Periodization Part III – Traditional and Non-Traditional Periodization

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Abstract

Current research has explored the degree of undulation (variation) necessary to optimize athletic preparedness. In this context Linear, Traditional, and Non-Traditional periodization strategies are analyzed. Special emphasis is placed on the advantages and disadvantages of increasing undulation.

Introduction

Kramer (2004) suggested that 'the key factor involved in going towards an individuals potential is 'variation' in the exercise stimulus with systematic rest programmed into the equation.' Periodization is a method which accounts for the above criteria. This is expressed through O'Bryant (2004), who defines periodization as 'a cyclic approach to training where periodic changes in training parameters (volume, intensity, loading, exercise selection) are planned in order for the athlete to achieve optimal performance at the appropriate time.' While it is acknowledged that variation and rest are key components to performance, current research attempts to tease out the laws which govern this complex process. In this context the purpose of this paper was to address the non linear nature of periodization in an attempt to explore the degree of variation necessary to optimize athletic preparedness. Special emphasis is placed on Traditional and Non-Traditional periodization.

Traditional Periodization

The following is a traditional format of periodization for strength athletes. Each cycle lasts for typically 4 weeks (Pearson et al., 2000; Haff, 2004).

General Fitness Cycle (GFC)—this involves the development of a general level of fitness for the novice athlete, before entering into their first training cycle of a periodized program. The athlete should lower intensity (15-20 reps), learn the exercise technique, and gain initial adaptation to resistance exercise (Pearson et al., 2000; Haff, 2004). The GFC is grounded on several theories such as the Learning Curve proposed by Fitts and Posner (1967). Another important factor is Thorndike's second law, the Law of Effect (see Wilson (2004) The Psychological Refractory Period Paradigm), which states that if a response is satisfying to a learner, they will be more likely to repeat it. It is absolutely vital that the priori experience of the athlete is a satisfying one. Training heavy and hard-core from the onset could very well lead to stress, and dissatisfaction. Thus, it is advantageous to start with this general fitness cycle for beginners. How acute and chronic training variables should be

programmed according to the fitness level of the athlete will be covered in-depth in future issues of JHR.

Hypertrophy Cycle (HC)—Also known as the preparation phase, the HC is defined by low to moderate intensity, limited rest, and relatively high volume. Typically 8-12 reps are performed, with 1-2 minutes of rest between sets. The goal is to develop peripheral factors such as stronger tendon, and ligament strength, and enlarge cross sectional area (muscle mass), in order to increase the capacity to express a given skill, and avoid future injuries (Pearson et al., 2000; Haff, 2004). Typically, the Hypertrophy Cycle is done first, as morphological changes (I.e. muscular hypertrophy) generally last the longest, followed by strength gains (Zatsiorsky, 1995).

1st Transition— this is the transition from the Hypertrophy Cycle, to Strength and Power mesocycles. The 1st Transition involves a progressive decrease in volume, an increase in intensity, and rest time, and emphasis on training specificity for the given event.

Strength Cycle—Repetitions here are typically 5-6, with 3-5 minutes rest in-between sets (Pearson et al., 2000).

Power Cycle—Repetitions are typically 2-4, with 2-3 minutes of rest between sets. Explosive movements should be employed.

It is strongly recommended that strength phases precede power and speed phases. And as will be discussed later on, many advise combining the two (Harris et al., 2000). There are two theoretical mechanisms for this. First, type II fibers are crucial for high force power movements such as sprinting, and weightlifting. These types of fibers are heavily targeted during a strength cycle. The second mechanism is that the speed of movement can be augmented if the workout results in high muscular force and the movement is ballistic (Harris et al., 2000). Evidence suggests that a periodized strength program followed by a power phase, produces superior results (Baker, 1996; Medvedev, 1981; Stone, 1982, 1987, and 1993).

Competitive Phase—here, intensity is heightened, volume is minimal, rest is 3-5 minutes, and exercises are specific to the criterion task. This can be considered a taper (also known as a regeneration cycle). The taper involves a systematic decrease in overload to facilitate a physiologic fitness peak (Wilson and Wilson, 2005). The goal is to remove fatigue, emphasize relaxation, and peak for a competition. For a complete analysis of this phase of training read the three tapering articles found in March 2005 of JHR.

Competition—here, the athlete enters the given competition. This may involve an event of short duration, or a season long training season. Recommendations will be given further on how to maintain training induced adaptations during the later scenario.

2nd Transition—depending on the accumulated fatigue, the participant will again taper after the competition, to relieve mental and physical stress, in anticipation of the next preparatory phase of training.

Start cycle over—the athlete now must assess weaknesses, and work on improving them.

The following table is a summary of traditional periodization (modified from Fleck and Kraemer, 2004):

Table 1. Comparison of Terminologies used to describe Traditional Periodization Models among Europeans, Americans, and American Strength/Power Athletes.

European Terminology	Preparation Phase	First Transition	Competition Phase	Second Transition Phase
Traditional American Terminology	Pre-season	Pre-season	In-Season	Off-season
American Strength/Power Terminology	Hypertrophy	Strength/Power	Peaking (tapering)	Active Rest

Comparisons of terminologies used to describe traditional periodization models among Europeans, Americans, and American Strength/Power Athletes found that Europeans order periodization as follows: 1.) Preparation phase 2.) First transition 3.) Competition phase 4.) Second Transition Phase. Americans traditionally order periodization as follows: 1.) Pre-season 2.) In-season 3.) Off-season. American strength/power authorities order periodization as follows: 1.) Hypertrophy 2.) Strength/power 3.) Peaking (tapering) 4.) Active rest.

