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Unilateral skin temperature control examined across method of training, type of feedback, and locus of control

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UNILATERAL SKIN TEMPERATURE CONTROL EXAMINED ACROSS METHOD OF TRAINING, TYPE OF FEEDBACK, AND LOCUS OF CONTROL

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TABLE OF CONTENTS

Abstract

Thirty-six undergraduate students were selected as subjects according to their scores on the 29-item Rotter Locus of Control Scale. Each subject was placed in either a correct, false systematic, or no feedback condition, and either an autogenic training or no training condition. Each then received four sessions of skin termperature training, some with a biofeedback monitor. The purpose of the study was to clarify the roles of feedback, training, and locus of control orientation in determining if there was a placebo effect in the acquisition of skin temperature control, the average increase for all subjects was 1.84° C. A three-factor factorial analysis of variance revealed one main effect for locus of control and no interaction effects. A post hoc repeated-measures test designed to measure relative improvement through the training sessions across locus of control revealed no significant differences between subjects. Supplemental *t*-tests revealed that internals performed better with autogenic training than externals, and that internals utilized systematic-contingent false feedback better. Reasons were offered for the findings according to differences in arousal level and personality traits, and it was concluded that the locus of control parameter is a critical variable in biofeedback research.

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

FIGURE PAGE

LIST OF ABBREVIATIONS

Autogenic Training.	AT
Autonomic Nervous System.	ANS
Biofeedback	BF
Biofeedback Conditioning.	BFC
Biofeedback Training.	BFT
Central Nervous System.	CNS
Conditioned Response.	CR
Conditioned Stimulus.	CS
Electrical Brain Stimulation.	ESB
Electrodermal Response.	EDR
Electroencephalograph	EEG
Electromyograph	EMG
External Locus of Control	E
Feedback.	FB
Homeostatic Adaptive Control Mechanism.	HACS
Internal Locus of Control	I
Parasympathetic Nervous System.	PNS
Placebo Effect.	PE
Self-Esteem	SE
Self-Reinforcement.	SR
Skin Temperature.	ST
Skin Temperature Control.	STC
Social Learning Theory.	SLT
Sympathetic Nervous System.	SNS

Unconditioned Response. . . . . UCR

Unconditioned Stimulus. . . . . UCS

Vasoconstriction. VC

Vasodilation. . . . . VD

CHAPTER I

INTRODUCTION

The study of consciousness in recent times began with William James around the turn of the century. Through studying the effects of nitrous oxide on the mind he became convinced that in an altered state of consciousness man is able to understand relationships between events that he would otherwise miss. He believed that these mystical experiences represented to man a deeper sense of reality which heightened man's feelings and knowledge. James noted these feelings in the following:

> . . . .The mind sees all the logical relations of being with an apparent subtelty and instantaneity to which its normal consciousness offers no parallel; only as sobriety returns, the feeling of insight fades, and one is left staring vacantly at a few disjointed words and phrases, as one stares at a cadaverous-looking snow-peak from which the sunset glow has just fled, or at the black cinder left by an extinguished brand (James, 1969, pp. 367-370).

James described these mystical experiences in reference to Unity and communicating directly with God in his religious conversion.

The study of consciousness is central to reaching an understanding of how emotions can affect the mind, and how the mind affects the body. Perhaps the best illustration of this is in psychosomatic (mind over body) medicine because of recent interest in determining to what degree the psyche (mind) can permeate the boundaries of the soma (body) in illness. For centuries medical practitioners have believed that many diseases are due to tissue pathology alone. But through the study of the etiology of neuroses and psychoses, psychiatry has shown that the cause of many diseases is psychopathological at least in part.

Practitioners in this field have emphasized that psychosomatic illnesses are of a psychological origin, and can be dealt with adequately only after the psychological factor is resolved. Thus there is a need to know the specific factors that caused the illness in addition to knowing how to treat it. Basic to the technique of behavioral medicine is the premise that anxiety is the root cause of all psychopathology, and is a prime factor in normal behavior as well. Anxiety is caused by a fear of physical harm or loss of love, and by secondary feelings which give rise to these two factors. Anxiety is expressed physiologically (somatically) in the respiration rate and the autonomic nervous system (ANS), through sweating, increasing the heart rate, blood pressure, and these effects can be felt in many tissues of the body (Weiss & English, 1957).

It has been estimated that between 60% to 75% of all medical problems are either caused or influenced by psychological factors (Brown, 1974). For the remainder of the cases, while it is recognized that foreign agents are responsible for the sickness, the person's emotions can play a large role in treatment progress. A few examples of the types of sicknesses which can result from the interaction of emotional and bodily functions will now be examined.

Functional disorders of the gastro-intestinal tract often center around the abdominal area, and include burning of the gums or mouth, indigestion, diarrhea, constipation, or peptic ulcers. Illnesses in the cardiovascular system include chronic dyspepsia (upset digestion) or dizziness. Disorders in the endocrine and metabolic system include hyperthyroidism (overactivity of the thyroid, or growth gland), chronic fatigue, or diabetes. Problems of this nature in the respiratory tract include a high incidence of the common cold, bronchial asthma, or pulmonary tuberculosis. Effects to the central nervous system (CNS) could include insomnia, headaches, epilepsy, cerebral vascular diseases, or even strokes. Such abnormalities as arthritis, visual or auditory disturbances, baldness, menstrual or child bearing disturbances, or frigidity, could result (Weiss & English, 1957).

For too long medical practice has relied on four curative elements in treatment: (a) re-establishing or revitalizing the body's natural recuperative powers (b) inducing pharmacologic action in the body, (c) making surgical intervention, or (d) relying on the person factor, or the doctor-patient relationship (Birk, 1973). But from this limited method how can a person know with any degree of accuracy how events in his daily life affect his mind, his ANS, and subsequently his health? The government and private industries have given the public statistics concerning such variables as population density, crime rate, and pollution level in cities, and limits are set for all of these factors for which people can coexist comfortably. But how do these factors affect the people when they prevail in moderate proportions? Increases in crime, population, or smog are likely to make people stressful and irritable, but isn't there any other way to combat these forces other than by heart attacks, high blood pressure, headaches, sleepless nights, worry, or crime?

With the advent of Biofeedback Conditioning (BFC) and the realization that the autonomic nervous system was subject to the same basic rules of learning as the voluntary cerebrospinal nervous system (Klinge, 1974), man has for the first time an opportunity to expand his frontiers of knowledge and abilities. Biofeedback (BF) involves countless complex interactions between the higher mental processes of reason and the basic processes of emotion and the body system which are affected. Never before has man had the opportunity to see himself in such a scathed, untouched manner, or to improve the biological activities in his body and ultimately himself to an uncompromised level. This is what the science of BF is about.

Yet the innovation of this entirely different procedure brought with it a host of far reaching claims about the efficacy of the treatment. Stroebel and Glueck (1973) suggested that BF could offer man an ultimate placebo in that it places the burden of the treatment itself squarely on the patient's own shoulders. Such factors as suggestions or expectations can easily influence treatment outcomes. Whether or not feedback (FB) is given, or how accurately it is given, are important variables in discovering whether or not FB is actually necessary. What personality types respond best to BFC is another important variable. These are serious methodological issues which need to be answered within the context of controlled experimental psychology, for it is here that the real effects and hence the true meaning of BFC can be assessed.

CHAPTER II

REVIEW OF THE LITERATURE

General Biofeedback

Biofeedback is derived from the areas of experimental psychology of learning and electrical engineering, and it focuses on the inner determinants, or the biological systems of an organism's behavior. BF can be defined as the process of detecting, amplifying, and feeding back internal physiologic information to an organism by way of monitoring electronic instrumentation in a manner by which the organism can perceive relative changes in these functions. The feedback (FB) can consist of auditory or visual cues for humans and electrical stimulation of the brain (ESB) for animals (Birk, 1973, Brown, 1974; Karlins & Andrews, 1975).

From this information the organism is able to modify internal physiologic processes, many of which were formerly thought to be involuntary or uncontrollable. Good Examples include control of heart rate and blood pressure, which are autonomic functions controlled by smooth muscles located within the organs themselves. Using, as the FB instruments, an electrocardiograph, which measures heart rate, or a sphygmotonometer, which measures tension in the arterial walls or blood pressure, a human can note his own physiologic processes. In time, with appropriate training, the subject can learn to actually control these internal functions to his own advantage. Thus patients with cardiac arrhythmias or premature ventricular contractions are able to control their cardiac rhythms to prevent these dysfunctions from occurring. Similarly patients with hypertension can learn the mechanisms involved in high blood pressure by using the FB monitor, and can eventually control their blood pressure without having to use the electronic monitor at all (Birk, 1973).

The application of FB itself is of course not a new one. The term was coined by Norbert Weiner, a pioneer researcher in radio around the beginning of the 20th century, and he defined it as "a method of controlling a system by reinserting into it the results of its past performance" (Karlins & Andrews, 1975). However, the actual concept of FB, in a general sense, began millions of years ago whenever organisms first began utilizing their senses to control their actions and behaviors. In hunting, for example, man would perfect his spear-throwing ability by feeding back the mistakes of each attempt to throw more accurately the next time. This same basic learning process is still used today. In sports activities, man learns from his mistakes in a trial-and-error manner, and this FB is very helpful in perfecting specific muscle tones and thus his game. Even in cognitive activities that don't require ostensible muscular strength or quickness, such as in learning to play chess or to visually scan pages of printing in learning how to read, improvement is based on information about past performance being fed back so as to improve future attempts.

