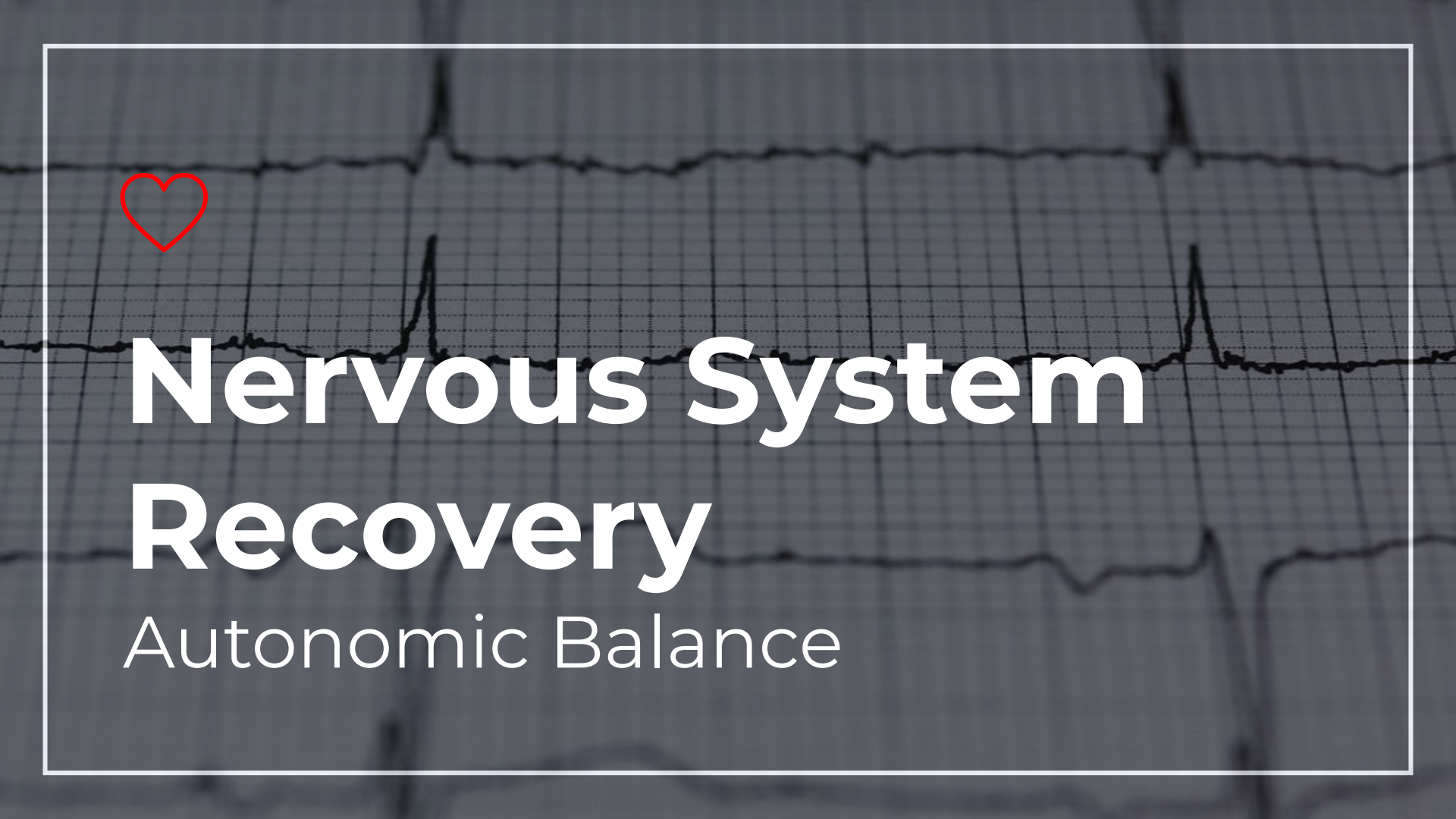
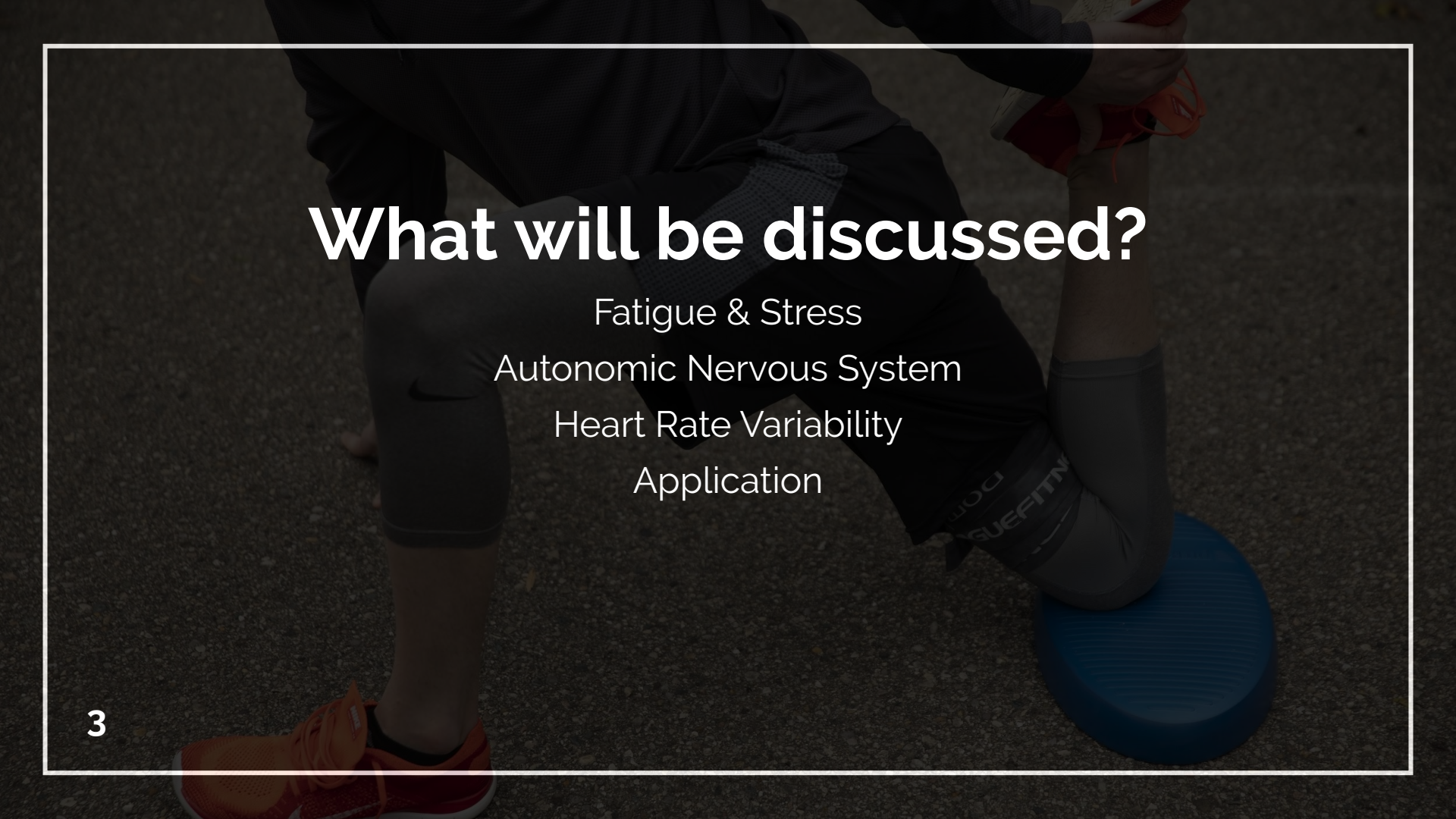