Studies Supporting Traditional Periodization

Traditional periodization has been extensively investigated. The evidence clearly suggests that this style of training is superior to linear training. The following section will analyze several of these studies.

Willoughby (1993) investigated the effects of three selected mesocycle-length weight training programs using partially equated volumes on upper and lower body strength. Participants consisted of 92 experienced weight lifting males. Three experimental conditions were used. Each condition trained for 16 weeks, and were tested on the bench press and parallel back squat strength before, during, and after the experiment. Condition one performed 5 sets of 10 reps every week. Condition two performed 6 sets of 8 reps every week. Condition three used a traditional periodized program involving 4 weeks at 5 sets of 10 reps, followed by 4 weeks of 6 sets of 8 reps, followed by 4 weeks of 3 sets of 6 reps, followed by four weeks of 3 sets of 4 reps. Results found that the periodized program was superior for upper and lower body strength gains when compared to non-periodized conditions with partially equated volumes. Willoughby (1992) reported a similar study, and found likewise results.

Stone et al. (2000) compared the effects of 3 weight-training programs on the 1 repetition maximum squat. Participants were 21 college-age men. Condition one performed 5 sets of 6 reps every week. Condition two used a stepwise periodized program (volume by reps decrease in steps—traditional periodization). Condition

three performed an overreaching periodized program. Condition one and two were equalized on programmed repetitions (720 and 732), and Group 3 was programmed at 18 and 19.4% fewer repetitions (590). Results found that a periodized strength program increased the 1RM squat to a greater extent than a constant repetition scheme, even when the repetitions were equalized (Group 1 vs. Group 2) or when the repetitions were substantially fewer (Group 1 vs. Group 3). These findings are in agreement with Bryant (1982) who reported similar results in squats with periodized protocols.

Numerous other studies attest to the superiority of a traditional periodized program over a linear program (Kraemer, 1997; O' Bryant, 1988; Stone, 1981; Stowers, 1983; Fleck and Kraemer, 2004; Haff, 2004; Pearson et al., 2000; Rhea, 2002; Graham, 2002).

Non-Traditional Periodization

As described above, traditional periodization involves undulations (variations) from mesocycle to mesocycle. For instance, training for hypertrophy for one month, and strength the next month. Non-traditional periodization increases the degree of undulation. Two popular forms of non-traditional periodization are summated microcycles, and Daily Undulated Periodization. Summative microcycles involves undulations during each *microcycle*. Daily undulated periodization involves undulations during each *workout*. Thus, the degree of undulation is heightened in a non-traditional periodized format.

These training variables are fairly new; however, a great deal of interest has been placed on them recently, and each shows tremendous promise. The following sections will analyze both forms of non-traditional periodization, and prescribe how they can be applied to the athlete.

Daily Undulated Periodization (DUP)

Poliquin (1988) is often recognized as the founder of undulated periodization (Stone and Wathen, 2001). Poliquin (1988) investigated five ways to increase the effectiveness of the training program for football coaches. The first suggestion was the use of undulated periodization, which he also called alternate accumulation and intensification phases. Here, emphasis is placed on the importance of frequently varying both volume and intensity in order to induce neuromuscular adaptations. The rational behind this was that past research had found that strength programs lost their efficiency after only two weeks (Kulesza & Poliquin, 1985; Poliquin, 1985, b). Thus, it was concluded that if a stimulus is provided in exactly the same way, results would diminish quickly. This is in accord with the biological law of accommodation, which states that the response of an organism to the same given stimulus decreases over time. For instance, load for elite athletes is roughly 10 times that of beginners having 6 months experience. Elite weight lifters (Bulgarians) lift around 5,000 tons a year. The load for novices is only 1/10th this level! Further, it is noted to take 8+ years to reach an elite (professional) athletic status [Vladimir, 1995].

Poliquin proposed that traditional periodization (described above) had several drawbacks. First, a given mesocycle, such as a hypertrophy cycle, was typically not deviated from for at least 4 weeks. This length, however, would be accommodated to

quickly, and gains would diminish. Secondly, traditional periodization involves a continual increase in intensity, resulting in an accumulation of stress, promoting overtraining. Lastly, he suggested that the hypertrophy gained from the first month of training would plummet over the next several months of strength/power phases, which involved higher intensities, and decreasing volumes (both of which are not conducive to hypertrophy), rendering the first month of traditional periodization practically worthless.

To combat these problems, Poliquin proposed undulated periodization. The following table demonstrates a modified program of traditional and undulated periodization strength programs, described by Poliquin (1988):

Table 2: Comparison of Traditional and Non-Traditional Undulated Periodized Strength Programs over 12 weeks

Traditional Periodization						
Weeks	1-4	5-8	9-12	13-16		
Reps	10	5	3	2		
Sets	5	3	3	3		
Non-Traditional Periodization						
Weeks	1-2	3-4	5-6	7-8	8-10	11-12
Reps	10-12	4-6	8-10	3-5	5-7	2-3
Sets	3	5	4	5	4	6

Comparison of traditional and non-traditional undulated periodized strength programs over 12 weeks found that non-traditional periodized strength programs decrease volume at a much slower rate, and intensity increases more gradually than traditional periodized strength programs. Moreover, phases are only two weeks in duration, in comparison to four in the traditional protocol, decreasing the chance of accommodation.

Poliquin concluded that such a program was superior to traditional periodization, and would result in a continual increase in gains, and avoidance of physiological and psychological plateaus caused by stagnant programs.

