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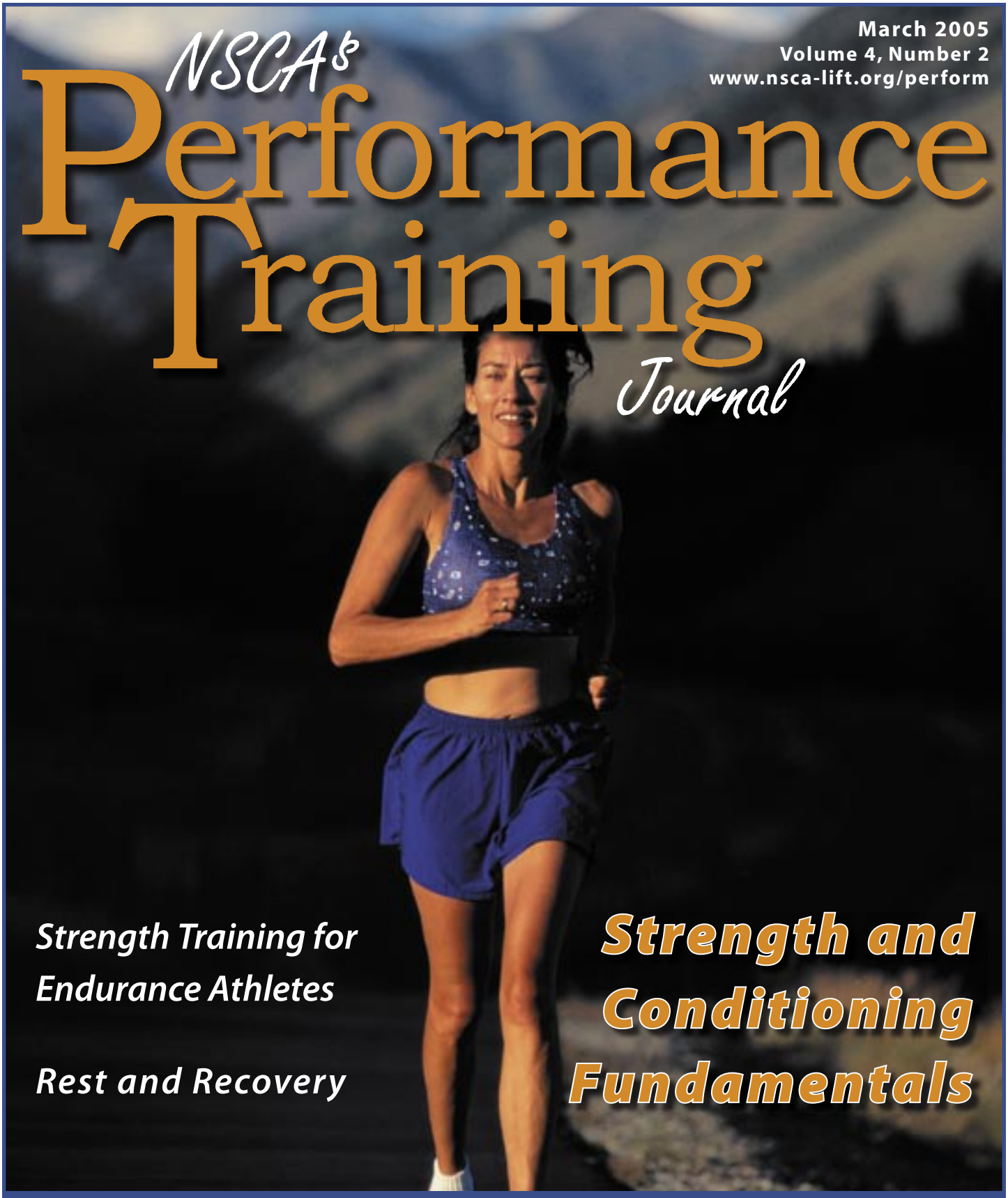


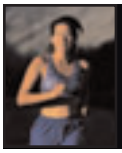
Strength Training for Endurance Athletes

Rest and Recovery

Strength and Conditioning Fundamentals

NSCA™ National Strength and Conditioning Association
Bridging the gap between science and application

Contents



Strength and Conditioning Fundamentals

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As the worldwide authority on strength and conditioning, we support and disseminate research-based knowledge and its practical application, to improve athletic performance and fitness.

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The Mental Cheat Sheet

As an athlete, you face a multitude of challenges. You are challenged with figuring out the training program that is going to work best for you, sticking to this training program, optimally fueling your body for peak performance, developing technical proficiency (if not excellence), managing your thinking in practice and competition, balancing your athletic pursuits with other endeavors, etc. The Mind Games columns in the *NSCA's Performance Training Journal* are designed to help you address many of the challenges you face. The intent is to provide you with tools and strategies to help you manage your thinking and enhance performance (or at least help you get out of your own way).