Nervous System
Recovery
Autonomic Balance

Dane Bartz, MS, CSCS

- **BS**: Exercise Science
- **MS**: Exercise Physiology & Adult Fitness
- **PhD(c)**: Human & Sport Performance

- Director: Linked Fit
- Adjunct Faculty: Oakland Community College
- Michigan Advisory Board Member: NSCA
- Academic Advisory Board Member: Maryville University
- Research Assistant: RMUoHP



What will be discussed?

Fatigue & Stress

Autonomic Nervous System

Heart Rate Variability

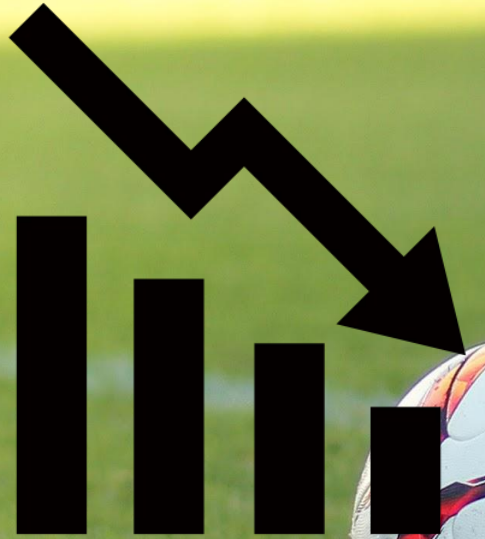
Application

Training is not linear, it is abrupt.

Unknown

Abrupt system changes due to minor disturbances are not linear, but non-linear.

