New Frontiers in Biofeedback

Tim Scully

Electronic ping pong, toy monkeys that jump with un-joy, slide shows for addicts and the universality of body language. One of biofeedback's most inventive thinkers glimpses into the future of an exciting somatic technology.

Exciting new developments are taking place in physiological data analysis and biofeedback training technology. Simple, first generation biofeedback instruments with their beeping tones, flashing lights and meters are beginning to give way to more sophisticated biofeedback systems, sometimes computerized systems. Biofeedback games have been developed which make lengthy training easier and more interesting. More is being learned about how to decode the body's language—to understand relationships between physiological and psychological events.

Biofeedback involves measuring *bio*logical processes and *feed*ing the results of the measurements *back* to the person being measured. Most researchers in biofeedback now agree that any body process which can be measured can be brought under some degree of voluntary control through biofeedback training. Such control of the body has proven to be of serious medical interest. Potentially even more interesting is the development of voluntary control over events in consciousness which often accompanies the learning of physiological control.

Neuromuscular reeducation is a classical example of body-oriented biofeedback training. People with damaged muscles can speed the process of re-learning control over them through electromyographic (EMG) biofeedback training which teaches voluntary control over the electrical signals associated with muscle action. EMG training has been used to help stroke and cerebral palsey victims as well as those with muscles damaged by trauma.

It can take many training sessions for a person with damaged muscles to learn to recover control, even with the help of EMG training. These sessions can be frustrating and boring, particularly if the feedback signal supplied to indicate progress is a simple tone or meter reading, and some patients have given up before complete training.

One solution to this problem has been the development of biofeedback games which make the training exciting and interesting. A television ping pong game has been modified (Scully, 1977) so that one of its two paddles can be controlled by the patient's EMG while the other is controlled with the conventional knob. A patient plays ping pong with the therapist while retraining the damaged muscle. The sensitivity of the ping pong paddle to muscle tension is slowly decreased as training progresses and the patient learns to recover strength and fine control in the damaged muscle. This game has also been used with success by educators: EMG training with young children with healthy muscles is more fun when it is a game.

EMG relaxation training has also become popular in clinical practice. It is well known that muscle tension is usually part of the stress response, and muscle relaxation has, for many, been effective in providing relief from tension. Most EMG relaxation training has been done by training the frontalis muscle in the forehead to relax. The rationale for choosing this muscle was simply that the frontalis is hard to relax, and it was hoped that in learning to let go of tension in the frontalis, patients would also learn to relax other muscles in the body as well as letting go emotionally. A problem here is that relaxing the frontalis doesn't always lead to relaxed feelings. Some people still feel tense after their frontalis has relaxed completely.

Physiological monitoring is beginning to be used to examine patterns of muscle tension in the body and learn how these patterns relate to events in consciousness. Gary Schwartz (1976) reported monitoring EMG levels in four muscle groups around the face: the frontalis in the forehead, the corrugator under the eyebrow, the masseter which operates the jaw and the depressor which circles around and under the mouth. He asked his subjects to imagine happy, sad and angry scenes, all without overt facial expression, while he averaged EMG levels over 30 second periods. He found only small changes in frontalis and masseter tension levels, but the corrugator and depressor muscles showed distinctive patterns of response. Happy thoughts with unusually low corrugator tension levels, sad thoughts produced high corrugator tension, while angry thoughts were accompanied by high depressor tension.

These results may explain why some patients found frontalis relaxation training effective as a treatment for stress and others didn't. Possibly the patients who obtained good results were trained with the sensing electrodes low enough on the forehead so that signals from the corrugator were being picked up. It may eventually be possible to develop a practical "mirror for emotions" by feeding EMG data from muscles to a microcomputer which can sketch covert facial expressions on a television screen. Such a system would be a valuable tool in counseling. Of course, the muscles in the face are not the only ones of interest, and the insights into relationships between knots of muscle tension and knots in consciousness which have been gained from body work such as rolfing and bioenergetics may prove very helpful in developing sophisticated biofeedback systems.

Muscle tension isn't the only

physiological response to stress. Another almost universal response is the galvanic skin response (GSR): a brief drop in the electrical resistance of the skin which follows arousal or stress. GSR instruments have been used in psychotherapy because they can detect arousal which the patient blocks from conscious awareness. Early GSR instruments used chart records, meters or tones to display information about skin responses. One more recent system (Scully, 1977a), designed for use with children, activates a toy monkey which jumps up and down and screams when a GSR response is detected.