In 1901, J.H. Bair reported a new approach to the study of muscles, and it is reportedly the first BF experiment in recorded history. He examined muscles in which, through evolution, most people had lost voluntary control, specifically the muscles which wiggle the ear lobe. He assembled a device which fit on the subject's ear lobe and on a small air-filled drum at the other end. This in turn was attached to a second air-filled drum which was connected to another lever that scratched the vibrations on a kymograph according to the specific muscle movements. Probably from some unrelated action, a subject's ear twitched slightly while being monitored by this apparatus. Once the subject noticed the variation in pressure, as scratched out on the paper, he learned to become conscious of the internal process which caused the movement. The important aspect in this pioneer BF study was that although the subject probably spent a good deal of time attempting to wiggle his ears through a variety of means to no avail, once the correct method was learned, he could begin to understand how to selectively control this function. All of the incorrect procedures could then be discarded and forgotten about as soon as the subject saw that it didn't alter the reading of the physiologic measure, the kymograph.

Hans Berger, a German psychiatrist, used the electroencephologram (EEG) to investigate BF. From this he noted the prominence of waves which occurred at a frequency of about ten Hertz (alpha waves) when the subject was relaxed with his eyes closed. He also noted smaller amplitude waves which ranged from 18-50 Hertz (beta waves) when the subject was attentive. He investigated EEG correlates of the effects from general anesthetics, hypoxia, hypoglycemia, epileptic seizures, anoxia, and barbiturate anesthesia, and he went on to propose a physiological model of attention and conscious perception based on his BF research. Other pioneers in this early EEG theater included Lord Adrian, B.H.C. Matthews in England, and Grey Walter (Brown, 1974; Karlins & Andrews, 1975; Thompson, 1975).

From this period around 1934 until 1960 little work was done in BF research, not because its applications were no longer needed but mostly because of a prevailing bias in experimental psychology. A distinction was made by B. F. Skinner in 1938 between two types of learning based on two types of behavior brought out in two discrete conditioning procedures:

conditioning to motor and visceral systems as well. A typical human research project would center on discovering the differences between using interoceptive cues, which are natural receptors located within the body or within an organ, and exteroceptive cues, which are located within the body but are stimulated by physical changes outside of the body (the CR). Using relative changes in the vascular walls as the dependent variable, scientists could determine which cue is the more powerful elicitor of the response (Razran, 1971).

Operant conditioning was first conceptualized by the great experimental psychologist, Edward Lee Thorndike, in the late 19th century, when he studied the trial-and-error escape behavior of cats from confining enclosures. He noted that the particular behaviors of the cats that led to escape occurred more frequently as the cat was put in the identical situation repeatedly. In this paradigm, the organism is rewarded (reinforced) after it makes a specific response which is preselected by the experimenter, and the organism makes the response more frequently in the future as a result (Kamiya, 1971).

Skinner, in the 1930s, expanded the concept of operant conditioning by equating it to what amounted to a reversal of classical conditioning. The method in this learning technique is to let the organism select its own reward from a variety of possible rewards controlled by the experimenter. The organism probes its environment in a trial-and-error manner until it performs some preselected behavior, and it is rewarded. The reward is thus the item which reinforces the given behavior utilized to obtain the reward. Essentially this system parallels classical conditioning by replacing the CR, for example salivation, with reward-seeking behavior emitted by the organism, for example lever pressing.

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" (Green, Green, & Walters, 1970). This principle merely asserts that all learning and sensations are accompanied by physiological reactions occurring in the brain.

Traditionally the peripheral nervous system has been divided into the voluntary nervous system (cerebrospinal) which mediates conscious activities involving primarily the striated muscles, and the involuntary (autonomic) nervous system which mediates control over the smooth muscles which in turn regulates the heart, digestive and vascular systems, endocrine system, and visceral activities. It is hoped that BF research will show that the two nervous systems, just as the two domains of conscious and unconscious activity in the brain, may be governed by different processes but are both influenced by one central learning mechanism (Norris).

A psychophysiological model called the Homeostatis Adaptive Control System (HACS) as proposed by Kenneth Gardner (1971) is shown in Figure 1. This model accounts for interoceptive and esteroceptive systems, the central nervous system (CNS), and how FB is established.

Interoceptive systems refer to stimuli arising within the viscera (ANS), such as thirst or hunger, while exteroceptive systems refer to stimuli which impinge on the organism's senses from the environment, such as through touch, sight, or smell. The CNS, consisting of cognitive and memory functions and the central information processor, acts on and is acted on by the interoceptive, exteroceptive, and muscle systems. The organism acts on its environment only through its muscle system, consisting of voluntary striate muscles, while the environment acts on the organism only through its exteroceptive senses.

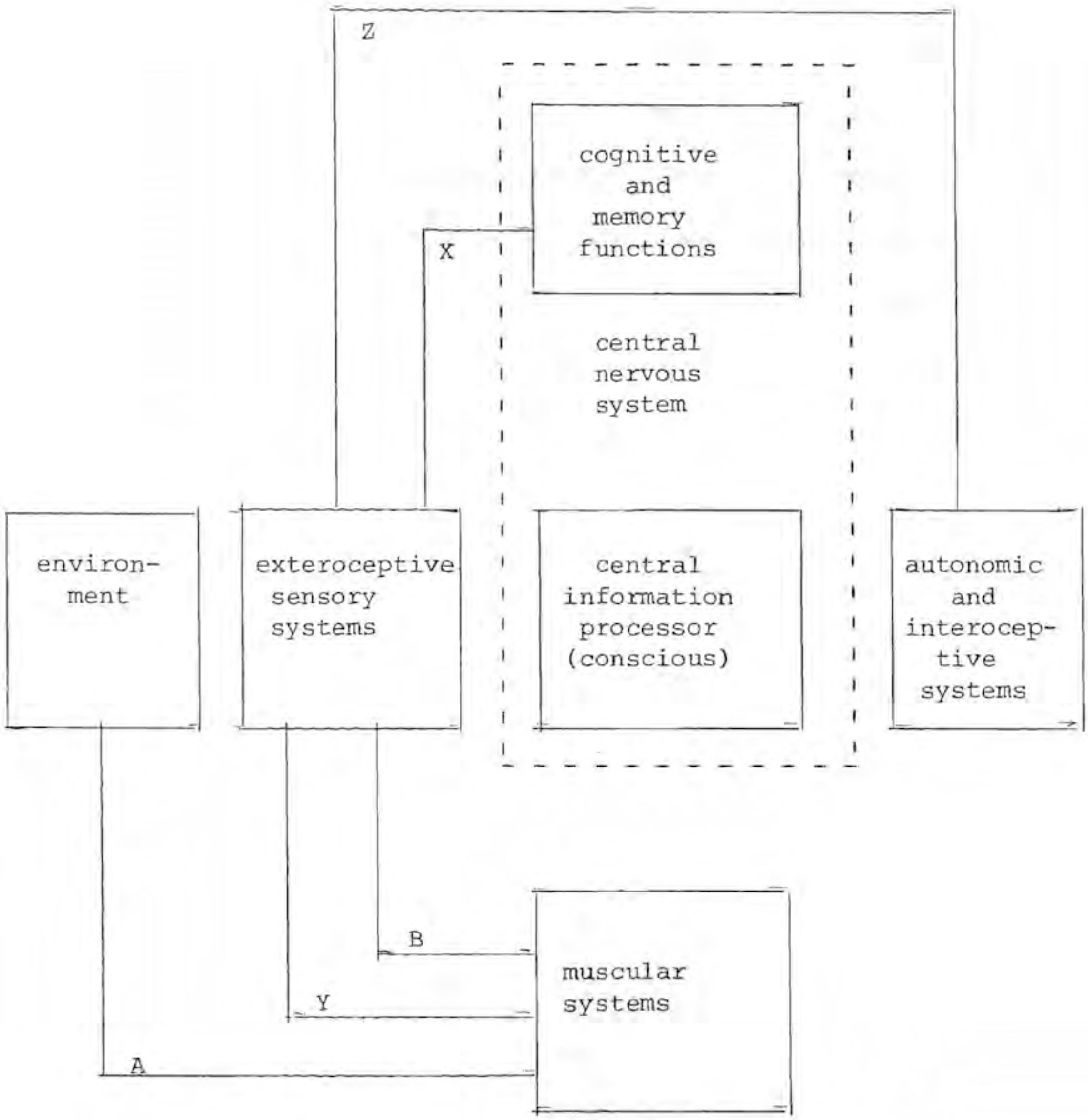

Figure 1. Homeostatic Adaptive Control System

The three FB loops, X, Y, and Z, represent the manner in which information that has already been processed by the organism is fed back to it via the exteroceptive senses. Loop X represents electroencephalographic (EEG) BF showing brain activity; loop Y represents electromyographic (EMG) showing muscle activity; and loop Z refers to autonomic FB showing autonomic and visceral activity playing back on the exteroceptive sensory systems.

and hypothalamic systems normally occur at an unconscious level, as Green (1974) has postulated, man could learn more about how information is processed by the limbic area and the hypothalamus through BF, and perhaps he could even come to exert direct control over these processes.

With this important function of the limbic area, it should come as no surprise that it is said to interact with the subject and the BF monitor. The case and point which most clearly illustrates the effects of emotion is peripheral temperature control, one of the means of measuring blood flow in the peripheral vascular system. It involves a great deal of emotion in trying to control finger temperature for example. In order to warm the fingers, vasodilation (VD or increasing the volume in the blood vessels, must result. And in order for this to happen, peripheral sympathetic outflow must be decreased (Sargent, Walters, & Green, 1973).

The sympathetic nervous system (SNS) and its counterpart, the parasympathetic nervous system (PNS) are the two dividions of the ANS. The SNS is the branch which prepares the organism for danger (called the ergotrophic or emergency branch), and is characterized by such phenomena as an increase in heart rate, sweating, blood pressure, and vasoconstriction (VC) of peripheral arteries. The PNS is the branch which restores the organism to rest or to homeostasis (called the trophotrophic branch). Examples of this include slowing of the heart, VD of the peripheral arteries, decreased sweating and lowering of blood pressure. Vasodilation is caused only by a decreased sympathetic outflow since the PNS has no outlets in the peripheral vascular system (Brown, 1974).

