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The Myth of the Myth? An Opinion

Michael H. Stone[1], Guy Hornsby[2], S. Alexander Long[3], Andrew Nelson[1], Nicholas Goode[1], Kurt McDowell[1], Satoshi Mizuguchi[1], Daniel Gahreman[1], Marco Duca[1], Kevin Carroll[1], Michael W. Ramsey[1], Margaret E. Stone[1], Kyle C. Pierce[4], Wes Gawel[1], Joe D'Amato[5], Andrew C. Fry[6], Amit Batra[7] and Gregory Haff[8]

[1]Center of Excellence for Sport Science and Coach Education, Department of Sport, Exercise, Recreation and Kinesiology. East Tennessee State University, Johnson City, TN, USA, [2]School of Sport Sciences, College of Applied Human Sciences, West Virginia University, Morgantown, WV, USA, [3]Department of Physical Therapy and Human Movement Sciences, Sacred Heart University, Fairfield, CT, USA, [4]Department. Kinesiology & Health Science, Louisiana State University in Shreveport, Shreveport, LA, USA, [5]Chicago White Sox, Applied Sport Science , USA, [6]Department of Health, Sport, and Exercise Sciences, University of Kansas, 1301 Sunnyside Ave, Lawrence, KS, USA, [7]Health Sciences and Physical Education, Kazimierz Wielki University, Chodkiewicza 30, Bydgoszcz, Poland, [8]Strength and Power Research Group, School of Medical and Health Sciences, Edith Cowan University, Joondalup, Western Australia, Australia

ABSTRACT

It has become quite popular to question accepted scientific evidence, particularly as it pertains to the validity of various aspects of sport science. Recently, the concept of periodization has been questioned as to its usefulness and even its existence being described as "Myth." It is the intent of the authors in this informed perspective to combat this idea through both a philosophical discussion on scientific theory as well as pointing out problems with their claim.

INTRODUCTION

It should be noted that in the recent book chapter by Steel et al. (2023), not only was the concept/ theory of periodization questioned, but many of the examples used concerned M.H. Stone and his colleagues. This paper has been written to address the questions and comments raised by Steele et al. 2023.

It has become quite popular to question accepted scientific evidence, particularly as it pertains to the validity of various aspects of sport science. Recently, the concept of periodization has been questioned as to its usefulness and even its existence (Kiely 2012; Mattocks et al. 2016; Steele et al. 2023). While these arguments have been rebutted (Cunanan et al. 2018; Hornsby et al. 2020; Stone et al. 2021), recently periodization "theory" has been described as a "Myth" (Steele et al. 2023).

There are different definitions for the term "Myth". Typically, myth is defined as:

"a usually traditional story of ostensibly historical events that serves to unfold part of the world view of a people or explain a practice, belief, or natural phenomenon"

It is also defined as:
"a person or thing having only an imaginary or unverifiable existence"
Merriam-Webster dictionary.

Using the second definition, it has been suggested that myths abound in the scientific world and that "periodization" is one of them (Steele et al. 2023). Interestingly, the authors (Steele et al. 2023) cite Karl Popper (1968). Popper (1902 – 1994) was an influential "Science Philosopher". Popper (Thornton 2023):

- Believed that most scientific theories began from myths, however, he also believed that the myth often contains important information (usually observational) that will eventually become a theory, thus it appears that Popper is using the first definition of a myth.
- Dismissed the idea that induction is the characteristic method of scientific investigation and inference, substituting falsifiability in its place. It is easy, he argues, to obtain evidence in favor of virtually any theory, and consequently Popper believed that such "corroboration", as he termed it, should count scientifically only if it is the positive result of a

genuinely "risky" prediction, which otherwise might conceivably have been false. In a critical sense, Popper's theory of demarcation is based upon his perception of asymmetry which, at the level of logic, holds between verification and falsification: it is logically impossible to verify a universal proposition by reference to experience, but a single but, genuine, counter-instance falsifies the corresponding universal law. Thus, an exception, far from "proving" a rule, conclusively refutes it. Genuine counter-instance falsifies the corresponding universal law. In a word, an exception, far from "proving" a rule, conclusively refutes it.

- Science, Popper suggests, begins with problems rather than with observations—it is, indeed, precisely in the context of struggling with a problem that scientists make observations in the first place. These observations are selectively designed to test the extent to which a given theory functions as a satisfactory solution to a given problem.

This brings up – what is a "theory"? (Dimaggio 1995):

In everyday use, "theory" usually is meant as an untested hunch, or a best guess without much supporting evidence. Among scientists, however, a theory has almost an opposite meaning. A theory is a well-substantiated explanation of some aspect of the world embodying scientifically derived laws, reasonable hypotheses and demonstrable facts. Indeed, a theory can be considered a logical, rational type of abstract thinking about an observable phenomenon, or the results of such thinking. A theory attempts to explain known facts; and allows scientists to make predictions of what they should observe if a theory is true. Scientific theories can be tested. New evidence (when gathered carefully and correctly) should be compatible with theory. If it isn't, the theory will be refined or even rejected. The longer the fundamental elements of a theory hold—the more observations it predicts, the more tests it passes, the more facts it explains—the stronger the theory.

In our opinion: As somewhat opposed to Popper's idea, the usual development of a theory, particularly in sport science, begins with observation, very often non-experimental in nature. From these initial observations, sport scientist (and sometimes coaches) ask questions about the observation and indeed develop these questions into problems that can be (eventually) solved. Thus, we agree with Popper that often theories develop from problems (but only after observing the world). After the problem has been identified, additional observations are made, often experimental observations; eventually a hypothesis (logical guess, i.e., abduction) is formed attempting to explain how the question is answered or problem solved. Hopefully, these events lead to additional observation and formal experimentation, not only by the originators of the question but also by other scientists. As more evidence is obtained from a variety of sources, eventually a theory is formed, usually by induction. One important aspect is that both hypotheses and theories evolve and are refined, indeed well-founded conceptual paradigms and theories are often not exactly as they were originally envisioned.

Another important aspect of theory evolution and development is, to what extent can a theory be supported by careful observation, experimentation and underlying mechanistic laws and theories. This question has also been the basis of much of the criticism of the theory of Periodization (Kiley 2013, Steele et al. 2023). Often, along the way, it is not unusual to find that not every observation or experiment supports the original thesis. For example, the Michaelson-Morley 1904-05 and Dayton Miller experiments of 1933 did not support Relativity, even today there are contradictory observations such as galaxies moving faster than they should and indeed, the theory predicts its own failure in space-time singularities such as inside a black hole (Banik and Zhao 2017). Never-the-less, based on the preponderance of evidence. Relativity is generally accepted as a valid theoretical paradigm.

It is quite apparent that the evolution of ideas forming the theory of Periodization have taken place over several millennia with a formalization occurring largely in the last 75 years of the 21st century (Stone et al. 2021). Critics express a number of questions such as:

- Why is there more than one definition of periodization. The essence of the question being – if it's a theory then everyone should provide and use the same definition and apparently that definition should be unchanging? (Steele et al. 2023). Is this criticism true?

One should note that in expressing and idea, a paradigm, a concept or a theory, scientists, particularly scientist that actually understand the idea, often use their own, but different, words to

express similar concepts, thus in the definitions offered, common themes should be apparent. For example, using the Theory of Evolution (Millstein 2022) (See Table 1a) it becomes apparent that scientists have used different wording with essentially the same conceptual meaning.

Historically (chronologically), it becomes apparent that the evolutionary theory developed and it was refined, modified and even expanded. The idea was then expressed in the authors' own words (Table 1a), but the basic meaning is quite clear, living things evolve over time (as do concepts and Theories).

