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Variety in Strength Training

by
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About the Author

Charles Poliquin received a B.Sc. in kinanthropology from the University of Ottawa, and is currently completing a M.Sc. in exercise physiology at the University of Montreal, researching in the area of strength training. Charles contributed to the recent revision of the strength training chapters of the theory manuals of the National Coaching Certification Program, and for technical manuals of various National Sport Organizations. He presented at various national coaching conferences for the Canadian Olympic Association and the Coaching Association of Canada, and lectured on sport-specific strength training applications for various National Sport Organizations such as gymnastics, judo, track & field, waterpolo, and swimming. Charles currently acts as the strength coach of the Canadian Men's and Women's Alpine Ski team.

Introduction

Variety is a critical factor in optimizing the strength training response, as it helps avoiding physiological and psychological stagnation caused by over-emphasized specialization. Practical experience indicates that the human body's adaptation to the training stresses can rapidly deteriorate, within only two weeks of exposure to a constant load[16, 23]. Unfortunately, few coaches realize that in order to optimize the benefits of a strength training program, the training loads must be periodically varied and/or progressively increased. As a result, many programs produce less than optimal results. This article will discuss various methods to build variety into training programs, to enhance their effectiveness.

Sources of variation

There exists a number of methods to incorporate variety into strength training programs, both in short and long-term contexts. The training program can be modified through the variation of one or many of the following factors: the magnitude of the training loads, the type and speed of muscular contraction, and the type of exercises performed.

Varying the training loads

The alternation of the training loads in terms of volume and intensity is of critical importance to the success of any strength training program[5]. The training load can be manipulated through the modification of the volume

and intensity of training. Volume can be controlled through the variation of the training frequency or the amount of work performed within a given training period. Phases of high volume (accumulation, extensive loading), high intensity (intensification, intensive loading), and unloading should be modulated within the program, to accommodate the principles of super-compensation.

There exists different views on the exact length of the loading and unloading phases. One approach suggests three weeks of loading followed by one week of unloading[18] (Figure 1). Another periodization method is based on the premise that the greatest overload occurs during the third week, when the athlete is the most fatigued. The latter approach therefore consists of a shorter loading period (two weeks) followed by a one week unloading period, to allow for super-compensation to occur (Figure 2). Both periodization methods fit the athlete's adaptive cycle particularly well, as opposed to the linear over-loading programming[2,20].

Varying the type of contraction

Various combinations of concentric, eccentric, and isometric training have been shown to promote faster rates of strength gains, as compared to concentric training alone[22]. The Soviet National Weightlifting coach, A.K. Worobojow[32] recommended the following proportional emphasis to be given to the different types of muscular contractions: 70% concentric, 20% eccentric, and 10% isometric. The increasing popularity of eccentric training is primarily due to the greater gains in hypertrophy and strength[14,15], which result from the larger muscular tensions and accompanying stimuli characterizing eccentric contractions[31].

The precise determination of the relative emphasis of each form of training should be based upon a consideration of the specific nature of the sport in question. Isometric training may be indicated, for example, for the mastery of certain movements in gymnastics, such as the Iron Cross, or the Front Arm Lever. On the other hand, greater emphasis on eccentric training would be appropriate for gymnasts experiencing difficulties in "sticking" upon landing, or for athletes participating in sports involving landings such as in ski jumping and long jumping. Finally, the demands of other sports requiring primarily concentric contractions (e.g. swimming) may also influence the relative importance of this type of training in the program.

Varying the speed of contraction

Muscular adaptations tend to be accelerated if the training loads are varied in their speed of movement, as opposed to maintaining a constant rhythm[3]. Maximal strength gains are produced through slow lifting movements[1,6], for several reasons. The first refers to the relationship existing between the speed of contraction and the resulting muscular tension. As shown in Figure 3, slow movements are associated with the development of high tensions, as opposed to the lower tensions developed during high velocity movements. That is to say that the greater the speed of the movement, the less will be the corresponding tension developed. Secondly, the movement of high loads at slow speeds precludes the possibility of the athlete taking the advantage of momentum created during the repetitions, thus increasing the stress on the muscles. Lastly, the deceleration of the movement (e.g. 3 to 10 seconds for each concentric and eccentric phase) augments the duration in which the stimulus is applied, to induce a more rapid development of strength.

