Chapter 3

Psychophysiological Assessment and Training with Athletes©

Knowing and Managing Your Mind and Body

By

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Abstract

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This chapter provides details on the psychophysiological systems used in the initial assessment of an athlete's ability to control the mind and body. Included are temperature (hand surface), electrodermography (palmar sweat response for emotional involvement), electromyography (facial and shoulder muscle tension), heart rate (for reactors and heart rate variability), and respiration rate (speed, ratio, and location of breathing). These measures are taken at baseline, during tasks such as computer games, and during recovery from the tasks. Typical data from athletes are reported as well as what constitutes a high or low atypical response for performers. The training of psychophysiological parameters is illustrated through actual case studies of athletes. The results of the psychophysiological assessment are used to guide the goals for the training process.

Chapter Outline

Introduction

Performance is enhanced if the athlete's mind and body are responding in the ideal state, which, for most settings, is automatic. Too often, an athlete does not know or recall when his or her mind/body is off or not at the ideal performance state, especially during the excitement of high-level performance or critical moments of competition. Consequently, the athlete is unable to return to the ideal performance state. This can be resolved by collecting data on how each mind/body system is operating when performing well and training athletes how to adapt the mind/body to return to this state when needed.

For more than 30 years, the authors have used psychophysiological recordings as objective measures for assisting athletes in identifying the different systems; how they respond under rest and competition; and if necessary, to train for changing system responses. For example, if an athlete is not performing as well in competition as he is in practice, a practitioner can assess if breathing is playing a part in nonperformance. Choking or a deer-in-the-headlights response are common for athletes who hold their breath or hyperventilate (Fried, 2000), and changing breathing patterns contributes to the cause of disruptive emotions such as fear (Phillippot, 2002). For other athletes, the failure to remain in a competitive state such as the zone may be a result of excessive self talk (Hatfield, 2006) or other interfering brain patterns. It is possible that these states can be assessed with electroencephalography. Psychophysiological monitoring in the office or in the sport arena while the athlete is at rest or, more commonly, during a competitive task can help identify these states. The objective is to then teach the athlete the skills to identify when an abnormal pattern is occurring, to prevent psychophysiological changes that lead to the non-optimal performance state, or to change the state to reach the desired level of optimal functioning.

Later in the chapter, we provide a self-assessment that we have used with athletes, as young as 8 years old, to help them identify what their typical response during competition and practice is. This is normally followed by a psychophysiological profile and, if necessary, telemetry or the measuring of the athlete's mind/body responses while in the field of performance.

Personal Program Development for Optimal Performance

There are many areas where psychophysiological measurements can be applied to benefit the athlete. In figure 3.1, the optimal performance model provides an overview of what is necessary to maintain optimal performance. Each of the components of the model is dependent upon the needs of the task, the abilities of the athlete, and the training of the athlete in the skills to perform those tasks. Psychophysiology can be used to objectively assess the athlete, train the athlete, and monitor the athlete during performance. Finally, the athlete needs reinforcement and reward and time periods of regeneration, which again can be assisted by psychophysiological monitoring.

Figure 3.1 Optimizing Performance and Health Model

Task Analysis
+ Person Analysis
+ Skill Training Analysis: Body/Mind
+ Reinforcement and Reward
+ Regeneration

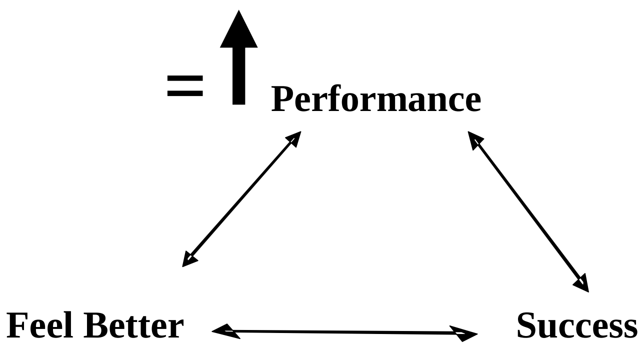

Figure 3.1: Performance enhancement model illustrating that performance is a complex but progressive interrelationship. A change in one variable will affect all others to varying degrees. Central to the concept is that a plan for enhancing performance is necessary, and the plan needs to be practiced.

1. Task Analysis

To optimize performance, the athlete first needs to know what the task requirements are and then whether he or she possesses the skills/abilities required to complete the task (or what is needed to continue to learn or improve). Before training begins, it is also helpful to know the situation (other competitors, coaches, etc.) and whether there are other factors that have a direct impact on the athlete or the training process (lack of sleep, nutritional status, etc.). Elite performers can then begin training in both physical skills and mental skills to be able to complete the task. Physical and mental tasks must consistently be performed with high quality if elite performance is to be attained and maintained.

Task analysis involves the evaluation of what is required to perform in the sport. For example, to be competitive in tennis, what percentage of successful first serves and what serve speeds are necessary? What free-throw percentage in basketball is needed to be a high performer? What is the time needed to win a race? Some tasks require physical flexibility, and others require primarily strength or endurance across a long period. Others require precise movements at the correct time.

Not only are physical skills necessary; mental skills are deemed critical to elite performance. The mental skills most often reported by athletes and cited by researchers as being beneficial for enhancing performance include the following (Williams, J., 2006):

- Goal setting
- Imagery
- Thought Control
- Arousal Management
- Pre-competition readying plans
- Competition plans
- Coping strategies

It is critical that the athlete understands the **task requirements** of his sport in order to select the best-learned self-regulation (LSR) technique to enhance performance. For example, for a long-distance swimmer, skier, or runner, an initial increase in heart rate and anxiety at the starting line is probably not too important as long as he gets off the starting line in a good position. However, the athlete's awareness and ability to control heart rate and muscle tension through the different stages of the race are crucial. The types of LSR an athlete needs to learn and use differ by sport task requirements and lead to bigger payoffs. Thus, if an athlete is about to compete in a race that lasts for several hours, it is reasonable to spend more time practicing skills such as maintaining the rhythm of breathing that keeps heart rate under control, frequent checking of the tension in muscles, and technical cues that maintain proper skill mechanics rather than practicing pre-race relaxation skills.

On the other hand, if the athlete is a rifle shooter, archer, or gymnast, it is crucial that the first response is correct. Much attention and skill learning has to be devoted to attaining the proper first response as there is little room for error correction, and one minor mistake can mean the difference between winning and losing. Whether the athlete needs to learn to shoot at a certain time in the cardiac cycle to get off good shots, to maintain a blank mind, or to use cue words to maintain fine motor control for a difficult mount in gymnastics, it requires specialized training relevant to that skill — not just deep relaxation. **The athlete's skill requirements will dictate how he will need to train his mind and body to perform.**

2. Person Analysis

In the **person analysis**, the goal is to determine how the athlete's abilities and skills meet the task requirements. Whether it is the farm or the racetrack, the saying goes "you can't make a racehorse out of a plowhorse." However, at a young age many individuals possess the ability to become competitive in almost any sport. The coach or athlete's observations are all that is sometimes needed to determine these capabilities at an elite level. While most athletes can obtain an elite level of performance with specific, quality practice across time (Dobbs, 2006), individual differences must be respected in how quickly the athlete learns and to what level he can achieve a desired result.

While an athlete's self analysis, competition videos, performance results, and coach or parent input is valuable, we often use psychophysiological monitoring to aid in the discovery of what the athlete's typical responses are likely to be. For example, in the case of a tennis player, does he begin with unnecessarily high muscle-tension levels in the shoulders such that further increases in muscle tension may inhibit the stroke and thus, power?

It is not the strengths or weaknesses of athletes that limit their ability to compete at the highest level. It typically is that they are unaware of, and thus have no control over, the responses that are necessary to perform in their sport situations. Or they know when something is wrong, but they cannot figure out exactly what and how to return back to winning form.