The same development and refinement have also occurred with the definition of Periodization, even for the same author (Table 1b). Again, the definition has evolved, has been refined, modified and expanded. Regardless of the wording, the basic meaning is clear, periodization is a sport training management system that is phasic, as such reaching specific goals depends upon variable manipulation (variation) in a sequenced manner.

Apparently, periodization and programming are still being conflated in the literature (Hornsby et al. 2020, Cunanan et al. 2018, Stone et al. 2021, Kataoka et al.2021, Steele et al. 2023). However, the answer to questions and problems of this nature have been clearly delineated in a number of recent publications (Cunanan et al. 2018, Stone et al. 2021, Stone et al. 2022). Programming and periodization are not the same thing. While periodization deals with macromanagement over timelines and fitness phases, programming deals with micromanagement (i.e. exercise selection, sets, repetitions etc.).

Some of the misunderstanding concerning periodization versus programming may be due to their development, as Block Periodization (BP) was initially constructed in the 1970's and early 1980's (Stone et al. 2021). In part, BP grew as a result of the development of the modern competition calendar, in which important competitions occurred more often and much closer together. As a result, periodization phases which could be manipulated (shortened or lengthened) to fit the calendar, and level of athlete, became an essential ingredient in the training of athletes. Thus, the development of periodization blocks, Accumulation, Transmutation and Realization took place (Stone et al. 2021). It should be noted that these terms were not typically in use (or even known) in the western sport science literature until around 2007-2008 (Issurin 2008). Although, differently worded, often traditional terminology (general preparation, special preparation etc.) was (and is) being used. However, the basic concepts of block periodization, particularly in strength-power activities were being studied and refined in the west before the BP terminology was generally applied. This last point can be evidenced by comparing the remarks of Stone in 2004 (Haff et al. 2004) to those of Stone and colleagues at later dates for example,

Table 1a. Statements expressing definitions for the Theory of Evolution

1.	The control of development by ecology (van Valen 1973).
2.	Evolution may be defined as any net directional change or any cumulative change in the characteristics of organisms or populations over many generations—in other words, descent with modification… It explicitly includes the origin as well as the spread of alleles, variants, trait values, or character states (Endler 1986).
3.	Biological evolution is change in the properties of groups of organisms over the course of generations…it embraces everything from slight changes in the proportions of different forms of a gene within a population to the alterations that led from the earliest organism to dinosaurs, bees, oaks, and humans (Fuyutma 2005).

Table 1b. Statements expressing definitions for the Periodization

1.	The concept of periodization, originally proposed by Matveyev in 1961, embodies and manipulates these basic training principles (frequency, duration, intensity, variation, specificity) in a manner that reduces the potential for overtraining and brings performance to optimum or peak levels (Stone and O'Bryant 1987).
2.	A logical phasic method of manipulating training variables in order to increase the potential for achieving specific performance goals (Stone et al. 1999, Stone in Haff et al. 2004).
3.	Periodization is a logical sequential, phasic method of manipulating fitness and recovery phases to increase the potential for achieving specific performance goals while minimizing the potential for nonfunctional over-reaching, overtraining, and injury (Stone et al. 2021).

DeWeese et al. 2015a & b, Cunanan et al. 2021 and Stone et al. 2021.

From this conflation, it seems most of the examples cited to "reduce" the concept/theory of periodization to myth status, particularly BP, have been selections of early studies. A case in point is the selection (Steele et al. 2023) of the first published periodization paper by Stone and colleagues (Stone et al. 1981). The study was actually carried out at LSU in 1978. Unfortunately, Steele et al. (2023) appear to have chosen to leave out several reasons for the study being carried out as it was:

1. It was our first study using such a paradigm. As such we used different terminology than we would use a few years later or today.

2. While, even in 1981, we recognized the importance of variation and specificity, the prevailing idea at that time was, that 3 x 6 or 3 x 6 RM was the best way to enhance 1RM values as cited in the 1981 paper. And, training to failure (RM values) should produce even better results. Thus, a primary reason for comparison of a variation program to a 3 x 6 or 3 x 6 RM program. Clearly, in the methods it was indicated that heavier weights were used by the periodized (variation) group in the last two weeks of the study.

3. It should be noted that the study lasted a short-term (6 wks), a period similar to what is encountered by many athletes preparing for several important competitions in a short time frame.

4. Furthermore, we had noted by observation and in discussions with many coaches, that a short period of "getting in shape" using higher volumes of training, often potentiated the next phases of training. Furthermore, unload weeks (a period of somewhat lighter loads compared to the previous week) produced superior results as a result of better fatigue management. Indeed, we briefly discussed these ideas using traditional terminology (preparation, competition) in the paper.

5. Steele et al. (2023) also failed to note that we followed this study up with two studies in weightlifters and high-school football players (Stone et al. 1981). These studies also provided similar results even though the comparison was with somewhat different programming. The observation with the weightlifters was especially interesting to use as the comparison group handled heavier loads throughout most of the training study. Apparently, according to Steele et al. (2023), the comparison group should have produced better results as they handle the heaviest average loads. This did not happen.

6. Although we learned (substantially) from these very early studies (Stone et al. 1981), would we prescribe exactly the same program for athletes currently, or use the same terminology – of course not, as with other scientist (and coaches) working on a particular paradigm, our ideas have evolved.

Steele et al. (2023) also cite O'Bryant et al. (1988) indicating the same problems, however, again failing to provide the entire story. Indeed, considering their criticisms, many of the same comments above, could be made for this study as well. One glaring omission was that the "Periodized" group in which there was a distinct block periodization stage (accumulation, transmutation, realization) not only produced superior 1 RM values, but also increased high intensity exercise endurance (HIEE) using a cycle test to a greater extent then the 3 x 6 RM group. Using the rationale offered by Steele et al., this should not have happened as the comparison group was training with more repetitions, greater volume load and to failure just before the test. While some evidence suggests that training to failure can result in increased HIEE (Izquierdo et al. 2006), training to failure is obviously not needed to enhance HIEE. In terms of stress management, O'Bryant et al. make this observation:

"It is possible that continuous use of the same set and repetition routine for 3 x 6 RM) produced some type of a relatively monotonous training program. This "staleness" might be responsible for the differences in the final maximum power output as well as strength gains between the groups."

Indeed, more recently training to failure has been shown to produced excessive fatigue and increase recovery time (Moran-Navarro et al. 2017; Vieira et al. 2022), supporting the contentions of O'Bryant et al. (1988).

Perhaps Table 2, will help in understanding the evolution of block periodization as an idea, particularly for strength-power training. This table very briefly summarizes some of the studies that Stone and colleagues have completed over the last 40 years. Indeed, in developing the concept of

