# OLYMPIC COACH
## SPORT PERFORMANCE DIVISION

TeamUSA.org

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2011 USOC Coaches of the Year

SPORT PERFORMANCE

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# Message from the Chief of Sport Performance

## Alan Ashley


Welcome back! London is 'calling' and in under 50 days we'll all have the opportunity to watch the athletes of Team USA represent themselves, their families, and all of us in what will certainly be the most widely-viewed Olympic Games in history! To date, nearly 250 Olympic and Paralympic athletes have been nominated by their respective NGBs to represent the United States in the Olympics and Paralympic Games. With several Olympic and Paralympic qualifiers scheduled in the coming weeks, we will likely end up sending over 500 athletes to the Olympic Games (July 27 – August 12) and over 275 athletes to the Paralympic Games (August 29 – September 9).

In addition to preparing for London, we will be honoring the best coaches of their respective National Governing Bodies through the USOC Coach of the Year Program. Each year we take great pride in working with each of the sports to identify and select coaches who have demonstrate excellence in their leadership and coaching ability. We are excited to honor the finalists for each Coach of the Year category – Developmental, Doc Counsilman, National, Paralympic and Volunteer – as part of the 2012 National Coaching Conference at the NCAA Hall of Champions on June 19th in Indianapolis and announce the national winners that evening. Once again we prove to have the best and brightest training team for USA athletes and we're excited to showcase their 2011 accomplishments.

In this issue of *Olympic Coach* we are fortunate to have articles from a number of USOC Sport Performance experts in Sport Science. Many coaches in our Olympic family of sports rely on these individuals for day-to-day assistance in planning and the execution of programs that will help their athletes reach maximum performance. You will see from their articles that there really is something for everyone to consider when training athletes – whether elite performance or pipeline athletes.

In closing, I'd like to share the exciting news that we have hired Chris Snyder to be the Director of the USOC's Coaching Education Department. Chris comes to us from US Lacrosse and I am excited about his knowledge, expertise, and enthusiasm to further our partnership with the National Governing Bodies and the coalition of national and international coaching partners. Chris, along with Christine Bolger, will form the backbone of our efforts to collaborate on ways we can work together to strengthen our coaching system and provide the acknowledgement of the coaching profession found in many other countries around the world.

## Five Lessons I Have Learned from Physiology and How They Can Make You a Faster Runner

Jason R. Karp, Ph.D.

One of the things I love most about the sport of distance running is that, in its simplicity of putting one foot in front of the other, it is also extremely complex. When done correctly, it is a scientific endeavor to maximize one's speed and endurance. Unfortunately, nearly all scientists spend their careers in academia without venturing into the arena that got many of them interested in physiology in the first place – competitive sport. As a result, few scientists are coaches. The opposite is also true – few coaches are scientists. Being both, I have learned that each can learn from the other, as my experience has given me a unique view of the sport and of the training process. Here are five lessons I learned from physiology and how they can make your athletes faster runners.

**Lesson 1: Lactate threshold and running economy are more important than VO2max.**

While VO2max (the maximum volume of oxygen your athletes' muscles can consume per minute) has received most of the attention among runners and coaches, a high VO2max alone is not enough to attain elite-level performances; it simply gains one access into the club, since a runner cannot attain a high level of performance without a high VO2max. But, while your athletes can improve their VO2max, it is largely genetically determined. The other two major physiological players of distance running performance – lactate threshold (LT) and running economy (RE) – exert a greater influence on your athletes' performances and are more responsive to training. I have tested many athletes in the laboratory with an elite-level VO2max, but few of them were capable of running at the elite or even sub-elite level because they did not have a high LT or were not very economical.

From the time of the classic study by Peter Farrell and colleagues published in Medicine and Science in Sports and Exercise in 1979, research has shown that the LT is the best physiological predictor of distance running performance. It is an important physiological variable that demarcates the transition between running that is almost purely aerobic and running that includes significant oxygen-independent (anaerobic) metabolism. It represents the fastest speed your athletes can sustain aerobically. (All running speeds have an anaerobic contribution, although at speeds slower than the LT, that contribution is negligible.) Since the LT represents your athletes' fastest sustainable pace, the longer the race, the more important their LT.

Running Economy (RE) is the volume of oxygen consumed at submaximal speeds. In 1930, David Dill and his colleagues were among the first physiologists to suggest that there are marked differences in the amount of oxygen different athletes use when running at the same speeds, and that these differences in "economy" of oxygen use is a major factor explaining differences in running performance in athletes with similar VO2max values. For example, research has shown that, while Kenyan runners have similar VO2max and LT values as their American and European counterparts, the Kenyans are more economical, possibly due to their light, non-muscular legs that interestingly resemble those of thoroughbred race horses. The heavier your athletes' legs, the more oxygen it costs to move them.

**Training Lactate Threshold (LT)**

**LT Pace**
For highly trained and elite runners, LT pace is 25 to 30 seconds per mile slower than 5K race pace (or about 15 to 20 seconds per mile slower than 10K race pace) and corresponds to about 85 to 90% max heart rate. The pace should feel comfortably hard.

**LT Workouts**
- continuous runs at LT pace, starting at about three miles and increasing up to seven to eight miles (or about 45 minutes) for marathoners
- intervals at LT pace with short rest periods, such as 4 to 6 x 1 mile at LT pace with one minute rest
- shorter intervals at slightly faster than LT pace with very short rest periods, such as two sets of 4 x 1,000 meters at five to ten seconds per mile faster than LT pace with 45 seconds rest and two minutes rest between sets
- long, slow distance runs with segments run at LT pace, such as 12 to 16 miles with last two to four miles at LT pace or two miles + three miles at LT pace + six miles + three miles at LT pace

Running Economy (RE) is the volume of oxygen consumed at submaximal speeds. In 1930, David Dill and his colleagues were among the first physiologists to suggest that there are marked differences in the amount of oxygen different athletes use when running at the same speeds, and that these differences in "economy" of oxygen use is a major factor explaining differences in running performance in athletes with similar VO2max values. For example, research has shown that, while Kenyan runners have similar VO2max and LT values as their American and European counterparts, the Kenyans are more economical, possibly due to their light, non-muscular legs that interestingly resemble those of thoroughbred race horses. The heavier your athletes' legs, the more oxygen it costs to move them.

RE is probably even more important than the LT in determining distance running performance because it indicates how hard your athletes are working in relation to their maximum abilities to use oxygen. For example, if two runners have a VO2max of 70 milliliters of oxygen per kilogram of body weight per minute and an LT pace of six minutes per mile, but Jack uses 50 and Martin uses 60 milliliters of oxygen while running at 6:30 pace, the pace feels easier for Jack because he is more economical. Therefore, Jack can run faster before using the same amount of oxygen and feeling the same amount of fatigue as Martin. I have yet to see a runner who has superior RE who does not also have a high VO2max and LT.

Despite its importance, RE seems to be the most difficult of the three physiological players to train. While many runners and coaches think that RE is a reflection of running form, it is more influenced by those microscopic structures that influence oxygen delivery to and use by the muscles—capillaries and mitochondria, the densities of which are both enhanced with high mileage. Research has shown that runners who run high mileage (more than 70 miles per week) tend to be more economical, which leads one to believe that running high mileage improves RE. In addition to increasing mitochondrial and capillary density, the greater repetition of running movements may result in better biomechanics and muscle fiber recruitment patterns and a synchronization of breathing and stride rate, which may reduce

the oxygen cost of breathing. RE may also be improved by the weight loss that often accompanies high mileage, which lowers the oxygen cost. Since VO2max plateaus with about 70 to 75 miles per week, improved RE may be the most significant attribute gained from running high mileage. However, it's hard to prove cause and effect, since it is not entirely clear whether high mileage runners become more economical by running more miles or are innately more economical and can therefore handle higher mileage.

Other forms of training, like intervals and tempo runs, can also improve RE since, as VO2max and LT improve, the oxygen cost of any submaximal speed is also likely to improve. However, it is possible to become more economical without improving VO2max or LT, as research on power training with very heavy weights and plyometrics has shown. Power training focuses on the neural, rather than metabolic, component of muscle force development to improve RE.

**Lesson 2: There are different muscle fiber types.**

There are two types of runners: those who have superior speed, whose performance gets better as the race gets shorter, and those who have superior endurance, whose performance gets better as the race gets longer. As a coach, it's important to acknowledge differences in runners' muscle fiber types and their associated metabolic profiles. The types of fibers that make up individual muscles greatly influence your athletes' performances.

Humans have three different types of muscle fibers, with gradations between them (see Characteristics of the three Muscle Fiber Types). Slow-twitch (ST) fibers are recruited for all of your athletes' aerobic runs, while fast-twitch B (FT-B) fibers are only recruited for short anaerobic, high-force production activities, such as sprinting, hurdling and jumping. Fast-twitch A (FT-A) fibers, which represent a transition between the two extremes of ST and FT-B fibers, are recruited for prolonged anaerobic activities with a relatively high-force output, such as racing 400 meters. It's a given that your athletes have more ST fibers than FT fibers, otherwise they would be sprinters rather than distance runners. However, even within a group of distance runners, there is still a disparity in the amount of ST fibers. Some runners may have 90 percent ST and 10 percent FT fibers (marathoners), while others may have 60 percent ST and 40 percent FT fibers (milers). In lieu of a muscle biopsy to determine your athletes' exact muscle fiber type composition, ask your athletes the following questions:

1) When you race, a) are you able to hang with your competitors during the middle stages, but get out-kicked in the last quarter to half-mile, or b) do you have a hard time maintaining the pace during the middle stages, but can finish fast and out-kick others? If they answer a, they probably have more ST fibers. If they answer b, they have more FT fibers.