Ernst, 2017



FATIGUE ↑

ENERGY ↓

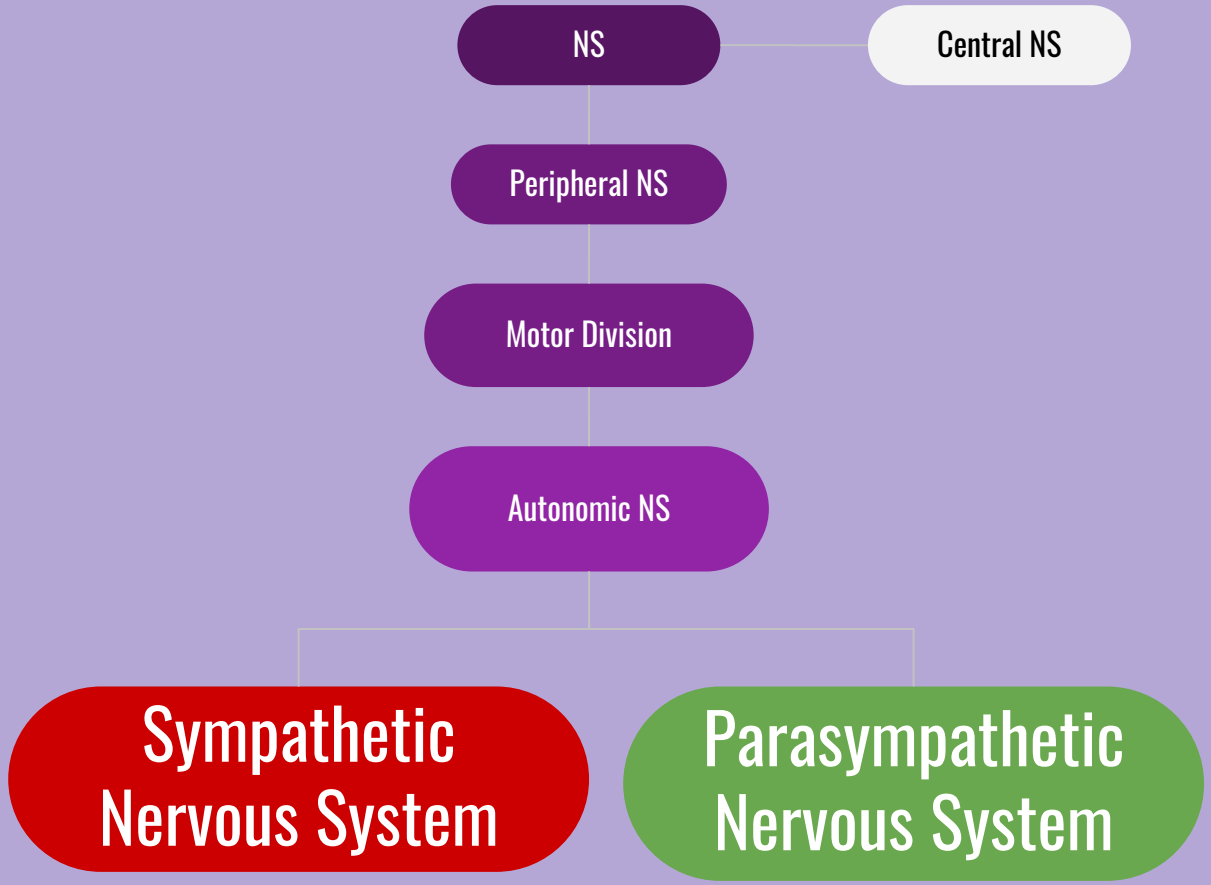
SORENESS ↑

FORCE ↓

POWER ↓

Buckthorpe et al, 2014; & Stults-Kolehmainen & Bartholomew, 2012

Stults-Kolehmainen & Bartholomew, 2012

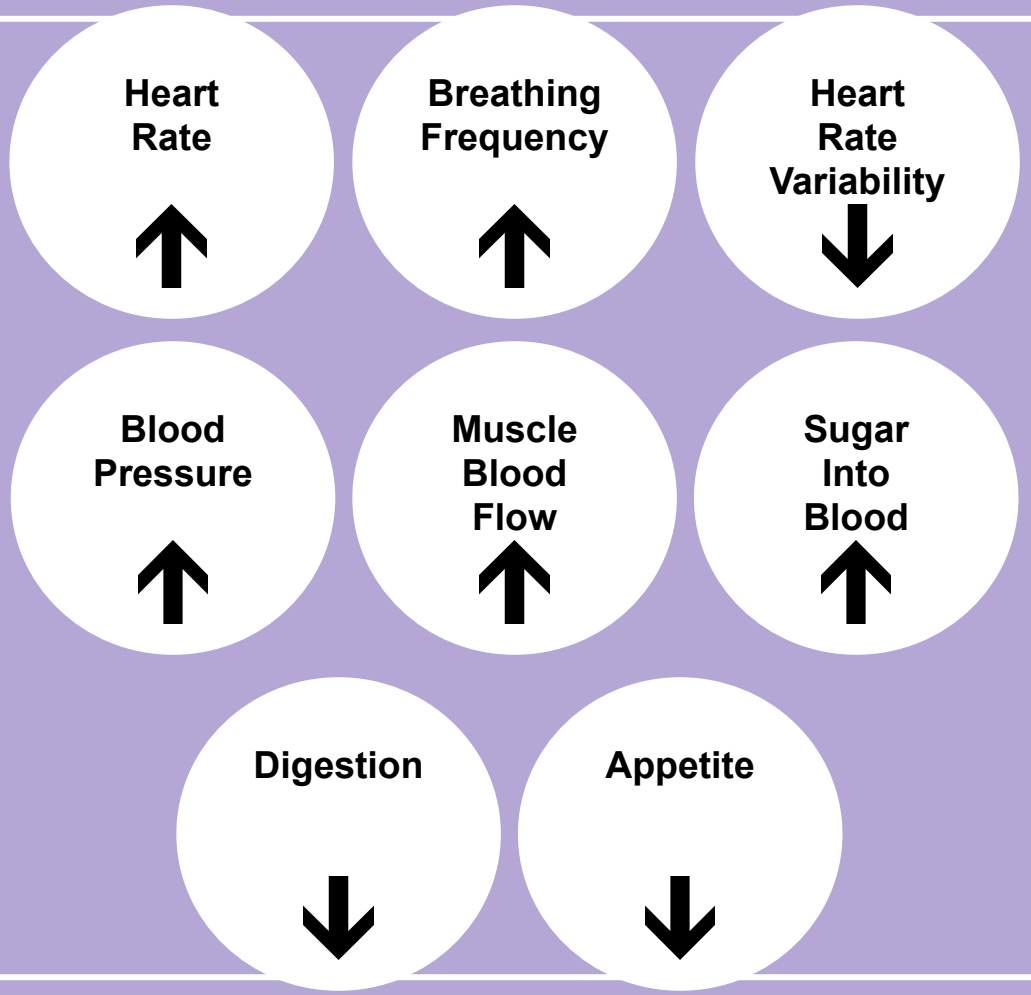

NS
Central NS
Peripheral NS
Motor Division
Autonomic NS
Sympathetic Nervous System
Parasympathetic Nervous System

SNS & PSN

Both branches of the ANS work together in harmony to regulate heart rate and heart rate variability (HRV) in order to optimize heart output in situational events.

