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AN INTRODUCTION TO BIOFEEDBACK TRAINING

Biofeedback training is the use of apparatus to provide a signal related to some physiological function, so that a person can use the signal to learn control over the function. The term is applied particularly to functions usually considered to be not under voluntary control. For example a person can learn to control his blood pressure if he is given information about its level. Also he can increase or decrease his alpha wave activity or nervous tension if he has apparatus which tells him what his brain-waves are like, or how aroused or relaxed he is. In every case the person has to be motivated; the apparatus provides information, but the user has to make the change himself.

Application to Physiology

The field of biofeedback training owes a great deal to Dr. Neal Miller of Rockefeller University, New York City. In a series of experiments lasting many years he showed that many functions of animals and man which had been thought to be involuntary could in fact be brought under control, provided that the subject knew what was going on in that function. He and his co-workers showed that animals could learn to control their gastric activity, intestinal contractions, peripheral circulation, kidney function and heart rate. He was particularly concerned with the technical question of whether their control was obtained through the autonomic nervous system or as a result of voluntary control of skeletal muscles, which in turn affected the function in question. To obtain his answer much of his work was carried out on animals paralysed with curare. Obviously the question has been very difficult to answer for human subjects. However it is incidental to the main idea of biofeedback, which is that types of bodily control absent in most people can be learned if there is a feedback signal to tell the learner about the state he is trying to control.

Work on human subjects has shown that they can control alpha wave activity, galvanic skin response (a measure of arousal in the autonomic nervous system), heart rate variability, peripheral circulation, blood pressure and muscle tension. This work has very significant therapeutic applications; it points the way to a new mode of treatment for high blood pressure, cardiac arrhythmia, epilepsy, migraine headaches, and possibly insomnia and asthma. The treatment originates within the patient instead of depending on the application of drugs.

Application to relaxation

In panic, people break out in a sweat. They also show a set of other changes due to arousal of the autonomic nervous system, including adrenalin release, increased gastric secretion, loosening of the bowels, erection of hair and so on. In mild excitement some of the changes still occur in a much milder form. There are changes in the sweat glands preparatory to actual sweating, for example. These are not usually detectable, but they cause a change in the electrical resistance of the skin, or Galvanic Skin Response

(GSR). The existence of GSR has been known for many years, as has the influence of excitement on it. It is also affected by the ambient temperature and humidity, and the natural skin resistance varies enormously even when these variables are controlled.

But for one person in one setting the changes in GSR depend on the activity of the autonomic nervous system. This is the part of the nervous system that controls functions normally considered involuntary, like intestinal contractions. Arousal, whether voluntary or involuntary, causes a drop in skin resistance. Conversely, someone coming from a complex environment such as a busy street into a peaceful setting and there sitting quietly, will show a gradual and prolonged rise in the skin resistance as he calms down inside.

The Relaxometer is a device for making the changes in GSR apparent to a user. It measures GSR by means of two simple fingertip electrodes, and provides an audible signal in the form of a continuous tone whose pitch changes with changes in GSR. If the user is startled the pitch rises sharply (after a second or so lag) and then drops back. If the user rests and allows himself to relax the pitch drops. When it reaches a very low level, adjusting a control to raise the pitch will provide the feedback necessary to relax further. This control also adapts the instrument to people with different natural skin resistance.

Among the factors which cause arousal in the autonomic nervous system besides being startled are fear, anger, self-consciousness, or enthusiasm about a topic of conversation, an idea or something seen. Users can with practice control this arousal in many cases. To use the Relaxometer as an aid to relaxation the subject attaches the electrodes and adjusts the control tone to a fairly high pitch, and then tries to calm down. As he succeeds the pitch of the instrument drops, and the user continues to do that which makes it drop. Everyone who has used the device so far has been able to make the pitch drop by relaxing. This relaxation technique is of interest specifically in the treatment of nervous headaches and nervous stammering, and more generally for people who know they need to relax and find it difficult.

The device also teaches the user what stimuli cause tensing responses. In the course of a conversation items will occur which cause arousal. Some of these will be predictable - emotionally charged ideas or words. Frequently other less predictable stimuli will be found too. This approach is of interest to psychotherapists, for the light it throws on patient-therapist relationships, and coupled with self-imposed relaxation as a tool in the systematic desensitisation of certain phobic patients. The Relaxometer is also useful in health education, to show the physical effects of mental changes, and in relaxation training for ante-natal classes and migraine sufferers.

Application to brain-wave activity

In the late 1920s a German scientist, Hans Berger, discovered that the brain generated a small amount of electricity which could be detected on the surface of the scalp. This electrical activity consists of rhythmically varying potentials varying from a few to a hundred microvolts. Eventually the major frequencies of the brain's electrical activity were identified and labelled with letter names from the Greek alphabet: frequencies

from 0.5 to 4Hz (cycles per second) - delta, 4 to 8Hz - theta, 8 to 14Hz - alpha, and 14Hz up - beta. This electrical activity can be recorded on an electro-encephalograph (EEG), and the records are of clinical value in the diagnosis of brain damage, notwithstanding the suggestions that they are meaningless artefacts, or due to eye muscles.

