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## BIOFEEDBACK AND SOME OF ITS NON-MEDICAL USES

By Tim Scully

Biofeedback is a process through which one can learn to control biological processes, by feeding information about the process, from a measuring instrument, back to the student.

Learning through biofeedback is different from some other kinds of learning. An instructor isn't essential and one often isn't very helpful (except in showing you how to use the measuring instrument) since no one can explain to you in words how to sense and gain control of the subtle, mind/body processes involved. The key to learning through biofeedback training is recognizing those moments when the feedback instrument is signaling the presence of the desired state, and then, learning how to prolong those moments by careful manipulation of your own thoughts and feelings. Learning takes place as you discover through experimentation what strategy leads to an increased reward in the form of longer bursts of feedback signaling the desired state.

Although Schultz's work in autogenic training, begun in 1910, and Jacobson's progressive relaxation, somewhat later, were useful in training people in voluntary control of at least some body processes, they were very slow and time-consuming. It wasn't until the 1950's and the work of Joe Kamiya, Barbara Brown and Elmer Green that the key to rapid learning of voluntary control of physiological processes was uncovered: biofeedback, the use of information from physiological measuring instruments as an aid to rapid and precise learning to voluntary control.

Romain Vigouroux's crude measurements of skin resistance (1879) have developed into sophisticated instruments for measuring BSR (Basal Skin Resistance) and GSR (Galvanic Skin Response—tiny fluctuations in BSR). BSR and GSR measurements are both used in monitoring systems which detect emotional responses and in feedback training.

Luigi Galvani's early discovery that muscles are controlled by electrical signals has led to the development of the EMG feedback instruments. EMG (Electromyography) is the measurement of the tiny electrical impulses which control muscles, and EMG feedback training is used in improving our control over various muscles.

Hans Berger's work in the 1920's led to the development of EEG or brainwave feedback instruments which are used in learning voluntary control of brainwaves.

Schultz and Jacobson's techniques sparked the idea Elmer Green developed into instruments for skin temperature training, a technique for teaching voluntary control of blood flow.

Although researchers have experimented with many different kinds of biofeedback, most of them are primarily of medical interest. Feedback of heart rate, blood pressure and glandular secretions fall into this category.

Brainwave biofeedback is of non-medical interest primarily because there is a relationship between learning to control brainwaves and learning to control your state of consciousness. For our purposes, brainwaves are extremely weak electrical signals which originate in the brain and which can be detected on the scalp. These signals are constantly changing as time passes. They also vary depending on the area of scalp measured.

Trying to measure consciousness by measuring the electrical signals picked up on the scalp is a little like trying to find out what is happening inside a large computer by measuring whatever electrical signals leak through its outer casing. The signals which can be picked up on the scalp are extremely weak and are the sum of many signals leaking through from different parts of the brain. Despite their weakness and fuzziness, some brainwave patterns have proven to be typical of particular states of consciousness.

EMG is capable of measuring levels of muscle tension which most people cannot sense consciously without the aid of an instrument. As we all know from personal experience, tense states of consciousness are correlated closely with tense muscles. For most people, learning to relax key muscles through EMG feedback training leads to learning to shift into relaxed states of consciousness at will.

Many psychologists believe that we hide behind "muscle armor". Their theory suggests that there are bands of tense muscles all over the body which we use in an unconscious effort to protect ourselves. Learning to relax these muscles through biofeedback training is said to lead to an opening up of defenses.

Skin temperature feedback is of interest because of the way our bodies manage blood flow. If we become anxious or frightened we exhibit the fight or flight response. Part of this response is a rechanneling of blood flow away from the extremities (hands and feet) and into the central portion of the body and brain. This results in a sharp drop in skin temperature at the hands and feet. People who are tense most of the time will have cold hands most of the time. Training in handwarming has proven to be a good technique for learning relaxation. Skin temperature measurements have also proven useful for measuring emotional reactions which we may not be conscious of.

BSR and GSR have long been used in the well-known "lie detector" as a measure of emotional responses. Skin resistance (BSR) tends to be very high when a person is very relaxed, in deep sleep or hypnotic trance. A waking, alert person will have a lower BSR while someone who is very tense and anxious will have still lower BSR. GSR is the measurement of tiny, short term variations in BSR. These changes are usually tiny temporary drops in skin resistance which are stimulated by an event which causes an emotional reaction. Training in increasing BSR has been used in teaching people to relax. Training in reducing BSR has been used in teaching people to increase their alertness. Monitoring BSR is one aspect of producing an "alertness alarm" which long distance truck drivers and others could use. GSR feedback has been used by people who want to learn to control their emotional responses to various stimuli.