Pertab et al, 2018

SNS

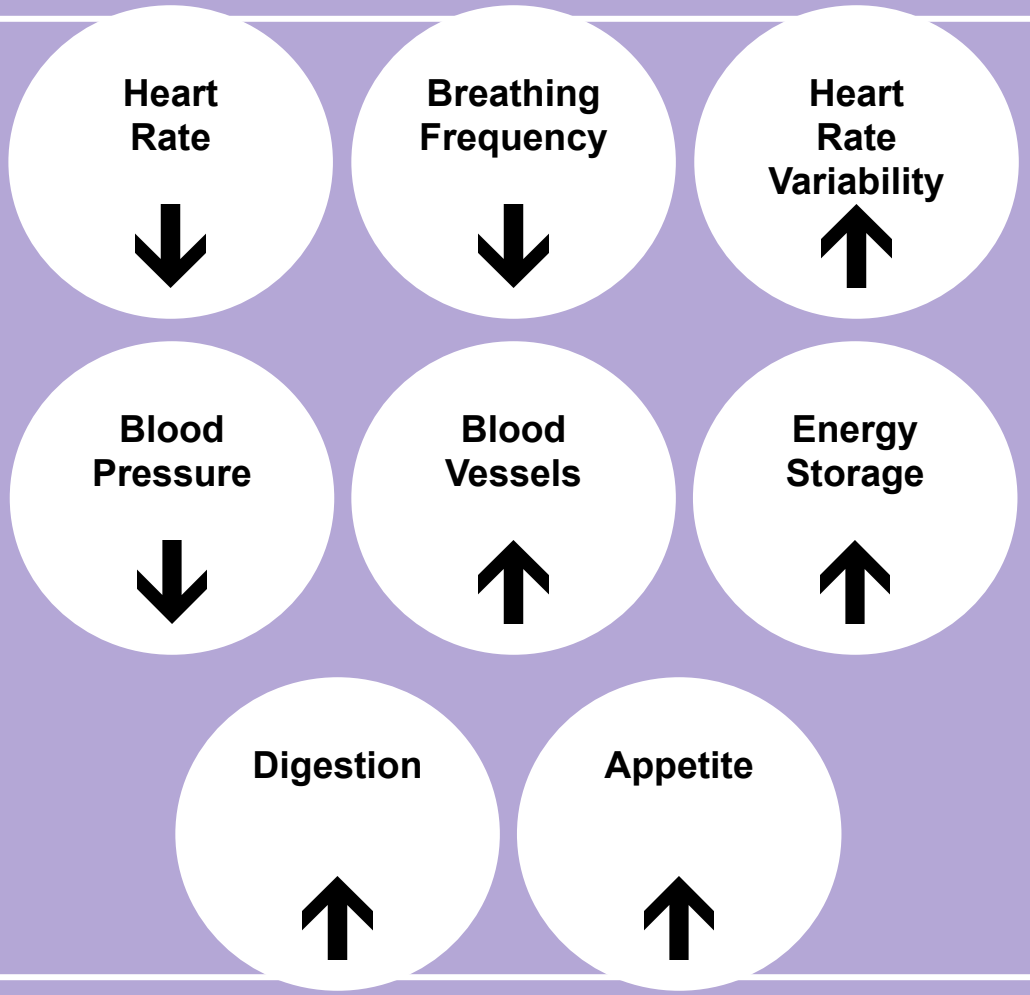


Berntson et al, 1997

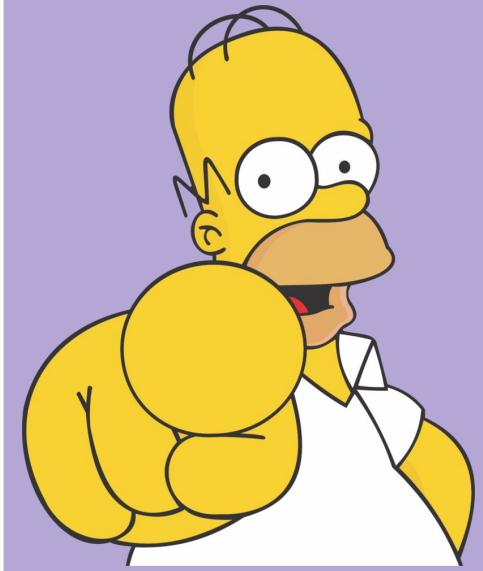
SNS is required to mobilize resources and prime for performance

Ernsberger & Rohrer, 2018

PNS



Berntson et al, 1997



PNS can hinder activity and performance by diminishing the SNS to properly activate

Ernsberger & Rohrer, 2018

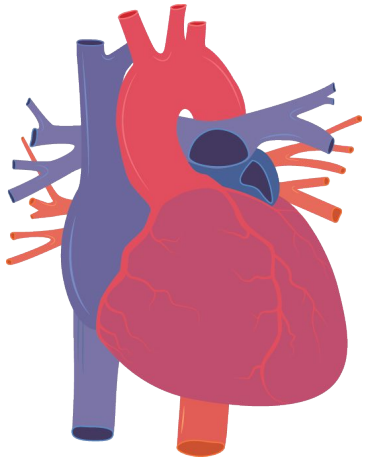
Heart Rate Variability

The heart is a prime target of autonomic innervation.