Although the operations of the limbic system occur on an unconscious level, as shown in Figure 2, through BF there is a direct perception of the physiological response associated with the operations of both the limbic area and the hypothalamus. It has been hypothesized that man has direct influence over the functioning of these subcortical areas, as demonstrated by Green's research (1974). What this revolution in the state of the art of neurophysiology means is that man is capable of controlling the way he feels about anything, since the limbic area can itself be modified.

Skin Temperature Biofeedback

Skin temperature control (STC), the specific focus of this project, is a measure of peripheral autonomic responding. Since peripheral skin temperature is a direct function of the amount of blood flowing in the blood vessels at a given locus, this temperature indicates blood volume. The technique for this measurement, called thermometry, consists of sensing the actual temperature on the surface of the skin from a thermistor. Operant conditioning of vascular responding has been well-established using this device (Bertelson, 1974; Danskin, 1973; French, Leeb, & Fahrion, 1975; Green, Green, Walters, Sargent, & Meyer, 1973; Herzfeld & Taub, 1976; Miller, 1971; Mitch, McGrady, & Iannone, 1975; Sargent, Walters, & Green, 1973; Sargent, Walters, & Meers, 1975; Savill & Koppman, 1975; Slattery & Taub, 1976; Roberts, 1973; Snyder & Noble, 1968; Taub, in press).

The principle of BF conditioning is that augmented, or supplemental, FB of one's autonomic functioning increases the subject's ability to control these specific functions. Homeostasis is the tendency of a biological system to remain constant, and peripheral temperature homeostasis is maintained through the blood pumped from the heart to the peripheries via the arteries. The blood then returns to the heart via blood veins, where the hypothalamus in the brain senses the temperature change and acts as a thermostatic regulator. The set-point of the system is 37^{o} centigrade, and a deviation away from this as little as 1^{o} centigrade can be detected and regulated (Thompson, 1975). When the temperature from the extremities registers too high, physiological mechanisms serve to cool these areas. These involuntary devices include a decrease in activity level and muscular tonus, a decrease in the metabolism of stored energy via regulation by the pituitary glands and the hypothalamus, and peripheral VD of the blood vessels to allow heat to dissipate from the blood through skin tissue. When the blood is too cool, the physiological mechanisms of warming include an increase in activity level and muscular tonus, and increase in the metabolism of energy maintained by hormonal influences, and peripheral VC, or narrowing of the blood vessels to conserve heat in the circulating blood (Green & Green, 1974).

This homeostatic system has traditionally been studied in relation to exteroceptive influences, such as from a hot or cold environment, or interoceptive interferences occurring in conjunction with disease or sickness such as a fever causing the body to feel hot. But with the advent of BFT and operant voluntary control over autonomic functioning this picture has changed so that internal events can be fed back to the organism to bring about a change in interoceptive activity. This new system is different mainly in that physiologic changes are not made in response to environmental forces from without, such as a change in climate, or from within, as from an infectious agent coming in contact with the body. Rather the changes are directly mediated by the brain in voluntary control over the ANS.

The method of increasing the temperature of one hand while simultaneously decreasing the temperature of the other has also been studied. This method controls for the same variables as varying the temperature direction of one hand only, plus it provides an immediate index of the subject's ability to modify skin temperature in either direction (Maslach et al, 1972; Roberts, 1973; Roberts et al, 1975).

One well-documented medical application of finger warming is the alleviation of migraine headaches. The location of these attacks is believed to be near the extracranial artery in the forebrain, so VC control of this artery can be very useful in alleviating headache symptoms (Keefe, 1974, Taub, in press). Since the target response for the peripheral ANS is VD while for the temporal (extracranial) artery is VC, several investigators have tested these responses simultaneously (Engel & Schaefer, 1974; Sargent et al, 1972; Savill, 1975) although the findings are inconclusive and more research needs to be done in the area (Engel & Schaefer, 1974).

Some work has focused on the anatomical specificity of vasomotor behavior in the hand. Taub (in press) suggested that the more control a person has over his skin temperature, the more specific that response can become to a particular part of the body. Taub (in press) found only a moderate correlation in temperature change between the FB site at the tip of the finger and a location on the same finger only a slight distance proximal to it. Slattery (1976) reported that when temperature was fed back to the subject from one hand, the other hand changed direction in a similar manner at first. When FB was given from one location in the hand, specificity developed early and progressed throughout training.

From these studies it is evident that subjects can learn succinct control over vasomotor behavior and temperature control in a short time with BFT. Since the sites studied on the hand and on the fingers are all known to provide a reliable index of sympathetic activity, all of the sites are sensitive to emotional influences (Taub, in press).

The manner in which subjects are instructed to regulate skin temperature is another variable which can make a difference in autonomic control. Studies have reported that instructions involving thermal sensations are conducive to raising skin temperature even without augmented FB (Taub, in press). Thermal sensations involve thinking or imagining that heat is penetrating the FB locus. Green (1970) reported that subjects learn STC better if they are instructed to utilize a concept called passive volition, which is a detached objective effortless volition. Green and his coworkers hypothesized that whereas an active volition principle governs the striate muscles, it is necessary for the subject to maintain a passive non-emotional voluntary state of consciousness in smooth muscle control.

Keefe (1974) distinguished between specific instructions, which ask the subject to move the FB needle by changing ST, and non-specific instructions which merely instruct the subject to move the FB needle in one direction. According to this classification scheme, except using the fingers, hands, or the forehead as the target response instead of just the forehead, studies which have utilized specific instructions have unequivocally found that subjects could control skin temperature (Diamond & Franklin, 1975; Gladman & Estrada, 1974; Herzfeld & Taub, 1976; Lynch et al, 1974; Maslach et al, 1972; Keefe, 1974; Roberts et al, 1975; Sargent et al, 1972; Green et al, 1973; Taub, in press). One possible exception is that of Lynch et al (1974) two experiments with adults who could not control to himself after putting himself into a trance, he would not become so dependent on the therapist and could subsequently play a more responsible role in his own treatment.

Following this line of reasoning, Schultz found that subjects who concentrated on verbal formulas suggesting heaviness and warmth in the extremities could induce in themselves a state similar to hypnosis. The key to making this autohypnosis work was passive concentration, which implies a casual, non-directive attitude about the performance and a similar belief about the functional result. This is in contrast to active concentration, in which the person focuses a high degree of attention on the performance and the result of the activity. The effectiveness of AT was found to depend primarily on how well the subject could maintain mental contact with his own body as indicated by the programmed formulae ("My arm is heavy," or "My heartbeat is calm."), and how well the subject could maintain a continuous vision of the autogenic formula in his mind.

Although it takes from four to ten months to accomplish autogenic control, it has been found to provide effective relaxation and treat nervous disorders in about 80-90% of all people, depending on the subject's age, level of development, and intelligence. In relation to STC it has been found that changes in peripheral circulation occur when the relaxation response is utilized, and the changes are greater in the distal (fingers) than the proximal (hand or forearm) areas. In some of Schultz's (in Luthe, 1969) experiments, subjects would increase the skin temperature of their fingers from 2 to 3.5^{O} C while in passive concentration, and the weight of their arms would concurrently increase because of the excess blood in the blood vessels. It was also found that this heaviness of the limbs was associated with a decrease in respiratory rate, heart rate, and blood pressure. These findings demonstrate that an increase in peripheral blood circulation is very closely associated with the relaxation response derived through AT and with other autonomic measures of the same phenomenon.

Green et al (1970) first attempted to systematically combine AT with BFT. He beliefed that when the psychophysiological principle (see page 11) is coupled with volition, it is possible for a person to regulate his own autonomic functioning, making it theoretically possible for him to regulate every psychologic and physiologic process in his body. Green knew furthermore that in the 1930s Schultz had actually already performed a BF experiment in conjunction with autogenic training when he asked subjects to put their hands over their thoraxic regions in order to let them feel their own heart beat to facilitate progress in AT.

Green (1973) believed that passive volition, which is similar to Schultz' concept of passive concentration, could give the subject the opportunity to become a master of his own progress. It is through the concept of visualization in both AT and BFT that a subject can learn how to exert cognitive control over autonomic responding, establishing a sort of mental contact with the body. Maslach, Marshall, & Zimbardo (1973) found that hypnotic induction could aid STC even without BFT because visual imagery and concentration are enhanced.

Using three BF monitors, the electromyogram (EMG) in the right forearm, a thermistor in the right hand, and the electroencephalogram (EEG) to detect alpha rhythms, in conjunction with autogenic-like phrases adapted from Schultz and Luthe, Green (1970) obtained favorable results. Although subjects at first found it difficult to control all of the monitors which contains some active substance but still has no significant effect on the specific problem. This placebo is utilized if it is felt that subjects can initially differentiate between a pure placebo and the active drug purported to be given (by taste for example). Both of these classes of placebos play powerful roles in experimental methodology (Evans, 1974; Luparello, Lyons, Bleecker, & McFadden, 1973; Sternback, 1964).

Because of the current issues prevalent in experimental psychology, such as informed consent and deception, these two classes of placebos are often not well controlled for in research (Miller & Dworkin, 1974). In fact the placebo variable is so powerful and omnipresent in clinical and experimental work that it is said to be difficult to separate the real from the contaminated PEs in virtually any human research (Stroebel & Glueck, 1974). The double-bind procedure, in which neither the subject nor the examiner knows whether the treatment drug is active or inert, is one way to help control for PEs. Yet even when this control procedure is utilized, studies find placebos more effective than the active drugs themselves (Shapiro, 1973).

