Biofeedback as Therapy

Some Theoretical and Practical Issues

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A central component in psychotherapy is the use of corrective feedback. This has been especially evident during the past 15 years with the emergence of many new approaches to treatment, including behavior therapy, sensitivity and encounter groups, and what have sometimes been called "video" therapies. In all of these approaches, the patient receives some form of augmented feedback about his own behavior, be it gradual shaping using contingent reinforcement, the reaction of other people in a group setting to the patient's feelings and actions, or the images and sounds of the patient–therapist interaction using videotape replays. Under the right conditions, with suitable motivation or incentives, the patient may develop awareness or "insight" into his own behavior and may learn new ways of experiencing and dealing with his environment.

In a similar vein, the growth of biofeedback can be seen as the development of new, more refined techniques for providing an individual with feedback for specific physiological processes and, with appropriate incentives, these procedures enable him to modify and control what were once considered "involuntary" and "automatic" functions such as heart rate, blood pressure, and brain waves. Actually, the growth of biofeedback simultaneously came out of two somewhat different traditions. One was operant conditioning, where early researchers (in the 1960s) such as Shapiro, Kimmel, Miller, and DiCara viewed the goal of research as demonstrating that operant control of visceral and glandular processes could be obtained in humans using contingent reinforcers such as money, and in animals with reinforcers such as electrical stimulation of reward centers in the brain. At about the same time, Kamiya, Brown, and others became interested in seeing whether human subjects could learn to discriminate higher nervous system activity and associated subjective states by providing them with external feedback such as brief lights or tones for specific electroencephalogram changes. It was reasoned that through the feedback and resulting discrimination, subjects would be able to develop voluntary control over these functions.

It is important to consider the history and scope of the issues raised by this research in order to more fully appreciate its implications and applications to clinical treatment. In particular, biofeedback has stimulated renewed interest in concepts such as voluntary control and consciousness and in the central question of the degree to which man can modify and control his behavior in the face of opposing forces in the environment. Consequently, the role of the individual patient in taking responsibility for the maintenance and control of his own health becomes of paramount importance. Although biofeedback is a form of behavior therapy, this does not alter the basic issues involved, especially since questions of self-control and cognition are becoming central issues in current behavioral approaches to treatment.

Over 250 papers have been published on the use of operant-feedback techniques in the control of physiological processes, and four volumes reprinting much of this work are now available (Barber et al., 1971; Kamiya et al., 1971; Stoyva et al., 1972; Shapiro et al., 1973). My wish is not to review this work, nor to cover all the potential clinical applications to date, since this material has been recently reviewed elsewhere (Shapiro & Schwartz, 1972).[2] Rather, this article considers some of the important issues or problems involved in clinically applying biofeedback techniques to the individual patient. Toward this end, I will discuss some of our basic and clinical research on the voluntary

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[2] Potential applications discussed in this article include essential hypertension, cardiac arrhythmias, tension and migraine headaches, rumination, Raynaud's disease, anxiety and fear reduction through relaxation and systematic desensitization, pain reduction through alpha training, meditation and yoga, attention and learning, and sexual behavior.

control of human cardiovascular responses, for it illustrates many of the problems involved.

Basic Research

The possible application of biofeedback to the control of essential hypertension (high blood pressure of unknown etiology) first requires the development of a suitable blood pressure measurement and feedback system. A prerequisite for any biofeedback application is the accurate sensing and processing of physiological activity, and, not surprisingly, one of the reasons why the field took so long in developing was that readily available biomedical technology, including accurate programming equipment, has only appeared in the past 15 years.

Actually, the technology for sensing and recording human blood pressure on a continuous basis was already available, but it was not practical for routine laboratory work since it required surgical insertion of a pressure-transducing tube into an artery. On the other hand, while the traditional stethoscope and blood pressure cuff procedure used by the physician was neither aversive nor dangerous, it was too intermittent (one could only obtain about two readings per minute) and too inaccurate to make it satisfactory as a feedback device. However, using new pressure-regulating devices and solid-state circuitry (coupled with an extension of blood pressure measurement theory), it was possible to modify and automate a constant cuff pressure system to accurately measure median blood pressure (± 2 millimeters of mercury) and at the same time provide the subject with binary (yes–no) feedback at each heart beat for increases or decreases in blood pressure (Tursky, Shapiro, & Schwartz, 1972). The details of this system need not concern us here—the point is to highlight the general problem of being able to detect and measure the function in question so that it can be easily and practically used by the patient.

