



NSCA
COACHES
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#NSCACoaches22

Monitoring Training-Induced Stress: *Strategies to find the Upper Limit of Work*

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Lecture Objectives

- Review the physiology of exercise induced training stress and its positive affect on adaptation.
- Discuss the signs, symptoms, and consequences of too much training stress, resulting in non-functional overreaching or overtraining.
- Survey tools and technologies that are practically relevant to monitoring athlete, training-related stress.
- Provide practical ideas and examples for how to utilize these tools to monitor stress in training, challenging athletes to find the upper limit of work.

Interesting “Trends” in Strength Training by Decade

Through the eyes of a non-historian

1970's

Bodybuilding; NSCA founded; Strength and Conditioning in collegiate sports; machine-based exercise emerges as more mainstream.

1990's

Growth of exercise literature related to periodization; more research and publications on overtraining; plyometric exercises, etc.

2010's

Movement tracking become more affordable and available in sports. Sports science emerges as a career path in American, professional sports. Load management, rest and recovery are focal points in holistic athlete performance.

1980's

Strength and conditioning becomes a viable profession; beginning of American literature on periodization; knowledge of strength training biology grows.

2000's

Instability exercises move from rehabilitation to the weight room; movement screening becomes more prevalent. Molecular biology of strength training.

2020?

What is Stress?

- Response to a stimulus that causes “strain” or a disruption in homeostasis of an organism.
- Stress is a normal experience, part of evolution within organisms, and a mechanism that allows organisms to adapt and thrive.
 - Positive Stress – “Eustress”
- Stress can be negative if the strain is too harsh or prolonged.
 - Negative Stress – “Distress”
- The response of an organism to stress is multifaceted.
 - Psychological
 - Emotional
 - Physical
 - Behavioral

Origins of our Understanding of Stress

Hans Selye

(1907-1982)

- Austrian – Hungarian Physician (Endocrinologist).
- Work on stress conducted in Canada and the United States.
- Multiple Nobel Prize nominations.
- Inaugural work published in 1936.

Selye, H. (1936). A syndrome produced by diverse nocuous agents. *Nature*, 138 (3479), 32-32.

“Experiments on rats show that if the organism is severely damaged by acute nonspecific nocuous agents such as exposure to cold, surgical injury, production of spinal shock (transcision of the cord), excessive muscular exercise, or intoxications with sublethal doses of diverse drugs (adrenaline, atropine, morphine, formaldehyde, etc.), a typical syndrome appears, the symptoms of which are independent of the nature of the damaging agent or the pharmacological type of the drug employed, and represent rather a response to damage as such.”

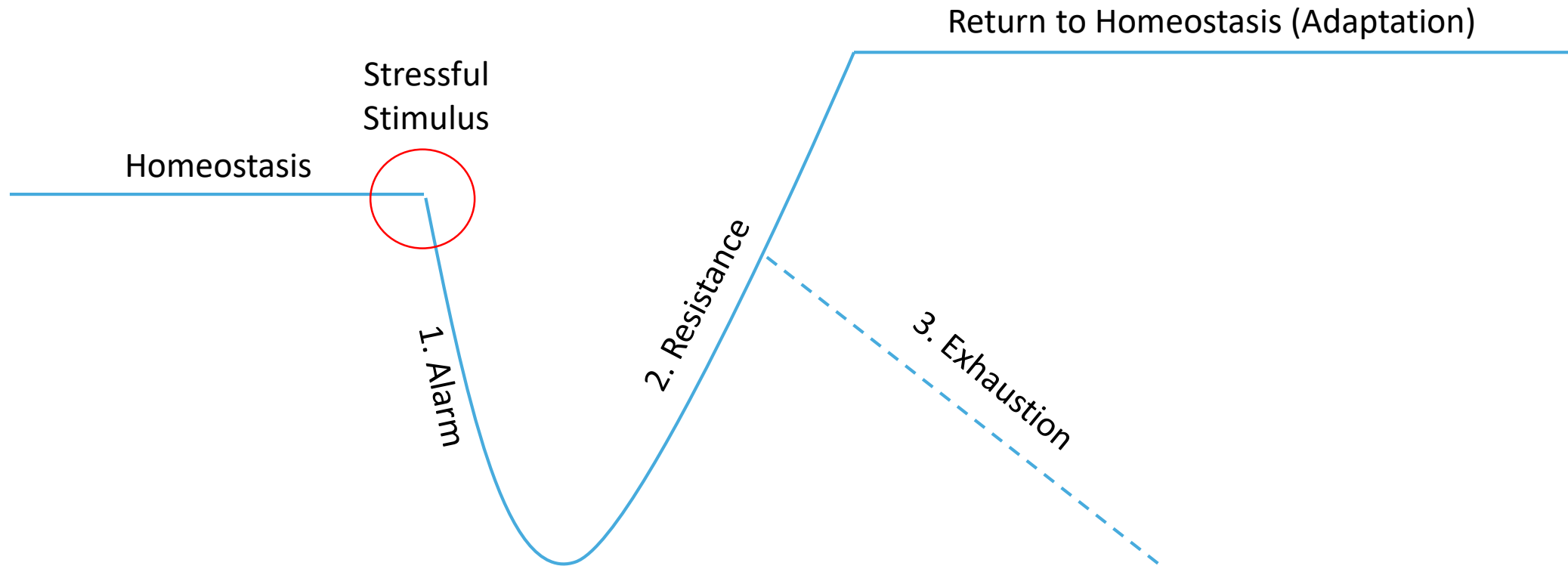
3-Stage Syndrome

“General Adaptation Syndrome”

- Alarm Phase: (6 – 48 Hours)
 - Characterized by sharp physiologic decline probably as a protective mechanism from the stressor
- Resistance Phase: (48 Hours)
 - Adaptation to stimulus begins with a reduction in stress related hormones in favor of restoration of homeostasis
- Exhaustion Phase (???)
 - Loss of resistance to the stimulus followed by prolonged symptoms of alarm phase