Table 2. Evolution and Summary of Periodization Studies

Study	Study Characteristics	Training Protocol	Reason	Outcomes and Realizations
1. Stone M.H. et al., 1981.	Untrained Males Duration = 6 weeks Design = Parallel	<table><tr><td></td><td>Wk 1</td><td>Wk 2</td><td>Wk 3</td><td>Wk 4</td><td>Wk 5</td><td>Wk 6</td></tr><tr><td></td><td colspan="3">5 x 10</td><td>5 x 5</td><td>3 x 3</td><td>3 x 2</td></tr><tr><td>Ctlr</td><td colspan="6">3 x 6 RM</td></tr></table>BP = Block Periodization, Ctrl = Control	Does block periodization work, and does it work better than other methods? Many sports have important competitions spaced only a few weeks apart – how to get ready between shortly spaced competitions. Observation – Weightlifters- comparison on actual competition performance.	The Periodized groups appeared to produce superior results. Note: inclusion of down sets – 1) we had noticed that decreases in volume resulted in loss of lean body mass (thus, an attempt to obviate this). 2) the lighter down sets were also an attempt to increase power and velocity of movement. Note: unload weeks were incorporated in the periodized group
	n = 31 trained high school football players Duration 12 weeks Design = Parallel	<table><tr><td></td><td>3 wks</td><td>4 wks</td><td>3 wks</td><td>2 wks</td></tr><tr><td>BP</td><td>5 x 10</td><td>3-5 x 5 ds (1 x 10)</td><td>3 x 3 ds (1-3 x 5)</td><td>3 x 2 ds (1-2 x 5)</td></tr><tr><td>Ctrl</td><td colspan="4">3 x 6 RM (only last set to failure)</td></tr></table>		
	n = 6 weightlifters Duration = 9 weeks Design = Observation	<table><tr><td></td><td rowspan="3">Competition</td><td>9 wks</td><td rowspan="3">Competition</td></tr><tr><td>BP</td><td>Periodized: Block like form</td></tr><tr><td>Ctrl</td><td>Norwegian System: 2-3 reps per set, heavy loading</td></tr></table>		
2. Stone, M.H. et al., 1982.	11 short-term studies Duration 6-15 weeks Design = Parallel	Studies completed in the same lab between 1977 and 1982. Comparison groups included: • 3 x 6 RM and various other set and repetition paradigms to failure • 2 – 3 repetitions per set • Pyramids	Does Block Periodization work. Does it work when compared to several different set and repetition schemes or to failure. Was there a difference between trained and untrained subjects? We decided to present a general overview of what we found to this point. Some of these studies were published separately and are covered later in this table.	Periodization appeared to produce superior strength and power: • Particularly apparent for lower body measures. • Trained, especially well-trained subjects (SE) often showed little or no gain in 1RM strength and no gain or a loss in VJ and estimated power. • Initial alterations in body composition, particularly in lesser trained subjects, was an important function of preparation (accumulation) as it appeared to potentiate further gains when training intensity was increased.
3. Stowers T. et al., 1983	n = 84 Untrained Males Duration = 7 weeks Design = Parallel	<table><tr><td></td><td>2 wks</td><td>3 wks</td><td>2 wks</td></tr><tr><td>BP</td><td>5 x 10</td><td>3 x 5</td><td>3 x 3</td></tr><tr><td>Ctrl</td><td colspan="3">3 x 10-12 RM</td></tr><tr><td>SS</td><td colspan="3">1 x 10 RM</td></tr></table>BP = Block Periodization, Ctrl = Training to Failure, SS = Single Set to Failure Total Work volume estimate: Ctrl > BP > Single Set	Training to failure was gaining in popularity, including 1 set to failure. This study was a comparison of periodization methods to methods of training to failure. Amount of work accomplished was generally believed to be a pivotal factor in the outcome of resistance training programs	Periodization protocol appeared to work better than training to failure. Note: Begin to realize that for strength-power gains, how work was manipulated was more important than the total work

Study	Study Characteristics	Training Protocol	Reason	Outcomes and Realizations
4. Stone, M.H. et al., 1983	n = 9 Minimally trained Males Duration = 8 weeks Design = Intervention	VO_{2max} Cycle Ergometer | 5 wks: SE 3 x 10 | VO_{2max} Cycle Ergometer | 3 wks: BS 3 x 5" | VO_{2max} Cycle Ergometer SE = Strength Endurance, BS = Basic Strength, "= additional ds (1x10)	Does an accumulation phase really accumulate? Are there residual effects?	Both the increases in VO_{2max} and cycle endurance realized after the SE block persisted through the stage although the volume was markedly decreased during the last summated microcyle (last 3 weeks). Interestingly, although aerobic power plateaued after the first summated microcycle (sets of 10), cycle endurance continued to improve although training volume decreased across the second summated microcycle (sets of 5), indicating a degree of disconnect between aerobic power and cycle endurance.
5. Scala, D. et al., 1987	n = 3 well-trained weightlifters, regional and national level Duration = 1 week Design = Observational	11 Sessions/Week SE = 3 x 10 Estimated the VO_2 and caloric expenditure during a week of SE training	Does an accumulation phase actually accumulate? Initiated a series of acute and chronic studies aimed at examining the effects of SE training.	Average caloric expenditure was 9.4Kcal · min^{-1} and 3918 Kcal x wk^{-1}. Large muscle mass exercises (i.e., squats, pulls, etc.) averaged 11.5 Kcal · min^{-1}. Small muscle mass exercises (i.e., bench press, sit-ups, etc.) averaged 6.8 Kcal · min^{-1}. Resting HR and RBP were largely unaffected. It appears that the volume and intensity of this type of training should be sufficient to elicit beneficial alterations in body composition, serum lipids and possibly cardiovascular function.
6. O'Bryant H.S. et al., 1988	n = 90 Untrained males duration = 11 weeks Design = Parallel	| | 4 wks | 3 wks | 4 wks | | BP | 5 x 10 | 3 x 5 | 3 x 3 | | Ctrl | 3 x 6 RM | BP = Block Periodization, Ctrl = Control Total volume of work: BP > Ctrl	3 x 6 RM was still generally considered the viable method of strength training: - Would strength training (relatively non-specific) transfer to cycle ergometry? - Amount of work accomplished was generally considered to be a pivotal factor in producing gains in High intensity exercise endurance (HIEE).	Periodized group produced superior gains in 1 RM squat and HIEE) cycle ergometry. Note: greater work and 1RM gains in BP may have contributed to HIEE outcome Note: the decreased performance in the failure group (3 x 6 RM) may have been due to lack of recovery. Failure may prolong recovery and reduce adaptation
7. McGee, D.S. et al., 1992	n: WL = 8 well-trained weightlifters, UF = 7 Untrained but Familiarized, SC = 6 Sedentary controls Design = Observational	Followed during and for 20 hrs post exercise session (WL and UF used same relative intensity, diet controlled.	Following Scala et al. 1987. How would WL respond differently to a standardized training session compared to minimally trained subjects. To describe adaptations among weightlifters, that enhance acute stress resistance and enhance recovery.	As with O'Bryant et al. 1988, resistance training clearly can enhance HIEE and does transfer to a relatively non-specific task (cycle ergometry). However, a degree of specificity was shown – squat training transfers to squat HIEE better than for cycle ergometry. Note: As expected larger volumes loads enhanced HIEE to a greater extent than a lower load. Note: Generally, gains in HIEE, cycle ergometry and squats to failure, were: GpH > GpP >> GpN

<table>
<tr><th>Study</th><th>Study Characteristics</th><th>Training Protocol</th><th>Reason</th><th>Outcomes and Realizations</th></tr>
<tr><td>8. McMillan, J. et al. 1993.</td><td>n: WL = 8 well-trained weightlifters, UF = 7 Untrained but Familiarized, SC = 6 Sedentary controls
Design = Observational</td><td>Followed during and for 20 hrs post exercise session (WL and UF used same relative intensity, diet controlled)</td><td>Following Scala et al. 1987. How would WL respond differently to a standardized training session compared to minimally trained subjects.

To describe adaptations among weightlifters, that enhance acute stress resistance and enhance recovery.</td><td>The WL showed a smaller metabolic/ homeostatic disturbance

WL recovered at a faster rate.

