As we have seen, Dr. Green's approach to biofeedback was not just mechanical, but instead concerned human empowerment. These matters are discussed in detail by Patricia Norris in the paper below. [Eds.]

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The following article appeared in: Anees Sheikh, Ed., ***Eastern and Western Approaches to Healing*** *(John Wiley & Sons, New York, NY, 1989), pp. 264-295.*

CURRENT CONCEPTUAL TRENDS IN BIOFEEDBACK AND SELF-REGULATION

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> The spirit is the master, imagination the tool, and the body the plastic material . . . The power of the imagination is a great factor in medicine. It may produce diseases in man and in animals, and it may cure them. . . . Ills of the body may be cured by physical remedies or by the power of the spirit acting through the soul."
>
> —Paracelsus, Father of Modern Medicine

The field of biofeedback, formally, is about 20 years old; the term "biofeedback" was coined at the first meeting of the Biofeedback Society of America (then named the Biofeedback Research Society) in 1969. However, the first psychophysiology experiment using biological feedback to the subject was probably that conducted by J. H. Bair at the turn of the century.[1] He undertook a study to teach subjects to activate the muscles used to wiggle their ears. Using mechanical levers that transmitted a tiny pressure change to a steel pen that scratched paper on a revolving drum, he provided the subjects with immediate feedback of their efforts. Soon they were able to learn to twitch their ears. He also recorded careful introspections of the accompanying mental states. Bair conducted the study because of his interest in volition and his desire to explore the nature of the will.

For most of this century there was little interest in volition, awareness, and introspection. A resurgence of these interests in the early sixties led to the exploration of self-regulation using feedback. Presently biofeedback work, especially in research, is conducted under two separate and distinct conceptual paradigms: (1) the drug and operant conditioning model and (2) the

self-regulation model. The drug model and the operant conditioning model of research assumes that 'specific effects' of biofeedback can and should be studied independently of subject variables such as expectations, instructions and strategies, and relaxation.[2] This dualistic approach, which tries to separate any mental and psychological events from the biological changes being monitored, is in contrast to the self-regulation model, which is based on the principles that psyche and physiology are inseparable, that any perturbation of one results in comparable and complementary change in the other, and that this fact must be taken into account in any research or clinical therapy with biofeedback.

Clinical work, too, has been provided under both these models, but it seems clear that as clinicians continue the use of biofeedback in therapy, they move more and more into the area of self-regulation. With the advent of a capacity to provide moment-by-moment biological feedback, certain distinctions existing previously in modern, Western scientific paradigms—distinctions between conscious and unconscious processes, between cortical and subcortical processes, between the voluntary and involuntary nervous systems-are being eroded. Control of the autonomic nervous system is no longer conceptualized as being only unconscious and involuntary. Self-regulation and voluntary control have a history that goes back thousands of years and has roots in both the East and the West. In the last decade, advances in physical and biological sciences have begun to elucidate the mechanisms necessary to transform these long-standing empirical sciences into modern technological science. In this chapter, some of these conceptual trends, connected with the self and with volition, will be explored and the importance and usefulness of this approach will be discussed.

Emotion, Cognition, and Volition

In the past decade there has been an explosion of new research and new knowledge in the areas of brain biochemistry and neurobiology highlighted by the discovery of the endorphins and a myriad of neuropeptides. The role of the limbic system and the hypothalamic-pituitary axis in human emotions, as well as the biochemical basis of these emotions, and their integration with higher cognitive functions is beginning to be understood. It is the limbic-hypothalamic-pituitary axis that has been conceptualized as the biologic

basis, the rationale, for the mediation of biofeedback-assisted self-regulation.[3] It is commonly accepted that emotional states have a role in health and disease and in immune functioning. It is now becoming evident that the neuropeptides provide a physiologic basis for emotions. Very recent discoveries have shown that the neuropepticles are "immunopeptides" as well—that is, the cells of the immune system not only have receptors for the various neuropeptides, but they also make these neuropeptides themselves.[4]

A new field of self-regulation, variously termed "psychoneuroimmununology," "neuroimmunomodulation," or, more simply, "behavioral immunology"—mind and immunity—sheds new light on the old mind-body problem. Self-regulation, learned with biofeedback and visualization, demonstrates that what we think and feel and visualize have biological consequences that can promote healing. Biofeedback provides the modern, technological objectification and verification of the effects of emotions, cognitions, and visualizations on physiological processes, which in turn mediate visceral behavior and immune system behavior.

