BIOFEEDBACK AND BEHAVIOR

Edited by

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BIOFEEDBACK AND BEHAVIOR

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Preface

Biofeedback and Behavior: A NATO Symposium, held on 27-30 July 1976 at the Max Planck Institut für Psychiatrie in München, was a multidisciplinary meeting that explored both theoretical and applied issues arising from the use of biofeedback procedures for the control of visceral, central nervous system and skeletal events. The symposium was multinational in its composition.

Financial support for the symposium was initially provided by the Scientific Affairs Division of the North Atlantic Treaty Organization as part of their continuing series of scientific symposia. Funds made available by a grant from the United States Office of Naval Research permitted wide-spread international participation in the symposium. The facilities for the meeting were graciously provided by the Max Planck Institut für Psychiatrie. We thank each of these organizations for their support in making this symposium possible. A special thanks is due to Dr. B.A. Bayraktar of the Scientific Affairs Division of NATO and Dr. Donald Woodward of the U.S. Office of Naval Research, whose counsel contributed substantially to the organization of this meeting.

The planning of this symposium was carried out in consultation with members of the organizing committee: Rolf Engel, Pola Engel-Sittenfeld, Laverne C. Johnson, George H. Lawrence, Gary E. Schwartz, and David Shapiro. The final form of this symposium reflects their contributions, for which we are grateful.

The rapid publication of these proceedings is due in large part to the support of our publisher, Plenum Press, and especially our editor, Paulette Cohen, whom we thank.

We would like to express our particular appreciation to Nancy Gaynor who prepared these proceedings for production and, as secretary to

the symposium, was responsible for coordinating various aspects of this symposium from its inception. We would also like to thank Petra Bottger, who provided additional secretarial assistance in München.

Jackson Beatty and Heiner Legewie
Los Angeles
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BIOFEEDBACK AND BEHAVIOR: INTRODUCTION TO THE PROCEEDINGS

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This volume is the record of a symposium, Biofeedback and Behavior, which was part of the NATO Human Factors Conference and Symposia Program for 1976. Seventy scientists from nine nations assembled at the Max Planck Institut für Psychiatrie in München in the last week of July, 1976, to present and discuss recent work on the learned modification of bodily processes using "biofeedback" procedures.

"Biofeedback" is an increasingly common term now used with reference to a wide variety of experimental procedures that present information obtained from biological signals to an organism in an attempt to modify underlying physiological processes. For this reason, the phrase "biofeedback research" describes a large and diverse body of experimental and clinical investigations that, in many instances, are unified only at the level of method, and not at the deeper levels of mechanism or theory. The München symposium reflects this diversity and the substantive issues discussed were wide-ranging.

The symposium was organized to fulfill two objectives. The first was to provide an overview of current experimental and clinical research in laboratories in both Europe and North America. In this respect the symposium was quite successful. Virtually every major laboratory was directly or indirectly represented. In reading these proceedings, one cannot help but note the diversity of substantive research interests represented and the varying degrees of success with which biofeedback methods have been employed in the study of behavioral problems.

The second objective of the symposium was to evaluate the usefulness of biofeedback methods as clinical and experimental research instruments. Opinions differed among the participants, but the general consensus of the symposium was critical: Biofeedback methods were seen to be useful in some experimental contexts and perhaps appropriate in some clinical settings, but the range of these applications was generally considered to be quite restricted. No participant expressed the once-common view that biofeedback procedures represent a unique and powerful technique for clinical treatment or method for scientific inquiry. Instead, the continuity between biofeedback procedures and other clinical and experimental methods was emphasized.

For the reader, these proceedings provide an opportunity to share with the participants of the symposium an international view of the current state of biofeedback research. From the many excellent presentations, the reader may learn why the mood of the symposium was critical and why some problems appear appropriate for biofeedback research or therapy and others do not. Most important, however, is for the reader to share in the developing understanding that these methods have many ties with other, more traditional methods of experimental research and clinical treatment. Biofeedback is no longer an unknown procedure with unknown promise. Instead it must be seen as a collection of experimental and clinical procedures, with particular strengths and weaknesses that may play some part in the study of man and in the treatment of human disorders. That part may not be large, but in selected areas it may be important.

Further it should be noted that, although this symposium was comprehensive, it was certainly not complete. The research contributions to the symposium primarily reflected new experimental and clinical work. It was not the purpose of the symposium to provide extended introductory material or to review previous research in depth. However several other sources may be consulted for an introduction to the area and a review of experimental work not presented by the symposium's participants. For a general treatment of both experimental and clinical issues, the reader is referred to a recent volume edited by Schwartz and Beatty (1977), Biofeedback: Theory and Research, which serves as a useful complement to these proceedings. Various aspects of learned regulation of central nervous system events are treated also by Chase (1974) in Operant Control of Brain Activity. The reader who is interested in clinical issues should consult Biofeedback-Therapie by Legewie and Nusselt (1975) and Biofeedback: Behavioral Medicine by Birk (1973). Biofeedback and Behavior reflects the present state of biofeedback research and provides a context for evaluating its scientific and clinical importance.