Data also indicated that resistance training may enhance the use of FFA during recovery.</td></tr>
<tr><td>9. Kramer J.B. et al., 1997</td><td>n = 53 recreationally trained
Duration = 14 weeks
Design = Parallel</td><td><table><tr><td></td><td>W1</td><td>W2-3</td><td>W4-5</td><td>W6</td><td>W7</td><td>W8-9</td><td>W10</td></tr><tr><td>BP#</td><td>1x10</td><td>3x5</td><td>3x3</td><td rowspan="3">Tests</td><td>1x10</td><td>3x5</td><td>3x3</td></tr><tr><td>SS</td><td colspan="3">1 x 8-12 RM
(1 x 10 WU 50% target)</td><td colspan="3">1 x 8-12 RM
(1 x 10 WU 50%)</td></tr><tr><td>Ctrl#</td><td colspan="3">3 x 10</td><td colspan="3">3 x 10</td></tr></table><table><tr><td></td><td>W11</td><td>W12</td><td>W13</td><td>W14</td><td>W15</td></tr><tr><td>BP#</td><td>1x10</td><td>3x5</td><td>3x3</td><td>3x2</td><td rowspan="3">Tests</td></tr><tr><td>SS</td><td colspan="4">1 x 8-12 RM
(1 x 10 WU 50% target)</td></tr><tr><td>Ctrl#</td><td colspan="4">3 x 10</td></tr></table>BP = Block Periodization, SS = Single Set to Failure, Ctrl = Control # Included Heavy and Light Days (10% less)

Volume Load: Ctrl >> BP > SS
Relative Intensity: BP > SS > Ctrl</td><td>Follow-up on the Stowers et al. 1983 and McGee et al. 1992.

Does the volume and intensity of work make a difference. How does variation impact differences in outcome.

Observe the effects of periodic "overreaching" (return to SE)</td><td>Variation is important for strength gains (1 RM, absolute and scaled by body mass and lean body mass).

BP > Ctrl >> SS

Results of this study also indicated that during the initial phase of training (weeks 1-5) volume may be more important than intensity for enhancing the 1 RM squat. However, after the initial phase, variation and intensity factors become more important than volume</td></tr>
<tr><td>10. Pierce, K. et al., 1993.</td><td>n = 21 Untrained but Familiarized
Duration = 8 weeks
Design = parallel</td><td><table><tr><td></td><td>3 wks</td><td>3 wks</td><td>2 wks</td></tr><tr><td>BP</td><td>3 x 10 RM</td><td>3 x 5 RM</td><td>3 x 10 RM</td></tr><tr><td>Ctrl</td><td colspan="3">Sedentary Control</td></tr></table>BP = Block Periodization, Ctrl = Control</td><td>Extension of Scala et al. 1987 and McMillan et al. 1993. Would previous untrained subjects adapt to an extended Accumulation Block of resistance training such that post exercise measures of stress (objective and subjective) are reduced and recovery is enhanced.</td><td>Results indicated that resistance training substantially reduces both objectively measured and subjective evaluations of exercise induced stress. Also, recovery was markedly enhanced.</td></tr>
<tr><td>11. Sanborn K., 2000.</td><td>n = 17 untrained
Duration = 8 weeks
Design = parallel</td><td><table><tr><td></td><td>W1</td><td>W2-4</td><td>W5</td><td>W6</td><td>W7</td><td>W8</td></tr><tr><td>BP</td><td>3 x 10</td><td>3 x 5</td><td>5 x 5
OR</td><td>3 x 5</td><td>3 x 5</td><td>3 x 2</td></tr><tr><td>SS</td><td colspan="6">1 x 8-12 RM</td></tr></table>BP = Block Periodization, SS = Single Set to Failure, OR = Planned Over-Reach</td><td>In the coaching literature 1 set to failure was still being touted as superior.

Note: the use of a planned overreaching phase at week 6 was based on previous observation in athletes and the study by Kramer et al. 1997.</td><td></td></tr>
</table>

Study	Study Characteristics	Training Protocol	Reason	Outcomes and Realizations
12. Stone, M.H. et al., 2000	n = 21 Untrained Duration = 12 weeks Design = parallel	<table><tr><td></td><td>W1,2</td><td>W3,4</td><td>W5</td><td>W6-8</td><td>W9</td><td>W10</td><td>W11</td><td>W12</td></tr><tr><td>Ctrl</td><td colspan="8">Major Exercises: 5 x 6 RM (last set to failure) Assistance Exercises: 3 x 8 RM</td></tr><tr><td>BP step</td><td colspan="2">Major: 5 x 10 Assist.: 3 x 10</td><td colspan="2">5 x 5 3 x 8</td><td colspan="3">3 x 3” 3 x 8</td><td>3 x 3 3 x 6</td></tr><tr><td>BP OR</td><td>5x10 3x10</td><td>3x5” 3x10</td><td>3x3’ 3x10</td><td>3x5’ 3x5</td><td>5x5’ 3x5 OR</td><td>3x5’ 3x5</td><td>3x3’ 3x5</td><td>3x3* 3x5</td></tr></table>Ctrl = Control, BP = Block Periodization, ” = additional ds (1x10); ‘= additional ds (1x10); * clustered 1+1+1, 30 s rest Volume Load Ctrl > > BPstep > BPOR	How would different BP designs work? Comparison of two variation groups versus linear loading. Comparison of “overreaching” to non-over-reaching. Comparison of different volumes of work. Would a large volume of work produce the same or better effects compared to smaller volumes with more variation?	1RM squat gains statistically showed BPOR = BPstep > Ctrl Calculated Effect Sizes (ES) indicated that based on absolute and scaled 1 RM squat values Ctrl > BPstep >> BPOR Again, data indicates that how volume is manipulated may be more important than total work. Results suggest that planned overreaching may be a valuable variation based on ES.
13. Harris et al., 2000.	n = 51 D-I Football Players Duration = 9 Weeks Design = parallel	<table><tr><td></td><td>4wks</td><td rowspan="4">PRE TESTS</td><td>5 wks</td><td rowspan="4">MID (1RM)</td><td>4 wks</td><td rowspan="4">POST TESTS</td></tr><tr><td>Strength</td><td rowspan="3">Strength Endur-ance sets of 10</td><td>5 x 5 #</td><td>5 x 5 #</td></tr><tr><td>Power</td><td>5 x 5 (25-35% 1RM)</td><td>5 x 5 (25-35% 1RM)</td></tr><tr><td>Com-bined</td><td>5 x 5 #</td><td>Power Emphasis</td></tr></table>	Note: study was carried out using well-trained American football players. With the goal of power development, support for sequencing was investigated.	Tests of strength and power related variables demon-strated a relatively high degree of training specificity for Strength and Power groups. However, the Com-bined group produced results equal or superior to the other two groups. Results indicate that completing a stage (complete sequence) offers superior results to only emphasizing strength or only emphasizing power.
14. Painter K.B. et al., 2012.	n = 26 D-I Track and Field Athletes Duration = 11 weeks Design = parallel	<table><tr><td></td><td>W0</td><td>W1-3</td><td>W4</td><td>W5,6</td><td>W7</td><td>W8</td><td>W9</td><td>W10</td></tr><tr><td>BP#</td><td></td><td>3x10</td><td>3x5’</td><td>3x3’</td><td>3x2’</td><td>5x5 OR</td><td>3x3’</td><td>1x3’</td></tr><tr><td>DUP</td><td></td><td colspan="7">Monday: Strength Endurance 3 x 8-12 RM Wednesday: Strength 3 x 5-7 RM Friday: Power 3 x 3-5 RM</td></tr><tr><td></td><td>Test</td><td></td><td>Test</td><td></td><td></td><td>Test</td><td></td><td>Test</td></tr></table>BP = Block Periodization, DUP = Daily Undulating Periodization, # = Included Heavy and Light Days (10% less), ‘ = ds (1 x 5), OR = Planned Over-Reach Exercises were equated Volume Load DUP >> BP	Compare Daily-Undulating Periodization (DUP – substantial daily variation) vs. BP method of strength-power training (variation by fitness block).	No statistical differences were noted between groups (e.g. 1 RM squat and bench press, isometric peak force or isometric RFD). However, calculation of ES and % gain indicated that the BP produce a some-what greater effect. When analyzed by gain per kg of VL. The BP group produced substantially greater gains. The data also indicated that most gains occurred from T1 to T3 for DUP then leveled out and decreased. Most of the gains for BP occurred from T2- T4. A follow-up from the same study (Painter et al. 2018), indicated that training strain and monotony were reduced in the block group and that hormonal altera-tions tended to favor the block group