The third class of PEs is those not utilizing a placebo substance, but a placebo component in the procedure itself, and BF applications would be included in this class. Birk (1973) advocated that research into the PE in BF is not appropriate because the effects of suggestion have a direct and substantive effect on autonomic responding. The demand characteristics of the situation, including attitudes and expectations of the subject are immediately revealed in autonomic responding, and they serve to either increase or decrease learning depending on their valence. But this argument in actuality would seem to accentuate the need for study of the past experience (Rotter, 1967). Thus through understanding generalized expectancies in behavior a more accurate attempt can be made to define dimensions of personality as a function of past behaviors and current expectations as well (Rotter, 1966).

The application of how a person perceives reinforcement as a function of his expectancy is a salient issue in BFT, particularly in regard to how the FB is given. If it is accurate FB then internals (Is) would be expected to show better STC since the FB is a direct result of their own forces. However, if the FB is false, externals (Es) could perhaps use this better since they would tend to perceive the reading as an occurrence of chance, and would not allow it to affect their performance as greatly. But since the false FB used in this investigation was systematic, and always varied in the correct direction, improvement was based on skill. Therefore, this difference between Is and Es was thought to be lessened. In the case of no FB Is would be expected to exhibit better STC because, as in correct FB, their progress is based totally on their own skills. The novelty or ambiguity in all of the conditions was expected to enhance efforts at STC in the college sample in all of the conditions. This is because it was considered doubtful that any of the subjects would have had experience in BFT previous to participation in the experiment (as measured by a pretest).

Rotter (1966) studied the effects of partial versus 100% reinforcement schedules with respect to skill versus chance determination. In the skill condition the 100% reinforcement schedule led suprisingly to slower extinction than the partial reinforcement schedule. However, in the chance condition the 100% schedule produced extinction quicker than did the

TABLE 1

PERSONALITY TRAITS ASSOCIATED WITH INTERNAL AND EXTERNAL LOCUS OF CONTROL

Author	Internals	Externals
Rotter (1966)	Dominance, Tolerance, Good Impression, Sociability, Well-Being, Intellectual Efficiency, Achievement via Conformance	Negative on all of these traits
Williams (1969)		Resentment, Suspicion, Aggression, Hostility, Indirectness, Irritability
Hersch & Scheibe (1967)	Defensiveness, Achievement, Dominance, Endurance, Order, Low on Succerance and Abasement, Clever, Efficient, Egotistical, Assertive, Perservering, Determined, Dependable, Enthusiastic, Independent, Self-confident, Industrious, Hard-headed, Ambitious, Ingenious, Insightful, Organized, Stubborn, Conceited, Reasonable.	Self-pitying
Heaten & Duerfeldt (1973)	Hi Self-reinforcement (SR) Hi Self-esteem (SE)	Low Self-reinforcement (SR) Low Self-esteem (SE)
Albert & Dabbs (1970)	Adopt smaller personal space	Adopt larger personal space
Strickland (1965)	Politically active	

Phares (1968) suggested that there is no difference in initial rate of learning between Is and Es, although Is show a tendency to associate items better. Davis (1967) found that while Is sought more information in ambiguous circumstances than Es, in chance conditions there was no their heart rates. Is on the other hand are thought to approach the conditioning task with an internal cognitive set, which produces heart rate speeding (or VC). Mental activity, such as problem solving or reading silently, produces an increase in heart rate, so perhaps Is are more likely to engage in problem-thinking than Es generally.

Gatchel (1975) found a regression toward the mean in scoring, which is a statistical phenomenon found when extreme scores which deviate markedly from average scores are selected for treatment. Upon retesting these extreme scores do not deviate so markedly in either direction, or the worst scorers get better while the best scores get worse. The reason for this regression is unclear, and is thought to occur because of imperfect measuring instruments utilized from the first test to the second (Isaac & Michail, 1972). In the current study a comparatively small sample of males and females (N=30) is used, so the scoring distribution on the pretest criterion, the 29-item Rotter scale, was unreliable. Consequently, the cutoff points for males and females in this study will be the means in each distribution in the standardization sample. This way even though the 29-item Rotter scale is probably an imperfect measure of locus of control, the phenomenon of regression will not be a problem since all scores would be eligible for treatment.

From these data it appeared that there are certain common qualities between the way a person's expectancies are balanced with his actual performance (placebo reaction) and the way he perceives reinforcement as being contingent on his own behavior or chance (locus of control). It was thought that when a person's expectancies are too high in accordance with his BFT, or when his initial conception about what to expect (instructional expected to promote learning better than either the correct FB-NoAT or the false FB-NoAT groups. In the NoFB groups, the AT condition was expected to be more effective than the NoAT condition.

It was also predicted that there would be no significant difference in the acquisition rates between Is and Es across all but three of the conditions. Es were expected to make better use of both AT conditions, since they were thought to be more influenced by outside stimulation (Frank, 1974), and false FB. Thus Es would probably excell in the false FB-AT condition. Because of their higher levels of SE and SR (Heaton & Duerfeldt, 1973), Is were expected to perform better under the conditions of correct FB-NoAT and NoFB-NoAT.

Formal Null Hypotheses

Hypothesis I: That there will be no significant difference in the group means between those who receive systematically correct FB, those who receive systematically false FB, and those who receive no FB.

Hypothesis II: That there will be no significant difference in the group means between those who receive autogenic training and those who do not receive autogenic training.

Hypothesis III: That there will be no significant difference in the group means between those with an internal locus of control and those with an external locus of control.

Hypothesis IV: That there will be no significant difference in the group means between the conditions in which subjects receive or do not receive FB and whether or not they receive autogenic training.

Hypothesis V: That there will be no significant difference in the group means between the conditions in which subjects receive or do not receive FB on how they perceive their locus of control orientation.

Hypothesis VI: That there will be no significant difference in the group means between whether or not the subjects received autogenic training on how they perceived their locus of control orientation.

Hypothesis VII: That there will be no significant difference in the group means between the conditions in which subjects receive or do not receive FB on whether or not they receive autogenic training according to how they perceive their locus of control orientation.

Significance of Study

This study was aimed at clarifying what role FB and autogenic training play in STC BF and what personality types are more influenced by the placebo response. It was hoped to be shown that the nature of the FB and training given in BFT have a high similarity to the nature of the drug and the instructions about what the drug is expected to do, in a drug study.

It was known that the PE is always present in procedures that purport to help patients by giving them something therapeutic or psychotherapeutic (Shapiro, 1973). It was also known that suggestion can serve to facilitate performance or detract from it (Stroebel & Glueck, 1973). The extent to which suggestion (training) can influence the efficacy of the procedure (FB) was examined across how persons perceive their own actions and behaviors or outside influences as responsible for their performances. When these issues are settled, investigators will better understand the necessity of giving training and FB to gain autonomic control and relaxation. The implications inherent in persons achieving autonomic control are great for psychosomatic illness and nervous anomalies in behavior.

CHAPTER III

METHOD

Subjects

The subjects used in this study were undergraduate male and female students at the Kansas State College of Pittsburg in Pittsburg, Kansas.

Apparatus and Materials

The 29-item Rotter Locus of Control Scale is a paper-and-pencil administered test containing 23 scorable items and six filler items. Each item consists of two statements, lettered a or b, from which the testee chooses the statement he feels is more representative of his life style. Each alternative in the scorable items represents either an internal or an external locus of control orientation. As in the Instructions For the I-E Scale (Rotter, 1966), a separate answer sheet (in this case a Standard Test Answer Sheet) is provided for each subject together with the instructions for the test and the three pages of test items.

The temperature Trainer Model number T3-P was manufactured by Systec, Incorporated located in Lawrence, Kansas. It is a precision medium range thermometer with a calibrated linear operating range from 60° F to 104° F, (15.55554° C) (39.99942° C) or a differential temperature of 45° F (7.221974°C) if either thermistor (temperature sensor) exceeds the limits of 60° F to 104° F. Each thermistor is a 1/10 inch diameter lead held inside a protective plastic tube which contains the thermistor probe. The sensitiv area of the probe is 1/8 inch from the tip of the probe, and it is attached to the desired location with a two inch long strip of cellophane tape allowing approximately 1/2 the width of the tape to extend beyond the end of the probe.

The temperature readout is a direct reading dial which indicates temperature change and direction of change with a zero adjust nulling meter which zeros the readout for absolute and differential temperature. The meter scale range can be set to measure $\pm 2.5^{\circ}$ F or $\pm 25.0^{\circ}$ F (1.3889° C) - (13.8889° C) by the function switch. The dial linearity is $\pm .2^{\circ}$ F (0.1111° C), and the accuracy of the 2.5° range is $\pm .05^{\circ}$ F ($\pm .027778^{\circ}$ C) and of the 25° F range is $\pm .5^{\circ}$ F ($\pm .277778^{\circ}$ C).

The 28 Autogenic Feedback Phrases were developed and used by Green et al (1973) (see Appendix A) at the Menninger Foundation, Topeka, Kansas. They were read out to the subject via a cassette tape recorder at the rate of one phrase every twenty seconds for a period of approximately 10 minutes. The tape was made by the examiner.

Procedure

The experimental testing rooms were located in rooms 201 and 202 of Willard Hall at Kansas State College of Pittsburg. All volunteers took the Rotter scale pretest in room 201 and were given the temperature training in room 202. Room 201 measured 10 feet by 17 feet (3.048 X 5.1816 meters) and was equipped with reclining chairs and tables to allow the volunteers a quiet and comfortable environment. Room 202 measured 13 feet by 17 feet (3.9624 x 5.1816 meters) and was equipped with two adjoining wooden desks and chairs with an additional chair located beside the desks. Both rooms had a single window with the window blind partially shut to discourage subjects from looking at moving figures outside the building.