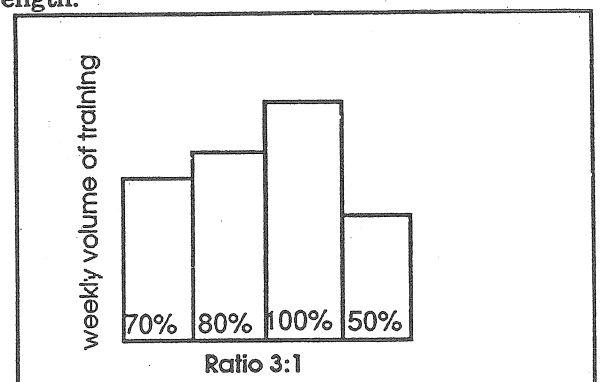

Figure 1. Loading distribution based on a four week cycle. Each block of the histogram represents a weekly volume of training in the form of percentage.

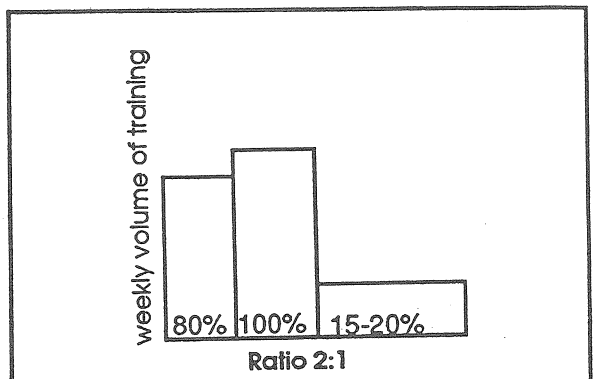

Figure 2. Loading distribution based on a three week cycle. Each block of the histogram represents a weekly volume of training in the form of percentage.

Many sports, such as those involving striking skills, are characterized by fast, explosive movements. It is important to consider the implications of high velocity training when designing sport-specific strength programs. While such training will enhance the muscles' power or speed-strength, it will not however produce maximal strength gains, due to the lower muscular tensions and corresponding lower stimulus levels observed in fast muscular contractions. Lastly, such training must follow the acquisition of a solid base of maximal strength, in order to limit risks of injuries.

Eastern Block countries typically use slow (30 degrees per second) to moderate (60 degrees per second) tempos of execution during the early stages of strength training[13,19]. The program should therefore progress from moderate to slow tempos in the early phases of the athlete's training schedule, followed by a gradual acceleration of the movements as the competitive season approaches.

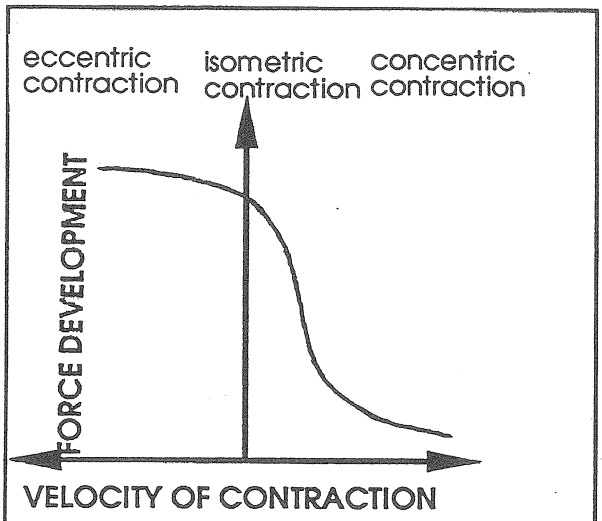

Figure 3. The relationship existing between the velocity of contraction and the tension developed. Differences can be seen in the total force developed in concentric vs eccentric contractions.

