SEQUENTIAL DEPENDENCIES OF THE LENGTHS OF CONSECUTIVE RESPONSE RUNS[1]

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In an earlier paper (3) a procedure was described in which a minimum number of consecutive responses on lever A was required before a response on lever B would be reinforced. That paper was concerned with the effects of each of two parameters upon a.) the shape of the function relating the probability of a response on lever B to the number of consecutive responses just made on lever A, and b.) the frequency distribution of the lengths of runs. (A "run" is a succession of responses on lever A followed by a response on lever B.) The main purpose of the present paper is to describe some aspects of the sequential dependencies of the lengths of consecutive runs under conditions similar to those in the earlier experiments. A second purpose is to examine some of the effects of withholding reinforcement altogether upon the lengths of successive runs.

APPARATUS

All equipment was the same as that described in the earlier paper (3). There was only one addition, namely, a printing counter on which the lengths of successive runs were individually recorded.

SUBJECTS AND PROCEDURE

Three of the rats which had been used in Experiment B of the earlier study (3) were maintained under conditions where 0.025 cubic centimeter of water was presented upon every completion of at least eight consecutive responses on lever A followed by a response on lever B. If the animal made the response on lever B before having completed the minimum eight consecutive responses on lever A, it had to repeat that run from the beginning. The first four days were arbitrarily allotted to stabilization. On the following seven days, separate frequency distributions of lengths of runs were collected for each of five values of the length of the run preceding the recorded run. Then, for the same animals, a printing counter was used for a run-by-run record of the lengths of successive runs. After 100 reinforcements had been delivered, extinction was carried out to a criterion of 10 minutes without the occurrence of a response. As soon as this criterion was met, the next reinforcement period was initiated by delivering to the animal a "free" reinforcement, which invariably resulted in an immediate resumption of responding. Each animal was taken through five such reinforcement-extinction cycles, which were completed within 3 hours for each of the three animals.

RESULTS AND DISCUSSION

Figure 1 shows the sequential dependencies of the lengths of consecutive runs. For each of the three rats studied, relative frequency distributions of run lengths

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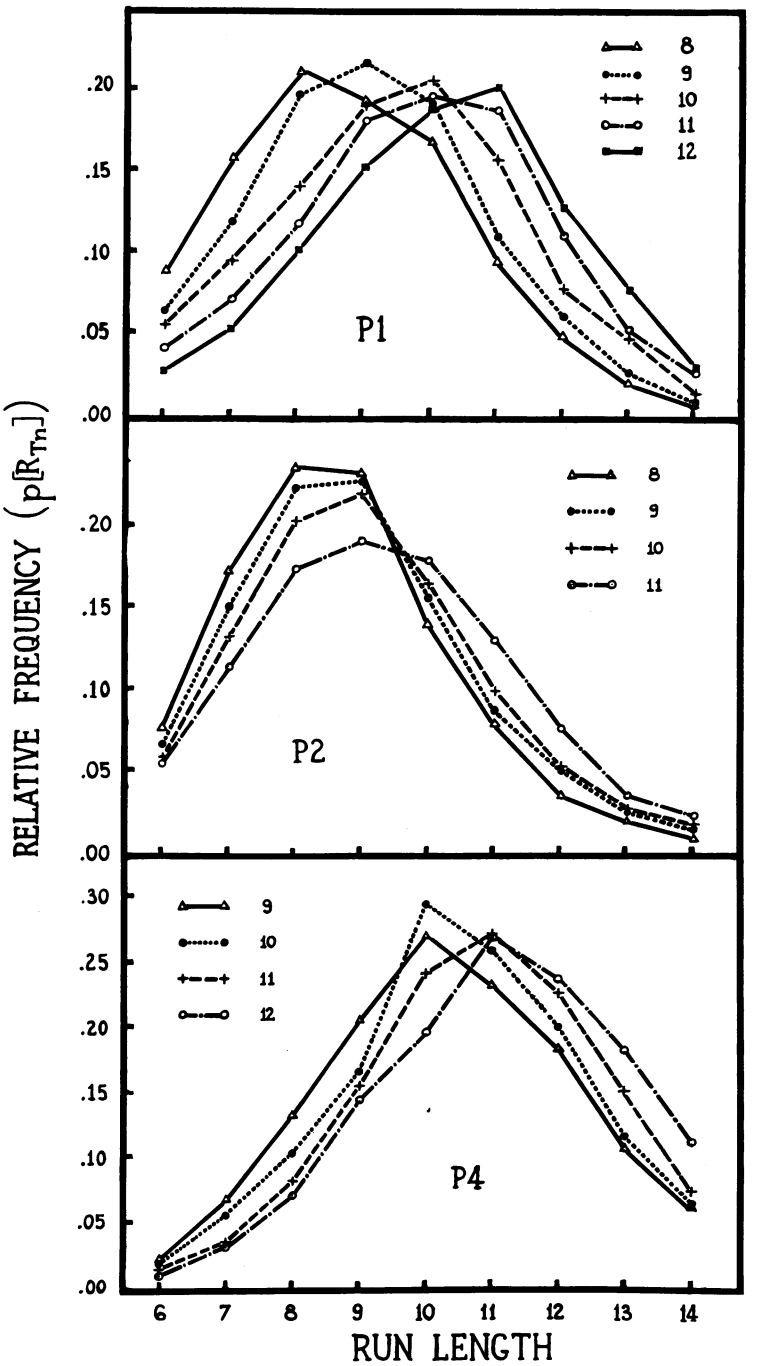

