Psychophysics and Neuroscience in Sport: Introduction to the Special Issue

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While clinical psychology has embraced the importance of psychophysiology and neuroscience when considering the client condition, the field of sport psychology has been slower to consider the potential importance of this area for athletic clientele. Therefore, this special issue of the Journal of Clinical Sport Psychology was conceptualized and constructed to describe the current state of psychophysiological and neuroscience research and illustrate how clinical sport psychologists may, in the future, use technologies such as biofeedback/neurofeedback and physiological measurement (EMG, EEG, skin temperature, EDR, HR, HRV, respiration, and hormonal responses) with high-level athletes from a variety of sports for both performance enhancement and diagnosis and management of head injury. As Guest Editor of this unique special issue, I have written the present introduction to highlight the issue’s important mission. This introductory paper sets the stage for five informative and cutting-edge articles by leading professionals. In all, the articles cover an array of topics on psychophysiology and neuroscience in sport, such as (a) the theoretical underpinnings of biofeedback/neurofeedback, (b) the empirical application of such approaches, (c) the current state of efficacy with regard to this newer line of research and practice, and (d) the use of fMRI in understanding psychological processes in sport. I hope that this timely special issue provokes many additional questions and advanced research in our collective pursuit to assist athletes.

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It is an honor and a privilege to be the Guest Editor of this special issue of the Journal of Clinical Sport Psychology that focuses on “psychophysiology and neuroscience in sport.” To date, very little research has been published on psychophysiology and neuroscience in sport, and as such, clinical sport psychologists may not be aware of developments that could potentially inform them as scientists and clinicians. Through this unique special issue, it is my hope that readers will become aware of current developments and research findings with athlete populations and develop an informed understanding of technologies and methods of contemporary psychophysiology and neuroscience.

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This volume defines *psychophysiology* as the application of biofeedback and neurofeedback technology to hopefully better assess and treat mental health and performance enhancement issues with an athlete population. Biofeedback and neurofeedback (also known as EEG biofeedback) are truly “applied psychophysiology,” as they use instrumentation to help individuals become aware of physiological functions such as muscle activity (EMG), brain activity (EEG), skin temperature, sweat gland activity (EDR), cardiovascular activity (HR, HRV), and respiration.

*Neuroscience* is also a relatively new term in the literature and refers to the scientific study of the nervous system. As such, neurofeedback (EEG biofeedback) often gets classified as a study in neuroscience. Today, the published work categorized as neuroscience clearly illustrates that neuroscience is an interdisciplinary science that collaborates with other fields such as computer science, medicine, physics, and psychology to better understand the brain and behavior. Neuroscience research during the past two decades has indeed helped advance our understanding of the role of the brain in human cognition, emotion, and behavior.

Biofeedback methodology for the assessment and treatment of psychological disorders has appeared in the literature since the late 1960s, when pioneers such as John Basmajian (1972), Barbara Brown (1977), Joe Kamiya (1968), and Neal Miller (1973) published studies demonstrating that humans could self-regulate physiological functions that were long thought to be under the control of the autonomic nervous system and as such, not “controllable” by thought processes (Zaichkowsky, 2009). These extraordinary clinical scientists and others started a professional organization called “The Biofeedback Research Society,” which later became the “Biofeedback Society of America” and is now called the “Association for Applied Psychophysiology and Biofeedback” (AAPB). I was fortunate enough to attend some of the early biofeedback meetings, meet the pioneers, and get a sense of the early power of biofeedback for teaching stress self-regulation and the self-regulation of a variety of physical and psychological disorders. This interest led to a number of articles that proposed the use of biofeedback in the sport domain (Zaichkowsky, 1975; Zaichkowsky & Kamen, 1978).

Unfortunately, although biofeedback has gained prominence in the clinical domain, it has gained little traction in sport science over the past 30 years, in part because the hardware and technology were either bulky or not well developed, the equipment was expensive, and few sport practitioners were trained in the theory and practice of biofeedback. While a few studies examining the efficacy of biofeedback were published in the 1980s, 1990s, and early 2000s (e.g., Peper & Schmid, 1983; Wilson & Bird, 1981; Zaichkowsky, Dorsey, & Mulholland, 1977) and several reviews of this work were also published (e.g., Leonards, 2003; Zaichkowsky, 1994; Zaichkowsky & Fuchs, 1988), they were few in number. It would be accurate to say that although the techniques of biofeedback have been around since the late 1960s, the application of biofeedback to sport has been minimal.

A dramatic change occurred in 2006, however, when Italy defeated France in the World Cup of Soccer. The press reported that several Italian players who played for AC Milan used biofeedback to help them with their mental preparation. It was reported that the psychologist used biofeedback technology to create what he called the “Mind Room” (DeMichelis, 2007). According to DeMichelis, in the AC Milan “Mind Room,” soccer players were taught to relax and recover from fatigue as well as control physiological reactions to pressure situations. In order
to control physiological reactions under pressure, the soccer players viewed short video clips of successful and unsuccessful performances while receiving feedback about brainwaves and cardiovascular and electrodermal activity. The success of AC Milan and Italian football in general resulted in much of the sporting world wanting to know more about how to develop their own version of the “Mind Room” for teaching athletes such self-regulation skills.