In our basic research (as well as clinical) studies to date, we have typically used the procedure of giving the subject binary feedback for small, desired changes in blood pressure (or heart rate) at each beat of the heart and, after producing a certain number of correct responses, of giving the subject a reward or incentive in the form of a slide.[3] The slides might be landscapes of Boston, pictures from around the world, photos of nude women, or numbers reflecting monetary bonuses. As will be seen, in multisession work involving patients, maintaining interest and motivation can become an important problem, one not easily solved by using simple extrinsic rewards.

In the first two studies (Shapiro, Tursky, Gershon, & Stern, 1969; Shapiro, Tursky, & Schwartz, 1970a), the basic question was whether healthy college students could learn to raise or lower their systolic blood pressure in a single session. All subjects received the same general instructions, and only the contingency of the feedback and reward was varied between groups. To control for possible instructional effects, subjects were not told what the bodily function was, nor were they told in what direction the function was to change. The results indicated that subjects reinforced for increases in blood pressure were able to raise or maintain their pressure, while subjects reinforced for decreases in systolic pressure were able to lower their pressure over the session. Another group given random reinforcement showed that its average pressure fell about midway between the increase and decrease groups, suggesting that the two contingent groups controlled their pressure above and beyond the nonspecific effects of the instructions, the stimulation afforded by the feedback and reward, and quiet sitting in a lounge chair for 40 minutes (Crider, Schwartz, & Shnidman, 1969). Interestingly, postexperimental questionnaires revealed that subjects were not aware they had actually controlled their blood pressure, nor did they realize the direction their pressure had changed.

Some questions consistently raised by this research were, What were the subjects doing or thinking to control their blood pressures? Were they getting excited or relaxed? Were they thinking specific thoughts, or possibly tensing their muscles in some way? Hence, questions of cognitive or somatic mediation were considered to be important, especially by those researchers interested in the theoretical question of whether operant conditioning of autonomic activity per se had in fact taken place (Katkin & Murray, 1968). As it turned out, the blood pressure data proved to be convincing in this regard, because when heart rate (a related cardiovascular function) was analyzed, no differences were found between groups. In other words, the subjects had not learned simply to raise or lower overall autonomic arousal, even within the

[3] An analysis of contingent reinforcement as a stimulus containing both information (feedback) and incentive (reward) value is discussed in Schwartz (in press) and Schwartz and Shapiro (in press), the latter completed just prior to publication.

cardiovascular system. In a later study (Shapiro, Tursky, & Schwartz, 1970b), when subjects were trained to raise and lower their heart rate using a similar binary feedback and reward technique, the subjects now learned to control their heart rate, without similarly affecting their systolic blood pressure. Altogether, findings of specificity of learning such as these were seen as important prerequisites for the application of biofeedback training to clinical problems (Shapiro & Schwartz, 1972), since alleviation of the "symptom" was desired without corresponding "side effects" such as those sometimes produced by drugs.

However, questions of mediation and specificity are more complex than originally envisioned (Schwartz, 1972) and have important implications for therapy (Schwartz, in press). On the one hand, the therapist is not usually concerned with obtaining a "pure" effect from a scientific point of view, but wants any combination of factors that will produce large, long-lasting, generalizable, and safe effects. Thus, if for a given hypertensive patient it was found that training in general muscle relaxation alone produced the most rapid and massive decreases in pressure, this would be clinically valuable. Cognitive and somatic mediation, if useful, is of significance to the therapist.

On the other hand, the therapist may be concerned with what else is changing when a person is given biofeedback for a particular function. In fact, there are instances where the therapist may be interested in *patterns* of responses. For example, the desired goal for those hypertensive patients having normal heart rates may be to lower stroke volume and/or peripheral resistance rather than to change heart rate per se. However, in reducing pain in patients suffering from angina pectoris, the desired goal may not be to lower just blood pressure, or heart rate, but rather to lower both functions simultaneously, since by decreasing rate and pressure, the heart requires less oxygen, which in turn leads to reduced pain (Braunwald et al., 1967). In other words, it becomes important not only to be able to predict under what conditions side effects may occur, but also how one might produce them in specific cases.