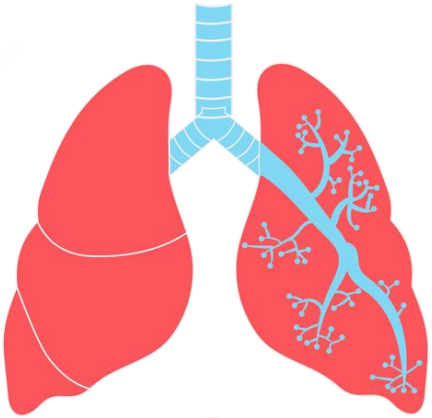
Ernsberger & Rohrer, 2018

3 Primary Systems

Nervous System



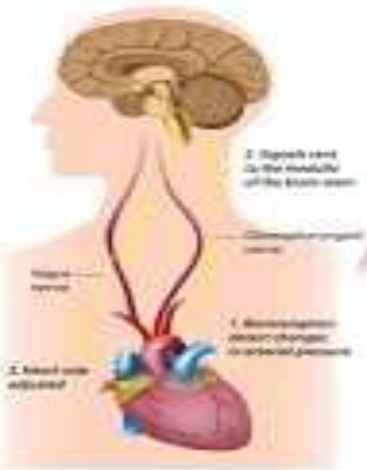
Circulatory System

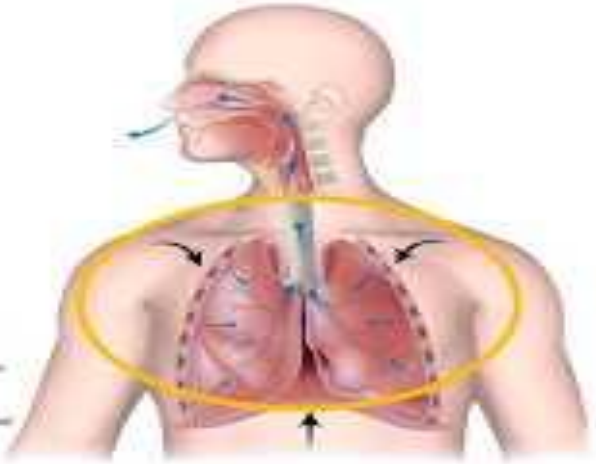


Respiratory System

Respiratory Sinus Arrhythmia (RSA)

- **During expiration**
  - Diaphragm relaxes and moves upward
  - Chest cavity size decreases





HRV DATA

Time Domains vs. Frequency Domains

Time Domain

Signal change over time and calculates the amount of variability in the heart beat.

Mean RR Interval

Overall average of the RR intervals during a reading.

rMSSD

Square root of the mean of the squared differences of consecutive RR intervals.

SDNN

Standard deviation of the RR intervals.

ln(rMSSD)

Natural logarithm applied to rMSSD for easier analysis.

Frequency Domain

Analysis of the measurement signal with respect to frequency.

Low Frequency

Frequency band:

0.04 to 0.15 Hz

SNS & PNS

High Frequency

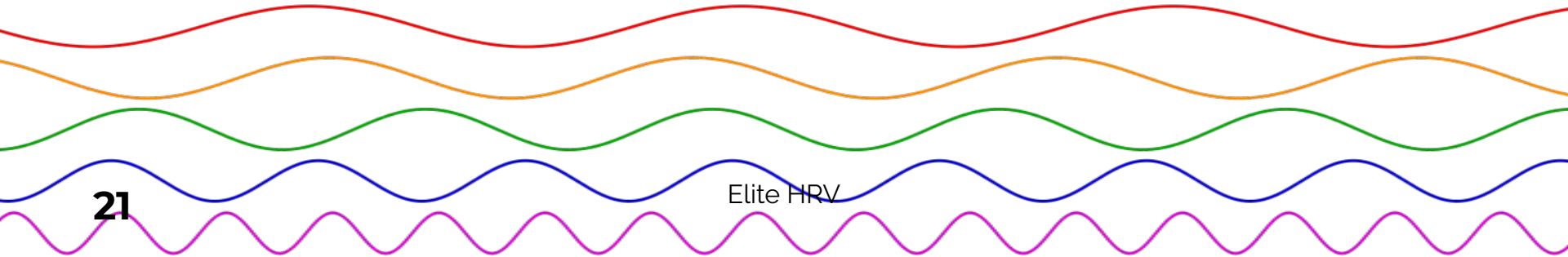
Frequency band:

0.15 to 0.40 Hz

PNS

Total Power

Signal power intensity in frequency domain with the given measurement.



Average

59.09

Elite HRV Application Users


HRV
72
Verizon
7:55 PM
38%
Details
Save
Feb 4, 2019 - 1:46 PM - 02:21
HRV Time-Domain Results
Mean RR interval: 774 ms
rMSSD: 110.69 ms
ln(rMSSD): 4.71 ms
SDNN: 116.14 ms
PNN50: 29%
NN50: 55
7 Day HRV CV: N/A
HRV Frequency-Domain Results
Total Power: 1,805.86 ms²
LF* (Low Frequency Power): 684.23 ms²
HF (High Frequency Power): 1,121.63 ms²
LF/HF ratio*: 0.61
*Recent research shows measurements longer than 4

