BIOFEEDBACK: EXTERNAL AID TO INTERNAL CONTROL

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It is well known that some who practice yoga in India gain remarkable control over certain physiological processes not ordinarily under voluntary control, such as heart rate and smooth–muscle responses [Wenger and Bagchi, 1961; Wenger, Bagchi, and Anand, 1961]. As you probably know, mastering the techniques of yoga requires years of study and long–continued & disciplined exercise. Thus it seems unlikely that more than a few individuals will ever learn to control their internal bodily states in this manner. Fortunately, though, a method developed in recent years—biofeedback—seems to offer a major short cut to such control. Recent studies suggest that organisms can learn to control their internal bodily reactions through instrumental conditioning. Such learning is often facilitated by biofeedback—a procedure in which internal bodily responses are amplified in some manner and are presented [fed back] to participants. Basically, biofeedback involves procedures in which minute changes occurring with in the body or brain are detected and amplified by complex electronic devices. These changes are than represented to subjects in some visible or audible manner. More exact definition developed by Bellack, A.S., Kazdin, A.E., & Hersen, M. (1982) declares, "Biofeedback involves in structuring the subject to generate a certain bioelectrical pattern of waveform. Information is then fed back to the subject regarding his or her performance." So, we can observe here, that the basic difference between any yogic techniques used for relaxation or voluntary control of normally involuntary processes with in the body or brain and the biofeedback is only in term of instrumental [e.g., electronic devices] support/aid for the individual who is overcoming these internally involved involuntary processes.

For example, an individual receiving biofeedback might hear a tone or see a light flash, each time a specific change in his or her internal reactions occur, or in some cases to prevent it from occurring.

Hence, "biofeedback is the immediate presentation to a person of information about his or her own physiological processes [Green, Elmer E and Green, Alyco M. (1977)]. The information is fed back by a needle on a meter, a light or a tone. For example, if a patient is suffering from high blood pressure, he is fed back the information as soon as his blood pressure is recorded as high. When his blood pressure is too high he gets one signal and when it is normal he gets another. By monitoring these cues the person himself in many cases is able to control his pressure by *some unknown internal mechanisms* [Mc Mohan: Frank.B]. We may consider these unknown internal mechanisms as they happen during the processes under yogic techniques especially used in India since the time of Vedas, three to four thousand years ago. The device or equipment, which gives them information about their physiological state, in its simplest form, this might simply be a GSR–sensitive pad that wraps around the finger, which is connected to a box that produces a tone. The higher the tone, the higher the level of autonomic activity. There are of course, many more sophisticated biofeedback machines on the market, but the type that we have described is fairly typical and commonly available [Nickey Hayes, (1994)].

When provide with this type of biofeedback, most individuals can readily learn to exert control over their own internal states. For example, they can learn to lower the blood pressure, increase or decrease their heart beat, encourage the presence of alpha waves in their brain, or alter the temperature of their skin [Brown, (1975); Miller, (1978)].

But, there is no strong evidence that such control is direct rather than indirect in nature [Benzamin Kleinmutz, (1974)].

CONTOLLING INTERNAL REACTIONS: EXPERIMENTAL EVIDENCE

The question of whether visceral reactions can be modified through instrumental conditioning has been studied in many recent experiments [Shapiro et al., (1973)]. As an example of this research and the problem it often faces, let us consider an early study by Miller and Carmona (1967). In this experiment, the researchers attempted to determine whether the "classic" response of classical conditioning–salivation–could be modified through the presentation of a positive reinforcer. The experiment was conducted with two groups of dogs that were deprived of water for sixteen hours in order to make them very thirsty. Then, they were rewarded with a drink for either increasing or decreasing their rate of salivation. Results indicated that under these conditions, subjects could infact show the required changes. That is those rewarded for increasing their rate of salivation showed a rise in the activity. Those rewarded for decreasing salivation showed a reduction in such behavior.

Unfortunately, these seemingly clear results were complicated by an important fact. The dogs rewarded for increasing salivation appeared to be more alert and active than those rewarded for decreasing salivation. This finding focuses attention on one of the most difficult problems faced by researchers working in this area. Many visceral reactions can be affected by voluntary activities such as testing of various muscles or changes in the rate or pattern of breathing. For example, it is well known that muscle tension increases heart rate [Schwartz, (1975)]. Unless such indirect sources of control over visceral responses are ruled out, of course, it is impossible to demonstrate that subjects have actually required the ability to control internal reactions in a direct, voluntary manner.

