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Mental Skills Training For Sports: A Brief Review

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Abstract

Mental skills training for sport is reviewed in relation to general cognitive-somatic techniques. These techniques include mental rehearsal, mental imagery and visualization, visuo-motor behavior rehearsal, cognitive-behavior therapy, biofeedback, progressive muscle relaxation and meditation. It is concluded that the initial and continued ability to self-monitor, though enhanced by mental skills training, is fundamentally important for any implementation of cognitive-somatic therapy.

Introduction

The interface between biomechanical (Hayes, 1982), physiological (Hasan, Enoka, & Stuart, 1985), and peripheral (Zajac, 1993) and central nervous system (Behm & Sale, 1993; Wolpaw, 1994) operation to coordination of movement are mediated by different facets of psychological involvement (Bergenheim, Johansson, Granlund, & Pedersen, 1996). To enhance the psychological component of physical movement, mental skills training has been recognised as an effective method (Driskell, Copper, & Moran, 1994; Feltz & Landers, 1983). Primarily, mental skills training has developed from the necessity of the athlete to learn more about their individual mental life to allow a degree of control in coordinating effective movement through various psychological states of performance (Martens, 1987; Rushall, 1992). There are many different methods used to develop mental skills in task performance, but most can be separated into two basic approaches, cognitive and somatic, even though there is much overlap between the two. Underlying both systems is the aim and motivation of the individual to attain self-mastery, that is, a desire to control their individual psychological world.

Self-Mastery and Motivation

The ability of the individual to control mental and emotional elements assists task performance as well as creating a psychological foundation for confidence and well-being (Boyd & Zenong, 1999). When the individual feels as though they possess a degree of self-mastery in relation to psycho-somatic function, this serves to motivate continued efforts in attempting to increase performance (Wuff & Toole, 1999). However, when the ability of the individual to control their psychological state is diminished, especially during times of injury or incapacitation, there is a risk of a decrease in self-confidence, well-being and future performance (Rotella & Heyman, 1986). Thus, as its first premise, mental skills training relies on a methodology of self-mastery, generated through self-knowledge, to enhance the psychological state of the individual.

Like any form of training, methods to develop self-knowledge require time, and distinct and definite goals. Furthermore, time set aside for mental skills practice, and the belief in the methods employed, require a certain level of motivation, even more so, than physical based training that has quantifiable results from the beginning and can be assessed and measured with regularity. Mental skills training takes a certain degree of patience and trust in their application because results may not come immediately, and are often qualitative and difficult to separate from significant increases in physiological performance (Strean & Roberts, 1992). Sustaining individual motivation with patience and persistence is important from the beginning.

The initial difficulties associated with implementing a mental skills training package can be alleviated by ascertaining the motivational characteristics behind the aim of increasing performance. Weinberg (1984) identified two distinct motivations underlying the desire for an athlete to improve performance, these were, extrinsic rewards and intrinsic motivation. Extrinsic rewards are those motivations that are essentially external to the athlete. These include the more material aspects of competition, such as prizes, trophies, money and security, and also the more immaterial, egocentric aspects of competitive events, such as recognition and respect from peers. Intrinsic motivations are mainly concerned with the desire for self-development, and to challenge and improve oneself.

Weinberg (1984), Martens (1987) and Rushall (1992) emphasize that athletes should be encouraged to improve performance from intrinsic rather than extrinsic motivation to help with attaining specific goals. This is because extrinsic rewards tend to govern the concept of self, and event performance, that is, the athlete’s self-confidence and overall satisfaction with training and performance are influenced and defined by external factors out of the control of the individual.

For example, if an individual obtains a good result, even though they may have performed below personal expectations, they may find satisfaction in his or her performance. If the individual obtains a poor result, despite having performed above personal expectations, they may be very self-critical and produce within themselves a depressed state that may affect future performance. In either case, if performance is

evaluated by external factors, such as what other people may think of them, or what material gains may be made from competition, an egocentric, almost narcissistic psychology may be developed. Furthermore, this may decrease the objectivity the individual requires to learn from failures, and face personal challenges that may be inhibiting further development.