2) Which type of workouts feel easier and more natural: a) long intervals (800-meter to mile repeats), long runs and tempo runs, or b) short, fast intervals (200- and 400-meter distances)? If they answer a, they have more ST fibers. If they answer b, they have more FT fibers.

3) Which workouts do you look forward to more: a) long intervals and tempo runs, or b) short, fast intervals? If they answer a, they have more ST fibers. If they answer b, they have more FT fibers. (People tend to get excited about tasks at which they excel, while being more anxious about tasks

that are difficult.)

Understanding your athletes' fiber types can help you train them smarter. While most runners do the same workouts to focus on a specific race, their training and racing should reflect their physiology. For example, if an athlete has 90% ST and 10% FT fibers, his or her best race will likely be the marathon and his or her training should focus on mileage and tempo runs. If an athlete has 60% ST and 40% FT fibers, his or her best race will likely be the 800 meters or mile, and his or her training should focus less on mileage and more on interval training. If both runners want to race a 5K or 10K, the former runner should initially do longer intervals, trying to get faster with training, such as 1,200-meter repeats at 5K race pace, increasing speed to 3K race pace or decreasing the recovery as training progresses. The latter runner should do shorter intervals, trying to hold the pace for longer with training, such as 800-meter repeats at 3K race pace, increasing distance to 1,200 meters or increasing the number of repeats as training progresses. Thus, there can be two paths to meet at the same point.

| Characteristics of the 3 Muscle Fiber Types | | | |
|---|---|---|---|
| | **Slow-Twitch (ST)** | **Fast-Twitch A (FT-A)** | **Fast-Twitch B (FT-B)** |
| Contraction time | Slow | Fast | Very Fast |
| Size of motor neuron | Small | Large | Very Large |
| Resistance to fatigue | High | Intermediate | Low |
| Activity | Aerobic | Long-term Anaerobic | Short-term Anaerobic |
| Force production | Low | High | Very High |
| Mitochondrial density | High | High | Low |
| Capillary density | High | Intermediate | Low |
| Oxidative capacity | High | High | Low |
| Glycolytic capacity | Low | High | High |

**Lesson 3: A larger, stronger heart can pump more blood and oxygen to runners' muscles.**

Probably the biggest difference between me and 2012 U.S. Olympic Marathon Trials champion Meb Keflezighi (besides my charming good looks) is the size of our hearts. The amount of blood the heart pumps with each contraction of its left ventricle (the heart's largest chamber that is responsible for sending blood to every part of the body except the lungs) is called the stroke volume. Multiply the stroke volume by the heart rate, and you get the amount of blood pumped by the heart each minute, called the cardiac output. The larger your athletes' left ventricle, the more blood it can hold; the more blood it can hold, the more blood it can pump. So characteristic is a large heart of genetically gifted and highly trained runners that it is considered a physiological condition by the scientific and medical communities called Athlete's Heart. Specific training can make your athletes' hearts larger and increase their stroke volume and cardiac output.

Long intervals provide the heaviest load on the cardiovascular system because of the repeated attainment of the heart's maximum stroke volume and cardiac output (and, by definition, VO2max). Evolu-

tionary biologists believe that the structure of an organism evolves to cope with the stresses to which it is subjected, which has led to the theory of symmorphosis—that an organism's structural design is regulated by its functional demand. As preeminent anatomist Ewald Weibel wrote, "…the quantity of structure incorporated into an animal's functional system is matched to what is needed: enough but not too much." Remarkably, structural changes can also occur in the short term in response to training: bones increase their density, muscle fibers increase their metabolic machinery, and cardiac muscle grows larger. In response to the imposed threat of running at the heart's maximum ability to pump blood, the heart responds by increasing its contractility (pumping strength) and by enlarging its most important chamber so that more blood and oxygen can be sent to the working skeletal muscles.

In lieu of a laboratory test to tell you the velocity at which your athletes' VO2max is achieved (vVO2max), you can use their current race performances or heart rate. vVO2max is close to 1-mile race pace for recreational runners and close to 3,000-meter or 2-mile race pace (10 to 15 seconds per mile faster than 5K race pace) for highly trained runners. Your athletes should be within a few beats of their maximum heart rates by the end of each work interval. Examples of workouts are: 1) 3 x 1,200 meters (or four to five minutes) at vVO2max with three to four minutes recovery; 2) 4 x 1,000 meters (or three to four minutes) at vVO2max with two-and-a-half to three minutes recovery; and 3) 6 x 800 meters (or three minutes) at vVO2max with two-and-a-half to three minutes recovery.

**Lesson 4: Metabolism is tightly regulated by enzymes and oxygen.**

Enzymes function as biological catalysts that speed up chemical reactions. In the absence of enzymes, chemical reactions would not occur quickly enough to generate the energy needed to run. The amount of an enzyme also controls which metabolic pathway is used. For example, having more aerobic enzymes will steer metabolism toward a greater reliance on aerobic metabolism (Krebs cycle and electron transport chain) at a given submaximal speed. Enzymes are also activated or inhibited (i.e., their effectiveness in speeding up chemical reactions can be either increased or decreased), determining which metabolic pathways are functional during certain cellular conditions. Thus, enzymes essentially control metabolism and therefore control the pace at which your athletes fatigue.

A number of studies have documented an increase in enzyme activity in response to training. One of the first among these was published in 1967 in *Journal of Biological Chemistry*, in which aerobically trained rats increased mitochondrial enzyme activity, increasing the mitochondria's capacity to consume oxygen. More recently, a study published in *Journal of Applied Physiology* in 2006 found that citrate synthase (a key aerobic enzyme) activity significantly increased by 37 percent in novice runners after 13 weeks of training during which weekly mileage increased from 15 to 36. Similarly, sprint training induces changes in the anaerobic enzyme profile of muscles and also increases aerobic enzyme activity, particularly when long sprints or short recovery between short sprints are used. For example, a study published in Journal of Applied Physiology in 1998 found that sprint cycle training three times per week for seven weeks using 30-second, maximum-effort intervals significantly increased both anaerobic and aerobic enzyme activity. Research on changes in enzyme activity with sprint running is currently lacking.

Metabolism is also regulated by its patriarch: oxygen. The availability of oxygen determines which metabolic pathway predominates. For example, at the end of the metabolic pathway that breaks

down carbohydrates (glycolysis), there is a fork in the road. When there is adequate oxygen to meet the muscle's needs, the final product of glycolysis – pyruvate – is converted into an important metabolic intermediate that enters the Krebs cycle for oxidation. This irreversible conversion of pyruvate inside your athletes' muscles' mitochondria is a decisive reaction in metabolism since it commits the carbohydrates broken down through glycolysis to be oxidized by the Krebs cycle. However, when there is not adequate oxygen to meet the muscle's needs, pyruvate is converted into lactate. An associated consequence of this latter fate is the accumulation of metabolites and the development of acidosis, causing your athletes' muscles to fatigue and them to slow down.

The more aerobically developed your athletes are, by focusing on increasing their mileage and doing LT runs, the more they'll steer pyruvate toward the Krebs cycle and away from lactate production at a given pace. That's a good thing, because the amount of energy your athletes get from pyruvate entering the Krebs cycle is 19 times greater than what they get from pyruvate being converted into lactate. While pyruvate will always be converted into lactate given a fast enough speed, the goal of training is to increase the speed at which that occurs.

**Lesson 5: Carbohydrates are extremely important.**

The many proponents of diets like Atkins and South Beach would have the public believe that carbohydrates are some kind of poison. Don't listen to them. Carbohydrates are a runner's best friend. Carbohydrates are stored in your athletes' skeletal muscles and liver as glycogen, and are also found as sugar (glucose) in their blood. When your athletes run, their bodies use a combination of blood glucose and glycogen as fuel to regenerate the high-energy chemical compound ATP through a process called glycolysis. Endurance performance is strongly influenced by the amount of pre-exercise muscle glycogen, with intense endurance exercise decreasing muscle glycogen content. Carbohydrates are so important that ingesting them during prolonged exercise can even delay fatigue. With the well-documented decrease in muscle glycogen content that accompanies endurance exercise, an empty-refill cycle becomes evident. Since your athletes' muscles prefer carbohydrates as fuel, a metabolic priority of recovering muscle is to replenish muscle glycogen stores. And the more their glycogen tank is emptied, the greater it's refilled. Empty a full glass, and you get a refilled larger glass in its place, much like college fraternity parties.

## UPCOMING EVENTS

USA Coaching Coalition
National Coaching Conference
June 19 - 21, 2012
Indianapolis, Indiana

National Athletic Trainers' Association
National Convention
June 26 - 29, 2012
St. Louis, Missouri

London Olympic Games
July 27 - August 12, 2012
London, England

London Paralympic Games
August 29 - September 9, 2012
London, England

USA Triathlon's Art & Science of Triathlon
International Coaching Symposium
October 25 - 27, 2012
San Diego, California

Glycogen synthesis is controlled by the hormone insulin and the availability and uptake of glucose from the circulation. Insulin, which is secreted from the pancreas, is the primary signal for glycogen synthesis. Through its effect on proteins that transport glucose, insulin draws glucose from the blood into muscle cells. Glucose is then used to make new glycogen, which is simply a branched chain of glucose molecules. The higher the blood insulin concentration and the greater the availability of glucose, the faster glycogen is synthesized and stored. So, how do you increase your athletes' insulin concentrations and make glucose available? Have them consume carbohydrates.