Figure 4 illustrates the effects of slow versus fast-speed strength training. Training at slow speeds raises the force-time curve, while training at high speeds shifts the curve to the left[26]. That is to say that athletes should train slowly to develop maximal tension during workouts and optimize strength gains, and then explosively for maximal improvements in the rate of force development.

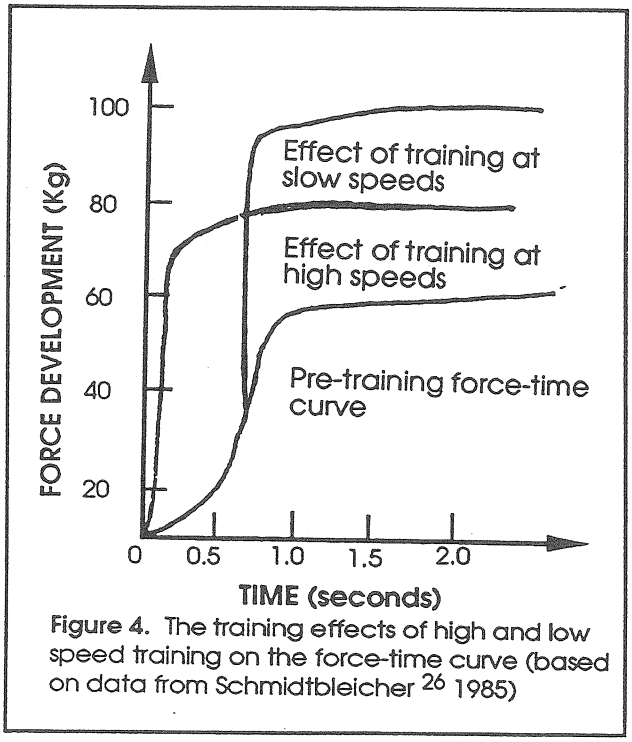

Figure 4. The training effects of high and low speed training on the force-time curve (based on data from Schmidtbleicher [26] 1985)

It is recommended that no more than 60 seconds of work be performed per set when training at slow speeds. For example, if the speed of the movement is reduced to 6 seconds for each concentric and eccentric portion of the lift, then no more than 5 repetitions per set should be permitted per set:
e.g. 5 X (6 sec concentric + 6 sec eccentric) = 60 seconds

Varying the exercise

The recruitment of motor units within a muscle appears to be fixed for a given movement, even if the speed of contraction varies[7]. However, in the case of a change in position[21] or for a multi-functional muscle performing different movements[8,11], this recruitment order can be changed.

The variation in the recruitment order relative to the movement pattern may partially explain the importance of specificity of training discussed in the literature[25], lending some support to the strength training practioners' long-held notion that full development of a muscle occurs when it is exercised through all its full range of motion[24]. Thus, the modification of the types of exercises in the training program (e.g. switch from dumbbell to barbell exercises, or incorporating different movement patterns in the exercises) represents another practical method to promote faster strength gains.

Short and long-term variation

Short and long term variation can be built into a strength training program. The following section will provide examples for application within both contexts.

Long-term variation

Long-term variation involves the alternation of the dominant modes of training methods of a program over the course of a macro-cycle, within a year or a multi-year plan. It is then a matter of modifying the nature of the exercises. Introducing a different type of training equipment, or progressing from general strength training to plyometrics training are examples of this form of variation. The following progression, recommended by Tschiene[28] for the various sport disciplines, illustrates how a program could vary over the course of a year.

Step 1: Emphasis is put on the general development of the athlete, of the so-called strength training base. This involves the training of maximal strength, speed-strength, and strength endurance.

Step 2: In this phase the emphasis is on the development of maximal strength of the specific muscle groups involved in the particular sport, without too much concern over the specificity of the movement direction and speed.

Step 3: Strength training is then focused on the specific needs for the sport in question. At this stage, consideration is given to the specific movement patterns observed in the sport, in terms of their speed and direction.