Motivation derived from external rewards appears to underlie the phenomenon of learned helplessness in sport, or the continued failures of the athlete despite no obvious, external cause being identified (Prapavessis & Carron, 1988). This is because those individuals whose definition of self lies with external elements tend to attribute failures to others, or outside events, and only successes to themselves (Weiner et al., 1971). If the athlete only ever learns from past successes, as a sign of the appropriate path to follow to increase performance, there will be a limited scope in development. In general, there are far more failures in fine tuning performance than there are successes, and learning from failure becomes a success if taken from the perspective of intrinsic motivation in self-mastery.

Intrinsic motivation derives from a desire to achieve for achievement's sake. Instead of defining oneself from the perspective of external agents, the individual measures themselves by themselves, success attributable only inasmuch as how they performed previously, regardless of the external reward. Intrinsic motivation allows the athlete a more objective perspective of themselves, decreasing an egocentric position that would normally be associated with external motivation, and freeing the individual to see performance as a means of self-development. Understanding this, the individual places awareness upon the importance of persistence in training, vital to the adherence of psychological and physiological based training (Dishman, 1984).

Moreover, the athlete is not limiting themselves by external events, that is, only setting goals to merely "beat" their opponent for some material or ego-oriented gain, but opens the door for much higher aims in performance. This is because goals set as a construction of external events, i.e., whether one "wins" or "loses", has been shown to be a source of great stress and anxiety due to the inherent uncontrollability of external events (Burton, 1989). Furthermore, one's goals will be focused mostly on those things believed to be controllable in the external environment, instead of focusing internally on the way one perceives external events. Under intrinsic motivation, a greater scope for self-development and self-improvement exists in comparison to external rewards because intrinsic motivation assists in changing perception of external events, rather than external events precipitating a change in perception. Therefore, before mental skills training can begin an assessment of underlying motivation is important because of the qualitative nature of results and gradual progression of training.

Methods of Mental Skills Training

Most mental skills training techniques can be grouped into two basic categories, cognitive and somatic methods. Cognitive methods include mental rehearsal, mental imagery and visualization, visuo-motor behavior rehearsal, and cognitive-behavior

therapy. Somatic methods include biofeedback, progressive muscle relaxation and meditation. Although cognitive and somatic methods develop the psychological apparatus of the individual from different perspectives there is much overlap because of the nature of psycho-somatic function. Therefore, elements of each tend to permeate elements of all, but an explanation of a variety of approaches is useful to characterize the different aspects of human nature that contemporary psychology has undertaken to enhance the mental development of the athlete.

Cognitive Methods

Mental Rehearsal

Most of the methods used to increase performance of a given task involve the individual mentally rehearsing the motor skill or strategy intended for training or for the event. Cohn (1990) has reviewed much theoretical and practical research citing mental rehearsal as an effective tool for performance. The theoretical support for mental rehearsal comes from a variety of sources.

1. Schema Theory: This theory developed by Schmidt (1975, 1976) describes movement as being primarily controlled by central structures with minimal input from sensory information that stores pre-programmed commands in the form of generalized motor patterns that are retrieved and executed upon demand. However, these commands, once executed, especially during quick movement, requires an almost absence of sensory information, otherwise, disruption of the motor pattern becomes inevitable and execution malformed. This is because conscious intervention is too slow to accommodate changes in motor coordination, and thus, unconscious execution is desirable. By mentally rehearsing the specific motor pattern the psychological "script" becomes more explicit in its expression, and tendencies to intervene at critical moments can be alleviated when the requisite cues have been made aware to the individual. Without awareness of the script, or motor pattern, to allow execution from start to finish without intervention, motor skills may not be effective.
2. Stages of Motor Learning: Much like Schema Theory, Fitts (1964), and Fitts and Posner (1967) describe the stages of motor learning as (a) the cognitive phase, i.e., consciously learning a new skill, (b) the associative phase, i.e., making minor adjustments to the newly learned skill in striving for perfection, and (c) the autonomous phase, i.e., the newly learned skill is capable of being executed unconsciously. However, even if the cognitive and associative phases are properly performed the autonomous phase may not be sufficiently reinforced within neural structures to allow proper unconscious activation. Practiced mental rehearsal can help to reinforce the appropriate neural coordination to allow the specific motor patterns to be retrieved and used. If not, conscious processes may still have to intervene and slow down, or even destroy the coordination process.
3. The Set Hypothesis: This hypothesis proposes that before a successful motor skill can be executed a specific internal state is necessary for optimal conditions of activation (Nascon & Schmidt, 1971), especially after prolonged periods of

> specific motor skill inactivation, such as the nature of golf and bowls (Adams, 1961). That is, adjustments in the level of arousal and attention need to be modified depending upon the particular demands of the task, and this must be repeated each time. By rehearsing this aspect of skill performance the individual will be able to practice eliciting those psychological states conducive for performance. If not, then before the skill has a chance to be executed the risk of failure is high because the requisite psychological background conditions are not sufficient for optimal activation.