Research has shown that the synthesis of glycogen between training sessions occurs most rapidly if carbohydrates are consumed immediately after exercise. Indeed, delaying carbohydrate ingestion for just two hours after a workout significantly reduces the rate at which muscle glycogen is resynthesized and stored. To maximize the rate of glycogen synthesis, tell your athletes to consume 0.7 gram of simple carbohydrates (preferably glucose) per pound of body weight within 30 minutes after they run and every two hours for four to six hours. It would be even better if they can eat or drink more often, since research has shown that a more frequent ingestion of smaller amounts of carbohydrates has an even greater effect on glycogen synthesis, as it better maintains blood glucose and insulin levels. Despite the many highly-advertised commercial sports drinks, any drink that contains a large amount of glucose is great for recovery. For example, my research published in the *International Journal of Sport Nutrition and Exercise Metabolism* in 2006 showed that chocolate milk is just as good, or even better, than other recovery drinks after exhausting exercise.

To help your athletes get the most from their training and racing, learn these lessons. Not only will they be rewarded with higher levels of fitness and new personal records, you'll make a complex sport a little simpler.

Dr. Jason Karp is a nationally-recognized running coach and 2011 IDEA Personal Trainer of the Year. He holds a Ph.D. in exercise physiology and is founder and coach of REVO2LT Running Team. He has taught USA Track & Field's level 3 certification. A prolific writer, he has more than 200 publications in international running, coaching, and fitness magazines, is the author of five books, including 101 Developmental Concepts & Workouts for Cross Country Runners, 101 Winning Racing Strategies for Runners, and Running for Women, and is a frequent presenter at national fitness and coaching conferences. All of his books may be ordered through his website at www.runcoachjason.com.

# Video Review: Tailoring the Process for Your Needs

Kimberly Popp, Sport Technologist, United States Olympic Committee

## Introduction

Video review is utilized by many coaches and athletes as a valuable tool for rapid performance feedback. Relatively simple, in-venue video sharing allows optimal performance analysis. There have been numerous obstacles to achieving this in the past, mainly due to difficulty in design and implementation of available technology. However, with the advent of new technologies, off-the-shelf solutions are readily available. These recent innovations allow relatively simple and inexpensive methods to review technique, athlete lines and competitor tactics through wireless video sharing. As with most technological tools, there is more than one pathway to meet user needs.

Video technology available on a smartphone or tablet can provide immediate feedback to enhance athlete performance. These devices are light, transportable and familiar to the majority of users. Video can be recorded and reviewed immediately using a single device. For this type of review, a tablet is recommended over a smartphone since the viewing screen is larger and more simple to manipulate. Use of a sole tablet is optimal for sports confined to a limited space in which the athlete can clearly be seen, along with venues where filming can be accomplished in close proximity to the athlete. Examples may include diving, gymnastics, archery, shooting and weightlifting

The major limitation to filming with a tablet is that it lacks zooming capabilities. Therefore, it is not adequate for filming sports with larger playing fields or for a competition in which the videographer is not adjacent to the action. For this, a camera with zoom capability is required. In this situation, recording action with a video camera in conjunction with playback on a tablet provides near real-time feedback for athletes and their coaches. Video feedback on a tablet eliminates the need for a computer review station. A coach and athlete can perform an invaluable video session “on the fly.”

## Sport Video Solutions

Listed below are three options for a camera to tablet solution.

*SD Card Reader*: Video is recorded with a digital camera to an SD card. The SD card is removed and inserted into or attached to the tablet to view videos. Some Android tablets have a built-in SD card slot. For an iPad, an SD card attachment is required. This device is available as an accessory (Apple iPad Camera Connection Kit). This is an excellent method to review relevant video after a practice/competition or during a break.

*Eye-Fi Card*: For continual video recording and simultaneous transmission of completed segments, an Eye-Fi card is a reasonable solution. An Eye-Fi card is an SD card that stores video on the card, but also has a chip with built-in wireless capabilities. Once a video is recorded on camera, it will automatically upload to a designated computer, tablet or smart phone. A major limitation to this option is that the camera-SD card system must be approximately 20 feet from the upload device. More detailed information is available at http://www.eye.fi/.

*Wireless video sharing*: The solution may be valuable for many competitions. This typically involves a large playing field, and a significant separation between the person recording the video and coach/athlete interface for video review. If this is your situation, the use of an Apple Time Capsule paired with live capture in Dartfish has proven effective. Time Capsule is a wireless hard drive on which you can share videos on up to 50 devices. Once the video is copied from the computer onto the Time Capsule, you will be able to view the videos on computers, tablets and smartphones. The distance for wireless transmission is about 300 feet for this device, making it effective for most sporting venues. For detailed instructions on this technique, please contact Kimberly Popp, USOC Sport Technologist, at kimberlyann.popp@usoc.org.

**Sport Video Apps**

In addition, there are several sporting video review apps available for smartphones/tablets. It is suggested that you make your own search of available apps due to the constant development of new products and upgrades. Categories to search with recommended apps are listed below. There are countless others, but make sure the app meets your needs for proper feedback to your athletes:

- Sports: Excelade, iCoachView, Coach's Eye, Coach My Video
- Health and Fitness: Kinesio Capture
- Video Review (a good search term, but not an official app category)
- Golf (these apps are applicable to other sports as well): Swing Reader, Golf SwingPlane, GolfProRx

**Conclusion**

As stated, "off-the-shelf" video recording is an extremely effective tool for enhancement of athletic performance. Hopefully, this brief review can inspire users to incorporate this technology into their sport program. Please contact us if you require support or need additional information.

Kimberly Popp is a Sport Technologist for the United States Olympic Committee based at the Olympic Training Center in Chula Vista, California. She provides services to various U.S. National Teams specializing in the use of technology to measure, interpret, and provide feedback to coaches with the goal of improving athletic performance.

# Defining the Expert Coach Within the Olympic Movement: A Study Performed to Enhance the Outcomes of Coaching Education Programming in the United States

Brad H. DeWeese, Ed.D., Sport Physiogist, USOC

## Introduction

By definition, participation at the elite level of sport is a rare opportunity that is most often granted to those athletes who display competitive excellence in their sport of expertise. As Allen (2007) reminds us, sport expertise is far more than physical prowess and good genetics. To be considered elite, athletes must perform at a high level on a consistent and long-term basis (Ericsson, Prietula, & Cokely, 2007). To be a fixture at the top of sport, it is commonplace for athletes to acquire the assistance of a coach. In fact, Gould, Greenleaf, Chung and Guinan (2002) found that a majority of the athletes competing in the Olympic Games held in Atlanta and Nagano correlated their success with the positive influences of their coach.

For coaches, the body of work that is typically assessed for advancement in the field is the competitive success of the athletes under their supervision. While consistent winning in sport is a reliable barometer in determining if an athlete is elite, it is not the case within leadership. Cote, Young, North and Duff (2007) provide insight into the weakness of this measuring system by explaining, “if we identify and describe the competencies of coaches who we deem as excellent solely based on athletes’ performances, we are mistakenly basing our search on indirect behavioral measures”. Ericsson et al. (2007) support this claim by stating that most leadership challenges are highly complex and specific to a given scenario, which makes it hard to compare performance across organizations and situations. Therefore, it is difficult to make a correlation between job advancement and expert status.

Considering the paucity of literature existing on elite sport coaching, the purpose of this research endeavor was to develop a standardized definition for an expert coach. Through the identification of common practices and beliefs regarding expert coaches, the aim of this study was to further the abilities of our national sporting system to sustain competitive success at the international level of competition. An additional priority of this research project was to expand the body of literature that exists on elite sport leadership by unearthing the key constructs of expert coaching status. The researcher believes that a clearly articulated definition of expert coaching can assist in the refinement of coaching education curriculum, which will improve many components of the coach-athlete relationship.

Within the United States, formalized coaching education programs have become a popular method of disseminating important information to the coaching profession. In Olympic-based sports, many coaching education programs are delivered by National Governing Bodies (NGBs). These independent federations that fall under the jurisdiction of the United States Olympic Committee (USOC) serve many purposes, but of primary importance is the development of athletes capable of attaining podium-worthy performances at international competitions. Initiatives, including coaching education, have been developed within the framework of most of the NGBs in order to equip coaches with the most up-to-date training theories for the athletes under their direction in hopes of bolstering competitive performance.

Although many studies have alluded to the benefit of various coaching education tactics, no study

to date had set out to determine the constructs that define an expert coach. Therefore, if a goal of coaching educators is to increase the pool of candidates that can be considered elite-level coaches, a working definition of expert coaching should be determined in order to tailor curriculum and modes of delivery. Specifically, Larkin, Duffy and O'Leary (2007) discovered that younger, developing coaches listed the ability to observe elite coaches at work was one of the most valuable tools for increasing their knowledge base. If this is the case, coaching education programs must have a template for defining an elite coach so that lower-ranking coaches have the opportunity to work with an expert in the field. Gilbert, Cote and Mallett (2006) find it surprising that the lack of conceptual framework to explain coach development is surprising, as this is a requisite for optimal coaching education program construction and delivery. Acknowledging the lack of framework and formal definition of expert coaching, research should be carried out in order to develop a definition that embraces the theoretical underpinnings of expert development through the acquisition of human capital over a career span. In addition, Cote, Young, North and Duff (2007) recommend a definition of coaching excellence should be multi-faceted so that it is reflective of the highly variable roles that a sport coach assumes, as well as emphasizing the constant personal interactions between coaches and their athletes in the training and competitive environment.