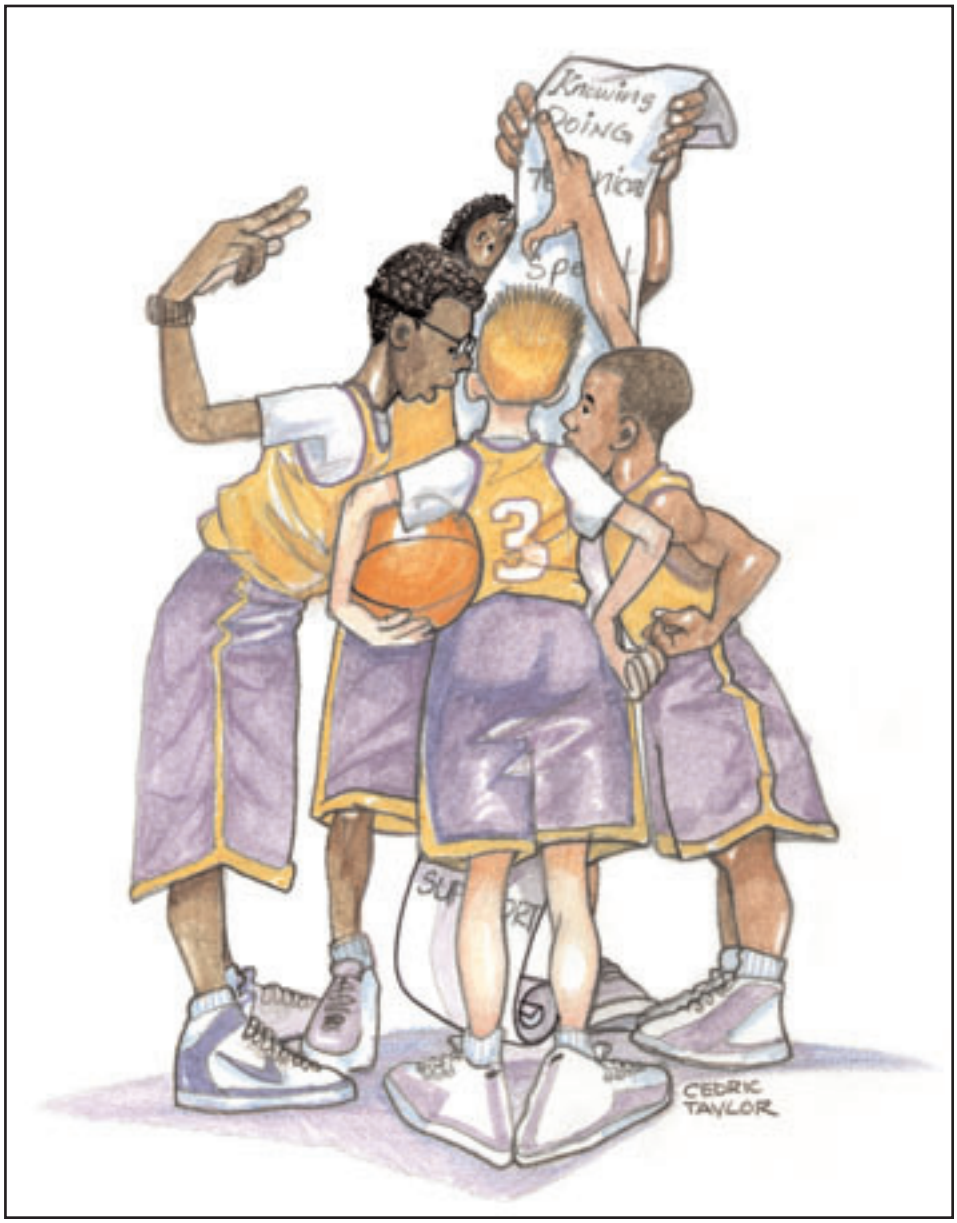
Knowing and Doing

As has been stated before, effectively managing your thinking requires both knowing and doing.

Knowing is all about awareness. Knowing entails understanding yourself and your tendencies regarding your thoughts, focus, self-talk, and confidence. What self-talk tends to help your performance? What tends to hurt your performance? What situations present the greatest mental challenges for you? An awareness of the answer to these questions is a critical step towards helping you manage your thinking.

Doing is the implementation. An awareness of the thinking, self-talk, and emotional state that is most conducive to performance must be put into action. A mental plan or approach that takes into account your tendencies, preferences, and mental strengths and weaknesses should be developed and implemented. This may sound easy in theory, but in reality it is tough to do.

Most athletes are able to do a pretty good job at controlling internal thoughts and



images during practices, but are presented with quite a different challenge of controlling internal thoughts and images during the heat of competition. The pressures, expectations, charged environment, competitors, and other mental challenges make it tough to control one's thinking. Are you one of these athletes who know what you should say, think, and do in competition but struggle in carrying it out? Once you know what effective thinking entails for you, how can you do a better job of managing your thinking in competition?

Creating a Mental Cheat Sheet

From the title, you probably thought this article would advocate cheating as a way to boost performance. Not quite. Remember back in college when your professor would allow you to bring in an index card or cheat sheet filled with any information you deemed relevant for the exam? Rather than getting mentally tied up by having to memorize specific formulas, definitions or lists for the exam, you had this information at your fingertips to refer to when needed. After all, the importance of this information was in the doing not just the knowing. Your professor understood that it was not just about regurgitating memorized information but about understanding where, when, how, and why the information was important. The cheat sheet helped take the pressure off during exam time. You were able to focus your attention on performing your best on the exam.

So, what does this have to do with you and managing your competitive thinking? Everything. You can create a mental cheat sheet for yourself to assist you in managing your competitive thinking. Your mental cheat sheet should include on it the things that are beneficial for you; what you should do, say, and think to optimize your performance. As an example, some common reminders on mental cheat sheets include:

- Specific technical cues,
- Specific elements of a competitive plan or strategy (explosive start, build into it, bring it home…),
- Attentional cues such as focus on yourself, focus on one shot/point/lift at a time, and keep your eyes and ears on the court,
- Confidence builders such as references to great workouts, past performances, or phrases such as "you've trained for this, you are ready."

Here are a few final tips you should keep in mind as you create your own mental cheat sheet:

- Keep it simple by limiting the number of reminders you include on the sheet. It is meant to serve as a reminder of the critical things you need to say, think, and do. It should not be an exhaustive list of everything you need to do.
- Keep it positive by writing down the things you need to do, not what you don't want to do.
- Keep it readily available. Have it in a handy place such as in your competition bag or in the pocket of your warm-ups. After all, it is only of value if you can access it when needed.
- Commit to implementing the reminders on your cheat sheet. These are the things you have identified as critical for your performance—stick to it. ▲

About the Author

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Debra Wein, MS, RD, LDN, NSCA-CPT

Calculating Your Daily Calories

Ever wonder how nutritionists or personal trainers are able to tell you exactly how many calories you need to lose the extra weight you put on over the holidays, or to gain the muscle mass you have been striving for? Well, there are various methods health professionals use to estimate your daily calorie needs. Let's first discuss what elements comprise your calorie requirements and then discuss how you can estimate your needs.

Your daily energy needs (caloric requirement) are determined by three factors. These are your resting metabolic rate (RMR), thermogenesis (calories required for heat production), and physical activity. Your resting metabolic rate is, essentially, the amount of energy (measured in calories) expended by the body during quiet rest.

Your RMR makes up between 60 and 75% of the total amount of calories you use daily. Physical activity is the second largest factor contributing to your daily calorie requirements. This is the most variable component of RMR, as this number changes based on the frequency, intensity, and duration of your workouts. Thermogenesis, also referred to as the thermic effect of food, is the smallest component. This is the amount of calories needed to digest and absorb the foods you eat. While certain diets claim to enhance this component (e.g. food combining programs), no research exists to support that concept. The bottom line is that regular physical activity is the best way to make a huge impact on your calorie needs.

Calculating Your Energy Needs

There are numerous ways to calculate your daily calorie needs. For a simple method, refer to the chart below and multiply your weight (in pounds) by the conversion factor.

Estimating Your Daily Calorie Needs

Multiply your weight (in pounds) by the conversion factor listed below. This will give you an approximation of how many calories your body needs to maintain its current weight, based on your activity level and gender. To lose or gain weight, see the section below.

Another method, which takes into your account your weight, height, age, and gender, but requires some calculations is provided below.