Cohn (1990) describes some of the practical implications of mental rehearsal from the theories extrapolated above. Depending upon the nature of the task (closed or open skill) and the skill level of the individual, the advantages of mental rehearsal are two-fold. First, mental rehearsal can be used to reinforce unconscious processes executing specific motor skills to increase skill efficiency. This is because conscious control of quick and/or complicated movements are too slow in their intervening power, and thus, contribute to disrupting, or destroying the intended movement. Secondly, initiation of a specific skill requires specific psychological conditions for optimal performance, such as specific arousal and attention processes. Therefore, the motor skill component and the pre-skill, or pre-performance lead-up, need to be rehearsed for efficient execution.

Cohn (1990) provides evidence of pre-performance routines used to facilitate sports performance in open- and closed-chain skills that include golf (Boutcher & Crews, 1987; Cohn, Rotella, & Lloyd, 1990), tennis service (Moore, 1986; Moore & Lloyd, 1986), basketball free-throw (Lobmeyer & Wasserman, 1986; Wrisberg & Anshel, 1989), soccer (Vealey, 1986), volleyball service (Heishman, 1989; Kolscher, 1984), bowling (Kirschenbaum, Ordman, Tomarken, & Holtzbauer, 1982), gymnastics (Mahoney & Avener, 1977), wrestling (Gould, Weiss, & Weinberg, 1981), skiing and skating (Orlick, 1986), and diving (Highlen & Bennett, 1983).

Lobmeyer and Wasserman (1986) investigated the effect of a pre-performance training routine upon a free-throw shooting task. Subjects showed a 7% increase in free-throws during practice when using their pre-throw routine versus not using it. Wrisberg and Anshel (1989) found that mental imagery in conjunction with arousal control was an effective pre-shot strategy to enhance the free-throw shooting performance of young athletes. Moore (1986) evaluated the effects of an overt-covert routine training program on adherence to, and performance of, a pre-service routine in tennis. Overt, or behavioral based strategies such as practice swings, setting and aligning feet and hands, etc., and covert, or cognitive based strategies such as picking a target, visualizing the ball in flight, etc., were used. The study showed that tennis players' adherence to a pre-service routine increased following the intervention program, but there were only slight increases in serving accuracy. The players reported in follow-up interviews that the intervention had a positive effect on second-serve aggressiveness and target selection.

A similar study investigated the effects of self-recording (a technique of self-monitoring) on adherence to a tennis service routine (Moore & Lloyd, 1986). The results indicated that self-monitoring had improved adherence to service routines, with only

slight but consistent improvements in serving accuracy. Moore and Lloyd (1986) concluded that small increases in performance with advanced athletes is still meaningful because of a "ceiling effect" that leaves only a small margin of improvement. Furthermore, a study using bowlers demonstrated that a positive self-monitoring technique enhanced performance for low-skilled bowlers (Kirschenbaum, Ordman et al., 1982).

Cohn et al. (1990) showed that cognitive behavioral intervention improved adherence to pre-shot routines in golf, and follow-up measures revealed that performance improved in actual competitions. In follow-up interviews, golfers reported that the intervention helped to improve concentration as well as deciding which club to select and the type of shot to be hit, and that it improved confidence and decreased controlling tendencies.

Heishman (1989) tested the set hypothesis versus the schema theory as alternate explanations for when to introduce a service routine in volleyball. The study attempted to determine whether learning the serve in conjunction with a routine (as schema theory suggests) was more beneficial than acquiring the serve first and the routine later in learning (as the set hypothesis suggests). The results showed that both groups made significant gains in service accuracy scores compared to controls, but the stage in which the routine was taught did not influence the accuracy or form scores. A retention test revealed that the set hypothesis group did not decline in accuracy whereas the schema theory group did. Heishman (1989) concluded that pre-service routines were effective for improving serving accuracy and form. Furthermore, the routine should be taught after the basic skill has been learned (supporting the set hypothesis), if the main objective is to enhance skill retention.