3. Skill Training Analysis

The purpose of repetition of practice is to make the skill automatic with over-learning. It is the over-learning that increases the probability of the skill being retained during times of fatigue, loss of concentration, or high stress. Effective **skill training analysis** assures repetition is executed with quality as well as quantity. Motor learning research (Magill, 2002) has firmly established feedback is essential for learning. Nowhere does psychophysiological monitoring improve performance more than in the provision of immediate, accurate feedback for training the athlete to control mind/body systems. Decisions regarding what feedback and when to provide feedback need to occur in an organized, planned fashion based upon the needs of the setting. Athletes need a mental plan for what to learn and then to practice what will be needed during the stress of competition (Lidor & Singer, 2002). Our Performance Preparation Plan (P3) is first practiced under ideal conditions in the office and then under stressful conditions. The coaches then have the athlete practice P3 with its mind/body skills in practice, under competitive practice situations, and then in actual competition (see the chapter on LSR for the P3 plan).

An example of using psychophysiology within the P3 would be in identifying and changing muscle-tension levels and breathing responses that interfere with performance prior to a serve in tennis. Athletes can quickly learn muscle release and breathing in the office (typically in one or two sessions), but it takes consistent monitoring and reinforcement (coach or sEMG telemetry) to see the changes in their serve on the court. Once athletes have acquired control in practice, they have heightened confidence as they now have additional weapons to control their mind and body under the stress of competition.

Psychophysiological monitoring can also be valuable when the athlete is using imagery as the changes in sEMG or EEG indicate when the athlete is no longer attending to the image, or as his or her skill increases, so does the imagery patterning (Bird & Wilson, 1988). Video recordings of athletes' performances can also be integrated with psychophysiology monitoring to enhance imagery or, when it is a past negative event that is limiting current skills, to desensitize the athlete to the past failure.

4. Reinforcement and Reward

Reinforcement of progress or success creates the probability of more progress or success, so the athlete is encouraged to take time to celebrate each small success. Some coaches recommend celebrating before an upcoming major event as they believe true success is the journey.

Reinforcement is the basis of improvement and overall satisfaction of achievement. It is important to plan and implement a regular reinforcement schedule. Motivation can be increased by having visual progress reports of improvement.

5. Regeneration

Regeneration is the time and techniques necessary to allow the body/mind to fully recover after either a series of extensive physical or psychological stresses or a long period where the mind/body have not had adequate recovery. Passive regeneration often requires a long period that is not available to the athlete. Consequently, more active regeneration includes activities such as deep relaxation sessions (see chapter 5 by Wilson), massage, meditation, yoga, water therapy, changing the workout environment, changing workout types and schedules, and possibly adding nutritional supplements. Biofeedback and neurofeedback can be used to also induce a deep relaxed state.

It is assumed in the optimizing performance and health model that motivation and commitment remain high but would be addressed if there is a concern. The other influences, such as the particular situation (opponents, facilities, coach, sleep, nutrition), are critical factors but will not be discussed here.

Self Assessments in Sport

Because the mental skills necessary for high performance have been established, the authors routinely perform assessment of these skills. The assessments can be done in groups at training camps or one-on-one. The authors trust that athletes will give honest responses. This is particularly true with internationally experienced athletes, cooperative coaches, and favorable consultant/client rapport. In this section, two different questionnaires are presented.

There are standardized inventories available (O'Connor, 2004) to assess almost all of the mental skills thought to be important in sport. Athletes generally do not like completing extensive paper-and-pencil questionnaires, and it can also be expensive. Consequently, the first questionnaire we use is the Sport Psychology Mental Skills Assessment (see Table 3.1) because it is quick and covers all aspects of mental training skills. The athlete can provide more details of his or her perceptions during the interview of strengths and weaknesses. The results can be used for pre-post assessment as well as comparing perceptions between the coach and athlete. This inventory is later compared to the information gathered from the psychophysiological profile.

Athletes have different abilities and needs. With self-knowledge and coaches' feedback, one can select and train the skills necessary for the athlete. (If left alone, athletes tend to practice what they are good at, not what they need). Some athletes are natural competitive animals and need more practice having intent rather than controlling anxiety during competitions. Other athletes are dedicated practice animals who need significant control of their mind/body to maintain a proper mind/body state prior to their performance during competition.

Table 3.1: Sport Psychology Mental Skills Assessment©

Use the following scale to assess, in general, how well you are able to use your mental skills in ________________(sport). Compare how well you perform the skills in practice and then under high-level competition

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Authors must review for accuracy done hope text doesn't change 1 is none high is 5

Negative		**OK**	**Positive**	
None/Low		**Average**	**Excellent/High**	
1	**2**	**3**	**4**	**5**

	Practice	**Competition**
Motivation	**1 2 3 4 5**	**1 2 3 4 5**
Ability to relax	**1 2 3 4 5**	**1 2 3 4 5**
Ability to energize	**1 2 3 4 5**	**1 2 3 4 5**
Use of imagery	**1 2 3 4 5**	**1 2 3 4 5**
Self-talk	**1 2 3 4 5**	**1 2 3 4 5**
Focus of attention	**1 2 3 4 5**	**1 2 3 4 5**
Decision making	**1 2 3 4 5**	**1 2 3 4 5**
Level of confidence	**1 2 3 4 5**	**1 2 3 4 5**
Goal setting	**1 2 3 4 5**	**1 2 3 4 5**
Control of distractions	**1 2 3 4 5**	**1 2 3 4 5**
Keeping perspective	**1 2 3 4 5**	**1 2 3 4 5**
Relationships with team	**1 2 3 4 5**	**1 2 3 4 5**
Relationship with coach	**1 2 3 4 5**	**1 2 3 4 5**
Contribution to team	**1 2 3 4 5**	**1 2 3 4 5**
Time management	**1 2 3 4 5**	**1 2 3 4 5**

The objective of the assessment is to determine the strengths and weaknesses of the athlete in the factors known to be important to high-level performance. If possible, we give the assessment to the coach to also rate the athlete to determine the congruency between athlete/coach on each of the mental skills. Discrepancies need to be objectively evaluated and agreements made between the coach and athlete as to how to best train the weaker skills.

Mental skills training enables the athlete to obtain a level of awareness and control of the following mind/body states, such that during high-pressure competition and critical moments, he or she may continue to perform the necessary sport tasks to the best of his or her ability. These psychological states have been identified as important to executing good performance:

- High self confidence
- High attentional focus
- Preoccupied with sport relevant thoughts/behaviors
- Lower anxiety
- Ability to park irrelevant thoughts or rebound from negative experiences

One skill that is often overlooked in sport psychology textbooks is the ability of the coach/athlete to maintain high levels of motivation for long periods of time. The state most often needed in practice is the ability to activate, rather than relax, and to focus attention to detail. The quality of the practice needs to be sufficient to maintain good skill development. If skills training is not simulated at a high-competition level in practice, the athlete may develop bad habits that surface during competition. The purpose of the endless hours of repetition in performance is over-learning, which is to make the skills automatic. Over-learned or automatic responses tend to withstand higher and longer periods of stress without breakdown in technique. Coaches assist in the process of over-learning at a high level by assuring the technical elements remain correct but also by making the skill drills challenging and fun while maintaining progress charts of the athletes' improvements. Visual progress charts are even more motivating than verbal reinforcement. We would contend that elite performance is based upon elite practice.

By extending the amount of time an athlete can maintain high-level skills in every practice, such as attending to every shot or skill or demanding technical excellence, the athlete becomes psychologically overloaded in the same manner as physiological overloading (Bompa,1999). This should result in the athlete's capacity to tolerate increased amounts of psychological stress.