Pre-Training HRV

72

Time Domain

Mean RR Interval = 774 ms

rMSSD = 110.69 ms

SDNN = 116.14 ms

ln(rMSSD) = 4.71 ms

Frequency Domain

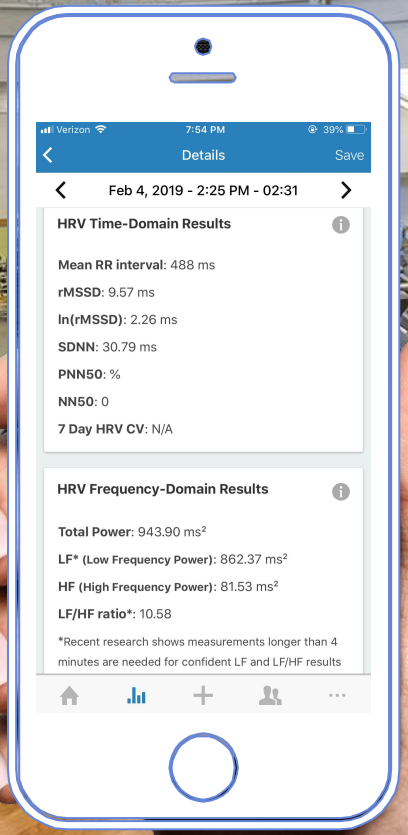
Low Frequency = 684.23 ms^2

High Frequency = 1,121.63 ms^2

Total Power = 1,805.86 ms^2

HRV

35


Verizon
7:54 PM
39%
Details
Save
Feb 4, 2019 - 2:25 PM - 02:31
HRV Time-Domain Results
Mean RR interval: 488 ms
rMSSD: 9.57 ms
ln(rMSSD): 2.26 ms
SDNN: 30.79 ms
PNN50: %
NN50: 0
7 Day HRV CV: N/A
HRV Frequency-Domain Results
Total Power: 943.90 ms²
LF* (Low Frequency Power): 862.37 ms²
HF (High Frequency Power): 81.53 ms²
LF/HF ratio*: 10.58
*Recent research shows measurements longer than 4 minutes are needed for confident LF and LF/HF results

Post-Training HRV

35

72 - 35 = 37

Time Domain

Mean RR Interval = 488 ms

rMSSD = 9.57 ms

SDNN = 30.79 ms

ln(rMSSD) = 2.26 ms

Time Domain:

Mean RR Interval = 286 ms reduction

rMSSD = 101.12 ms reduction

SDNN = 85.35 ms reduction

Frequency Domain

Low Frequency = 862.37 ms^2

High Frequency = 81.53 ms^2

Total Power = 943.90 ms^2

Frequency Domain:

LF = 178.14 ms^2 increase

HF = 1,040.1 ms^2 decrease

Total Power = 861.96 ms^2 decrease

PRACTICAL APPLICATION

How can professionals help regulate HRV with clients/athletes?

Baseline HRV recordings are needed!