Another advantage of mental rehearsal is the absence of major physical exertion that the individual would have to perform under traditional physical training regimes. This can alleviate the risk of over training that is a constant source of anxiety amongst many amateur and professional athletes (Warr, 1996). Therefore, mental rehearsal has been demonstrated to be an effective tool to increase performance. Though there are many varying techniques in mental skills training, some fundamental methods are described below.

Mental Imagery and Visualization

The brain regions responsible for motor execution (specifically the prefrontal cortex and its connections to the basal ganglia maintained in working memory) appear to be also responsible for imagery processes under conscious thought without the intended movement being evoked (Decety, 1996; Jeannerod, 1995). That is, those neural operations involved in executing motor coordination also play a role in mentally representing those actions in conscious thought, through imagery, without generating the actual movement. However, imagining the event happening is not enough to elicit the correct imagery process, and like motor skills, if the mental imagery technique is performed inadequately, without sufficient attention on appropriate execution, subsequent gains in motor performance will be substandard.

There are many requirements in achieving the desired effect of mental imagery, but the first is the approach to teaching and learning the specific techniques. The visuo-spatial and temporal components form the "procedural" knowledge required for effective mental imagery, while conceptual (ideas of movement) and symbolical (language representations) elements form the "declarative" knowledge of mental imagery (Annett, 1995, 1996). Procedural knowledge is the knowledge of "knowing how" to do mental imagery based on performance results, i.e., the success achieved in mentally forming the correct image in the mind. Declarative knowledge is different because it is the knowledge of "knowing that", or the concept or idea behind the mental imagery method in order to gain an understanding of the mental imagery process, and intervening conceptually, or symbolically to assist understanding. This sort of distinction has a similar foundation in "implicit" and "explicit" knowledge in cognitive psychology, in that, these terms signify whether the individual knows what they are doing (explicit) compared to the individual knowing how they are doing it (implicit) (Anderson, 1980). These two forms of knowledge are critical if the individual is to learn the techniques needed to perform mental imagery properly. This is because imagining the skill, and actually performing the skill, needs to be as closely executed as possible for effective transfer and reinforcement to neural structures (Currie & Ravenscroft, 1997). Thus, mental imagery competency requires a degree of attention and psychological effort to elicit the desired effect.

Once declarative knowledge has been absorbed and understood and conscious attention to detail during mental imagery forms a reinforcing feedback loop that enhances neural structures, then procedural knowledge can begin. There are many guidelines to enhance the imagery process, and most, if not all, fit within the spectrum of techniques in mental imagery training (Ievleva & Orlick, 1991; Martens, 1987; Rushall, 1992). Some of these guidelines include:

1. The individual practices mental imagery with the aim of recruiting as much sensory information of the actual skill as possible. That is, not only are visual and temporal data used, but also acoustic (hearing), olfaction (smell), gustation (taste), and kinesthesia (body awareness). By drawing in as much of the sensory information as possible concerning the conditions of skill performance the more realistic simulation of the mental imagery process can be created.
2. The ability to mentally control the image in a dynamic mode is important. For example, visualization of the image dynamically in first person and third person, or the individual attempts to "see" the performance of the motor skill through their eyes (first person), as well as the eyes of another person observing them (third person). Creating third person and first person visualization allows a multiply perspectives to the continually changing environment to make the process more objective that would be difficult in first person imagery. However, ultimately, the individual must master first person perspective in order to simulate actual events.
3. As mentioned above in 'Mental Rehearsal', specifically The Set Hypothesis, creating the appropriate psychological background pre-performance is essential in effective initiation of the required motor skill. Therefore, not only should the individual draw in as much sensory information as possible, and the necessary

conscious control of the image, but also evocation of the emotional content specific to the skill intended. That is, retrieving the desired arousal and attentional processes involved before the initiation of the skill sequence.