**Research Methods**

In order to determine the division between expert coaches from the remainder of the profession, this study utilized Q methodology. A benefit of Q methodology lies in the fact that it helps identify the similarities and differences in the subjective perceptions across a sample group. A considerable difference between Q methodology and correlation coefficients is that "Q does not need large numbers of subjects as does correlational research, for it can reveal a characteristic independently of the distribution of that characteristic relative to other characteristics" (Smith 2001; as cited by Brown, 1994). Simply put, instead of a large number of people receiving a small number of test items, now a small number of people are receiving a large number of tests. This inversion of traditional quantitative research tactics allows the investigator to correlate persons instead of tests.

For this study, seven current U.S. National Team coaches and eight current U.S. National Team athletes with previous experience at the Olympic Games sorted 34 statements regarding expert coaching on a scale of "most like an expert coach" to "least like an expert coach" using Q-assessor, an online software program developed by Stan Kaufman. In addition to ranking the 34 statements, each participant was asked a series of open-ended questions regarding their decisions behind his or her final statement ranking. As a result of the factor analysis on the 15 sorts and post-sort questionnaires, a total of five factors emerged from the data.

**Table 1**

| Breakdown of sporting discipline for coaches sampled | | |
|---|---|---|
| **Sporting Discipline** | **Participants** | **Percentage** |
| Bobsled | 1 | 14.29% |
| Skeleton | 1 | 14.29% |
| Ski Jump | 1 | 14.29% |
| Canoe/Kayak | 3 | 42.85% |
| Biathlon | 1 | 14.29% |

**Table 2**

| Highest competitive level of athletes under coach supervision | | | |
|---|---|---|---|
| **Coach** | **Sport** | **Highest Level of Competition** | **Olympic Medal Earned Under Coach's Supervision** |
| 1 | Bobsled | Olympian | No |
| 2 | Biathlon | Olympian | No |
| 3 | Canoe/Kayak | Olympian | Yes |
| 4 | Canoe/Kayak | Olympian | Yes |
| 5 | Canoe/Kayak | Olympian | Yes |
| 6 | Skeleton | Olympian | Yes |
| 7 | Ski Jump | Olympian | No |

**Table 3**

| Breakdown of sporting discipline for athletes sampled | | |
|---|---|---|
| **Sporting Discipline** | **Participants** | **Percentage** |
| Bobsled | 4 | 50% |
| Freestyle Ski | 1 | 12.50% |
| Luge | 1 | 12.50% |
| Biathlon | 2 | 25% |

**Table 4**

| Highest level of competitive success for sampled athlete population | | | |
|---|---|---|---|
| **Athlete** | **Sport** | **Highest Level of Competition** | **Olympic Medal** |
| 1 | Bobsled | Olympian | Bronze |
| 2 | Bobsled | Olympian | Gold |
| 3 | Bobsled | Olympian | Gold |
| 4 | Freestyle Ski | Olympian | No |
| 5 | Luge | Olympian | No |
| 6 | Biathlon | Olympian | No |
| 7 | Biathlon | Olympian | No |
| 8 | Bobsled | Olympian | No |

**Results**

The five factors identified in this study represent the unique perspectives and beliefs regarding expert coaching within the United States Olympic Movement. The five factors were identified as (a) the Knowledgeable Coach, (b) the Evolving Coach, (c) the Communicating Coach, (d) the Trustworthy Coach and (e) the Teaching Coach. Additionally, common themes were discovered between the factors.

Factor A was responsible for most of the variance unearthed in this study with 40% (6) of the respondents loading onto this factor. When considering the results of the online card sort and post-sort interview data, the coaches and athletes loading onto Factor A considered an expert coach to be knowledgeable. In other words, the individuals relating to this factor believe that an expert coach should have the technical knowledge to outwit their opponent while at the same time having the ability to identify and act upon the individualized needs of the athletes under his or her supervision. In addition, coaches who are unwilling to pay attention to the individual needs of the athletes competing at this level may be less likely to keep athletes motivated.

Factor B accounted for 33% of the variance explained in this study with five of the 15 respondents loading on this factor. Evidence from the data analysis and post-sort responses indicates that individuals loading onto Factor B consider an expert coach someone who evolves throughout their career. In other words, the belief presented in Factor B suggests that expert coaches continue to refine their knowledge through interactions with other expert coaches or informal, self-directed educational opportunities. These coaches are motivated to maintain their education as a result of a desire to provide their athletes with competitive advantages. Concurrently, the coaches and athletes who loaded onto this factor argue that an expert coach is also able to keep things simple for the athlete under his or her supervision. That is, the coach is cognizant of an athlete's threshold with regard to information overload in the practice and competitive setting.

Factor C accounted for 13% of the variance explained in this study with two of the 15 respondents loading on this factor. These two individuals loading onto Factor C consider an expert coach as someone who is an effective communicator. In other words, the belief presented in Factor C is that coaches at the highest level of competition are effective communicators who have previous experience as an athlete in the sport they supervise. Based on the data analysis, the respondents who loaded onto this factor assert that an expert coach effectively communicates logistical and high-performance-related information to the athlete on a regular basis. This open line of communication builds the trust between the coach and athlete, which may improve the competitive chances of the athletes under his or her supervision. In addition, the coach's previous experience as an athlete in the sport may provide him or her with technical knowledge that can be used in the development of athletes. Lastly, respondents loading onto Factor C do not believe that an expert coach has to be involved in the personal matters regarding his or her athletes. According to this factor, it can be suggested that athletes at the Olympic level of competition prefer a coach to communicate technical knowledge rather than providing insight into personal information.

Factor D accounted for 7% of the variance explained in this study with one of the 15 respondents loading on this factor. This individual considers an expert coach to be someone who is

trustworthy. More specifically, the level of trust between the coach and athlete may play a significant role in competitive outcomes. In addition, the expert coach described in Factor D is a good teacher who is astute on sporting principles from previous experience as an athlete in the sport, not his or her involvement in coaching education programs. Further, the respondent loading onto Factor D presents additional evidence that a coach is not deemed an expert by his or her confirmation as a National Team coach. Regardless of title, the coach must work to gain the trust of the athletes under his or her supervision.

Lastly, Factor E accounted for 7% of the variance explained in this study with one of the 15 respondents loading on this factor. The data analysis indicates that the individual loading onto Factor E considers an expert coach as someone who is a good teacher. The ability to teach may come from their adaptations to specific occurrences in their sporting careers. In addition, this individual described an expert coach who not only teaches well, but also has garnered respect from other coaches in the profession.

**Table 5**

| Highest Rated Statements for Each Factor | | | |
|---|---|---|---|
| **Factor** | **Highest Rated** | **2nd Highest Rated** | **3rd Highest Rated** |
| 1 | Advanced Technical Knowledge | Identify Athlete Needs | Effectively Communicate |
| 2 | Commitment to Profession | Consult Other Expert Coaches | Keep Things Simple |
| 3 | Effectively Communicate | Competitive Experience in Sport | Commitment to Profession |
| 4 | Trustworthy | Good Teacher | Doesn't Over-Coach |
| 5 | Adapt | Good Teacher | Clearly Defined Role |

**Table 6**

| Lowest Rated Statements for Each Factor | | | |
|---|---|---|---|
| **Factor** | **Lowest Rated** | **2nd Lowest Rated** | **3rd Lowest Rated** |
| 1 | Assigned by NGB | Degree in Sport Science | Coaching Certification |
| 2 | Competitive Experience at Elite Level of Sport | Competitive Experience in Sport | Assigned by NGB |
| 3 | Exposed to Early Leadership Opportunity | Understanding of Athlete's Personal Issues | Advanced Ability in Program Design |
| 4 | Assigned by NGB | Coaching Certification | Advanced Ability in Program Design |
| 5 | Exposed to Early Leadership Opportunity | Assigned by NGB | Understanding of Athlete's Personal Issues |

## Discussion

Upon further investigation of the five factors and data collected from the questionnaire, it was apparent that coaches and athletes participating in this study shared particular beliefs regarding the meaning of expert coaching. Specifically, these commonalities in describing an expert coach were categorized as (a) the value of interpersonal skills, and (b) development of coaching knowledge.

Within leadership theory, coaching is defined as a high-directive and high-supportive approach style found in the Situational Leadership II Model, developed by Blanchard et al. (as cited in Northouse, 2004). The assertion that coaching is both a directive and supportive leadership style is supported by the factor arrays resulting from the data analysis. First and foremost, a majority of the individuals participating in this study believe that an expert coach is a good teacher, which was a positively scoring statement for four of the five factors. In addition, four of the five factors were highlighted by the belief that an expert coach is trustworthy. Lastly, three of the five factors demonstrated the opinion that expert coaches attempt to create a positive training environment. Therefore, the ability to teach an athlete utilizing effective communication strategies while at the same time nurturing a trusting relationship may give a coach the ability to create a training environment that is favored by the athlete. Collectively, the information gathered from the factors resulting from the data analysis suggests that an expert coach is someone who values effective interpersonal skills as they relate to the coach-athlete dyad.