The parole success rates for graduates of the biofeedback training program was 23% higher than for untrained addicts.

Byron Allen and Ken Lebow (1974) developed a slide projector system controlled by GSR for use in their work with heroin addicts. They collected slides depicting heroin use and purchase, and connected a slide projector to a timer so that slides normally advanced at regular intervals. If a GSR response was detected, the projector stopped advancing and began reversing to earlier slides. It was impossible for an addict to get past a slide in the series unless he could view it without GSR response.

The addicts responded to almost every slide at first, but after considerable training, many were able to learn to stop responding. Some of the men who stopped responding also stopped feeling an automatic desire for heroin: the parole success rates for graduates of the biofeedback training program was 23% higher than for untrained addicts (Cupp, 1976). But some addicts learned to stop having GSR responses without giving up the desire for drugs. Lebow & Allen (1974) noted that these men often experienced a drop in fingertip skin temperature while watching the slide show.

Peripheral vasoconstriction is a part of the fight or flight response to stress: the body withdraws blood from the hands and feet so that it is available for the vital muscles and organs. This leads to a drop in fingertip skin temperature. It appears that the addicts who were able to give up their desire for drugs actually learned to relax while watching the slide show, while those who were not able to give up the desire for drugs, but who did learn to suppress GSR responses, did so by a stressful active volitional control process.

An improved slide projector control system has been briefly tested in the Gladman Memorial Hospital drug program (Scully, 1976, 1977a). This projector advanced at regular intervals unless either a GSR response or a drop in fingertip skin temperature was detected. A GSR response caused the projector to back up three slides and stop until relaxation occurred, then the normal advance would resume. A drop in fingertip temperature caused the projector to stop at the slide which triggered the temperature drop. The slides would advance again only after the fingertip temperature returned to normal. GSR responses were detected when the patient became excited or aroused by an image, while the fingertip temperature dropped if an image was stressful or if the patient tried to actively suppress a GSR response.

Another innovation tried in this experiment was the use of personalized slides: photos of the patient's family, work associates, places where drinking or drug use had happened and places where liquor or drugs were purchased. The preliminary results were encouraging. GSR responses were produced for most drug or alcohol related images, while skin temperature decreases were detected during slides that pictured stress points in the patient's life. Desensitization to the drug images was combined with stress detection and management training.

Brainwaves, the electrical signals from the brain which can be detected on the scalp, are of interest too. Simple alpha wave biofeedback training became a fad a few years ago when the press popularized research reports of brainwave studies done in Japan and India in which Zen Monks and Yogis were found to produce unusual amounts of alpha brainwaves while meditating. Many hoped to learn instant enlightenment through brainwave training. The results of simple alpha training vary widely: some do experience a meditative state of unusual calmness, but others find alpha to be nothing special or even uncomfortable.

Simple alpha training involves the measurement of brainwaves from only one scalp area. Brainwaves normally vary all over the scalp, and training for alpha at one location doesn't pin down the brainwave activity in other areas, hence the varied results from simple alpha training. Another source of this variation may be individual differences in correlations between brainwaves and events in consciousness, i.e., two people producing the same brainwave patterns all over the scalp may still experience different events in consciousness, though it may be reasonable to expect that their states of consciousness are much more alike than two people producing very different brainwaves.

A two channel brainwave training system has been built which allows a person to train two scalp areas at one time. This system is used to train symmetrically located scalp areas in the right and left hemispheres of the brain to produce alpha waves which are phase synchronized (i.e., so that the waves are exactly in step with each other). Zen monks have been observed to produced unusually phase synchronous alpha during meditation, one of the features which distinguish their alpha from garden variety alpha. Members of a Zen meditation group (who are just learning to meditate) are being trained with this two channel brainwave system (Nakakshima & Scully, 1977) and early reports indicate that this training is an aid to meditation. Even this brainwave monitoring system is quite simple: more sophisticated, computerized systems are likely to replace simpler instruments because their ability to detect and identify complex patterns of response can improve the reliability of biofeedback training.

Zen monks have been observed to produced unusually phase synchronous alpha during meditation.

