

Performance Improvements in Swimming: A Multi-Disciplinary Approach

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Abstract

There are several facets of the training process that have the potential to influence a swimmer's performance. The purpose of this review is to introduce a holistic model of performance improvement for swimmers which includes the following four components: training, adequate rest and recovery, proper nutritional habits, and positive psychological mechanisms. At the core of the model is discipline which connects each of the four aforementioned components. Within this review we will present an overview of each element and the methods in which each can be applied and emphasized within the coaching setting.

Introduction

Effective coaching of competitive swimming is a combination of science and art. For optimal results, it is important to identify the proper combination of those two components and implement these variables into the training process. Performance improvement is arguably the primary focus of an athlete. Striving to progress in sport is (or at least should be) of paramount importance for the athlete. Even world record holders pursue advances in training techniques and procedures in order to continue to upgrade their performance. Certain sports are skill-based, some technique-based, while others are conditioning driven. Many sports employ different combinations of these three factors, and swimming is a prime example of a sport that utilizes all three components.

Many swimmers will continue to attend practice and “work hard” in an attempt to achieve some measure of improvement. The success they attain is frequently attributed directly to the amount of practice time expended. Conversely, lack of success is often attributed to inadequate practice time. Therefore, undue emphasis may be placed on the continuation of practice at the expense of other important areas. Coaches will work with athletes to correct deficits in their performance, but not all performance problems are related to lack of practice or poor practice skills. Success in the swimming pool is undoubtedly not a factor of practice time alone. Several facets of the training process will influence an athlete's success. Within this paper, we will introduce a model of performance improvement for swimmers which includes the following components: training, adequate rest and recovery time, proper nutritional habits, and positive psychological mechanisms. The core of the

model is discipline which connects each of the four aforementioned components (see Figure 1).

Training

There is no doubt that the quantity and quality of physical training an individual undergoes has a direct relationship on her/his success in the pool. An individual's training load, based on the frequency, type and intensity of the training sessions will often dictate the athlete's results. The type of stroke and distance swum is influential on the nature of the practice and conditioning session. For example, sprinters will require an entirely different training regimen than distance freestylers. Also, a butterflyer will focus on different aspects in training than a breaststroker.

Optimal utilization of training time may be determined by identifying the technical aspects of the stroke and aligning them with the body's ability to utilize available energy. By determining the strengths and weaknesses of a swimmer, the optimal training distances and type of training can be determined (Toussaint & Hollander, 1994).

The combination of both an effective dry-land and in-water training protocol appears to offer the greatest benefits in swimming improvement, especially in sprint performance (Aspenes & Karlsen 2012; Aspenes, Kjendlie, Hoff, & Helgerud, 2009; Girold, Maurin, Dugue, Chatard & Millet, 2007). Dry-land training may take several different approaches including the utilization of free weights and machine weights, resistance bands, plyometrics, and body weight exercises. All of the different dry-land techniques have associated positive and negative aspects, and swimmers and coaches would be well advised to research the benefits and potential drawbacks of each of these methods of training.

Proper Nutritional Habits

While training remains an important component of improved performance, proper nutritional practices play an integral role in the athlete's development and improvement. There is extensive research regarding optimal nutritional factors for sport and activity. The American Dietetic Association and the American College of Sports Medicine both agree that physical activity, athletic performance and recovery from exercise are enhanced by optimal nutrition (Rodriguez, DiMarco & Langley, 2009). Both the selection of food and the timing of ingestion are important components in performance. Pre-practice/competition consumption and post-practice/competition consumption are equally important. The nutritional component for energy and recovery after exercise is also extremely important. Principal issues include restoration of liver and muscle glycogen stores and the replacement of fluid and electrolytes lost in sweat (Burke, 1997).

Optimal nutrition should be primarily determined by the training load and the individual's body mass (Hawley, Dennis, Lindsay & Noakes, 1995). Often, swimmers will consume an overabundance of food, incorrectly assuming that their training load will take care of the calories. Even though this intake provides valuable electrolytes to the body, adding sports drinks into a nutritional plan can dramatically increase calories. Therefore, caution is advised on the utilization of sport drinks.