Cognitive and Somatic Anxiety Questionnaire

It is particularly important to know thyself when involved in the high-stress world of competitive sport. The reader may wish to fill out the questionnaire in Table 3.2 as a brief educational assessment of what mind/body responses occur during stressful times.

Table 3.2: Mind/Body Stress Response Assessment

This questionnaire allows you to become more aware of how your body and brain respond under stress. Rate yourself using the scale below for each question.

Scale: 4 Almost Always
3 Often
2 Sometimes

1 Almost Never

"When I get under pressure at important competitions or become anxious during critical moments, I ...

____ 1. Tend to think of the negative things that are happening or may happen.
____ 2. Notice my heart rate and/or my breathing change.
____ 3. Feel as if I have little control over what is happening.
____ 4. Feel my muscles become tense and/or my hands tremble.
____ 5. Worry before a stressful event about how well I will do, and/or after the event is over, I replay the situation.
____ 6. Notice that I sweat or perspire.
____ 7. Become upset, distracted, or confused when many activities or ideas are going on at the same time.
____ 8. Feel knots in my stomach or become nauseous.
____ 9. Become emotionally involved and cannot concentrate on the immediate task.
____ 10. Notice my hands and/or feet become cold.

Cognitive (or Brain Stress) Response SCORING

For questions 1, 3, 5, 7, and 9, add the total point score and put it here: _____

Low score is below 9, average score is 10–14, high score is above 15.
The average score for both male and female athletes is 12.

Somatic (or Body Stress) Response SCORING

For questions 2, 4, 6, 8, and 10, add the total point score and put it here: _____

Females: Low score is below 9, average score is 10–14, high score is above 15.
Males: Low score is below 7, average score is 8–12, high score is above 13.
The average score for female athletes (approx. age 21) is 11.
The average score for male athletes (approx. age 21) is 9.

Technical note: The norms for this questionnaire were taken from more than 1,000 student-athletes. The scale correlated at .85 with Spielberger's STAI trait anxiety on a subsample of 150 university student-athletes.

An athlete can have a high somatic response and/or a high cognitive response or any combination of low, average, or high in body and mind responses. A few athletes have self-reported low mind/body stress but still have poorer sport performance under stress. Others have high levels of mind/body stress and perform well under stress. What is important is that the athlete is aware of and capable of controlling his stress responses, so they do not interfere with performance.

For athletes who are competing at very high levels and consistently need excellent performance — and especially those who do not perform well under competitive stress — we recommend a psychophysiological profile assessment. The profile assists the athlete in knowing what is occurring in the mind/body during performance and rest that is not always possible to know through self-observation. This is especially true when the athlete is focusing on performance and not himself. A comparison is made between the self assessment of the athlete and the more objective measures from the profile of how the mind/body responded during the stressors in the profile. A profile also helps to locate which systems may need fine tuning to maximize performance.

Working with athletes is different from non-athletes in that the outcome in the sport arena cannot be ignored. And generally, there is a shorter timeframe in which the athlete, coach, and parents expect to see progress. Fortunately, most athletes tend to have excellent motivation, commitment, and discipline, which translate into more practice at a higher quality outside the office setting. Normally, we involve the coach in the training process so the skills can be consistently practiced in the sport setting. As the coach is the controller of the life of most athletes, and most athletes and parents request coach involvement, all assessment and training results are shared with the coach. The coach typically provides information from his perspective on the nature of the sport problem and how well the mind/body skills are being integrated into practice and success of the techniques. This may create a conflict of interest that has to be professionally dealt with to avoid confidentiality problems (see Chapter 14 on ethics).

Psychophysiological Assessment of Body/Mind Systems

Clinicians should recognize that if everything were going well, the athlete would not be there. They have run into roadblocks they cannot find or fix, or they are concerned the opposition may be learning newer, better skills. Thus, it is important for the clinician to define what can and cannot be done for the athlete and the timeframe for developing the necessary skills. The authors' orientation is that of education, not therapy, with a focus on finding what is not working and providing skills to enhance performance and placing sport within the framework of the total life. All clinicians have the responsibility to refer athletes to appropriate sources of help in areas in which they are neither trained nor qualified.

Clinician modeling is especially important when working with elite coaches and athletes. Athletes expect the clinician to be able to demonstrate most of the skills that are being taught. Demonstrating hand-temperature increases, muscle relaxation, and lowering sweat responses are examples of biofeedback skills that show the athlete the clinician can walk the talk. It is also helpful for credibility and communication if the clinician knows the technical language of the sport.

Psychophysiological Stress Profile

The psychophysiological profile assessment is the cornerstone of our person analysis. The results from the profile are compared with the athlete's self evaluation; others' evaluations; and where possible, with sport skill performance data.

Why measure the mind and body systems?

1. One can gain a holistic picture of what the mind/body of the athlete is doing at rest and during competitive tasks and recovery. While it is possible athletes have learned to control one or two systems (maintaining a poker face, relaxed muscles) this does not mean other systems are not showing signs of distress, which can interfere with their performance.

2. Because time is a crucial limiting factor to overall athletic achievement, it is imperative that only relevant training occurs. Pinpointing what mind/body system is not fully under the athlete's control saves time and increases the probability of sport performance improvement.

3. The profile helps to determine what system(s) is similar or different from other top performers, if the system is important to the tasks of that sport, and where to begin training for control of the mind/body. The profile can provide confirmation of being normal, and even more importantly, sharing strategies on how to obtain or maintain the necessary performance states that are common with other elite performers can be a confidence booster.

4. The results can be compared with paper-and-pencil measures,

evaluations from the field, and the athlete's own self report. Particularly important is to find athletes who are incongruent — that is, those athletes who do not know how their mind/body is reacting.

5. Being able to see and actually participate in altering one's own mind/body systems often creates an "aha" experience (Wilson, Peper, & Gibney, 2004) that can motivate athletes to take more responsibility for their behavior.

When an athlete or coach does not have access to psychophysiological profiling, the authors have devised an overview box of the different systems in disregulation, the health symptoms, and the signs that performance is being affected and how the coach or athlete can assess these without psychophysiological equipment. Common signs of what a coach can observe or ask the athlete are reviewed in the following "Performance and Health Assessment Summary" (see Table 3.3), which offers guidelines as to what system is in disregulation and would most benefit from biofeedback or neurofeedback training.

An example is when a coach or athlete notices that the athlete has tight fists and elevated shoulders while at competitions. This table suggests skeletal muscle tension is too high. If surface electromyography is available, the actual degree of muscle contraction can be measured. The athlete may show performance symptoms such as loss of flexibility or even health symptoms such as headaches. This suggests the athlete would benefit from training for awareness and control of muscles in the body.

