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Periodization: Effects Of Manipulating Volume And Intensity. Part 1

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WHILE PERIODIZATION HAS BECOME a household word in recent years among athletes, coaches, and sports scientists, actual research concerning strength training is scant. Most of our current knowledge concerning periodization or variation of strength-training protocols is derived from observational evidence, anecdotal data, inference from related studies (such as overtraining research), and a few mesocycle-length periodization/variation studies. The purpose of this 2-part paper is to discuss briefly the issues of periodization/variation, volume and intensity manipulation, and related research. Although some discussion is necessary, the primary purpose of this paper is not to elucidate underlying mechanisms, which have been presented previously (5, 21, 23), but to concentrate on performance.

The concept of periodization grew out of ideas at the turn of the century concerning the preparation of athletes for a seasonal competitive program. Thus, there could be different periods of preparation (and competitions) for fall and winter as compared with spring or summer (3). Matveyev (12) studied and summarized the modern concept of periodization based on these early ideas as well as on his earlier work from 1962. Matveyev (12) divided the training year into distinct phases, each with different characteristics. Several sports scientists and coaches have modified these phases depending upon the characteristics of different sports, the length of the sports season, and the individual characteristics of various athletes. However, the fundamental concepts presented by Matveyev (12) remain valid and widely used (3, 4, 23).

Periodization may be defined as "a logical phasic method of manipulating training variables in order to increase the potential for achieving specific performance goals" (20). Thus, a basic tenet of periodization is training nonlinearity. The primary goals of periodization are as follows: (a) reduction of overtraining potential and (b) peaking at the appropriate time or providing a maintenance program for sports with a specific season. The goals are met by appropriately manipulating volume and intensity factors and by appropriately selecting exercises. Briefly, periodized training can be divided