Pre event/competition nutrition is individualized and depends on the needs and gastrointestinal (GI) tract of each competitor. During exercise, blood flow is redirected to working muscles, thereby decreasing blood flow to the gut by as much as 80% which can possibly lead to GI dysfunction (Jeukendrup & Gleeson, 2010). Salo and Riewald (2008) recommend athletes consume a meal of low glycemic index carbohydrates between one to four hours before practice. The timing of ingestion is dependent on the swimmers digestive capabilities. However, as many workouts are scheduled in the early morning hours, eating four hours before practice may not be feasible. Therefore, consuming a smaller CHO containing snack (e.g., power bar, small dish of pasta, fruit) 1-2 hours before the swim may be more realistic. The intensity of the workout will also dictate pre-event nutritional needs, as additional digestion time may be required for higher intensity workouts. Approximately .5-.7 grams of CHO per pound of body weight should be consumed immediately after a workout or competition. This should be combined with 6-20 grams of protein as a part of the post-workout meal (Salo & Riewald, 2008).

Adequate Rest and Recovery Time

Many athletes neglect the component of rest and recovery in their training regimen and some coaches will overemphasize the practice component. As a result, athletes will extend their pool and dry-land training in order to satisfy an increased training regimen. Often a "quantity" approach to training is utilized which may lead to less than optimal performance in the pool (Hooper, Mackinnion, Gordon & Bachmann, 1993).

Without sufficient time to recover from strenuous training, the body will begin to breakdown and further training benefits will be compromised. The negative result of overtraining and inadequate recovery is the increased likelihood of illness and/or injury. A primary component of improvement is adaptation to the stress of training. The body can adapt to increased training and thereby become stronger and more efficient. However, there are limits to how much the body can adapt to increased training. A large training volume combined with insufficient recovery has been associated with overtraining (Halsen & Jeukendrup, 2004). Positive overtraining is defined as the natural process when the end result is adaptation and recovery. However, if the athlete is unable to recover within 72 hours of training, she/he may have worked too hard and has experienced negative overtraining (Kentta & Hassmen, 1998). The goal of any training program is to find the optimal distance and intensity of training to assist in performance improvement. If the training

program is less than adequate, making significant gains are impossible. Too much training can lead to potential fatigue and injuries. High fatigue levels from hard training are associated with increased muscle soreness and fatigue (Hooper, Mackinnon, Howard & Gordon, 1995). Fatigued tissue does not respond to stress as well as healthy tissue, this lack of recovery time may lead to structural damage in the body. While ordinarily the athlete may be able to withstand traumatic or chronic forces on the body, increased fatigue levels may unfortunately result in increased likelihood of structural injury in the athlete (Dugan & Frontera, 2000).

Another interesting side effect of increased training is the effect on sleep patterns. Intuitively, high intensity training should lend itself to increased quantity and quality of sleep. Ensuring appropriate quality and quantity of sleep appears to be extremely important of optimal athletic performance (Halson, 2008). However, evidence of overtraining has been shown in sleep disturbance in athletes leading to decreased performance levels (Hooper, Mackinnon, Howard, & Gordon, 1995).

Increased training load has also been shown to suppress the immune system. While an athlete may be able to withstand certain bacterial or viral pathogens on a normal basis, immunosuppression may result in an opportunistic infection. The constant cycle of training and recovery can lead the body to breakdown past the point of optimal recovery. Certainly in any sport requiring large volume training this is an ever present risk that should be addressed (McKenzie, 1999).

Rest and recovery may take several forms. Immediate recovery (as an athlete proceeds from event to event) is best achieved by performing light activity immediately after competition (Greenwood, Moses, Bernardion, Gaesser & Weltman (2008). Certainly coaches constantly emphasize the importance of warming up and cooling down properly. However, effective long-term recovery for an overtrained athlete appears to be achieved by physical inactivity (Budgett, 1998).

Positive Psychological Mechanisms

Psychological skills are the mental and emotional attributes that affect how an athlete will perform in certain situations. Athletes need psychological conditioning to attain their optimal performance; mind and body need to work together. Excess tension, distractions and misdirected focus are negative factors that psychological skills can help control and, thus, allow athletes to perform at their best. Research suggests that more successful athletes differ from less successful ones in their development of psychological skills (Durand-Bush & Salmela, 2002; Gould, Greenleaf, Chung, & Guinan, 2002). Durand-Bush and Salmela (2002) and Frey, Laguna and Ravizza (2003) concluded that more successful athletes were characterized by higher confidence, greater self-regulation of arousal, better concentration, positive thoughts/attitudes, and possess more determination and commitment.

Psychological skills are similar to physical skills in that they can be developed and improved; they are every bit as important as physical training. In competition, it is often psychological skills which determine who comes closest to her/his potential. Many athletes and coaches, however, think they must practice longer and harder - they are reluctant to include psychological tools in their training and performance regime. Coaches and athletes typically only turn to learning and practicing psychological skills when there is a crisis or a specific problem, even though a preventative approach is considerably more effective.