<table>
<tr><th>Study</th><th>Study Characteristics</th><th>Training Protocol</th><th>Reason</th><th>Outcomes and Realizations</th></tr>
<tr>
<td>15. Hornsby W.G., et al., 2013.</td>
<td>n = 9 D-I Track and Field Throwers
Duration = 11 weeks
Design = observational</td>
<td>
<table>
<tr><td>W1</td><td>W2,3</td><td>W4</td><td>W5</td><td>W6,7</td><td>W8</td><td>W9</td><td>W10</td><td>W11</td></tr>
<tr><td>3x10</td><td>3x5~</td><td>5x5 OR</td><td>3x5'</td><td>3x3'</td><td>3x10</td><td>3x5'</td><td>3x3'</td><td>3x2'</td></tr>
<tr><td>Test</td><td></td><td></td><td></td><td>Test</td><td></td><td></td><td></td><td>Test</td></tr>
</table>
~ = ds (3x10), ' = ds (1 x 5), OR = Planned Over-Reach

Included Heavy and Light Days (10% less)
Assistance exercises were 3 x 10 for first block and dropped to 3 x 5 during periods of major exercises at ≤ 5 repetitions.
</td>
<td>Will block periodization work with athletes in training? Will training enhance potentiation effects?
Observation of Athletes with integrated throwing and additional conditioning factors.

Test: both isometric pulls and dynamic pulls from mid-thigh. Dynamic pulls were also used to investigate potentiation effects.</td>
<td>Eleven weeks of training produced marked alterations in isometric and dynamic force capabilities (particularly scaled).

Dynamically, potentiation was noted (based on ES), however, at best, training had a trivial effect for increasing potentiation capabilities.</td>
</tr>
<tr>
<td>16. Hornsby G. et al., 2017.</td>
<td>n = 7 weightlifters (6 national level
Design = intervention</td>
<td>
<table>
<tr><td>W0,1</td><td>W2-6</td><td>W7</td><td>W8</td><td>W9,10</td><td>W11</td><td>W12,13</td></tr>
<tr><td>3x3 AR</td><td>3x10 (2/day)</td><td>3x5' (2/day)</td><td>5x5' OR (2/day)</td><td>3x3' (2/day)</td><td>3x2' (1/day)</td><td>3x3' (1/ day) AR</td></tr>
<tr><td>Test</td><td></td><td>Test</td><td></td><td>Test</td><td></td><td>Test</td></tr>
<tr><td>Meet</td><td></td><td>Meet</td><td></td><td></td><td>Meet</td><td></td></tr>
</table>
<table>
<tr><td>W14</td><td>W15,16</td><td>W17</td><td>W18</td><td>W19</td><td>W20</td></tr>
<tr><td>5x5' OR</td><td>3x3'</td><td>3x2'</td><td>5x5'</td><td>3x3'</td><td>3x3'</td></tr>
<tr><td></td><td></td><td>Test</td><td></td><td></td><td>Test</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>Meet</td></tr>
</table>
AR = Active Recovery, ' = ds (1 x 5), OR = Planned Over-Reach
Included Heavy and Light Days (10% less)
</td>
<td>Will the model used create performance peaks when a peak should take place.

Investigation of multiple cycles (Stages).</td>
<td>Performance peaks did occur for isometric peak force, isometric RFD, vertical jump, and weightlifting performance when the programming indicated this should happen.

Additionally, weighted jumps were more sensitive to VL alterations then were unweighted jumps.</td>
</tr>
<tr>
<td>17. Carroll K.M. et al., 2018</td>
<td>n = 15 well trained males
Duration = 11 weeks
Design = parallel</td>
<td>
<table>
<tr><td></td><td>W1-3</td><td>W4-7</td><td>W8</td><td>W9</td><td>W10</td></tr>
<tr><td>BP RM</td><td>3x8-12RM</td><td>3x4-6RM</td><td>5x4-6M OR</td><td>3x2-4RM</td><td>3x1-3RM</td></tr>
<tr><td>BP RI_{SR}</td><td>3x10</td><td>3x5</td><td>5x5 OR</td><td>3x3</td><td>3x2</td></tr>
</table>
P = Block Periodization, OR = Planned Over-Reach, RM = Repetition Maximum Training, RI_{SR} = Relative Intensity for Sets and Reps

Training Strain: BP RM >> BP RI_{SR}
Monotony: BP RM >> BP RI_{SR}
</td>
<td>Direct comparison (same basic set and repetition scheme) of training to failure versus no failure.

Investigation of taper effects.</td>
<td>Compared to BP RM, BP RISR group showed somewhat greater improvements in isometric PF and RFD, and markedly greater gains in vertical jump variables.

Response to tapering was markedly superior in the RISR group. Note: this occurred even though the RM group used ballistic movements during the taper and was provided 72 hr. recovery between the last workout and the post tests.

A follow-up from the same study (Carroll et al. 2029) indicated that the RISR group realized greater gains in muscle thickness and CSA (ultrasound). Biopsy results suggested that the RISR group realized greater CSA gains in both type I and type II fibers and that the gain in the type the gain in the II:I CSA was greater in the RISR group.</td>
</tr>
</table>

<table>
<tr><th>Study</th><th>Study Characteristics</th><th>Training Protocol</th><th>Reason</th><th>Outcomes and Realizations</th></tr>
<tr><td>18. Suarez D.G. et al., 2019.</td><td>n = 9 well-trained weight-lifters
Duration =
Design = observational</td><td>Athletes were well-trained Collegiate weightlifters (n= 5 males; 4 females) at or above the National University Championship level.
<table><tr><td>W1-3</td><td>W4</td><td>W5,6</td><td>W7</td><td rowspan="3">Gap</td><td>W1</td><td>W2,3</td><td>W4</td></tr><tr><td>3x10</td><td>3x5’</td><td>3x3’</td><td>3x2’</td><td>5x5 OR</td><td>3x3’</td><td>3x2’</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td>Meet</td></tr></table>‘ = ds (1 x 5), OR = Planned Over-Reach
Included Heavy and Light Days (10% less), Training 2/day</td><td>Description of alterations in performance related variables across an entire stage in well-trained strength-power athletes.

Previous research indicated that RFD is quite important in weightlifting. Thus, RFD enhancement across a stage of training should be beneficial. Furthermore, RFD seemed to follow alterations complementary to the alterations in volume load – did this take place.</td><td>RFD alterations did follow the predicted alterations associated with VL alterations in strength-power athletes. PF, as expected, remined relatively constant throughout.