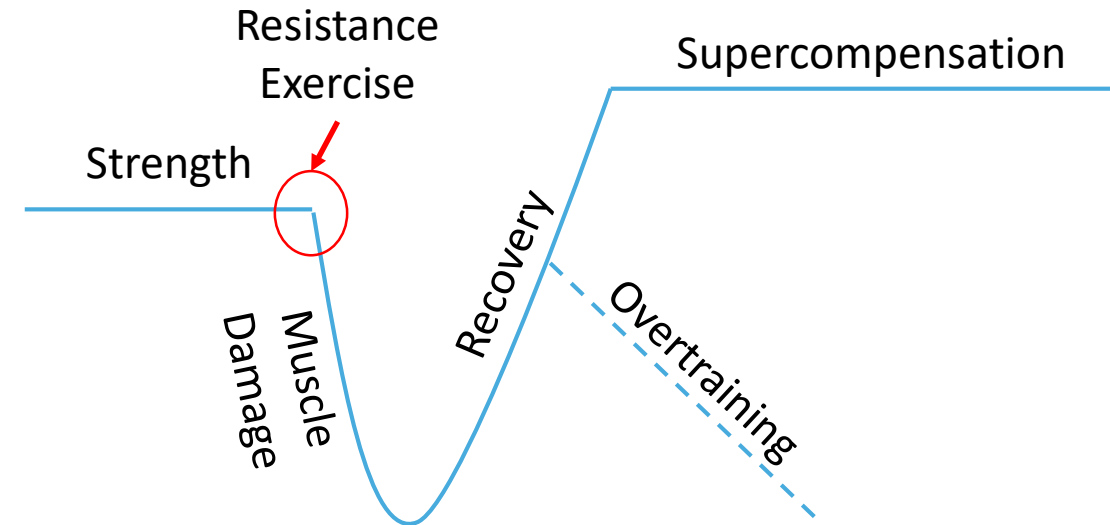
3-Stage Syndrome

General Adaptation Syndrome

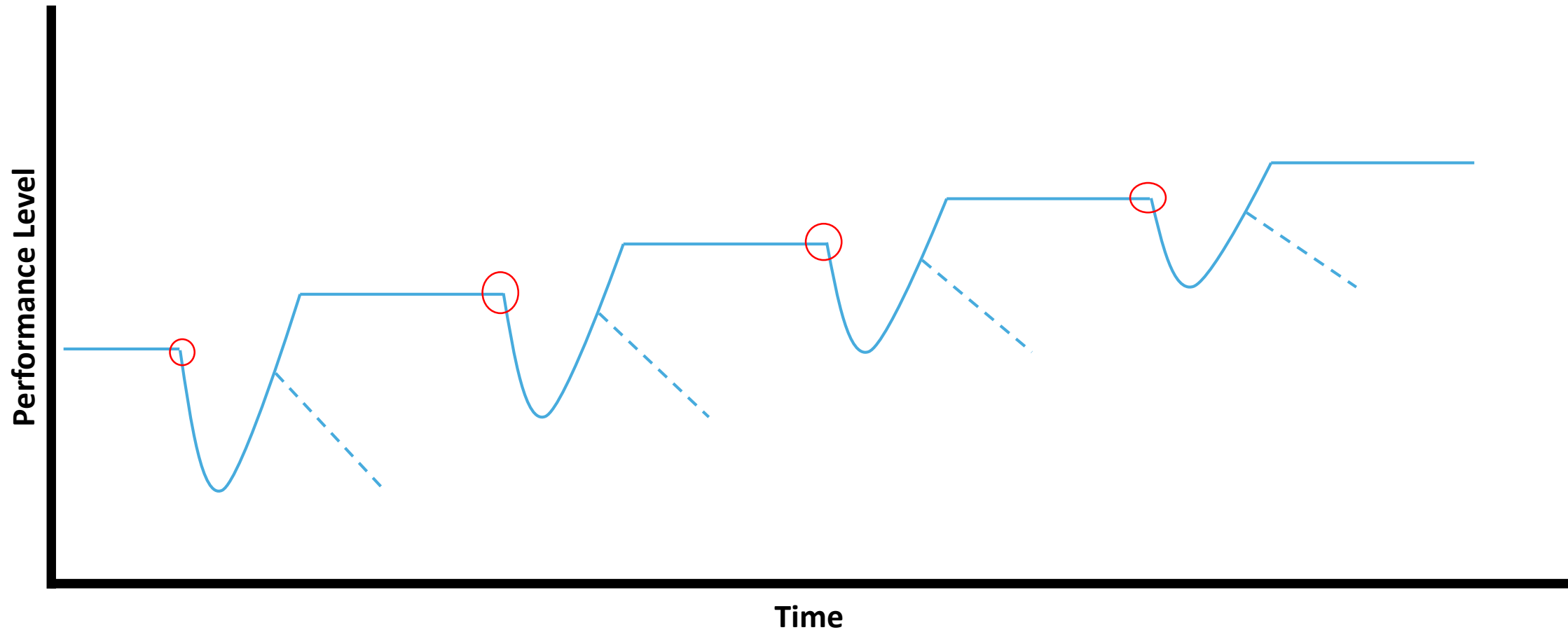


Stress and Resistance Exercise Literature

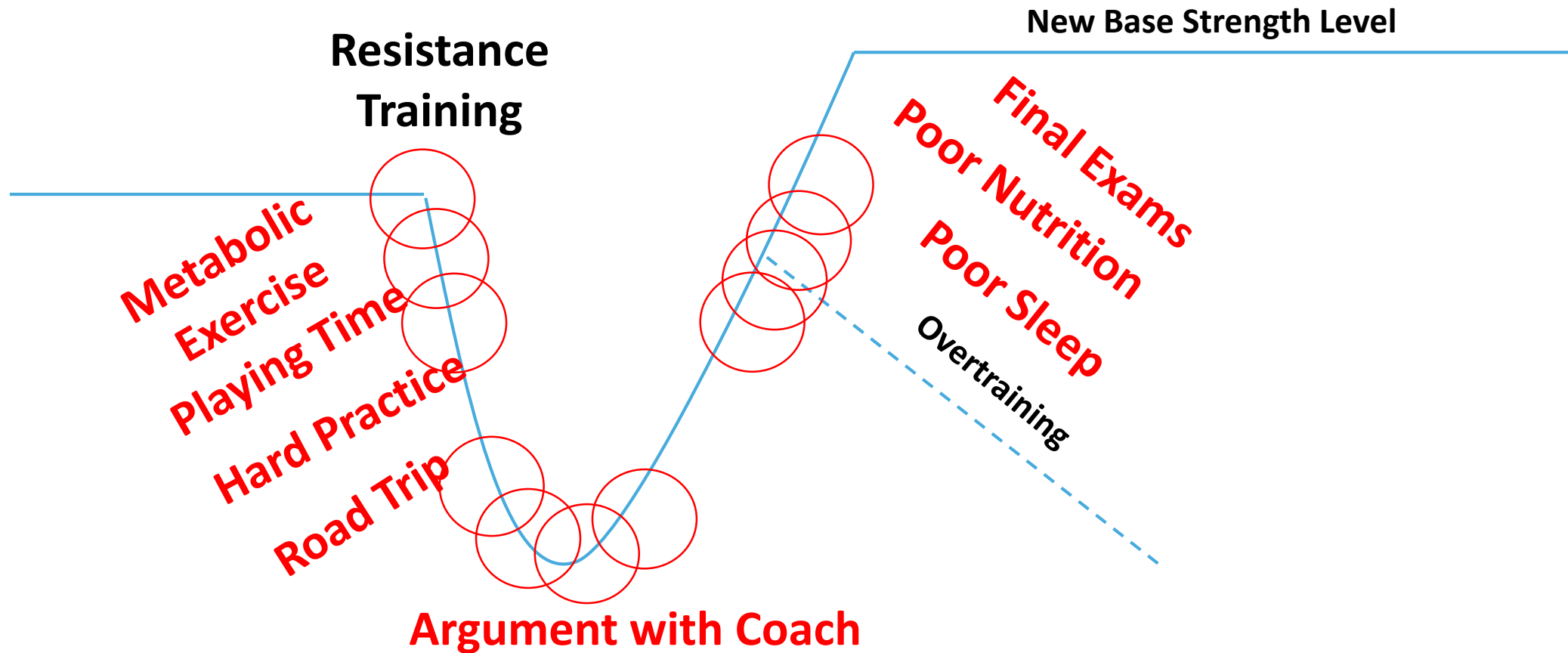
- Dr. Tomas DeLorme and World War II
 - DeLorme TL (1945). Restoration of muscle power by heavy resistance exercises. *J Bone Joint Surg*, 27: 645–667.
 - DeLorme TL, Ferris BG, Gallagher JR (1952). Effect of progressive resistance exercise on muscle contraction time. *Arch Phys Med Rehabil*, 33: 86–92.
- American Periodization Literature