The importance of psychological skills in the development of athletic performance is widely recognized across various sports and levels of competition. There are a number of psychological skills that an athlete can use to enhance her/his performance, many of which coaches and athletes are already utilizing. Mental imagery, relaxation, goal setting, positive self-talk, and cognitive restructuring are some of the techniques used to enhance athletic performance, readiness and satisfaction.

Mental Imagery

Mental imagery is a technique in which the athlete employs as many senses as possible (sight, sound, taste, feel, smell) to recreate a sport experience in her/his mind. Imagery can help prepare an athlete for scenarios that may occur during a competition (or practice). Athletes across a range of sports have been found to use imagery to prepare for competition, correct errors and/or learn from poor performances, motivate themselves, and reduce anxiety.

Relaxation

There are many forms of relaxation that athletes may employ to reduce their mental (i.e., worry, self-doubt) or physical (i.e., butterflies in stomach, shaking) anxiety, while also increasing concentration and performance. Centered breathing, progressive muscular relaxation, meditation, and autogenic training are some of the techniques athletes can use to regulate their anxiety.

Self-Talk

All athletes talk to themselves. This talk plays a significant role in how they perform. If an athlete learns to change her/his inner dialog to be positive and more constructive, there is a better chance the athlete will perform well. Negative thoughts tell the body that something is wrong and in response, the body goes into a defensive mode and performance may suffer.

Goal Setting

Goal setting is often described as a map, it lets you know where you are going, how you will get there and how well you are progressing on that journey. Without the map, one's journey may drift aimlessly. While most athletes set goals, most are set

ineffectively and fail to follow the SMART principle of goal setting: specific, measurable, attainable, realistic, and timely. While long-term goals serve as a focal point, it is the short-term, process-oriented goals that are necessary if one is to reach her/his long-term goals.

While most coaches advocate for the importance of psychological skills and can introduce or deliver some techniques, few coaches are specifically trained in sport psychology. Furthermore, coaches wanting to incorporate psychological skills training with their athletes should consider the ethical and practical issues associated with such a dual role (Watson & Clement, 2008). Coaches cannot do it all without reducing their competency as a coach. Ideally, it is important to seek the expertise of a Certified Consultant, AASP (CC, AASP; Association for Applied Sport Psychology) who has met the minimum standards of education and training in the sport sciences and in psychology.

Discipline

Discipline is often viewed as the deciding factor between wins and losses, perceived successes and failures, and the overall quality of an athlete's athletic experience. Without integrating all four components (i.e., training, nutrition, rest/recovery, psychological) into their competitive routine, athletes are at risk for decreased performance.

Behavioral components of discipline are loosely defined as adhering to practice, implementing adequate recovery practices, utilization of optimal nutrition, and implementing the use of psychological skills during swim training. In order for a swimmer to reach her/his full potential, it is proposed that the aforementioned aspects must be employed on a regular basis. In order to do so, a fairly high degree of discipline in the individual athlete must be implemented. Based on available studies, personality, environmental, and behavioral factors appear to affect levels of discipline in individual athletes (Dorfman & Kuehl, 2002; Young & Starkes, 2006).

Personality factors such as commitment, motivation, self-awareness, and goal-orientation may affect a swimmer's level of discipline. Young and Starkes (2006) found that swimmers who were higher in self-regulation displayed more discipline in workout. Self-efficacy could also potentially affect levels of discipline in swimmers to their training (Bandura, 1997). According to Clingman and Hilliard (1987), a group of "super adherers" to a training program were found to have higher levels of personality traits of achievement and autonomy motivation, which can relate to discipline to applying principles of an all-encompassing training regimen. Furthermore, swimmers who are high in self-motivation and commitment may display more discipline in the areas of practice intensity, recovery outside of practice, nutrition to support training, and attention and maintenance of the psychological aspects of their sport.

Environmental factors also appear to play a role in levels of discipline in swim training. In his work with baseball players, Dorfman and Kuehl (2002) emphasizes congruency of focus on task both on and off the pitcher's mound; each is to be designed to maximize performance. This principle can be applied to swimming as well. An athlete is adhering to the four aspects of swim training by structuring his or her environment in a way that reduces distractions, incorporates rest and recovery, and includes easy access to nutrition that enhances performance. Athletes who "engineer their environments" toward their goals may display more discipline in their behavior towards training. In order to accomplish any athletic task, a level of discipline is required. While individual differences exist, several factors are prominent that a competitive swimmer can utilize and implement into her/his training in order to improve performance: appropriate practice, adequate recovery, proper nutrition, and the implementation of strong psychological skills.

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Figure 1. Model of Performance Improvement