CSA and muscle thickness increased across the stage reaching their largest increase at the end of the SE block. Both CSA and MT decreased from the end of the SE block, but remined larger than initial values. Interestingly, PA increased through the accumulation periodization block (SE + SP) then deceased to below initial values. FL length increased steadily throughout the stage. Although these were non-statistically significant, percent changes and ES suggest moderate effects took place. Taken together this data suggests that this type of training with substantial alterations in volume and intensity across a stage may be producing a faster muscle.</td></tr>
<tr><td>19. Hornsby W.G. et al., 2020</td><td>n = 9 D-I Track and Field Throwers
Duration = 11 weeks
Design = intervention</td><td><table><tr><td>W1</td><td>W2,3</td><td>W4</td><td>W5</td><td>W6,7</td><td>W8</td><td>W9</td><td>W10</td><td>W11</td></tr><tr><td>3x10</td><td>3x5~</td><td>5x5 OR</td><td>3x5’</td><td>3x3’</td><td>3x10</td><td>3x5’</td><td>3x3’</td><td>3x2’</td></tr><tr><td>Test</td><td></td><td></td><td></td><td>Test</td><td></td><td></td><td></td><td>Test</td></tr></table>~ = ds (3x10), ‘ = ds (1 x 5), OR = Planned Over-Reach
Included Heavy and Light Days (10% less), Assistance exercises were 3 x 10 for first block and dropped to 3 x 5 during periods of major exercises at ≤ 5 repetitions.</td><td>Is Block Periodization compatible with athletes in training? How does the variation in volume and intensity effect markers of inflammation and stress?</td><td>As predicted: the T:C increased as volume load decreased, and adiponectin increased pre-post in concert with decreases in C and increases in the T:C. This suggest a lesser degree of inflammation and a higher degree of “fitness” and preparedness.</td></tr>
<tr><td>20. Wetmore A.B. et al., 2020.</td><td>n = 15 trained subjects
Duration = 11 weeks
Design = parallel</td><td><table><tr><td></td><td>W1-3</td><td>W4-7</td><td>W8</td><td>W9</td><td>W10</td><td>W11</td></tr><tr><td>S</td><td rowspan="3">3x10</td><td rowspan="3">3x5’</td><td rowspan="3">5x5 OR</td><td rowspan="3">3x3’</td><td rowspan="3">3x2’</td><td rowspan="3">3x2</td></tr><tr><td>M</td></tr><tr><td>W</td></tr></table>S = Strong (squat: body mass = 1.96 ± 0.16), M = Moderate (squat: body mass = 1.46 ± 0.14), W = Weak (squat: body mass = 1.17 ± 0.07), ‘ = ds (1 x 5), OR = Planned Over-Reach
Included Heavy and Light Days (10% less),</td><td>Do different levels of strength respond differently to BP.

Some evidence indicated that stronger subjects/athletes have a greater response to transmutation and realization phases

A basic tent of BP is that the accumulation block (SE + BS) should “prepare” the athletes for greater gains than typical during transmutation and realization. -does this happen?</td><td>All subjects improved 1 RM and jumps heights over 11 weeks.

1 RM improvements and jump over 11 weeks:

W > M > S

While all groups improved from block to block – the strong group showed its greatest alterations after the SE block and particularly during the taper. With jump and relative 1RM performances showing a greater % gain during the taper compared to the other two groups.

In a follow-up using the same study groups (Moquin P. et al. 2021) It was shown that lean body mass shows the greatest improvements during the accumulation phase (SE + BS).</td></tr>
</table>

block periodization, comparison efforts were made using a variety of paradigms including, heavier loading/lower repetitions, non-variable repetitions, variable loading and repetitions, sets to failure etc. Importantly several of the basic comparison paradigms were repeated with essentially the same result. In support, it is again, worth noting that in numerous reviews of the literature as cited by Stone et al. (2021) the concept of periodization, including block periodization have consistently been shown to have advantages as a training methodology.

It is worth noting that Steele et al. (2023) largely discuss periodization in regard to periodization for strength development. More specifically, these authors primarily discuss (and challenge) block periodization, a specific periodization strategy, and resultant strength development. While, we contest their views on both fronts (strength adaptation and the strategy of block periodization) we believe it is important to note that periodization of training goes far beyond those 2 aspects. For example:

1. Periodization of training was originally and is still mostly focused on training, adaptation and performance within the context of performance in sport competition. This is important to note in that training for strength related adaptations, while often an important aspect, (particularly for anaerobic based sport) is typically far from the only aspect. Indeed, a central aspect of periodization within an athlete's strength and conditioning plan is in an effort to integrate all of the various factors of an athletes technical, tactical and other performance related training (e.g. practice). Considering an integrative approach, efficiency is an important factor. For example, the idea that if two training plans produced the same strength benefit, if one plan required substantially less training volume, that would be the superior training plan (Painter et al. 2012). Simply put, Periodization, in practice, includes all aspects of training, not just the weight room. Indeed, this is a primary reason that, in our studies, we have, as often as possible, engaged athletes in training or introduced additional training to mimic sports as much as possible e.g. Painter et al. (2012); Carroll et al. (2019).

2. Related to #1, again, while we believe periodization for strength power adaptation produces superior results it is important to appreciate the idea that simply enhancing a strength related adaption(s) is not the only goal of a coach and not the only goal of periodization. Indeed, directing specific adaptations at specific times and navigating an athlete's preparedness and sport specific performance is central to periodizing the training process. For example, an athlete could undergo a training plan that produces substantial gains in strength, but if this training was performed during the competition phase and the athlete performed poorly in his / her sport, particularly in critical competitions, no coach would consider this scenario a success. Indeed, both research and actual competition data has supported the idea of peaking. From this supporting data, not only do athletes tend to peak at the most important competitions but that the athletes that experience superior peaks are more likely to perform well and medal (Hellard et al. 2019; Mujika 2010; Stone et al. 2021).

   Additional support for the idea of managing competition can be found in a recent paper by Matomäki P. and Räntilä (2022). While this study only includes competition data, we can reasonably assume that hundreds of professional athletes (and amateur) don't simply perform better at the most important competition(s) because they are not interested in performing well at the less important competitions. The lesser competitions, still often, provide considerable financial incentive to perform well, are often very public with large crowds, often televised, and along with competitive drive and pride typical of athletes provide substantial incentive to perform well. While, the observations (Matomäki and Räntilä, 2022) may not have involved measures of underpinning physiology (which would have been impossible with such a sample), many case studies on high level athletes in measured sports have demonstrated alterations in underlying physiology and resultant performance changes, indicating that periodized training models lead to enhanced performance (Stone et al. 2021; Szymanek-Pilarczyk 2023) and is commonly used in elite sport situations when the stakes are the highest, i.e. major competitions.

3. It is surprising that there is no mention of periodization for endurance performance. Some of the most scientifically oriented coaches can be found in the world of endurance sport, likely due to the nature of the well-studied connection between physiology and performance. Indeed, the strategy of employing periodization is commonplace within the endurance sport world and has a strong evidence base (Mølmen et

al. 2019; Rønnestad and Hansen 2018; Mujika 2019), and while not the only reason, we believe a case can be made for the continued record breaking in various endurance sports and events to be due to in some part because of such a detailed approach to highly individualized, highly monitored, and highly scientific approaches to periodization, particularly block periodization. For a basic example, it is commonplace, both during an athlete's early(ier) development and beginning of macrocycles to build their athletes aerobic (oxidative) base through longer distance, lower intensity (e.g. heart rate = zone 2) exercise, performing greater overall training volume to, #1 develop the athletes VO2 max and to, 2) build a physiological foundation to support the subsequent higher intensity training to follow. Thereafter, pyramidal and polarized training are often used leading up to a peaking phase (Galen-Roja et al. 2023; Mølmen et al. 2019).

This is indeed a common periodization strategy used by endurance coaches embedded in sports such as rowing, track, swimming, cycling, cross country skiing throughout the world (Mølmen et al. 2019; Stone et al. 2021). Endurance athletes performing primarily high intensity / threshold (and above threshold) training at the beginning of a macrocycle and then switching to primarily slow zone 2 aerobic work for several months leading into a competition would likely lead to meaningfully different (worse) competition results; as would simply performing a chronically employed mix of both styles of training due to fatigue management issues and the conflicting nature of the 2 strategies and adaptations.