At first, experiments designed to eliminate this potential problem seemed to yield positive results. When animals were paralyzed by a special drug so that they could not tense various muscles, they seemed capable of controlling their internal reactions. For example, they could raise or lower their heart rate, increase or decrease intestinal contractions, and even make one ear blush while the other remained unchanged [Dicara and Miller, (1968); Miller, (1969)]. Unfortunately, though, it has not always proven possible to replicate these findings [Miller and Dicara, (1972)]. As a result, the question of whether subjects can actually bring their internal bodily responses under direct voluntary control remains open [Schwartz, (1975)]. That animals can learn to influence their internal bodily processes in some manners though seems to be clear [Kimmel, (1974)]. If rats and other animals can learn to affect such reactions, it seems reasonable to expect that human being–with their vastly superior abilities–should be able to accomplish this task, too. And indeed, a large number of recent experiments indicate that this is actually the case [e.g., Balanchard and Epstein, (1978)]. For example, in one study, Frezza and Holland (1971) found that college students could learn to increase or decrease their rate of salivation when provided with small amounts of money for showing such changes. Perhaps the most dramatic demonstration of the extent to which humans can exert control over their most vital bodily functions, however, has been reported by a team of Indian scientists [Anand, Chhina, and Singh, (1970)].

These researchers obtained the aid of a famous yogi, who agreed to permit careful study of his vital bodily processes during a stay in an air–tight box. Before entering the box, the yogi's normal use off oxygen when completely at rest was found to be 9.7 liters per half hour. Presumably, this was the minimum amount required by his body for its vital functions. Soon after entering the air–tight chamber, though, both his heart beat and breathing slowed. As a result, his use of oxygen dropped to only 6.8 liters during the first half hour. As time passed, he reduced this rate still further. Thus in the middle of his six–hour stay in the box, he use oxygen at the rate of only 2.2 liters per half hour. In short, he succeeded in voluntarily reducing his body's consumption of oxygen to less than one fourth its normal rate. When he was released from the box at the end of the experiment, he was found to be in an excellent condition. The fact that he had brought the most basic functions of his system to a virtual halt seemed to have no harmful effects. It is hard to imagine a more dramatic demonstration of our ability to exert a great degree of control over our internal bodily reactions [Baron, Robert A., Byrne Donn, & Kantowitz Barry H. (1980)].

Many of the various biofeedback experiments first done on animals have now been done on humans. For example, it is possible to change the blood distribution to the two hands so that the temperature in one hand is increased and the other decreased [Maslach, Marshall, and Zimbardo, (1972); Roberts, Kewman, and Macdonald, (1973)]. Hence the laboratory method has made it easier for many to achieve, without intensive practice, the kind of control achieved by a yogi in India, or in western countries through other kinds of training, such as progressive relaxation [Jacobson, (1970)] or autogenic training, a form of self–control closely related to hypnosis [Schultz & Luthe, (1969)].

HOW DOES BIOFEEDBACK WORK?

1. Biofeedback evidently works for at least some health problems, but how does it work? Probably the most common view is the idea that biofeedback is an instrumental conditioning procedure. According to this view, feedback information rewards learners for specific physiological responses, such as speeding up their heart rate or expanding certain blood vessels [Morgan, C.T., King, R.A., Weisz & Schopler, (1993)].
2. However, several alternative explanations have been proposed [Raczynski et al., (1982)]. One is that biofeedback is effective because it teaches people skills in generalized relaxation. Relaxation lowers overall sympathetic nervous system activity; this, in turn, moves many physiological processes (heart rate, for example) away from overactivity.
3. Another explanation is that biofeedback effects are mediated by cognitions. For example, the cognitive behaviorist Meichenbaum (1976), proposes that people learn to control internal processes by using self–statements or specific mental images; these in turn, trigger specific physiological reactions. For example, one headache victim learned to control her temporal artery blood flow and stop headaches by picturing in her mind "the cameo lady' from a soap advertisement she had seen.

There is some evidence to support all three views—the instrumental conditioning, relaxation, and cognitive models. We may eventually discover that how biofeedback works depends partly on which people and which problems it is used to treat.