These proceedings of the symposium have been organized in five sections. The first provides an introduction to the general issues treated in the meetings. The present chapter explains the purposes of the symposium and sketches its contents. In the second chapter, Black and Cott provide an overview of the state of our knowledge and some major problems facing biofeedback research. The third chapter by Anliker gives a broad theoretical framework for a cybernetic approach to psychobiological research. The following chapter by R. Engel is concerned with some methodological questions that are more specific to research using biofeedback methods. In the final paper of the introductory section, Garcia and Rusiniak present some new facts and concepts from the behavioral study of learning that may come to be extremely important for understanding the plastic properties of visceral response.

The second section of the proceedings addresses the question of the modification of central nervous system events. Johnson begins this section with a comprehensive and critical overview of research on the operant modification of brain rhythms in man. In Chapter 7, Mulholland describes an application of biofeedback procedures for the analysis and quantification of the mechanisms regulating the alpha rhythms of the human electroencephalogram. The following two chapters are concerned with the control of alpha activity in the human brain, with Orne and Wilson (Chapter 8) raising the important question of individual differences and Plotkin (Chapter 9) providing a social psychological approach for the study of the so-called "alpha-experience." In Chapter 10, Birbaumer reviews some of the literature concerning the regulation of theta frequency activity in the EEG and suggests that these rhythms may reflect different processes in different brain regions. O'Hanlon, Royal and Beatty next (Chapter 11) show that theta activity in the posterior portions of the cerebral cortex is closely related to the state of behavioral alertness in vigilance-type tasks. This section is concluded by Sterman's comprehensive review of research on the regulation of the "sensorimotor rhythm" with an emphasis on therapeutic applications in epilepsy.

The third section contains a diverse collection of papers addressing issues related to the control of autonomic functions. The question of visceral learning is first treated in Chapter 13 by Harris, Goldstein and Brady, who present the results of a detailed and long-term investigation of blood pressure and heart rate conditioning in primates. In Chapter 14, Pickering, Brucker, Frankel, Mathias, Dworkin and Miller present data on the acquisition of control of blood pressure in patients with generalized bodily paralysis. Intimately related to the question of control of visceral functions is the problem of visceral perception, which is treated in the following two chapters. Brenner (Chapter 15) gives a comprehensive re-

view of the western contribution to the study of visceral perception and describes a series of experiments performed in his laboratory. Roberts (Chapter 16) considers the problem of visceral perception from the perspective of discrimination theory. The patterning of learned responses in the autonomic nervous system is first treated by Kimmel and Burns from the perspective of learning theory (Chapter 17). In the following chapter, Schwartz proposes that different behavioral consequences arise from learning different patterns of autonomic activity.

The behavioral effects of visceral learning are also considered by Shapiro in Chapter 19, who describes a series of experiments investigating the effects of learned control of autonomic response under conditions of experimentally-induced stress.

Theoretical models of visceral learning are treated in the next three chapters. Lang, in Chapter 20, presents evidence that visceral learning may be analogous to the acquisition of motor skill, a proposition that Johnston questions in Chapter 21. Furedy (Chapter 22) discusses experimental results suggesting that neither the operant nor the Pavlovian models may be fully satisfactory in accounting for the learned control of heart rate.

The next three chapters present new methodological procedures for the study of plasticity of autonomic functions. Steptoe (Chapter 23) describes a non-invasive indirect method that may be clinically useful in measuring blood pressure. Ernst and Kordenat (Chapter 24) present some preliminary findings on the regulation of coronary blood flow in animal preparations. Welgan (Chapter 25) is concerned with the operant modification of gastrointestinal activity.

The remaining two chapters of this section address the clinical applicability of biofeedback procedures for the control of autonomic dysfunctions. In Chapter 26, B. Engel gives a critical review of the application of biofeedback methods in the treatment of cardiovascular disorders. In Chapter 27, Surwit and Shapiro present the results of a comparative therapeutic study with hypertensive patients.

The fourth section of this volume examines the use of operant techniques to modify responses of the skeletal muscle system. Fetz, in Chapter 28, shows how operant procedures may be used to study the functional relationships of different cell populations in the central motor system, an extremely fruitful approach that combines operant procedures with more standard methods of neurophysiological analysis. In Chapter 29, Engel-Sittenfeld presents a comprehensive overview of the application of operant

procedures to the treatment of neuromuscular disorders. Next, DeBacher and Basmajian (Chapter 30) describe a large-scale project for the treatment of spasticity and other neuromuscular disorders. In the last paper of the section, Stoyva (Chapter 31) discusses one of the most popular applications of electromyographic feedback, the clinical use of relaxation training.