Table 3.3: Performance and Health Assessment Summary©

	HEALTH SYSTEMS	PERFOR-MANCE SYSTEMS	ASSESS-MENT: LABOR-ATORY	ASSESS-MENT: FIELD
PRIMARILY SOMATIC				
Skeletal Muscles	Tension headache, muscle tics, low back pain	Coordin-ation, flexibility, postural changes	Surface electro-myography (sEMG)	Elevated shoulders, grimace, tight fists, furrowed brow
Smooth Muscles	Migraine, stroke	Poor recovery, flexibility	Hand temper-ature, blood volume, pulse	Cold hands or feet, poor recovery from fatigue
Cardio-vascular System	Irregular heartbeats, rapid heartbeat	Breathless, tires quickly	Electro-cardiogram (EKG)	Rapid pulse, speech, and movement
Breathing	Hyper-ventilation	Fatigue, muscle tension, coordin-ation	Spirometer	Sighs often, breathless
Immune System	Allergies, illnesses	Poor recovery, not reaching max training intensity	Chemical analysis (hormones, blood count, etc.)	Number of colds, flu

	HEALTH SYSTEMS	PERFOR-MANCE SYSTEMS	ASSESS-MENT: LABOR-ATORY	ASSESS-MENT: FIELD
PRIMARILY COGNITIVE				
Cognitions (Thoughts)	Busy brain, personality problems (obsessive)	Forgetting, wrong skill or strategy selection	Intelligence test, attentional style test	Missing cues, attention to wrong cues
Affects (Emotions)	Anxiety, depression	Try too hard, give up	Tachisto-scope, electro-dermal (EDR)	Over-reaction, short-tempered
Behavior	Poor lifestyle habits	Slow or poor decision making, nonper-formance	Timed decision making tests, video	Poor strategy, slow to act

What to look for in the eight-channel profile recording:

In general, we are looking for an atypical response for each of the psychophysiological systems assessed in the laboratory. “Atypical” is a relative measure. When an athlete has scores that are outliers relative to teammates or a database, the athlete is questioned as to whether the results are correct and whether they represent typical reactions in sport. Additionally, the athlete confirms what degree of relevance the response has to health and performance. If possible, measurements are taken during practice, and coaches are consulted. Unless there is a need to make changes, no action is taken. For example, if an athlete has very cold hands, reports no health problems, has a hand temperature that is not related to the required sport performance, and does not see a reason to have warm hands, then no temperature training is undertaken.

A more accurate measure of atypical can be determined by comparing each athlete’s response to his or her normal. For example, a track athlete consistently had very low electrodermal sweat responses during training or discussions of success or failure. Thus, one day when the athlete’s EDA was very high (compared to his normal response but low relative to other athlete’s responses), he was asked whether there were emotional issues occurring. There were. He was furious with the coach, and the issue needed to be resolved prior to leaving for world competitions.

Another example of an atypical response was an Olympic gymnast whose imagery of executing a vault with a high degree of difficulty generated high trapezius muscle tension. The athlete’s sEMG was then assessed in practice, and again, high trapezius muscle tension was noted. However, when the athlete actually performed this difficult vault with the feelings of tightness in his shoulders, his performance scores were high. Because the athlete was nearing Olympic competition and did not want to change his pre-competition routines, no attempt was made to change the high muscle tension for the one vault. However, during other gymnastic events, he believed high muscle tension interfered with his performance, and thus, he worked on sEMG biofeedback to maintain an optimal feel for shoulder relaxation during the other events.

The patterns of profile responses are equally as important as finding outliers. When does the athlete appear to be most relaxed? Prior to, during, or after the stressful event? Does the athlete consistently increase in stress across the session or show signs of focusing during activities and then recovering following the activity? The profile allows the sport psychology consultant to point out the responses to the athlete and determine if this pattern is typical of responses during sport and if it is relevant for the athlete's optimal performance. Figure 3.2 is a sample stress profile report obtained from an elite athlete.

Examples of responses that can be observed in the psychophysiological measures from the profile are any extreme responses relative to the age, gender, and sport of the athlete. In this case, the heart rate during the startle task is excessive with an increase from approximately 58 beats per minute to more than 100 beats per minute (this is displayed in event 14). Typical responses are in the 20 beats-per-minute range. This suggests this athlete activates easily, and in this case, it is confirmed by both the athlete and coach. For some situations, this may be beneficial, but in the case of this athlete, she overreacts, and it interferes with her sport performance. For a highly conditioned athlete, her respiration rate is high during rest (averages over 17 breaths/minute). This high respiration rate in a seated, non-activity task suggests either holding her breath earlier or an overreaction to the task.

Figure 3.2: Stress Profile Report

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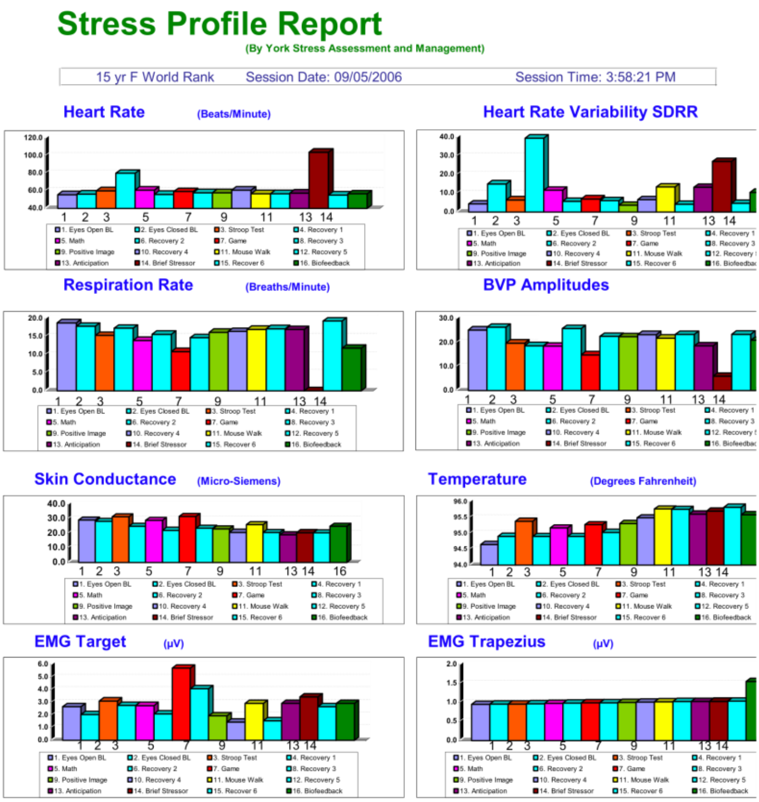

Statistics Tables

	Rest	Events
Ave HR (bpm)	59.91	58.59
Ave HRV(bpm)	10.70	8.74
Ave RR (brpm)	17.16	14.18
Ave BVP Amp	23.70	19.78

	Rest	Events
Ave eda (µSiemens)	23.65	27.61
Ave temp (F)	95.18	95.42
Ave emg t (µV)	2.41	3.23
Ave emg trap (µV)	0.99	1.08

Another example is the high sweat response (EDA or electrodermal activity), which may be genetic or driven by anxiety as a result of new situations. Subsequent sessions showed a typical EDA response for her was less than one-tenth her initial response to the test setting. She confirmed high anxiety in new situations or evaluations. It should be noted that while there are several atypical responses for an elite performer, this athlete remains in the top 10 in the world and responds exceptionally well under stress. The problem is that, on occasion, her performance is negatively affected, and there is a high emotional cost for the athlete and the coach when the athlete overreacts**. There is no single profile that can determine who will perform optimally.**

Guidelines for interpretation of psychophysiological ranges of profiles

Below are some ranges or averages the authors have found in their work with high-performance athletes and executives. Note: these averages are not research-based databases**. Perhaps, more important than numbers is the use of the data to ask relevant questions**. The authors recommend looking at overall patterns in all modalities and compare these with the self-report questionnaires and information gathered from the initial interview. Is the profile information congruent with the other athlete information and, therefore, strongly suggestive of where to begin the skill training? Or does the information collected not show a clear picture of what skill training is needed? In this case, further questioning is essential. For example, a first-year university basketball player was referred by his coach because he was not maintaining the high shooting average he had in high school. The coach believed the problem was related to anxiety. Yet the paper-and-pencil interview and psychophysiological profile did not consistently show anxiety under rest, stress, or recovery. Further questioning revealed the athlete was cognitively confused, not anxious. In high school, he was accustomed to receiving the ball and then shooting. The university coach wanted him to scan the environment for an open player under the basket, then look for a cutter, and finally decide if his guard was far enough away for him to shoot. Because the player had never practiced this *new* skill, he was slow, and the opposing defensive guards were able to disturb his shooting pattern. He did not need anxiety training but rather practice on how to scan and make quick decisions. What an athlete or coach perceives to be the problem, may not be the problem.