Use the following equation and plug in your weight (kg), height (cm), and age (years) in the following formula:

Males:

66 + (13.7 x Weight) + (5 x Height) – (6.8 x Age)

Females:

655 + (9.6 x Weight) + (1.7 x Height) – (4.7 x Age)

Note:

- To determine weight in kg: divide weight in lb/2.2
- To determine height in cm: multiply height in inches x 2.54

Table 1. Conversion factors for estimating daily caloric requirements based on gender and activity level.

Activity Level *	Light	Moderate	Heavy
Male	17	19	23
Female	16	17	20

* **Light activity level:** walking (level surface, 2.5 – 3.0 mph), housecleaning, child care, golf.
Moderate activity level: walking at 3.5 – 4.0 mph, cycling, skiing, tennis, dancing.
Heavy activity level: Walking with load uphill, basketball, climbing, football, soccer[1].

To this, you must add an activity factor between 1.2 and 1.5 to account for your average amount of physical activity[2].

- 1.2 bed rest
- 1.3 sedentary
- 1.4 active
- 1.5 very active.

I know my calorie needs, how does this affect my weight?

Once you have an estimate of how many calories you need daily, you must then decide if you are trying to lose, gain, or maintain weight. In order to change your weight by one pound, you must increase (to gain) or decrease (to lose) your intake by 3500 calories. For weight loss, it is advisable to reduce your daily caloric intake by 250 calories per day (to lose one pound per week) and to increase your daily expenditure (through exercise) by 250 calories. This 500 Calorie difference, when multiplied by 7 (days in one week) will allow you to offset your caloric balance and result in one pound of weight loss. Double these numbers if you are trying to lose 2 pounds per week. Most health organizations recommend a weight loss rate of 1 – 2 pounds per week.

To gain weight, add 300 – 500 calories to your daily intake in order to promote a weight gain of up to one pound per week. Be sure to continue your exercise routine so that the additional calories can be used to fuel muscles, rather than simply store additional fat. Follow your new calorie plan for a few months and make changes as needed. ▲

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2. Roitman J (Ed). (2001). *ACSM's Resource Manual: For Guidelines for Exercise Testing and Prescription (4th ed.)*. Philadelphia: Lippincott, Williams and Wilkins.

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Jason Brumitt, MSPT, SCS, ATC, CSCS

Exercise Modifications for Shoulder Instability

Injuries to the shoulder are common in sports. Compared to other joints of the body, the shoulder sacrifices joint stability to allow for greater mobility. This mobility allows for athletic performance with overhead motions such as the baseball pitch or the volleyball spike. Athletic injuries though can result from repetitive stresses placed upon the shoulder joint.

Shoulder Joint Instability

Ligamentous laxity (or looseness) may develop in an athlete's shoulder, especially among those who perform repetitive overhead activities (throwing, volleyball). For example, baseball pitchers often experience laxity of the anterior shoulder's ligamentous structures[1]. The repetition of throwing will stretch those structures over time, creating laxity. Shoulder joint instability, especially anteriorly, may predispose the shoulder to an increased likelihood of developing other shoulder conditions. Incorrect or inappropriate weight training may further damage an unstable shoulder.

Exercise Considerations

If an athlete is experiencing shoulder pain, he or she may benefit from a referral to physical therapy for a rehabilitation exercise program after first consulting with his or her physician. Athletes who are injury free, but have had a history of anterior shoulder instability, should develop a comprehensive and safe training program with the help of a Certified Strength and Conditioning Specialist. In the meantime, adopting these exercise technique modifications to some frequently performed exercises will protect and maintain shoulder health.

Bench Press

When performing the traditional bench press, the bar is lowered to the chest with the elbows dropping below the body. This position places excessive stress upon the anterior shoulder. Instead of lowering the bar to the chest, modify the exercise by lowering the bar toward the chest and stopping when the elbows are bent at a 90-degree angle (Figure 1). The elbows should not drop below the side of the torso.

Shoulder Press

Performing the "behind-the-neck" version of the shoulder press (figure 2) will create shearing forces directed through the anterior shoulder. To modify the exercise, lower and raise the bar in front of the body (figure 3). Some may find the need to avoid lowering the elbows below shoulder height.

Lat Pulldown

The lat pulldown performed behind the neck (figure 4) places stress upon the anterior shoulder in a similar fashion to the behind-the-neck shoulder press. Pulling the lat bar toward the chest (figure 5) will help to reduce the anterior shearing forces upon the shoulder joint.