 - Stone, M. H., & O'Bryant, H. (1981). A hypothetical model for strength training. *J Sport Med Phys Fit*, 21(4): 342-351.
 - Stone, M. H., O'Bryant, H., Garhammer, J., McMillan, J., & Rozenek, R. (1982). A theoretical model of strength training. *Strength Cond J*, 4(4), 36-39.



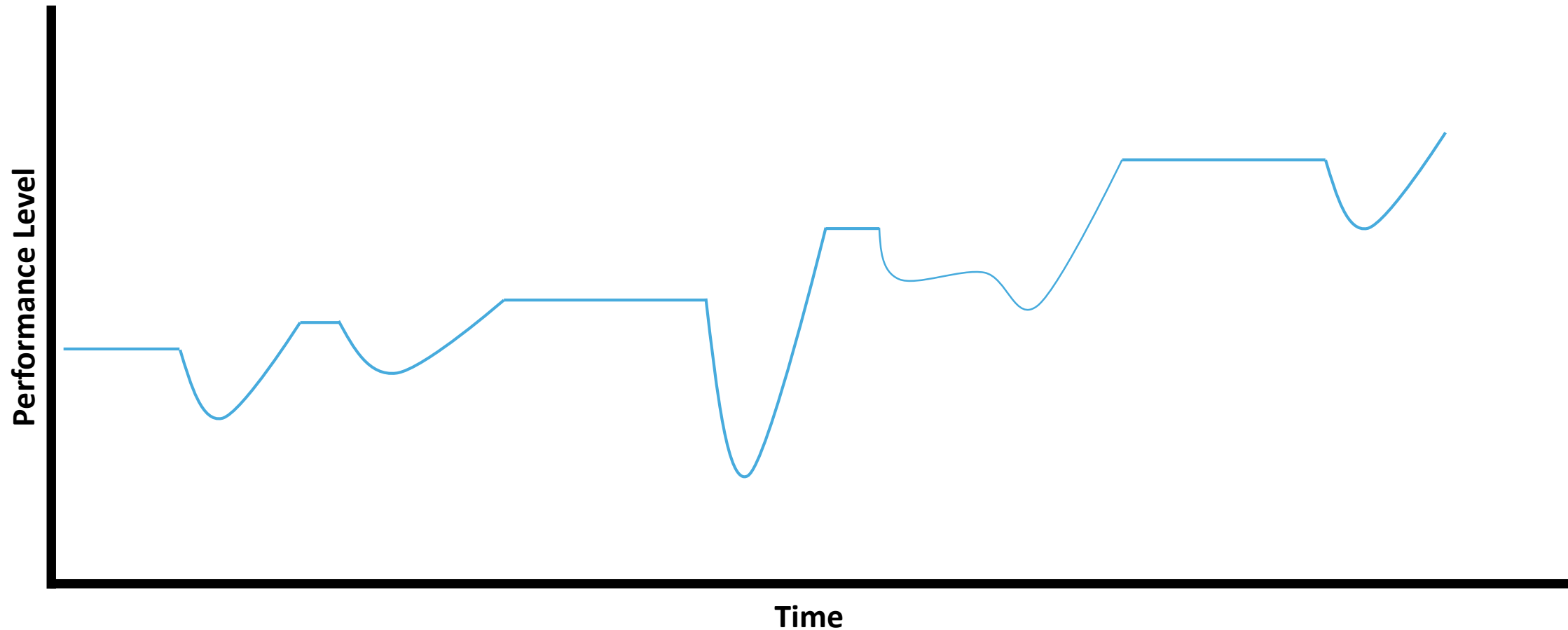
Simplistic View of Training Theory



The Reality of Training



The Unpredictable Nature of Adaptation



The Complex Physiology of Exercise Induced Stress

Spiering, B. A., Kraemer, W. J., Anderson, J. M., Armstrong, L. E., Nindl, B. C., Volek, J. S., & Maresh, C. M. (2008). Resistance exercise biology. *Sport Med*, 38(7), 527-540.