Body and brain profile responses at rest, under stress, and in recovery will be discussed with regard to the following:

1. Normal ranges
2. Changes from rest to task and during the task
3. Changes from tasks to recovery
4. Training

In general, multiple systems are evaluated when training. The training may only be conducted in one system initially, but monitoring is often done on many systems. The typical **order of training** is establishing abdominal breathing; lowering muscle tension; reducing emotional involvement; and sometimes, enhancing blood flow. This is then followed by neurofeedback training for attention and calming and then reduction of self talk. If the athlete has only one reactive system from the profile, this system is trained first. Or if the athlete comes with specific performance requests such as being too tight or losing focus, the order of training is then changed to target his requests.

The **training goals** may include attaining average levels (if the baseline was outside this range), deep relaxation, and faster recovery to average/baseline and sport/activity-specific levels.

If there is **no response** in any one of the systems, check for good sensor contact or equipment malfunction such as improper connections. If sensors are OK and there continues to be no response, check to make sure the athlete is performing the task requested. It is also appropriate to check for the use of medication (including recreational drugs), a history of post traumatic stress disorder, or a history of having learned not to respond (i.e., athletes who suppress their emotions).

The psychophysiological measurements noted below are from the authors' clinical practice and are not based upon research findings. Caution is needed when interpreting one's own measurements as equipment, environment, and other factors affect the actual measures obtained during each session.

Heart Rate (HR)

Using a photoplethysmograph monitor on the non-dominant thumb gives an indirect measure of HR (electrocardiogram chest leads can also be used). Under stress, the number of beats per minute (bpm) or HR should increase initially and then should decrease after the task is complete. Typically, athletes show much lower than average HR; however, genetics and the physical condition of the athlete determine the baseline.

Average HR ranges at rest:

Note: there is a high genetic and fitness effect on baseline heart rates.

1. Normal non-conditioned individuals: Males,72 bpm; females, 80 bpm. Highly trained athletes often have HRs of 45–60 bpm.

2. Look for missed beats or double beats, cold hands, very low resting heart rate, or poor sensor placement. These may give such readings, so check for these variables. If abnormal readings do not appear to be equipment issues and reappear with repeated testing, refer the person to a physician. In our testing history, we have had two undiagnosed heart

conditions in athletes that first showed up in our psychophysiological profiling.

HR changes from rest to task:

Note: The degree of heart rate change is associated with the type of task that is administered. HR is generally higher on tasks that are competitive.

1. Increases of 10 to 20 bpm are normal.

2. Check for hot reactors or athletes who have high increases in heart rate when the task does not call for such a change. This can be cross-checked with EEG for high beta activity. In this case, the athlete may over-respond to challenges, but in exchange for a busy brain (high beta activity), he may typically have faster reaction times.

HR Changes from Task to Recovery:

Note: HR should decrease as the athlete lets go of the past activity.

1. HR typically returns close to baseline within a minute.

2. The athlete may return to baseline HR, but the pattern is more erratic, up and down. This may indicate he is more reactive or perhaps returning to thoughts about his performance on the last task. (Again, this can be cross-checked with other modalities and responses and by asking the athlete if he is still thinking about the last activity.)

Case Study

An orienteer (a competitor who navigates through the woods with a compass) was world-caliber but failed to break into the top 10, generally making one serious mistake in each race. The coach could not find a pattern for these mistakes. The athlete could not identify the thoughts or feelings that might explain what went wrong during these times. And while in our office during psychophysiological monitoring, we did not detect any problems during discussions with the athlete about the races. By putting heart-rate telemetry on the athlete during training competitions, we were able to notice the heart rate elevated significantly (over 185 bpm) above what would be expected but at different locations on the courses. Being able to probe right then, we found the athlete had momentarily lost concentration on locating the next route and had a lot of negative self talk: "I hope I don't lose now, I need to win this one, etc." This worry focus coming at the same time as heavy demands on the cardiovascular system (usually climbing hills) was enough to push him into a zone of not thinking, and decision errors then occurred. This is an important point as the problem was not observable until the state of high heart rate from exertion was combined with an additional load factor of worry.

Training of Heart Rate

Personal heart-rate monitors are the norm for athletes training to remain within a specific heart rate range such as long-distance runners or skiers. Beyond this, the authors seldom train heart rate unless there is an extreme response to a stressor or a known problem. Rather, it is recommended to monitor heart rate and note unexpected changes from base rates and ask the athlete to monitor HR during training and competition if it is relevant to his or her sport. Typically, the authors focus on respiration training to lower anxiety, which usually lowers heart rate.

When working with athletes in the field, **telemetry** can be used to evaluate if there are any changes from a normal performance heart rate. When there are large increases — and they are not associated with increased physical activity — they often are related to worry or anxiety. In these cases, clinical work is related to identifying and addressing the causes and then to reducing the excess anxiety.

Heart Rate Variability (HRV)

The photoplethysmograph monitor can also determine heart rate variability (HRV). Heart rate variability has been associated with better heart health and sport performance. In order to record heart rate variability, one needs data samples collected over a period of at least 64 seconds. The authors have just recently begun monitoring HRV in the sport setting as it is reported to be related to the ability to perform during critical moments (Carlstedt, 2004). Training of heart rate variability is discussed in detail in Chapter 6 and will not be presented here.

Respiration

For respiration training, a strain gauge is placed around the abdomen below the ribcage. Disregulation in breathing can often occur during tasks. In this case, the athlete uses shallow breathing (the shoulders, not abdominal region, are doing most of the work), holds his breath during tasks, and/or increases his respiration rate (breaths per minute or bpm). These responses have been associated with poorer performance during stress. Additionally, look for smooth, continuous expansion of the abdominal region with inhalation as a sign of more effortless breathing. The sEMG of the shoulders can also pinpoint whether the person is overusing shoulder muscles during inhalation and if the shoulder muscle tension is released during exhalation.

Average Respiration Ranges at Rest in Breaths/Minute (brpm)

	Male	Female
Slow	8–10 brpm	10–11 brpm
Average	10–12 brpm	12–13 brpm
Fast	12+ brpm	14+ brpm

Case Study

A 15-year-old sprinter had a consistent resting rate of 22–25 breaths/minute. This would increase with the excitement of competition, and she was often breathless in competition. Inquiry found that she had once suffered a broken back in another sport and spent six months in a body cast, spending much of her time lying flat on the floor. She had learned to lock her body and breathe shallowly, probably as a realistic mechanism to lessen pain. She was sent to physiotherapy to learn to unlock her entire trunk musculature and also to practice abdominal breathing.

Respiration Changes from Rest to Task:

Note: Breathing rate is typically faster during tasks.

1. Normal breathing rates fall somewhere under 20 brpm. With individuals who have a high brpm to begin with (e.g., 15–20 brpm), we have seen these rates elevate to a range of 25–35 during tasks.

2. Check amplitude: If the athlete begins to shallow breathe, you will see a decrease in the amplitude of the wave on the graph. If there is essentially no amplitude, i.e., flatlined, the athlete is usually holding his breath. Short choppy waves suggest the athlete may be switching between chest/shoulders and diaphragm breathing, which can be verified by observation and checking trapezius sEMG levels.

Respiration Changes from Task to Recovery:
Note: Typically, brpm decreases and the amplitude wave appears more rhythmical and smooth.

Training of Respiration

Respiration, heart rate, and muscles are usually monitored if not always trained in the same session. If shallow breathing is a problem, trapezius sEMG is monitored or an upper chest strain gauge is also used to detect when the athlete is trying too hard. Monitoring of the abdominal strain gauge is done during training of other modalities such as electrodermal activity or electroencephalography, and if the athlete is holding his breath or using shallow breathing, the training of the other modality is suspended until proper breathing is reestablished.