These aspects of the mental imagery process need to be constantly practiced in order to elicit results. Even though individual differences exist in mental imagery ability, generally, better imagery control correlates to better performance in the motor skill (Annett, 1995). Another approach is to combine the techniques of mental imagery with physical practice of the intended skill labeled visuo-motor behavior rehearsal.

Visuo-Motor Behavior Rehearsal

Visuo-motor behavior rehearsal (VMBR) is an extension of mental imagery, in that, it combines the psychological aspect of generating the mental image with feedback from the performance of the physical skill (Lane, 1980). This method has been used successfully, especially with closed motor skills, in a number of sports including Karate (Weinberg, Seabourne, & Jackson, 1981), basketball (Gray & Fernandez, 1989; Onestak, 1997), racquet ball (Gray, 1990), tennis (Noel, 1980), and cross-country running, golf, track and field, gymnastics, and diving (Lohr & Scogin, 1998). VMBR involves three phases, first, an initial relaxation phase to retrieve a psychological state conducive for mental imagery, second, visualizing performance through various imagery techniques, and finally, performing the actual skill under realistic conditions.

By repeating this process with the intended skill during training it is hoped that real-time feedback ensues between mentally coordinating the visualization and imagery component with actual performance, thereby, minor changes in either the skill, and/or the imagery process, can be maintained in parallel. The rationale behind VMBR is keeping mental imagery and skill performance closely associated in training, which should correspond to an increase in performance because the individual can fine-tune both processes simultaneously.

Before VMBR can begin, the mental imagery techniques are required to be learnt and understood within the context of performance, otherwise, VMBR can be detrimental to the motor skill activity. This is because insufficient attention during motor performance may result if the individual is concentrating to heavily on the method of mental imagery due to unfamiliarity with procedure (Lane, 1980). VMBR can be used as an effective extension of mental imagery training. An alternative method is cognitive-behavior therapy that attempts to change skill performance, and behavior towards performance, through altering the way one cognizes the event or events.

Cognitive-Behavior Therapy

Cognitive-behavior therapy (CBT) has been used successfully in a wide range of applications, from developing social skills (Curran & Monti, 1982), dealing with psychiatric disorders (Hawton, Salkovskis, Kirk, & Clark, 1992), to the treatment of depression (Williams, 1992). Primarily, CBT focuses on methods that strengthen positive

behavior and weaken negative behavior towards a desired goal. Over time, and with maintenance of treatment, it attempts to condition the individual to cognize in specific ways to create desired psychological states as a foundation for psycho-somatic events. This approach has found favor amongst sport psychologists and educators because athletes' attitudes to the way they approach training and competition, and the cues they use to adapt to given situations, influence sporting performance (Kirschenbaum & Bale, 1984; Steinberg, Chaffin, & Singer, 1998). CBT is a method to alter perceptions and conceptions about given situations that create a psychological atmosphere conducive for other mental skills techniques to be used effectively, such as mental imagery and VMBR.

Many factors appear to influence the success of CBT in any intervention strategy, such as, the interpersonal relationship between trainer and trainee (Fosshage, 1995, 1998; Keijsers, Schaap, & Hoogduin, 2000), quality and quantity of feedback (Grieve, Whelan, Kottke, & Meyers, 1994; D. S. Kirschenbaum, Wittrock, D.A., Smith, R.J. & Monson, W., 1984), athlete motor skill level (closed/open) and gender (Anshel & Porter, 1996a, 1996b), recreational versus elite athletes (Ryska, 1998), and state and trait anxieties (Martin & Hall, 1997). However, Gordon (1995) has reviewed CBT in relation to sports performance and has concluded that, although there are many ways with which to use CBT in an individual (Bond, 1995) and team (Miller, 1995) sport's environment, guidelines can be followed as a fundamental design procedure in any CBT strategy.

Gordon (1995), reviewing conceptual strategies in approaching cognitive retraining of athletes, based on the work of Kirschenbaum and colleagues (D. S. Kirschenbaum, 1984; Kirschenbaum, Tomarken, & Ordman, 1982; Kirschenbaum & Wittrock, 1984), defines the central problem of CBT as self-regulation. That is, attempting to alter habits, whether psychological or physical, in order to change attitudes toward a given situation, or motor coordination to a given task, depends on the individual's ability to regulate their own behavior. A five stage process of self-regulation to change behavior towards a given task is offered as a guideline.