Just as important as the component of interpersonal skills is to defining an expert coach is the coach's development of coaching knowledge. A majority of the participants in this study agree that an expert coach is one that has attained an advanced level of technical knowledge regarding the sport. Interestingly, data collected from the post-sort questionnaire gives rise to the interpretation of valuable educational experiences. Initially, it can be suggested that individuals taking part in this study believe that field-based experiences are the most influential educational opportunities for developing coaching expertise. Specifically, many of the respondents replied that daily interactions with peer and mentor coaches provides the necessary technical knowledge needed for sporting success. In addition, the individuals taking part in this study believe that an expert coach knows how and where to go for answers regarding difficult questions, and is motivated to pursue this information by his or her commitment to the profession and desire to improve an athlete's competitive abilities.

Collectively, the data unearthed in this study expands the current understanding of coaching theory by providing the constructs of how expert coaching is defined. Specifically, an expert coach is an individual who is knowledgeable on the technical demands of his or her sport and can convey this information to each athlete according to individual needs and motivational patterns. This ability not only improves the coach-athlete dyad, but also portrays the coach as an effective teacher. In addition, expert coaches demonstrate a continued desire to hone his or her craft through self-directed educational opportunities. The aim of the continued study is to further the competitive chances of the athletes under their supervision.

## Conclusion

This study and its findings are meant to provide insight into the current attitudes and beliefs regarding expert coaching at the highest level of international competition, namely the Olympic Games. The

data collected and interpreted in this study is meant to elucidate important themes that can be used by coaching educators within higher education and coaching education programs within the United States to further improve the profession of coaching. Using these defining constructs of expert coaching as a guide, coaching educators can provide curriculum and educational activities that increase the probability of creating expert leaders. This type of programming may be of upmost importance to sports in the Olympic catalog since most of the them, such as bobsled, canoe/ kayak, biathlon, ski jumping, archery, and weightlifting, witness the rise of former athletes to coaching positions due to a lack of participation, visibility, and/or interest at the grassroots level of sport in America. While the reasons for this matter are beyond the scope of this research study, it can be deduced that the overriding popularity and economic impact of traditional American sports such as baseball, football, and basketball leave little room for the development of Olympic-based programming at the club, scholastic and collegiate levels. This limited exposure to a wider population of potential athletes and coaches results in even lesser pools of candidates for high-performance coaching positions. Therefore, for lesser-known Olympic sport programs to continue, former athletes may need to graduate into the coaching ranks in order to pass on valuable information regarding technical and tactical developments in the sport. A side effect of the promotion of former athletes to Olympic sport coaches may be the existence of a coaching profession who understands the technical aspects of their sport, but lacks awareness in methods of improving interpersonal skills, leadership, pedagogy and andragogy, self-directed learning, and critical reflection, which have all been alluded to play a role in defining coaching expertise by the participants in this study.

As such, the author recommends that coaching educators within the U.S. Olympic Movement utilize the constructs provided in this study to guide the process of refining educational material and delivery systems to match not only the needs of athletes who are competing in elite sport, but the demographics of the entering coaches to the profession. Through improved coaching education, the U.S. Olympic Movement can maintain sporting excellence by fostering a collection of coaches who are armed with the characteristics necessary to achieve success on the international stage.

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**2011 NGB Coaches of the Year**

| | | | |
|---|---|---|---|
| **Developmental Coaches of the Year:** | | | |
| Jeff Hewitt, Baseball | Jill Rankin Schneider, Basketball | Michael Nyitray, Bowling | Lawrence Nolan, Cycling |
| John Wingfield, Diving | Kori Ade, Figure Skating | James Hrbek, Judo | Dustin Baldis, Karate |
| Pat Anderson, Luge | Tom Inglesby, Racquetball | Steve Keene, Sailing | Chris Haslock, Skiing |
| Oscar Pareja, Soccer | Karen Johns, Softball | Scott Koons, Speedskating | Brian Brown, Swimming |
| Stefan Feth, Table Tennis | Alvara Mendez, Taekwondo | Vesa Ponkka, Tennis | Jenny Weber, Triathlon |
| Joe Felder, Track & Field | Gabe diaz DeLeon, Paralympic Track & Field | Stephanie Wheeler, Wheelchair Basketball | |
| **Doc Counsilman Coaches of the Year:** | | | |
| Nicholas Bohanan, Bowling | Neal Henderson, Cycling | Christine Krall, Figure Skating | Shane Domer, Speedskating |
| | Craig Boynton, Tennis | John Smith, Track & Field | |
| **NGB National Coaches of the Year:** | | | |
| Scott Brosius, Baseball | Jennifer Rizzotti, Basketball | Kim Kearney, Bowling | James Herrera, Cycling |
| Adam Soldati, Diving | Mark Phillips, Equestrian | Marina Zoueva, Figure Skating | Jimmy Pedro, Judo |
| Terrance Hill, Karate | Miroslav Zayonc, Luge | Mike Duidry, Racquetball | Luther Carpenter, Sailing |
| Rick Bower, Snowboard | Pia Sundhage, Soccer | Ken Eriksen, Softball | Jae Su Chun, Speedskating |
| Gregg Troy, Swimming | Costantini Massimo, Table Tennis | Kathy Rinaldi, Tennis | Cindi Bannink, Triathlon |
| | Rana Rieder, Track & Field | | |
| **Paralympic Coaches of the Year:** | | | |
| Craig Griffin, Cycling | Melissa Ransehousen, Equestrian | Scott Moore, Judo | Jeffrey Kohn, Karate |
| Jay Hoffman, Soccer | Dave Denniston, Swimming | Stellan Bengtsson, Table Tennis | Dan James, Tennis |
| | Joaquim Cruz, Track & Field | Matt Oberholtz, Water Ski | |
| **Volunteer Coaches of the Year:** | | | |
| Kerry Kincaid, Baseball | Chris Preble, Bowling | Christopher Skelley, Judo | Brody Burns, Karate |
| Phil Wheeler, Racquetball | Tom Waqa, Rugby | Jeff Brand, Speedskating | Duane Gall, Table Tennis |
| | Henry McCallum, Jr., Track & Field | Jimmy Cuevas, Paralympic Track & Field | |

*National Coaches of the Year will be announced at the 2012 National Coaching Conference in Indianapolis June 19th*

# Strength and Power Training for the Elite Swimmer: Can Weights Positively Impact Elite Swim Performance when "Elite Performance" Requires 15 – 25 Hours/ Week of Practice?

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## Introduction

Weights are just one of the tools in a coach's toolbox to help an athlete achieve his or her optimal potential. In the sport of swimming, weight training is meant to supplement an athlete's in-pool training program, not replace it. However, with all the ideas that come to mind when someone uses the term "weights," "power," "lifting," "weight training," "power training," or "strength training" it is hard to really understand what this means exactly. Try it: compare what came to your mind with what the rest of this article describes. Understanding the most beneficial and time-efficient ways to use weights is from where the confusion and hesitation stem.

In the world of sport - and specifically swimming - it all comes down to power. Power, (Power=work/ time) is the amount of work that is done in a certain amount of time and because the "work," or distance, (50m, 100m , 10,000m, etc.) doesn't change, the only way to improve an athlete's time is to look at the equation from the competitive perspective: Time=work/power. The only way to decrease the time would be to increase the amount of power an athlete can produce for an event. Thus, it is the goal of every competitive swimmer, whether elite or novice, to become as powerful as possible so they can generate a high enough level of force, for a long enough period of time, to finish a race before someone else does (Heusner, 1980).

The purpose of this article is to:

- Introduce the various methods and protocols of weight training
- Clearly define the use of weight training to improve strength and power specifically how it relates to athletes
- Dissect and dispel common misconceptions related to strength and power training
- Clearly define strength and power training specifically as to how it relates to athletes.
- Elaborate on the different ways that strength and power training can positively enhance a swimmers training sessions and overall performance

There are numerous misconceptions with regard to weight training and it is important to clearly understand the difference between the specific strength and power training in which elite Olympic athletes should participate and the range of activities that are encompassed within the terms "resistance training" and "weight training." As expressed in the introduction, weights are a tool with many uses. As many people know, weights can be used to stimulate hypertrophy (muscle growth), lose fat, build strength, define a physique, and improve an individual's metabolic function (conditioning). These typical ways of using weights are often found in the local gym, health club or fitness and athletic setting. On the other end of the spectrum, weights can provide a missing ingredient to an elite athlete's training routine. The design of a weight program is of extreme importance for the athlete looking to improve

ability while complementing their practice schedule. A sport-specific weight program can make athletes more powerful, improve movement patterns and stimulate the body and its tissue to become stronger and more resilient to the wear and tear of a demanding practice schedule (Layne, 1999 and MacDougall, 1986), all of which can have a significant positive impact on an elite swimmer's performance.

The largest misconception related to weight training is that all weight training programs are the same and one can achieve different goals by training the same way. It is also incorrect to believe that just by incorporating weight training into an athlete's routine that strength and power will improve. There are endless ways to create programs that are tailored to very specific goals. For example, here are four specific modifiable variables in any training program. They are volume, intensity, rest, exercise selection, and speed of exercise execution. One training program, "Program A," could be designed with a very high volume (amount of total repetitions per training session) with low intensity (lighter loads of weight or resistance) and minimal rest periods. Another training program, "Program B," could be designed with very low volume with high intensity and longer rest periods. Below is an example of one exercise from these two hypothetical programs:

| **Program A** | **Program B** |
|---|---|
| Exercise One<br>Three sets of 10 repetitions at100 lbs.<br>Rest: 30 -60 seconds | Exercise One<br>Three sets of 5 repetitions at150 lbs.<br>Rest: Two minutes |
| Approximate total work is<br>3x10x100= 3000lbs | Approximate total work is 3x5x150=2250lbs |
| ***Results*** | ***Results*** |
| Strength Gain = Moderate<br>Muscle Gain = High<br>Residual Fatigue Affect = High | Strength Gain = High<br>Muscle Gain = Low<br>Residual Fatigue Affect = Low |

These two programs would elicit two very different adaptations from the body. Over a training period, Program B could serve to improve the strength and power of an athlete while not imposing the same amount of fatigue that is imposed on the athlete because of the decreased amount of work as compared to Program A. This would be advantageous to an elite athlete whose training fatigue is already relatively high due to sport-specific training. This simple variation in the volume and intensity of a workout program alone could help improve an athlete's strength and power while reducing fatigue as compared to other programs.