To a certain degree, concepts of biofeedback and self-regulation training combine Eastern and Western approaches to healing. The present trends in biofeedback therapy are both a reflection of and a contribution to current trends in self-regulation therapies. This is especially true of the psychologies related to healing and psychophysiological psychotherapy. The renewed interest in psychosomatic medicine and the emerging and rapidly expanding field of psychoneuroimmunology attest to the fact that the psyche is reemerging in psychology.

It has been said that in an attempt to separate itself from religion and to emulate physics and hard science, in the old Newtonian model, psychology first lost its soul, then lost its mind, and finally lost consciousness! But now, it seems, psychology has regained consciousness and is awake and moving again.

Consciousness has reentered the theoretical framework of behaviorism in cognitive-behavioral therapy. The cognitive therapy movement has its basis in the view that beliefs interact with situational factors to result in feelings and behaviors.[5] For Beck and Emery, cognitive-behavioral therapy consists of a series of strategies to correct distorted and maladaptive thinking, to restore

health and healthy homeostatic functioning.[6] The therapy is based on a theory of psychopathology that recognizes the reciprocal relationship between the cognitive, emotional, somatic, and behavioral systems. This is similar, in the mind-body connection, to the psychophysiological principle stated by Green and Green as part of the rationale for psychophysiological self-regulation (PSR):[7]

> Every change in the physiological state is accompanied by an appropriate change in the mental-emotional state, conscious or unconscious; and conversely, every change in the mental-emotional state, conscious or unconscious, is accompanied by an appropriate change in the physiological state. . . . This [closed] principle, when coupled with volition, allows a natural process-psychosomatic self-regulation to unfold. (pp. 33-34)

Self-regulation has been a part of the lexicon of biofeedback training and therapy since the term "biofeedback" was first chosen in 1969 to describe the investigations into voluntary control of various internal processes.[8-18] Much of the early work was collected in the Aldine Annuals under the title 'Biofeedback and Self-Control.'[19] The Biofeedback Society of America titled its journal *Biofeedback and Self-Regulation.* In an editorial in the journal's first issue, Johann Stoyva (1976) defined self-regulation as "the endeavor to modify voluntarily one's own physiological activity, behavior, or process of consciousness."[(20,p.2)]

The Idea of a Volitional Self

It has not been obvious to everyone working in the area of biofeedback what has always been implicit in the idea of *feedback*—namely, that feedback is feed-back to a *self* and that voluntary control over usually unconscious autonomic processes, autonomic self-regulation, by definition means conscious self-regulation. If it is not conscious, it is not intentional, and if it is not intentional, it is not voluntary control.

The study of consciousness and volition is playing an increasingly important role in the behavioral sciences. Although controversies are not all resolved, concepts of a volitional self permeate the paradigms of all the behavioral sciences. In psychodynamic psychotherapy, a psychology of the self is articu-

lated by Heinz Kohut.[21] In *The Restoration of the SELF,* Kohut and his followers place the self at the center of personality development and example the role of the self in health and disease. Concepts of consciousness, belief, meaning, and volition in theories of behaviorism and cognitive behavior therapy are compared and contrasted by top practitioners in these fields.[22] For comprehensive examinations of the importance of self, consciousness, and volition in biofeedback training and psychophysiological therapy, see studies cited in references.[2,3,7,12,23-25]

. . . It is becoming apparent, and acceptable, that consciousness and volition are the most essential factors in developing self-regulation skills in the central nervous system, regardless of which neurologic and biochemical mechanisms of the body and brain are employed. This is equally true of striate and neuromuscular skills and of smooth muscle and autonomic skills. Memory in the body is not really in the tissues, for either type of activity, but is stored in appropriate brain centers. [New evidence concerning cellular memory and cellular communication is demonstrating that memory *is* in the body as well as in the brain. –Eds.] Whether we are learning to walk, serve a tennis ball, decrease gastrointestinal motility, or regulate heart rate, we are not really training our body, we are training our brain. We are gaining cortical control over subcortical processes. We are learning to exert conscious control over the unconscious. . . .