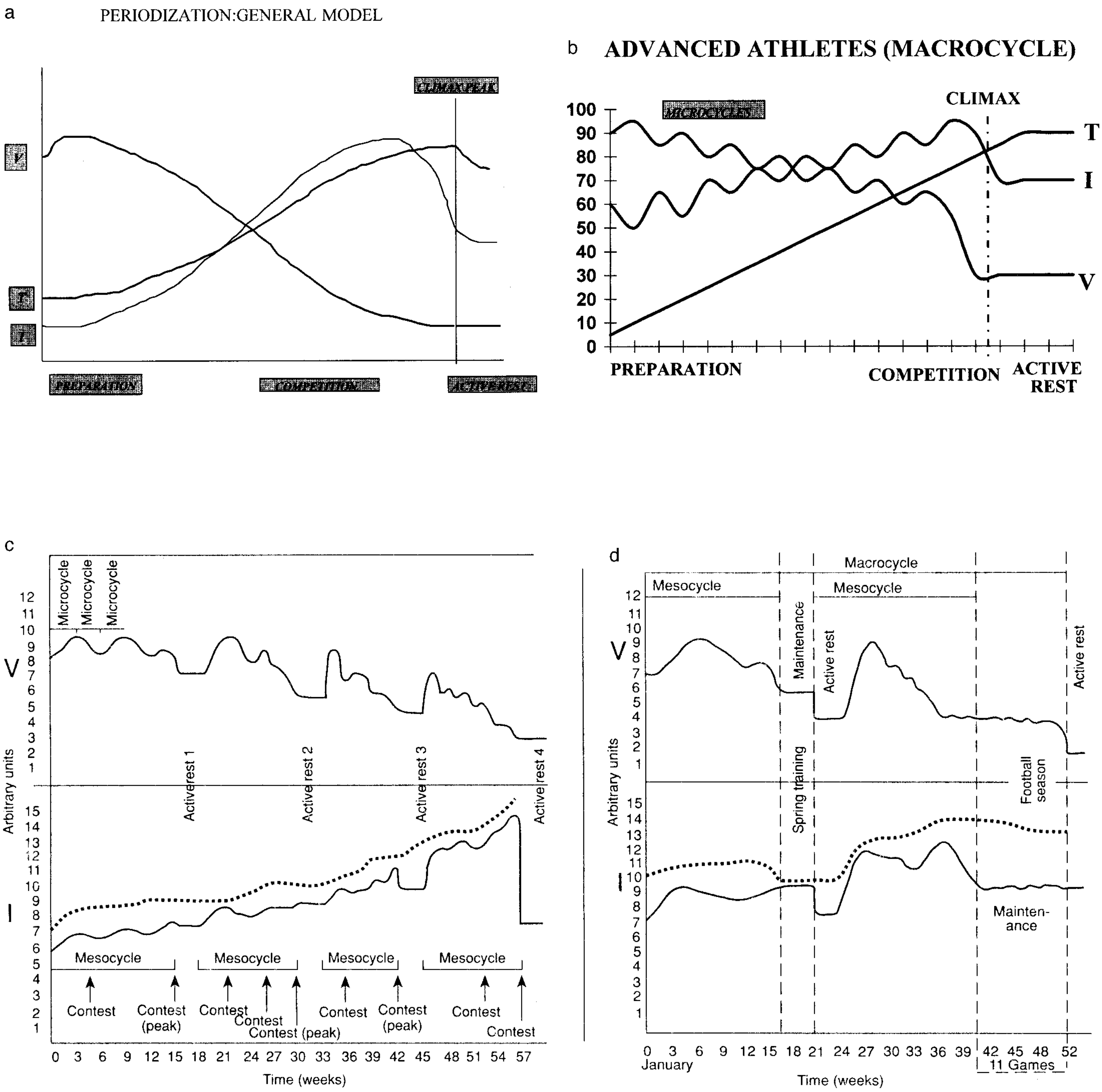

Figure 1. **(a) A generalized periodization model for strength training. Shows simple variation for a macrocycle or mesocycle. Volume begins relatively high and decreases; training intensity begins relatively low and increases. Emphasis on technique training increases in step with intensity (7). (b) A generalized model for advanced athletes. Shows that overall variation is similar to that in Figure 1b. Additionally, there are week to week and day to day variations (microcycles). (c) A theoretical, macrocycle-length training period for an elite shot-putter with multilevel variation. (d) A theoretical variant, macrocycle-length program for collegiate football.**

Table 1
Squats 4 Weeks Apart

	Load (kg)	Sets	Repetitions	Volume load (VL)	Time per set (s)	kg/s	Relative intensity (RI)
Day 1	60	1	10	600	25	24	24
	100	1	10	1,000	30	33	40
	140	1	10	1,400	30	47	56
	180	1	10	1,800	45	40	72
	180	1	10	1,800	47	38	72
	180	1	10	1,800	54	33	72
Total			60	8,400			
Mean	140		10		38.5	35.8	
Day 2	60	1	5	300	15	20	24
	100	1	5	500	15	33	40
	160	1	5	800	16	50	64
	210	1	5	1,050	22	48	84
	210	1	5	1,050	23	47	84
	210	1	5	1,050	23	47	84
Total			30	4,750			
Mean	158.3				19	40.8	

Note: Lifter's 1 repetition maximum was 250 kg.

into 3 stages or levels: the macrocycle (long-length cycle), the mesocycle (middle-length cycle), and the microcycle (short-length cycle—day to day variation). Each macro- and mesocycle generally begins with a high volume and low intensity of training and ends with a high intensity and low volume of training. The macro- and mesocycle can contain 4 phases: (a) preparation (general and special), (b) competition, (c) peaking, and (d) transition or active rest (7, 23, 27). Each of these phases has different goals and requires different degrees of variation. A generalized scheme for a macrocycle (or mesocycle) is shown in Figure 1a,b,c. A modification of the typical scheme can be made for sports with a definite season in which winning all contests (games) is a goal, such as in football (Figure 1d).

Theoretically, well-planned periodized programs can allow for tighter control of training variables, reduction in overtraining potential, superior performance adaptations, and generally superior performance at the appropriate time, such as peaking phases (5, 23). It should be noted that a true periodized plan is not only concerned with immediate competition but also prepares the athlete for subsequent years. Thus, periodization should be viewed as a method of long-term planning.