Building on the work of Poliquin, many advantageous modifications have been made to his theory. First, the term undulated periodization is tautologous (redundant, a needless repetition of an idea, statement, or word). Periodization by its very nature is undulated. Authors have also said the argument is between linear and non-linear (i.e. "undulated") periodization. But again, all forms of periodization are non-linear.

Therefore, a new, and proper name has been chosen in its place—*daily* undulated periodization. This variation emphasizes that it is not the inclusion of undulation that makes this technique novel, but rather the *degree* of undulation. While a traditional periodized program would modify its training program from one mesocycle to the next, daily undulated periodization (DUP) makes modifications every workout! Stone

and Wathen (2001) propose that the terms traditional and non-traditional periodization should be used. DUP would fall under the later form of periodization.

DUP takes Poliquin's theory to another level. Instead of modifying training every three weeks, workouts in this paradigm are modified every session. An example of DUP would be training an exercise three times a week, such as squats. Monday, the athlete would perform three sets of squats, at a 12-15 RM, Wednesday four sets at a 8-10 RM; Friday, three sets at a 1-5 RM; Monday, repeat cycle. Various examples of DUP will be discussed further on.

The following sections will be dedicated to further explaining the scientific rational behind DUP, as all research is theory driven.

S^{I_R}—Conditioned inhibition

Hull (1943) suggested the principle of reactive inhibition, which entails the organism reacting to inhibit the action which causes fatigue. This is manifested in the form of lactic acid during a set of squats, heavy eyes in states of sleep deprivation, among other examples. According to Hull (1943) reactive inhibition masks the positive effects of practice, and a period of rest is needed to dissipate this effect. Thus, it is imperative that the athlete dissipate the IR in order to peak performance.

What the athlete must be sensitive to is that you can actually condition reactive inhibition, such that when the athlete is confronted with a given training task, or environment, the body will react to inhibit the task *before* it causes fatigue, diminishing performance. Wilson (2005) masterfully explains this topic, and how to avoid such a predicament in, Hull's Quantitative Equation on Human Performance. Here is a quote:

> Hull (1943, 1952) also found another effect. He found that if practice continued without drive reduction that the response would go to extinction (the organism would stop responding). However, as figure 3 displays the response would regenerate with heightened amplitude after a period of rest. He further noted that if extinction were continued over several days (or longer) that the spontaneous generation of the response that occurred after rest would actually lower with each subsequent period of rest. The effect was denoted as conditioned inhibition. In postulate 9, Hull suggested that reactive inhibition produced a negative drive state. The drive state was negative, as lowering it required the organism to lower activity. Upon a lowering of activity the drive was reduced, which strengthened a learning response. This learning response is known as conditioned inhibition. An illustration can be seen when students enter what they deem as a boring class. Almost involuntarily they begin to yawn. Therefore according to this postulate, reactive inhibition can be conditioned, if practice occurs without reinforcement (Drive reduction). This may explain burn out. Athletes often set up goals which could take years to reach. They work incessantly towards the goal, but reinforcement or drive reduction will not occur until years of persistence have taken place. Under these conditions the behaviors associated with optimal performance will go to extinction, or be masked by conditioned inhibition. In this context, Knowlden (2004) suggested that participants set up short term goals, or smaller need states which can be reduced frequently. Further, it is also important to keep training fresh according to the

Specificity Hypothesis. This hypothesis states that fatigue is specific to the system or effecter (body part) fatigued (Payne, 1979). In this context Payne (1979) investigated whether reactive inhibition in one effecter had negative effects on a second effecter. It was found that the effect was specific to the limb used. This suggests that an athlete can avoid conditioned inhibition by properly sequencing their workouts and training splits. This means that performing the same routine consecutively for weeks on end would produce fatigue specifically to that routine. Routines normally follow an asymptotic curve:

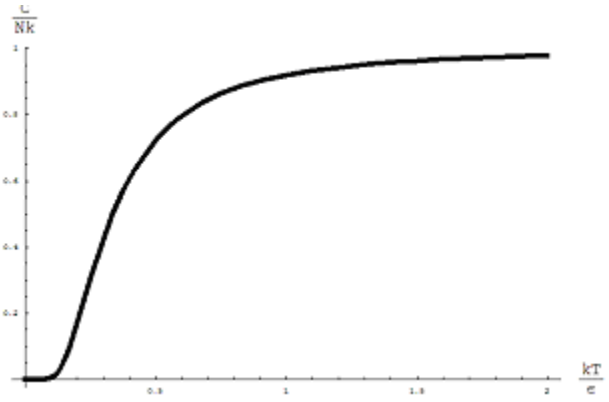

Figure 4 graphically depicts an asymptotic curve. The vertical axis represents performance, and the horizontal axis represents total trials.

The vertical axis represents performance, while the horizontal axis represents the amount of trials or practice sessions that the routine has been performed. Note that as time increases, performance increases decreases. Zatsiorsky (1995) refers to this as the biological law of accommodation, which states that the response of a biological object to a given stimulus decreases over time. If performance is viewed as drive reduction, then consecutive sessions without performance increase can lead to conditioned inhibition. By changing the routine to (A) dissipate the reactive inhibition and (B) work on another area which has not been affected by the fatigue the participant can avoid conditioned inhibition. Such a concept is a form of periodization, which attempts to break a number of skills and competencies into manageable components.

As stated by Wilson (2005) periodization is an effective method to avoid conditioned inhibition.