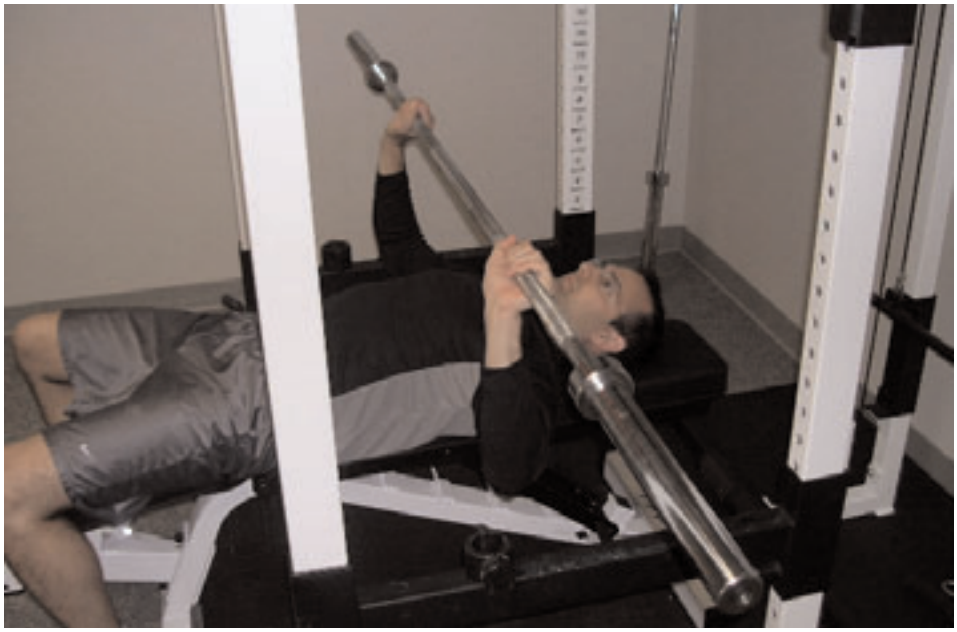

Figure 1. Modified Bench Press Bottom Position

Figure 2. Shoulder Press Behind the Neck

Figure 3. Shoulder Press in Front of the Body

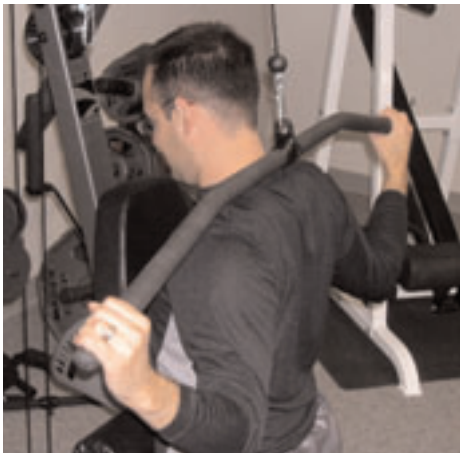

Figure 4. Lat Pull Down Behind the Neck

Figure 5. Lat Pull Down Pulling Bar Toward the Chest

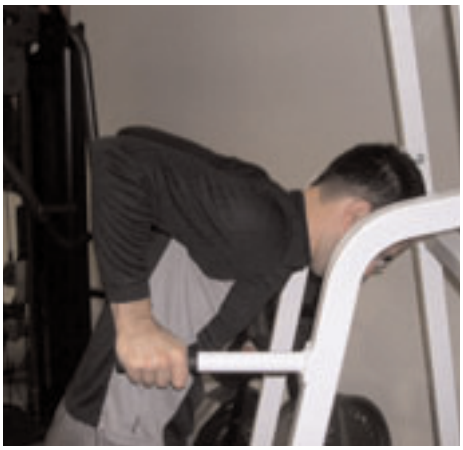

Figure 6. Deep Dip Bottom Position

Figure 7. Modified Dip Bottom Position Neck

Dips

Instead of performing a "deep" dip, which will increase anterior shear forces to the shoulder joint (figure 6), stop the body's descent once the elbows are bent to a 90-degree angle (figure 7). One should not feel as if all of their body weight is directed through the shoulders.

Conclusion

Adopting these exercise modifications will allow one to safely continue with a strength-training program while maintaining the health of the shoulder joint. ▲

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About the Author

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The Effects of Body Size and Gender on Overarm Throwing Performance.

Researchers from the Norwegian University of Science and Technology in Trondheim, Norway recently examined the relationships between maximal isometric strength, anthropometry, and maximum overarm throwing velocity in 20 male and 20 female handball players. Research showed throwing velocity was higher in the male athletes (23.2 m/s) when compared to the female athletes (19.1 m/s). However, these differences were not statistically significant.

Overall isometric markers of strength were significantly correlated with throwing velocity (men: r=0.43; women: r=0.49). This suggests that overall strength plays a role in an athlete's ability to throw at higher velocities. Further examination revealed that isometric strength and throwing velocity were related to overall body size for both the male and female athletes—with larger athletes exhibiting greater isometric strength and throwing velocities.

When examining the throwing velocities by body mass or height for each gender, a significant difference existed between the male and female athletes: When velocity was expressed—related to fat free mass—the difference between genders was insignificant. The researchers concluded that overall size (or as they termed it "muscle bulk") and muscular strength explained part of the differences in throwing velocity seen between male and female handball players. This data strongly suggests that strength training, which increases muscular size and/or strength, plays a significant role in an athlete's ability to throw at high velocities and generate high measures on tests of isometric strength. Therefore, it would be beneficial for athletes looking to throw at high velocities to include some form of strength training in their programs.

Van den Tillaar R, Ettema G. (2004). Effect of body size and gender in overarm throwing performance. *European Journal of Applied Physiology, 91(4)*:413 – 418.

Does Listening to Music Improve Endurance Performance?

Many athletes believe that listening to music during exercise results in improvements in performance. However very little research has been conducted examining the ergogenic effects of music on actual sports performance.

Recently researchers from Loughborough University and Liverpool John Moores University examined the physiological and psychological effects of music on 10-km cycling time trial performance. A total of 16 endurance athletes who utilized cycling in their training were recruited for this study. Each subject performed two 10-km time trials, one of which required subjects to listen to music. The music selected was categorized as "trance" music, which was a form of dance music with a tempo of ~142 beats per minute.

The results of the study suggest that the utilization of music did contribute to a significantly higher mean speed (+2.6% km/h), mean power (+4.7% W), and mean heart rate (+4.2 beats/min) when compared to the time trial performed without music. Close inspection of the music time trial revealed that the subjects cycled faster during the first 3 km and last km of the time trial when compared to the condition that did not have music.

When looking at the subjects' rating of perceived exertion (RPE) during the time trials, it was determined that the music

condition elicited a significantly higher average RPE (+5.6%) when compared to the time trial performed without music. Further exploration into why the music was effective revealed that the music's "tempo" and "rhythm" were the most motivating components of the music.

In conclusion, it appears that using music can enhance performance through increasing the athlete's ability to maintain higher speeds, power output, and heart rates during 10-km time-trial performance. However, the athlete may have to pay particular attention to the initiation of the time trial, as a fast start may impair performance at the end of the race.

Based upon this research, it appears that dance music that has a fast "tempo" (and contains strong rhythms) may be the most beneficial type of music for the athlete to select.

Atkinson G, Wilson D, Eubank M. (2004). Effects of music on work-rate distribution during a cycling time trial. *International Journal of Sports Medicine, 25*:611 – 615.

How Does Getting Older Affect Weightlifting and Powerlifting Performance in Men and Women?

A recent study published by researchers from the University of Texas at Austin explored the effects of gender and age on weightlifting (snatch and clean & jerk) and powerlifting (deadlift, squat, and bench press) performance. Age group records were collected in various age categories from U.S weightlifting and Powerlifting Organizations. When examining the data, it was apparent that overall lifting performance, regardless of the type of lifting sport, decreased with advancing age (<40 to 69 years of age) regardless of gender. Also, it appeared that weightlifting performance demonstrated a significantly greater performance decrease with advancing age when compared to powerlifting—regardless of gender.

> **"strength training… plays a significant role in an athlete's ability to throw at high velocities…"**

The rate of weightlifting-performance decline seemed to be curvilinear with the most rapid decreases in performance occurring between the ages of 40 – 44 in both men and women. Additionally, it appeared that women experienced a greater overall magnitude of performance decline (-70%) in weightlifting as they age than men (-45%). However, the decline seen in women weightlifters may be a function of the fact that women's weightlifting is a relatively new sport.

When closely examining the performance decrements associated with aging during powerlifting, it was noted that performance decreased linearly with each five year increment from the age of 40 to 69 (-35% men; -55% women from 40 to 69) and that there were no significant differences between upper (bench press) and lower body exercises (squat). Additionally, the rate of decline in powerlifting performance was not significantly different between genders.

The researchers concluded that muscular strength and power do in fact decline with age. Additionally, they concluded that muscular power and exercises that require greater neuromuscular coordination (weightlifting) experience greater reductions in response to aging. Close examination of the present study suggests that weightlifting performance is much harder to maintain as weightlifters become older versus that of powerlifting performance.