Different variation schemes than the periodization protocol described above have been used in practice (with some success) and investigated over a short term (8). Although these variation protocols have been loosely termed "periodized" schemes, they do not always completely fit the traditional periodized concept. While variation may be an important factor, not all variation schemes will produce exactly equal results (8, 21, 22).

The use of training-factor variation or periodized strength-training programs has gained considerable popularity in recent years. Several studies have attempted to examine models of periodized/variation programs for strength training (1, 6, 8–11, 12, 13, 16–19, 24–26, 29). All of these studies were of the mesocycle length and were 7 to 24 weeks in length. Two of these are actually a series of comparative studies (8, 16). Of these 15 studies, all but 2 (1, 6) indicated that periodized models produced statistically superior results in 1 or more of a variety of performance measures relating to strength, power, and endurance, compared with linear models. Of these papers, only 6 discussed experimental protocols with subjects with reasonably extensive previous strength-training experience (1, 8, 10, 16, 25, 29). Two additional studies (21, 22) compare 2 different variation models over a short term in elite junior weightlifters.

A factor that may confound interpretation of the efficacy of various mesocycle-length models deals with the total work accomplished as a result of the training program. All but 4 (1, 19, 25, 29) of the 15 periodization/variation studies were comparative investigations that attempted to ascertain which protocol for sets and repetitions produced superior results in a short period of time, regardless of work. Thus, in the majority of these studies, equalizing work for comparison's sake was not a primary consideration, not because it was overlooked by the authors but because this was not the purpose of investigation. In 1982, O'Bryant (16) indicated that periodized models result in superior gains in strength that are at least partially independent of total work (volume) accomplished and that variation of volume and intensity are the more important factors. O'Bryant (16) primarily based his conclusions on correlations between volume load (repetitions × mass lifted) and strength gains at different points in a mesocycle. In partially equating periodized and linear groups for volume by an estimation of work (volume load), Willoughby (29) supported O'Bryant's interpretation. However, Baker et al. (1) found that mesocycle-length models of strength training using equalized planned-repetition schemes (which assume work is essentially equal) produced essentially the same gains in maximum-strength measures.

Baker et al. (1) suggest that total work (volume) accomplished during a training program is the more important factor, regardless of the variation (or lack of variation) scheme used. Thus, it is possible that simply providing a greater volume of work (based on repetitions) would produce greater strength gains. They (1) also indicate that if volume and intensity are equal over a training period, the gains in strength will be equal. On the other hand, if O'Bryant (16) is correct, then superior strength gains are a function of both total work accomplished and manipulation of volume and intensity of training. Equalization of volume and intensity will be considered in some detail in Part 2 of this article.

In order to discuss the effects of volume and intensity factors, reasonable definitions must be used. The following definitions for training volume and intensity will be used in this discussion. *Volume* represents the amount of work performed per exercise, per day, per month, and so on. Work = force × distance. Consider performing 5 repetitions of a squat with 100 kg in which the vertical excursion was 0.6 m. The positive work performed would be 100 kg × 0.6 m × 5 repetitions = 300 kg-m (= 2940 joules). Work is proportional to the caloric cost of an exercise and is proportional to the energy used during a weight-training exercise, as well as to recovery (2, 15). Thus, measuring or estimating work is useful in estimating the energy consumption and training stress provided by a specific training session. In a practical setting, especially with large numbers of athletes, it is not typically feasible or necessary to calculate work; valid estimations are more efficient. In adults, the distance a mass is moved for a given exercise is relatively constant; thus, a reasonable estimate of work can be ascertained by calculating the volume load (repetitions × mass lifted). A secondary method for estimating training volume is to calculate the repetitions accomplished. Of these 2 methods, volume load gives a superior estimate of the training volume (20).

Intensity represents power output. Power is equal to work/time and is related to the rate of energy consumption. In our previous example, if the work during the squat (300 kg-m) were performed in 20 seconds, then the power output would be 300 kg-m/20 seconds = 15 kg-m/second (= 147 watts). This calculation represents the average concentric power during the execution of the exercise. In most sports, power is the most important characteristic to develop (5, 23, 28, 30).