Non-
Modifiable
Factors

Modifiable
Factors

Systemic
Responses

Cellular
Signaling
Responses

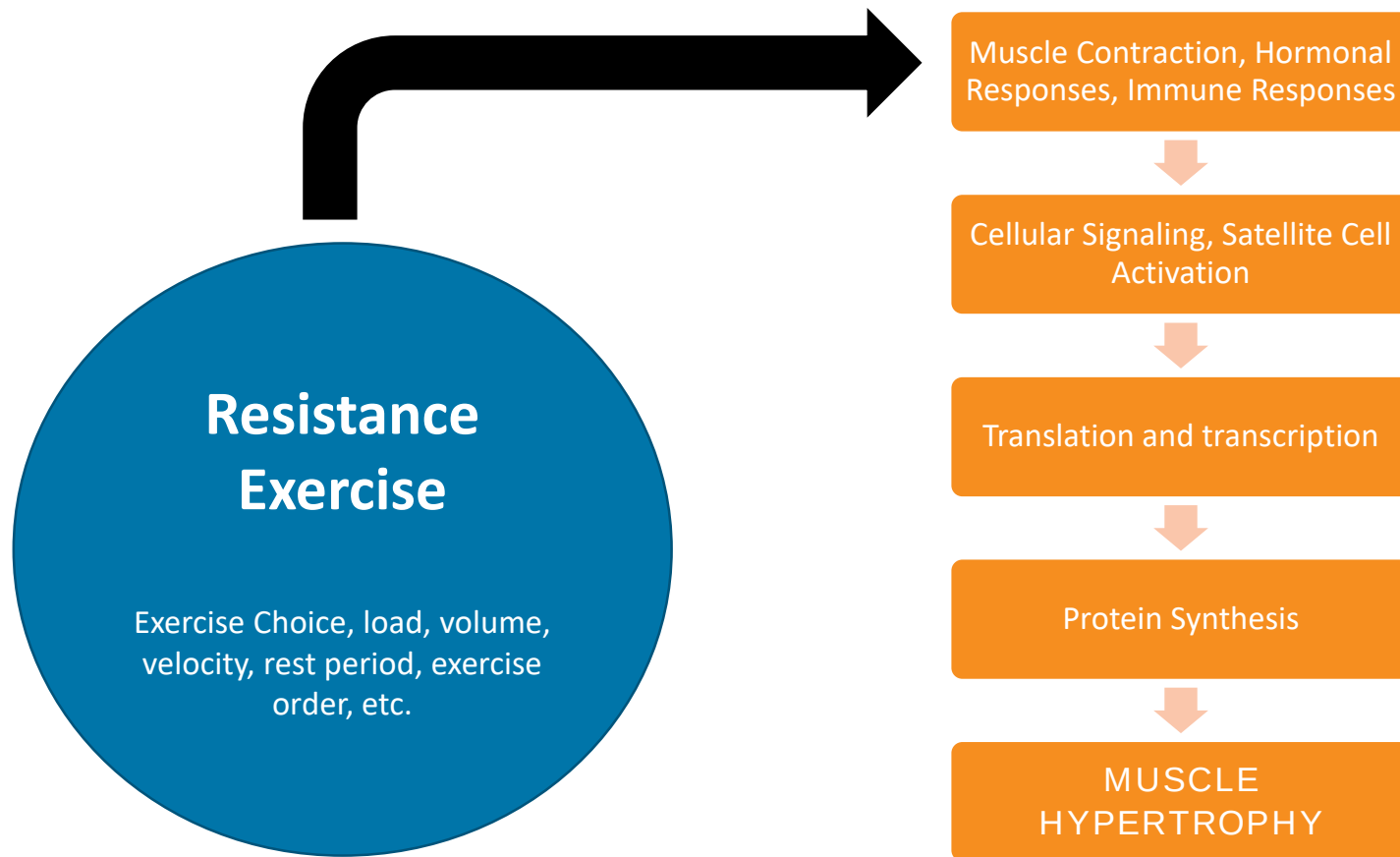
Genetic
Responses

Protein
Metabolism

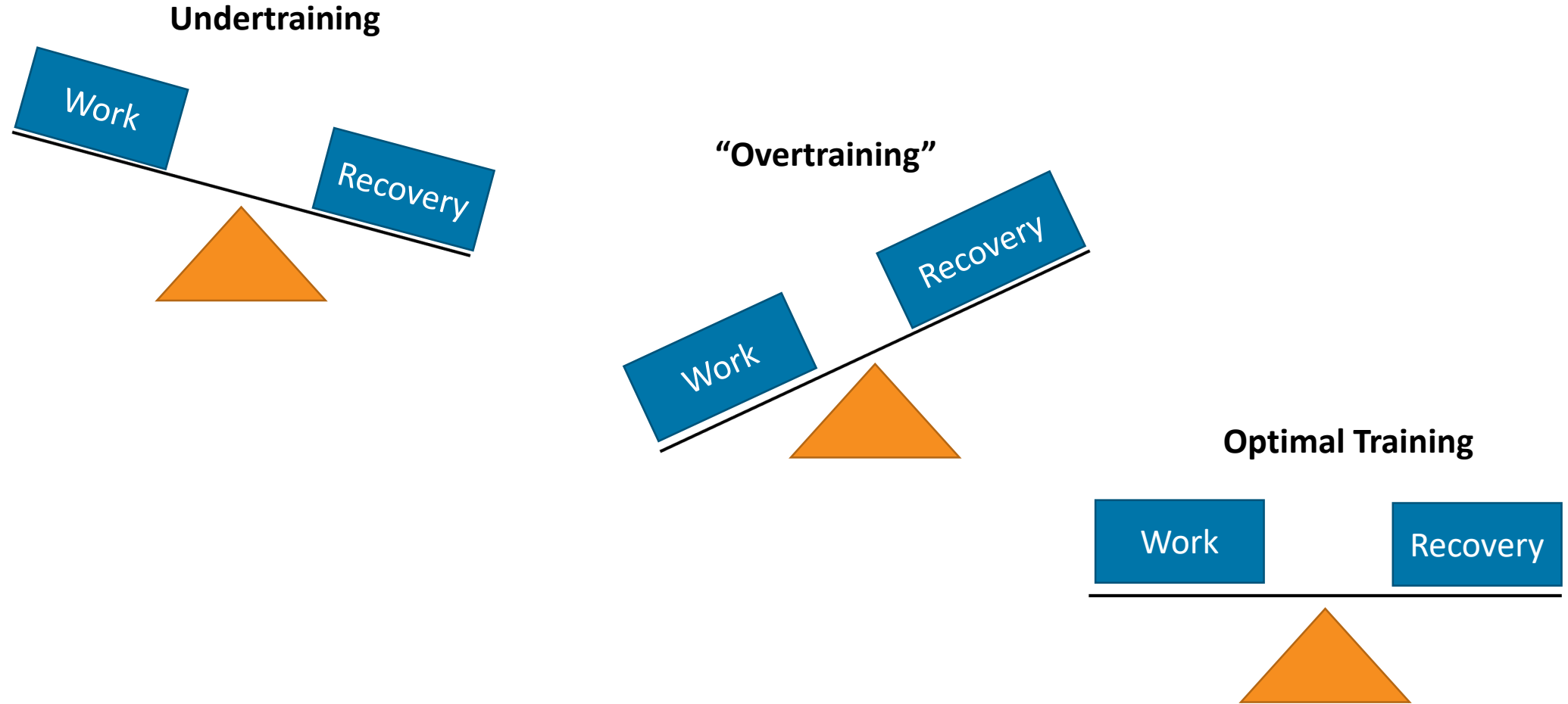
Functional
Adaptations

The Complex Physiology of Exercise Induced Stress

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The Challenge for the Strength & Conditioning Coach



Overtraining vs Overreaching

- Overtraining results from “mistakes” made in the application of training stress over many months and sometimes years of training.
 - True overtraining is catastrophic to an athlete and often career ending
- Overreaching is the result of too much training stress over a short period of time resulting in a temporary performance decline.
 - Non-functional Overreaching
 - Functional Overreaching

Overtraining vs Overreaching

Meeusen R, et al (2006). Prevention, diagnosis and treatment of the overtraining syndrome: ECSS Position Statement Task Force . *Eur J Sport Sci.* ;6(1):1-14.

Term	Definition	Time	Outcome
Functional Overreaching	Increased training load leading to temporary decrement after rest	Days to weeks	Positive (supercompensation)