Hierarchy of Self-Regulation

The scientific study of self-regulation in western European societies began around the middle of the 19th century, when medical and biological scientists turned their attention to hypnosis, self-suggestion, and the scientific study of learning. Although I. P. Pavlov is best known for his work in classical conditioning, according to A. S. Romen, a Russian psychiatrist, his investigations were particularly significant in structuring a scientific approach to psychophysiological self-regulation. He proposed and supported a materialistic basis for the study of hypnotic suggestion and self-suggestion. He addressed the problem of sleep and the physiological understanding of hysteria.[26,27] Clinical hypnotists such as Janet, Charcot, and Mesmer laid an early foundation for psychophysiological change resulting from hypnotic

suggestion, and during the first half of this century scientific study of self-regulation through voluntary control of internal states got underway.[28-30] Hypnosis as a therapeutic tool is again gaining prominence and is frequently used in combination with biofeedback and other psychophysiological therapy techniques.[31,32]

Healing that takes place with biofeedback-assisted self-regulation is sometimes dismissed as a suggestion effect or as a placebo effect. This, however, does not really constitute a dismissal. Neither the *power* of suggestion nor the placebo effect is a fake. The power of suggestion lies in the physiological changes that take place as a result of it; and the *effect* of the placebo is the physiological effect that occurs as a result of what the recipient believes the placebo to be. Any internal physiological response to hypnotic suggestion, to a placebo, to self-hypnosis and self-suggestion, and to an image or visualization, is a self-regulation response. What differentiates them is the degree of conscious volition or intentionality employed. We can think of these in terms of a hierarchy of self-regulation, with the position on the hierarchy determined by the degree of awareness and volition; at the top of the hierarchy lies voluntary control.

Placebo Effect as Self-Regulation

Placebos are, by definition, inactive. But the placebo effect is both active and specific. The same inactive ingredient—a "sugar pill"—can cause nausea and vomiting when posing as an emetic, pain relief when posing as an analgesic, sleepiness when posing as a hypnotic, and wakefulness when posing as an amphetamine. The reaction, of course, is caused by the "name"—the meaning—given to the placebo and by the ensuing visualization and expectation of the named change occurring, not by the contents of the pill.

In one well-known experiment, a group of women with continuous, severe morning sickness were given either an antiemetic or a placebo. A number of the women responded to the placebo with cessation of the nausea and vomiting. In the next phase of the experiment, these women were given ipecac, a powerful emetic, still under the guise of an antiemetic, with no return of their nausea. Their self-regulation, brought about by visualizing the cessation of nausea, had more powerful effects than the emetic.

Effects on Physiology of Suggestion

Suggestion can have a powerful effect on physiology if it is accompanied by belief. A person may start sneezing on seeing a bowl of artificial flowers of a type to which they are allergic, because they believe them to be real. Upon learning that they are artificial, the sneezing stops. In the first instance, the person visualized an allergic reaction, and the lower brain centers, which control that reaction, responded with the same neurohumoral sequelae that accompany exposure to an actual antigen. In the same way, healing suggestions can have remarkable effects. In the introduction to *The Healing Heart*, Bernard Lown describes a patient who was critically ill with irreparably damaged cardiac muscle following a massive heart attack.[33] With congested lungs, uncontrollably rapid heart rate, chaotic arrhythmia, and labored breathing, he required both oxygen and an intravenous drip of cardiac stimulant to keep him alive. On rounds at his bedside Dr. Lown told his attending staff that the patient's heart had a "wholesome, very loud third sound gallop," which denotes that the heart is straining to the point of failure. Following this, the patient unexpectedly improved and was discharged from the hospital. Later Dr. Lown asked him about his "miraculous" recovery, and he responded that he not only knew what had happened but even the exact moment when it happened.

> I was sure the end was near and you and your staff had given up hope. However, Thursday morning when you entered with your troops, something happened that changed everything. You listened to my heart; you seemed pleased by the findings and announced to all those standing about my bed that I had a wholesome gallop. I knew that the doctors, in talking to me, might try to soften things. But I knew they wouldn't kid each other. So when I heard you tell your colleagues I had a wholesome gallop, I figured I still had a lot of 'kick' to my heart and could not be dying. My spirits were for the first time lifted, and I knew I would recover.

The perceived suggestion changed his belief, his visualization, and his heart behavior.