Figure 1. Each of the three sets of coordinates shows the relative frequency of runs of various lengths. The parameter, whose values are indicated on the graphs as ranging from 8 to 13, is the length of the run preceding the one described by the distribution. The reinforcement requirement was always eight consecutive responses on lever A.

are shown for each of four (five in the case of P1) lengths of the preceding run. Thus, each frequency distribution describes the runs immediately following all runs of a given length. For all three animals, the run-length distribution shifts to the right as the length at which the preceding run is taken increases. Figure 2 summarizes the effect by showing for each rat how the length of a run depends on the

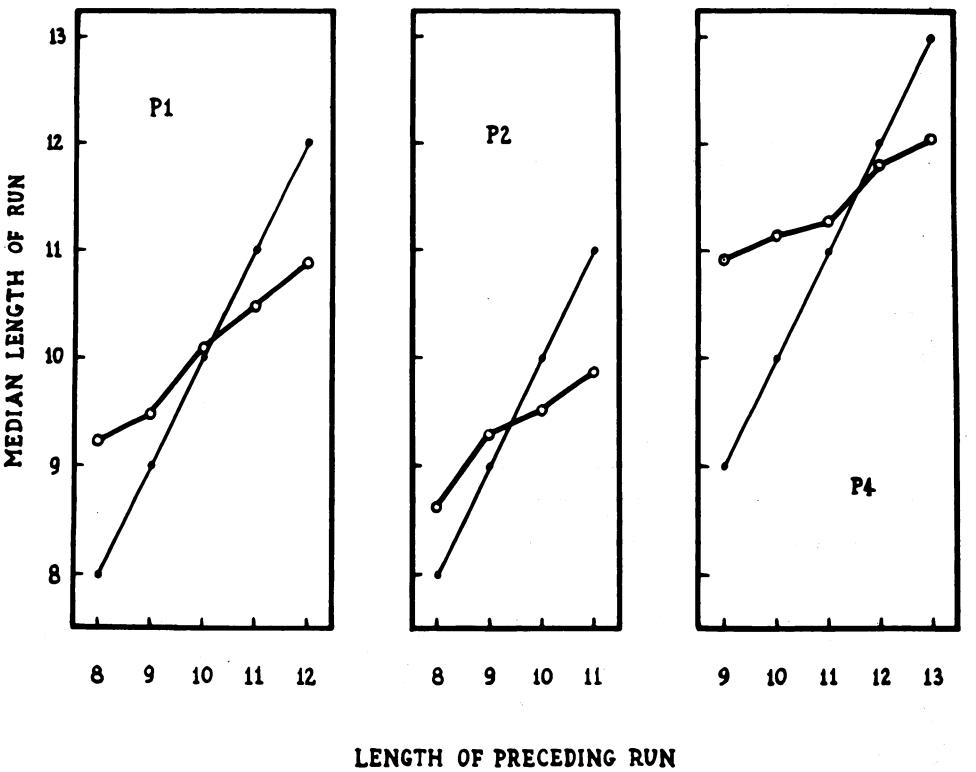

Figure 2. Median lengths of runs as a function of the lengths of the run preceding the one whose median length is shown. The line through the filled-in points is what the function would be if consecutive runs were of the same length. Each of the three graphs shows the data of one animal.

length of the preceding run. The slope of the solid-point function (which shows what the function would be if consecutive runs were of the same length) has approximately twice the slope of the empirical function, indicating that the medians fall approximately midway between the length of the preceding run and the over-all median run length.

These results establish the presence of sequential effects that extend over at least one run. They do not, however, provide any information concerning the possible existence of higher-order sequential effects. Investigating them would require more powerful data analysis techniques. Some ancillary information concerning higher-order sequential effects is, however, supplied by the run-by-run recordings shown in Fig. 3. Visual inspection of a few selected close-ups of the regular reinforcement portions of these records, which are shown in the lower half of Fig. 3, suggests the