As progress is being made in decoding the body's language, it is becoming clear that some components of physiological response are universally similar, while others vary from person to person. Clynes (1973), for example, found that distinctive fingertip motions were identifiable expressing love, hate, joy and sadness, and that these patterns were similar for subjects from the United States, Japan, Bali and Mexico. Pinneo and Hall (1975) were able to identify distinctive brainwave patterns associated with thinking each of a limited vocabulary of words. Although these patterns were somewhat different for different subjects, they found it necessary to use personalized templete patterns for each subject in order to attain 55% accuracy in identifying words as they were being thought (by computer analysis). Scully (1977b) used a computerized physiological data analysis system to detect brainwave and GSR response patterns typical of different ego states (affective/behaviorally defined states of consciousness from Transactional Analysis); once again, although there were individual variation in response pattern, the overall patterns for each ego state were identifiably similar for different subjects.

To the extent that the body's language is universal, it may eventually prove possible to develop a practical non-verbal communication system from computerized physiological data analysis systems. It is also likely that practical biofeedback systems will soon be developed with much more powerful and specific capabilities than existing simple systems. These new systems will be computer based and will make use of modern multivariate statistical techniques, such as discriminant analysis, to identify the precise pattern of physiological response which correlates with a desired event in consciousness. These systems may make it possible to develop training techniques for new affective and cognitive skills, opening new frontiers in inner space. Hopefully we'll use them to learn to become better human beings.

BIBLIOGRAPHY

Clynes, Manfred Sentics: Biocybernetics of Emotion Communication, *Annals of the New York Academy of Sciences* 220:57-131 (1973).

Cupp, H.C. *Biofeedback Stress Management Program at Oregon State Penitentiary* (1976) (unpublished)

Lebow, K. & Allen, B. *Finding a Cure for Treatment*, Lompoc F.C.I. DAP program (1974).

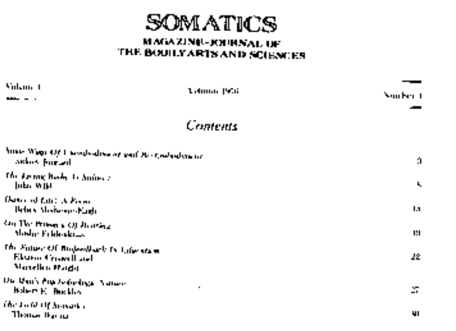
Nakashima, D.B. & Scully, T. EEG *Biofeedback Pilot Study*, McNeil Island Penitentiary, Psychology Services (1977).

Pinneo, L. & Hall, D. *Feasibility Study for the Design of a Biocybernetic Communication System* Stanford Research Institute final technical report on SRI project # LSU-1936-NS (1975).

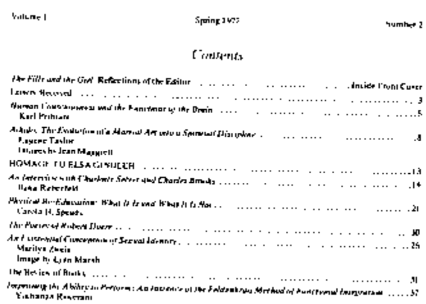
Scully, Tim Visual Image Desensitization Pilot Study, *6th Trimester Report to HPI* (1976)

Scully, Tim Biofeedback and Drug Rehabilitation *7th Trimester Report to HPI* (unpublished) (1977a).

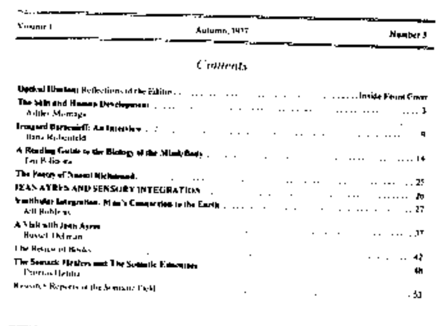
Scully, Tim *Biofeedback and Drug Rehabilitation: a Search for Better Physiological Correlates of Events in Consciousness* PhD dissertation for HPI (not yet complete) (1977b).


SOMATICS
MAGAZINE-JOURNAL OF
THE BODILY ARTS AND SCIENCES

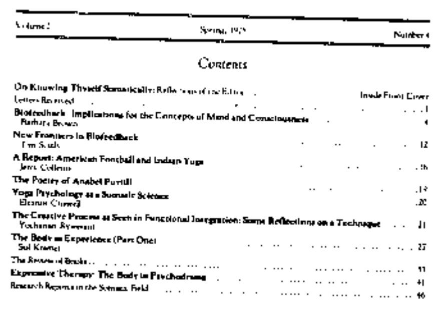
Contents


Volume I | Spring 1977 | Number 2

Contents


Volume I | Autumn, 1977 | Number 3

Contents


Contents