comparison of earthquakes would be impossible, and at Shide he enthusiastically promoted this concept. In all, Milne was to establish 80 of his horizontal-pendulum instruments at more than 60 stations throughout the world. The catalogues of earthquakes that resulted from this world seismic net—the "Shide Circulars"—published with the encouragement of the British Association for the Advancement of Science, were to be the forerunners of the International Seismological Summary.

Milne's retirement years in England produced no major advances of the kind that in Japan had won him international fame. He did write two textbooks on seismology as well as a "Catalogue of Destructive Earthquakes AD 7 to AD 1899." After 1900, the progress of modern seismology was so rapid that one man working alone probably could not keep abreast of all the advances. Milne did not live to see the arrival at Shide of the Milne-Shaw instrument—designed to overcome the two major drawbacks of his earliest seismograph, low magnification factor and lack of satisfactory damping. Curiously, despite all the earthquake records that Milne collected, he never attempted to devise a magnitude scale—preferring to classify earthquakes by three simple degrees of intensity based on the radius of the area affected. Nor did he successfully investigate the question of travel-time curves, something that was eventually solved by Mohorovičič in 1910. Nevertheless, Milne was still in the mainstream of scientific life at Shide. Among his many visitors were Prince Boris Galitzin, who had developed the first electromagnetic seismograph, and H. F. Reid of Stanford University, who visited Milne after the 1906 San Francisco earthquake. A frequent guest was H. H. Turner, professor of astronomy at Oxford, who, after Milne's death, was to encourage the continuation of the "Shide Circulars," the project being transferred to Oxford in 1919.

Milne was undoubtedly a pioneer—adventuresome, unable to resist a challenge, and having a fanatical interest in his chosen field. That his life and work are unknown is largely because his major accomplishments were in Japan, where earthquakes are frequent, whereas in the English-speaking world they are not. It is important to have such a well-researched biography available, not only as a reminder of his immense contributions to modern seismology but as a legacy of one of the last great Victorian pioneers.

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Psychophysiology

Biofeedback and the Modification of Behavior. AUBREY J. YATES. Plenum, New York, 1980. xii, 512 pp., illus. $24.50.

Yates defines biofeedback as referring to "the display of some aspect of the physiological functioning of the individual with the expectation that observation of the characteristics of the display will enable the individual to attain increased voluntary control over the physiological function being displayed." Research on biofeedback has many origins, among which are developments in information and control system theory and the technology of electrophysiology. However, its beginnings may be found in the fumblings of clinical electromyographers who learned that they could turn their oscilloscopes around and let their patients use the visual tracings of their own recorded muscle potentials (or amplified auditory equivalents) to reeducate their damaged muscles. Other psychophysiologists were simply curious about their own ability to control or detect changes in their brain waves, skin temperature, heart rate, or palmar sweating. It is well recognized that the concept of feedback is critical to our understanding of the regulation of biological and learning processes. Moreover, the deceptively simple idea of making physiological information directly available to the individual generating it quickly caught the imagination of lay persons, researchers, and clinicians.

As a serious concern in psychophysiology and behavioral sciences, biofeedback is now more than two decades old. It may be showing its age, if not its maturity, with the publication of this first comprehensive account of the field.

Previous books on biofeedback have ranged from sensationalized popularizations to grandiose personal statements to "how-to-do-it" guides for clinicians to surveys and evaluations of clinical applications. The most serious books have been collections of empirical research papers or theoretical overviews by leading individual investigators in the field.

What Yates has done is to take the 1500 or so papers published on biofeedback and related topics and neatly summarize and integrate them. His account includes a survey of historical antecedents, a detailed examination of issues of instrumentation and methodology, and an exhaustive coverage of biofeedback research on the control of muscle activity, autonomic functions, electrical activity of the brain, and other physiological processes. The great variety of applications of biofeedback in medicine, psychiatry, psychology, dentistry, and education are given careful coverage. A special chapter is devoted to theoretical issues. A concluding chapter presents an overview and evaluation of the past, present, and future of biofeedback. Just in providing the information and bibliography Yates has performed an enormous service for students and investigators. He assures the reader that he has obtained and read virtually all the references cited in the book, and that is no mean feat. The painful detail may frustrate the impatient reader.

Although he is not at all a novice in behavioral and psychophysiological research, Yates's own work has not been directly concerned with biofeedback. (He has studied the effects of delayed auditory feedback on speech, and this may explain his interest in the topic.) This inexperience permits a certain freshness of outlook. Yates can examine methods, findings, and interpretations without undue skepticism or special bias.

Yates's dissection of the independent variables involved in biofeedback results in a new attempt at classifying feedback displays. They may be visual, digital, auditory, or tactile. The information may be presented within a trial or at the end of a trial; it may be proportional or binary; it may be continuous or noncontinuous. Although such a taxonomy may strike one as sterile, it can guide us in the evaluation and integration of completed research and in the search for more effective displays and a definition of the critical features of feedback per se. On the other hand, Yates's repeated complaints about inadequate controls and confounding variables reflect a failure to put the phenomena of biofeedback into the broader context of psychophysiological research. For example, his discussion of the "drift effect" (changes in physiological function resulting from "naturally occurring changes over the passage of time") would have greatly profited from a close consideration of the vast psychophysiological literature on habituation, sensitization, and adaptation. In addition, understanding the rationale for the use of biofeedback for various specific medical disorders requires a more thorough consideration of the particular physiological as well as behavioral factors involved. It would have also been useful to have more extensive coverage from Yates's behavioral standpoint of the issues of generalization and maintenance of treatment effects in clinical applications of biofeedback.

Yates's discussion of theoretical aspects of biofeedback (chapter 7) centers on the recognized inability of the experimenter or clinician to instruct a subject or patient how to utilize the biofeedback display to achieve control and the inability of the subject or patient to explain how he or she achieved control when it has been achieved. This inability is not surprising to Yates; he rejects the notion that biofeedback enables the individual to become "aware" of the target physiological activity or of cognitive processes (thoughts, images) that may be controlling it. Also rejected is the view that biofeedback learning comes about because the requisite responses are reinforced (in the sense of operant conditioning). Yates maintains that the "language" that is learned relates not directly to the activity of the function or to its perception and detection but rather to the servocontrol system underlying the activity of the function. Feedback merely serves to teach the individual about his or her control systems. The task of the biofeedback researcher or clinician then is to attempt to formulate servocontrol systems for functions of interest as well as the components of such systems, and to specify the nature of the defect in the control system in the case of disorders of function. Biofeedback is seen as a tool in the process of helping the individual "to learn the language of the servosystem so that the correct relative settings of the component parts of the system may be achieved in order that appropriate responding may be obtained in a given situation." Once the tool has been used effectively, it is to be dispensed with. That is, the feedback device should not become a "crutch," and the control is to be "internalized." This is an intriguing although somewhat abstruse theoretical position that warrants further development and new experimentation.

This book comes at the right time, when serious questions are being raised about biofeedback. What effects are specific to it? What effects relate to expectancies or simple suggestion? When is the feedback necessary? For which disorders is biofeedback effective? How do the effects of biofeedback compare with those of other behavioral methods of physiological regulation, such as hypnosis, progressive relaxation, guided imagery, and the like? How does biofeedback work? This book provides the frameworks and background information, as well as the inspiration, that are vital to the pursuit of these questions. Yates concludes by expressing the hope that further advances in our basic knowledge will enable us to use biofeedback as a precision tool in enhancing voluntary control of physiological and behavioral processes and in understanding the mechanisms of voluntary control.

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