Undergraduate students who volunteered to take part in the experiment were called by the experimenter to work out convenient times to report for training. The training sessions for each subject were for 30 minutes at the same time on four consecutive days, as in the Taub (in press) study. Twenty-four subjects were run during one four-day period lasting from Monday, October 25 through Thursday, October 29, 1976, and 12 additional subjects were run during a second period lasting from Monday, November 1 through Thursday, November 4, 1976. The training times were scheduled every half hour beginning at 8:30 a.m. and ending at 9:00 p.m. Each subject was led to room 201 and asked if he had any history of heart trouble or cardiovascular disturbances, or if he had any previous training in BFC. Any subject answering positively was immediately eliminated from the data before any training.

Each volunteer then completed the pretest after reporting for training on Monday. It was estimated that this scale would take between 10 and 15 minutes to complete, so it would not interfere with the testing arrangements of other subjects on the first day of training. After completing the scale, each volunteer was assigned to a training and a feedback condition (Figure 5, p. 61) on the basis of this score.

Since only 36 subjects were used, the sample was probably not representative of the student population of the midwest region. To control for this bias in sample selection, the same criteria formulated in the original standardization sample (Rotter, 1966) was employed as the cutoff for I/E scoring. Subjects with scores falling above the mean of the standardization scale (mean was 8.42, standard deviation was 4.06 for females; mean was 8.15, standard deviation was 3.88 for males) were designated as externals, while subjects with scores falling below the mean as internals. It was hoped that this selection procedure would yield an approximately equal number of Is and Es.

After arbitrarily assigning a number to each of the three feedback conditions and to the two training conditions, a table of random numbers was used to determine the sequence of feedback conditions given under the methods of training. The sequence of the three FB conditions was determined for each training condition, whichever came first. In this manner the first three volunteers who served as Is and the first three who served as Es were assigned to the first FB-training condition. The second and third groups of Is and Es served in the second and third FB-training conditions. The fourth, fifth, and sixth groups of Is and Es served in the same feedback sequence under the other training condition depending on which method of training was selected first. By this method each of the FB conditions were filled across both training conditions until 36 volunteers were utilized (18 Is and 18 Es).

However, because of this selection procedure, the number of volunteers who scored as Is or Es could not be controlled for. Therefore, if, for example, more than 18 volunteers scored as Es before there were 18 Is, the additional Es could not be used as data and their training would be terminated after the first day.

After each subject completed the Rotter scale, he was led to room 202 for the temperature training. After entering, the subject was taken to the desk situated nearer the door and the examiner sat at the other desk. The desks were adjoined at the back so that subject and examiner were seated face-to-face. The temperature trainer was placed

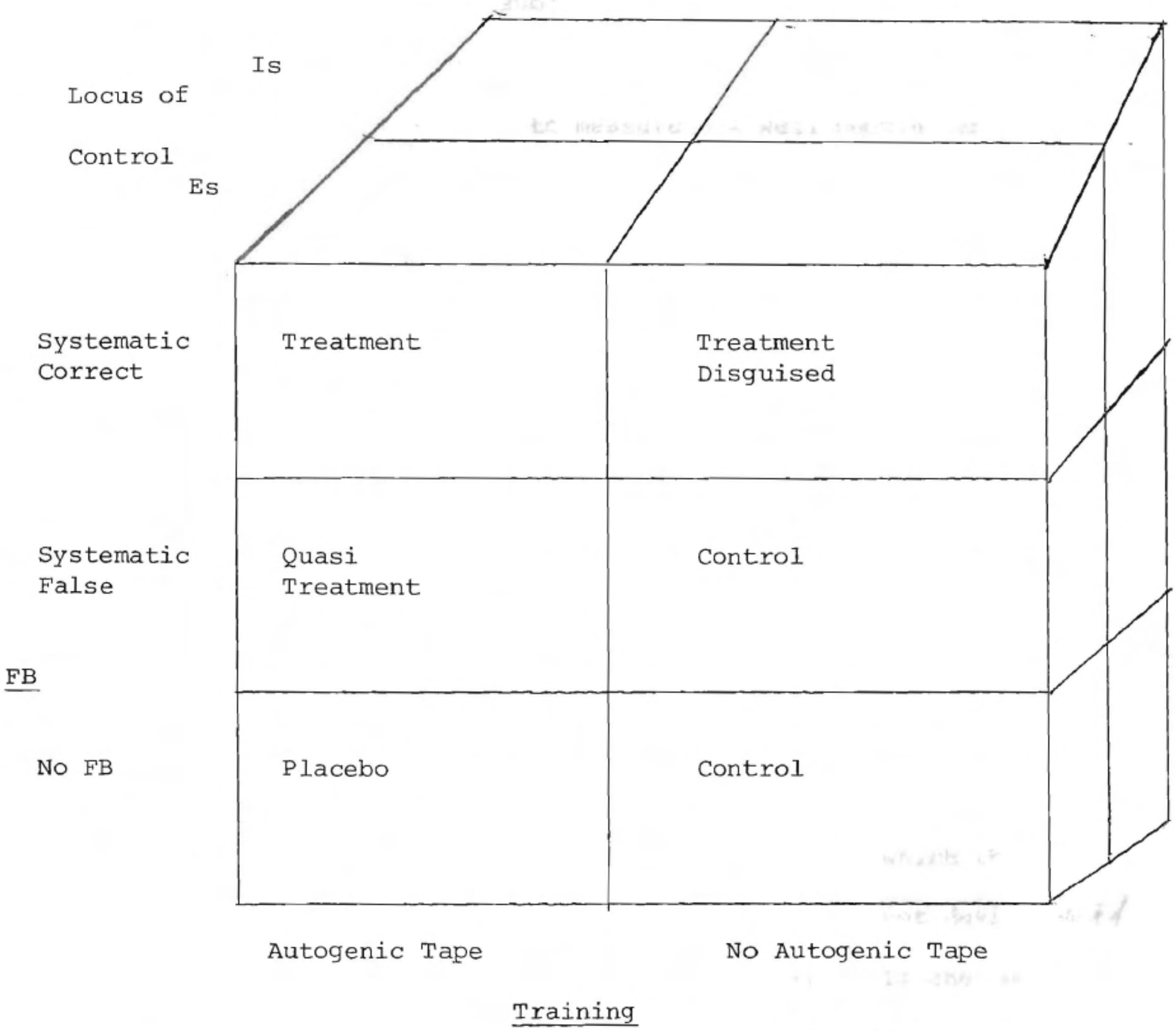

Figure 4. Skin Temperature Biofeedback and Relaxation Training Expressed in a Drug Model

on the examiner's desk facing toward the examiner in all of the FB conditions at this time. All subjects were then given the following instructions by the examiner

> This is an experiment to measure how well people can learn to control the skin temperature in their hands. Specifically, I want to measure how well you can increase the temperature in your dominant middle finger. Are you left or right-handed?

Subjects were then wired with one thermister probe attached with electrical tape to the fingerprint area of the middle finger of the dominant hand. This lead was extended from the warm jack on the temperature trainer, which was still pointed toward the examiner. After zero adjusting both the 25° F and the 2.5° F scales, the examiner recorded the first temperature as the subject's absolute skin temperature. He then gave the subject the following instructions: "Before we begin I will need to take a baseline reading, so please just sit there and try not to move for a few minutes."

This was the eight-minute stabilization period in which the examiner took continuous skin temperature readings until it did not deviate more than $\pm.25^{\circ}$ F (0.1389° C) in four consecutive minutes. If the temperature did not stabilize, the final reading after eight minutes was used as the baseline and training began anyway. The examiner initiated an informal conversation during this period with all subjects. This procedure was essentially similar to that used by Taub (in press).

The Temperature Trainer was then turned around to face subjects in both of the feedback conditions, and subjects were given the following instructions:

> This device is a physiologic feedback or biofeedback monitor which measures the temperature of your finger, and plays back the temperature in degrees on this meter. It is believed that BF

> helps people to learn how to control their internal functions such as temperature control. The meter indicates increases of temperature by moving to the right, and decreases by moving to the left. If your temperature increases two and a half degrees you will need to reset the meter by turning this black knob on the right (indicating) until the meter registers zero in the middle. If your temperature decreases by two and a half degrees you will need to reset the meter by turning this black knob to the left until the meter registers zero in the middle. Now training will last fifteen minutes and I'll be gone during this time. Do you have any questions before you begin?

In all FB conditions the indicators on the function switch and the zero-adjust meter were covered with black paper so the subject could not know which scale the meter was reading out. The meter was set at the $\pm 2.5^{\circ}$ F ($\pm 1.3889^{\circ}$ C) scale in the correct FB condition, and at the $\pm 25^{\circ}$ F ($\pm 13.889^{\circ}$ C) scale in the false FB conditions.

Subjects in the autogenic tape conditions were then given the following instructions: "Now I'm going to play a tape with phrases on it that will help you to relax. After you hear each phrase, repeat it silently to yourself and concentrate on what it says. Okay we'll begin."

To all subjects: "Now please don't fold your hand up, move it around, or blow on the tape during training. Just try to sit still and concentrate."

To subjects not in FB conditions: "Training will continue for fifteen minutes and I'll be gone during this time. So before we begin do you have any questions?"

The examiner then left the testing room to allow the subject to concentrate completely on the task. Fifteen minutes later the examiner returned and noted where the needle was on the meter. Subjects were then asked what mental techniques they used in achieving STC. This discussion lasted for approximately five minutes and it also served to allow the subject's blood to circulate from their extremities to their central regions to prevent fainting when they stood up. The importance of arriving for each session on time was emphasized to all subjects and they were informed that if they missed a session their training would be discontinued. Subjects were asked not to discuss the nature of the experiment with anyone until the training period was completed. The examiner then calibrated the subject's progress and checked the final absolute temperature reading. He subtracted the first reading from this final reading to determine the value of the dependent variable.