Something important to remember though is that Program A may still serve a purpose to a different elite athlete, at a different time of their training season, with different goals. This is precisely why it is important to realize that all weight training programs are not the same and that a program must be tailored based on an athlete's past and present training experience and the athletes present and future goals.

Another misconception that often scares coaches and athletes is that to become stronger you must

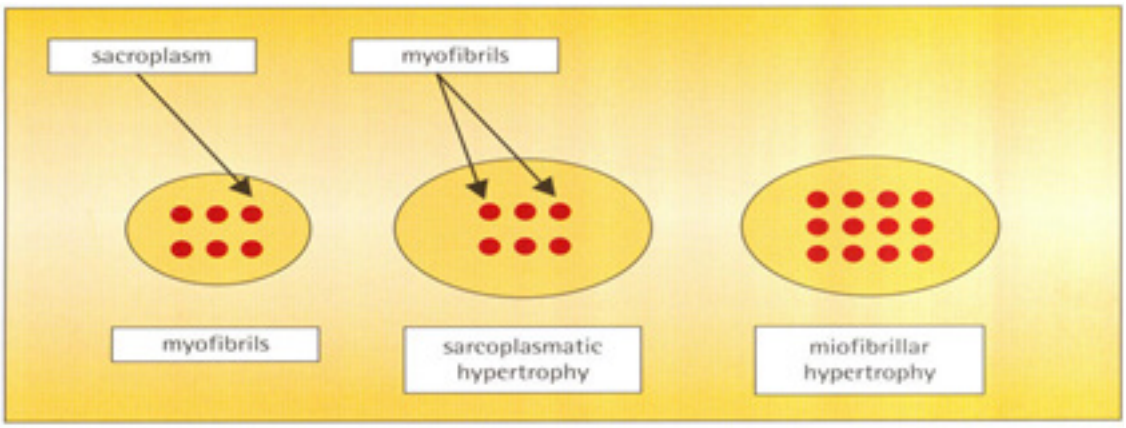



*Figure 7: Different kinds of hypertrophy. Modified from SIFF & VERKHOSHANSKY, 1998.*

gain more muscle, and that all weight training stimulates muscle growth. It is important to realize that the initial and long term improvements of strength can be improved without increase in muscle size (Sale, 1992). Yes, more muscle can help improve strength and power, but is not always necessary. On the other hand, if it is the specific goal of the athlete to increase lean body mass (muscle) a training program can be created to elicit such adaptations.

Before we go any further, here are very simple definitions of two very important factors - both critical to improving the performance of an Elite Swimmer:

- Strength: the ability of the muscle to exert maximal force at a specified velocity (Knuttgen, 1987)
- Power: The amount of work done in a specified time or the product of a force and velocity (Cronin, 2005)

To visualize the spectrum of different ways people use weights for training, the chart on the next page depicts different modes of weight training and characteristics of each mode. Notice how the characteristics between an elite Olympic sporting athlete differ from the four other modes.

**Performance Enhancement**

There are multiple ways that weight training can be beneficial to the performance of an elite Olympic swimmer. To understand the various ways that weights can benefit an athlete of this level it is important to first describe the different ways in which performance can be "improved." The obvious answer is that specific modes of weight training such as Olympic weightlifting movements (squatting movements, clean and jerk, snatch and modified variations of these lifts) can make an athlete stronger and more powerful (Stone, 2005). The less obvious answer is that the stress imposed by weight training can stimulate adaptations in the body that will aid recovery from training sessions (Leite, 2011), and reduce the risk of injury to an athlete's body associated with sport-specific training (Weil, 1999). With recovery improving and the likelihood of injury lower, an athlete will have the ability to train more frequently and at greater intensities. There is no doubt that this will allow an athlete to improve performance.

**Development of Strength and Power**

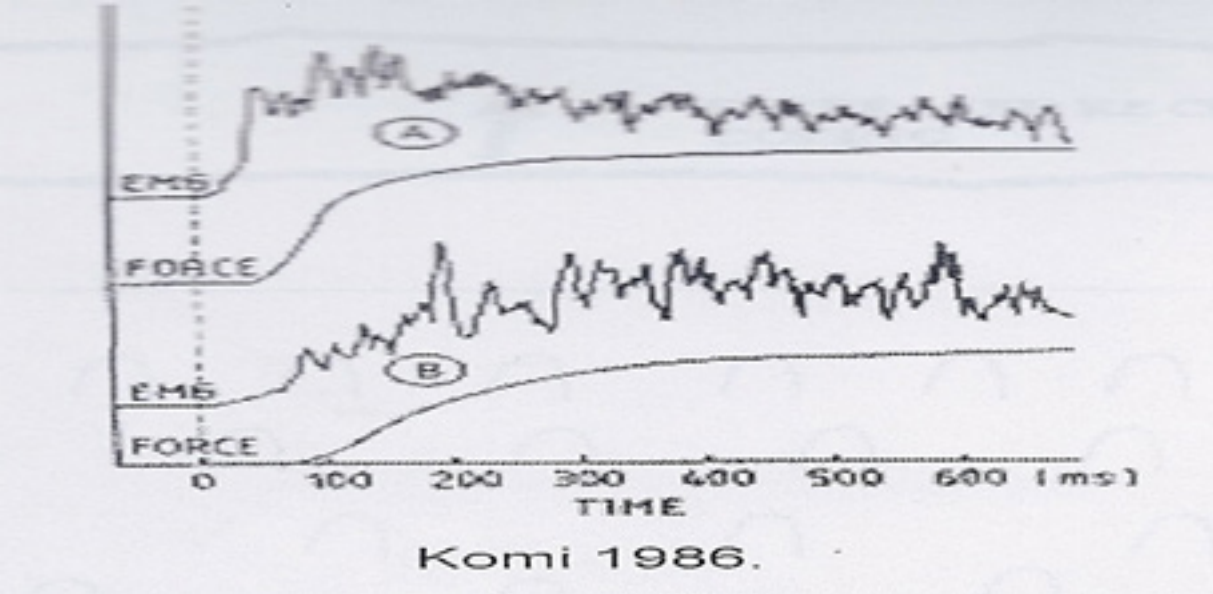
It is commonly accepted that strength and power training can lead to the improvement of strength and

| | Fitness Enthusiast (gym member) | Body Builder | Typical Collegiate Football Athlete | Elite Olympic Sporting Athlete | Typical Weight Routine (3x10) |
|---|---|---|---|---|---|
| Sets and repetitions | 2-5 sets of 10-20 repetitions | 3-5 sets of 8-20 repetitions | 3-5 sets of 3-12 repetitions | 3-6 sets of 0-8 repetitions | 3 sets of 10 repetitions |
| Focus | Muscle based | Muscle based | Primarily movement based | Movement based | Muscle based |
| Purpose | Self image and aesthetics | Muscle aesthetics | Performance of strength, power and size | Performance of strength, power and durability | Health and cardiovascular wellness |
| Loads Used | Light to moderate | Mostly moderate and some heavy | Moderate to heavy | Moderate to heavy | Light to moderate |
| Percentage of exercises focusing on maximal strength | 0% | 0-10% | 30-60% | 30-40% | 0% |
| Percentage of exercises focused on explosive power | 0% | 0% | 30-40% | 45-55% | 0% |
| Percentage of exercises focused on core strength | 5% | 10% | 50% | 60% | 10% |
| Fatigue | Moderate | High | Moderate to high | Low | Low to moderate |
| Amount of muscular damage | Moderate | High | Moderate to high | Moderate | Moderate |
| Impact on reduced motor control | 6 hrs | 48-72 hrs | 48-72 hrs | 12-24 hrs | 6 hrs |
| Days per week | 2-4 | 3-5 | 3-5 | 2-3 | Varies |
| # of exercises per muscle group | 2-3 | 2-4 | 3-5 | 1-2 | 2-4 |
| Duration of lifting routine | 60-90 min | 90-120 min | 90-120 min | 30-60 min | 60 min |
| Fiber types recruited | Primarily slow twitch | 70% slow twitch; 30% fast twitch | Primarily fast twitch | Primarily fast twitch | Primarily slow twitch |
| Influence on explosive power | N/A | N/A | High | High | N/A |
| Impact on muscular development | Low to moderate | High | High | Low | Moderate |
| General cortisol levels post-workout | Moderate to high | High | Moderate to high | Low | Moderate |

power even without an increase in muscle size (Sale, 1992). These improvements can be credited to an increase in the ability to recruit and synchronize the firing of motor units (muscle fibers) (Sale, 1992) and changes in intracellular factors such as myosin heavy chain composition and enzyme activity (Adams, 1993 and Hather, 1991). To put it more simply, an athlete will be able to tap into more fibers, and improve synchronization of activation of each individual fiber leading to a larger force. Imagine each of the fibers were one person in a game of tug-of-war on the same team. If they were to all "tug" at the same time it would create a more

powerful force than if only one person would “tug” at a time. In addition, imagine that there were some lazy people on the team that usually only chose to “tug” if the team were losing; these teammates would be conditioned to tug in unison with the team from the very beginning of the game leading to an overall much more powerful “tug.” The adaptation to the physical properties of the muscle fibers would be that the fibers themselves would become stronger and the enzymes within the fiber would become more effective at initiating biochemical reactions.