EVIDENCE SUPPORTING OPERANT CONDITIONING APPROACH OF BIOFEEDBACK MECHANISM

1. **ALPHA WAVE CONDITIONING:** In a pioneering study, Joe Kamiya (1962), a psychologist at the University of California Medical School, undertook train a subject to

change his brain wave activity, particularly his alpha wave reading [8 to 13 cycles per second]. To accomplish this he used an operant conditioning approach that consisted of wiring the subject to a remote electroencephalograph [EEG] recorder and providing him with a discriminative stimulus [for example, the ringing of a bell] at varying intervals. The subject's task was to guess whether he was in alpha or not at the sound of the bell. After each guess, he was given the correct information. After two or three days, the subject guessed correctly when he was in alpha on almost all trials, and by the fourth day he was accurate on every trial. Subsequently Kamiya demonstrated that not only could human beings identify alpha but they could also learn to produce it on command Kamiya, (1968) and to produce as much alpha as possible and as little as possible [Nowlis & Kamiya, (1970)].

The subjective descriptions of feelings accompanying alpha production were compared to hypnosis by some participants in another study [Engstorm et al., (1970)]. This study demonstrated that successful training to increase the alpha rhythm also raises hypnotic susceptibility (measured by a group scale of hypnotic susceptibility).

Other research has suggested that enhanced alpha activity is associated with pleasant feeling states (Brown, 1970, 1971), not unlike those reported to accompany the hypnotic and posthypnotic states. States of attention and inattention have also been linked to changes in alpha rhythm production [Luce and Paper, (1971)].

2. **CARDIOVASCULAR CHANGES:** The similarities between biofeedback and conditioning are also apparent in a number of studies in which individuals learned to control their blood pressure, heart rate, and other glandular activities. Especially, noteworthy in this regard is the work that originated in Neal Miller's Psychological Laboratory at Rockefeller University. In a series of pioneering studies, he and his colleagues demonstrated that almost all of an animal's autonomic responding can be brought under control, an accomplishment which for the first time showed that voluntary behavior is not necessarily limited to the movement of the skeletal muscles but can be exercised in the control of the vegetative or autonomic functions [Miller, (1969); Miller and Banuazizi, (1968); Miller et al., (1970)].

However, according to several psychologists (Katkin & Murray, 1968; Katkin et al., 1969), the evidence on instrumental autonomic conditioning, as it sometimes also called is far less convincing among human beings than among animals (Crider et al., 1969).

IMPLICATIONS OF BIOFEEDBACK

The fact that we learn to exert voluntary control over many of our most basic bodily processes raises a number of intriguing possibilities. For example, as noted by Brown (1974), it suggests that we might someday be able to control the activity of our brains, and so facilitate learning or even creativity. The most important implications of biofeedback, though, relate to its possible use in the treatment of physical and psychological ailments. With respect to physical problems, growing evidence suggests that individuals can learn with the aid of biofeedback, to induce beneficial bodily changes. For example, they can learn to lower their blood pressure from dangerous levels, to reduce irregularities in heart action, and to eliminate narrowing in their veins and arteries which prevent the normal flow of blood to the limbs [Kimmel, (1974);Schwartz, (1973)].

Turning to psychological problems, there is growing evidence that here, too, biofeedback can be of help.

1. In several studies, individuals receiving biofeedback have learned to induce relaxation

so as to overcome several kinds of anxiety [Blanchard & Epstein, (1978)]. Biofeedback procedures are often applied in the treatment of anxiety or phobic states. In this section, an overview is given of the research that has been conducted in this area. Most of the research has concerned electromyographic feedback and heart–rate feedback.

(i) **Electromyographic Feedback:** A number of researchers have investigated whether electromyographic [EMG] biofeedback results in a reduction of anxiety symptoms. Studies involving normal volunteers as subjects have produced equivocal results. Several studies [Coursey, 1975; Haynes, Moseley & McGowan, 1975; Reinking and Kohl, 1975] found EMG feedback superior to relaxation instructions as far as changes in EMG level are concerned; no differences were found on other measures. However, other studies found EMG feedback no more effective [Schandler & Grings, 1976] or even less effective than relaxation procedures [Beiman et al., 1978].