4. Monitoring Feedback: an often-overlooked (or taken for granted) aspect of good planning and management for sport performance is *Athlete Monitoring* (Hornsby and Wagle 2022). Monitoring can take two forms: *Fatigue Management* (FM) and *Program Efficacy* (PE). Fatigue can be described as an inability to maintain a given force or power output, which can be acute (exercise related) or chronic (training related). Sports training is simply not possible without some level of fatigue. Fatigue Management deals with measuring/ estimating fatigue levels resulting from the training stimulus, that could interfere with the desired adaptations or expected performance level of the athletes. FM deals with both measurement of fatigue resultant from training, but also the reduction of fatigue as a result of recovery efforts. FM takes advantage of both objective and subjective measures/estimates. PE is concerned with whether the program is producing the desired effects (appropriate adaptations and performance). Although there is some overlap, FM and PE are not exactly the same thing. It should also be noted that both FM and PE can take place across different time spans. These time periods could include macro-monitoring (e.g. across meso-cycles/stages) or micro-monitoring (e.g. across weeks or from day to day).

Arguably some form of fatigue management should take place from day to day, especially in sports in which the training stimulus is not controlled by the strength and conditioning coach or the sport scientist performing the monitoring. This brings up an important point concerning *Periodization and Programming*. Indeed, planning and having a good management system in place, in which rest and recovery is built into the program as should occur with a well-designed periodization program, often reduces excessive fatigue and enhances PE (Hornsby and Wagle 2022; Stone et al. 2021). Never-the less, adequate monitoring and program adjustment can further reduce the potential for excessive fatigue which could lead to non-functional overreaching and over training.

In terms of PE, periodic planned monitoring, as part of an annual plan, can provide coaches and sports scientists with substantial evidence as to the effectiveness and success of a training program at various stages. PE monitoring, in order to be most valuable, should be programmed (annual plan) and carried out at key times such as at the beginning and end of training phases associated with specific goals. If the goals are not being met, programming can be altered. It should also be noted that PE monitoring not only gives and indication of the direction of positive alteration (or negative) but also provides quantifiable measures allowing more precise estimates of the degree of alteration.

As exercise and training responses and adaptations can be influenced by outside factors, both FM and PE monitoring should not only consider training associated measures, but also outside factors such as sleep patterns, diet

etc. Further, monitoring can be "summarized" as aggregate data, however, appropriate monitoring should also be reported on an individual bases. As a result of following this simple process, necessary correction to training programs, including on an individual basis can be made.

SUMMARY

Theoretical paradigms typically develop over long periods. Evolutionary development of these theories results from careful, detailed observation, objective study and a great deal of logic. Inspection of Table 2 alone indicates the development of Block Periodization as it pertains to strength and conditioning, by only one group of investigators. It should be noted that the 20 studies listed in table 2 took place over 20+ years and represent only part of their total investigative work. Furthermore, it should be noted that in more than 10 reviews of the literature, encompassing a wide variety of sports (Stone et al. 2021), all have found Periodization "to produce superior effects compared to different strategies". The authors believe that "Periodization" has indeed developed to the point at which it can be termed "*Periodization Theory*"

REFERENCES

1. Banik I. and Zhao H., Dynamical history of the Local Group in ΛCDM – II. Including external perturbers in 3D, Monthly Notices of the Royal Astronomical Society, Volume 467 (2):2180–2198, 2017.
2. Carroll K.M., Bernards J.R., Bazyler, C.D. Taber C.B., Stuart C.A., DeWeese B.H., Sato K. and Stone M.H. Divergent performance outcomes following resistance training using repetition maximums or relative intensity. International Journal of Sports Physiology and Performance. 29:1-28, 2018
3. Cunanan, A.J., DeWeese, B.H., Wagle, J.P., Carroll, K.M., Sausaman, R., Hornsby, W.G., Haff, G.G., Triplett, N.T., Pierce, K.C. and Stone, M.H., 2018. The General Adaptation Syndrome: a foundation for the concept of periodization. Sports Medicine, 48:787-797, 2018.
4. DeWeese, B. H., Hornsby, G., Stone, M., & Stone, M. H. The training process: Planning for strength–power training in track and field. Part 1: Theoretical aspects. Journal of Sport and Health Science 4(4): 308-317, 2015a.
5. DeWeese, B. H., Hornsby, G., Stone, M., & Stone, M. H. The training process: Planning for strength–power training in track and field. Part 2: Practical and applied aspects. Journal of Sport and Health Science, 4(4): 318-324, 2015b.
6. DiMaggio, P.J. Comments on" What theory is not". Administrative science quarterly, 40(3), pp.391-397, 1995.
7. Endler, J. Natural Selection in the Wild, Princeton, NJ: Princeton University Press, 1986.
8. Futuyma, D.J., Evolution, Sunderland, MA, Sinauer Associates, 2005.
9. Galán-Rioja, Miguel Ángel, José María Gonzalez-Ravé, Fernando González-Mohíno, and Stephen Seiler. "Training Periodization, Intensity Distribution, and Volume in Trained Cyclists: A Systematic Review." International Journal of Sports Physiology and Performance 1: 1-11, 2023.
10. Haff, G.G., 2004. Roundtable discussion: Periodization of training—Part 1. Strength & Conditioning Journal, 26(1): 50-69, 2004.
11. Hellard P, Avalos-Fernandes M, Lefort G, Pla R, Mujika I, Toussaint JF, Pyne DB. Elite swimmers' training patterns in the 25 weeks prior to their season's best performances: insights into periodization from a 20-years cohort. Frontiers in physiology. 2019:363, on-line.
12. Harris G.R. Stone M.H., O'Bryant H.S., Proulx C.M. and Johnson R.L., 2000Short-Term Performance Effects of High Power, High Force, or Combined Weight-Training Methods. Journal of strength and Conditioning Research 14(1):14-20, 2000.
13. Hornsby W.G., Fry A.C., Haff G.G., Stone M.H. Addressing the Confusion within Periodization Research. Journal of Functional Morphology and Kinesiology 2020, 5(3), 68; (on-line)
14. Hornsby G., Gentles J.A., MacDonald C.J., Mizuguchi S., Ramsey M.W. and Stone M.H. Maximum Strength, Rate of Force Development, Jump Height, and Peak Power Alterations in Weightlifters across Five Months of Training. Sports 5(4): 78, 2017.
15. Hornsby W.G., Haff G.G., Sands W.A., Ramsey M.W., Beckham G.K., Stone M.E. and Stone M.H. Alterations in strength characteristics for isometric and dynamic mid-thigh pulls in collegiate throwers across 11 weeks of training. Gazzata Medica Italiana – Archives of Science and Medicine 172: 929-940, 2013.
16. Hornsby W.G., Haff G.G., Suarez D.G., Ramsey,M.W., Triplett N.T., Hardee J.P., Stone M.E. and Stone M.H. Alterations in adiponectin, leptin, resistin, testosterone, and cortisol across eleven weeks of training among division one collegiate throwers: A preliminary study. Journal of Functional Morphology and Kinesiology. 2020 Jun 19;5(2):44. On-line
17. Hornsby W.G. and Wagle J. Athlete Monitoring (Ch 9) In Stone M.H. Suchomel T. Hornsby W., Wagle J. and Cunanan. Strength and Conditioning in Sports: From Science to Practice, Routledge, London, 2022.
18. Issurin, V. Block periodization versus traditional training theory: a review. Journal of Sports Medicine and Physical Fitness, 48(1):65-75, 2008.
19. Izquierdo, M., Ibanez, J., González-Badillo, J.J.,