The relation between brain wave patterns and state of mind is now being actively explored, but it is a difficult problem because of the effect of the skull on the electrical signals, which originate within it and are detected outside it, and because of the subjective evaluations of state of mind. It is broadly true that lower frequencies are associated with less-structured mental activity. The fastest waves, beta, are found normally when people are processing information during thinking, feeling, seeing, doing and so on. Alpha waves are associated with a pleasant state of relaxed readiness, neither drowsy nor alert, and also with meditative trance states. Theta waves are not normally found in adults, but can be induced by training and are found in deep trance states and in young children. Delta waves are found in sleep. The alpha-producing state of mind is a pleasant and agreeable one, achieved not by striving but by 'letting it happen' by way of a general calming down of the mind. It is not compatible with mental activity, so if a person is producing alpha he is not involved in the day-to-day problems of living, but is experiencing an altered state of consciousness distinct from everyday mental activity. Perhaps because the mind is not active in the ordinary way, latent tendencies can become manifest, and subtle forms of activity can occur which are normally inhibited by thought patterns. This may account for the apparent associations between alpha activity and ESP performance, and the observations that hypno-suggestible people have high levels of alpha activity when not in a trance and that alpha wave training increases hypno-suggestibility. People in meditative trance states have a high level of alpha wave activity also.

Alpha wave training has been of limited use in dealing with a case of intractable pain, and both the alpha and the producing states have interesting associations with memory and learning and recall.

Theta waves are associated with deep trance states, and with a state of mind called 'reverie' by Drs. E.E. and A.M. Green. They describe this state as being 'associated with hypnogogic imagery' and corresponding to 'descriptions given by geniuses of the past of the state of consciousness they experienced while being their most creative'.

All adults produce beta waves most of the time. Some adults can produce alpha readily by closing their eyes, and a few can with their eyes open. Most can increase the amount of alpha wave activity if they are presented with a feedback signal indicating their success.

The Alpha Sensor provides the necessary feedback signal. It uses two simple electrodes which are attached to the scalp, without shaving, to pick up the signal, which is amplified greatly. Then the signal is filtered to exclude unwanted frequencies, and if it exceeds an (adjustable) threshold it causes an audible 'beep' for each alpha wave peak. By turning a knob the theta wave frequency can be selected in place of alpha.

After a few minutes of calming down, most users begin to hear 'beeps' which indicate that they are making alpha, and as they continue to try to elicit the beeps, burst of alpha become more frequent and longer. Certain Yoga exercises and participation in collective chanting facilitate alpha production in many people. Opening the eyes or internal visualisation or mental activity will usually interrupt alpha.

It is important to note that, as with other biofeedback devices, the Alpha Sensor is a passive instrument which provides the user with information, but does not itself alter the user. Change has to originate within the user. The Alpha Sensor is not a short cut to Karma, Satori or other mystical states or paranormal powers.

Application to Muscle Action

Muscles are controlled by electrical impulses passing down to them through nerves from the spinal cord. When a group of muscle fibres which comprise a muscle or part of it contracts, an electrical signal can be detected by a pair of electrodes in the muscle, and usually by a pair of electrodes close by on the surface of the skin. A completely relaxed muscle shows no electrical activity.

It is possible to detect and amplify the electrical activity and feed back to the subject a signal related to that activity; with this the subject can learn to control the nerve impulses to the muscle and so control whether it is tensed or relaxed. The Myophone, marketed by Aleph One early in 1973, is designed to provide just such a feedback signal.

In an excellent survey of work in this field, Basmajian describes how most subjects can rapidly learn to maintain a desired level of activity in a muscle with the aid of a feedback signal, even when the activity is too subtle to perceive otherwise. Some subjects can in fact achieve very refined control and produce numerous bizarre responses including isolated nerve impulses and rhythmical bursts.

This type of biofeedback has numerous therapeutic applications, for example in the treatment of tension headaches and of the back-ache and neck-ache which are often symptoms of stress. Since it can show the level of activity in a muscle it may be useful in the correction of certain postural defects and associated disorders caused by an unwittingly strained position, and in the correction of certain muscular tics.

Summary

Biofeedback training is a relatively new field of enormous potential significance. It offers new therapeutic methods for psychological, psychosomatic and somatic disorders. And it offers a way to learn about how we work, and so to understand and control our own workings, both in the physiological and psychological spheres. Its novelty means that many of these areas are awaiting scientific exploration; much needs to be done.

Aleph One Limited is the first source of biofeedback equipment in Britain, and it will continue to provide further devices as the field expands. Development work is under way now, drawing on British and American research. Periodic up-to-date information about work in the field will be made available to those who express an interest, and relevant books will be available from Aleph One Limited.