1 week of recordings

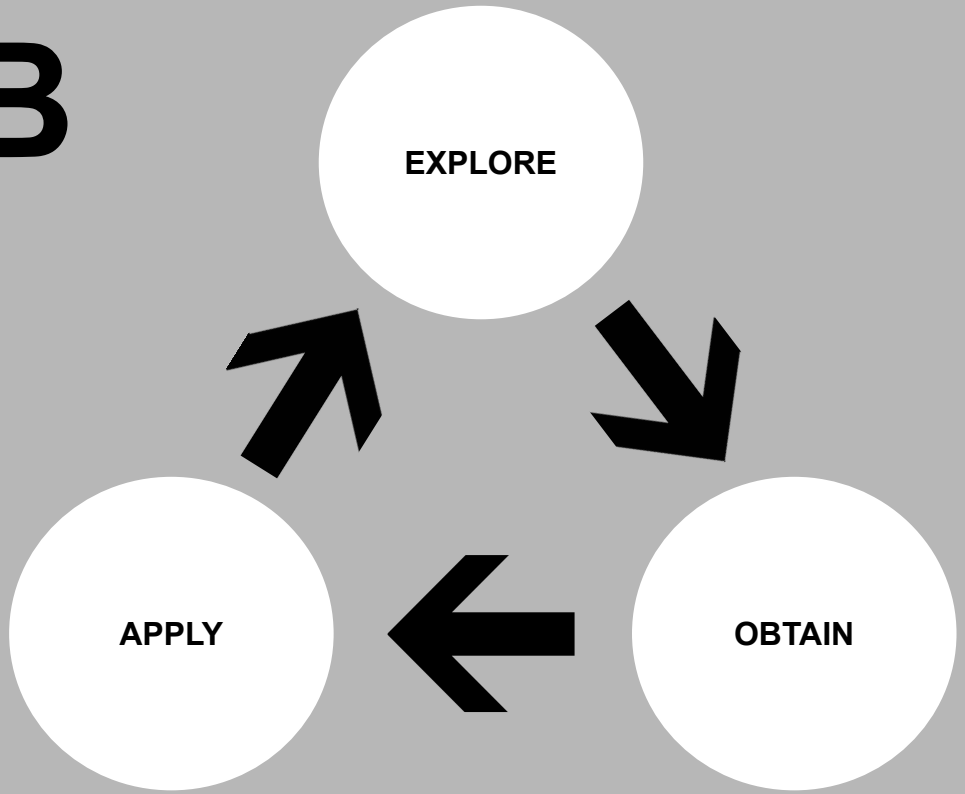
Morning

or

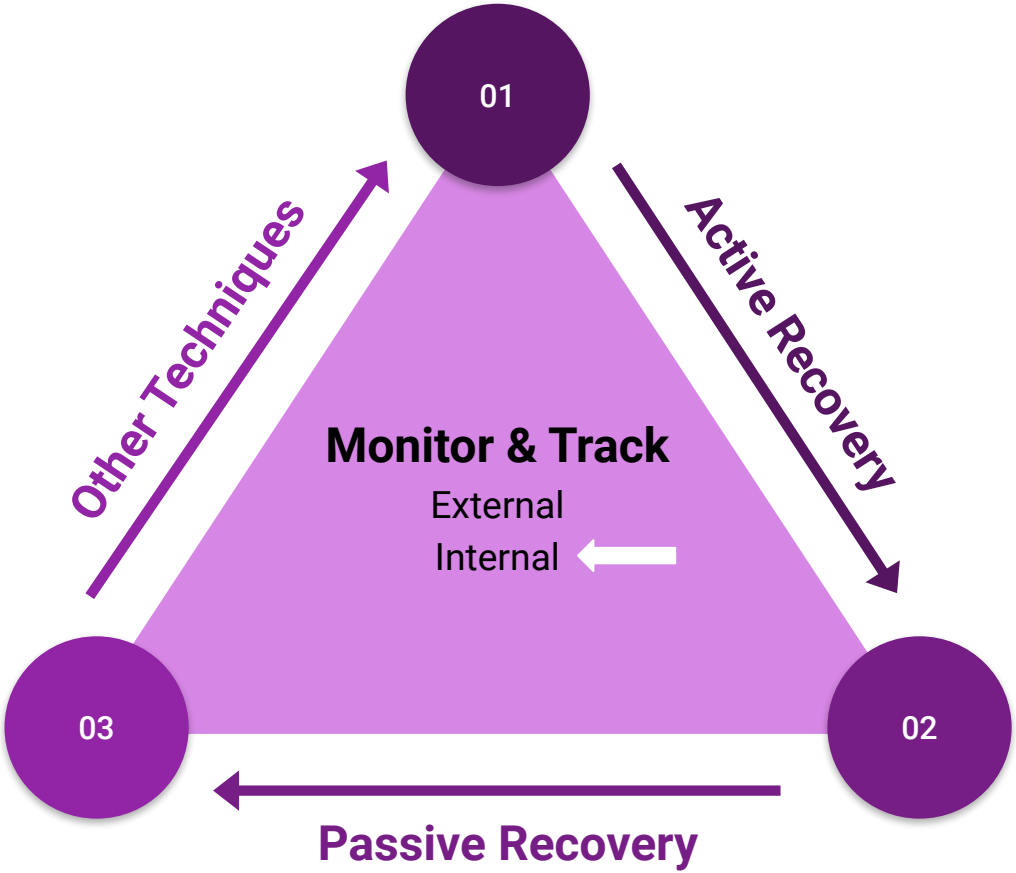
Pre-Training

EOB

Explore
Obtain
Apply



Parasympathetic Activation



~Active Recovery~

-Optimal Programming-
De-load
Off-load
Re-direct

~Passive Recovery~

Breathing
Nutrition
Sleep

~Other Techniques~

Massage
Flexibility
Mobility
Vibration
Compression
Hydrotherapy
Cryotherapy

Pre-Training Measurement

High

Higher than average = Time Domains

High = High Frequency

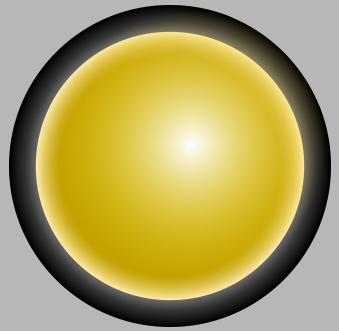
Low = Low Frequency

Medium

Lower than average = Time Domains

Low = High Frequency

High = Low Frequency

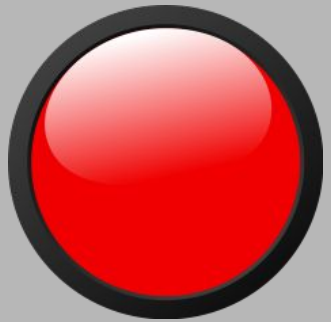


Low

Significantly lower than average = Time Domains

Low = High Frequency

High = Low Frequency



Example

Average = 62

56 to 62+

Higher than Average

High

Time Domain & High Frequency

Low

Low Frequency & LF/HF Ratio

52 to 54

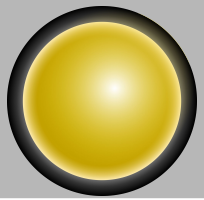
Slightly Lower than Average

Slightly Lower

Time Domain & High Frequency

Slightly Higher

Low Frequency & LF/HF Ratio



Less than 51

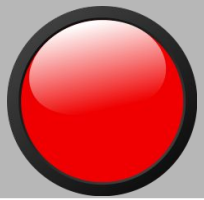
Significantly Lower than Average

Significantly Lower

Time Domain & High Frequency

Significantly High

Low Frequency & LF/HF Ratio

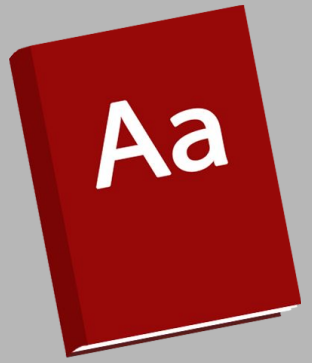



Stress
Sleep
Nutrition
Training
Health

STEPPING UP

Individuals need to develop coherence.

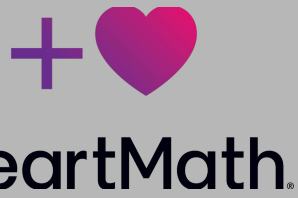
Ernsberger & Rohrer, 2018



“

The quality of being logical and consistent.

