympathetic branch of the nervous system activates production of fight or flight hormones, including cortisol.
  - Modern perceived stressors and over reaching training keep fight or flight in chronic "on" position
- HRV, HPA and Sympathetic activation during stress test
  - HRV is used to measure ANS (SNS and PNS)
  - SNS activates the HPA – see next slide
- Cortisol is one of the moderators of sleep cycles and has 24 hour circadian rhythm
  - Stress hormone helpful in the short term, harmful in the long run as it weakens the immune system
  - Released by adrenal gland and regulated by the pituitary gland (and hypothalamus indirectly)
  - Cortisol has feedback inhibition of CRH and ACTH
  - Cortisol is at peak in morning around 9am, decreases gradually with a dip around noon and 3-4 pm then continuous drop until midnight when it starts the gradual increase to a max at 9am.
- Dysfunctional HPA axis activity may play a role in some sleep disorders, but in other cases the HPA axis dysfunction is actually the result of a sleep disorder, as seen in obstructive sleep apnea.
- Sleep Cycles
  - Stage 1 transition from wake to sleep – mixed frequency theta waves – 5-10 minutes
  - Stage 2 light sleep, temp and HR begin to decrease – 20 minutes
  - Stage 3 is transition between light and deep sleep, 20%-50% slow delta brain waves
  - Stage 4 deep sleep >50% delta brain waves
  - Stage 5 REM increased respiration and brain activity with mixed frequency theta waves



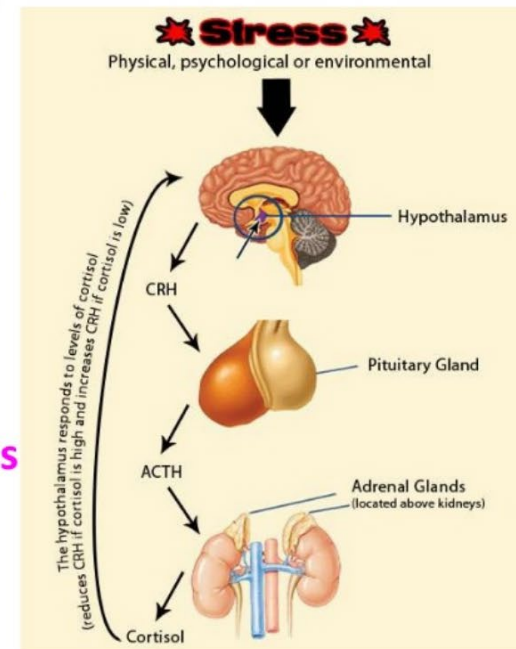


## HPA axis

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Clip slide

- **Hypothalamus** triggers the release of
- **CRH** (Corticotrophin releasing hormone) which activates the
- **Pituitary Gland** which releases the hormone
- **ACTH** (Adrenocorticotrophic hormone) which is carried by the blood to the
- **Adrenal gland** which releases stress hormones
- **Cortisol/ Adrenalin and Noradrenalin**
- **To assist the body deal with the stressor**







## ■ Thyroid function

- Cortisol creates inactivation of T3 thyroid hormone shunting it into a form called reverse T3
- Almost any time thyroid hormones fall, body perceives stress and activates HPA and cortisol
- Body loses ability to regulate cortisol in perfect 24 hour rhythm
- Chronic thyroid and cortisol dysregulation can result in adrenaline acting as a substitute for cortisol creating panic feeling
  - Waking in panic at 2, 3 or 4 am

## ■ Moral of the story:

- Monitor your HRV for stress and for over training
- Monitor you HRV all night to check nervous system repair and ensure HRV has increasing trend



# Dig Deeper with Kubios

## ■ Intro to Kubios

- Kubios is a tool used by scientists to do a deeper analysis of HRV. There is a free and paid version depending on what you want to do.
- Options Overview
  - Artifact correction
  - Analysis options

## ■ Examples

- Quality of reading and the importance of artifact removal
- Coherent example – the effect of regular deep breathing
- Exercise example



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Thank You!