Biofeedback and Sports Science

Edited by

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Foreword

There is a new breed of athletic coach in the educational arena. While on speaking engagements around the world, I've encouraged coaches to jump "head first" and quickly into sports science. The reason is simple. With new electronic communication systems coming on the market almost daily, athletes can get valid and reliable information to help them maximize sports skills, and this information can come faster than most coaches are able to deliver.

Coaches have historically rejected most sports science efforts in favor of traditional "seat of the pants" systems, but now there is a new kind of athlete who is asking questions never before presented to the coach. Professional athletes are individually seeking out sports scientists for answers to their particular problems. Stories appear daily in the media about athletes making quantum jumps in performance as a result of their association with sports scientists. The tidal wave is building and no one can stop it—not even the sporting goods industry. "High-tech" athletic equipment is now a must in nearly every sport. Large sporting goods companies have nearly gone bankrupt because of competitors' new "high-tech" products.

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The tail is wagging the dog. Professional, amateur, and weekend athletes alike are demanding technical answers of our sports leaders, and they are going elsewhere if the correct answers aren't available. The number of Olympic athletes visiting our Coto Research Center in California is staggering. They want scientific answers. They used to come alone, but more and more are showing up with their coaches.

Biofeedback is beginning to reach sports practitioners and researchers like myself. It represents the leading edge of the entry of science into sports training. No longer do I hear my colleagues speak negatively about the scientific analysis of performance. Coaches and trainers are beginning to realize that they can understand science, and some scientists are learning how to swing a tennis racket correctly. As others in our society are now finding out, it's okay to have more than one profession. For me, the joy comes in helping to tailor feedback systems for a variety of sports and athletic movements. Sandweiss and Wolf have laid the groundwork upon which some exciting work will undoubtedly follow.

Biofeedback and Sports Science should raise the eyebrows of all coaches. The writing is on the wall. All paths lead to biofeedback systems because it is no longer a case of the athlete responding to the coach—it's the coach responding to the physiological and psychological world of the athlete. This book will help coaches better understand the athlete's world.

Vic Braden
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Preface

Within the last two decades, many uses for biofeedback protocols in medicine and psychology have evolved from experimental paradigms into accepted clinical practice. Because the initial research in biofeedback was primarily reported in the academic psychology literature, individuals in sports medicine and physical training saw little relevance of this work to their needs. However, the applications of biofeedback techniques to some aspects of sports science soon became obvious to a handful of research-oriented psychologists, physical therapists, and exercise physiologists. Sporadic reports involving the interfacing of biofeedback to specific sports began appearing in diverse journals, but much information at this early stage was passed by word of mouth.

Then, in 1978, under the direction of Charles Stroebel, the Biofeedback Society of America undertook the development of Task Force Reports with the stated purpose of evaluating the efficacy of biofeedback for various applications. One of these reports addressed the *Athletic Applications of Bio-*

feedback. This report was later revised in 1980 and outlined three potential applications of biofeedback within athletics:

A. stress management for athletes
B. rehabilitation of sports injuries
C. training to enhance athletic performance

Applications of biofeedback focusing on stress management and rehabilitation were borrowed, with some modifications, from clinical work in psychology and physical therapy, respectively. Interest in direct performance training with biofeedback began to grow, and instrument designers started to address the special problems associated with monitoring athletes in motion. Miniaturized telemetry systems have now appeared in the marketplace, but research in this crucial area has not been as rapid as many would like.

Within the last three years, there emerged a perceived need to present within a single volume the work and ideas of some of the more noteworthy scientists in this field. This text, therefore, represents a conscientious effort to express the creative thoughts and applications of clinicians and researchers who not only represent several disciplines, but who share a common desire to apply contemporary behavioral approaches and technological advances to help optimize the multifaceted aspects of human performance. Because biofeedback applications to sport are still in the infancy stages, the content of this text should be viewed much like a newborn coming to grips with continual novelty. The ideas and applications contained herein *are* novel and subject to modification and change with time and experience. Only through assimilation or experimentation can the reader alter these notions to attain the most relevant goals for his or her athletes. We hope that this book will serve as a framework for the

development of future efforts, discussions, and applications of biofeedback to sport science.

The editors wish to thank the contributors for their thoughtful time and effort in developing their ideas for this book. The typing skills of Gloria Bassett are greatly appreciated.