Further, DUP is one of the most effective components of periodization that can be used to avoid conditioned inhibition and overtraining. For instance, overtraining is often caused by monotonous heavy training. Literature very clearly shows that high intensity strength training, performed too frequently, and or too long (in as little as two weeks in some cases) can result in overtraining (Haff, 2001). In both humans and animals, inclusion of a submaximal training day within a microcyle results in greater performance and fewer incidents of overtraining (Bruin et al., 1994; Foster, 1998). Therefore, including a light training day would be very beneficial.

Now, some argue that in order to avoid this predicament, the participant should simply train less frequently (Bradley, 2001). However, the above information showed

that this would not be as effective, due to the monotony of such a split; moreover, the organism would still have great stress during every single workout. Finally, evidence suggests that the more frequently you can train, while avoiding overtraining, the better (Haff, 2001). Thus, inclusion of a lower intensity day would facilitate this, and concomitantly prevent overtraining. It has also been suggested that continually training heavy would result in neurological fatigue, and therefore, decrease strength gains. The solution for this has been to alternate between light and heavy workouts (Haff, 2001)..

Wilson and Wilson (2005) in Tapering Part 2 - Manipulation of Load for Peak Performance provided extensive support for increasing the frequency of training during a given split. For more information on this topic, refer to their dissertation.

Lastly, the constant stress of training heavy every single workout for an entire mesocycle can be overwhelming to the athlete, resulting in a conditioned inhibition on various criterion tasks such as squats. DUP is the key to avoiding this. Training light to moderate 2 out of 3 workouts or every other workout is more variable, and less stressful than training heavy every single workout. After performing 1-2 light workouts of squats, for instance, the athlete will be mentally, and physically ready to go heavy again. This will result in continued results, and prevention of conditioned inhibition and overtraining. In accordance with this theory, Haff (2001) suggests that a traditional periodization program would promote overtraining, and that for reasons such as this, a non-traditional approach may elicit better results.

Training for Multiple Goals

DUP has been suggested for athletes trying to achieve more than one goal. For example, a program that desires to gain both strength and hypertrophy can be designed using DUP (Hoffman, 2003; Fleck and Kraemer, 2004; Haff, 2004). This is significant for many athletes, such as bodybuilders, who desire strength gains to increase the capacity to gain muscle mass, but still, want to train within an optimal hypertrophy rep range—both can be done effectively by using DUP.

Size Principle

Another proposed advantage of DUP, is fiber specific depletion. The size principle states that smaller motor units are recruited first. Thus, recruitment follows this pattern: Type I > Type IIa > Type IIb. Wilson (2001) discusses this topic in Muscle Fibers Part Two. Here is a quote:

> The motor unit fires with a frequency that is conducive to the fibers it stimulates. Simply put, a slow twitch motor neuron will cause the muscles in to twitch slowly. This again is conducive to endurance, while a fast twitch unit will fire quickly. The way your body recruits these motor units is fundamentally as follows. If the activity is light it will mainly stimulate slower twitch muscle fibers, when it becomes too intense it will call on its fast twitch IIA fibers, and last of all (for the highest intensity movements) it will recruit the fast twitch IIB fibers. This is why slow twitch muscles are called low threshold, and fast twitch IIB's are called high threshold. Low threshold because they are the first muscle fibers to be recruited and high threshold because they are only recruited under the most intense circumstances.

Thus, training light will place more stress upon slow twitch fibers, while allowing fast twitch fibers to recovery. Conversely, training heavy will place more emphasize on fast twitch fibers, allowing slow twitch fibers (and II A fibers) to recover. Haff (2001) therefore, proposes that including daily fluctuations in intensity will resist fiber specific fatigue, and increase performance. Note that the size principle is not always correct. For example, explosive movements results in selective recruitment of fast twitch fibers first by the nervous system. Wilson (2001) discusses several ways to manipulate such principles in the previously mentioned article.

Numerous studies support that stress is not general but very specific in its pattern. This supports the sequencing theory of periodization, presented in the first article of this series. According to this theory, fatigue is specific to the exercise utilized during a training session. Kraemer (2004) also supports these concepts. He proposes that on light days, you will not be using the same motor units as on heavy days, thus, allowing them to recover through active recovery protocols.

Results also suggest that muscle glycogen is depleted specific to slow and fast movements. In endurance events, there is an immediate loss of muscle glycogen in slow twitch fiber, but no significant loss in fast twitch fibers during the first 20 min. Conversely, in a speed or power task, there is a more rapid loss of fast twitch fibers, in comparison to slow twitch fibers. This is because the body is selectively recruiting fast twitch, or slow twitch motor units to a higher extent to accomplish a given task (Caplan, 2005).

Wilson and Wilson (2005) extensively cover fiber specific recruitment patterns in Analysis of Nutrient use during Low, Moderate, and High Intensity Exercise. Refer to their article for more information on this topic.

It should be understood that no workout routine will only work slow or fast twitch muscle fibers. For example, Wilson (2003) states the following in, Pre Contest Week - An In Depth Analysis:

> Interestingly studies indicate that as low as 30 percent 1 rep maximum variations can actually deplete fast twitch IIa fibers [of glycogen], but do little for IIb fibers in a lower repetition range. The latter will yield very little micro trauma, and I would not go above the former as it should be sufficient for depletion. I have mixed a combination of high rep as well as intense posing work for the ST fibers, and explosive work to deplete the FT IIa and b fibers. We are also keeping micro trauma low, and I must emphasize that you should not emphasize the eccentric portion of the repetition. Many athletes prefer to have their partner take the eccentric portion of the rep during this phase.

The point being made is, during light days, more emphases will be placed on slow twitch fibers, allowing fast twitch fibers to recovery quicker (especially type 11b fibers). And visa versa.