Two manuscripts in the *Journal of Clinical Sport Psychology*’s special issue on psychophysiology and neuroscience in sport, “An Integrated Biofeedback and Psychological Skills Training Program for Canada’s Olympic Short-Track Speedskating Team” (Beauchamp, Harvey, & Beauchamp) and “Setting the Balance: Using Biofeedback and Neurofeedback With Gymnasts” (Shaw, Zaichkowsky, & Wilson) are excellent examples of the contemporary use of biofeedback and neurofeedback with elite athletes (collegiate and Olympians). Particularly noteworthy is that both papers report on interventions with populations that are quite difficult to study. Few coaches or Olympic governing bodies will allow systematic research with their athletes, and very few coaches of elite collegiate gymnasts will allow outsiders to conduct interventions and study the effectiveness of the interventions. Work with these populations usually prevents the use of “gold standard,” randomized controlled experiments, and that was indeed the case in these two studies. Nevertheless, the protocols are well described and carefully analyzed. The paper by Beauchamp et al. (2012) explains and attempts to evaluate the effects of a biofeedback training program as part of an overall psychological skills training program for Canadian short track speedskaters as they prepared for the Vancouver Olympic games. Readers not familiar with biofeedback modalities and protocols are introduced to the psychophysiological measures of heart rate, heart rate variability (HRV), respiration rate, muscle activity (EMG), skin temperature, skin conductance, and electroencephalography (EEG). The paper also effectively outlines how an integrated psychological skills training program can be systematically introduced at the elite level. The paper by Shaw et al. (2012) provides an example of biofeedback/neurofeedback intervention and evaluation, with elite athletes on a highly rated U.S. collegiate women’s gymnastics team. In this paper, electroencephalography (EEG) and heart rate variability (HRV) methodology and training protocols are described so that readers can understand the efficacy of the training program and replicate/build upon the intervention.

The manuscript by Faubert and Sidebottom (2012), entitled “Perceptual-Cognitive Training of Athletes” goes beyond biofeedback and into the broader field of cognitive neuroscience and its application to sport. Dr. Faubert is a psychophysicist at the University of Montreal whose recent research has focused on the plasticity of the human brain. Faubert’s original research dealt with aging subjects, mild traumatic brain injury (TBIs), and others with perceptual-cognitive deficits. His interest in sport applications, however, has led to the transfer of cognitive neuroscience findings to athlete populations. Faubert and colleagues are currently conducting research examining the effectiveness of perceptual-cognitive training with elite athletes across a variety of sports. The importance of perceptual cognitive training, particularly for fast paced “open” sport athletes such as basketball players and hockey players, has long been recognized by coaches and sport psychologists; however, a practical methodology for training skills such as high-speed decision-making, anticipation, pattern recognition and spatial reasoning, focus, and tracking
has to date been lacking. The methodology of 3D-MOT and an extension into “virtual reality” may hold promise, not only for the psychological preparation of athletes, but (as the authors note) as a possible diagnostic and rehabilitation tool for concussions, which is a current medical crisis in sport at all levels.

The issue of concussions and its assessment and management is described by Thompson and Hagedorn (2012), in their paper, “Multimodal Analysis: New Approaches to the Concussion Conundrum.” The authors are critical of existing assessment and treatment protocols of traumatic brain injuries (TBIs) or concussions and propose a concussion management program that utilizes current research findings emanating from the neuroscience literature. The authors propose that new approaches should consider utilizing the science of quantitative electroencephalography (qEEG), event related potentials (ERPs), electrocardiography (EKG), heart rate variability (HRV), and balance measures so that diagnosis can be more sensitive and specific, that treatment can perhaps be more effective, and decisions regarding “return to play” can hopefully be more accurate.

The paper I describe last, “Neural, Mood, and Endocrine Responses in Elite Athletes Relative to Successful and Failed Performance Videos,” by Davis et al. (2012), will actually appear first in this special edition of JCSP. The editors and I chose to have this paper as the lead paper for a number of reasons. Most importantly, this paper introduces many clinical sport psychologists and other sport scientists to the method of functional Magnetic Resonance Imaging (fMRI). While fMRI as a methodology to better understand brain mechanisms of cognitions, emotions, and action are commonplace in clinical psychology, fMRI studies in sport psychology, or general neuroscience using elite athletes as subjects have been essentially non-existent. One of the first studies was published by Davis, along with eminent neuroscientists Mario Liotti and Helen Mayberg (Davis et al., 2008), whose methodological expertise allowed this research to occur. Another unique feature of this study is that endocrine data (testosterone and cortisol) are correlated with right premotor cortex BOLD activity, illustrating the interdisciplinary nature of neuroscience research. Additionally, this paper illustrates how a clinical sport psychologist in private practice can collaborate with world-class neuroscience researchers to answer questions that are important for practicing clinical sport psychologists. The Davis et al. paper, and the papers that follow it, also demonstrate how clinical sport psychologists can use the technology of psychophysiology and neuroscience to quantify developmental changes in self-regulation.

While there is still much empirical work to be done in this area, the compilation of these papers into this cutting-edge special issue of the Journal of Clinical Sport Psychology will hopefully stimulate further research using the methods of neuroscience, particularly biofeedback, quantitative EEG, and fMRI, so that we may better understand the complex role of the brain in athletes’ cognitions, affect, and performance states.

References