Several control studies have been conducted with anxious patients as subjects. Both Canter, Kondo, & Knott (1975) and Townsend, House, & Addario (1975) found EMG feedback superior to control conditions, when EMG was taken as the primary dependant variable. As far as anxiety symptoms were concerned, no significant differences were reported between EMG and relaxation [Canter et al., 1975] and between EMG and group psychotherapy [Townsend et al., 1975]. Finally, it is noteworthy that Jessup and Neufeld (1977) could not demonstrate a significant change on the EMG measure in a study involving psychiatric patients. Perhaps even more significantly, noncontingent tone presentation (control condition) led to significant changes in heart rate and anxiety measures, while EMG feedback [contingent tone] did not. Counts, Hollandsworth, and Alcorn (1975) sought to determine whether biofeedback could enhance the effectiveness of cue–controlled relaxation in the treatment of test anxiety. The results of this study indicated that biofeedback did not contribute to the effectiveness of cue–controlled relaxation.

In summary, there is no evidence that EMG feedback has something to offer that other treatments [e.g., relaxation] do not. The few differences that have been found in favor of EMG feedback all concerned EMG level as the dependent variable. Although it has generally been assumed that high levels of frontal EMG are related to anxiety, a study by Burish and Horn (1979) indicates that this is not the case. While several arousal–producing situations were stressful in increasing arousal as measured by self–report and physiological measures, these situations had no effect on EMG levels.

(ii) **Heart–Rate Feedback:** Gatchel and his colleagues have investigated whether heart–rate biofeedback can be used in the treatment of speech anxiety. In the first study of this series [Gatchel & Proctor, 1976], heart–rate control was found to be more effective than a condition of no heart–rate control on physiological indexes, self–report, and observer's rating. There was also a near significant expectancy effect, indicating that improvement was at least partially due to expectancy factors. In a subsequent study [Gatchel, Hatch, Watson, Smith, & Gass, 1977], the relative effectiveness of heart–rate biofeedback and muscle relaxation was assessed. Therefore, the effect of (a) heart–rate biofeedback, (b) relaxation, (c) relaxation plus heart–rate feedback, and (d) false heart–rate feedback [placebo] were compared in a between–group design. The results indicated that all treatments [including placebo] improved on self–report measures, with no differences among the groups. Only on physiological indexes during the posttest speech situation did the placebo group differ from the active treatment groups. Moreover, the combined procedure was found to be the most effective on this measure. Finally, the last study of this series [Gatchel, Hatch, Maynard, Turns, & Taunton–Blackwood, (1979)] replicated the placebo effect found in the Gatchel et al., (1977) study. The results of this study demonstrated that false heart–rate feedback was an effective as true heart–rate feedback and systematic desensitization on self–report indexes and overt motor components of anxiety. Only on heart–rate level, was heart–rate feedback found to be more effective relative to desensitization and placebo. No significant group differences were found for skin conductance and EMG indexes. Moreover, the results indicated that the placebo effect was not short–lived, since identical results were obtained at one–month follow–up.

Nunes and marks (1975, 1976) investigated whether true heart–rate feedback enhanced the effectiveness of exposure in vivo. In contrast to the studies by Gatchel and his colleagues, this study involved real patients with specific phobias. Although it was found that heart–rate feedback substantially reduced heart rate, this effect did not generalize to skin conductance or to subjective anxiety. In addition to the studies by Nunes & Marks, some case reports have been published demonstrating the effectiveness of heart–rate feedback with phobic patients [e.g., Blanchard & Abel, 1976; Wickramasekera, 1974; Gatchel, 1977]. However, these studies have typically confounded exposure and biofeedback and thus prevent the drawing of any conclusion.

Finally, the results of several studies indicate that heart–rate feedback is more effective with low–anxious subjects than with high anxious subjects [Blankstein, 1975; Shepherd & Watts, 1974]. The results of the Shepherd and Watts study are the most interesting, since they compared student volunteers with agoraphobic patients. It was found that agoraphobic patients did significantly worse than phobic students in decreasing their heart–rate.

In summary, while heart–rate feedback may lead to some control over heart rate, this control does not lead to a greater reduction of subjective anxiety relative to control conditions. Thus, feedback of heart rate seems to have little to offer in the treatment of anxiety.

Furthermore, it should be noted that heart–rate feedback during exposure to a phobic stimulus may even inhibit approach behavior, as was found in two analogue studies with snake–phobic volunteers [Carver & Blaney, 1977 a, b].

In 1974, Engel had already questioned the usefulness of heart–rate feedback in the treatment of anxiety: It may not be feasible to treat anxiety by teaching subjects to slow their heart rates since heart rate is merely one peripheral manifestation of anxiety and not the illness. If one taught an anxious patient to slow his heart, the end results could be an anxious patient whose heart beats slower" (P. 303). The present review suggests that this indeed the case.

