SweetWater Health
Ben Greenfield Fitness
HRV Workshop Notes

SweetWater Health™

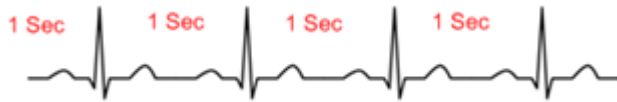### BeatHealthy™

October 29,2014

Introduction

- Most athletes know that getting enough rest after exercise is essential to high-level performance
  - Still many over train and feel guilty when they take a day off
- Continuous training can actually weaken the strongest athletes
  - Rest is physically necessary so that the muscles can repair, rebuild and strengthen
- Standardized training programs 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 endurance training*
- The status of the Nervous System is an important indictor of training response
  - 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 overtraining
  - HRV can be used to guide an optimal training program
  - HRV is non-invasive and can be measured with an off the self chest strap
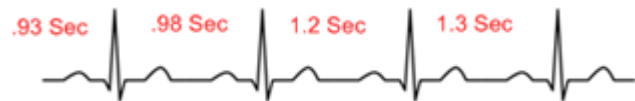
- What is Heart Rate Variability (HRV)?
- HRV is the variation in time between each heart beat

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

Heart Rate Variability System

Environment

Thoughts

Thoughts & Emotions

Nervous System
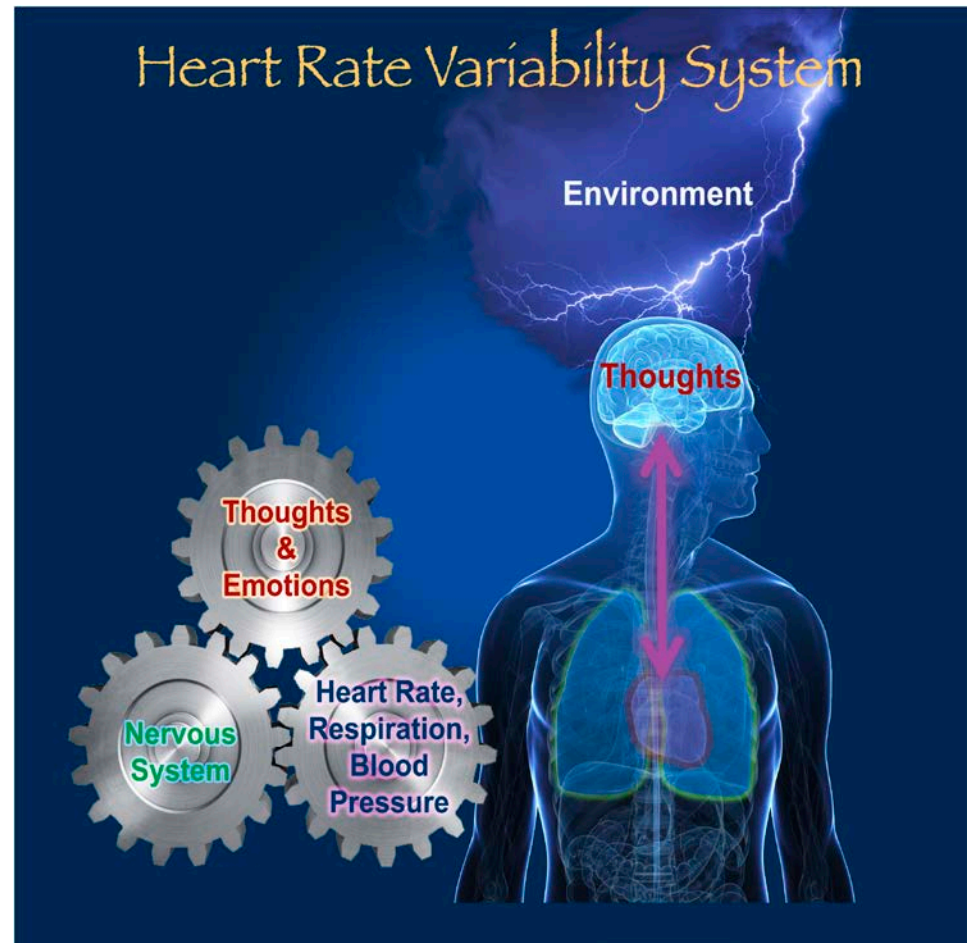
Heart Rate, Respiration, Blood Pressure

- The Vagus Nerve is the 10th of 12 paired cranial nerves and 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 higher the HRV, the stronger the Vagal Tone

