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# EFFECT OF AMOUNT OF TRAINING ON RATE AND DURATION OF RESPONDING DURING EXTINCTION[1]

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Four experiments are reported in which the amount of CRF training prior to extinction is examined as it effects transient changes in response frequency and duration immediately following extinction onset. The first two experiments, using albino rats as subjects and water reinforcement, revealed a reliable relationship between length of time on CRF and the tendency to increase response frequency, duration, and the variability of response frequency and duration. Two comparative experiments were conducted using 53-to-69-month old children as subjects, and recorded music as reinforcement. The results of the first child study failed to conform with those obtained in the rat experiments. However, manipulation of the reinforcer in a subsequent study reproduced the rat extinction effect. Despite the differences in the rat and child experiments, the qualitative similarity of the results of the four studies suggests a basic underlying comparability of the relationship between the amount of training and transient changes in response frequency.

The experiments reported here are part of a comparative research program designed to examine a variety of response topographical changes in extinction and the variables effecting these changes. Previous research by one of the authors has dealt with the effects of pharmacological agents on the increased frequency of emission of a lever-pressing response following extinction onset (Thompson, 1961; in press). A number of other investigators have reported changes in response frequency, duration and force during extinction (Amsel and Roussel, 1952; Hurwitz, 1954; Margulies, 1961; Millenson and Hurwitz, 1961; Notterman, 1959). However, there is little information relating specific topographical extinction changes to antecedent behavioral manipulations. The present series of studies examines the significance of the amount of training prior to the extinction test session using albino rats and children as subjects.

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## EXPERIMENT I

### METHOD

#### *Subjects*

Fourteen experimentally naive male albino Sprague-Dawley rats, 70-90 days old at the beginning of the experiment were used.

#### *Apparatus*

A standard, two-lever Foringer-Skinner box with automatic control equipment was used for training and testing.

#### *Procedure*

After arrival in the laboratory, the animals were housed in pairs in home cages and given *ad libitum* food and water for one week. This period was followed by two weeks on *ad libitum* food, with the animals receiving 30 min of water daily. Beginning the fourth week the animals were randomly assigned to one of seven training groups, each receiving equivalent treatment except different amounts of lever-press training for water reinforcement as follows: 15, 30, 60, 90, 120, 150, and 180 min of CRF beginning at the time of the first response. The animals were placed in the boxes 23½ hr thirsty, (+ ½ hr). Each training session consisted of 15 min of CRF, so that all groups, except the 15 min group, received more than one session in the box.