A combination of temperature and GSR feedback is now becoming popular as a training device for controlling emotional responses. There are two kinds of self-control: passive and active. A person using active control to eliminate GSR responses will show a drop in skin temperature while a person who has learned passive control will be able to maintain a high skin temperature (indicating relaxation) while controlling GSR responses.

ESP feedback training is still a speculative area of research. As with any other kind of feedback training, the process involves signaling to the student when the mind/body process being measured is in the desired state. In this case the process being measured is the elusive property sometimes called intuition. The theory being tested states that most people have some intuitive ability but that they have a hard time distinguishing valid intuition from simple guessing. In this case, a feedback signal is provided to identify valid intuition. Preliminary experiments indicate that people can learn to recognize and distinguish intuition from guess by this technique. Researchers at Stanford Research Institute, in a program funded by National Aeronautics and Space Administration (NASA), are using feedback, not necessarily biofeedback, training in an effort to enhance extra-sensory perception (ESP) ability.

EEG biofeedback instruments are finding increasing use in education. Marge King, in her recent paper,[see June 1975 AHP Newsletter, pages 20-21, "Biofeedback in the High School Curriculum"] reported on the successful use of EEG biofeedback in continuation high school science classes. Students who had shown little or no interest in any academic subject were fascinated by the possibilities of EEG biofeedback and even began doing library research into journals such as the Scientific American to further their studies.

Pierre St. Jean, a professor of Social Sciences at Algonquin College in Ottawa, Ontario, has been using EEG and EMG biofeedback in his junior college social sciences classes for over two years now. About 1,500 students are involved in feedback training on the several campuses of the Algonquin College System.

One course (called Man and His Environment) also includes behavioral feedback : the students keep a journal of daily intoxicant and food intake, moods, etc. The fundamental purpose of the course is to mirror to the students a few of the many elements which make them unique individuals and perhaps to teach them some voluntary control over these elements.

Another project at Algonquin is more research oriented but it may point the way to future practical applications of biofeedback in education. The research project involves hooking volunteer students to a physiological monitoring system. Two channels of EEG monitor brainwaves from the two hemispheres of the brain. Another channel measures muscle tension, and still another measures eye movement. Galvanic skin response (GSR) and basal skin resistance (BSR), which correlate to emotional changes, are also monitored, as are skin temperature changes, another factor related to emotion, nervousness and, perhaps, drowsiness. All these measurements are digitized to translate them into computer language and then they are fed into a computer. The computer will try to find patterns of physiological response which are related to good or poor performance at the computer-aided instruction task. Eventually, this work may lead to development of a teaching machine which "knows" when the student is paying attention.

At other colleges biofeedback instruments are being used in first year psychology classes to demonstrate operant conditioning and make experimental technique in experiments more interesting and easier to relate to students' lives than the traditional animal experiments.

Graduate students at universities all over the world are using biofeedback instruments in their thesis projects. Often their work applies biofeedback techniques in fields seemingly unrelated to psychology. For example, researchers at several schools are studying the relationships between brainwaves and music.

A graduate student in parapsychology at the Humanistic Psychology Institute, Jean Millay, has used biofeedback of the phase angle between two people's EEG signals as a training technique in an attempt to enhance telepathy. Although she was unable to get significant telepathy scores in her experiments, she was able to teach pairs of subjects to phase lock their EEG. The reports from these subjects indicated a substantial increase in subjective feelings of rapport.

Part of the process of learning more about ourselves is the exploration of "inner space" through the study of altered states of consciousness. In 1902, psychologist William James said:

"...our normal waking consciousness, rational consciousness as we call it, is but one special type of consciousness, whilst all about it, parted by the filmiest of screens, there lie potential forms of consciousness entirely different . . . No account of the Universe in its totality can be final which leaves these other forms of consciousness quite disregarded."

Although our power to improve, control or destroy the world around us has increased greatly in the past century or so, our knowledge of ourselves and our relationship to the world around us has failed to keep pace. The fantastic power of modern technology now leaves us with a choice between learning more about ourselves so we can use this power wisely, or being destroyed by our own foolish misuse of technology.