This use of strength training - and more specifically power training - can improve the rate of force development of the muscle, muscle groups, and overall athlete, which has been suggested to be a greater determinant of athletic success than just power alone (Newton and Kraemer, 1994).




It is important to realize that within the human body movements are primarily a result of torques and the magnitude of the torques will decrease with velocity (Heusner, 1980). Therefore, at the elite level an athlete should not only train to be strong and generate large forces, but train to develop a larger torque at high sport-specific velocities. A simple example would be to try and increase the speed of a moving object in the same direction. If the object is moving at a slow speed it will be easy to apply a force to the object and accelerate it. But if the object is moving too fast, it may be too difficult to apply an impulse to the object to accelerate it. This is a simple example that can easily be applied to swimming. If an athlete has an improved rate of force development then the athlete will be able to “catch” the water, begin generating torque and start applying force in a shorter amount of time, leading to greater acceleration of their body through the water. When an athlete does not possess a high rate of force development, an athlete will not be able to “catch” and “pull” water more quickly than their opponent.

Another important concept related to strength and power training of elite athletes is the focus on training movements, not muscles. Rather than focusing on the development of each muscle individually, a program that improves performance focuses on the training of movements, primarily pushing and pulling. Training the muscles of the extremities is secondary to training the muscles near the torso as the muscles of the torso tend to have a greater ability to generate forces that would help enhance athletic performance. An example of training a movement would be the use of an Olympic weightlifting move-

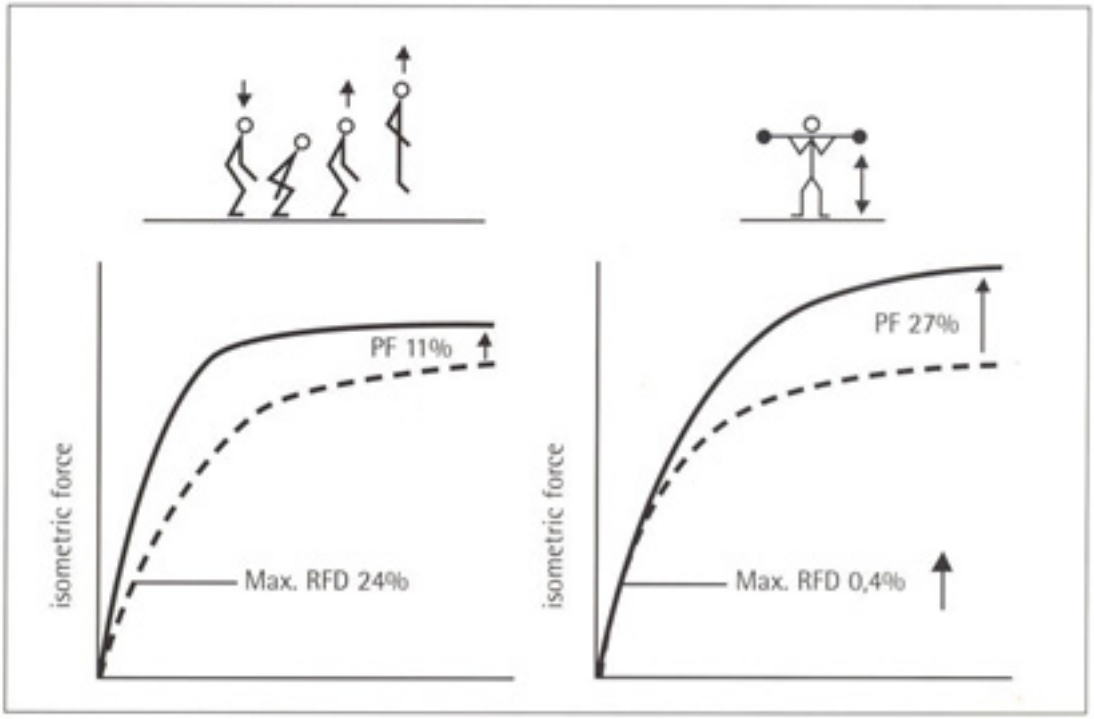



*Figure 11: Effects of jumping training and heavy weight training on Maximal Strength (PF) and Rate of Force Development (RFD). Partially reproduced from SALE (1992).*

ments would be the use of an Olympic weightlifting or modified Olympic weightlifting movement; such exercises promote high levels of activation of the core and promote improvements in the ability to generate power in a triple extension movement (extension of the hips, knees and ankles). Triple extension is a movement linked to many sports. In the sport of swimming, triple extension can be seen in "block starts" and the "push-off" from the wall. It has been suggested through findings that swimmers need to incorporate lower body strength and power training into their workouts to improve sprint swim starts as the start has a considerable correlation to competition success (West). An athlete gains a greater advantage when they generate more power from the block start or a push off on a turn.

Integrating exercises that require multiple muscle groups to contract simultaneously under resistance during various planes of motion can create improvements in the body's neural network. This network serves as a platform that enables greater transfer of strength and power into movements performed in the pool. This increased neural control and coordination while moving under sport resistance (water) may not improve a swimmers kinesthetic awareness (feel of the water on the body), but the increased neural-motor abilities can enhance the kinesthetic control or proprioception (connection, feel of the body and control of the body while in sport motion).

**Strength and Power Training Improves Recovery**

Along with strength and power training's ability to improve performance, both modes of training have also shown to have mechanisms that could assist in recovery. Athletes who train 15-30 hours per week already deal with a large training volume. Because of the large demands of sport-specific training as an Olympic swimmer, accumulation of fatigue from sport-specific training is hard to avoid. Large volumes of training and fatigue lead to an increase in cortisol levels and a decrease in the testosterone-cortisol ratio

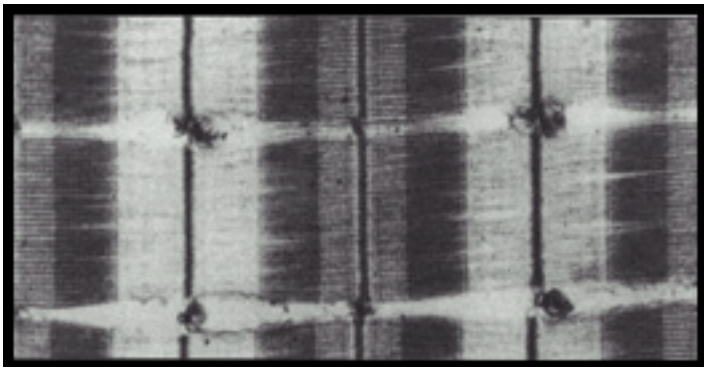
(Blair, 2011). Ideally, an elite athlete would maintain a high testosterone-cortisol ratio. A higher ratio is advantageous for many of the following reasons: preventing muscle break down, reducing body fat storage, increasing energy level and improving competitive drive (Blair, 2011). In trained individuals, it has been shown that a low volume-high intensity weightlifting program (three sets at 80 percent of six RM [repetition max]) and high volume-low intensity (three sets at 80% of 12 RM) weightlifting program both stimulated an increase in testosterone. However, the high volume-low intensity program stimulated a greater increase in cortisol levels. This leads to a lower testosterone-cortisol ratio (Leite, 2011). Thus, the use of lower volume, higher intensity strength and power weight training could be advantageous to the recovery as well as performance of an elite Olympic swimmer. It is important to note that naturally circulating levels of testosterone decrease with age. This important and powerful fact would suggest that it is more beneficial to an elite athlete to utilize strength and power training to help prevent decreasing levels of testosterone and maintaining the greatest testosterone-cortisol ratio possible throughout their athletic career.

**Strength and Power Reduce the Risk of Injury**

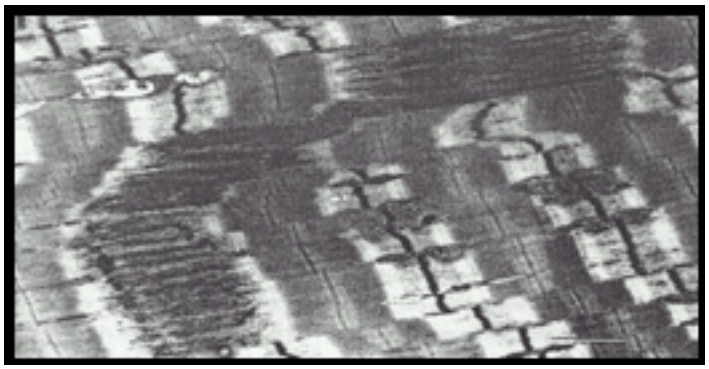
Strength and power training can also help to enhance performance by reducing the risk of injury. It is important to realize that the less frequently an elite athlete has to deal with injury, whether acute or chronic (tendonitis or torn rotator cuff) the more frequently an athlete can train. This increase in frequency of training may then allow for an athlete to increase performance.

One benefit of strength and power training is its effect on bone and connective tissue. It has been shown that resistance training, strength and power training included, has produced positive changes in bone and tissue density (Layne, 1999 and MacDougall, 1986). Increasing tissue density and tensile strength is similar to enhancing a ropes ability to deal with higher forces. This adaptation allows the tissue to deal with larger forces and decreases the micro-damage done by all forces. Micro-damage to tissue is constantly occurring in any form of training including in the pool. The stronger the tissue becomes the less micro-damage that is done to tissue within each in-pool session. With less damage, the body has less work to do to recover and thus each following training session can be more productive.