Non-Functional Overreaching	Longer decrements after rest psychologic and neuroendocrine systems	Weeks to months	Negative due to loss of training
Overtraining Syndrome	Longer or permeant decrements, severe physiologic and psychologic distress and malfunction; unexplained signs and symptoms.	Months	Negative due to possible end of athlete's career

Signs of Overtraining Syndrome

Halson, S. L., & Jeukendrup, A. E. (2004). Does overtraining exist? *Sport Med*, 34(14), 967-981.

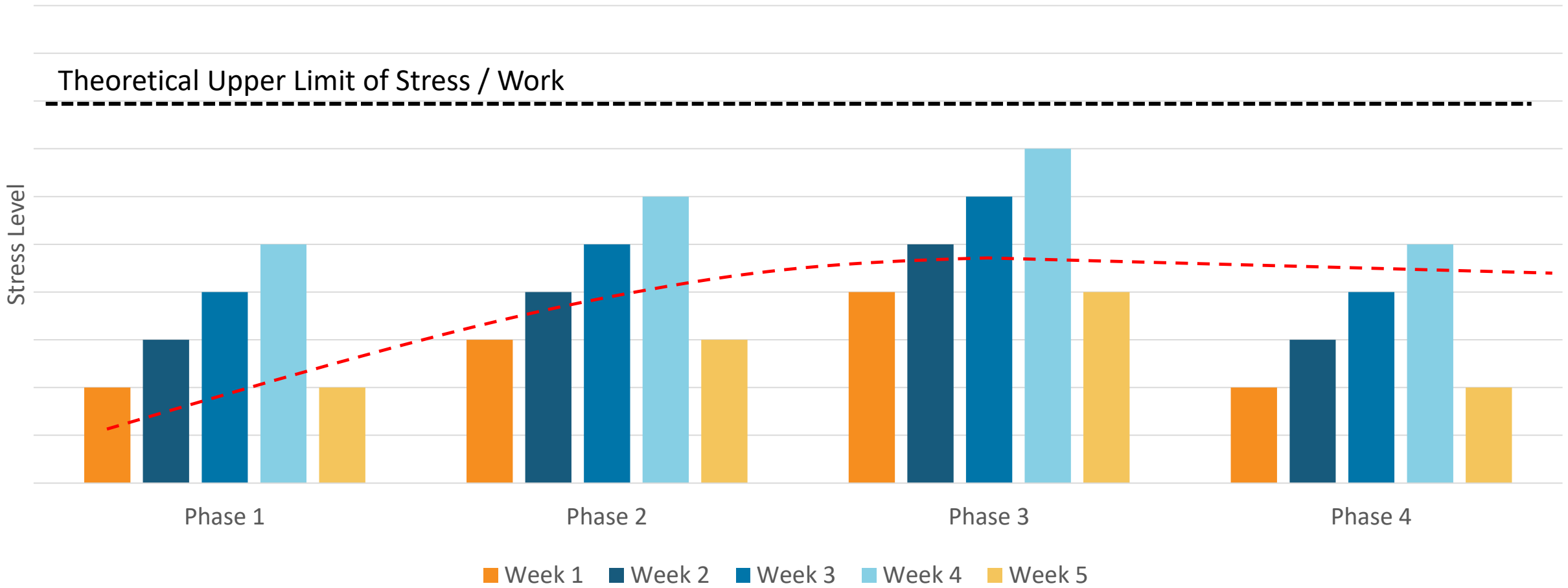
- Performance
- Mood-State
- Physiology
- Biochemistry
- Substrate Availability
- Immunological Function
- Hormones
- Autonomic Function
 - Catecholamine Levels
 - Heart-Rate Variability

How often does Overtraining Occur

- It is commonly cited that approximately 10-20% of Olympic athletes experience overtraining.
- Critical evaluation of evidence suggests that a high percentage of these cases are non-functional overreaching.
- Overtraining may occur in strength / power sports but more likely to occur in endurance or ultra endurance sports.
- Very few if any published data showing the incidence of overtraining in team or non-Olympic sports.