One approach to this problem is to analyze carefully what else is simultaneously being "reinforced" when feedback and reward are given (Schwartz, 1972, in press). Returning to the blood pressure–heart rate example, if systolic blood pressure and heart rate were so related over time that increases in one of them were always associated with increases in the other, and vice versa, then when an experimenter chose to give feedback and reward for one, he would unwittingly provide the identical contingency for the other as well. Therefore, from learning (or feedback) theory we would expect that both functions should in fact be learned simultaneously and in the same direction. If these two functions were so related that whenever one increased the other simultaneously decreased, and vice versa, then if feedback and reward were given for one, the other would simultaneously receive the opposite contingency. Both functions should also be learned, only now in opposite directions. However, since neither of these results was empirically obtained, it would follow that systolic blood pressure and heart rate are unrelated in such a way that binary feedback for one results in some form of simultaneous random reinforcement of the other.

Assuming for the moment that this conclusion is true, the next question that arises is, How could a person be taught to control both of them? One approach that follows from the above analysis is to give the feedback and reward only when the desired pattern of responses occurs. In theory, it should be possible to teach a person to voluntarily integrate his systolic blood pressure and heart rate (make both functions increase or decrease together), or to differentiate them (make them go in opposite directions) by providing feedback and reward for the desired pattern. In subsequent studies, it has been verified that systolic blood pressure and heart rate are only integrated 50% under resting conditions (they spontaneously change from beat to beat in the same direction only half of the time) and that subjects can learn voluntarily to make them go together (Schwartz, 1972; Schwartz, Shapiro, & Tursky, 1971) or apart (Schwartz, 1972) when given feedback for the appropriate pattern.

Thus, the interrelationships among bodily functions over time, as well as the exact nature of the contingency (feedback) involved, control the degree to which learned specificity or patterning occurs. Although this type of formulation may provide a useful first step in the prediction and control of multifunctions using biofeedback, it must be incomplete, for it treats physiology as if it operated in a vacuum, without constraints. However, physiological (and associated cognitive) constraints do exist and must be taken into account (Schwartz, 1972). The extent to which simple predictions from learning or feedback theory fail can reveal the exact nature of the constraints involved.

For example, it is easier for subjects to learn to make their systolic blood pressure and heart rate go together than to make them go apart (Schwartz, 1972). Furthermore, feedback for integrating these functions produces somewhat larger effects and more rapid learning than feedback for either single function alone. In addition, when subjects are taught to lower both functions simultaneously, they now begin to report feelings of relaxation and calmness, states one would expect to be associated with more general autonomic relaxation. Altogether, it would seem that in the process of trying to understand and extend biofeedback techniques to patterns of responses, the research uncovers more about the nature of the physiological systems themselves and their relation to cognition.[4]

The combined behavioral-biological approach to biofeedback outlined here has a number of implications for treatment. One is that the clinician should carefully evaluate exactly how he administers feedback to an individual patient, so that he is better able to precisely determine and control what the patient will and will not learn. Understandably, this applies not only to simple discrete-digital feedback, but to more complex forms of continuous-analog feedback as well. For example, if a patient is receiving analog feedback for beat by beat changes in heart rate, and he has sinus arrhythmia (heart rate rising and falling with each breath), the subject will be simultaneously receiving feedback for respiration, and he may modify it accordingly. The clinician should be aware of this possibility and should make a rational decision as to whether or not such learning is desirable.

For applications involving the self-control of more complex states like anxiety or fear, it becomes important to determine what function, or pattern of functions, occurs in these states for the individual patient. It is well known that individuals differ in their autonomic specificity and that situations may evoke different patterns (Lacey, 1967); thus, it makes good sense that the feedback be selected so as to optimize its integration (correlation) with the problem in question.

As for the question of constraints, it follows that if it is possible to clinically evaluate the flexibility or variability of the function(s) in question, it may be possible to assess whether biofeedback will ultimately work for a given patient. For example, if a patient wtih fixed hypertension (possibly due to excessive hardening of the arteries) has blood pressure levels constantly elevated above normal, it seems unlikely that biofeedback will have any significant effect on purely physiological grounds. Evaluating the potential for organ change (e.g., by taking sleep measurements) may be a useful screening technique. It follows that early diagnosis of the individual for preventive feedback training before the organ system is seriously damaged may be the most meaningful application to psychosomatic medicine.