In sessions two through five, each subject was reminded that his task was to increase the temperature of his dominant hand when he was attached to the apparatus. Subjects in the FB conditions were reminded how to zero the meter when it registered two and a half degrees increase or decrease, and subjects in the autogenic training conditions were reinstructed to concentrate on the phrases after repeating them silently. Each subject was reminded not to move his dominant hand or blow on it. The examiner then stated that he would be gone during training, and asked if the subject had any questions.

On completing the second through the fifth sessions the examiner again asked the subjects what mental techniques they used to achieve STC, and these reports were kept for final analysis. On the fifth session all subjects were debriefed. Each was told that this was an experiment in learning STC BF; that some of the groups of students tested received FB from the meter while others didn't; that some students received training in autogenic relaxation and others didn't; and that the purpose of the investigation was to find out how useful these methods really were in learning STC. Subjects who received false feedback were told that their progress in the sessions was actually ten times what the meter read. The subject was then asked not to discuss the nature of the experiment if he was in Period I so he would not inform any of the participant in Period II of what was being manipulated.

Method of Data Analysis

After the data were collected and converted to SI units the means and variances for each of the feedback, training, and locus of control groups were calculated (See Table 2) and compared using F tests. Any of the conditions which were significantly different were transformed according to how the distributions were shaped (Wike, 1971). The significance level was set at .05 for all of the statistical treatments.

A three-factor factorial design analysis of variance was then performed on the data (Bruning & Kintz, 1968). This treatment compared the variances of the three feedback conditions with the variances of the training conditions and the locus of control conditions. This analysis of variance adequately tested for the main effects and interaction effects stated in the Hypotheses. Since the focus of this project was exploratory in nature, additional tests were run post hoc according to the main and interaction effects found from the first analysis of variance.

CHAPTER IV

RESULTS

The randomization procedure of the subject-condition-selection proceeded well. The condition selection order was FB-AT, False-FB-AT, NoFB-AT, FB-NoAT, False FB-NoAT, NoFB-NoAT.

All of the data was converted to metric equivalents (Fahrenheit to Centigrade) before any computations were made. A prima facie observation of the data revealed that there was significant learning of STC. The average increase of skin temperature for all subjects was 3.32° F (1.845° C). This compared with increases of 2.2° F (1.22° C) (Taub, 1975), 1.25° F ($.694^{\circ}$ C) (Taub, in press), 1.6° F ($.889^{\circ}$ C) (Keefe, 1974), 2.5° F (1.3889° C) (Taub, 1974), 1.985° C (Roberts et al, 1973), 3° F (1.667° C) (Green et al, 1970), and 2.81° C (Roberts et al, 1975). The average increases for all subjects in their respective feedback, training, and locus of control groups are shown in Table 2.

When the variances for each of the FB conditions within each group were calculated, only the NoFB condition was significantly different F (22)=4.58, (p .02). Since homogeneity of variance is one assumption underlying a test of two independent means, the data were given square root transformations when comparing the FB conditions. *t*-tests revealed no significant differences between the types of FB given.

T Three-Factor Factorial Design analysis of variance was then performed on the non-transformed data (see Table 3) (Bruning & Kintz, 1968). The assumption of unequal variances is mitigated by the randomness of the selection procedure and the equal sample sizes, although the probability of making a Type I error of inference could still exist (Wike, 1971). Although the main effects for type of feedback and method of training were not significant, the main effect for locus of control was, F (1, 24)=5.16, p .045. None of the interaction effects reached significance.

TABLE 2

MEAN SKIN TEMPERATURE INCREASES FOR ALL SUBJECTS, IN THE RESPECTIVE FEEDBACK, TRAINING, AND LOCUS OF CONTROL GROUPS

Feedback	Training: AT	Training: NoAT
Correct	Is 2.139 Es 1.57	Is 2.334 Es 1.338
False	Is 2.247 Es 1.137	Is 1.883 Es .944
None	Is 3.35 Es 2.361	Is 2.009 Es .826

TABLE 3

THREE-FACTOR-FACTORIAL-DESIGN ANALYSIS OF VARIANCE

Source	SS	df	ms	F
Total	56.14394	35	----	----
Feedback	2.04377	2	1.021885	.6295814
Training	3.00734	1	3.00734	1.8528167*
Locus Control	8.36849	1	8.36849	5.1558115
Feedback X Training	3.42777	2	1.713885	1.0559214
Feedback X Locus	0.15436	2	0.07718	0.0475504
Training X Locus	0.05099	1	0.05099	0.0314148
Feedback X Training X Locus	0.13639	2	0.068195	0.0420148
Error	38.95483	24	1.6231179	----

*= $p < .05$

Since the focus of this project was exploratory in nature and the N was relatively small considering the number of variables and conditions tested, trends relating to the I-E parameter were further analyzed. In Figure 5 is a historgram which illustrates how the Es and Is that were accepted as subjects scored on the Rotter scale. There was a tendency for the volunteers to score as Es, and five of them had to be terminated after the first period because the sample cells with Es were filled (n=18).

A Treatments-by-Subjects, or Repeated-Measures Design (Bruning & Kintz, 1968) was then performed on the two locus of control groups as a post-hoc measure. The purpose of this statistical treatment was to measure any differences between Is and Es across the four training sessions. From an initial observation of the data it was felt that, besides actually increasing temperature better, Is would show a greater rate of learning, or improvement, as well. Tables 4 and 5 show the non-significance found here.

Supplemental comparisons using the Newman-Keuls method were made on the I-E parameter to delineate how the two groups differed. Although there were no significant differences in any group means, internals demonstrated a greater overall tendency to learn STC. Internals excelled in all of the NoFB and No Training conditions, but the groups performed similarly when given feedback of either type or training.

Additionally, it appeared that several subjects in some sessions (11% of total sessions for all subjects) would stabilize their temperatures at low levels, while meeting the stabilization criterion. The majority of subjects would stabilize between 80° and 91° F (29.555° and 32.889° C). In fact, 55% of the increases greater than or equal to 5° F (2.778° C) were stabilized at temperatures lower than 85° F (29.555° C). And since most of the temperatures finalized between 90° and 96° F (32.333° and 35.6667° C), including the temperatures that initially stabilized at low levels, the dependent variable could in effect only have measured how low of a stabilization temperature subjects could maintain.

APPENDIX A

Autogenic Training-like Phrases

TABLE 5

TWO FACTOR MIXED DESIGN: REPEATED MEASURES ON ONE FACTOR
EXTERNALS

Source	SS	df	ms	F
Total	176.86241	71	----	----
Subjects	100.26536	17	----	----
Treatments	2.11306	3	.70435	.482278
Error	74.48399	51	1.4604703	----

The mental techniques used by subjects showed nothing conclusive or unexpected. Verbal reports ranged from imagining the fingers hot or the whole body hot, to relaxing or concentrating on stressful situations. Several subjects reported that AT had hindered their progress, but the skin temperature increases for these subjects over the four sessions did not support these claims.

CHAPTER V

DISCUSSION

The first prediction of less learning in the NoFB conditions was incorrect in both of the training groups, particularly in regard to the NoFB-AT group which showed the greatest increase of all the groups. This remarkable turn of events happened because two of the subjects in this group, one I and one E, had low temperature stabilizations. In fact these two subjects comprised 5 of the 16 total sessions of these unexplainable low stabilizations, and both made the largest two increases in skin temperature. Both of these extreme scores, 18.35° F (10.194° C) and 16.5° F (9.1667° C) met the four-minute stabilization criterion employed by Taub (in press) in seven and seven-and-one-half minutes respectively.

Of the eleven subjects who met this low stabilization requirement in at least one session, eight of them later reported to be nervous. Such reports as embarrassment about training performances, or worry and anxiety about school tests were generally found in these instances. Indeed it could have been that subjects who were worried about some matter could manifest low skin temperatures for an extended time. In the 16 sessions involving these eleven subjects, all but three met the four-minute criterion in eight minutes or less.

Except for the NoFB-AT group, the groups scored close to the predicted order. It was surprising that there was no main effect for FB because a significant difference was found in the pilot study in the predicted direction, $\underline{t}(2)=4.486$, $p < .05$. Aside from the methodological flaw in the stabilization procedure, this project did demonstrate that systematic false FB does promote learning of STC. This would confirm Klinge's (1972) and Harris' (1976) hypotheses that the systematically contingent reinforcement can promote learning while randomly contingent reinforcement will not, since there was no main effect for feedback in the current study.

Although there was no main effect for method of training, there was a tendency for the AT groups to perform better than the NoAT groups. This lack of significance is interesting because several of the subjects reported that the phrases were detrimental to progress in the third and fourth sessions as in Bertleson's (1974) and Danskin's (1974) findings. It appears that even with the verbal protests in later sessions, AT can facilitate learning at least comparable with complete silence.

The locus of control variable was the most important dimension in this study. The locus of control main effect indicated that Is can increase their skin temperatures higher than Es. This phenomenon involves decreasing the sypathetic outflow (Green, 1973; Taub, in press), and is associated with a decreased arousal level. This finding is subsequently in contrast with Ray and Lamb's (1974) finding that Es can decrease their heart rates better. It also casts doubt on Fotopolous' (1974) and Ray's (1974) reports that Is can increase their heart rates better, although the current findings do not disconfirm these reports. Budzynski and Stoyva's (1974) finding that Is can reduce tension better is supported.

Is made significantly better use of NoAT than Es as predicted, although both groups performed better with AT. In the false FB-AT condition, Is performed better than Es contrary to the prediction. This finding provides support for James and Rotter's (1958) finding of partial versus 100% reinforcement schedules that Es tend to perceive any partial reinforcement schedule as involving chance determinants. Since the false FB was systematically contingent, skin temperature changes were in fact reflected on the meter, except on an attenuated linear scale. And the reinforcement schedule was not partial, but 100%. If the FB had been random, then the reinforcement schedule would have been at best partial, and Es would have been expected to excel.