- Higher HRV is an indication of an individuals ability to "put the brakes on stress" by mediating the sympathetic control over the nervous system and heart rate.
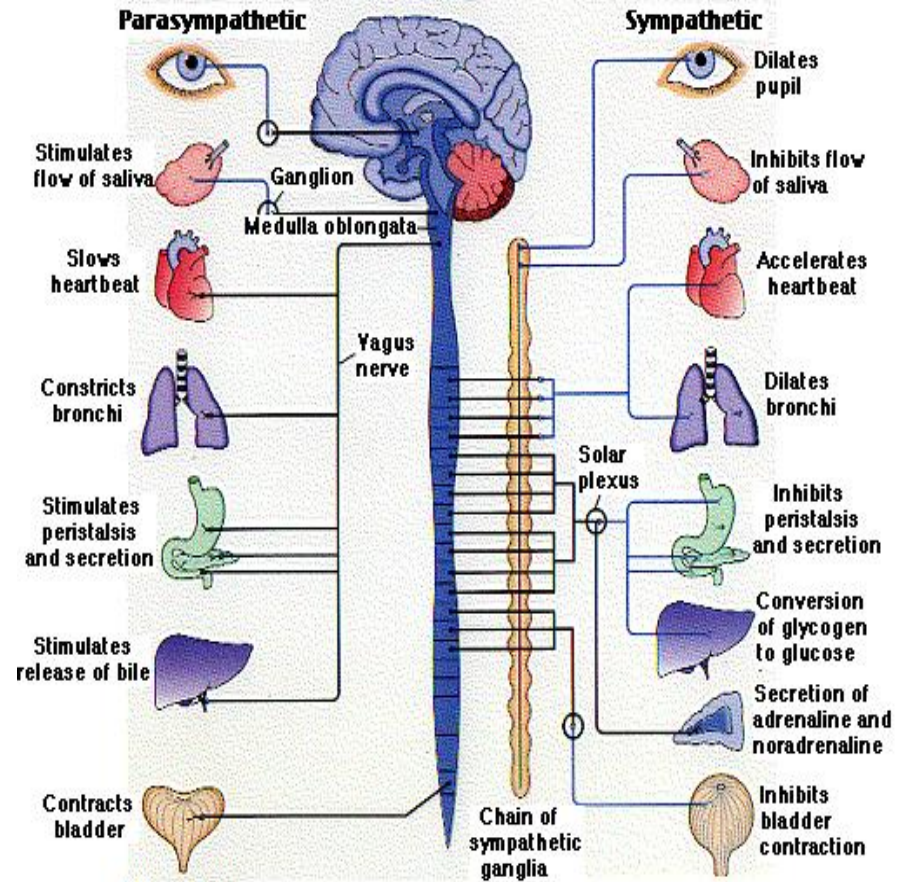
LF, HF and the Autonomic Nervous System

The Autonomic Nervous System (ANS) has two branches:
- Sympathetic
- Parasympathetic

LF is the measure of the Sympathetic Branch
HF is the measure of the Parasympathetic Branch

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
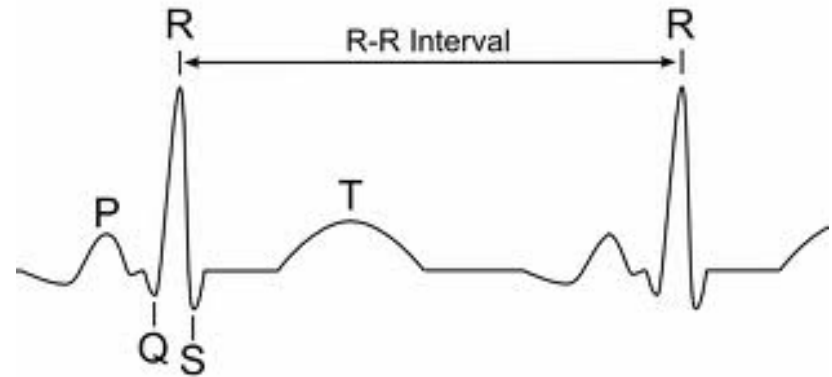
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- HRV calculations are performed on the "RR interval time series". What exactly is that?
  - ECG "R" point can be though of as the beat time
  - The R-R interval is the time between beats
- The resulting "RR interval time series" looks something like this:

        0.978516
        0.982422
        1.06641
        1.06738
        0.974609
        1.05273
        1.08887
        0.974609
        0.961914
        1.04688
        1.02734

- **Statistical Analysis**
  - Standard Deviation (SDNN)
    - RR intervals have also been called NN intervals which is why SDNN instead of SDRR
  - Root Mean Square of Successive Differences, (rMSSD)
  - pNN50, TINN, Triangular index

- **Frequency analysis**
  - Very Low Frequency (VLF)
  - Low Frequency (LF, associated with sympathetic activation)
  - High Frequency (HF, associated with parasympathetic activation)

- **Non-Linear:**
  - SD1/SD2, ApEn, SampEN
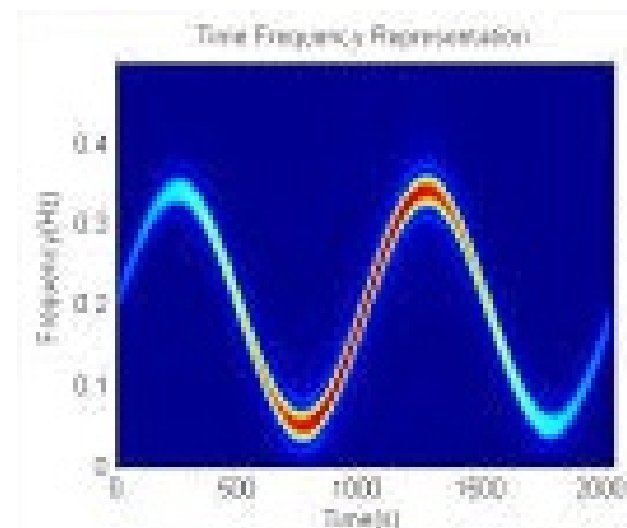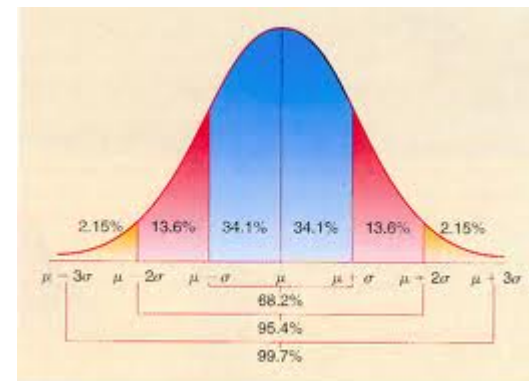
- rMSSD is a reflection of Vagal Tone
  - rMSSD is non-stationary and varies +/- 10 ms at rest
  - Average rMSSD ranges from ~20ms to ~80ms depending on age and state of health
  - Generally calculated on 5 minute window
    - SweetBeatlife uses 3 minute window per customer requests
  - Used in clinical research for HRV and performance training
- Most consumer HRV applications provide a number 0-100 based on rMSSD
  - 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 health and training recovery