Before considering further issues raised by clinical work, it may be useful to show how this model applies to animal biofeedback research, where curare is used to paralyze the muscles. Miller (1969) and DiCara (1970) have argued that by paralyzing the muscles with curare, the question of somatic mediation is eliminated. However, all the curare procedure (using moderate doses) does is eliminate potential feedback from actual muscle contraction; it does not stop the rat from struggling and tensing his muscles "in his head." According to the model, to the extent that heart rate and muscle activity are naturally integrated at the level of the brain, reinforcement for the former will result in consistent reinforcement of the latter as well, regardless of the actual state of the muscles.[5] A. H. Black (personal communication, 1971) has found that when he teaches a curarized dog to "move in his head," that is, to produce or inhibit theta waves from the hippocampus (in a nonparalyzed dog, theta occurs when the dog makes voluntary movements), heart rate simultaneously increases or decreases as well. Recently, Goesling and Brener (1972) have found that teaching a rat to tense or relax prior to curare greatly influences his later ability to raise or lower his heart rate while under curare. Hence, the question of mediation is complex, especially at the level of the brain, and one

[4] These findings have been extended, and predictions of the model replicated, in current research on the voluntary control of diastolic blood pressure and heart rate (Schwartz, Shapiro, & Tursky, 1972; Shapiro, Schwartz, & Tursky, 1972). The approach also has been applied to the voluntary control of EEG alpha and heart rate (Schwartz, Shaw, & Shapiro, 1972), but this material will not be reviewed here.

[5] Although there is good psychophysiological evidence for believing that heart rate and somatic activity are centrally integrated (Obrist, Webb, Sutterer, & Howard, 1970), this does not imply that other autonomic responses are also so integrated.

must evaluate (*a*) relations between responses, (*b*) the nature of the reinforcement contingency, and (*c*) natural biological, environmental, and "state" constraints in order to understand and predict exactly what is being learned (Schwartz, in press).

Preliminary Clinical Applications to Essential Hypertension and Raynaud's Disease

We have attempted to apply the general procedures developed in the basic research to patients diagnosed with essential hypertension (Benson, Shapiro, Tursky, & Schwartz, 1971). First, the seven patients participated in from 5 to 16 control sessions, during which blood pressures were taken under resting conditions. Then systolic blood pressure feedback and reward sessions were initiated and continued until no further reductions in blood pressure occurred for 5 consecutive sessions. The number of conditioning sessions varied from 8 to 34, with a mean of about 22 sessions. The results showed that six of the seven patients decreased their pressure by as little as 3.5 millimeters of mercury and by as much as 33.8 millimeters of mercury (mean decrease for all patients was 16.5 millimeters of mercury). Interestingly, the one patient who failed to show any decrease in blood pressure was later diagnosed to have renal artery stenosis, which relates back to the question of biological constraints.

Although these findings are encouraging, they are a long way from demonstrating that biofeedback can be a clinical treatment for hypertension. First, it is not known whether patients can control their pressure without the feedback, or even if the feedback was the significant factor in the research. Placebo variables may have been operating and can only be evaluated by the use of the appropriate control groups (Shapiro & Schwartz, 1972). On the other hand, as in all forms of therapy, positive expectations on the part of the patient may well be a prerequisite for positive gains, especially in behavioral therapies where patient cooperation and practice are necessary for change.

Related is the general question of patient motivation. As described in the review of the clinical research (Shapiro & Schwartz, 1972):

> Central to all forms of psychotherapy is patient motivation and involvement. The question, at the simplest level, is how to motivate patients to spend the necessary time practicing the desired behavior. With severely retarded and/or emotionally disturbed children, reinforcers such as food, candy, or other desired objects (e.g., watching a fan spin) are often necessary for modifying the behavior. However, with less severe problems, therapist praise, praise from significant others in the patient's environment, or self-reinforcement (a sense of competence) may be more than sufficient. One predictor of success in psychotherapy is the extent to which the patient's problems are causing him pain or suffering. With regard to biofeedback, Miller has suggested that feedback for controlling the function in and of itself may be all that is necessary. However, as progress is made, and the novelty of the situation wears off, what will keep the patient working at the task? In our experience with patients suffering from essential hypertension, a potpourri of rewards was successful, including money for participating and for succeeding (most of these patients were on welfare and thus the money they earned was quite significant), slides of scenes around the world, and general, non-specific praise from the physician and research assistant running the sessions. However, this was an experiment, and the patients were receiving a sizeable monetary reward. One wonders whether they would have spent the same number of hours trying to control their blood pressure in the absence of such incentives, which are impractical on a large-scale basis. In this respect, learning to control physiologic processes is like any other self-control procedure (e.g., dieting) since sacrifice on the patient's part may be necessary for the sake of health [p. 180].

