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SPECIAL ISSUE

Managing the Stress Response: The Use of Biofeedback and Neurofeedback with Olympic Athletes

Margaret Dupee, MA, BCB, and Penny Werthner, PhD

University of Ottawa, Ontario

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Excessive stress and tension are major threats to optimal athletic performance. The goal of this project was to help the athletes optimize the management of their stress response through self-awareness and self-regulation of the activation levels of their autonomic and central nervous systems. Fifteen elite athletes preparing for the Vancouver 2010 Olympics underwent an EEG and psychophysiological stress assessment, as well as a bio–neurofeedback (BNFK) training intervention. Both athletes and coaches reported that the bio–neurofeedback intervention helped the athletes in managing the stress of training and competition and was a factor in producing better performances.

Introduction

Coaches, athletes, and sport psychologists agree that the manifestation of excessive stress and tension before and/or during competition are major threats to the ability of the athlete to meet or exceed their performance goals (Sime, 2003). Athletes with greater psychophysiological self-regulation over somatic (physical) and cognitive (mental) components of anxiety have a greater sense of personal control over their performance, and cope better with the stress of competition (Hatfield & Hillman, 2001). In studying the ability to adjust physiological and psychological activation levels, Bois, Sarrazin, Southon, and Boiche (2009) also found that frequent use of strategies for managing emotional control predicted superior sport performance. Logically then, management of the stress response should be a high priority for elite level athletes.

Responses to stress are observed in multiple psychophysiological systems, with linkages between the nervous system, the endocrine system, and the immune system, all of which form the collective heart of the stress response (Cacioppo, 1994). Intervening at the level of the nervous system through the use of biofeedback and neurofeedback assessment and training can enhance an athlete's competitive advantage (Sime, 1985). As William James put it, ''The greatest thing in all education is to make our nervous system our ally instead of our enemy,'' (James, 1899).

Our Project

It is from this perspective that we began working with elite Canadian athletes preparing for the Vancouver 2010 Olympics, in order to assist them in going from ''good to great'' in the management of their stress response. Specifically, our work with these athletes was based on the belief that the focus/relaxation dynamic is a crucial component of optimal performance. When this dynamic is disrupted, the human body and mind suffer, as does the sport performance.

Our Goal

The bio–neurofeedback (BNFK) training focused on enabling each of the 15 athletes to learn how to manage the activation levels of their autonomic and central nervous systems. In order to achieve this, an intervention was designed to optimize four skills: (a) a calm, narrow focus; (b) brief recovery, which involved quieting both the autonomic nervous system (ANS) and central nervous system (CNS) for 1–3 minutes; (c) the ability to switch between narrow focus and brief recovery at will (Thompson & Thompson, 2003); and (d) deep recovery, which involved quieting the ANS and CNS for 6–20 minutes.

Bio–Neurofeedback Assessments

To gain insight into each athlete's autonomic and central nervous system activation levels and patterns under stress and in recovery, we conducted a psychophysiological stress assessment and an 18-site electroencephalography (EEG) assessment on each athlete. The initial assessment used the Optimal Performance Assessment (Biofeedback Foundation of Europe Optimal Performance Suite) created by Vietta Wilson (2006), followed by a second assessment using the The Learning Curve (TLC) 18-site EEG assessment developed by Peter Van Deusen (2006). Measures were gathered in seven areas: EEG, surface electromyography (SEMG), respiration rate, heart rate, heart rate variability, skin conductance, and peripheral body temperature. From the data, we identified how each athlete responded to

stress and their activation levels. Their ability to recover, both mentally and physically, was also of interest.

Generally speaking, analysis of the assessment data revealed good to excellent focusing skills and a less well-developed ability to put the body and mind in recovery. With respect to the autonomic nervous system, some athletes did not return to baseline after the stressor/task and occasionally went in the opposite direction, where they became more activated in recovery. The most consistent pattern was seen in the heart rate variability (HRV) measure. Almost without exception, athletes had higher HRV during the stressor/task than during recovery, indicating that their cardiac and pulmonary systems were more coherent during a task than in recovery. In the central nervous system, an examination of the percentage of slow, medium, and fast waves revealed higher than target values in the fast waves (beta and high beta). The athletes most often produced higher than target values in the temporal lobes.

