PROGRAM ABSTRACTS/ALGORITHMS

VOLTWIN: A computer program to establish criteria for reinforcement of stable levels of EMG activity

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The goal of the VOLTWIN program is to establish a voltage "window" against which electromyographic (EMG) activity emitted by subjects in biofeedback experiments may be compared. The program is designed to calculate both upper and lower limits of continuous EMG signals conditioned by a contour-following integrator and to control auditory reinforcement to subjects for maintaining EMG levels between the upper and lower threshold values. In biofeedback experiments, the former function is implemented during a baseline period, whereas the latter function is used during biofeedback training. Reinforcement of stable EMG levels is a useful alternative to noncontingent procedures employed in biofeedback research when the effects of participants' subjective impressions of feedback are not trivial (Kotses, Harver, & Schnitter, 1983).

Computer and Hardware. The program is written in 8085 assembly language for use with a single-board microcomputer. An 8-bit analog-to-digital (A/D) converter (National Semiconductor ADC0817) accepts a 0-1.4 V signal from a physiological recorder. The A/D converter and the digital-to-analog (Motorola MC145 L8) and voltage-to-frequency (Intersil 8038) converters were added to an 8085 microcomputer trainer.¹ Since both A/D and tone-generating hardware are configured to match the requirements of various micro- and mini-computers, a generic flow chart of the program, rather than its specific code, is presented. Because of the greater speed with which it operates, assembly language is preferred over higher level languages such as BASIC.

Program Description. A flow chart of the program is shown in Figure 1, on page 321. To establish the upper

and lower threshold values of EMG activity automatically, the Autoset option is selected. Once selected, the program initiates control over collection of 16 consecutive sample units of 16,128 data points each. Both the maximum value and the minimum value of each sample unit are stored in memory and are averaged at the end of the Autoset sequence. We employ a conversion rate of approximately 2,700 samples/sec, and each of the 16 samples requires approximately 6 sec to obtain. More sample units, each with fewer data points, are preferred if spurious noise is a problem. The Autoset sequence continues directly into the feedback portion of the program (see Figure 2, on page 322). All conversions subsequent to those used to establish the window's limits are compared with both upper and lower threshold values. If a given data point falls within the window, a fall counter is decremented; when the fall counter reaches a value equal to zero, it is returned to its original value (user determined), and the pitch of the tone is decreased. If the obtained data point exceeds the boundaries of the window in either direction, a rise counter is decremented; when the rise counter reaches a value equal to zero, it is returned to its original value (user determined), and the pitch of the tone is increased. In the present design, additional monitor options provide for setting and displaying threshold values, as well as rise and fall rates, manually. The unit is also able to provide a voltage-dependent tone (STVCO) only.

Availability. Requests for reprints and additional correspondence should be addressed to Andrew Harver, Department of Psychology, Ohio University, Athens, Ohio 45701.

REFERENCE

- KOTSES, H., HARVER, A., & SCHNITTER, P. (1983). Equating subjective experience between biofeedback training and control groups. *Psychophysiology*, 20, 453.

NOTE

1. The authors gratefully acknowledge that the microcomputer trainer and monitor program employed in the development of this program was designed by James Guilford, Department of Electrical Engineering, Ohio University, Athens, Ohio 45701.

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Figure 1. Block diagram of the VOLTWIN sequence to establish threshold values.

Figure 2. Block diagram of the VOLTWIN sequence to provide either threshold-dependent feedback (START) or voltage-dependent feedback (STVCO).