Therefore, it is likely that master's weightlifters (>40 y) will experience rapid decrements (25 to 35%) between the ages of 40 – 44 in performance in response to aging—while powerlifters experience smaller decreases (10 – 15%).

Anton MM, Spirduso WW, Tanaka H. (2004). Age related declines in anaerobic muscular performance: weightlifting and powerlifting. *Medicine and Science in Sports and Exercise, 36(1)*:143 – 147. ▲

About the Author

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The Benefits of Strength Training for Endurance Athletes

Travis M. Erickson, MS, CSCS

Introduction

Many athletes abhor the idea of running laps for football or being on the stationary bike to cut weight for wrestling, but if the desire to compete remains strong enough for an athlete even after their athletic career is completed, they may actually find themselves entertaining the idea of competing in an endurance race of some sort. Of course this is only one example of why an athlete may get into endurance sports; other examples such as a desire to lose weight, remain healthy, or picking an activity that does not hurt (e.g. a basketball player who begins swimming because chronic knee pain does not allow them to run up and down the court anymore). The point is—not all endurance athletes were born endurance athletes.

> "Intelligent use of the weight room… can have a dramatic influence on the success of the competitor."

An endurance "newbie" often has no idea how to train for the sport. He or she may simply buy a pair of running shoes and begin running. This is not a bad way to start, but at some point if this person is going to get serious about actual competition, he or she is going to need to learn how to train for the sport.

The endurance athlete who was "born" to run, cycle, or swim, likely has this information down already, but there may be one area lacking in their training: effectively using the weight room to best enhance performance. This is an area where the cross-over athlete may have an advantage. It is no secret that one is more likely to see the football team in the weight room than the cross country team. Although a football-specific workout is not designed to enhance cardiovascular fitness, it stands to reason that athletes who were previously engaged in sports that required use of the weight room are more likely to return to the weight room again due to the enjoyment that they may have had there and experience in doing such activities.

From this standpoint, the 35-year-old former basketball player who wants to seriously compete in 10k's could have an advantage over the 35-year-old non-athlete who just decided to begin running. Intelligent use of the weight room, just like intelligent implementation of a running program, can have a dramatic influence on the success of the competitor. This success can be defined as faster running times, but can also be extended to include reduced injury risk, and an overall heightened enjoyment of the sport, a goal that many athletes surely have.

Training

In very general terms, sports have an in-season and an off-season. The goals of these different periods vary drastically, as should the training. During the off-season, an endurance athlete is often looking to incorporate a variety of different training methods (commonly referred to as cross-training) as they look to expand their

endurance base. The exercise intensities are often fairly low, but the duration of activity is fairly long. During the in-season period, the athlete has scheduled some races of varying importance. The training becomes more intense (workouts at race-pace for example), which may be slightly shorter in total duration. Obviously this is a simplification of the process, as each athlete will utilize his or her own strategy, but in general terms, it is how most endurance athletes train throughout the year.

The resistance training program should, in essence, parallel this pattern of training. The common fault for endurance athletes is that the lifting workout never really changes. The athlete continues to do circuit training or high repetitions and sets throughout the year at very low intensities. Tables 1 and 2 demonstrate how strength programs should be designed for endurance athletes.

Table 1. Endurance Off-Season

Program variables			Repetitions per Set					Notes
Day	Order	Exercise	1	2	3	4	Rest	
1	1a	Back squats (figure 1)	20	20	20	20	60s	Stay light and go deep
1	2a	Walking lunges	15	15	15	–	60s	15 repetitions on each leg
1	3a	Romanian deadlifts (figure 2)	20	20	20	–	45s	Keep weight on heels—slight bend in knee
1	4a	Leg extensions	20	20	20	–	45s	May be contraindicted for some people
1	5a	Calf raises	20	20	20	–	45s	Seated or standing
1	6a	Anterior tibialis exercise	20	20	20	–	45s	Anti-shin splints exercise
1	7a	Leg raises	20	20	20	–	45s	For lower abdominals
2	1a	Bench Press	20	20	20	20	60s	
2	2a	Bent over barbell row (figure 3)	20	20	20	20	60s	Keep back bent over—don't jerk
2	3a	Flat DB chest flyes	20	20	20	–	60s	May use machine instead
2	4a	Front lat pulldown	20	20	20	–	60s	May do pull-ups instead (or pull-up assist)
2	5a	DB shoulder press	15	15	15	–	60s	May use machine instead
2	6a	DB bicep hammer curls	20	20	20	–	45s	Seated or standing
2	7a	Cable tricep pushdowns	20	20	20	–	45s	Rope or bat attachment
2	8a	Weighted crunches	20	20	20	–	45s	Or crunch machine
2	9a	Oblique crunches	20	20	20	–	45s	Twisting crunches or machine
3	1a	DB step-ups	15	15	15	15	0s	Alternate legs—15 each
3	1b	Push-ups	15	15	15	15	0s	
3	1c	Step-back (reverse) lunges	15	15	15	15	0s	Hold dumbbells or use body weight only
3	1d	Seated row	15	15	15	15	0s	
3	2a	Leg press	15	15	15	15	0s	
3	2b	DB lateral raise	15	15	15	15	0s	
3	2c	Stability ball leg curls (figure 4)	15	15	15	15	0s	Or machine leg curl
3	2d	DB pullovers	15	15	15	15	0s	Get a good stretch
3	3a	EZ bar bicep curls	15	15	15	15	0s	
3	3b	Back extensions	15	15	15	15	0s	
3	3c	EZ bar lying tricep extensions	15	15	15	15	0s	

*** The third day is a circuit day: go through circuit 1 twice and then go to circuit 2 and then three. After you have gone through each circuit twice, go through all three circuits again. There should be little to no rest between exercises.**

Table 2. Endurance In-Season

Program variables			Repetitions per Set					Notes
Day	Order	Exercise	1	2	3	4	Rest	
1	1a	Split jerk (figure 5)	5	5	5	–	2 min	Barbell or dumbbell—land in split position
1	2a	Back squat	8	6	4	–	2 min	Go pretty heavy
1	3a	Forward stepping lunge (figure 6)	6	6	6	–	2 min	Do all one leg first, then the other
1	4a	Bench Press	8	6	4	–	2 min	
1	5a	DB shoulder press	8	8	8	–	90s	
1	6a	Tricep exercise (choice)	8	8	8	–	90s	
1	7a	Weighted crunch	15	15	15	–	90s	
1	8a	Oblique crunches	15	15	15	–	90s	
2	1a	Standing tuck jumps (figure 7)	5	5	5	5	3 min	Be quick off the ground and jump high
2	2a	Alternating leg bounding (figure 8)	4	4	4	4	3 min	4 bounds each leg
2	3a	Underhand medicine ball throw (figure 9 & 10)	5	5	5	5	3 min	Throw backwards—use 6 – 12 lbs ball
2	4a	Bent over barbell row	8	6	4	–	2 min	
2	5a	Bicep exercise (choice)	8	8	8	–	90s	
2	6a	Back Hyperextensions	12	12	12	–	90s	

*** Find a soft surface to do your jumps—grass works well, just make sure there are no holes.**

Note that the workouts are very different from one another. As stated earlier, many athletes choose to train in the same manner the whole year, but this method does not take advantage of the body's ability to specifically adapt to the workout variables that are presented during each phase of training. An endurance athlete should not have the goal of achieving their fastest times during the off-season because there are no races then. Likewise, this athlete should not do heavy, intense lifting during this time either. When in the meat of the competition schedule, the athlete needs to remain healthy and fast. The more intense, but lower volume lifting workout is meant to accomplish these goals. Table 3 explains the rationale between the key differences between the two workouts.