Concluding Remark: {Bellack, Hersen & Kazdin, 1981)— Despites claims made by the proponents of biofeedback, there is no substantial evidence that biofeedback is of any value in the treatment of anxiety–related disorders. The application of biofeedback in this area seems to have been more beneficial to the industry than to anxious and phobic patients.

Paul Grim(1971) has lowered anxiety in subjects by self–induced muscle tension and by relaxation with respiration feedback. Of course relaxation techniques, have been reported since the 1930s (Jacobson, 1938); but the addition in Grim's study of a respiration feedback device is new. In this study each of 95 nursing students was administered a test to measure level of anxiety and was then hooked up to the electronic equipment he designed to amplify breathing. The idea was to train each person to breath more and more smoothly until a state of complete relaxation was achieved. Grim then retested the students with self–report anxiety measures and noted their reduced scores.

2. **TENSION HEADACHE:** Budzynski and the associates (1970), use a feedback–induced muscle relaxation technique to reduce tension headache. They described the application of their method to five patients with such headaches; their procedure was somewhat as follows: patients were given electromyography (EMG) feedback information from activity in a relevant muscle group area. In the case of headache Budzynski decided to use the frontals (forehead) muscle group and the feedback was in the form of a high–pitched tone (to indicate heavy EMG activity) or a low–pitched sound (to indicate low EMG, activity). The feedback tone has thus tracked the fluctuating level of EMG activity in the muscle. During the training session each patient reclined on a couch in a dimly lighted room. The two sessions consisted of practicing relaxation without feedback; and from the third session on (training time consists of two or three 30–minute sessions and the total amount varied from four weeks to two months) the patient was instructed to try to keep the tone low in pitch and was told that the tone follows his tension level.

Case Report—1 describes one instance in which this feedback training was used, with partial success, to relieve the tension headaches of a hard–driving businessman. Left out of this report is how Budzynski made it increasingly difficult for the patient to reduce his EMG activity after he had achieved a criterion level of relaxation: he adjusted the volume gain on the feedback amplifier so that the patient was forced to achieve even greater amounts of relaxation. Budzynski parallels this procedure to the operant procedure of shaping and notes that the relaxation response is no different from other responses in a person's behavior repertoire.

Case Report—2 Biofeedback Training For Tension Headache

Patient G.A. was a dynamic, middle–aged businessman who, ever since early adolescence, had suffered from frequent and severe tension headaches. He had previously received some training in deep relaxation while undergoing behavior therapy. Consequently, he learned to relax his frontalis muscle very quickly and was able to maintain low EMG levels at all times during feedback training. Although, his baseline headache activity was very high, it decreased rapidly during the second week of training and remained low for the duration of the training.

After his fourth week of feedback training, the patient went on a 5-week vacation. Upon his return to work his headaches also returned. Significantly, the patient had neglected his daily relaxation session. He reported he had to "get things back in order" after his vacation, and was in a state of high tension. He was then given two more feedback sessions and was strongly advised to schedule a period of relaxation practice everyday. His headache activity then returned in low levels and has remained there for the rest of the 3–month past–training period.

SOURCE: Budzynski et al. (1970).

3. **CONVULSIVE DISORDERS AND BIOFEEDBACK:** Convulsive disorders occur in about 2% of the general population and are characterized by a variety of types of seizures. The most common type of seizures are grandmal, petitmal, and focal seizures of Jacksonian and psychomotor epilepsy. Whether "organic" in nature (i.e., associated with physical pathology) or "psychogenics" seizures can come under the control of environmental stimuli and can be evoked by stress and emotional factors (Schaefer et al., 1979).

Research into the use of biofeedback to reduce seizures was largely stimulated by the work of Sterman and his colleagues (Sterman & Friar, 1972; Sterman, 1973;cf. Mostofsky & Iguchi, 1982). These researchers focused their efforts on training animals to sensory motor rhythms (SMR), which consisted of 12–15 Hz activity. They discovered a marked decrease in susceptibility to monomethylhydrazine (MMN)–induced seizures in SMR–trained animals. Attempts to extend the feelings to clinical work with humans were successful (Sterman & Friar, 1972; Sterman, Mc Donald, & Stone, 1974; Sterman, 1973). However, other studies (c.f. Mostofsky & Iguchi, 1982; Mostofsky & Balaschak, 1977) produced mixed results and noted increased seizure activity when SMR biofeedback training was stopped.