Studies on DUP

Now that the theoretical groundwork for DUP has been firmly established, the following section will put theory to practice.

In one of the earliest documented studies on DUP, Baker et al. (1994) examined the effects of manipulating volume and intensity on power and strength in 22 experienced male athletes. Participants were divided into two experimental conditions (and one control condition). Each condition trained three times a week for 12 weeks, with relative volume and intensity equated. Participants were tested on the squat, bench press, vertical jump, lean body mass, and neural activation levels. Various exercises, such as squats, were performed 2 times a week, spread out through 3 sessions. Condition one (control group) performed 5 sets of 6 reps all 12 weeks. Condition two (traditional periodization) did 5*10 the first 3-4 weeks, 5*5 the next 3-4, and 3*3 the last 6. Condition three (DUP) did 5*10 the first two weeks, 5*6 the next two weeks; 5*8 the following two; 5*6 the next two, and 4*3 the last two. Results found a significant increase in performance across criterion tasks; but surprisingly found no significant difference between groups. However, DUP had a significantly greater change in these variables in terms of percentages over the course of the study.

Rhea et al. (2003) suggested that the differences between the traditional and DUP training programs in Bakers (1994) study were not severe enough to elicit statistically significant differences. What is interesting is that those against DUP consistently source this Baker study. Yet, if the reader will notice, this is not true DUP! Rather, it is the method Poliquin (1988) prescribed. As discussed above, this method has been modified to DUP, and seemingly, would elicit better results. Moreover, his study is not consistent with the scientific body of knowledge, which consistently has shown that periodized training is superior to linear training programs (as displayed throughout this article). Lastly, DUP still has significantly greater percentage gains in this study. Therefore, these results should be viewed cautiously.

Working off the findings of Baker (1994), Rhea et al. (2003) investigated the effect of traditional periodization and daily undulating periodization on strength gains. An additional purpose was to examine a more intensive approach to DUP than that used during Bakers (1994) study. This was done by altering volume and intensity on a daily bases, and equating volume and intensity, so that any increase in performance could only be attributed to differences in the degree of undulation. Participants consisted of 12 men, with a mean age of 21 years. Participants were trained, with a minimum of two years of weight lifting experience.

Participants were equally divided into two experimental conditions. Each condition performed three sets of bench press and leg press each, three days per week. A 1RM test was recorded for each criterion task before, during, and after the experiment. Condition one followed a traditional periodization program, in which they performed sets of 8 RM during weeks 1-4, 6 RM during weeks 4-8, and 4 RM during weeks 9-12. Condition two followed a DUP training program, in which training was altered on a daily bases. This consisted of an 8 RM Monday, a 6 RM Wednesday, and a 4 RM on Friday, every week, for 12 weeks total.

Results found that DUP had a significantly ($p<.05$) greater increase in strength in both the bench press and leg press task compared to the traditional periodization program. The traditional group had a 14% increase in strength on the bench press,

and a 25% increase on the leg press. While the DUP group had a 29% increase in strength on the bench press, and a whopping 56% increase on the leg press!

There were some extremely fascinating findings in this study. There was actually no significant difference between groups during weeks 6-12 ($p>.05$). Thus, these differences occurred primarily in the first 6 weeks. Interestingly enough, during weeks 10-12, participants in the DUP condition reported extended soreness, and fatigue—classic signs of overtraining (King, 2004). The authors suggested that the participants may have been burnt out.

The implications of this are many. First, the optimal duration of DUP still needs to be investigated. The current study seems to suggest that 6 weeks (one mesocycle) may be optimal.

DUP might also be combined with traditional periodization to elicit maximal results. For instance, using the same parameters as this study, instead of using this same format of DUP for 12 weeks, the first four weeks could have been a hypertrophy cycle (12 reps Monday, 10 RM Wednesday, 15 RM Friday), a strength phase the next four weeks (8 RM Monday, 6 RM Wednesday, and 4 RM Friday), and a Power phase the last four weeks (5 RM Monday, 3 RM Wednesday, 1 RM Friday). This would further increase the variation, and perhaps would have avoided accommodation. Again, this is just theory—experiments need to be done on this combination of traditional periodization and DUP.

Additional, the reader may have noticed that the participants trained relatively heavy for the duration of the study. While DUP would increase variation, thereby, inhibiting accommodation, this protocol may result in conditioned inhibition. Perhaps going on a hypertrophy cycle first, then on a strength and power cycle for only 8 weeks would have prevented the overtraining and conditioned inhibition, which presumably occurred during this experiment.

Another solution may be the implementation of a taper (refer to the tapering article sourced earlier in this article), to dissipate the fatigue. Perhaps performing DUP for 6 weeks, tapering for one, and then repeating the same protocol would have elicited superior results.

Another viable option would be to go on a DUP split for 6 weeks, and then completely change the program for a certain amount of time, and go back to it whenever the athlete chooses.

Which brings up an important point. There are numerous acute and chronic training variables which can be manipulated by the athlete to bring about a beneficial physiological and neurological adaptation. DUP is just one of many that has been found to be extremely effective. JHR will be discussing numerous others in upcoming issues. These should not be seen as contrary, but rather, complimentary to each other. Many of these can, and should be used within a given macrocycle (i.e. one year).

All these theories are very sound, and may be applied by the athlete. But again, more studies need to be done.

Baker (2001) investigated the effectiveness of non-traditional periodization during a 19-week in-season resistance program in 14 professional and 15 college rugby players. Results found that power was maintained, and strength significantly increased. It was suggested that this type of training model would be effective for sports such as football; with extremely physical demands during the season.