Breath training typically begins by having the athlete control the number of breaths per minute from normal down to 4–7 breaths while maintaining a continuous, smooth rhythm from the diaphragm. It takes time before the athlete acquires a breathing pattern that feels natural and effortless. This is followed by respiratory sinus arrhythmia (RSA) training in which the heart rate increases while the athlete inhales and heart rate decreases when the athlete exhales (see Chapter 6).

When performing with heavy exertion as in the explosive sport of wrestling, it is normal to gasp for air and/or use the upper chest, etc. Focusing on controlling the athlete's breathing while gasping has not worked well. Rather, the focus should be switched to the cue words that maintain good technique and low shoulder muscle tension. Then the athlete can return to slow, deeper breathing patterns.

When training an athlete for breathing rhythm, it should be checked with the timing of the activity, or poor performance may result. For example, a boxer does hold his breath before being hit. A swimmer cannot slow down respiration without consideration for the speed of the turn or speed of the stroke.

Home training of both brief and deep breathing exercises are recommended. (See the LSR Chapter 5 for an explanation of these exercises.) These skills can be practiced at home and in the sport environment, and often the athlete is also asked to practice the rhythm and slow rate of breathing using the home respiration-training software program (available at no cost at www.bfe.org).

Electrodermal Activity (EDA, also called galvanic skin response or GSR)

The EDA electrodes are placed on the palmar surface of the skin of the non-dominant hand to measure changes in sweat gland activity. Under stress, the normal response is increased sweat activity; thus, it is an indirect measure of arousal. Peper and Schmidt (1983–84) report that gymnasts who had higher EDA responses had poorer competitive performance. They used EDA to illustrate how thoughts affect the body and performance, to monitor physiological relaxation, to identify stressful components of the athletic performance during imagery rehearsal, and to facilitate concentration training (Peper & Schmid, 1983–1984). They also used home trainers to help the gymnasts learn self regulation of arousal.

Just as there are variations in patterns for some subpopulations, athletes who have been trained to suppress their emotions may show little or no response during tasks. This is not to be confused with individuals who may have had post traumatic stress disorders and who also show little or no EDA activity or response. This should be evaluated by the practitioner.

EDA Average Ranges at Rest:

Note: There is no standard for determining who is a high or low sweat responder. EDA has a large genetic component based on the number of sweat glands and other factors that influence baseline levels and responses. Again, what is important is to look for changes that are not typical for each athlete.

Typically, we find dry-hand athletes around 1 microsiemens and wet-hand athletes above 10 microsiemens. Most EDA levels are between these two levels.

EDA Changes from Rest to Task:

Note: The typical pattern is a quick increase, a leveling off, and a smooth decrease or decline across the task.

1. Extreme response: Check for extreme increases and responses that continue to rise as the task progresses. A doubling of microsiemens may be normal if the athlete has a low EDA baseline (1 to 2 microsiemens), but a doubling of a response, for example, from 5 to 10, is a large change.

2. Paradoxical response: Reduction in EDA during the task relative to rest may mean the athlete is more comfortable with things he knows (i.e., knows to follow directions to complete the task) and is more uncomfortable with the rest period. We have often seen this pattern in individuals who tend to worry, anticipate, or feel as they are being judged and constantly judge themselves.

EDA Changes from Task to Recovery:

Note: Return to baseline is typical.

If the athlete is slow in returning to baseline, and EDA is still elevated after one minute, it suggests the athlete is not able to emotionally let go of the past task and is probably still evaluating or judging the performance. If baseline is not regained, it will skew the next baseline prior to the next activity.

CASE STUDY

A skater was referred as she had fallen at her first Olympic trial, had seen a traditional talk therapist, and yet, for months, failed to land that difficult jump in competition. Psychophysiological monitoring showed when she was emotional, her EDA responses were high (20–30 microsiemens) compared to her relaxed EDA of 3–4 microsiemens. A program of relaxation, biofeedback, and self talk helped in her desensitizing to the past failure of the jump. Once she could see and feel herself relax while talking about or imaging the jump, her mental rehearsal of successful jumps in the upcoming competitions were practiced. Finally, simulations were done at the rink of the upcoming competition. No jump was attempted until the skater was able to demonstrate lower EDA levels.

She was then able to compete for the remainder of the season without fear or failure on this jump.

Training of Electrodermal Activity

If the athlete has high electrodermal activity (EDA), which indicates emotional involvement, we ask about other emotion-related signs or symptoms such as gastrointestinal upset (butterflies), insomnia, anxiety, and rumination. The authors' experience is that high EDA responses are frequently found in athletes overly concerned with outcome (winning) or psychosocial dynamics (typically interactions with parents, coaches, or partners). EDA is monitored for athletes who tend to be very worried about winning (outcome) as opposed to the process for which they practice and can exert control (e.g., proper movement of feet, ready position, hiking the hip). Soon the athlete realizes EDA increases when the focus is on things that cannot be controlled (winning), and EDA drops when the athlete asks himself, "What do I do right now to get what I want?" This enhances self-awareness of mind/body reactions and helps shift attention to an action plan.

Visual and auditory displays are used as the athletes learn to increase (get more aroused for practice) and decrease (during stressful times) their EDA activity. This training includes the concept that other mind/body activities affect EDA. Using a baseball diamond analogy, you can get to first base in decreasing EDA by switching off muscle tension. To get to second base, lower the respiration rate to 4–7 breaths per minute using diaphragmatic breathing (see Chapter 6). Continue to third base by shutting off negative self talk or clearing the mind. To hit a home run, shift your focus to a try-easier approach, which means passive awareness versus trying too hard. The athlete then tracks his progress with a GSR home trainer to see if changing the other modalities lowers EDA activity. The modality that affects EDA the most gives a clue as to what is contributing to the elevated EDA.

If initially the athlete has difficulty lowering EDA, the focus of training returns to slowing down respiration to 4–7 breaths/minute. The overwhelming majority of athletes will simultaneously lower EDA with a smooth, slower respiration rate. Further work continues using EDA biofeedback screens to help the athlete learn to lower his EDA response.

Continuously high EDA activity, even after the athlete becomes comfortable in the office setting with the clinician, or failure to lower EDA after sufficient practice may suggest underlying issues that need to be examined. For example, very low self esteem, past trauma (such as loss at a critical event), and unrealistic expectations for perfection significantly affect one's EDA.

In addition to practicing in the office with sophisticated EDA measures, the athlete can take home a portable GSR monitor for additional real-world training. The athlete is encouraged to practice when at home with annoying siblings, traveling to competitions, waiting in airports, and during pre-competition.

Hand Temperature (T)

Surface hand temperature is measured with a thermistor on the second or index finger of the non-dominant hand as an indirect measure of vasoconstriction during tasks and recovery. Constant cold hands may mean an unknown underlying stress response or medical condition is causing a decrease in blood flow to the hands. There are few documented performance problems directly attributed to cold hands (perhaps gymnasts grasping bars or smooth release of shots). However, it is important to emphasize temperature training for good blood flow for full recovery from fatigue.

Skin temperature is especially sensitive to physical activity and all the parameters of measurement change (typically increase) if the athlete has not had 1–2 hours of recovery before being monitored.

Average Temperature Ranges at Rest

1. Typical temperature (while seated in a room with room temperature in the 70s in degrees Fahrenheit(°F); during winter months, the athlete should be given at least 20 minutes to acclimate to the office setting before beginning training):

	Male	Female
Low	< 90°F	<85°F
Average	90–92°F	87–89°F
High	92+ °F	89+ °F

2. Gender differences: More women register very cold temperatures, in the 70s, and temperature will vary with hormonal cycles. Women will swear this is genetic and that they can never warm up, but within weeks of temperature biofeedback, most will increase their temperatures to the upper 80s.