Barber made a thorough review of 30 years of research using suggestion to alter physiology, culminating with the unambiguous conclusion that words can direct specific autonomic physiological events.[34] It seems clear that autonomic physio-

logical control by suggestion is mediated in the same way that physiological control is mediated under any other circumstances, by the same limbic-hypothalamic-pituitary mechanisms that always mediate the autonomic process. As Green has pointed out, these lower brain centers behave in the same way (except perhaps in degree) whether the brain sees danger, thinks it sees danger, or imagines it sees danger.[23] In other words, perception of an object and the image of that object are neurologically similar events in the cortex, and the lower brain centers cannot tell the difference.

Hypnotic Self-Regulation

In a hypnotherapy workshop conducted by Erika Fromm and Daniel Brown, I saw a wonderful film of a Cesarean section conducted with hypnosis, with no local or general anesthetic. The obstetrician performed both the surgery and the hypnosis, telling his patient just what he was doing as he was doing it and maintaining conversation with her. At the point when he was ready to open the uterus and lift out the baby, he informed her that he was ready to do so and would be very busy for the next few minutes but did not want to lose communication contact. He asked her if she could sing a song to welcome her baby into the world, which she proceeded to do, without a quiver in her voice.

Dentists have frequently used hypnosis to help patients experience pain-free extractions and fillings. During World War II, when narcotics were not always available, this was commonly practiced among military dentists. It was then a simple matter to add the instruction that there would be little bleeding and rapid healing, and indeed these patients did bleed less and did heal more rapidly than those receiving traditional anesthesia. At the Third International Congress on Ericksonian Approaches to Hypnosis and Psychotherapy, Kay Thompson, a Philadelphia dentist, reported that people with hemophilia, whose blood normally did not clot, could prevent themselves from bleeding during surgery and extractions, using self-hypnosis. Since it has been shown that with the aid of biofeedback both increase and decrease of blood flow to an area can be learned, such training could prove useful to individuals with hemophilia.

Theoretically, any process that can be controlled by hypnosis also can be controlled voluntarily without hypnosis. Obviously, the obstetrician had no

internal control of the patient's body; the patient herself was controlling the internal events (relaxation, absence of pain) by self-regulation. In practice, however, it would be most difficult and beyond the capacity of most of us without training to undergo major surgery without either anesthesia or hypnosis. On the other hand, many people have learned to control the pain of minor surgery, dental procedures, and so on. When Jack Schwarz gave a demonstration of control of pain and bleeding at the Veterans Administration Hospital in Topeka, thrusting the large sailmaker's needle through his biceps, the feat was duplicated by a psychiatrist with only a slight prompting from Schwarz in the middle of the experiment, when the psychiatrist momentarily lost concentration and confidence.

Wadden and Anderton found in their review of the clinical uses of hypnosis that suggestion is largely ineffective for controlling behavior involving the skeletal muscle systems, such as eating behavior and smoking; in contrast, hypnotic suggestion does affect physiological responses involving the smooth muscle systems of the autonomic nervous system.[35] For such physiological processes as gastric motility and secretions, cerebral blood flow, bronchial airway activity, and wart remission-all presumably outside an individual's control-verbal suggestions can produce greater physiological change. This general finding was reached by a large number of independent investigators who often noted the greater strength of the positive relationship between suggestion and the change in so-called involuntary processes. Biofeedback clinicians are finding the same thing to be true of visualization and intentionality; visualizations in the form of intentional formulas act with immediacy and directness on autonomic nervous system processes.

Voluntary Control of Internal States

Voluntary control speaks of volition and choice. With biofeedback, the effects of the suggestion, the belief, and the visualization on the internal process being monitored can be seen objectively. An important component of true self-regulation is knowing that we know. This is one of the ways in which awareness is essential to the operation of voluntary control. The ability of conscious intentions to influence the internal process being monitored are instantly available to consciousness. Eventually the person learning self-regulation knows just what to do and how to do it and can bring about the desired physiological change under essentially any circumstances. Psychophysiological self-regula-

tion is really under voluntary control when one can exert this control "in the crunch," when one can warm hands and feet on a ski lift 50 feet above the ground in a cold wind or reduce autonomic arousal on an airplane that has gone into full emergency procedure because of engine trouble. For patients who need to reverse a severe symptom when it suddenly arises, such as extreme tachycardia, a rheumatoid arthritis flare up, or colonic spasm, this degree of voluntary control is essential. The importance of this is clearly illustrated by the following case.