Working off the findings of Baker (2001) Hoffman et al. (2003) compared linear (L) and nonlinear (NL) in-season training programs in freshman football players during the course of two separate seasons. The linear program was issued during the first season; the non-linear program was issued during the second season. Participants consisted of 28 freshman college football players, with weight lifting experience. All participants trained two times a week, 3 sets per exercise. Exercises consisted of squats, power cleans, push press, and bench press. Condition one (linear training) trained at 80% of their 1 RM (6-8 reps) every workout for the duration of the study. Condition two (non-linear) trained at 70% of their 1 RM (8-10 reps) the first workout, and 90% of their 1 RM (2-4 RM) the second workout. No significant increase in bench press was seen in either group; while squats increased significantly in the L group, but not in the NL group.

The authors suggested that the low frequency contributed to these results. The majority of studies train 3-4 times a week, with the same volume. They further suggested that maintaining a high intensity when using a low frequency, low volume program may be necessary to maintaining adaptations. Another option could be to increase training volume, and maintain frequency.

Stone et al. (1997) found that fluctuations within and between microcycles resulted in greatest strength improvements in comparison to both non-periodized, and traditional methods of periodization. The authors suggested that daily and microcycle variations produce superior strength gains.

Ivanov (1980) compared non-traditional periodization with traditional periodization in track athletes competing in throwing events. Results found that non-traditional periodization was superior for strength in both the bench press and squat.

Harris et al. (2000) examined the effects of three different resistance training methods on a variety of performance variables representing different portions of the force velocity curve, ranging from high force to high speed movements. Participants consisted of 42 previously trained young (approximately 19) males. All participants performed 4 weeks of high volume (10 reps per set) routines four weeks prior to the study. Participants were then separated into three experimental conditions. Training was done 4 times a week, for nine weeks. Condition one was high force, in which they used 80-85% of their 1 RM. Condition two was high power, in which they used 30% of their peak isometric force. Condition three was a combination group (DUP), in which the first four weeks were similar to the high force group, with the inclusion of heavy and light training days. The last four weeks, participants in condition three switched to a high force/power protocol. Various training variables such as squat strength were monitored.

Results found that the HF group improved in 4 training variables, the HP group in 5 training variables, and the combination group in seven variables. Moreover, comparison among conditions found that the combination group increased significantly greater than other conditions in several variables such as squats, and a

10-yard shuttle. Additionally, in every case, the combination group had greater percentage gains than either condition.

The authors noted that several authorities have suggested that a combination of training for power and strength would result in optimal performance, particularly in sports that rely on power and speed. And this study certainly supported this.

Hunter et al. (2001) compared the effects of linear high-resistance training, 3 times per week at 80% maximum strength, with 3 times per week of variable resistance training (once-weekly training at 80%, 65%, and 50% 1RM) in older adults. There were similar increases in absolute strength and fat free mass. However, the DUP condition had a greater percentage of strength gains; moreover, participants in the DUP condition had a significantly greater decrease in the difficulty of performing a carrying task.

Alvar et al. (2002) compared the effectiveness of single and multiple sets of weight training for strength gains in recreationally trained individuals. Participants consisted of 16 males, who were divided into two experimental conditions. Condition one performed one set for bench press and leg press. While condition two performed three sets. Additionally, condition two followed a DUP protocol, using a rep scheme between 4-8 reps. Results found that three sets of DUP training was superior to one set for eliciting maximum strength gains.

Three very similar studies compared multiple sets of DUP training, to single sets of linear training. Kraemer (1997) examined college football players, and found that DUP resulted in significantly greater gains in strength, local muscular endurance, and motor performance. A follow up study by Kraemer (2000) on female collegiate tennis players for nine months, found that DUP in comparison to single set training resulted in significantly greater increases in strength and motor performance measures. Marx et al. (2000) during a six month study with untrained college age females, using a similar protocol to Kraemer, found that DUP resulted in greater strength, motor performance, and local muscular endurance. In this study, it was also found that the athletes had a higher concentration of anabolic hormones IGF-1, and testosterone, and lower levels of cortisol in the DUP condition. All these studies also found a significantly greater decrease in percent body fat and greater increases in lean body mass in the DUP condition. These studies clearly indicate the superiority of DUP using multiple sets, compared to a single set, linear protocol.

Navy seals are elite groups of military commandos, with superior physical conditioning. Incidentally, a DUP training model has been prescribed for them in the journal of strength and conditioning (Rhyan, 2000).

DUP has also been prescribed for the fitness challenge, which is a myriad of strength, endurance, and agility exercises presented in a public event (Rhyan, 1999).

Numerous studies are also applying DUP as a standard training model now in experiments (NSCA Conference Abstracts, 2002). So its popularity is becoming extensive.

In conclusion, DUP is strongly grounded in sound theoretical doctrines. And while many studies do in fact support DUP, the scientific body of knowledge is relatively limited on this discussion. More studies need to be done to replicate previous results,

and more variables must be introduced in order to apply DUP to various situations, and find the optimal combination, duration, and intensity for DUP.

Testimonies on DUP

Though not recorded in a controlled scientific experiment, several athletes have employed DUP with excellent results.

Poliquin (1988) the credited founder of DUP, has reported excellent results with his athletes, and is obviously a strong supporter of the method, of which he popularized.