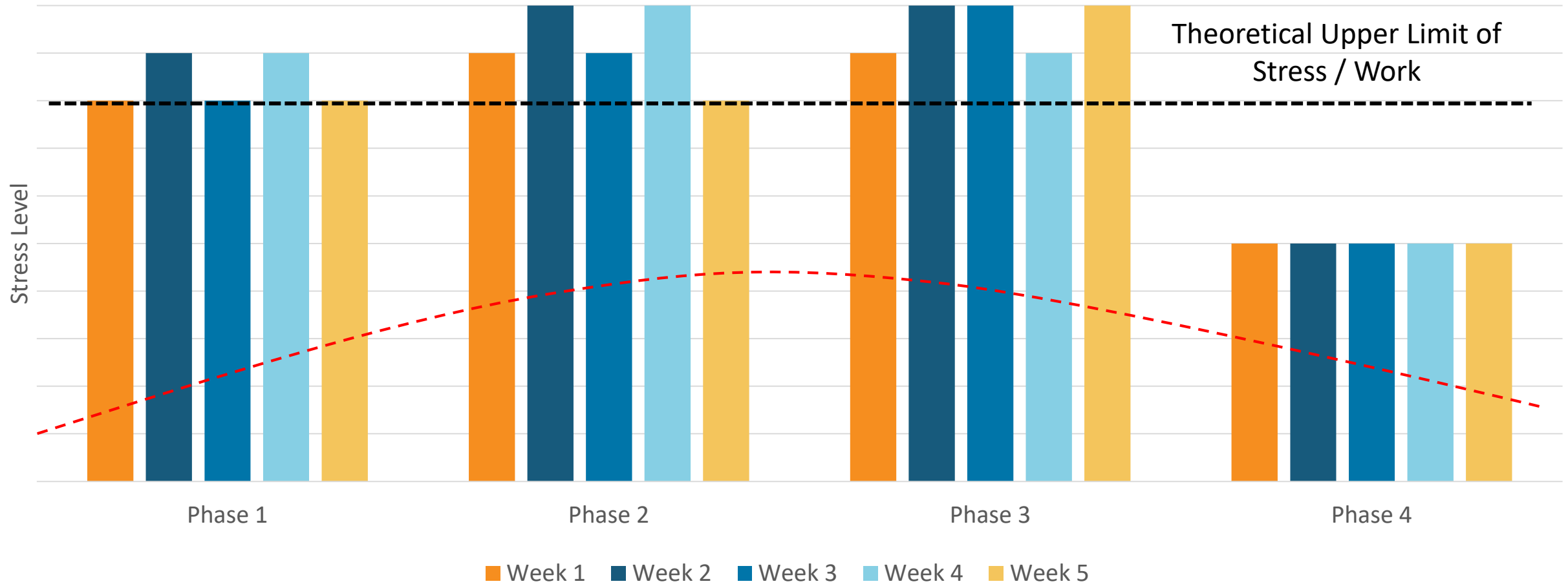
Training Paradigm

Undertraining (Too Little Stress)



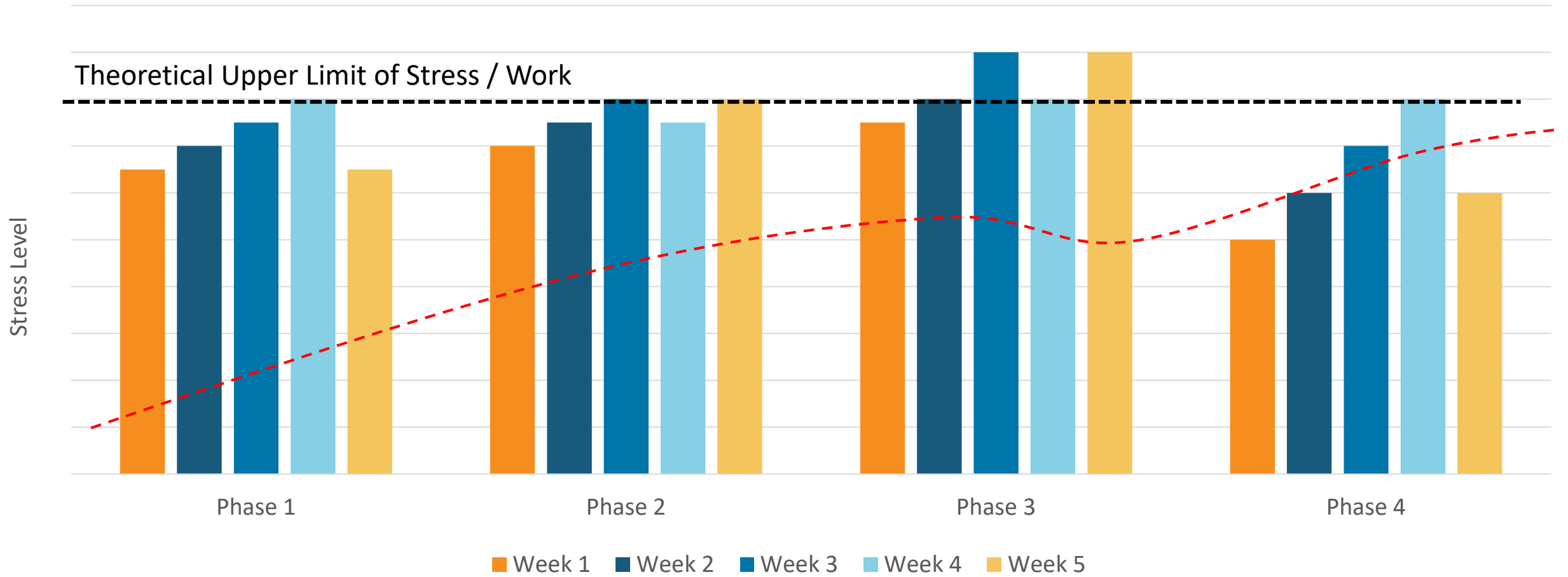
Training Paradigm

Non-Functional Overreaching (Too Much Stress)



Training Paradigm

Undertraining (Too Little Stress)



What do we measure to determine training induced stress?