Mary D. is a 35-year-old married professional woman with one child. She has Marfan's syndrome, characterized by tall stature, joint hyperextensability, scoliosis, and ocular and cardiovascular abnormalities. Despite these conditions, she was in good health until she suddenly suffered an "aortic dissection" that occurred while she was driving her car. She managed to stop her car and, realizing no one would stop, rolled out on the highway before she lost consciousness. Shortly after being taken to the hospital, she had open-heart surgery. She received an aortic valve replacement and bypass grafts of her aorta and pulmonary vein. She has a double-barreled aorta resulting from the dissecting aneurysm, which reaches down nearly to the juncture of the femoral arteries. She was referred for psychophysiological therapy by one of her physicians for the amelioration of resulting symptoms (e.g., shortness of breath, loss of stamina, and anxiety). She was initially heavily stressed, fearing that death was imminent. With the aid of biofeedback training, she learned to deepen her breathing, increase circulation to any desired area of her body, and to slow her heart rate. She is now able to control stress reactions and prevent the vasoconstriction that normally accompanies stress and arousal. She has learned to avoid additional strain on her heart and on the aorta, without having to avoid the vicissitudes of life.

At the beginning of therapy, when stress of any sort caused her heart rate to increase noticeably, she could hear her heart rate increase, which would cause fear and panic. The sound made by her artificial aortic valve is clearly heard by anyone sitting next to her and sounds quite loud internally. Hearing this increase would cause her heart to beat faster still, and a vicious circle of anxiety and accelerating heart rate would ensue. At these times, she would feel quite out of control and at the mercy of her body. During self-regulation training, as she gained confidence in her ability to control autonomic symptoms of stress, the situation changed. Now when she hears her aortic valve speeding up from

stress or anxiety from any source, she almost always can reverse it by using self-regulation strategies she has learned (e.g., deep diaphragmatic breathing, peripheral vasodilation, and visualizing a calm and steady heart beat). For the most part, she feels in charge of her body's responses.

This degree of voluntary control is useful, and often necessary, to achieve. We have the potential to achieve this level of control over many autonomic processes, and thereby we can develop a much heightened sense of our own autonomy, healing ability, and self-mastery, psychologically as well as physiologically. . . .

Voluntary Control and Healing

In the present decade, self-regulation strategies have found their way into virtually every clinical area, including both medical and psychological treatment. In fact, it is as mistaken to say that an illness is strictly physical or strictly psychological as it is to separate the mind from the body in a dualistic manner. The psychophysiological principle previously stated affirms that even a broken leg or any other physical malady resulting from an accident will generate mental and emotional changes that will affect healing. Likewise, every psychological illness is reflected in the body in a myriad of ways.

It has become fashionable to say that biofeedback is disappointing, not living up to its promise, by those ignoring the self-awareness-volition link. Meanwhile as biofeedback training has become more and more identified with self-regulation training and the acquisition of internal skills, a proliferation of biofeedback-assisted self-regulation techniques has occurred in many diverse areas of human health and performance. It would be impossible to cover all of them in this chapter; therefore, only a few areas representative of the changes taking place will be focused upon.

Everyone familiar with the biofeedback literature is familiar with the general postulate that any biological process that can be continuously monitored and fed back to an individual can be brought under some degree of conscious control. So far, I believe, this has been shown to be true. This concept can be expanded and made more specific with the statement that any internal process that can be triggered or controlled by suggestion, perception, experi-

ence of stress, or any psychological process *without* volition also potentially can be brought under *voluntary* control. It is a cortical-subcortical connection that we can learn to make voluntarily. This concept was expressed by Elmer Green: "If there is such a thing as psychosomatic illness, then obviously there is such a thing as psychosomatic health. . . . If we can make ourselves sick [involuntarily), then perhaps we can learn to [voluntarily] make ourselves well."[36]

We have long known that the muscles of the heart, stomach, and intestines have responded to images and emotions; thinking of something frightful leads to fear, which leads to vascular and intestinal responses. Biofeedback is showing that these same 'involuntary' muscles also respond to volition and visualization. Biofeedback is making this knowledge and these abilities accessible to everyone, and biofeedback is making our potential for conscious control of the unconscious scientific, measurable, and verifiable. . . .[25]

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