The final section presents two evaluative summaries of the issues posed by the symposium. In the first, Legewie (Chapter 32) reviews the evidence for the clinical utility of biofeedback procedures and concludes that a balanced approach to treatment is necessary. In the second, Beatty (Chapter 33) reviews the contributions made by biofeedback methods to the scientific understanding of the psychobiology of behavior and concludes that these procedures are helpful new tools that have been profitably employed in conjunction with other experimental methods in the study of selected research problems.

Thus, in evaluating the state of an area of scientific research that is barely a decade old, the München symposium revealed progress. Over the past ten years, increasingly specific and difficult scientific questions have received experimental treatment. The level of scientific rigor in the field has increased. Although the early hopes that biofeedback would produce major scientific and clinical breakthroughs have not been fulfilled, a more moderate and potentially more productive sense of biofeedback as a part of the scientific and therapeutic enterprises has emerged. These we believe are healthy trends. We hope that this perspective is communicated to the reader in the present volume.

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A PERSPECTIVE ON BIOFEEDBACK

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INTRODUCTION

When beginning to prepare the opening address for a symposium such as this, one immediately feels the hand of tradition attempting to guide his own. There are certain topics that should be covered, and certain forms that should be followed. In such an address, the history of the field is reviewed, and attention is focused on interesting and impressive contributions. Above all, there is a compulsion to be positive--to praise what has been done, and to forecast an even more rosy future.

The thought of breaking with these traditions arouses anxiety. Our first reaction to this anxiety was to return to the folds of orthodoxy. But, we resisted the temptation to do so for the following reason. There is a real danger that the misrepresentations and overblown claims that have been made about biofeedback will lead to a rejection of the field by many scientists. We can no longer, therefore, be satisfied to stand by while unsubstantiated claims are made for biofeedback--not only in popular literature, but even in psychology textbooks. In short, unless we are honest about the failures, the inadequacies, and the problems of biofeedback research, we face a serious danger that biofeedback will be unable to make those contributions that it is capable of making. Therefore, this opening address will not be as positive as tradition would dictate. We shall not, however, break completely with tradition because we will begin with a few historical comments.

The beginning of modern biofeedback is usually identified with the

research of five people in the 1960s--Basmajian, Kamiya, Kimmel, Miller and Olds. At first glance, the differences in their research seem so great that one wonders why they should be grouped together. For one thing, the response systems that they studied were very different. In addition, their goals varied. Kamiya was interested in developing voluntary control over complex psychological states (Kamiya, 1968). Kimmel and Miller were interested in testing certain theories of learning, which postulated that autonomic responses are not amenable to instrumental or operant control (Fowler & Kimmel, 1962; Kimmel, 1967; Miller, 1969; Miller & DiCara, 1967). Basmajian was interested in understanding the neural systems that control striate muscles (Basmajian, 1963, following up the work of Harrison & Mortensen, 1962). Olds thought that the operant conditioning of single unit activity would be a valuable analytic technique for studying the physiology of the brain, and in particular for understanding the neural basis of learning (Olds & Olds, 1961).

It is on the basis of two common features that the research of these men is grouped together. First, the responses which they studied could not be observed directly by the experimenter nor by the subject himself; some device had to be employed to record the response and display it. Second, the goal of the research was to train the subject to acquire control over the response by making some stimulus which the subject could observe contingent on the response. (Whether one could describe this contingent stimulus as an operant reinforcer or a biofeedback stimulus is an issue which we shall consider later.) In summary, it is the concern with responses that cannot be directly observed, and the goal of producing control over these responses by providing the subject with response contingent stimulation that are the common features of the work of these five men.

Following these beginnings, one would, we think, have expected the gradual accumulation of both basic and applied research on biofeedback. To some extent, this expectation was met--most noticeably by research which was concerned with the use of biofeedback as an analytic tool for studying brain function in animals. This development follows directly, in our opinion, from the work of Olds (Olds & Olds, 1961). We have employed biofeedback techniques to train various patterns of electrical activity in the hippocampus in an attempt to further our understanding of hippocampal function (Black, 1971, 1975). Fetz, who will describe his research later in the symposium, Fox, Rudell and Rosenfeld, and Sterman and his associates had also been carrying out successful research with the purpose of analyzing brain function. (See Fetz (1969), Fox & Rudell (1968), Sterman, Wyrwicka, & Roth (1969) for some early papers on this topic.)