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Biofeedback and Sports Science

JACK H. SANDWEISS

INTRODUCTION

Although the notion of physiological self-regulation dates back centuries and is found throughout the Eastern literature (Suzuki, 1956), its value as a medical therapy is now only in its second decade. Biofeedback, as it has come to be called, is the only self-regulatory approach that has gained widespread acceptance in the medical community and is now practiced at most major hospitals and medical centers in the United States. There are several reasons for this occurrence. First, biofeedback evolved out of rigorously controlled scientific experimentation in experimental psychology and psychophysiology. Thus, there exists today a large and growing data base in traditional medical journals attesting to the efficacy of biofeedback when used with a wide variety of medical disorders.

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Second, within the medical milieu, biofeedback finds application in the treatment of disorders for which there is often no medical or surgical alternative. Furthermore, it is difficult to find any toxicity associated with biofeedback as a medical intervention, even if one searches (Gans, 1982). Finally, as a practical matter, biofeedback is very cost-effective when compared to the usual alternatives.

Because biofeedback teaches persons voluntary control over their own physiological functioning, it soon became apparent that the development of such training had relevance to nonmedical applications as well. The extension of ideas and protocols from clinical work into athletic areas soon became obvious (Sandweiss, 1980). As will be pointed out, feedback techniques devised to assist in the enhancement of athletic performance may now find application in rehabilitation medicine. Thus, the interdisciplinary influence is beginning to come full circle.

This volume is presented in an effort to help bridge the gaps among laboratory and field scientists and those who are involved with enhancing athletic performance at all levels. But to provide a framework for understanding the utilization of physiological feedback in contemporary sports, an examination of biofeedback's historical roots and a brief overview of medical and psychological applications is appropriate.

HISTORICAL ORIGINS OF BIOFEEDBACK

Those who set out to become biobeedback therapists soon realize that they must acquire knowledge from several disciplines, including physiology, psychophysiology (not to be confused with physiological psychology), electronics, learn-

ing theory, counseling, and so forth. Researchers from all of these areas contributed to the evolution of biofeedback, and there are many historical paths that could be delineated. But most investigators would agree that the impetus for much of the early work in biofeedback grew out of questions concerning the differences between humans and "lower" animals that have plagued humankind for thousands of years. Simply, it was noticed that humans share some attributes with other animal species, including functions governing heart rate, blood flow, respiration, and other metabolic activities. Not surprisingly, these activities came to be known as "vegetative functions," akin to those of plants. Those functions and abilities that helped to separate us from the rest of the animal kingdom (i.e., judgment, intelligence, imagination) came to be called higher mental processes. Moreover, vegetative processes are involuntary (not under conscious control) whereas higher functions are voluntary. This division of function, based upon an egocentric view of the universe, runs throughout the history of psychology and medicine. It is still with us today in our writings and in our society.

Near the close of the eighteenth century, Bichat added weight to this perspective with the identification of separate bodily systems for voluntary and involuntary action (Boring, 1950). During the early part of the twentieth century, these physiological distinctions inspired parallels in numerous animal learning experiments that took place primarily in the United States and Russia. An analysis of this work and the complicated theoretical issues that were argued are well beyond the scope of this volume. The interested reader is referred to the excellent discussion of these matters by Kimble (1961).

Briefly, the learning paradigm associated with the veg-

etative system (now referred to as the autonomic nervous system) is usually called "classical" conditioning and is most identified with the work of Pavlov (1927). In this type of learning, behavior changes take place by association. As Pavlov demonstrated, a neutral stimulus such as a tone has little effect upon an animal until the tone is repeatedly paired with another (not-so-neutral) stimulus. This second (unconditioned) stimulus was usually meat powder placed in the mouth of the dog causing salivation. When the situation is arranged properly, the previously neutral tone will start producing salivation in the dog when presented alone. What is important to remember in this example is that the salivary glands are innervated by the autonomic nervous system.

In contrast to classical conditioning is a paradigm put forth by Skinner (Skinner, 1938) and usually referred to as operant conditioning. Whereas classical conditioning depends upon association of stimuli, operant conditioning is based upon reinforcement.

Reinforcements are events that "follow" the responses to be learned and increase the chances that these responses will occur again. In other words, reinforcements are rewards. Positive reinforcement occurs when someone is rewarded for a particular performance with a trophy, for instance. Negative reinforcement takes place when something unpleasant does not occur following the event to be reinforced. This could be a feared meeting with a coach that is avoided by a good performance. However, both positive and negative reinforcements are rewards. Negative reinforcement is not the same as punishment. Punishment does not teach but only suppresses behavior which often occurs after the punishment. This difference is often misunderstood.

For many years it was agreed that only autonomic re-

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