Two different intensities or power outputs are involved in strength training: *training intensity* and *exercise intensity*. These intensities can be calculated or estimated in different manners. Training intensity represents an estimate of the average rate at which training proceeds; exercise intensity represents the actual power output for a single movement or group (set) of movements (20).

Training intensity can be estimated by the average mass lifted per exercise, per week, per month, and so on. Exercise intensity can be monitored by the relative intensity (RI; percentage of 1 RM [defined as the athlete's 1-repetition maximum lifting weight]). The example in Table 1 is taken from actual data; by comparing these 2 days, it can be seen that day 1 produced a higher volume (i.e., more work: 8400 vs. 4750 kg) but at a much lower training intensity (35.8 kg/second vs. 40.8 kg/second). Thus, training volume can be estimated by the volume load and training intensity by the average weight lifted. If reasonable weights are being used in training, heavier weights (for the same exercise) will produce a higher training volume and intensity. This is not true for exercise intensity.

It is known that the highest power outputs occur at approximately 30% of peak isometric

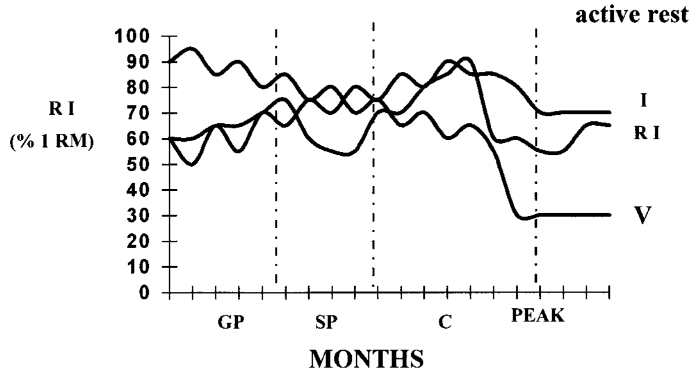

Figure 2. **The integration of exercise and training intensity in a mesocycle emphasizing speed and power development. The training intensity (I) is concerned with exercises that are typically devoted to basic strength (i.e., squats, lunges, and pressing movements); relative intensity (RI) depicts high-power (speed—strength) exercises, such as weighted vertical jumps, snatch and clean & jerk and derivatives and speed squats. GP is general preparation; SP is special preparation, which is a phase of relatively high volume but uses exercises that are more specific to performance; C is the competition.**

force. This corresponds to about 40–80% of the 1 RM depending upon the exercise and the level of training (5, 28). Note in the example that the highest estimates of power output did not occur at the heaviest loads. Thus, RI can be used to monitor the exercise intensity of training, with intermediate RIs producing the highest power. Exercise intensity is an important consideration in transfer of power from training to actual performance. Three published studies have addressed the importance of exercise intensity in a comparative manner (5, 14, 28). These studies using strength-trained subjects conclude that training-specific movements with a high exercise intensity (i.e., high power) can produce greater effects on power- and speed-related performance than can traditional, heavy-weight training. Furthermore, Harris et al. (5) and Medvedev et al. (14) have shown that the pattern of sequencing volume and intensity factors is strongly related to transfer of training effect and performance outcomes. Briefly, Harris et al. (5) indicated that in order to beneficially alter a variety of performance variables, particularly those concerned with power and speed, a mesocycle should progress from an emphasis on gaining strength to an emphasis on speed and power movements. This agrees with the previous observations of Medvedev et al. (14) and the general observation of numerous coaches (personal communications). An example of the integration of exercise and training intensity is shown in Figure 2.

Part I Summary

Periodization is a logical manipulation/variation of training variables to achieve specific goals. While simple variation of training volume and intensity can offer benefits in the reduction of overtraining and stimulate performance gains, periodized variation with specific sequencing of exercise selection, volume, and intensity factors offers a superior method of performance enhancement (5, 14).

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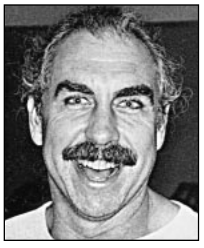

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