Most endurance athletes who have little experience in resistance training will not appreciate what intense resistance training will do for them in their sport. Some fear that they will add unnecessary bulk to their frame, or that heavy lifting will reduce their VO_2 maximum and thereby make them slower. These fears are not unfounded, as heavy lifting will add lean muscle tissue, and high intensity, long rest period workouts can have the effect of reducing aerobic efficiency. However, these adaptations will only happen if this workout is maintained over a long period of time (several months). But, when properly inserted into a workout over a short period (two different four week periods), the adaptation is mainly neural in nature, meaning there is only a small physiological change that would have any chance of negatively influencing the endurance athlete[1].

Even for those who buy in to an aggressive in-season program for endurance activities, may do so for the wrong reasons. They believe that the only time in which being fast and powerful would be of real benefit to the endurance athlete would be during the final kick, or perhaps climbing a difficult hill.

Suppose, for example, that you could reduce the number of strides you took in a distance race by 10%. Do you think that this would allow for faster running performance? Tall, lanky runners with long, loping strides are often the envy of their shorter counterparts. You cannot change how tall you are, but you can influence your running stride by learning better running mechanics, and also increasing the amount of force with which you push-off the ground on each step. A small increase in force will allow for a slightly longer stride

For example, let us assume that a given runner has a stride length of five feet. During the course of a 5K race they would take 3280 strides. An increase in stride length of just 6 inches would allow for the individual to take just 2981 strides, a reduction of over 9%. Heavy resistance training, and specifically some form of plyometric training, is the best way to increase stride length, and therefore running economy.

Conclusion

In endurance competition, individuals who come from a strong resistance training background but have never participated in endurance sports may have a leg-up on those who have never lifted weights before, because they are accustomed to a variety of lifting protocols including power type exercises and plyometrics. These athletes may, therefore, be able to successfully enter the fun and personally challenging realm of competitive athletics again even though their football or track and field days are long gone. Although resistance training is not a panacea for all athletes, if one is serious about taking his or her training to the highest level, even the endurance athlete has to seriously consider how resistance training can positively influence performance. ▲

Table 3. Differences between in-season and off-season programs

Acute Program Variable	Off-season	In-season
Volume	The high volume in the off-season is meant to increase local muscular endurance. This is meant to parallel the longer duration running, cycling, etc. that is also going on at this time to help build a stronger endurance base	Lower volume in-season allows for higher intensities. In addition, high stress demands of intense endurance workouts and races require lower lifting volume to reduce the risk of overtraining
Intensity	Very low intensity during this time period ensures that some degree of aerobic benefit is seen, but it is also required to be low when the volume is so high	A higher intensity during this period is utilized to elicit a neurological response that makes the muscles stronger and more powerful, which will enhance stride length, thus increasing running efficiency/economy
Rest Periods	Short rest periods keep the heart rate up and blood pumping, which adds to the endurance qualities of the athlete during this period	Longer rest periods are required in order to "re-load" the muscles with the fuel necessary to exert high levels of force and power. High complexity activities, such as plyometrics, require a longer rest period for the nervous system to adapt
Choice	Exercise are basic in nature that hit all major muscle groups. There are a combination of multi- and single-joint activities, and some are in place to aid in injury prevention	Exercises are sports-specific in nature or purposely chosen to be explosive. Single-joint exercises are included, but not required as part of the workout, as they do not typically aid the athlete at this time

Figures

Figure 1. Back Squat

Figure 2. Romanian Deadlift

Figure 3. Bent Over Barbell Row

Figure 4. Stability Ball Leg Curl

Figure 5. Split Jerk

Figure 6. Forward Stepping Lunge

Figure 7. Standing Tuck Jump

Figure 8. Alternate Leg Bounding

Figure 9. Underhand Medicine Ball Throw 1

Figure 10. Underhand Medicine Ball Throw 2

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About the Author

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Mark Roozen, MEd, CSCS,*D

Using a Slant Board for Agility "Triple Extension" Development

In the past, we have mentioned in this column that agility is the ability of the body to rapidly change direction without the loss of speed, balance, or body control. We've also talked about how it is important to have the different components that make up agility (balance, strength, deceleration, etc.) working together as one unit. In this article, we would like to address a simple training tool that, when used properly, can help you achieve appropriate positioning and help to coordinate movements. The device is the slant board, which is a simple tool to use.

Triple Extension

When working with explosive and power movements such as Olympic lifts and speed work, many training experts talk about the "triple extension" that is needed to reach maximum power development. Triple extension describes the extension through three lower body extensors; the ankles, the knees, and the hips. When coordinated in proper sequence and with proper motor skill development, peak levels of power output can be obtained.

The same holds true when we speak about developing power and proper sequence of movement in agility work. Making sure that a "triple extension" position is achieved is vital to reach optimal success when working on agility and quickness. Figure 1 demonstrates the appropriate body position (utilizing triple extension) during the breakdown of lateral movement. Proper position includes: weight on the inside of the foot, the ankle to knee angle less than 90 degrees, and the hips (center of gravity) in a low position to achieve extension. In figure 2, the foot is flat, the ankle and knee are in a vertical line and the hips high, as we lose our "power angles" and the ability of the body to produce force and movement.

The Slant Board

The slant board (see figure 3) is a simple device you can use to help learn, or improve your ability to get into, the triple extension position. A key here is to avoid maximum speeds when first using the slant board. Use the board more to help develop proprioception and achieve the triple extension position with assistance. A good place to implement the slant board into your training program is as part of the warm-up progression. This helps to: activate the nervous system, stretch and warm the muscles that will be used for agility work, and develop proper joint angles[1].

Figure 1. Proper triple extension during lateral movement

Figure 2. Improper body position during lateral movement

Figure 3. The slant board

Table 1. Guidelines for beginners to advanced athletes using slant boards.