Häkkinen, K., Ratamess, N.A., Kraemer, W.J., French, D.N., Eslava, J., Altadill, A., Asiain, X. and Gorostiaga, E.M. Differential effects of strength training leading to failure versus not to failure on hormonal responses, strength, and muscle power gains. Journal of Applied Physiology 100(5):1647-56, 2006.
20. Kataoka, R., Vasenina, E., Loenneke, J. et al. Periodization: Variation in the Definition and Discrepancies in Study Design. Sports Medicine 51: 625–651, 2021.
21. Kiely, J. Periodization paradigms in the 21st century: evidence-led or tradition-driven? Int. J. Sports Physiol. Perform. 7: 242–250, 2012.
22. Kramer J.B., Stone M.H., O'Bryant H.S., Conley M.S., Johnson R.L., Nieman D.C., Honeycutt D.R. and Hoke T.P. Effects of single versus multiple sets of weight training exercises on body composition and maximum leg and hip strength. Journal of Strength Conditioning Research, 11(3): 143-147, 1997.
23. Matomäki P. and Räntilä A. Does periodization work? Athletes perform better in major events than in minor competitions. International Journal of Sports Science & Coaching. 17(2):430-436, 2022.
24. Mattocks, K. T. et al. Periodization: What is it good for? J. Trainology 5: 6–12 (2016).
25. McGee D.S., Jesse T.C., Stone M.H. and Blessing D. Leg and hip endurance adaptations to three different weight-training programs Journal of Applied Sports Science Research, 6(2): 92-95, 1992.
26. McMillan J., Stone M. H., Sartain J., Marple D., Keith R., Lewi, D., and Brown C The 20-hr Hormonal Response to a Single Session of Weight-Training. Journal of Strength and Conditioning Research, 7(1): 9-21, 1993.
27. Millstein, Roberta L., "Evolution", The Stanford Encyclopedia of Philosophy (Spring 2022 Edition), Edward N. Zalta (ed.), https://plato.stanford.edu/archives/spr2022/entries/evolution/.
28. Mølmen, K.S., Øfsteng, S.J. and Rønnestad, B.R., 2019. Block periodization of endurance training–a systematic review and meta-analysis. Open access Journal of Sports Medicine, pp.145-160, on-line.
29. Morán-Navarro, R., Pérez, C.E., Mora-Rodríguez, R. et al. Time course of recovery following resistance training leading or not to failure. Eur J Appl Physiol 117: 2387–2399, 2017.
30. Mujika I. Intense training: the key to optimal performance before and during the taper. Scandinavian Journal of Medicine & Science in Sports. 20:24-31, 2010.
31. Mujika I, Sharma AP, Stellingwerff T. Contemporary periodization of altitude training for elite endurance athletes: a narrative review. Sports Medicine. 49:1651-1669, 2019.
32. O'Bryant H.S., Byrd, R. and Stone, M.H. Cycle ergometer and maximum leg and hip strength adaptations to two different methods of weight training. Journal of Applied Sports Science Research, 2(2): 27 30, 1988.
33. Painter K.B., Haff G.G., Ramsey M.W., McBride J., Triplett T., Sands W.A., Lamont H.S., Stone M.E. and Stone M.H Strength Gains: Block Vs DUP Weight-Training among Track and Field Athletes. International Journal of Sport Physiology and Performance 7(2):161-169, 2012.
34. Pierce K. Rozenek R. and Stone M.H. Effect of high volume weight training on lactate, heart rate and perceived exertion. Journal of Strength and Conditioning Research, 7(4): 211 215, 1993.
35. Plisk, S. & Stone, M. Periodization strategies. Strength and Conditioning Journal 25(6): 19-37, 2003.
36. Popper, K. R. Conjectures and Refutations: The Growth of Scientific Knowledge, Harper & Row, New York, 1968.
37. Rønnestad BR. and Hansen J. A scientific approach to improve physiological capacity of an elite cyclist. International Journal of Sports Physiology and Performance. 13(3):390-393, 2018.
38. Sanborn K., Boros R., Hruby J., Schilling B., O'Bryan, H. S., Johnson R. L., and Stone M. H. Weight training with single sets to failure versus multiple sets not to failure in women. Journal of Strength Conditioning Research 14(3):328-331, 2000.
39. Scala, D., McMillan J., Blessin, D., Rozenek R. and Ston, M. Metabolic cost of a preparatory phase of training in weightlifting: A practical observation. Journal of Applied Sports Science Research, 1(3): 48 52, 1987.
40. Steele J., Fisher J., Loenneke J., and Buckner S. The Myth of Periodisation. In: Myths of Sports Performance, eds. A. Whitehead & J. Coe. Preprint, 2023. DOI: 10.51224/SRXIV.323. –available on ResearchGate.
41. Stone M.H., Hornsby W.G., Haff G.G., Fry A.C., Suarez D.G. Liu J., Gonzalez-Rave J.M., Pierce K.C. Periodization and Block Periodization in Sports: emphasis on strength-power training: A provocative and challenging narrative. Journal of Strength and Conditioning Research 35(8): 2351–2371, 2021.
42. Stone, M.H. and O'Bryant, H. Weight Training: A scientific approach (2nd ed.), Burgess Publishing, Minneapolis, 1987.
43. Stone M.H., O'Bryant H. and Garhammer J. A hypothetical model of strength training, Journal of Sports Medicine and Physical Fitness 21: 342 351, 1981.
44. Stone, M.H., O'Bryant H., Garhammer J., McMillan J. and Rozenek R. A theoretical model of strength training. National Strength and Conditioning Association Journal, 4(4): 36 39, 1982.
45. Stone M.H, Potteiger J., Pierce K.C., Proulx C.M., O'Bryant H. and Johnson R.L. Comparison of the effects of three different weight training programs on the 1 RM squat. Journal of Strength Conditioning Research 14 (3): 332-337, 2000
46. Stone, MH., O'Bryant, HS, Schilling, BK, Johnson, RL., Pierce, KC., Haff, GG., & Stone, M. Periodization: Effects of manipulating volume and

intensity. Strength and Conditioning Journal. Part 1. 21(2): 56-62, 1999.
47. Stone, M.H. Wilson G.D., Blessing D. and Rozenek R. Cardiovascular responses to short term Olympic style weight training in young men. Canadian Journal of Applied Sports Science, 8(3): 134 139, 1983.
48. Stowers T., McMillan J., Scala D., Davis V., Wilson D. and Ston, M. The short-term effects of three different strength power training methods. National Strength and Conditioning Association Journal, 5(3): 24 27, 1983.
49. Suarez D.G., Mizuguchi S., Hornsby W.G., Cunanan A.J., Marsh D.J. and Stone M.H. Phase-Specific Changes in Rate of Force Development and Muscle Morphology throughout a Block Periodized Training Cycle in Weightlifters. Sports 7(6): 129, 2019.
50. Szymanek-Pilarczyk, Marta, Michał Nowak, Robert Podstawski, and Jacek Wąsik. "Development of muscle power of the lower limbs as a result of training according to the model of modified tactical periodization in young soccer players." Physical Activity Review 11, no. 2 (2023).
51. Thornton S., "Karl Popper", The Stanford Encyclopedia of Philosophy (Fall 2023 Edition), Edward N. Zalta & Uri Nodelman (eds.), forthcoming URL = h
52. Van Valen L. Festschrift: Evolutionary Biology. Vol. 6. Theodosius Dobzhansky, Max K. Hecht, and William C. Steere, Eds. Appleton-Century-Crofts, New York, 1972. xvi, 446. Science, 180(4085): 488-488. https:/plato.stanford.edu/archives/fall2023/entries/popper/>.
53. Vieira, J.G., Sardeli, A.V., Dias, M.R. et al. Effects of Resistance Training to Muscle Failure on Acute Fatigue: A Systematic Review and Meta-Analysis. Sports Medicine 52, 1103–1125 (2022).
54. Wetmore A.B., Moquin P.A., Carroll K.M., Fry A.C., Hornsby W.G. and Stone M.H. The Effect of Training Status on Adaptations to 11 Weeks of Block Periodization Training. Sports, (on-line), 2020.