Below is a microscopic photo of muscle fibers taken pre-training and post training.
(Friden, et al. 1988)

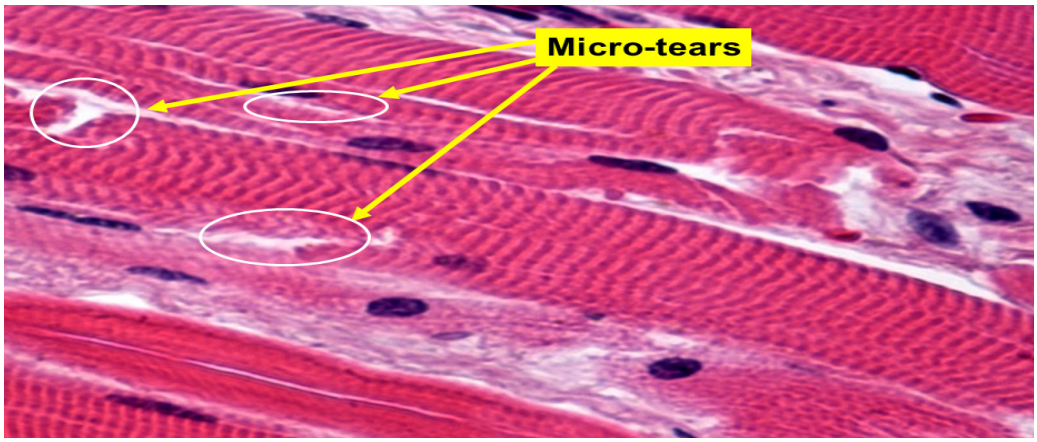


Pre-training



Post-training

Below is a photo of the muscle damage acquired during training.




It is important to realize that there are common chronic injuries that must be addressed in the sport of swimming. Because shoulder girdle etiologies are one of the most prominent injuries that swimmers encounter (Pink, 2000), it is vital to strengthen the tissue surrounding this joint. Tendonitis, a common issue occurring in the rotator cuff, can usually be addressed by strengthening the external rotator muscles and muscles that stabilize the scapula (Weil, 1999). Thus, the use of strength and power training focusing on these joints and surrounding musculature is advantageous when trying to reduce the risk of injury in elite swimmers. To most effectively reduce the risk of injury, a strength and power program should focus on movements that incorporate joints that are used in training and muscles that may be neglected in sport-specific training (Newton, 1994). One such exercise is the snatch and overhead squat, where the movement requires a load to be held overhead, which can strengthen and improve the integrity of the shoulder joint and surrounding musculature while improving an athlete's ability to generate full body power.

**Summary and General Concepts**

Hopefully with the information provided you recognized that there are different ways to use weights and that using weights can have a very positive impact on an elite Olympic swimmer's performance if used in the correct manner. It is important to remember that weight training for this caliber athlete is simply a supplement to sport-specific training and should not hinder, but rather enhance, the athlete's in-pool training sessions by improving performance, aiding recovery and reducing the risk of injury. For an athlete at the highest level, it is important to recognize three very general concepts to optimize the use of weights for improving performance.

First, because of the larger training volume of elite athletes, it is important to manage fatigue by managing frequency and duration of weight training sessions as well as using movements and exercises that will have the greatest benefit for their time.

Second, it is important that the program created is individualized to meet that athlete's past and present weight training experience, load tolerance, and injury history in combination with the athlete's performance goals.

Lastly, it is important that an athlete of this caliber has a program that is properly periodized in order to allow for optimal enhancement of performance throughout training and optimal peaking before competition, as strength and power training can be beneficial in the tapering process as well.

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## Preventing Sexual Offenders in School Programs: What the Coach and Administrator Should Know

Catherine Sellers, Associate Director of High Performance, US Paralympic Track & Field

All too often, we read about a coach or teacher who was arrested for indecent activity with an athlete or student. As coaches and administrators, we are dismayed when we read of the misbehavior, arrest, or unethical behavior of a coach. We realize the dramatic affect this has on the athlete, his or her parents, the school or club, the community, and the coaching community as a whole.

Prevention is paramount. Background checks to identify criminal activity that might be associated with the potential coaches or employees is a crucial first step, but this strategy may have its limitations. A coach may have a history of offenses, but was never charged. The depth of a background check is also a concern; some agencies only run them for the state in which the person is currently residing. People with troubling histories or with these alleged tendencies will move - and do move - frequently.

More can be done. The great majority of coaches and administrators understand what appropriate and ethical behaviors are for a coach. How or where we learned those lessons is unclear, but we know there are acceptable and unacceptable behaviors.

Unacceptable behaviors include dating your athletes or having sexual relations with your athletes (regardless of sex or sexual orientation). Sexual relations include:

a. fondling
b. exposure to pornographic materials
c. masturbation
d. oral sex
e. anal sex

As the coach or administrator, the statement must be very clearly and publicly made that these types of actions will not be tolerated in your school, district, organization, or club. We cannot assume that people receive this message today. By making this statement to your staff, those who may be involved in or considering this type of activity may deter misconduct.

The vast majority of the coaching community understands the “positional power” they hold and the importance of trust between the coach, athlete, parents, school, and the community. Abuse of trust is one of the reasons we are so dismayed when reading about sexual violations against children. It is not that one person let us down; it is the fact that the whole belief system failed. How did all the people around an abused athlete (friends, assistant coaches, parents) miss the clues?

What clues might we have seen? Two or more of the following clues should be of concern:

1. Does the coach spend significant amounts of time with one athlete, often isolated from others?
2. Does this coach volunteer to transport the athlete home after practice?
3. Does the coach travel with an athlete in their car on long trips without others being present?

4. Is there a blind allegiance or unquestionable loyalty and obedience to the coach?
5. Does this person consider themselves the best coach and the only coach who can get your child to the next level (ex. college scholarship, Olympic team, etc.)?
6. Does the coach make your athlete feel particularly "special"?
7. How does the athlete react to punishment from this coach?

These are just some of the cues and red flags that can be cause for concern by adults, friends, or parents. Individually, these cues may not be cause for concern, but collectively they may give rise to suspicion. People who are sexual offenders tend to be expert manipulators and use their "power" to ensure that their secrets are safe. They work with athletes who want to please the coach and the sexual offender knows how to use this power. They can be very convincing in their concern for a particular athlete to avoid suspicion. They might use lines like, "they are having a hard time at home," or "I am concerned about who they are hanging out with," or other similar statements.

In 2010, the USOC convened the Working Group for Safe Training Environments and charged it with the task of developing a set of recommendations concerning misconduct in sport. The diverse group, that included individuals from the Olympic family as well as external experts, foucsed on four primary objectives:

- Address sexual and physical misconduct in sport
- Review the guidelines across sport and sport-related organizations for responding to these issues
- Assess the needs of athletes, coaches, staff, National Governing Bodies, clubs and other sport organizations
- Develop a set of recommendations to promote athlete well-being

In 2011, the USOC hired Director of Ethics and Safe Sport, Malia Arrington, who was charged with developing a robust program to address misconduct in sport by providing information, training, and resources. An 80-page handbook titled "Recognizing, Reducing and Responding to Misconduct in Sport: Creating Your Strategy," aims to guide the development, implementation, and internal review of effective athlete welfare and misconduct prevention strategies for local, regional, and national sport organizations. The handbook has been distributed to each of the NGBs in the U.S. Olympic family and is endorsed by the NGB Council.

In March of this year, the USOC launched Safe Sport, a training program aimed at improving the safety of athletes. The new website, safesport.org, offers downloadable material and other resources to identify the potential signs of abuse, the environments in which abuse can occur, and direction on how to raise a red flag before any inappropriate behavior occurs. Finally, a Safe Sport Legal Referral Network has been formed to provide NGBs free legal support to aid them in appropriately investigating claims of athlete maltreatment.

We all have a role to play in creating a healthy setting for sport. Safe Sport helps raise awareness about misconduct in sport, promote dialogue and provide training resources. When we work as a team, we can build a game plan to make sport safe - for everyone.

**Common Sense Practices for Coaches:**

1. When meeting with an athlete, never meet in private. Have another coach present and leave the door open.
2. Always be publicly open when working with athletes. Avoid situations where you and an individual athlete are isolated from the group.
3. Do not share a room with an athlete while on the road, even to save money.
4. Do not make it a practice to take athletes home from workouts. If you do, do not stop along the way; take them straight home and avoid having large blocks of time alone with one athlete. Let one of the other coaches know you are taking the athlete home. Have the athlete call their parents or guardians to relay how and what time he or she is getting home.
5. Do not have athletes stay at your home.
6. Avoid entering the dressing room when the athletes are dressing or showering.
7. When mixed teams compete away, have chaperones of both sexes present.
8. If an athlete needs to be touched, make sure that it is in an appropriate way. If it is a compromising area of his or her body, ask the athlete's permission and make sure you do so openly for the purposes of offering care for injury or risk of injury. Discuss alternatives with the athlete and provide instruction to avoid uncomfortable or perceived inappropriate action.
9. Avoid sarcasm. Sarcasm only develops feelings of resentment, discomfort and avoidance of the coach, which can be misconstrued.
10. Do not use sexually suggestive comments; they are easily misconstrued as well.

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On the cover: 2008 Team USA Gold Medal Wheelchair Basketball Team

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