Actually, the hypertensive patient may be a special case, more similar to the average cigarette smoker than to the headache patient. Although the pain caused by tension or migraine headaches is relatively immediate, as is its relief, it may be years before the potential harm from high blood pressure or smoking is experienced directly by the patient. Hence, it is understandable why headache patients are willing to pay for experimental biofeedback treatment (T. Budzynski, personal communication, 1971), while we must pay our research hypertensive patients to potentially help themselves.

The question of motivation leads to another important problem: namely, whether the patient is able, or willing, to control his bodily functions in the hectic, rapidly changing environment outside of the laboratory. It is well known that environmental stressors can augment, or even cause, psychosomatic disorders, and it should not be surprising if many patients desire biofeedback for their blood pressure, just as they take medicine for their stress-related stomachaches. Simply put, the typical patient would rather change his body than change his lifestyle or his environment, the two factors which together augment or cause the bodily dysfunctions in the first place. In this context, it would seem reasonable that biofeedback should be viewed as but one approach to the treatment of the "total person," realizing that to "cure" a problem such as hypertension will require more than just the patient consciously attempting to lower his pressure. Similar views concerning behavioral therapies in general have been stressed by Lazarus (1971).

A good example of this point comes from one of our hypertension patients who, during the feedback sessions, was successful in lowering his pressure. Over the five daily sessions of a typical week, he might lower his pressure by 20 millimeters of mercury and thus earn a total of over $35. However, we consistently noticed that after the weekend, he would enter the laboratory on Monday with elevated pressures again. In interviews with the patient, the problem became clear. After earning a sizable amount of money, the patient would go to the race track on the weekend, gamble, and invariably lose. The likelihood of teaching this patient to "relax" while at the race track through simple laboratory blood pressure feedback would seem slim, indicating that there is a need to work on other aspects of the patient's behavior (e.g., by changing the contingencies of reward) and personality which are related to the high pressure.

Depending on the particular function, dysfunction, and patient involved, biofeedback training may take many sessions. Getting the patient committed to spending this amount of time is difficult enough; getting him to travel to the laboratory for each session often becomes a formidable problem. For this reason, the development of home feedback devices, coupled with weekly consultation with the physician and/or therapist, appears to be a fruitful direction in which to move. In addition, the use of portable feedback devices makes it possible for the patient to evaluate his progress under different environmental conditions outside of the laboratory, and this may significantly enhance the potential for generalization.

Whether or not the patient can learn to control these processes without feedback is still an open and important question. Procedures for "weaning" the patient from the feedback need to be worked out (Weiss & Engel, 1971). However, patients may be able to learn certain cognitive or somatic strategies which they then can use without feedback. One example of this comes from a patient we were experimentally treating for Raynaud's disease, a problem of peripheral constriction and reduced blood flow that under extreme conditions can lead to gangrene in the hands and feet. Symptoms of Raynaud's disease include a feeling of "cold" in the afflicted area that can be quite painful. The patient was a man in his early sixties with very cold feet; this patient was somewhat unusual in that he was a practicing psychoanalyst who came for behavioral treatment of his problem. Briefly, blood volume was recorded simultaneously from the big toes of each foot, and the patient was given binary feedback for each heart beat that was followed by a small increase in blood volume. The feedback and reward procedure was modeled after the blood pressure work, and similar slides were used. Although placebo and expectancy effects cannot be discounted (and were probably operating), over 10 sessions he began to show large increases in blood volume, particularly in the left foot, the foot initially selected for feedback and reward. In the middle of a later session, we then switched to providing feedback and reward for the right foot, which subsequently reached similar increases in overall blood volume. This finding of relative specificity was not surprising, because it was observed on the polygraph that spontaneous dilations and constrictions frequently occurred in one foot and not the other, and therefore the feedback was really contingent to the particular foot controlling the programming equipment, while the other simultaneously received a form of random reinforcement.

This particular patient was unusually inclined toward "free association" and interpreted the purpose of the slides as diverse material for him to covertly free associate to. In one of the later sessions, the slide projector accidentally jammed and, rather than showing a slide, flashed just a white, bright light on the screen. This proved to be a fortunate accident, for the patient began free associating to the sun, warmth, beaches, and so forth, and he reported that these thoughts were particularly helpful in warming his feet. Furthermore, these "hot thoughts," as the patient described them, were the images he used to control his feet outside of the laboratory. Interestingly, this procedure proved to be highly adaptive for him since if his feet got cold, even while he was doing therapy with patients, he reported that all he had to do was "turn on his hot thoughts" for a few moments and he felt relief. Whether or not he actually was able to control his feet out of the laboratory is not known, nor it is known if these images were really the significant mechanisms by which he controlled his blood volume. Nonetheless, the case illustrates the potential use of cognitive mediation in the development of self-control of bodily processes.[6] While this patient remained symptom free for about a year and a half, he later contacted us indicating that his symptoms had returned and that he desired further training.