Kraemer and his colleagues (2004, 1990; and Haff, 2004) have over the years (in the lab, and outside) claimed to use DUP out of necessity due to its adjustability for academic sports training situations and ease of administration in multi-competition sports with long seasons. He has achieved tremendous success at the University of Connecticut and in research over the past couple of years using this approach. Moreover, their strength coach, Andrea Hudy, has used DUP for the women's basketball program, and reported excellent success. They are reported to be working on quantifying their progress in the near future in research and journal articles.

Kraemer suggests that DUP is an excellent protocol that allows flexibility in ones schedule. For instance, when a coach gave a hard-core practice, training for power in the weight room that day would not be optimal. So the coach could adjust, and simply make that day a light day, and perform the power day in place of the light day later in the split. Or if one workout session is missed due to sickness, etc., the workout schedule can be simply pushed up a day, and continued. Kraemer also suggests that DUP would be excellent for in-season sport schedules. Here are some final thoughts from Kraemer on this topic (Haff, 2004):

> As scientists, we have carefully tried to quantify this [DUP] in both specific and general models as being more optimal than other forms of training progressions. We have tried to get beyond the level of opinion and provide some data to work with. This is key to my approach in training-program development. Such data seem to support the use of very dramatically different training days, ranging from a base of 3 different training days, for example, to many more with completely different target goals for that training session and very little cross-over of another style of training during that session to allow motor units to be very selectively recruited. Thus, when we are training on a heavy day, for example, with a 3 to 5RM zone for our exercises, there are not a lot of light repetitions performed except for needed warm-up. On light days, one never gets into the resting heavy and power recruitment patterns, thus providing a very different physiological experience for the workout that day.

Sawyer (2005) is a renowned expert in sensory motor skill acquisition, chairman of California State University Hayward, and successful coach of various collage sports, including football. Dr. Sawyer has said to have predominantly utilized a DUP type protocol. And the results of both himself and his athletes are a great testimony to this method.

DUP has also been reported to be popular among weight training coaches in Eastern Europe, West Germany, and Canada. (Poliquin, 1988).

The former 100 meter record holder, Ben Johnson, is another advocate of this method (Poliquin, 1988).

Lastly, the current authors—Wilson and Wilson (2005)—have been utilized DUP in their training. For small muscle groups such as biceps, triceps and forearms, the typical three days per week—light, moderate, to heavy—training sessions have been used. Due to the massive amounts of volume during their workouts, however, large muscle groups have only been trained twice a week, with a split between one heavy day, and one light-moderate training session. The results have been absolutely fantastic in both strength and hypertrophy gains.

How to Apply DUP

The athlete may implement DUP into a training split through various avenues.

Rhea (2003) suggests that a solid DUP program would be 12-15 reps on Monday, 8-10 Wednesday, and 3-5 on Friday, then, start over on Monday.

Rhea (2003) found in his experiment that a program consisting of 8 RM Monday, a 6 RM Wednesday, and a 4 RM Friday, every week, for 12 weeks total, gave excellent results in leg press and bench press strength. It should be noted that such a program seemed to result in staleness after 6 weeks. This may be attributed to the fact that participants trained relatively heavy during all workouts. Thus, such a program should be monitored closely. Including a moderate-light rep day is postulated to relieve such effects.

Poliquin's (1988) suggestions for DUP can be found in table 2.

Harris et al. (2000) examined three experimental conditions. Condition one was high force, in which they used 80-85% of their 1 RM. Condition two was high power, in which they used 30% of their peak isometric force. Condition three was a combination group (DUP), in which the first four weeks was similar to the high force group, with the inclusion of heavy and light training days. The last four weeks, participants in condition three switched to a high force/power protocol. Results found that the combination group was superior on various measures of performance. If the reader is participating in sports that rely on power and speed, it was suggested that a combination of training for power and strength (such as this protocol) would result in optimal performance. This also provides evidence for the combination of traditional and non traditional periodization.

Hunter et al. (2001) compared the effects of linear high-resistance training, 3 times per week at 80% maximum strength, with 3 times per week of variable resistance training (once-weekly training at 80%, 65%, and 50% 1RM) in older adults. There were similar increases in absolute strength and fat free mass. However, the DUP condition had a greater percentage of strength gains; moreover, participants in the DUP condition had a significantly greater decrease in the difficulty of performing a carrying task. Such a protocol may therefore, be optimal for older athletes.

Kraemer (Haff, 2004) has suggested a DUP of 4 sets 12-15 reps on Monday, 4 sets 8-10 Wednesday, and 3-4 sets of 4-6 reps on Friday, then, start over on Monday. Additionally, he proposed that the athlete could slightly adjust this, and perform 4-5

sets, 1-3 reps on Monday, and then start over. This may be of interest if strength and power are the dominant goals.

Kraemer also suggested using a 2 day DUP protocol, such as alternating between heavy (4-6 reps) and moderate (8-10 rep) training days, to maximize both strength and hypertrophy gains.

DUP can be applied to an entire workout. But it can also be applied to a single body part, or even one lift. However, it is cautioned that if only applied to one lift, that training the rest of the workout light and heavy would affect the criterion task.

Wilson and Wilson (2005) have also applied DUP with excellent results. Currently, for small muscle groups such as biceps, triceps and forearms, the typical three days per week—light, moderate, to heavy (following the rep range prescribed by Kraemer)—training sessions have been used. Due to the massive amounts of volume during their workouts, however, large muscle groups have only been trained twice a week, with a split between one heavy day ($\geq$6 reps), and one light-moderate training session (8-15 reps). The results have been absolutely fantastic in both strength and hypertrophy gains.

