SOME ELECTRONIC CONTROL UNITS FOR OPERANT BEHAVIOR STUDIES: II. A RANDOM RATIO GENERATOR¹

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We present below an apparatus used in our laboratory, in conjunction with the translator described in an earlier note (Schoenfeld et al., 1960), for generating programs of random ratio reinforcement.

The general principle underlying the operation of this generator involves a high frequency pulse, the duration of which is manipulable (without changes in the frequency). This makes possible a temporally defined reinforcement schedule with the $t^D + t^A$ cycle made very short with respect to the minimal inter-response time of the organism. The coincidence of response with t^D yields reinforcement, and the probability of this coincidence is defined by the ratio $t^D/(t^D + t^A)$ because of the small values of the time parameters involved (see also Brandauer, 1958). The properties of ratio schedules generated in this way include: (a) equal probability of reinforcement for each response; and, (b) independence of the probability of reinforcement (coincidence) and inter-response time.

The circuit diagram of the random ratio generator is given in Fig. 1, which is accompanied by an index of components. The operation of this circuit may be traced as follows:

(1) A 100 cps wave is squared (E_1) and sent to a flip-flop (E_2) for frequency division by two. In our laboratory, we have used the 100 cps output of a Hewlett-Packard secondary frequency standard, but both the frequency and the source may be varied without substantial change in the circuit. As divided by E_2 , 50 complete cycles per second are available, each constituting a $t^D + t^A$ cycle with t^D occurring at the beginning of each cycle and continuously variable from less than 10 microseconds up to the full cycle length of 20,000 microseconds.

(2) The output of E_2 passes through a pulse amplifier (E_3) giving an 80 volt negative pulse of 50 microseconds' duration for each input pulse. The output of the amplifier is fed to: (a) an additional amplifier (involving tubes T_4 and T_5), and thence to the translator earlier described, where it initiates t^D ; (b) a phantastron circuit.

(3) The phantastron (E_4) and its related components operate to produce a delayed output by generating a positive gate. The duration of this gate is variable by means of C_3 and R_2 , the output being finally used (after differentiation) for the initiation of t^A .

(4) Operation of this random ratio generator requires a well-regulated power supply. When desired, calibration by a high quality oscilloscope against a standard time base will give a high degree of precision.

Calibrated delay generators of good quality are commercially available and may be substituted for the phantastron circuit used here.

REFERENCES

- Brandauer, C. M., The effects of uniform probabilities of reinforcement upon the response rate of the pigeon. Unpublished doctor's dissertation, Columbia University, 1958.
Schoenfeld, W. N., et al., Some electronic control units for operant behavior studies: I. A response and reinforcement contingency translator, *J. exp. anal. Behav.*, 1960, **3**, 17-20.

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