The results of this investigation must be interpreted only as indications. As Wike (1971) noted, conclusions are only the result of experimental replications. Although undergraduate students were also used in the standardization sample of the Rotter (1966) scale, it is prossible that the mid-western student population in 1976 is different from this 1966 sample. For example, this population of students could be more externally oriented, as reflected in the higher I-E scores. The volunteer sample used in this study may not be representative of the student population in the mid-west region. Such uncontrolled factors as sex, age, maturity, college major, intelligence, diet, or smoking or drinking behaviors of the subjects could have affected the results. The time of year, middle fall, could have affected the results because of the mid-term tests and term papers generally due in school at this time.

Four students complained of noise from the steam radiator in the experimental room (202) affecting concentration on the first day of training in the first period. But this problem was resolved, and the same four students commented on the quiet environment on the next training day.

This study demonstrated that there is a placebo reaction in BFC. The influences of demand characteristics such as suggestion are thought to be prevalent in BFT, since the group receiving NoFB performed on the same level with the FB groups. Since no Training X FB interaction effect was found, it cannot be speculated that the type of training together with the method of FB produces differences in STC as in the Walsh (1972) study. However, the current study has isolated the person's locus of control as being a critical variable of heuristic value in STC, and presumably other kinds of BFT as well.

Since the NoFB groups performed so well, more thought should be given to the precise role of BFT and relaxation training in autonomic control. The problem of low stabilization levels was thought to be largely due to the subject's own emotional state. Perhaps if this period could be extended commensurate with a 10- or 12-minute criterion, this problem could be eliminated. The question of whether progress in STC is facilitated by the type of instructions, the method of FB, the type of relaxation training, the subject's personality, or some other factors still needs investigation. A replication of the current study with a 20-minute stabilization period and a non-systematic false FB group would shed more light on these problems.

APPENDIX A

(1) I feel quite quiet.

(2) I am beginning to feel quite relaxed.

(3) My feet feel heavy and relaxed.

(4) My ankles my knees and my hips feel heavy, relaxed and comfortable.

(5) My solar plexus and the whole central portion of my body, feel relaxed and quite.

(6) My hands, my arms and my shoulders, feel heavy, relaxed and comfortable.

(7) My neck, my jaws and my forehead feel relaxed. They feel comfortable and smooth.

(8) My whole body feels quiet, heavy, comfortable and relaxed.

(9) Continue alone for a minute.

(10) I am quite relaxed.

(11) My arms and hands are heavy and warm.

(12) I feel quite quiet.

(13) My whole body is relaxed and my hands are warm, relaxed and warm.

(14) My hands are warm.

(15) Warmth is flowing into my hands, they are warm, warm.

(16) I can feel the warmth flowing down my arms into my hands.

(17) My hands are warm, relaxed and warm.

(18) Continue alone for a minute.

(19) My whole body feel quiet, comfortable and relaxed.

(20) My mind is quiet.

(21) I withdraw my thoughts from the surroundings and I feel serene and still.

(22) My thoughts are turned inward and I am at ease.

(23) Deep within my mind I can visualize and experience myself as relaxed, comfortable and still.

(24) I am alert, but in an easy, quiet, inward-turned way.

(25) My mind is calm and quiet.

(26) I feel an inward quietness.

(27) Continue alone for a minute.

(28) The relaxation and reverie is now concluded and the whole body is reactivated with a deep breath and the following phrases: "I feel life and energy flowing through my legs, hips, solar plexus, chest, arms and hands, neck and head. . . The energy makes me feel light and alive." Stretch.

REFERENCE NOTES

1. Holmes, D. S. Personal communication, April, 1976.

2. Phares, E. J. Personal communication, February, 1976.

REFERENCES

Albert, S., and Dabbs, J.M., Jr. Physical distance and persuasion. Journal of Personality and Social Psychology, 15, 265-270.

American Psychological Association. Publication Manual. Washington, D.C., 1975

Benson, H., Beary, J.F., & Carol, M.P. The relaxation response. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, pp. 467-476.

Benson, H., Rosner, B.S., Marzetta, B.R., & Klemchuk, H.M. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, pp. 501-507.

Bertelson, A. Biofeedback: the effects of autogenix and antiautogenic phrases on ability to increase and decrease hand temperature. Paper presented at The Biofeedback Research Society, Colorado Springs, 1974, pp. 1-17.

Birk, L. Biofeedback--furor therapeutics. In Birk, L. Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 1973, pp. 1-4

Birk, L. Biofeedback--specific learning component versus nonspecific learning component (placebo effect). In Birk, L. Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 1973, p. 17.

Birk, L. Migraine headache. In Birk, L. Biofeedback: Behavioral Medicine. New York: Grune & Stratton, 1973, pp. 51-53.

Birk, L. Hypertension. In Birk, L. Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 1973, pp. 133-143.

Birk, L. Epilepsy. In Birk, L. Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 1973, pp. 145-146.

Brecher, M., & Denmark, F.L. Internal-external locus of control and verbal fluency. Psychological Reports, 1969, 25, 707-710.

Brolund, J.W., & Schallow, J.R. The effects of feedback, reward, and locus of control on occipital alpha enhancement. Paper presented at the Biofeedback Research Society, Colorado Springs, 1975, p. 53.

Brown, B.B. New Mind, New Body. New York: Harper & Row, 1974

Bruning, J.L., & Kintz, B.L. Computational Handbook of Statistics. New York: Scott, Foresman Company, 1968.

Budzynski, T.H., Stoyva, J.H., Adler, C.S. & Mullaney, D.J. EMG biofeedback and tension headache: a controlled outcome. In Birk, L., Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 1973, pp. 37-50.

Campbell, H.J. The Pleasure Areas. New York: Delacoure Press, 1973.

Clayman, K.K., & Simkins, L. The relationship of temperature control to menstrual distress. Paper presented at The Biofeedback Research Society, Colorado Springs, 1975, p. 58.

Connon, W.H. Effects of brief relaxation training on autonomic response to anxiety-evoking stimuli. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, pp. 477-486.

Danskin, D.G. Biofeedback in counseling and education. Paper presented at the "Symposium: Biofeedback for Counseling and Psychotherapy," October 10, 1973.

Danskin, D.G., & Walters, E.D. Biofeedback training as counseling. In press.

Davis, M.H., Saunders, D.R., Creer, T.L., & Chai, H. Relaxation training facilitated by biofeedback apparatus as a supplemental treatment in bronchial asthma. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, pp. 513-520.

Diamond, S., & Franklin, M. Intensive biofeedback therapy in the treatment. Paper presented at The Biofeedback Research Society, Colorado, 1975, p. 52.

Engel, B.T. Clinical applications of operant conditioning techniques in the control of the cardiac arrhythmias. In Birk, L., Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 1973, pp. 73-78.

Engel, R.R., & Schaeffer, S. Operant conditioning of forehead skin temperature. In 5th Annual Meeting of the Biofeedback Research Society, 1974.

Evans, F.J. The placebo response in pain reduction. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, pp. 72-79.

Frank, C. Biofeedback applications in rehabilitation. In Franck, C., Norris, P., Lebow, K.E., & Allen, B.L. Applications research of biofeedback in rehabilitative programs in prison settings, pp. 1-4.

French, D.J., Leeb, C.S., & Fahrion, S. Biofeedback hand temperature training in the mentally retarded. In Proceedings of the Biofeedback Research Society, 6th Annual Meeting, Colorado: Biofeedback Research Society, 1975, p. 59.

Gaardner, K. Control of states of consciousness. Archives of General Psychiatry, 1971, 25, 429-447.

Gaardner, K.R. Biofeedback in relation to the placebo effect. In Proceedings of the Biofeedback Research Society, 6th Annual Meeting, Colorado, 1975, 137.

Gatchel, R.J. Locus of control and voluntary heart-rate change. Journal of Personality Assessment, 1975, 5, 634-638.

Gold, D. Some correlation coefficients: relationships among internal-external scores and other personality variables. Psychological Reports, 1968, 22, 983-984.

Green, E., & Green, A. The ins and outs of mind-body energy. In Science Year. Chicago: World Book Annual Field Enterprises Educational Corporation, 1973, pp. 137-147.

Green, E.E., & Green, A.M. Biofeedback and volition. Paper presented at the conference of New Dimensions of Habilitation for the Handicapped, June, 1974, pp. 1-7.

Green, E.E., Green, A.M., & Walters, E.D. Voluntary control of internal states: psychological and physiological. Journal of Transpersonal Psychology, 2, 1970, 1-26.

Green, E.E., Green, A.M., Walters, E.D., Sargent, J.D., & Meyer, R.G. Autogenic feedback training. Paper presented at the 9th International Congress of Psychotherapy, Oslo, Norway, June, 1973.

Gladman, A.E. & Estrada, N. Biofeedback techniques used successfully in psychotherapy. Paper presented at the 21st Annual Meeting of the Academy of Psychosomatic Medicine, Scottsdale, Arizona, November, 1974.

Gladman, A.E. & Estrada, N. Clinical applications of biofeedback in the context of the new medicine. Paper delivered at the First National Congress on Integrative Health, Tuscon, Arizona, October, 1975.

Harris, A.H., & Brady, J.V. Instrumental (Operant) conditioning of visceral and autonomic functions. In Birk, L. Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 1971, 9-16.

Heaton, R.C., & Duerfeldt, P.H. The relationship between self-esteem, self-reinforcement, and the internal-external personality dimension. The Journal of Genetic Psychology, 1973, 123, 3-13.

Herzfeld, G.M., & Taub, E. Effects of suggestion on feedback-aided self-regulation of hand temperature. Paper presented at The Biofeedback Research Society, Colorado Springs, 1976.