Ernsberger & Rohrer, 2018

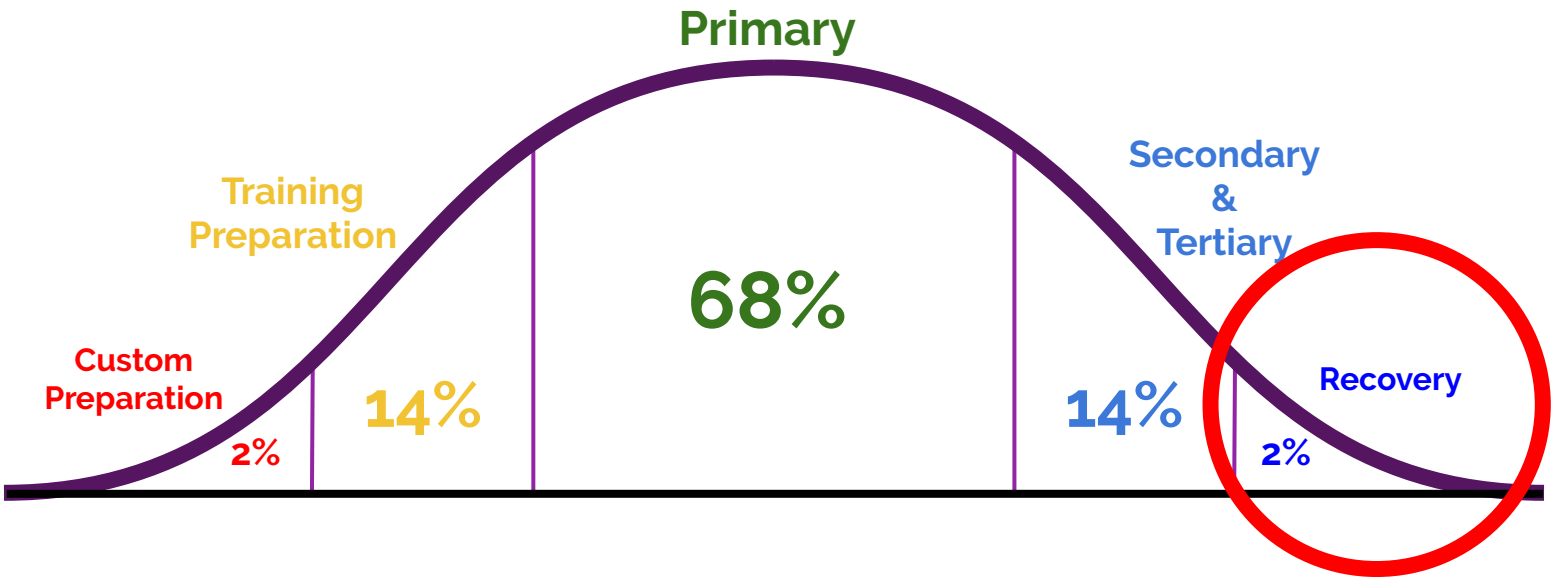


Heart Rate Variability

Software & Applications

Hands-On

Bell Curve Training



THANK YOU!

NSCA National Strength and Conditioning Association

Host:

Renée Hoppe, MS, CSCS

Ferris State University

 248.759.8986

 dane@linked-fit.com

 @dane.bartz

 @danebartz

References

- Berntson, G. G., Bigger, J. T., Eckberg, D. L., Grossman, P., Kaufmann, P. G., Malik, M., … Molen, M. W. (1997) Heart rate variability: origins, methods, and interpretive caveats. Psychophysiology, 34(6), 623-648.
- Buckthorpe, M, Pain, M. T. G., & Folland, J. P. (2014) Central fatigue contributes to the greater reductions in explosive than maximal strength with high-intensity fatigue. Experimental Physiology, 99(7), 964-973.
- Ernsberger, U., & Rohrer, H. (2018). Sympathetic tales: subdivisions of the autonomic nervous system and the impact on developmental studies. Neural Development, 13(20), 1-21.
- Ernst, G. (2017). Heart-rate variability - more than heart beats? Frontiers in Public Health, 5(240), 1-12.
- Figueiredo, D. H., Figueiredo, D. H., Moreira, A., Goncalves, H. R., & Stanganelli, L. C. R. (2019). Effects of overload and tapering on individual heart rate variability, stress tolerance, and intermittent running performance in soccer players during a preseason. The Journal of Strength and Conditioning Research, 0(0), 1-10.
- Grgic, J., Mikulic, P., Podnar, H., & Pedisic, Z. (2017). Effects of linear and daily undulating periodized resistance training programs on measures of muscle hypertrophy: a systematic review and meta-analysis. PeerJ, 5, 1-20.
- Haff, G., & Triplett, T. (2016). Essentials of strength training and conditioning. 4th edition. NSCA: Human Kinetics.
- Koenig, J., Jarczok, M. N., Ellis, R. J., Hillecke, T. K., & Thayer, J. F. (2019). Heart rate variability and experimentally induced pain in health adults: A systematic review. European Journal of Pain, 1-14.
- Pertab, J. L., Merkley, T. L., Cramond, A. L., Cramond, L., Paxton, H., & Wu, T. (2018). Concussion and the autonomic nervous system: An introduction to the field and the results of a systematic review. NeuroRehabilitation, 42, 397-427.
- Slults-Kolehmainen, M. A., & Bartholomew, J. B. (2012) Psychological stress impairs short-term muscular recovery from resistance exercise. Medicine & Science in Sports & Exercise, 12, 2220-2227.