rMSSD

10.2   106.3
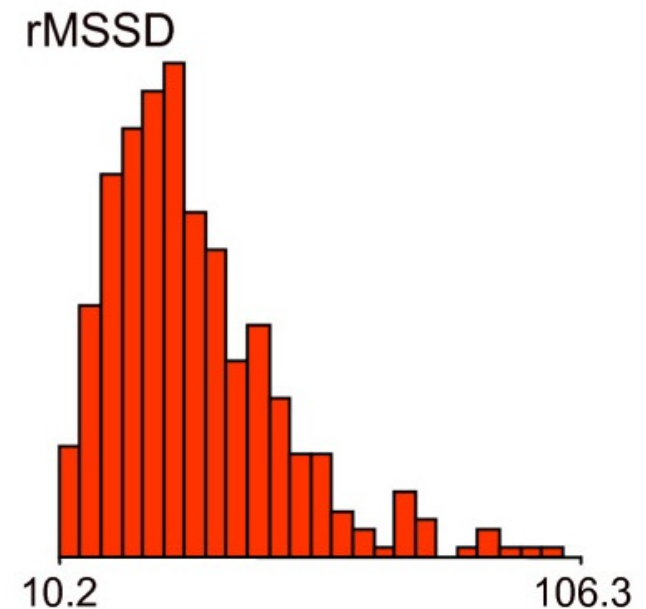
- LF is associated with sympathetic nervous system

- 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 units are Power
  - Power represents "amplitude" of electrical impulses flowing through nervous system

- LF and HF Ratio is another standard of measure
  - LF/HF < 2 is indication healthy stress levels
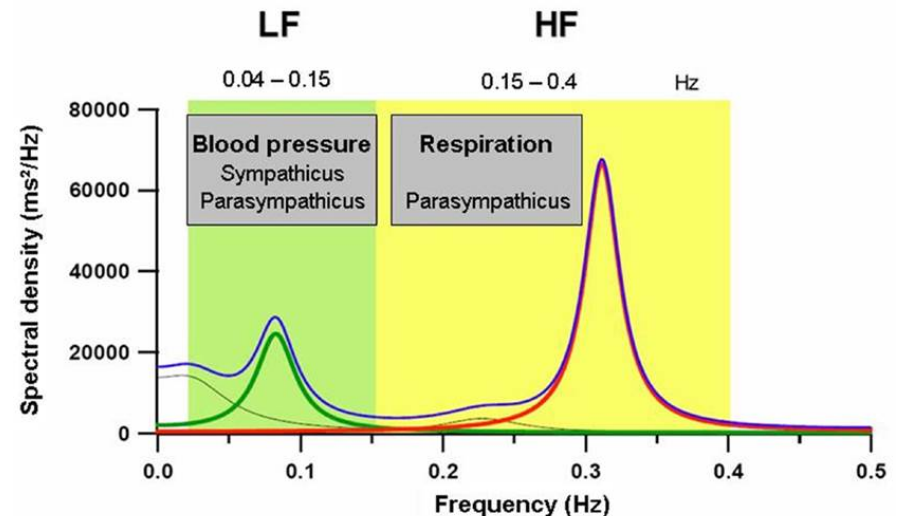
- HRV is an indication of your resilience – the ability of the nervous system to **respond** and **recover** from physical or psychological stressors
- IMPORTANT: HRV values depend on length of measurement
  - 5 Minutes = Short term HRV
  - 24 Hour = Long term HRV
- IMPORTANT: HRV is age and gender dependent
- HRV has a circadian rhythm
- HRV may change day to day with your biorhythm or due to emotional or physical stress
- Chronic low HRV is an indication of systemic health (psychological or physical) issues

- **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 has a circadian rhythm

Circadian Rhythm

HRV

6am   12pm   6pm   12am

Time of Day
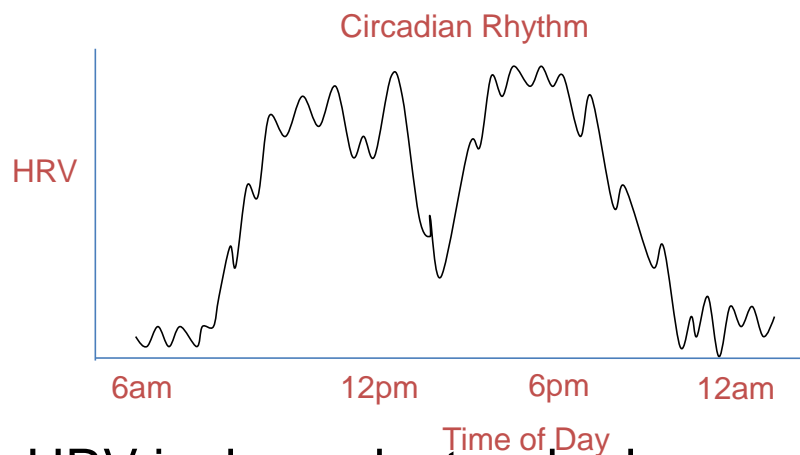
- HRV is dependent on body position

- HRV value is dependent 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
  – In same position
    - Lying down
    - Sitting
    - Standing
  – Measurement for same length of time each day (3 minutes typical)

Ben G.