Level	Contacts	Approach Distance	Speed
Beginner	10 – 20 each leg	1 – 2 Steps	25 – 50%
Intermediate	15 – 30 each leg	1 – 3 Steps	40 – 65%
Advanced	25 – 40 each leg	1 to 4+ Steps	55 – 80%

Table 1 shows a user's guide for beginners to advanced trained athletes. Make sure not to overuse the slant board. As with any training device that is implemented into a program, the movements should progress from simple to complex.

Conclusion

The slant board can be used as a great tool to assist with development in your agility program. Once you're able to perform basic moves on the slant board, you can work toward more complex movements such as turns, change of the angle of approach, added resistance, and more. The key is to progress slowly, making sure you are able to control the movement and your body position. With proper order and sequence of training, you will be able to see improvements in other areas of your agility training program as well. ▲

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Tracy Morgan Handzel, CSCS

Interval Training

To Improve Energy System Development

Experts suggest that interval training is the most appropriate method of training for improved energy system development (ESD)[1]. This method of training involves alternating predetermined periods of work at specific intensities, with periods of rest (inactivity) or recovery (low intensity activity) for a given amount of time or repetitions. Because most sports demand alternating periods of work and rest, this type of training can be highly sport specific and therefore beneficial in improving performance.

You can create your own interval training program based on the specific demands of your sport and the goals you wish to achieve. But first you must have a general understanding of the energy systems that play a role in your sport. Here is a quick review of the three energy systems responsible for providing your body with fuel for activity.

The phosphagen system fuels activity that is very short (<30 seconds) and intense. It is called into play at the beginning of all activities.

The glycolitic system provides energy for intense to moderately intense activities that last longer than 30 seconds and up to about three minutes.

The aerobic system fuels activity of low to moderate intensities for longer than three minutes.

Keep in mind that these energy systems do not work in isolation. One energy system may dominate and at times systems overlap and/or alternate.

Follow the steps below to determine the energy systems that are involved in your sport and create your own interval training program based on the specific demands of your sport.

Step 1

Assess your sport's intensities.

Intensity is the first factor that determines which energy system comes into play during activity[1]. Most sports require athletes to work at varying intensities. That is, sometimes all out effort is demanded and at other times more moderate effort is demanded. Periods of rest are included as well. Identify the ranges of intensities demanded from your sport. Very high intensity signifies all out effort. Moderate intensities require medium degrees of effort and low intensity requires minimal efforts.

Step 2

Identify work-to-rest ratios.

Duration is the second factor that determines which system is responsible for providing energy during activity[1]. It can be difficult to characterize typical work-to-rest ratios in most sports, as the nature of sport makes them highly unpredictable. Do your best to determine a range in the length of time you are active in the intensities you've already identified. Also determine a range in the length of time you are able to rest or recover during activity.

Step 3

Replicate the energy system demands to create a defined training regime.

Once you have determined the intensities and work-to-rest ratios involved in your sport you will be able to recognize the energy systems that are in use in your sport and reproduce the demands of your sport. Simply create a series of work-to-rest ratios at specific intensities that reflect the information you have already obtained. Here are a few tips that may be helpful.

Interval training tips

Rest periods affect intensity.

It may seem that the work periods of your program determine how hard your workout will be. However, the amount of rest you have can be a greater determinate of overall training intensity. Shortening your rest periods requires your energy systems to recover quicker. If you begin your next interval bout without sufficient recovery from the previous bout, the accumulation of training stress can create fatigue. As a general guideline, if you are a beginner keep rest periods longer than work periods. As training becomes more tolerable, decrease the rest periods gradually. Highly trained individuals may keep rest periods very short to increase the training challenge during specific training periods.

Include sport specific movements.

With the exception of water sports, most sports rely on running as a means of locomotion. However, few sports solely involve running straight ahead for a given period of time. Be sure to include change of direction and any sport specific movements like shuffling or backpedaling where appropriate.

Follow basic periodization guidelines.

Interval training can be an intense but beneficial form of training. In order to prevent overtraining or injury, keep in-season training at lower volumes and fewer times per week. In the off-season increase the volume of interval training and add general forms of energy system development as appropriate. ▲

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Joseph M. Warpeha, MA, CSCS, NSCA-CPT

Accommodating Resistance

We are all aware of the benefits that resistance training offers in terms of strength. If you have ever attempted a maximal lift, you are also aware that a "weakest point" exists in any range of motion that ultimately will limit your ability to complete the lift if the weight is heavy enough.

Traditional free weights offer one set resistance through any given range of motion. Due to joint angles, biomechanics, and the involved musculature, the body has different strength capabilities at different positions throughout a lift. For example, most people can "lock out" the final few inches of a bench press with a weight substantially greater than that which they can fully press. The idea of accommodating resistance is based around the need to "accommodate" the strong and weak points of any given motion by using such tools such as elastic bands or chains that alter the resistance throughout the movement.

Let's take the squat for example. The weakest point is generally somewhere in the bottom half. We must recall at this time that power is a function of mass moved per unit of time The greatest power athletes typically spend a good deal of time training with loads of 40 – 70% of a 1-repetition maximum and concentrate on moving the weight as fast as possible, thus increasing the rate of force development and producing the greatest power.

"It might not seem obvious right away that using lighter weights will make you more powerful."

If your best squat is 300 pounds, training with 270 for singles, doubles, or triples all of the time probably would not be optimal (if you have not been supplementing your routine with power/speed training) since that weight will not be moved with a lot of speed and your sticking point will come into play more times than not because you were not able to produce enough momentum to push through it. Perhaps you would be better off reducing the load on the bar and incorporating accommodating resistance. This can be accomplished by attaching a large rubber band around each end of the bar (2 bands total) with the other ends of the bands fixed to the ground directly beneath the bar's vertical plane of movement.

Let's say at the bottom of the squat the bands are totally relaxed but at the top they add 100 pounds of extra resistance due to the elastic energy exerted by the bands. Now put 200 pounds on the bar with these bands. At the bottom, you are essentially dealing with 200 pounds (which a 300-lb squatter should be able to accelerate quite rapidly). As you ascend, the resistance gets greater and greater up to 300 pounds at the very top (200 lbs + 100 lbs), but you are able to keep accelerating the bar because of the momentum you were able to produce at the beginning of the concentric phase due to the light load. Additionally, in general, most people are stronger at the end of extension-type movements due to more favorable biomechanical position (leverage) so the bands in this case accommodate the increased strength potential near the completion of the movement. If you move the 200-lb bar fast enough, you are producing far greater power (even at the bottom where you are truly only moving 200 pounds) than you were with 270 pounds on the slower moving bar.