Medsger (2005), a hard-core bodybuilder, credentialed Kinesiologist, and fellow colleague of the current authors, suggests that it may be advantageous to design a split that does not combine light and heavy days on successive sessions. This was also suggested by Kraemer, who proposed that a coach that gave a hard-core practice should not train for power in the weight room that same day. So the coach could adjust, and simply make that day a light day, and perform the power day in place of the light day later in the split.

Wilson and Wilson (2005) have applied this method with excellent results. For instance, the authors are currently using a split training protocol of delts and pecs the same day. These muscles are synergistic to each other; thus, training one muscle would hinder the other later. To counter these side effects, the authors have used the Medsger (2005) protocol. Delts are trained heavy the first session of the day and pecs are trained light-moderate at night. Then, for the second workout of that week, pecs are trained heavy during the first session, and delts are trained light-moderate at night. Due to the specificity of fatigue, this has minimized the hindrance training these muscle groups would have on each other. This again demonstrates the flexibility of a DUP split. Using DUP would increase the athlete's ability to prioritize various muscle groups.

This method could also be applied to other synergist muscle groups. For instance, currently Wilson and Wilson (2005) do legs followed by back in their current split. To minimize the negative effects these have on each other, legs are trained heavy one day, and back is trained light-moderate the next. And visa versa later in the week. This again has worked extremely well.

More studies need to be done on the optimal duration of DUP and other effective variations of it to be applied for various goals such as hypertrophy training. But the current literature should provide the athlete with a plethora of new training methods.

Summative Microcyles

Stone, in a round table on periodization (Haff, 2004) discussed a novel method, known as summated microcycles. This method uses undulations on a weekly basis. It usually consists of 4 weeks of blocked microcycles, representing one mesocycle. This mesocycle can then be repeated for further gains. There are numerous variations of this program. One method is to take a traditional periodized program, and scale it to the microcycle level. For example, week one would be a hypertrophy cycle, week two a strength cycle, week three a power cycle, and week four a taper. Using this type of program would result in a continual increase in training intensity, which is why a taper is applied during the fourth week. After this, the cycle would start over.

Plisk (Haff, 2004) proposes that summated microcycles have three benefits: 1.) Summating overload over several weeks can increase the probability of converging training benefits. 2.) Weekly variations in training would obstruct accommodation. 3.) Lastly, the unloading phase would curtail stress, minimizing the likelihood of overtraining.

Further, it is commonly advised to arrange training phases into 4 weeks (Plisk and Stone, 2003). Matveyev (1972) proposes that natural monthly biocycles support the notion of a 4 week training cycle, divided into 4 varying microcycles. Zatsiorsky (1995) suggests that training cycles should be structured to a 4 (+-2) week phase, to superimpose the delayed training effects of several training variables dispersed over time.

Summated microcycles show great promise; however, the method is largely based on inference. More studies need to be done on its effectiveness, and proper applications.

Conclusion

King Solomon discussed various seasons in the book of Ecclesiastes. The following passage demonstrates that material possessions cannot satisfy man, as King Solomon said, all is vanity.

Ecclesiastes 3

1 To every thing there is a season, and a time to every purpose under the heaven: ***2*** A time to be born, and a time to die; a time to plant, and a time to pluck up that which is planted; ***3*** A time to kill, and a time to heal; a time to break down, and a time to build up; ***4*** A time to weep, and a time to laugh; a time to mourn, and a time to dance; ***5*** A time to cast away stones, and a time to gather stones together; a time to embrace, and a time to refrain from embracing; ***6*** A time to get, and a time to lose; a time to keep, and a time to cast away; ***7*** A time to rend, and a time to sew; a time to keep silence, and a time to speak; ***8*** A time to love, and a time to hate; a time of war, and a time of peace. ***9*** What profit hath he that worketh in that wherein he laboureth? ***10*** I have seen the travail, which God hath given to the sons of men to be exercised in it.

11 He hath made every thing beautiful in his time: also he hath set the world in their heart, so that no man can find out the work that God maketh from the beginning to the end. ***12*** I know that there is no good in them, but for a man to rejoice, and to do good in his life. ***13*** And also that every man should eat and drink, and enjoy the

good of all his labour, it is the gift of God. ***14*** I know that, whatsoever God doeth, it shall be for ever: nothing can be put to it, nor any thing taken from it: and God doeth it, that men should fear before him. ***15*** That which hath been is now; and that which is to be hath already been; and God requireth that which is past.

16 And moreover I saw under the sun the place of judgment, that wickedness was there; and the place of righteousness, that iniquity was there. ***17*** I said in mine heart, God shall judge the righteous and the wicked: for there is a time there for every purpose and for every work. ***18*** I said in mine heart concerning the estate of the sons of men, that God might manifest them, and that they might see that they themselves are beasts. ***19*** For that which befalleth the sons of men befalleth beasts; even one thing befalleth them: as the one dieth, so dieth the other; yea, they have all one breath; so that a man hath no preeminence above a beast: for all is vanity. ***20*** All go unto one place; all are of the dust, and all turn to dust again. ***21*** Who knoweth the spirit of man that goeth upward, and the spirit of the beast that goeth downward to the earth? ***22*** Wherefore I perceive that there is nothing better, than that a man should rejoice in his own works; for that is his portion: for who shall bring him to see what shall be after him?

At the end of this great book, King Solomon comes to this conclusion:

13 Let us hear the conclusion of the whole matter: Fear God, and keep his commandments: for this is the whole duty of man. **14** For God shall bring every work into judgment, with every secret thing, whether it be good, or whether it be evil.

For as Jesus said, "For what is a man profited, if he shall gain the whole world, and lose his own soul?" Let us therefore plan our spiritual seasons, as wisely as our training seasons.

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