3. Reactive temperatures: A few people have highly reactive temperature changes. We have not been able to associate this with any patterns, but there is evidence that temperature drops with hyperventilation and with the fight/flight responses.

Temperature Changes from Rest to Task

1. Temperature typically drops less than one °F in one minute tasks.

2. Pattern of response: Temperature may continue to drop throughout the entire task, or temperature stabilizes after the task begins,.

Temperature Changes from Task to Recovery

1. Normal response: A normal response is indicated by a general increase in temperature during all the recovery periods following a brief delay of 15–30 seconds.

2. Consistent decline in temperature across the entire session: If the pattern of temperature is a decline during the entire session, of which the athlete is typically unaware, the athlete would be classified as a temperature responder (unless it was ascertained that the temperature change is due to hyperventilation).

3. If temperature goes down in some, but not all, recovery periods, check the nature of the stressor. Women may not show decreases in temperature to a math stressor any more than men do, but they may not recover after the math stressor, i.e., they may not be as confident in math and process it long after the task with negative self statements.

Case Study

A sailor received severe damage to his wrist and hand caused by an electrical accident, which rendered him unable to do small grasping movement. He was particularly frustrated by his inability to handle the lines of his sailboat and to participate in his favorite sport. For 14 sessions, he practiced temperature biofeedback and was able to increase his hand temperature from 77°F to more than 98°F. He reported being able to increase hand temperature at will after training. The planned surgery to repair the damage and remove the scar tissue was cancelled as his recovery was such that he no longer required it. That spring, he was out sailing on the lake holding the line in his damaged hand. (Bird, 1980).

Training of Hand Temperature

Inexpensive thermometers that measure to a tenth of a degree and are averaged across 8–10 seconds are available in most electronics stores. These thermometers are sufficient to indirectly measure the change in blood flow to the hands or an injured muscle area. The small hand thermometers that measure two-degree changes are not sufficient for training. They may be helpful for indicating when an athlete has cold hands, but for most athletes, it is too difficult to move hand temperature two degrees, and they become discouraged and quit.

The long-term goal of temperature training is to attain a fingertip temperature of approximately 96°F during deep relaxation training. Some athletes achieve this within a week or two, and others require more training time.

In the past, we have used thermometers with athletes with injured knees, shoulders, and ankles and were able to increase blood flow to each specific area. It should be noted that it is much harder to move blood flow to the feet and legs than the hands or arms. Therefore, it is advised to begin training with an area where the athlete can achieve success.

Typically, we measure the temperature on the first phalange of any finger (but maintain the same finger throughout training) of the non-dominate hand. If the hands are needed for actions in the sport, the probe is placed on the back of the finger.

Surface Electromyography (SEMG)

The sEMG can be used to locate atypical muscle responses to tasks or to identify failure to release muscles following a task. We have also found sEMG can be used when a skilled performer with some imaging ability is imagining a task. In this case, the athlete will find a similar muscle pattern between actual and imagined movements (Bird & Wilson, 1988). One sEMG lead is typically placed on a muscle group of interest to the athlete, such as monitoring forearm tension in an archer or a muscle recovering from injury. The second sEMG is placed on the shoulder on the middle third of the belly of the upper trapezius muscle of the non-dominant side. When assessing sEMGs, it is helpful for the practitioner to ask the following questions: Does the athlete habitually maintain above-average muscle tension? Does the athlete release muscle tension quickly and completely? Is he or she co-contracting incorrectly, causing loss of coordination or speed?

For athletes with muscle injuries, during imagery, the athlete is asked to imagine the sport performance when he or she is completely free from injury and then imagine it with the current injury. Often, only the affected, injured muscle will show an increase in tension (relative to previous non-injured levels or relative to contralateral muscle measures) during imagery or discussions of the injury.

Average SEMG Ranges at Rest

Comment [V3]: Put ave in box like others?? vew

1. Non-dominant shoulder (upper trapezius)
    a. Low: less than 1.5 microvolts (μV)

b. Average: 1.5–5 µV

c. High: above 5 µV

2. SEMG special sites: The placement of electrodes changes depending on the sport task in question. For example, forearm sEMG can be used for the grip on the tennis racquet.

3. When monitoring two sEMG bilaterally, or anterior/posterior, check to see if the two microvolt levels are approximately the same. If there is a small difference, it is probably not significant. However, unexpected significant differences should be addressed with biofeedback. In some cases, the sport creates this imbalance, such as a larger forearm in tennis, and while we recognize bilateral symmetry will probably not occur, we continue training for balance in the musculature.

SEMG Changes from Rest to Task

1. SEMG increases in appropriate muscles. The practitioner should check to see that only the appropriate muscle is being used. For example, when practicing imagery (mental rehearsal), there is no need to use shoulder muscles. However, if the athlete is performing a keyboard task, he might expect to see some increase in the forearm but a lot less muscle increase in the shoulders.

2. The practitioner should check for exaggerated amounts of muscular effort. Check for an exaggerated sEMG increase during tasks, such as from 2 to 22 µV while the athlete performs the Stroop test.

3. Agonist/antagonist relationship. If motor skills are important, then check for co-contraction of agonistic and antagonistic muscles. If both sets of muscles use approximately the same degree of muscle tension throughout an entire movement, it suggests there is too much tension in

the antagonist. The agonist (movers) should have more activation at the start of the movement, and the antagonist (brakes) should turn on more at the end of the movement. Coordination, rhythm, and smoothness are poor if the two muscles are not coordinated during action.

4. Bilateral symmetry. If the practitioner is monitoring two muscle groups for symmetry, such as in posture, the µv levels should be approximately the same. For example, both upper trapezii should be approximately the same at rest, or paraspinal muscles should be the same when standing at rest and equally balanced on both feet.

SEMG Changes from Task to Recovery

1. Typically sEMG levels will return to baseline or will drop very quickly, within a few seconds, after a task. Often, the practitioner will see a rebound, or letting go, of tension to below the initial baseline, especially if the task involved some physical movement.

2. The practitioner should check for residual tension: Some athletes might have a quick release of muscle tension, but it does not return close to their previous baseline. Whereas, some athletes may return to baseline levels, but it takes longer to achieve the release.

3. The practitioner should check for rebound muscle tension: A few athletes will respond after-task with an increase in muscle tension.

4. Observe the degree of shoulder elevation with breathing: Some athletes may hold their breath during the task, and then during the recovery phase, they overuse the shoulders to reestablish breathing.

5. The practitioner should check for bilateral release if monitoring bilateral muscles.

Case Study

A 100-meter sprinter (considered by other runners as a world champion at 80 meters) would tie up or slow down in the last 20 meters, and his competition times were slower than his practice times. While performing imagery of the past race while attached to sEMG, the author and another runner noticed his shoulder tension significantly increased at the 80-meter mark. The athlete was asked to imagine running another race in which he tied up in the last 20 meters. Again, significant increases in shoulder-muscle tension was present. The athlete was shocked when we showed him the changes as he was unaware of the tightness nor had the coach observed his elevated shoulders. Following sEMG training in the office, a small, portable sEMG was used to practice staying relaxed during simulated races at the track. His times from competition then matched his training times.

Training of Muscle Tension (SEMG Biofeedback)

Most athletes report being too tight, and because most sports require flexibility and speed, the ideal place to start training is with muscle awareness and control. Athletes are unaware of small increases in muscle tension, but the difference between being a champion sprinter at 80 meters and at 100 meters may be the reduction of these small amounts of muscle tension. Even when performing imagery, excessive muscle tension can often be seen.