This patient was highly educated (and high up on the socioeconomic ladder), experienced and comfortable in laboratory situations, and greatly desirous and expectant of success. The other Raynaud's patient we have tried to work with so far was from a lower-middle-class background, inexperienced and wary of the laboratory setting, and of questionable motivation and expectancy concerning exactly what the feedback really was and what it was supposed to help her to do. This woman was seen for fewer than 10 sessions, and there was little indication of clinically meaningful (as opposed to statistical) increases in blood volume in her hands. Although it is not known if further training would have yielded large enough changes to constitute therapeutic success, this seems unlikely since she appeared to have a severe case of the disease (she was being considered for a sympathectomy); and on top of this, we had little success in improving her attitude and reactions toward the whole situation. Her experience illustrates how personality and individual differences make it impossible to provide a simple "cookbook" approach to questions such as "What should I tell the patient?" or "What kinds of incentives should I provide?" On the other hand, to the extent that specific instructions direct a patient's attention to certain aspects of his behavior or lead him to utilize certain strategies in learning control, it can be speculated that what the patient is told, and what he is asked to do, may depend on both the specific nature of the desired function(s) to be changed and the personality of the patient.[7]

Summary and Conclusions

Biofeedback is clearly an important discovery, one that may prove to have some value in medical and psychological treatment. However, there are many problems that need to be solved, particularly when applied to the individual patient. Biofeedback, if used in conjunction with other medical and psychological techniques, may be useful with certain patients. However, in the face of specific biological and environmental constraints, I am somewhat pessimistic about its application to chronic physical disease, particularly in the absence of other therapeutic procedures.[8] Emphasizing the problems involved is not meant to discourage experimental attempts at clinical application. Although a combined behavioral–biological approach that emphasizes (*a*) the natural relations between responses, (*b*) the exact manner that the feedback and reward is given, and (*c*) biological, cognitive, and environmental constraints is indicated, it is not implied that all of these factors need to be taken into account before using biofeedback in a specific case. Rather, the purpose of the article is to illustrate potential areas of inquiry and evaluation that may be clinically useful.

Even if "direct" voluntary control of certain bodily functions or patterns of functions proves to have little therapeutic value, biofeedback per se can still serve an important function—to signal both the therapist and the patient that the patient is currently thinking, feeling, or doing specific things that are detrimental to his physical or emotional health. In the same way that a scale helps direct the therapist and his obese patient in learning how to reduce food consumption and/or increase exercise in order to control weight,

[6] Specific cognitive control of skin temperature (relative dilation in one hand and constriction in the other through hypnosis and imagery of warmth and cold) has recently been reported by Maslach, Marshall, and Zimbardo (1972). Further evidence for cognitive control of cardiovascular activity due to specific thought processes can be found in Schwartz (1971) and Schwartz and Higgins (1971).

[7] For example, if a subject is instructed to close his eyes and to think a neutral word over and over in a relaxed fashion, a reduction in a number of psychophysiological responses (a pattern) may occur, such as those seen in certain forms of meditation (Wallace, 1970).

[8] Learning to relax a chronically tense (but otherwise healthy) muscle with biofeedback, for example, would seem to be a more likely candidate for success. Also, in this case the response in question is likely to be already under some voluntary control since it is part of the motor system. This point would similarly apply to learning to control certain electroencephalographic rhythms, to the extent that they involve self-regulatory sensorimotor processes.

biofeedback for visceral and neural disorders may be so employed as well. By means of immediate, augmented feedback (with its associated increased bodily awareness), the patient may be able to learn new ways of coping *behaviorally* with his environment, or he may be able to alter his *life-style* in such a way as to keep his physiological processes within safer limits. In this respect, biofeedback is really similar to current psychotherapies, for they all provide corrective feedback.[9]

[9] It might be noted that this approach to the use of biofeedback removes the negative clinical implications suggested by recent difficulties in replicating large magnitude effects in the curarized rat (N. E. Miller & L. V. DiCara, personal communication, 1972). Rather than trying to eliminate those overt somatic "mediators" capable of producing large autonomic changes, the goal here is to deliberately use them to produce more physiologically adaptive reactions (e.g., through breathing exercises or other yoga procedures).

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