The first stage in self-regulating is problem identification. Athletes can become so task focused and rigid in their training routines that the perception of significantly improving performance above and beyond their current level may be non-existent. This may be especially applicable for elite athletes who think that they have already "peaked" and that further improvements are unlikely. Therefore, the main concern at this stage is to assist the athlete in evaluating their training and behavior for possible ways to enhance performance. It does not analyze the specific task for improvement, but attempts to identify ways the athlete can strategically alter their psychological approach to the given task, thereby, opening up new and possible paths to increase performance.

The second stage in self-regulating is commitment. If the athlete does not want, or does not see the need for changing behavior, then any CBT method will not work. Commitment to schedules and training sessions, taking responsibility for their behavior, and a desire to succeed, are based upon the motivational perspectives involved, as for example if the athlete possesses characteristic extrinsic or intrinsic motivations. Without

commitment, and the motivational factors that compose commitment, no CBT strategy can be effective.

The third stage in self-regulating is execution. This concerns the actual method of regulating behavior in order to change it. Generally, observation of one's behavior (self-monitoring) and evaluating one's behavior in relation to the set goal (self-evaluating) is coupled with communicating feedback to oneself (self-consequating). For example, after self-monitoring and evaluating a specific behavior that has been identified as positive in light of the expected goal, then affirmation and reinforcement of that behavior can be given in the form of positive self-consequating, such as saying to oneself "keep up the good work, that's it!" Behavior identified as negative in light of the expected goal can be negated by negative self-consequating, such as "it's not working, leave this and try something else to help reach that goal."

The emphasis behind the self-monitoring to self-evaluating to self-consequating and back to self-monitoring schema, is a negative feedback loop. That is, anything self-monitored that negatively affects reaching the specific behavioral goal (over self critical, easily frustrated, etc.) is negated by positive self-consequating techniques. These techniques may include mental rehearsal, mental imagery and visualization, VMBR, and relaxation to help the athlete de-emphasize negative states and allow positive states to permeate their psychological landscape that is more conducive for performance. Of course, employment of these techniques will depend upon the various factors that affect CBT interventions as stated above, specifically because every CBT strategy needs to be individualized.

The fourth stage in self-regulation is environmental management. This stage can affect all others if not properly done. This is because the athlete's environment, the social and physical support networks associated with attaining the desired goal, such as friends, family, colleagues, coaches, management services and facilities, are the foundations for psychological and physiological security. Without this, anxiety levels concerning the support framework in place for the athlete may adversely affect attempts at self-regulation. Therefore, when the first three stages have been identified and mapped out, environmental management is necessary to allow concentration on the important aspects of CBT.

The fifth stage in self-regulation is generalization. In order to change behavioral habits in the long term, and maintain a consistent CBT strategy throughout the lifestyle of the athlete, the specific CBT method can be generalized or translated into all aspects of life, such as work and study. Altering behavior is a time consuming effort that, in order to be successful, should be promoted into as many aspects of the athlete's life as possible. If not, deviation from the original goal of the CBT strategy may occur because of constant distracters, such as irrelevant thoughts and stresses, from other areas of life. Thus, by combating these issues with similar or different CBT plans, the constant, and consistent improvement of the individual as a whole is more likely.

The overall goal of CBT is to strategically plan and execute a definite approach that the athlete can follow according to relevant cues indicated by the mutual agreement of the therapist and athlete. CBT attempts to change the way the athlete approaches the given task in order to lay the foundation for specific performance enhancement techniques to occur, like mental rehearsal, mental imagery and VMBR. Thus, CBT concentrates more on the general aspirations and psychological profile of the athlete, rather than specific task affective actions.

Another way of attempting to improve performance is through somatic methods. Somatic methods employ a number of self-awareness approaches that directly support the modalities of CBT but are primarily concerned in gaining control of various bodily functions.

Somatic Methods

Biofeedback, Progressive Muscle Relaxation, and Meditation

To increase the level of self-awareness, that contributes to enhanced self-monitoring and self-regulation, employment of somatic methods to improve performance begins with concentrating on physical sensation to heighten attention of the perception of movement or non-movement (Prentice, 1998). Often, to start the athlete focusing on thoughts and emotions can be difficult because of the subjectivity of experiential content, whereas awareness of bodily sensation can give a more objective sense of self. One approach in the somatic method is biofeedback, that is, employing various devices that amplify specific body functions for psychosomatic feedback (Prentice, 1998).