****These should sound familiar*

- Physical
- Psychological
- Emotional
- Behavioral

Before you decide WHAT to measure...

- Create a system to store and easily access your data.
 - Microsoft Excel
 - Microsoft Access
 - Athlete data management systems
- Create realistic testing intervals that coincide with time needed to observe changes in variable.
- Consider the construct and face validity of testing.
- Educate the staff on the importance of testing.
- Educate your athletes – establish expectations and ensure everyone has “bought into” the idea of testing and its importance.
- Plan to periodically assess data collection strategies and when necessary, alter.

Measuring Physical Aspects of Stress

Training Load and Volume

- Prescribe loading for the core exercise based on some normalized value.
 - One-repetition maximum
 - Time
 - Velocity
- Record the actual load and volume completed for the core exercises.
- Track volume load (sets x reps x load) as your key metric of resistance training induced stress.
- Add session rating of perceived exertion as a perceptual metric of training stress (0-10 scale).

Measuring Physical Aspects of Stress

Session RPE

Numerical Rating	Qualitative Assessment
1	Nothing
2	Very Easy
3	Easy
4	Comfortable
5	Somewhat Difficult
6	Difficult
7	Hard
8	Very Hard
9	Extremely Hard
10	Maximal / Exhaustion

Measuring Physical Aspects of Stress

Physical Performance

- Game-specific performance – be careful with this one.
- Actual weight room performance vs. prescriptions vs. RPE.
- Standardized testing:
 - Choose a test or set of tests that are easily obtainable, have face validity, and great reliability.
 - Administer this test(s) in more regular intervals as a gauge of training induced stress.
 - Consider using as an autoregulatory variable or set of variables for intensity prescription.

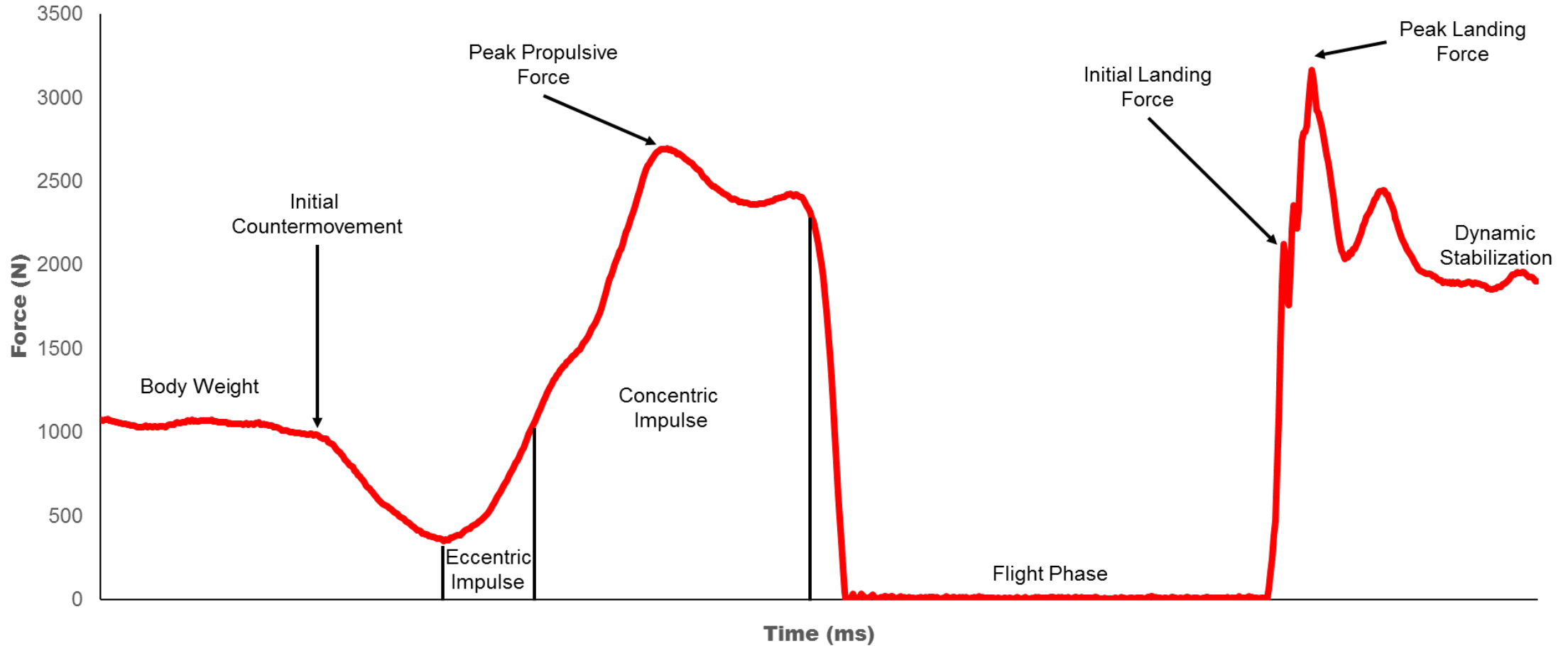
Measuring Physical Aspects of Stress

Claudino, J. G., et al. (2016). Autoregulating jump performance to induce functional overreaching. J Strength Cond Res, 30(8), 2242-2249.