Hicks, R. The effects of bogus amounts of perceived success on achieving a desired physiological state. Unpublished thesis, Kansas State College of Pittsburg, Pittsburg, Kansas, 1976.

Houston, B.K. Control over stress, locus of control, and response to stress. Journal of Personality and Social Psychology, 1972, 21, 2, 249-255.

Isaac, S., & Michael, W.B. Handbook in Research and Evaluation. San Diego: Robert R. Knapp, 1972.

Jacobson, E. Progressive Relaxation. Chicago: University of Chicago Press, 1938.

James, W. Subjective effects of nitrous oxide. In Tart, C.T., Altered States of Consciousness. New York: John Wiley & Sons, 1969, 367-370.

Julian, J.W., & Katz, S.B. Internal versus external control and the value of reinforcement. Journal of Personality and Social Psychology, 1968, 8, 1, 89-94.

Katkin, E.S., & Murray, E.N. Instrumental conditioning of autonomically mediated behavior: theoretical and methodological issues. In Biofeedback and Self-Control. Chicago: Aldine Atherton, Inc., 1971, 422-437.

Keefe, F.J. The effects of instructions upon the conditioning of changes in absolute skin temperature. Paper presented at the Biofeedback Research Society, Colorado Springs, 1974.

Kimmel, H.D. Instrumental condition-ng of autonomically mediated behavior. In Biofeedback and Self-Control. Chicago: Aldine Atherton, Inc., 1971, 413-421.

Klinge, V. Effects of exteroceptive feedback and instructions on control of spontaneous galvanic skin response. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1973, 297-310.

Kolb, L.C. Modern Clinical Psychiatry. Philadelphia: W.B. Saunders Company, 1973.

Lasagna, L., Mosteller, R., von Felsinger, J.M., & Beecher, H.K. A study of the progressive relaxation. American Journal of Medicine, 16, 1954, 770-779.

Lichtenstein, E., & Keutzer, C.S. Further normative and correlational data on the internal-external (I-E) control of reinforcement scale. Psychological Reports, 1967, 21, 1014-1016.

Luparello, T., Lyons, H.A., Bleecker, E., & McFadden, E.R., Jr. Influence of suggestion on airway resistance. In Biofeedback and Self-Control. Chicago: Aldine, 1973, 244-250.

Luthe, W. Autogenic training: method research, and application in medicine. In Tart, C.T., Altered States of Consciousness. New York: John Wiley & Sons, 1969, 316-326.

Lynch, W.C., Hama, H., Kohn, S., & Miller, N.E. Instrumental learning of vasomotor responses: a progress report. Paper presented at The Biofeedback Research Society, 1974.

Maslach, C., Marshall, G., & Zimbardo, P. Hypnotic control of peripheral skin temperature. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1973, 429-434.

Miller, N.E. Learning of visceral and glandular responses. In Biofeedback and Self-Control. Chicago: Aldine Atherton, Inc., 1971, 3-25.

Miller, N.E., & Dworkin, B. Visceral learning: recent difficulties with curarized rats and significant problems for human research. In Biofeedback and Self-Control, Chicago: Aldine Publishing Company, 83-103.

Mitch, P.S., McGrady, A., & Iannone, A. Autogenic feedback training in treatment of migraine: a clinical report. In Proceedings of the Biofeedback Research Society, 6th Annual Meeting, 1975, 56.

Nicassio, P., & Bootzin, R. A comparison of progressive relaxation and autogenic training as treatments for insomnia. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, 487-493.

Norris, P. Biofeedback applications in a consciousness training program. In Frank, C., Norris, P., Lebow, K.E., & Allen, B.L., Applications research of biofeedback in rehabilitation programs in prison settings, 4-8.

Pearse, B.A., Sargent, J.D., Walters, E.D., & Meers, M., Exploratory observations of the use of an intensive autogenic feedback training procedure in a followup study of out-of-town patients having migraine and/or tension headaches. In Proceedings of the Biofeedback Research Society, 6th Annual Meeting, Colorado, 1975, 53.

Penk, W.E., Age changes and correlates of internal-external locus of control scale. Psychological Reports, 1969, 25, 856.

Prociuk, T.J., & Breen, L.J. Locus of control, study habits and attitudes, and college academic performance. The Journal of Psychology, 1974, 88, 91-95.

Ray, W.J. The relationship of locus of control, self-report measures, and feedback to the voluntary control of heart rate. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, 203-211.

Reinking, R., Tamayo, F., & Morget, M. Comparative effectiveness of various forms of relaxation training. In Proceedings of the Biofeedback Research Society, 6th Annual Meeting, 1975, p. 86.

Razran, G. The observable unconscious and the inferable conscious in current soviet psychophysiology. In Biofeedback and Self-Control. Chicago: Aldine Atherton, Inc., 1971, 479-545.

Roberts, A.H., Kewman, D.G., & MacDonald H. Voluntary control of skin temperature: unilateral changes using hypnosis and feedback. Journal of Abnormal Psychology, 82, 1, 163, 168, 1973.

Roberts, A.H., Schuler, J., Bacon, J.G., Zimmerman, R.C., & Patterson, R. Individual differences and autonomic control: absorption, hypnotic susceptibility, and the unilateral control of skin temperature. Journal of Abnormal Psychology, 1975, 84, 3, 272-279.

Rotter, J.B. Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 1966, 80, 1, (Whole number 609).

Rotter, J.B. Personality Theory. In Helson, H., and Bevan, W. Contemporary Approaches to Psychology. New York: D. Van Nostrand Company, Inc., 1967, chapter 12.

Rotter, J.B. Some problems related to internal-external locus of control. Journal of Consulting and Clinical Psychology, 1975, 43.

Sargent, J.D., Green, E.E. & Walters, E.D. The use of autogenic feedback training in a pilot study of migraine and tension headaches. Headache, 12, 120-124, 1972.

Sargent, J.D., Walters, E.D., & Green, E.E. Psychosomatic self-regulation of migraine headaches. In Birk, L. Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 55-68.

Savill, G.E., & Koppman, J.W. Voluntary temporal artery regulation compared with finger blood volume temperature. In Proceedings of the Biofeedback Research Society, 6th Annual Meeting, Colorado, 1975, 55.

Shapiro, A.K. Contribution to a history of the placebo effect. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1974, 217-243.

Slattery, P., & Taub, E. Specificity of temperature self-regulation to feedback loci. Paper presented at the Biofeedback Research Society, Colorado Springs, March, 1976.

Shapiro, A. Factors contributing to the placebo effect. American Journal of Psychotherapy, 18, 1, 73-88, 1964.

Snyder, C., & Noble, M. Operant conditioning of vaso constriction. Journal of Experimental Psychology, 1968, 77, 2, 263-268.

Steptoe, A., Mathews, A., & Johnston, D. The learned control of differential temperature in the human earlobes: preliminary study. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, 427-432.

Sternbach, R.A. The effects of instructional sets on autonomic responsivity. Psychophysiology, 1, 1, 1964, 67-72.

Stoyva, J., & Budzynski, T. Cultivated low arousal--an antistress response? In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, 265-290.

Strickland, B.R. The prediction of social action from a dimension of internal-external control. The Journal of Social Psychology, 1965, 66, 353-358.

Stroebel, C.F., & Glueck, B.C. Biofeedback treatment in medicine and psychiatry: an ultimate placebo? In Birk, L. Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 19-33.

Surwit, R.S. Biofeedback: a possible treatment for Raynaud's disease. In Birk, L., Biofeedback: Behavioral Medicine. New York: Grune & Stratton, Inc., 123-130.

Systec, Incorporated. Temperature Feedback Trainer Instruction Manual, 1972.

Taub, E. Self-regulation of human tissue temperature. In Schwartz, G.J.E. & Beatty, J.C. (Eds.) Biofeedback: Theory and Research. New York: Academic Press, Chapter 11, in press.

Taub, E. Feedback aided self-regulation of skin temperature with a single feedback locus: I acquisition and reversal training. In Biofeedback and Self-Regulation, 1975, in press.

Taub, E., Emurian, C., & Howell, P. Further progress in training self-regulation of skin temperature. Paper presented at the Biofeedback Research Society, Colorado Springs, 1974.

Thompson, R.F. Introduction to Physiological Psychology. New York: Harper & Row, 1975.

Ude, L.K., & Vogler, R.E. Internal versus external control of reinforcement and awareness in a conditioning task. The Journal of Psychology, 1969, 73, 63-67.

Walsh, D.H. Interactive effects of alpha feedback and instructional set on subjective state. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, 351-359.

Karlins, M., & Andrews, L.M. Biofeedback-Turning on the Power of Your Mind. New York: Warner Books Edition, 1975.

Kamiyo, J. Operant control of the EEG alpha rhythm and some of its reported effects on consciousness. In Tart, C.T., Altered States of Consciousness. New York: John Wiley & Sons, 1969, 519-529.

Turin, A. Biofeedback for migraines. In Proceedings of the Biofeedback Research Society, 1975.

Weiss, E. & English, S.O. Psychosomatic Medicine, Philadelphia: W.B. Saunders Company, 1957.

Weiss, H. & Sherman, J. Internal-external control as a predictor of task effort and satisfaction subsequent to failure. Journal of Applied Psychology, 1973, 57, 2, 132-136.

Wickramasekera, I.E. Temperature feedback for the control of migraines. In Biofeedback and Self-Control. Chicago: Aldine Publishing Company, 1975, 433-435.

Williams, C.B., & Vantress, F.E. Relation between internal-external control and aggression. The Journal of Psychology, 1969, 71, 59-61.

Wolf, S., Doering, C.R., Clark, M.L., & Hagans, J.A. Chance distribution and the placebo reactor. Journal of Laboratory and Clinical Medicine, June, 1957, 837-841.

Zuffuto, A.A., & Auffuto, M.O. Alphagenics. New York: Warner Paperback Library, 1975.