Several useful exercises to help the athlete become more aware of muscle tension are provided in the LSR chapter; however, sEMG training is faster and precise. Often, only one sEMG session practicing rising, lowering, and eliciting just right muscle activity is needed to sensitize the athlete. We typically begin with trapezius-muscle training. Occasional sEMG sessions to check and fine-tune the just-right level are needed to remind the athlete of just-right muscle levels in practice and competition. This is particularly true when the sport mechanics have been adjusted. Home trainers are often sent with the athlete, and a threshold can be set so sound biofeedback comes on when the athlete is not performing with the appropriate level of muscle activity. Telemetry is now available and will eventually become the standard tool for muscle training at practice, just as heart-rate monitors are used as the standard for maintaining the optimal zone for heart rate.

It is usually necessary to have the athlete assume the sport skill position when learning to control muscle tension. Maintaining control of muscle tension while sitting in an office chair is very different than maintaining the same control while on the swimming blocks or lying down on the bobsled. This must be practiced and reinforced for proper transfer of skills to competition.

Target muscles can be identified for each sport and athlete. If the athlete tends to grip the racquet too tightly or drops his elbow on an archery shot, the sEMG can be used to train awareness and control of the forearm or shoulder. Even athletes with years of experience can have improper posture/biomechanics without the athlete or coach noticing. Periodic muscle checks can help the athlete identify and alleviate these problems.

SEMG can be used when recovering from injuries. An injured muscle can be compared with the contralateral (opposite) uninjured muscle to determine symmetry during activity. (This presumes both muscle sets are similar in structure and sport function).

Identify and practice when and where to relax the muscles. Sitting on the bench between shifts, waiting for a free throw, or between points are when muscles need to be released. With telemetry, one can assess whether the athlete is complying with the training during practice, and by using home trainers that fit into the athlete's pocket, he can become more aware of and make fine adjustments in muscle-tension levels.

Coaching Hint

Athletes have consistently reported the benefits of being able to relax their muscles between performances and especially prior to critical competitions. This not only changes the focus of attention from outcome (and the worry that is associated with one's inability to control the outcome) to an action plan (in which activities relevant to the performance can be done). The action plan we found most beneficial is to begin with abdominal breathing at 6–8 brpm and then loosen and stretch the muscles. The slowing down and release of tension is typically accompanied by a mental "I'm ready." We find it beneficial to provide biofeedback-assisted booster sessions for high-skilled performers. In our lab, gymnasts requested the booster session about once a month, and professional tennis players have requested it every two or three months.

Electroencephalograph (EEG)

The electroencephalograph (EEG) is used to assess the amount and speed of electrical activity in the brain. It has mostly been used to assess and train individuals with epilepsy or attention deficient disorders but recently has become a tool of choice for the training of high performers (Egner & Gruzelier, 2003; Raymond, Sajid, Parkinson & Gruzelier, 2005).

The use of EEG will be reviewed in more detail in the second section of this book.

Group Database and Reports

Sport organizations often request evaluations of team members to identify strengths and weaknesses. It has been useful to be able to compare an athlete with his or her peer group, which we do by maintaining group databases. An example of the usefulness of the data is illustrated in figure 3.3, which shows the reports given back to the coaches about their respective teams.

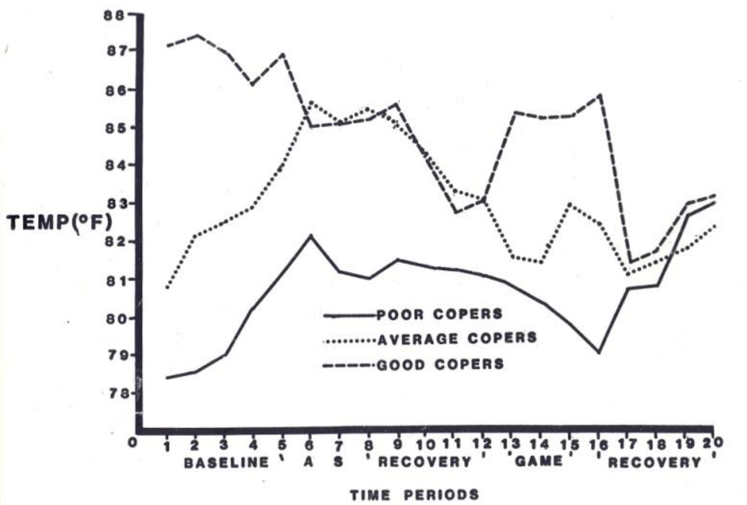

FIG. 4 SKIN TEMPERATURE MEANS FOR COPING ABILITY

Figure 3.3: Temperature of university track-and-field athletes during a laboratory session of stressors and recovery. The data suggests athletes who had colder hand temperatures in laboratory baseline, stressors, and

some recovery periods also were rated as not capable of coping as well with the stress of important competitions.

In figure 3.3, the coping ability of the 22 athletes was assessed by the head coach as their ability to perform in important competitions relative to their abilities demonstrated in practices. In addition to baseline differences, the athletes who had good coping skills in competition also increased their hand temperature in the track and field computer game. The authors have repeatedly found, with other sports, that the athletes who possess good coping skills tend to show more signs of stress following an activity (lower hand temperature in both recovery periods). With this information, the coach and athletes were more willing to target individuals who may benefit more from biofeedback-assisted relaxation training.

This is not an unusual group profile in that it is not an ideal profile (where athletes with good coping skills would be expected to increase temperature during recovery). If this pattern of appearing more relaxed during tasks versus the recovery period is also noted in the EEG and EDA measures, the consultant then needs to determine what the athlete was doing during the recovery period. When questioned, athletes will often respond that they are busy evaluating what they did and how they could improve it and often some negative self statement. This pattern shows each profile is unique, and the clinician has to use *all* of the available information to understand what is really occurring.

Program and Session Design

When the practitioner has finished the assessment and is preparing to train the athlete, it is necessary to develop an overall plan as well as a within-session plan on how to best proceed. As noted in the beginning of the chapter, the sport task, the environment, and the personal skills of the athlete need to be considered before training commences.

One of the best published program guides was produced by Blumstein, Bar-Eli, and Tennenbaum (1997). It outlines a five-step approach using biofeedback to train arousal and then practice transferring this control to a more game-like setting. The steps include an introduction of self-regulation techniques; identification and experimentation with biofeedback modalities; training biofeedback responses with simulated competitive stress; transferring the preparation to the training conditions with portable biofeedback devices; and live sport-specific films in the office; this is followed by checking to see if the skills are working in the competitive environment.

Our program is very similar to Blumstein's with a few modifications. Within each session which lasts 1–1.5 hours, we do the following:

1. Use a psychophysiological profile requiring less time to identify which modality may need fine tuning.

2. Structure the teaching and practice of the self-regulation skills that are needed for performance (brief, i.e., seconds), so they are differentiated from those traditionally taught (deep, i.e., 15–20 minutes), which are best for total relaxation and regeneration. See Chapter 5 on LSR for a description of brief and deep relaxation.

3. Structure the timeframe of the training, so it matches the timeframe and requirements of the sport. For example, if the average time of a tennis rally is 25 seconds, we practice biofeedback/EEG training for 25 seconds with many repetitions.

4. Incorporate EEG training along with the other psychophysiological modalities.

The format we use within each session includes the following:

1. Homework check up.

2. Review of LSR sport skills (such as “Ahhsome” or breathing — see LSR chapter).

3. Training of new skills or fine tuning with biofeedback/neurofeedback (typically combined).

4. Assignment of new homework and reinforcement of the skills learned.

Summary

In summary, research has shown certain psychophysiological states are associated with improved performance and can be trained. Much remains to determine exactly which biofeedback or neurofeedback training is most efficacious in improving actual sport performance. With the use of telemetry, psychophysiological assessment and training during actual performance is now possible. When we know what is occurring within the mind/body of the athletes in their actual performance in the gym, field, court, or arena, then we may more directly answer the question of how much of an impact any skills-training program, including biofeedback or neurofeedback, has upon their performance when it counts.

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