Step 4: Plyometric training[17] should be part of the last phase of the program, presented immediately before the commencement of the season, and maintained during the competitive schedule.

Figure 5 offers an example of the above progression, depicting the variation in the dominant loading modes over time, to improve the performance of the vertical jump.

Schimdtbleicher[27] suggested that athletes reach their potential more rapidly if training methods favoring the development of muscle mass are first employed, followed by intensive training norms focussing on the enhancement of motor-unit activation (increasing the recruitment and firing rate of the motor-units). The recommended approach is to alternate between stages of two weeks in duration, initially promoting adaptation through volume of training (accumulation phase) then through intensity of training (intensification phase), as shown in the examples provided Tables 1 and 2. It is important to note the inverse relationship between the intensity and volume of training illustrated in Tables 1 and 2. As the intensity of training increases, the volume of training decreases accordingly. Conversely, training intensity is reduced with increases in the volume of training.

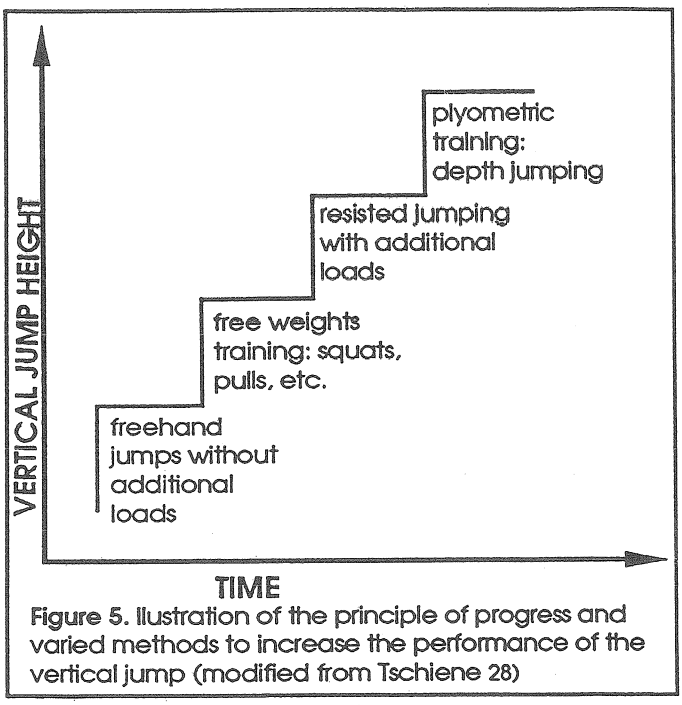

Figure 5. Illustration of the principle of progress and varied methods to increase the performance of the vertical jump (modified from Tschiene 28)

Table 1. Alternating accumulation and intensification phases for strength development, in sports where absolute strength is of critical importance (e.g. throws, sprinting, football).

Weeks	1-2 A	3-4 I	5-6 A	7-8 I	8-10 A	11-12 I
Reps	10-12	4-6	8-10	3-5	5-7	2-3
Sets	3	5	4	5	4	6
Intensity	70-75%	82-88%	75-78%	85-90%	80-85%	90-95%
Volume (total reps)	30-36	20-30	32-40	15-25	20-28	12-18

Note: A = Accumulation; I = Intensification

Table 2 depicts the undulation of intensity and volume of training within the program. The speed of contraction prescribed in the beginning of the program is relatively slow, in order to favor the accumulation of maximal strength, then gradually increased to train speed-strength.

Table 2. An eighteen week program to develop the strength and power of hip and knee extensors in general prepatory phase.

