



## Symposium Summary

### **INTEGRATIVE SPORT PSYCHOLOGY**

This symposium advances the perspective that although the field of Sport Psychology has produced a large body of quality research on peak performance much of it stands alone and for the most part has not integrated or adequately considered potentially relevant concepts, methods and data emanating from various sub-fields of psychology. While the field's central theories of peak performance have been extensively explored it will be argued that they have overlooked or not considered potent primary higher order and moderator variables that appear to mediate the psychological and physiological mechanisms that are central to these theories. Moreover, the field has made little progress in isolating more sensitive criterion variables that may help explain more of the variance in the performance equation that can be attributed to psychological factors.

Preliminary research presented in this symposium will address these shortcomings and demonstrate that high amounts of variance explained “depends on the dependent variable” as well as potent independent/predictor measures that have been shown to be intimately linked to attention, physiological reactivity and cognition, key components of peak performance. Additional potentially revealing predictor and outcome variables will also be discussed in the context of innovative neurophysiological research of performance phenomena.

Relative to applied Sport Psychology it will be argued that sophisticated methods, technologies and advanced approaches to the evaluation of athletes are available but rarely used and that mental training interventions need to be implemented more

selectively, cognizant of individual differences that new approaches to athlete assessment are revealing.

As such, this symposium will present research, methods, models and data that advance an *Integrative Sport Psychology* including new and provocative findings emanating from the fields of Neuroscience (fMRI, neurochemical-and anatomical data), Neurotherapy (i.e., Neurofeedback), Behavioral Medicine, Personality Psychology and Psychophysiology. Their relevance to peak performance research and mental training interventions will be discussed.

New theories and models will also be introduced including the *Theory of Critical Moments* and the *Transient Hypofrontality* hypothesis, along with a comprehensive empirically field-tested intervention protocol for applied practitioners.

## 1.

### **FUNCTIONAL MRI (fMRI) IN MOTOR IMAGERY**

Mental imagery involves rehearsing or practicing a task in the mind with no physical movement. Imagery is considered to play a pivotal role in memory and motivation and can be used to improve competitive performance in sports. However, the actual physical foundation of imagery has not been evaluated for fast, complex, over-learned automatic motor movements such as the golf swing. This study evaluated motor imagery of the golf swing, of 6 golfers of various handicaps, using functional Magnetic Resonance imaging (BOLD technique) to: assess whether areas of brain activation could be identified and define any association between activated brain areas and golf skill. The results show that: 1) Defining brain areas of activation using fMRI in complex motor imagery is feasible; 2) Decreased brain activation occurred with increased golf skill level

for the supplementary motor area, and cerebellum (vermis) in particular; 3) Golf swing motor imagery produced little activation of cingulate gyri or basal ganglia across all skill levels. 4) The “wall vs. golf” paradigm appears to offer more discriminatory power in areas of activation compared to the more general activation of the “rest vs. golf” paradigm.

The presence of increased brain activation with poorer performance could have important implications for golf learning theory. The presence of increased activation with high handicap players could potentially relate to two effects: 1) that increased activation reflects a failure to learn and become highly automatic or 2) that increased activation is essentially pathologic, and related to a loss of automaticity with compensatory increased brain activity. Development of automaticity is relative and can be dynamic and reversible. A classic example of this pathology is writer’s cramp (focal dystonia) where the severe functional disturbances can be explained in terms of a loss of automaticity and an increased need for controlled processing (i.e., more thinking). If the first scenario is correct, then poor performance could be improved by teaching and practice. If the second scenario is correct, and the brain activation reflects the need for compensatory processing, this would require more radical methods to measurably improve performance, since dystonic states typically are resistant to change. Functional MRI is a powerful tool for defining areas of brain activation during sports imagery.