Good Recovery Proceed or Increase

Good HRV Proceed with training

Low Exertion Day Recommended

Rest Day Recommended

Low Exertion Day Recommended

Daily H

Referen
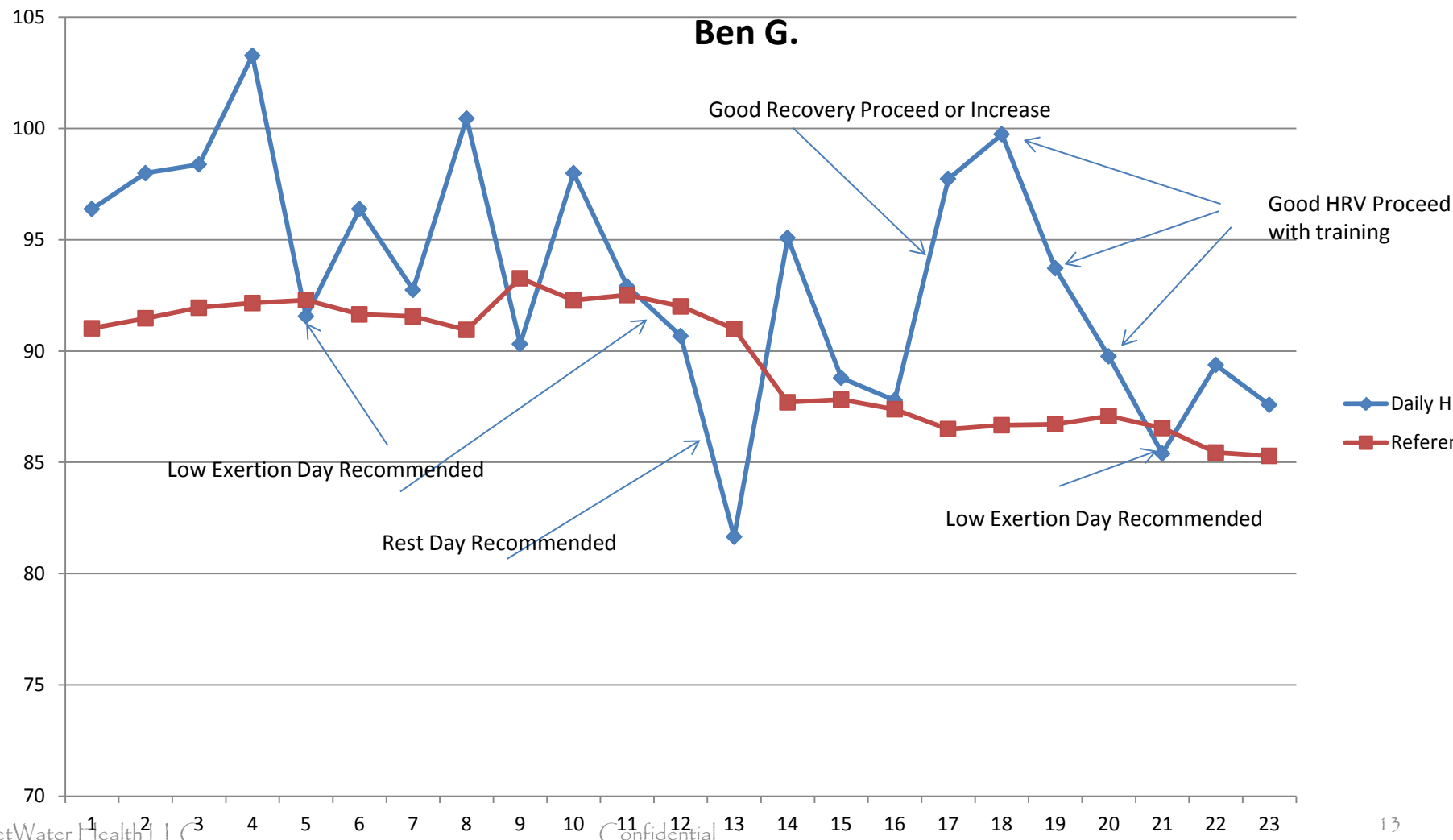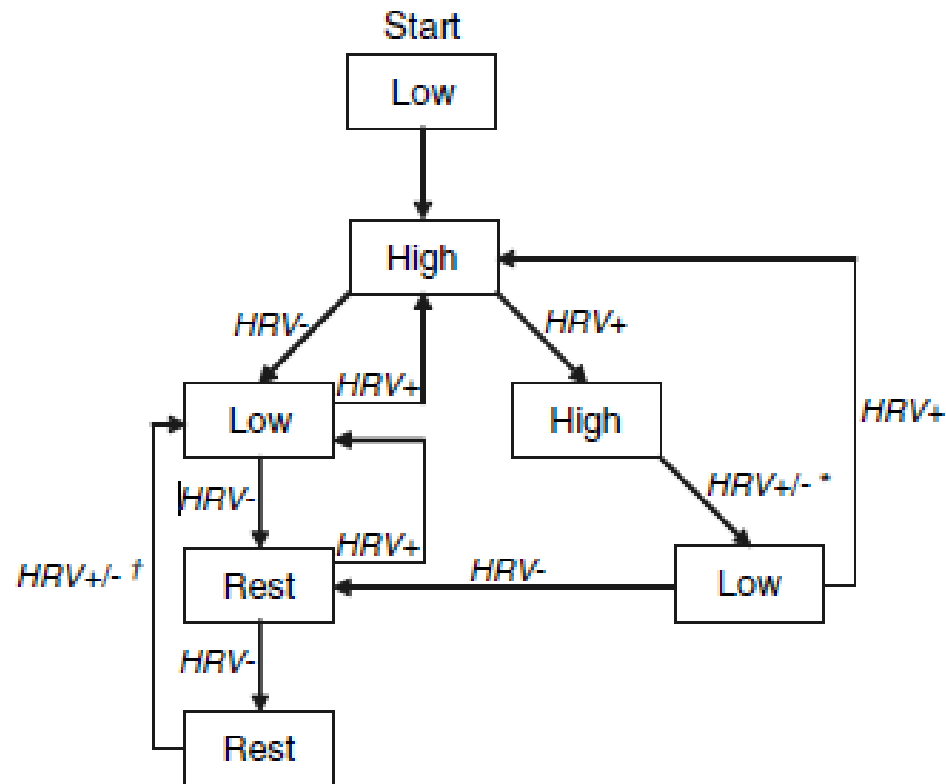
Source: Endurance training guided individually by daily heart rate variability measurements . Kiviniemi et al. 2007