As with many of the other procedures; relatively little work has been done with children using SMR biofeedback training. On such study, however, is reported by Finley, Smith, & Etherton (1975). The subject was a 13–year old boy with a history of seizures dating from age 20. The training procedure employed was similar to that utilized by Sterman. The subject was reinforced with money for every 5 sec of uninterrupted SMR activity. The detection of a spike and/or a wave discharged was followed by the appearance of a red light. The subject attempted to turn out the red light and to keep it off as long as possible. The results showed that the boy's SMR activity increased from 10% to 65% as a function of biofeedback training. A concomitant reduction in seizures was noted.

4. **HYPERACTIVITY IN CHILDREN & BIOFEEDBACK:** It is estimated that from 3% to 10% of school children demonstrate enough problem behaviors to be classified as hyperactive or hyperkinetic, and males are so diagnosed more often than females [Office of the Child Development, 1971; Sleator, Von Neuman, & Sprague, 1974].

Brand, Lupin and Braud (1975) use Biofeedback technology for removing this disorder. The subject was a 6–5 year–old hyperactive boy exposed to 11 sessions of frontalis electromyographic (EMG) biofeedback. The child was instructed to turn off the tone that signaled th4e presence of muscle tension. Muscle tension, as measured by the EMG, and overt activity decreased with in and across sessions. The authors noted that the child was able to control his hyperactivity during a 7–month follow up [Kazdin, Bellack, and Hersen (1982)]. Improvements were also noted on achievement tests, reports of self–confidence, and behaviour at school and at home.

5. **HYPERTENSION:** This disorder, which is just another name for high blood pressure causes dizziness and nausea and is a serious problem for many people in that it may culminate in cerebral vascular accident (strokes) and death. Following the leads of others who have applied operant techniques to modify autonomic functions (Miller et al., 1970), David Shapiro of the Harvard Medical School demonstrated that human beings can be taught, through operant biofeedback procedures, to raise or lower their blood pressures.

In one such study [Shapiro et al., 1970], Shapiro worked with 21 male college students, each of whom was laced in a light–and sound–

proofed room. A conventional blood pressure cuff was wrapped around the upper arm of the student and a crystal microphone was mounted in the cuff to amplify sounds from the brachial artery. A red flashing light also signaled lowered blood pressure. The sounds gave information about relative upward and downward changes in systolic blood pressure. Under on of the reinforcement conditions studied, subjects were rewarded for lowering their pressure. The reinforcer was a slide projected on a screen, and subjects were told that successes, (lowered pressure) would be rewarded by viewing slides of nude females and by receiving bonus sums of money in addition to the three dollars an hour they received for participating. Almost all subjects learned to lower their blood pressure under these circumstances and learned how to control their blood pressure by themselves. The work to be pursued now, according to Miller and his associates, "might best to carried out in hypertensive patients or in older persons in whom blood pressure levels are much higher and the possibility of sizable reductions might be greater than…normal college students" [Shapiro et al., 1971, p. 398].

6. **OVERCOMING SEXUAL PROBLEMS:** At least one study (Csillag, 1976) indicates that biofeedback may even aid individuals in overcoming sexual problems. In this experiment, men who experienced difficulty in maintaining erections were shown erotic slides–pictures of couples making love–and were asked to try to achieve an erection. During this time, they also received biofeedback of two types. First, they heard a tone which rose in pitch as penis size increased. And second, they saw a meter, which provided information about the size of their erection. Over the course of the study, subjects learned to achieve erections. Unfortunately, no control group, in which subjects did not receive biofeedback, was included. Thus, the results are not as conclusive as we might wish. The changes observed in subjects' behavior, however did seem to be of practical value. Five of the six participants reported that as a result of their training, they became able to function sexually. Together with the results of many other studies, these findings suggest that biofeedback may often be useful in helping individuals to overcome several kinds of personal problems.

REMARK

We should note, however, that so far most of these findings have been obtained only under controlled laboratory conditions. The extent to which they can be applied to actual medical practice is yet to be determined. In particular, it is uncertain whether the changes produced through biofeedback will be large enough to be of practical importance. And it is not yet clear that they will persist over relatively long periods of time [Melzack, 1975; Miller, 1978].

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