## 2.

### **VALIDATING INTEGRATIVE EEG AND CARDIOVASCULAR BIOFEEDBACK IN SPORT**

EEG-biofeedback and cardiovascular coherence training are widely applied to optimize sporting performance, however, so far these approaches have been developed in isolation. Furthermore there is a dearth of controlled studies necessary to validate claims of efficacy. Following on from our controlled studies which have validated optimal performance EEG-biofeedback protocols by showing improvements in attention and memory disclosed with both cognitive and ERP measures, and remarkable improvements in artistry in music performance in conservatoire students, we have extended this approach to sporting performance. In addition single case field studies with ambulatory heart rate variability (HRV) recording in world-class golfers, has shown that on-course performance was influenced by the coherence of the afferent HRV signal. We have shown in numerous field tests that the coherence of cardiac afferent traffic can be brought under volitional control to enhance performance and alter cognitive function. The value of HRV training and the ability to self regulate coherent states to improve performance, have been extended to include formal controlled studies.

Furthermore, EEG and cardiovascular approaches have been combined, along with complementary approaches such as audiovisual entrainment, in order to improve the efficacy with which optimal flow-like states can be attained. Individual differences in personality such as hypnotisability and introversion have been explored to predict good from poor learners and to understand better the strategies that are required to learn self

control of neurophysiological modalities. Finally, operant learning to enhance theta states, known to be successful in treating forms of addiction, and which were successful in enhancing music performance, are being applied to individuals with high scores on anxiety and schizotypy scales with a view to improving the operant learning of self regulation.

### 3.

## **THE ELECTROENCEPHALOGRAPHY OF THE IDEAL PERFORMANCE STATE**

Athletes describe the ideal performance state as one in which there is no fear, no thinking about performance, a narrow focus of attention, a sense of effortlessness and personal control, and a disorientation of time and space. The purpose of this presentation is to discuss the literature regarding the electroencephalographic (EEG) correlates of the ideal performance state.

Recording EEG activity during sport is not only feasible but is also a valuable alternative and/ or addition to the more typically utilized, questionnaire-based research methodologies. Offering greater responsiveness and relative noninvasiveness, EEG and performance data have been collected from athletes in a variety of (mostly stationary) sports, including archery, shooting, weight lifting, golf, and karate.

Studies have shown a fairly consistent configuration of EEG activity associated with optimal performance. Generally, the identified configuration includes decreased activation and increased laterality; and appears consistent with the principle of psychomotor efficiency. Moreover, studies have linked the identified configuration of

EEG activity to the psychological (as opposed to the physiological) demands of skilled performance and to both inter- and intra-individual performance variability.

Additionally, studies have shown that different types of training can develop the identified configuration of EEG activity. For example, researchers have shown that archery training decreased activation and increased laterality and that psychological skills training (i.e., EEG biofeedback training) not only shifted EEG activity towards the ideal configuration but also improved archery performance.

Finally, there are a number of weaknesses in the EEG/ sport literature; including not only theoretical but also methodological issues and the knowledge base would likely benefit from the adoption of more sophisticated electrophysiological techniques.

#### 4.

### **EXERCISE, MENTAL HEALTH, AND NEUROSCIENCE:**

#### **THE TRANSIENT HYPOFRONTALITY HYPOTHESIS**

Decades of research have demonstrated that exercise is beneficial to mood and cognition. Despite this evidence, a satisfactory *mechanistic* explanation of this phenomenon is still lacking. Current explanations remain focused on neurotransmitter mechanisms and the field of sports psychology is plagued by the underuse of sophisticated methods and the lack of unifying theories. If we are to further our understanding of how exercise improves mental health, a broader neuroscientific approach that includes areas other than neurochemistry must be taken. To date, significant advances in the neurosciences that pertain to the neurobiology of brain functions and its disorders have not been applied to sport psychology. The aim of this

presentation is to outline neuroanatomical considerations for the study of mental health in exercise science. To that end, the functions of the prefrontal cortex and research implicating that structure as the site of two common mental health disorders, depression and anxiety, are reviewed.

Based on the functional neuroanatomy of the prefrontal cortex, I propose a neural mechanism, “transient hypofrontality,” for the exercise-induced improvements in mental health. A cornerstone of cognitive psychology is the concept that the brain has a limited information processing capacity and is continuously balancing costs and benefits associated with efficient information processing. Yet, global cerebral blood flow to the brain during exercise, as well as global metabolism and oxygen uptake, is constant. Building on the fundamental principle that processing in the brain is competitive, coupled with the fact that there are no additional resources available during exercise, the massive and sustained activation of motor and sensory systems during exercise must come at the expense of activity in other neural structures. The transient hypofrontality hypothesis suggests that this results in the temporary inhibition of brain regions that are not essential to performing the exercise such as areas of the prefrontal cortex involved in higher cognitive functions. Finally, I report the first evidence that exercise of moderate intensity activates the endocannabinoid system, suggesting a new mechanism for exercise-induced analgesia and possibly other psychological adaptations to exercise.