Data Sharing

- There are multiple ways for coaches/trainers to access data
  - SweetBeatLife now works seamlessly with Restwise recovery program
    - HRV and Resting Heart Rate automatically entered into Restwise when SweetBeat session is uploaded
    - HRV may be displayed in relation to recovery score and any of the other RestWise metrics
  - Login to MySweetBeat to access SweetBeatLife session summaries
    - Create client accounts/share login credentials
  - Add to notes section in Training Peaks
  - Email Screenshots
    - Clients take a screenshot of their SweetBeatLife summary screens
    - Client emails screenshot of graphs or sessions summaries to coach
  - Download client sessions and view in SweetBeatLife
    - Within app, login as client and download sessions

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 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 athletes may have values at the high end of average

Gender	Age	Average 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

- Source: http://www.sciencedirect.com/science/article/pii/S0735109797005548
- Values based on 24 hour measurements
- HRV represents rMSSD scaled to a value between 0 – 100 and is SweetBeat specific

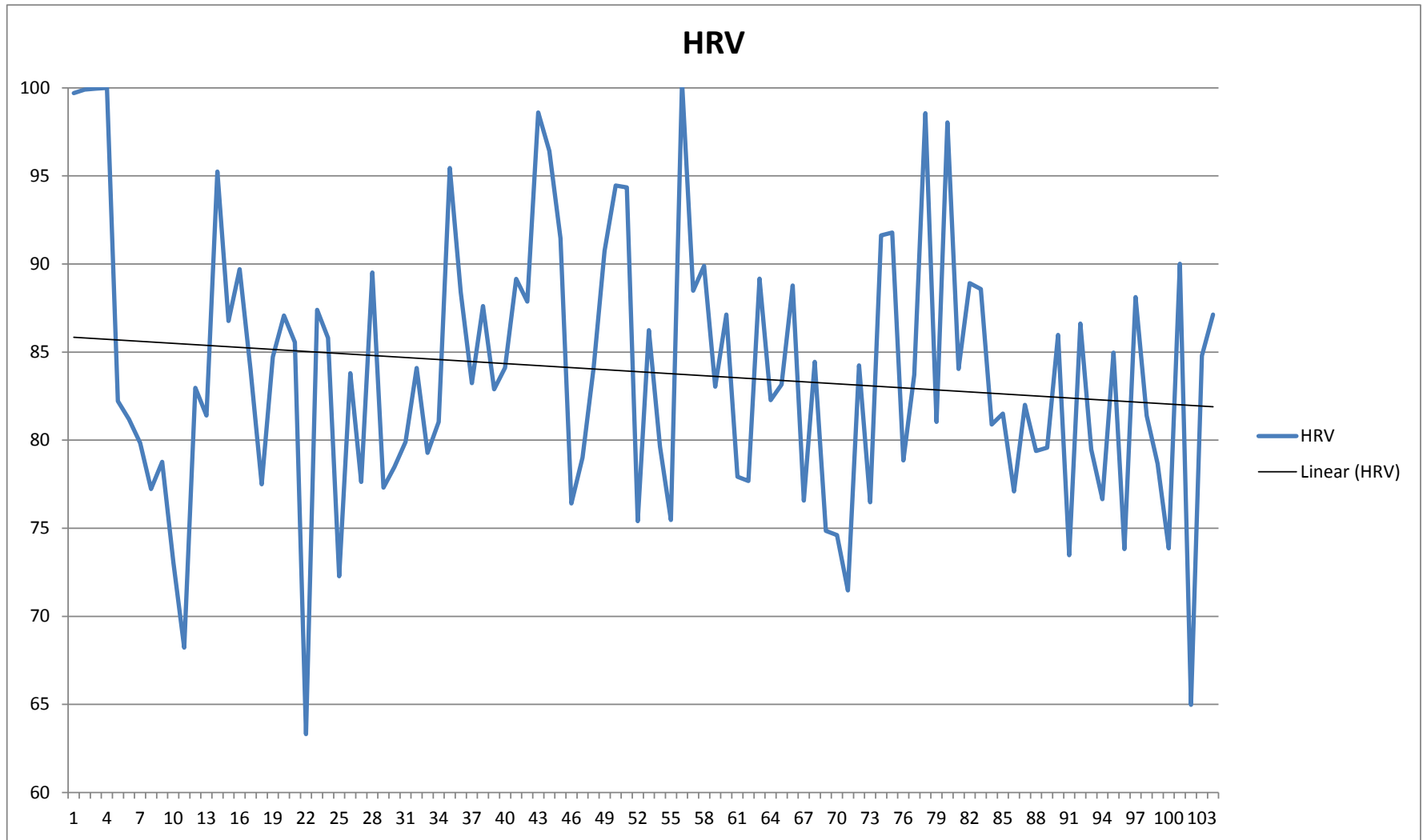- Through time you will start to see the individual range for each client
  - The following graphs indicate healthy and expected variations of HRV
  - This range may trend down by 10% during heavy training
  - Average stress is "yellow" with sensitivity setting = 5 (LF/HF avg <1.5)
- Red Flag Warnings
  - 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
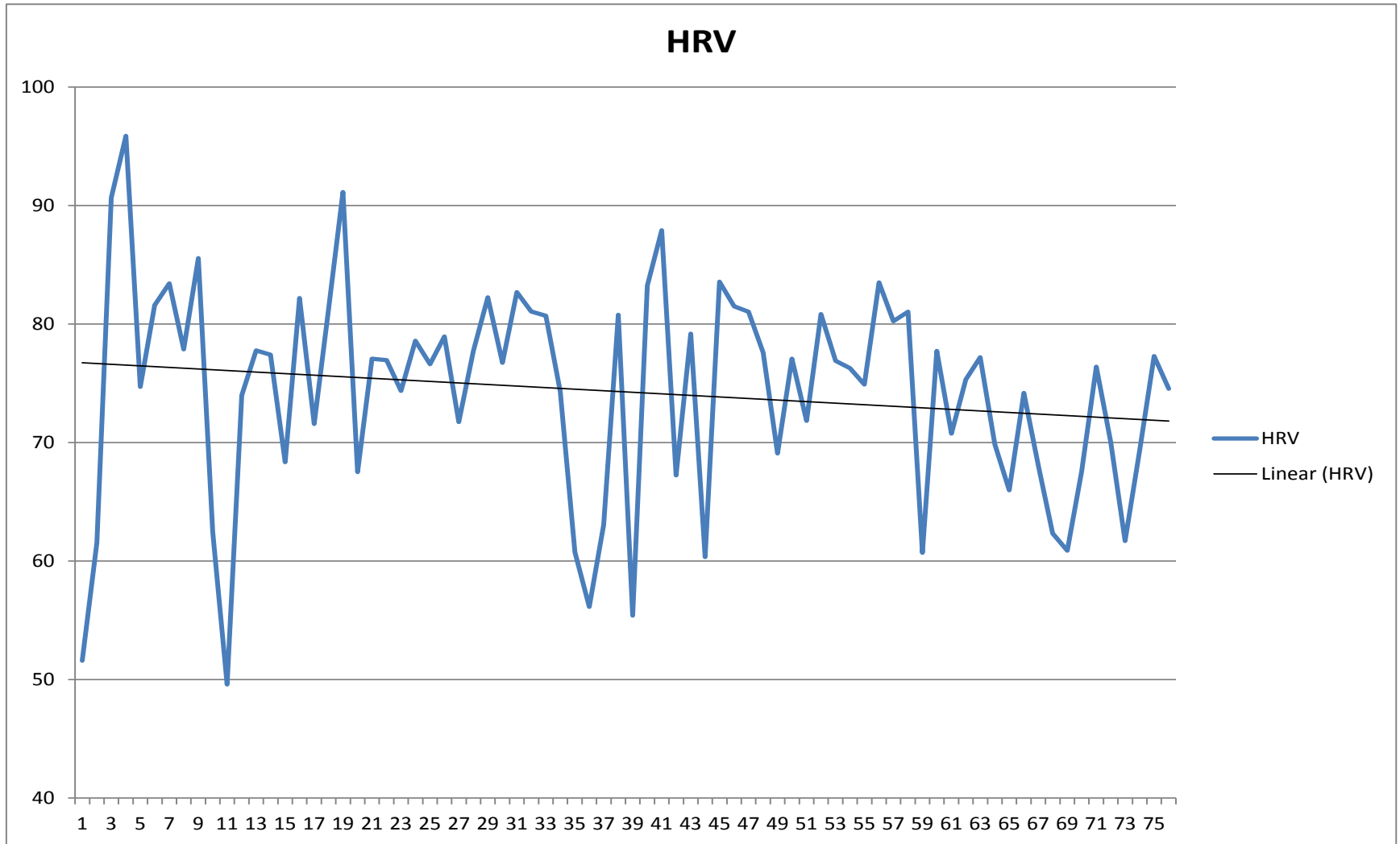
*HRV measured using SweetBeat
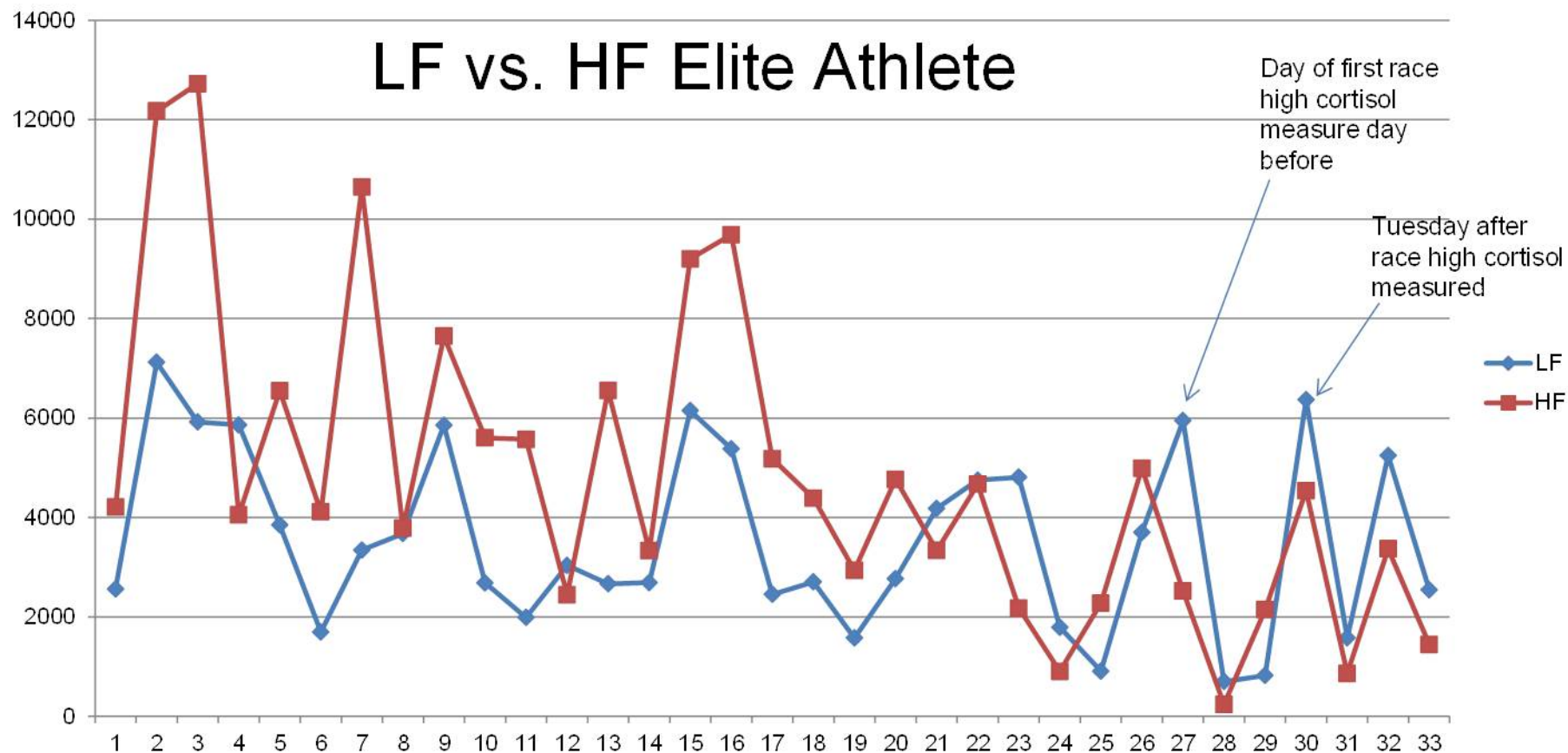
HRV