Biofeedback has been demonstrated to increase running economy in long distance runners by presenting the athletes, when treadmill training over a six week period, their heart rate (heart rate monitor) and ventilation (VO2 spirometer) data (Caird, McKenzie, & Sleivert, 1999). Treadmill running with additional electromyogram (EMG) data, used as a feedback treatment, demonstrated significant increases in running efficiency (Hatfield, Spalding, Mahon, & Slater, 1992). The three above mentioned biofeedback devices have also been used in various ways to increase performance in basketball free throw scores (Kavussanu, Crews, & Gill, 1998), mental skills training (Blumenstein, Bar, & Tenenbaum, 1997), arousal regulation (Gould & Udry, 1994), and especially anxiety reduction (Costa, Bonaccorsi, & Scrimali, 1984; DeWitt, 1980; Prapavessis, Grove, McNair, & Cable, 1992; Sahni, 1996) in athletes.

Though biofeedback appears to be an effective method of increasing performance, either directly through the applied task, as in running and free throwing, or indirectly through anxiety and arousal regulation, the biofeedback devices can be impractical and sometimes difficult to ascribe causes of results if two or more modalities are used (Petruzzello, Landers, & Salazar, 1991).

Another somatic modality similar to biofeedback is progressive muscle relaxation (PMR). Unlike biofeedback, PMR attempts to use the athlete's awareness of muscle

contraction/relaxation sensations to derive degrees of self-awareness. This method has been successfully used in decreasing anxiety for optimal psychological states of performance (Khasky & Smith, 1999; Rasid & Parish, 1998) and pain tolerance (Broucek, Bartholomew, Landers, & Linder, 1993). PMR is performed by instructing the athlete to contract then relax specific muscles in a definite order. Normally, this starts with the facial muscles because of their role in gesture and expression of psychological states, and then progresses to larger muscles that have a lesser role in postural awareness. Depending on the sport and individual this sequence may change. For example, a weight-lifter may need to relax specific muscles not associated with the lifting movement to allow an energy efficient execution during performance. Conversely, an archer may need to focus on relaxing facial and upper extremity muscles to assist in concentration when pulling and releasing the arrow. However, PMR is often combined with biofeedback methods to enhance self-awareness during training that can be transferred to the competitive environment where biofeedback equipment is impractical.

The somatic method of meditation, though it combines frequently with biofeedback and PMR, is another way of increasing awareness of self in sport performance (Thiese & Huddleston, 1999). Meditation derives from yogic science (Morris, 1998) but has been transferred to sport because of its holistic emphasis in integrating psychophysical function (Hickman, Murphy, & Spino, 1977). Meditation is defined as mental exercise and by focusing on particular aspects of physical sensation the individual can begin to be aware of the correlations between physiological functions and psychological activity. For example, when certain muscles tense before a specific task, and are detrimental to that task, meditation can be a way to identify what is happening within self and intervene before undertaking the activity, thereby, averting a possible poor performance. There are many methods to develop meditation and the appropriate intervention strategies to improve performance, but the fundamental principle is beginning with an awareness of the physical self as a tangible expression of the psychological self (Layman, 1978). Eventually, meditation can be a practical extension to biofeedback because there is no use of equipment, and as an extension to PMR because there is no specific muscular activity. The meditative state requires awareness of internal physical and psychological cues, and thus, may be useful as a mental skills technique during competitive situations.

Conclusion

The cognitive and somatic techniques of improving performance interrelate because before effective cognitive based strategies can be used appropriate psychosomatic states conducive for performance require specific conditions for operation. Reduction in anxiety, achievement of critical levels of arousal, and the appropriate attention processes require a degree of psycho-somatic congruency. These criteria presuppose a depth of self-awareness that allows self-regulation and self-monitoring to be effective in identifying psychosomatic cues for intervention. Though these techniques offer a way to increase self-awareness and self-monitoring to regulate behavior and performance, it is the initial and continued ability of the individual to self-monitor that influences their capacity to use mental skills training. Without this ability any application of cognitive-somatic technique to increase performance will be limited.

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