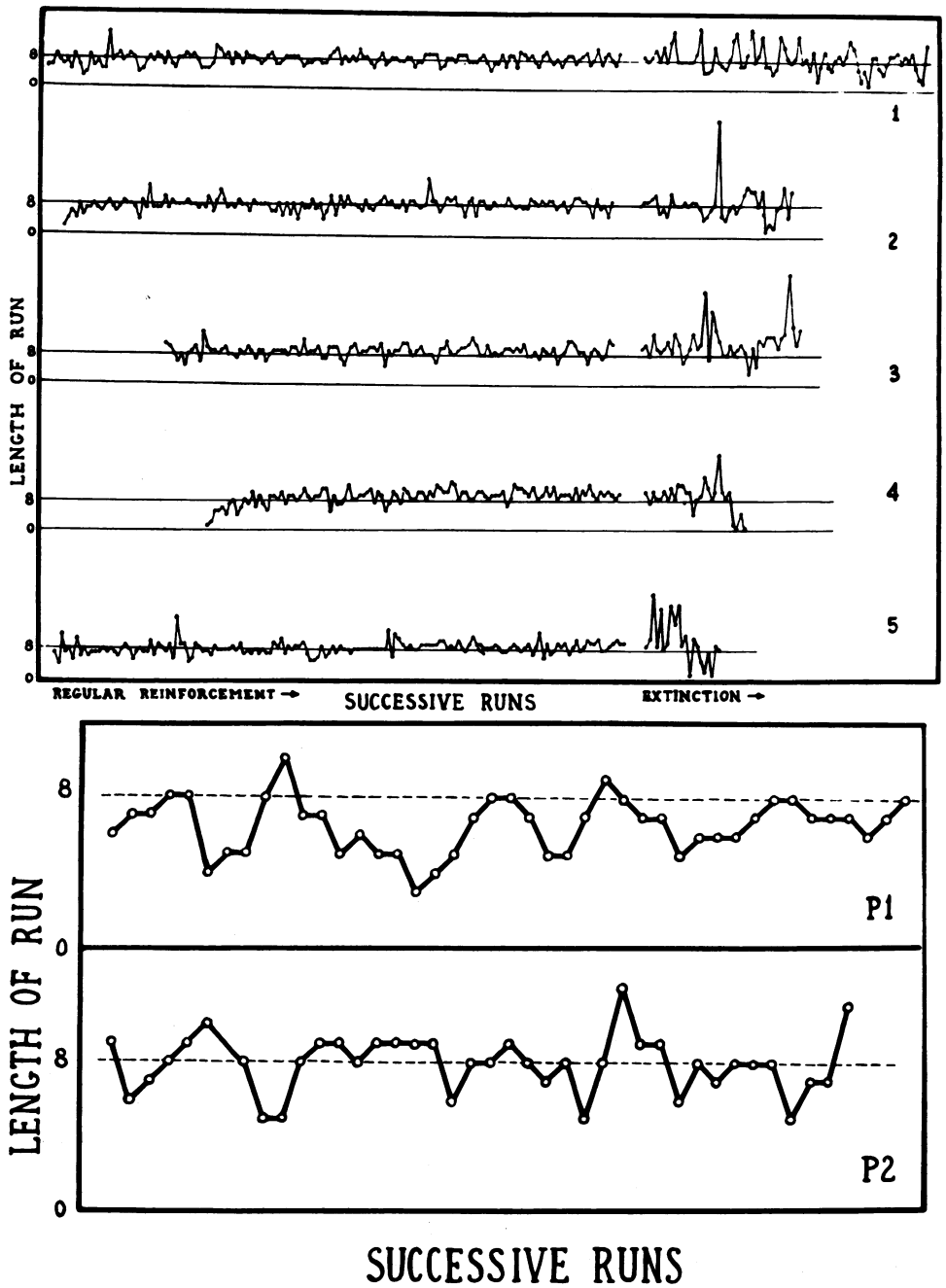

Figure 3. Top: Length of successive runs under the condition where every run at least eight responses long is reinforced, and under subsequent extinction. Bottom: Close-ups of selected segments of the run-by-run records.

possible existence of cyclic fluctuations in the length of successive runs. These fluctuations may well lie at the root of the sequential effects shown in Fig. 1 and 2. Not much more can be said, however, until a suitable technique for quantifying this type of effect has been devised.

The extinction portions of the run-by-run records shown in Fig. 3 show a striking increase in the run-length variability. The effect sets in almost as soon as extinction is instituted and persists until the end. This result is in line with the findings of related investigations of variability during extinction (1, 2). Another noteworthy feature of the run-by-run record is the "warm-up" effect, or the gradual increase in run length, at the start of some of the reinforcement sessions. It can be seen clearly in Records 2 and 4 in the upper half of Fig. 3.

SUMMARY

Three male albino rats, working under thirst drive in two-lever Skinner boxes, were trained under a procedure in which the reinforcement requirement was a minimum of eight consecutive responses on lever A followed by a response on lever B. The following aspects of the resulting performance were investigated: a.) sequential dependencies of the lengths of consecutive runs; b.) cyclic fluctuations in the length of successive runs; and c.) run-length changes during extinction. It was demonstrated that the length of a run is related to the length of the immediately preceding run, that there sometimes appear cyclic fluctuations in the length of successive runs, and that run-length variability increases under conditions of extinction.

REFERENCES

1. Antonitis, J. J. Variability of response in the white rat during conditioning and succeeding extinction and reconditioning. Doctoral dissertation, Columbia University, 1950. A shortened version of this study may be found in: *J. exp. Psychol.*, 1951, **42**, 273-281.
2. Bregman, M., and Berryman, R. Response magnitude changes in extinction. Paper presented before the Amer. Psychol. Assoc., September, 1956.
3. Mechner, F. Probability relations within response sequences maintained under ratio reinforcement. *J. exper. anal. Behav.*, 1958, **1**, 109-121.