Chains hung from a bar have a similar effect to that of bands and both serve the purpose of training the neuromuscular system to recruit more motor units, thus increasing the rate of force development. According to Cal Dietz, Head Olympic Strength Coach at the University of Minnesota, "More and more of my athletes are seeing maximal weights increase as well as enhanced performance on the field because they incorporated workouts into their program where they reduced the weight on the bar and concentrated on speed and accommodating their

strength curves." It might not seem obvious right away that using lighter weights will make you more powerful. However, if speed/power training is performed properly, the heavier weights will become easier because now you have taught your body how to fire a greater number of muscle fibers and to increase the rate of force development. These things are much more easily accomplished with lighter loads and greater speeds.

Note: *Only elastic bands that are specifically designed for strength training or powerlifting should be used (Jump Stretch, Flex Bands®, etc.) as other types of rubber bands are not made to handle high tension loads and pose a serious risk of injury or bodily harm if the bands break.* ▲

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Joe Warpeha, MA, CSCS, NSCA-CPT, is an exercise physiologist and strength coach and is currently working on his PhD in exercise physiology at the University of Minnesota-Minneapolis. His current research focuses on vascular biology, particularly relating to endothelial function in overweight children and the efficacy of resistance training and nutrition in improving cardiovascular disease risk factors. Joe teaches several courses at UM including advanced weight training and conditioning; measurement, evaluation, and research in kinesiology; and human physiology. He has over 12 years of resistance and aerobic training experience and has been a competitive powerlifter since 1997. Joe is a two-time national bench press champion and holds multiple state and national records in the bench press while competing in the 148, 165, and 181-pound weight classes.

Rest and Recovery

The Forgotten Training Component

Keith E. Cinea, MA, CSCS,*D, NSCA-CPT

Training is a key component for any athlete. As an athlete, you understand how improved strength, power, or whatever parameter you are working on will benefit you in your sport. You also understand that training will help you improve in these areas to allow you to take your performance in the sport to the next level. The question is, when do all the sets and repetitions pay off, when do the adaptations occur? These adaptations occur during recovery, which is why recovery is such a vital component to your training. However, often times, recovery is not seen as important. In reality, the bottom line is that without proper recovery, your body will not achieve all the potential benefits from training.

So how do you determine how much recovery time you need? The amount of recovery time required between workouts depends on several variables. These variables include: training history, training intensity, volume, and program goals.

As more years of training are accumulated, less recovery time is needed because the body has adapted to the training. So beginners require more recovery time than experienced athletes. Beginners should train with 48 hours of recovery between strength training sessions. A program with this type of frequency lends itself nicely to a Monday, Wednesday, Friday design (see table 1).

Table 1. Sample Beginner Workout with 48 hours Rest

Monday	Tuesday	Wednesday	Thursday	Friday
Bench Press	Recovery Day	Bench Press	Recovery Day	Bench Press
Squat	Recovery Day	Squat	Recovery Day	Squat
Row	Recovery Day	Row	Recovery Day	Row
Shoulder Press	Recovery Day	Shoulder Press	Recovery Day	Shoulder Press
Leg Curl	Recovery Day	Leg Curl	Recovery Day	Leg Curl
Lat Pull Down	Recovery Day	Lat Pull Down	Recovery Day	Lat Pull Down
Triceps Extension	Recovery Day	Triceps Extension	Recovery Day	Triceps Extension
Bicep Curl	Recovery Day	Bicep Curl	Recovery Day	Bicep Curl

More experienced athletes require higher intensities and volumes to continue seeing gains with training. As training experience, intensity, and volume increases, so should recovery time. As a result experienced athletes may train with 72 hours of recovery between workouts of the same muscle group.

This is the key to building more time into workout sessions. Beginners only require 48 hours of recovery between workouts, and they are most likely performing full body workouts. The advanced athlete requires more frequency, intensity, and volume to achieve their goals, while working with a larger recovery period. So their workouts are divided or split so that opposing muscle groups or body parts are targeted on consecutive days.

For example, a common split is to perform upper body exercises on Monday and Thursday and lower body exercises on Tuesday and Friday. This provides four training days per week. Although each area is only targeted twice per week versus the three times per week with the beginners program, more time is available to train each area (see table 2). Now there is more time in each training session since only half of the body is targeted that day. This way more exercises, or higher volumes and intensities, can be used. Additionally, longer rest periods can be used in between sets.

This four-day spilt provides 72 hours of recovery between upper body exercises. Additionally, it will provide 72 hours of recovery between lower body exercises. This longer recovery time is vital for adaptations to occur with advanced programs.

Program goals also affect recovery. If you are in a phase of training where the goal is to improve power (such as pre-season), then the training intensity should be very high. As a result of high training intensity, recovery should be high as well. But during the season when maintenance is the goal, not improvement, intensity and volume should decrease. Consequently, less recovery is needed when the goal is maintenance. Although it does little good to recover so rapidly from a workout that may not be repeated for a week, it does play a part when complete recovery from the workout is needed by game day.

Guidelines for Recovery

Recovery from working out is important, but it does not mean doing nothing. One option is an active recovery. For a beginner who is not performing strength training on Tuesday or Thursday, a light cardiovascular workout or recreational game may be an option. The key is to keep the intensity light, and not go all out during the active recovery workout. The body still needs to continue recovering from the previous workout, and does not need the cumulative stress of an additional intense workout.

Other things to consider during recovery are sleep, nutrition, and hydration. All these things tend to come into play during recovery. If you are not drinking enough water, getting enough sleep, or eating the right things, your body may not completely recovery from the workout. Although you may not be in the weight room on your recovery day, you need to be mentally aware that you are recovering, and act accordingly.

Table 2. Sample Advanced Workout with 72 hours Rest

Monday	Tuesday	Wednesday	Thursday	Friday
Bench Press	Leg Press	Recovery Day	Bench Press	Leg Press
Row	Leg Curl	Recovery Day	Row	Leg Curl
Shoulder Press	Leg Extension	Recovery Day	Shoulder Press	Leg Extension
Lat Pull Down	Calf Raise	Recovery Day	Lat Pull Down	Calf Raise
Triceps Extension		Recovery Day	Triceps Extension	
Biceps Curl		Recovery Day	Biceps Curl	

Optimizing Recovery

If recovery is too short, you may reach a state called overtraining. During overtraining performance decrements occur, along with feelings of fatigue and staleness. On the other end of the spectrum, if too much recovery time is used, your maximum possible potential at that time will not be realized. Worse yet, in a completely terrible program you may detrain, or lose the attributes you are trying to improve.

Recovery is a key component of any training program, but not one that many individuals consider. The weight room is important, but all the changes you are driving for need time to occur. The only time these changes can occur is during your recovery. It may not be the most exciting time of training, but it is just as important as every set and repetition you perform. So be sure when designing your program to include appropriate recovery periods. ▲

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