- 18 national level, U17 futsal players.
- Preseason testing of 8 countermovement jumps using a contact mat.
- Randomly assigned to a regulated group and control group.
- Control group completed a prescribed training load.
 - 3-weeks standard periodization
 - 1-high intensity week (functional overreaching)
 - 2-weeks tapering
- Regulated group completed 4-weeks of periodized training with intensity regulated by weekly assessment of CMVJ. Load was increased when there was a detectable change in VJ.
- Regulated group experienced significant increase in VJ over time-period.

The future of autoregulation or perhaps the present

Countermovement Vertical Jump Test



Measuring Physical Aspects of Stress

Measuring Autonomic Function

- Resting heart rate is a good indicator of training induced stress.
 - Same time of the day
 - Same physical location
 - Same waking conditions
 - Same ...
- Heart rate variability is a better indicator of training induced stress.
 - Standardization is crucial and maybe harder than resting HR
 - Becoming easier with wearable devices
 - Question the usefulness of a single indicator provided by a device

Measuring Physical Aspects of Stress

Hormones and other biomarkers of stress

- Biomarkers of muscle damage
 - Myoglobin
 - Creatine Kinase
 - Aspartate Aminotransferase (AST)
 - Blood Lactate(?)
- Hormones
 - Testosterone
 - Cortisol (be careful)

Measuring Physical Aspects of Stress

Immunological Function

- Non-functional overreaching and overtraining results in immunosuppression.
- Result is increased susceptibility to illness, infection, and viruses.
- Some suggest an increase in “one-day colds.”
- Simple strategy to track immune function is to document illness.
 - Document in data management system
 - Observe illness in the context of volume load, RPE, performance, etc.

Measuring Psychological Aspects of Stress

Mood and Motivation

- Changes in mood and training / competitive motivation are two of the most sensitive measures of overtraining.
- May occur before any changes in biomarkers of overreaching or performance.
- Assessing mood and motivation are critical but how we assess may inaccurately influence our scores.
 - Length of the survey
 - Regularity of assessment intervals
 - Face validity of the survey
 - Etc.

Measuring Psychological Aspects of Stress

Mood and Motivation

- Profiles of Mood States (POMS) one of the most common assessment tools.
 - McNair et al. (1971) Manual for the Profile of Mood States. San Diego, CA: Educational and Industrial Testing Service.
 - 65 Question survey
 - Assesses anxiety, depression, anger, vigor, fatigue, and confusion
 - Uses 5-point scale
 - Questions are grouped by negative and positive subscales
 - Score is arrived at by subtracting the negative and positive sums

Not at all	A little	Moderately	Quite a lot	Extremely
0	1	2	3	4

- Several derivatives of the survey including a 35 and 40 item survey.

Measuring Psychological Aspects of Stress

A snapshot of POMS

	Not at all	A little	Moderately	Quite a lot	Extremely
Angry	0	1	2	3	4
Worn Out	0	1	2	3	4
Unhappy	0	1	2	3	4
Proud	0	1	2	3	4
Lively	0	1	2	3	4
Confused	0	1	2	3	4

Measuring Psychological Aspects of Stress

Kenttä, G., Hassmén, P., & Raglin, J. S. (2006). Mood state monitoring of training and recovery in elite kayakers. *Eur J Sport Sci*, 6(4), 245-253.

- Eleven Olympic development athletes were assessed for POMS and RPE during an intense, 3-week training cycle.
 - 6-7 day per week training
 - 38 total training sessions.
- Survey was implemented 19 times during the training period
- General association between rating of perceived exertion, changes in mood, and training volume / intensity.
- Particularly strong associations with measurements of fatigue, vigor, and depression.

Measuring Psychological Aspects of Stress

Mayer, J. D., & Gaschke, Y. N. (1988). The experience and meta-experience of mood. *J Person Soc Psych*, 55, 102-111.

Shearer, D. A., et. al. (2015). Measuring recovery in elite rugby players: the brief assessment of mood, endocrine changes, and power. *Res Quart Exerc Sport*, 86(4), 379-386.

- Alternative to POMS that could be distributed on a more regular basis
 - Brief Assessment of Mood
 - 6-item survey
 - 30s to complete

	Not at all	A little	Moderately	Quite a lot	Extremely
Tense	0	1	2	3	4
Depressed	0	1	2	3	4
Angry	0	1	2	3	4
Vigorous	0	1	2	3	4
Fatigued	0	1	2	3	4
Confused	0	1	2	3	4

Measuring Psychological Aspects of Stress

Sleep, Soreness, etc.

- Implement a generalized wellness survey in your athletes.
 - Sleep Quality
 - Perceived Stress
 - Soreness
 - Mood
 - Perceived Fatigue
- Many derivatives available, but general Likert scale may not work.
- Use one from the literature or develop your own that fits your teams needs.

Some General Thoughts on Survey Administration

- Administer baseline testing in a period with low physical and competitive stress.
- If you administer the survey too often may result in boredom, non-compliance, and generally poor data.
- Readminister long surveys during times of known training and competitive stress or during unloading phases when you expect a super-compensation effect.
- Readminister shorter surveys on a more regular basis.
- Ensure your athletes understand the importance of the survey – educate the team without influencing or guiding results.

Conclusions

- Stress is a normal part of the human and competitive experience.
- Stress is multifaceted but follows a predictable 3-stage pattern.
- Humans are incredibly resilient and capable of adapting to training and competitive stress.
- Overtraining is real, but in reality, probably doesn't occur often except in the most elite environments. Overreaching is much more common and can be functional if managed appropriately.
- Stress affects multiple physiologic functions that can adversely affect or enhance performance; Our assessment and monitoring of training induced stress must also be multifaceted.

Conclusions (cont.)

- To manage the complexities of tracking work and recovery the S&C Specialist needs a robust, but simple data management system.
 - Track training data
 - Track competitive data
 - Track sickness
 - Track performance and psychological data
- The purpose of monitoring stress, “load management,” is to facilitate MORE quality work.
 - Traditional periodized models at times may result in under or overtraining.
 - Autoregulation based on an amalgamation of data may be the future.
- Our goal should be to subject the athlete to as much training stress as possible without pushing them to the point of exhaustion. We need to find the upper limit of work and stress for each athlete to optimize their potential.



Questions?

CONFLICT OF INTEREST STATEMENT

I have no actual or potential conflict of interest in relation to this presentation.