*HRV measured using SweetBeat

LF vs. HF Elite Athlete

Day of first race high cortisol measure day before

Tuesday after race high cortisol measured

LF
HF

LF vs. HF Fitness Enthusiast
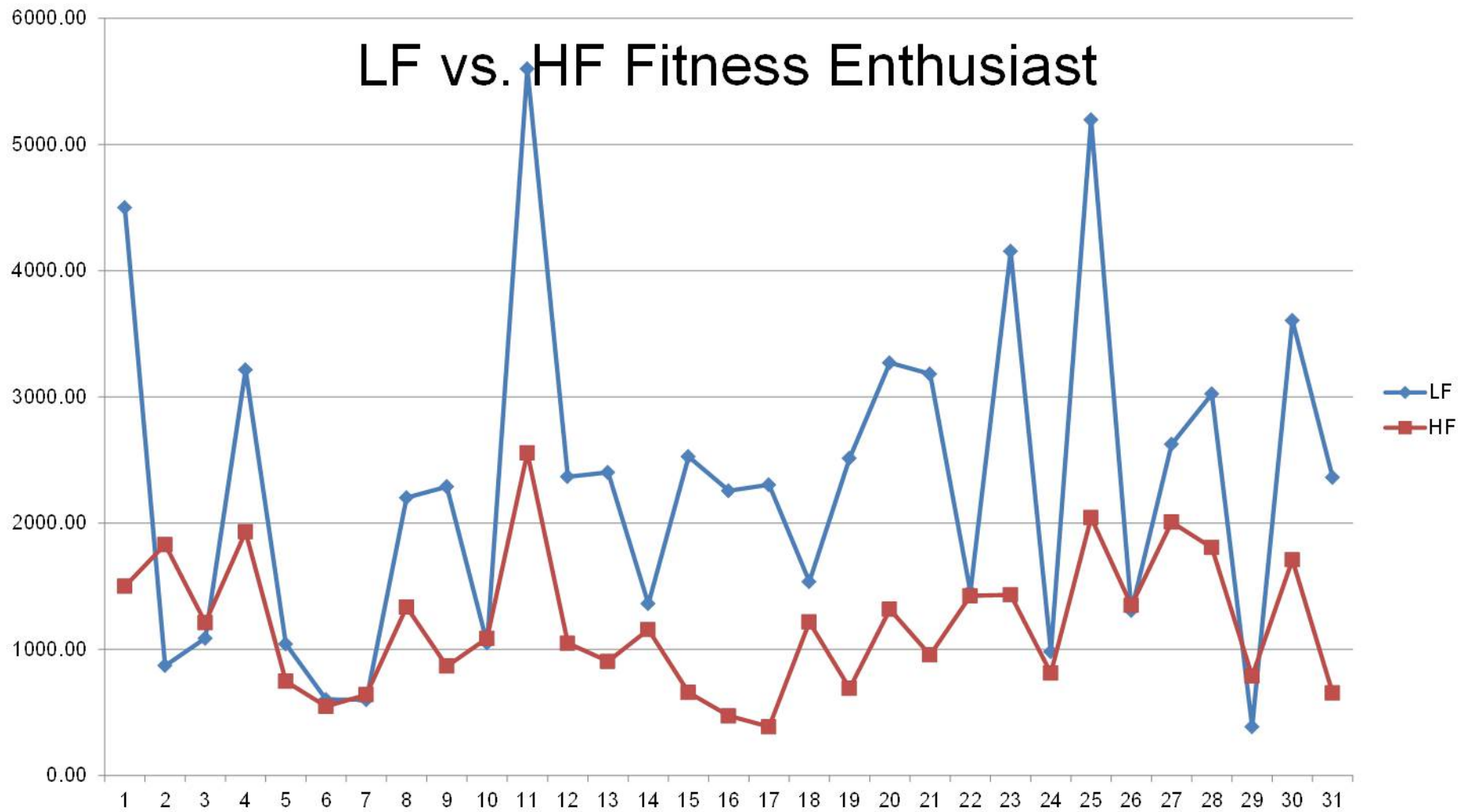
- For those who want to Geek Out further…..
  - Plot LF, HF, rMSSD for any given session in Excel
  - You will need the data from SweetBeatLife
    - From session summary select Share -> Email
    - 2 Files will be emailed, 1 will contain the rMSSD, LF, HF, HealthPatch metrics
- For even more geekiness……
  - Download Kubios for free http://kubios.uef.fi/
  - You will need the RR intervals from SweetBeatLife
    - From session summary select Share -> Email
    - 2 Files will be emailed, 1 will contain RR intervals
    - Follow these instructions for preparing RR intervals for import to Kubios
      - http://www.sweetwaterhrv.com/documents/RR%20Interval%20CSV%20File%20Explanation.pdf