Phase	Exercises	Sets/Reps	Speed of Contraction	Comments
G.C.S.	• Dumbbell deadlifts	3/15-20	Moderate	Stop and go
	• Hack squats	3/15-20	Moderate	
Acc 1	• Trap Bar Deadlifts	4/8-10	Moderate	Stand on a 4' block
	• Heels elevated back squats	4/8-10	Moderate	Raise heels 3"
Int 1	• Snatch deadlift on podium	4/5-6	Super slow	5-6 seconds
	• Front Squats	4/5-6	Super slow	to raise and lower the weight
Acc 2	• Stiff-legged deadlift	3/10-12	Moderate	Stand on a bench
	• Power Squats	3/8-10	Moderate	Two second pause at sticking point
Int 2	• Sequence deadlifts	9*/3-5	Moderate	* 3 sets each at of these starting positions: floor, below knee, and mid-thigh.
	• Front Squats	6/2-3	Varied	8 seconds to lower the bar, up explosively
Acc 3	• Hang clean pulls	5/5-6	Fast	Explode from hang position.
	• Back squats	6/5-6	Varied	Alternate sets of normal work with sets of pure eccentric work
Int 3	• Snatch pulls	9*/1-3	Explosive	Perform the sets in a wave form of loading. (3, 2, 1, 3, 2, 1, 3, 2, 1).
	• Front Squats in • Power Rack	5/2-3	Moderate	Set bar at sticking point, and squat up
Acc 4	• Power Cleans	5/3-5	Explosive	Use 5,3,5,3,5 loading pattern
	• Speed Squats	3/8-10	Explosive	
Int 4	• Speed Cleans	6/2-3	Explosive	
	• Speed Halfsquats	4/5-7	Explosive	

Legend:
G.C.S.: General conditioning phase
Acc: Accumulation phase
Int: Intensification phase

Short-term variation

The training loads can be readily varied within a micro-cycle, through the use of any of the methods discussed earlier in this article. The exercise prescription may vary within a training session, or from one session to the next, through manipulation of the sets of exercises. Table 3 offers an example of the variation which can be built into a micro-cycle, in this case to train the shoulder extensors of a wrestler, during an intensification stage.

Table 3. Example of a micro-cycle for the training of the shoulder extensors of a wrestler, during an intensification phase.

Monday	Friday
Mid-grip chins (5 X 4-6)	Time chins 4 X 1 (20 sec. up, 20 sec. down)
One arm dumbbell rows (5 X 4-6)	Cable rowing to neck (4 X 4-6)
Incline curls (4 X 4-6)	Scott curls (1 X 8; 2 X 4-6; 3 X 2-3)

Considerations regarding the manipulation of the sets

The determination of the ideal number of sets per exercise has yet to be fully investigated. However, the following considerations are in order when defining the sets:

- Usually 1 to 2 sets suffice as a training stimulus for beginners. After 6 to 12 sessions, the workload should be increased to accommodate the adaptation of the muscles, up to 3-6 sets or more.
- Coaches must bear in mind the individuality of athletes' response to training.
- There should be an inverse relationship between the number of repetitions and the number of sets. Generally, as the number of repetitions performed per set decrease, the number of sets needed to overload the muscle must increase.
- Small muscle groups (e.g. biceps) tend to recover faster than larger muscle groups (e.g. quadriceps), and can therefore handle a greater amount of sets.
- Muscles not normally submitted to intense loading in daily activities, such as the thigh adductors and the neck flexors/extensors, respond well to a small amount of sets.
- Workout should be restricted to 20-25 sets.
- Sufficient rest must be allowed between sets to permit replenishment of the muscle phosphagens. After a few sets, the muscle may become fatigued to the point where the number of repetitions to failure is reduced.

Considerations relative to the design of a program

Prior to the design of a strength training program, several questions should be considered:

- What amounts and type of strength are required in your sport?
- Where do most of your sport's performances fit on the force-velocity curve?
- What muscle groups are solicited during your sport's performances?
- What are the typical movement patterns and velocities for which to train your athletes?
- What is your competitive schedule, and what is/will be the relative duration and timing of the various training phases?
- How will variety be worked into your training program?

Summary

There is a wide range of strength training exercises available to coaches and athletes, and several methods to ensure variety into the training program. Since the training response is the result of a disruption caused by the training stress, it is important to frequently create this type of disruption in the training routine. Such manipulation will result in the stimulation of the super-compensation processes, maintain the athletes' interest, and avoid finally boredom and stagnation.

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