Bio–Neurofeedback Training

The goal of the BNFK training was to enable the athletes to learn to identify and exercise control over the activation levels of their autonomic and central nervous systems, first in the lab and, ultimately, when competing at various international competitions and the Olympic Games, which would be the most stressful environments. All 15 of the athletes learned how to identify their optimal performance state. Through the training, they developed the ability to achieve optimal levels of physical activation, as well as optimal patterns in thinking, feeling, and focusing. However, many of them admitted that at times they could not consistently sustain these states during competition. As Krane and Williams (2006) have noted, achieving one's own ideal internal climate is not a simple task.

As mentioned earlier in the article, our training program was developed around the optimization of the four key focus/recovery skills: (a) ability to sustain a calm, narrow focus; (b) ability to briefly recover (wide focus); (c) ability to switch states at will (between narrow and wide focus; Thompson & Thompson, 2003); and (d) ability to recover deeply. A crucial component of all four skills is the ability to keep high beta (rumination and worry) low.

In order to work on these four key skills, each training session was broken down into three components:

1. *Quieting the ANS*. This component was identified as brief physical recovery exercises. Self-awareness and self-regulation of muscle tension, respiration rate, heart rate, skin conductance activity, and peripheral body temperature were trained both with eyes open and eyes closed.
2. *Managing the CNS*. The EEG modality was used for the three aspects of this component: (a) brief mental recovery (wide focus), (b) narrow focus, and (c) switching states between narrow focus and brief recovery (narrow and wide focus; Thompson & Thompson, 2003).
3. *Quieting both the ANS and CNS*. All seven measures, (EEG, SEMG, respiration rate, heart rate, heart rate variability, skin conductance, and peripheral body temperature) were monitored for the physical and mental deep recovery component. Paced breathing (Gervirtz & Lehrer, 2007) was used to help them decrease activation in both systems.

Training sessions lasted 1–1½ hours in length, with each athlete completing between 20–40 hours of training overall. Each training session was broken down into 10 minutes for set-up, 20 minutes quieting the ANS, 30 minutes managing the CNS, 20 minutes deep recovery, and then 10 minutes to unhook sensors and wrap-up the session. Initial training sessions were shorter and focused more on self-regulation of the ANS. These skills were then used to assist with regulation of their CNS. Deep recovery work began as a 6 minute session and over time was increased to 20 minutes.

In order to help the athletes develop their strategies for optimal self-awareness and self-regulation, on each training task we asked them (and had them ask themselves for personal reflection and learning) several questions: (a) What is the task? (b) What do I need to be physically feeling and mentally focused on? and (c) What strategies will I use?

Sime (2003) described the psychological preparation of athletes for competition as ''taking the brain to the weight room'' (p. 583). Perhaps then it is no coincidence that the athletes in the present study often called bio–neurofeedback training ''brain pain.''

By far, the most common question we have been asked was whether or not the athletes found the BNFK training helpful and whether they liked to do it. In order to answer this question effectively, at the completion of each competition season, the athletes and coaches were asked if the BNFK training was useful in helping each of the athletes to focus better, manage their anxiety, and ultimately improve their performance that season, and if they wanted to continue to do it the following year. From the perspective of the athletes, all 15 responded that it was very helpful, and they wanted to continue. It is important to note that several of the athletes did state that it was a great deal of work learning how to manage their physical and mental states.

From the perspective of the coaches working with these athletes, they uniformly reported that the training in BNFK definitely helped their athletes in managing the stress of training and competition, and they stated that it was a factor in producing better performances.

Conclusion

Our experience assessing and training elite level athletes with bio–neurofeedback techniques was an extremely positive one for us, both professionally and personally. Working with individuals that are highly motivated to be the best in the world helped us refine and develop training protocols to manage the activation levels of the autonomic and central nervous systems. Based on this experience, we feel that bio–neurofeedback training should be an integral part of an athlete's training regimen to optimally manage the stress response.

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Margaret Dupee

Penny Werthner

Correspondence: Margaret Dupee, MA, BCB, University of Ottawa, 18 Pondside Private, Ottawa, Ontario, Canada, K1K 4X3, email: bioneurofeedback@rogers.com.