- 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

sugar & white flour products
FEAR
lack of SLEEP
emotional stress
financial pressures
gut-irritating FOODS such as grains & legumes
allergies
death of a loved one
unwanted unemployment
over exertion
marital stress
too much or too little EXERCISE
negative attitudes & beliefs
INFECTIONS: actute & chronic
SMOKING
prescription & non-prescription drugs
psychological stress
wound healing
lack of relaxation
nutrient-poor food
CAFFEINE
lack of nutrient-dense food
TOXINS

ADRENAL STRESSORS
source: "Adrenal Fatigue," Wilson
BALANCED**BITES**

Source: http://robbwolf.com/2012/04/09/real-deal-adrenal-fatigue/
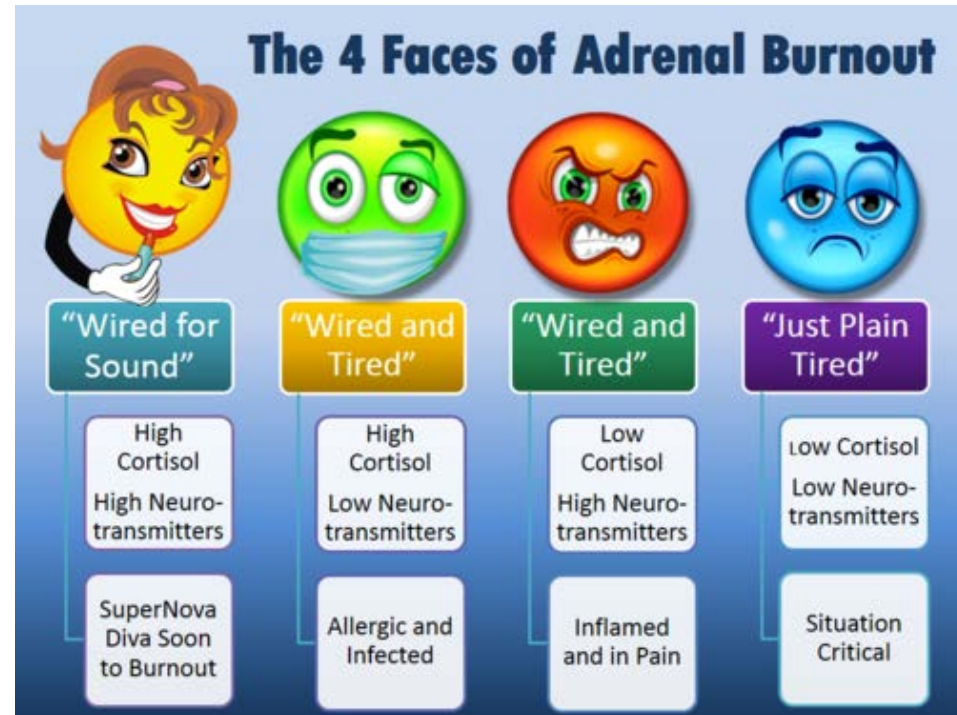
- When this response becomes the norm for your body, whether it is from workouts, stress or food, it becomes a low-level feature in your physiology
  - Mild, chronic, inflammation produces few symptoms and subtle changes on blood tests, though has a very different effect on your metabolism
  - Chronic 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
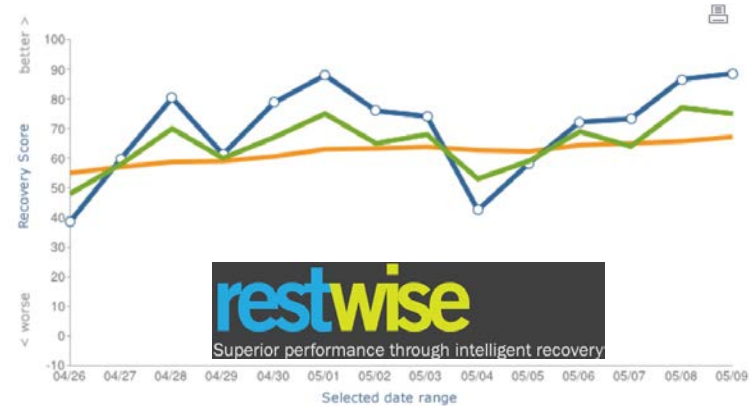

The 4 Faces of Adrenal Burnout

"Wired for Sound"	"Wired and Tired"	"Wired and Tired"	"Just Plain Tired"
High Cortisol	High Cortisol	Low Cortisol	Low Cortisol
High Neuro-transmitters	Low Neuro-transmitters	High Neuro-transmitters	Low Neuro-transmitters
SuperNova Diva Soon to Burnout	Allergic and Infected	Inflamed and in Pain	Situation Critical

Source: http://www.integrativepsychiatry.net/adrenal_fatigue.html

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  - HRV and Resting Heart Rate automatically entered into Restwise when SweetBeat session is uploaded
  - HRV may be displayed in relation to recovery score and any of the other RestWise metrics

- **We are working with TrainingPeaks to automatically upload HRV**
  - Write them asking for SweetBeat support
  - Cast your vote for HRV to TrainingPeaks
  - https://peaksware.uservoice.com/forums/106657-trainingpeaks-customer-feedback/suggestions/4479321-heart-rate-variability-as-tp-metric

- **Write support@sweetwaterhrv.com to request your training site**

restwise — Superior performance through intelligent recovery

TRAINING PEAKS™