## 5.

### **THE ROLE OF PERSONALITY IN SPORT: CONCEPTUAL AND METHODOLOGICAL CHALLENGES**

Predicting athletes' behavior from their personality characteristics has long been one of the most attractive applications in sport psychology. Yet, despite its intuitive appeal, the overall progress in this area has been quite disappointing, supporting a "skeptical view" of the "personality and sport" issue. Repeated attempts to examine the role of personality in sport have yet to establish a consistent pattern of personality predictors of athletic behavior. Why this lack of progress? Is personality really so irrelevant in sport? Or are we just failing to detect its influence? If the area of "sports personology" is to prove its worth, what is needed is a rigorous search, beyond the conventional, for more meaningful questions about personality influences in sport and for more sophisticated methods of answering them. The paper will address these questions while discussing the possible ways out of the widely acknowledged lack of methodological and conceptual rigor in this field.

In particular, the paper will discuss two conceptual principles well developed in mainstream personality research but commonly overlooked in sport psychology. The first one relates to the long-term nature of personality influences. Indeed, personality does matter when critical long-term issues (e.g., career prospects or health risks) are at stake. To capture this fundamental influence, personality-performance relationship has to be examined longitudinally, in a life-span context – an approach that has not been popular in sport psychology.

Second, personality is a known source of moderator variables, and the search for their effects in sport has been largely misplaced. Personality variables are more likely to exert interaction - rather than main - effects in predicting outcomes of importance, such as educational attainment or work-related behaviors. Arguably, personality is not the strongest predictor of task performance (whether academic, work or sport-related) but it can certainly influence the likelihood of *converting one's ability into achievements*. In other words, personality makes a difference when other factors, such as ability, are controlled for. A number of recent studies will be cited to illustrate how useful the concept of personality moderator influences can be in a range of practical applications.

## 6.

### **INTEGRATIVE ATHLETE ASSESSMENT AND INTERVENTIONS: A FIELD-TESTED PROTOCOL**

This paper presents an applied field-tested athlete assessment, intervention and efficacy testing protocol that integrates research findings and methods from various sub-fields of psychology. The protocol was designed to initially assess so-called *Primary Higher Order* (PHO) factors that have been shown to mediate psychophysiological responses, cognitions and attention, especially during critical moments of competition. The isolated PHO factors include hypnotic ability or absorption, neuroticism and repressive coping. This triad of traits and behavioral propensities is emerging as a potent predictor of performance when it counts the most, having explained up to 44% of the variance in the performance equation on the basis of objective longitudinal outcome

measures. These measures have been localized in various regions of the brain and shown to interact to mediate focus or attention, thought processes and physiological reactivity important components of peak psychological performance. In addition to their direct link to neuropsychophysiological processes associated with performance, research has demonstrated that constellations or combinations of these PHO factors play an important role in the ability to benefit from a particular intervention and should be routinely assessed.

In addition to advancing an individualized approach to assessment the protocol also advocates in-the-field ambulatory monitoring of athletes using heart rate variability and heart rate deceleration analyses to evaluate psychological states and performance during competition. Preliminary longitudinal analyses of heart activity suggests that certain heart rate variability parameters may reflect *Zone* or *Flow*-like states.

In-the-field application of interventions will also be discussed including manipulation of cortical states and heart rate variability to achieve better level of attention and self-regulation. Assessment of cortical functioning using QEEG, MRI and MRS methods, efficacy or outcome testing, critical moments analysis and database management will also be addressed in this presentation.

#### Protocol Overview

1. Assessment of PHO factors and Cortical Functioning
2. Pre-competition Psychophysiological Stress Testing
3. On-field HRV/HRD Analysis
4. Critical Moment Analysis (CMPPQ)
5. Post Competition Data Analysis using Psychological Performance Statistics

6. Individualized Intervention Selection and Mental Training
7. Efficacy Testing of Intervention
8. Continual Monitoring-Database