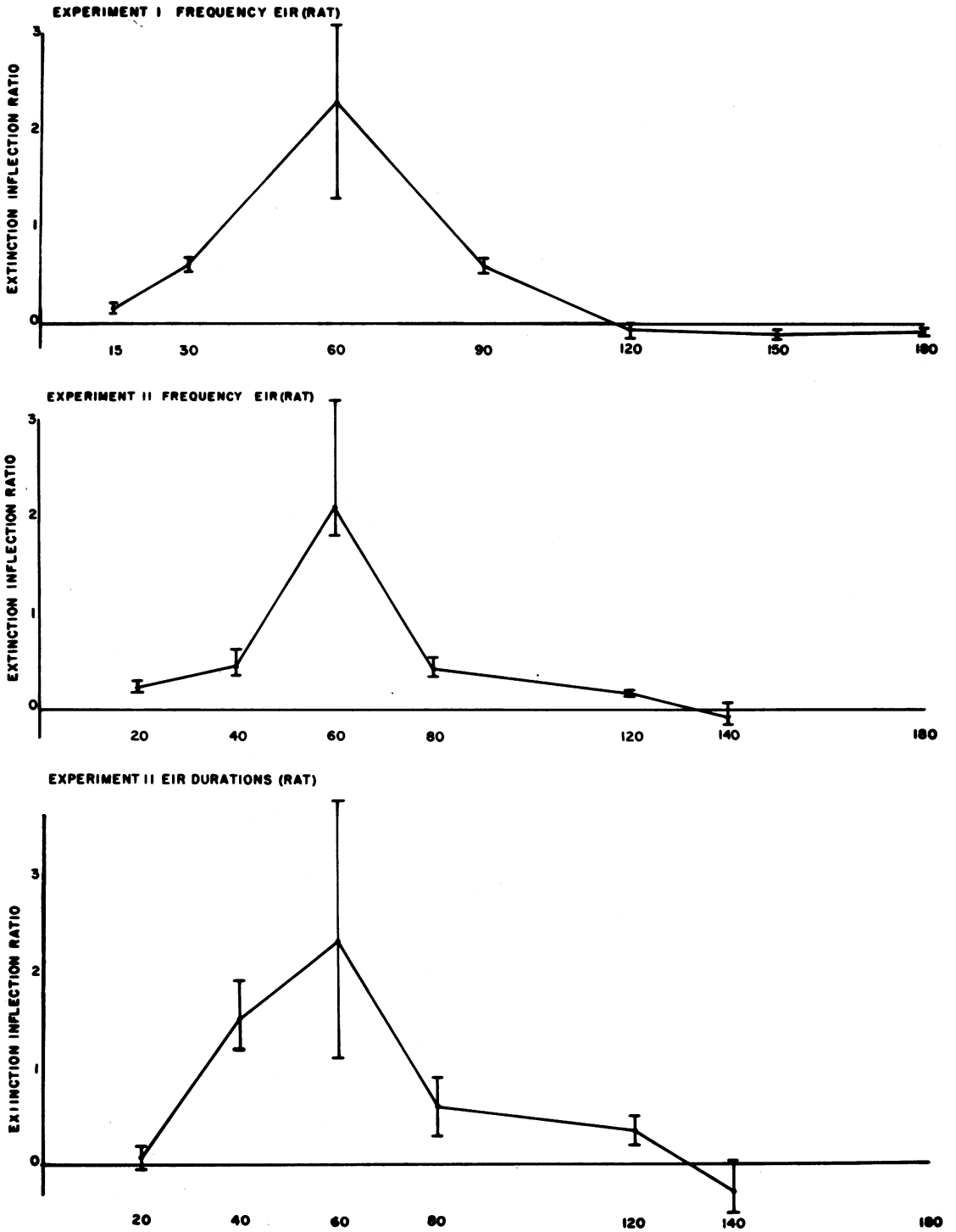


Fig. 1. Response frequency and duration Extinction Inflection Ratios as a function of the number of minutes of prior CRF training in Exp I and II (rats).

On the day of the test session the animals received 15 min of CRF as usual, but at the end of the 15th min a timer switched the animal to an extinction schedule. The training and test sessions were run on consecutive days from the first CRF session to the test session. A printout counter recorded responses at 1-min intervals beginning with the first response and terminating at the end of the 20th min after that time.

## RESULTS

The effects of these manipulations were assessed by extinction inflection ratios. These indices were designed to indicate changes in rate and were obtained by determining the relative difference between the number of responses per minute over a 10-min period prior to extinction, multiplied by two, and the average number of responses during the 2-min after extinction, applying the following formula: EIR = (average number of responses after—average number of responses before) ÷ average number of responses before. The average over a 10-min period prior to extinction was used to provide a more stable baseline from which inflections in rate could most reliably be measured. Figure 1 presents the EIRs as a function of the length of prior training. The maximum EIR was obtained following 60 min of CRF (+ 2.30) with markedly lower values at both longer and shorter amounts of training. The range in EIRs is indicated by the vertical line, and the means are the points connected by the continuous line. Despite the attempt to reduce EIR variability by using a 10-min pre-extinction sample, a sizable increase in EIR variability is seen following 60 min of prior training.

An examination of cumulative lever-press records for animals A-15, B-15, A-60, B-60 and A-180 and B-180 (receiving 15, 60, and 180 min of CRF respectively), reveals some characteristic differences in response frequency following extinction onset (Fig. 2). The 15 min subjects (*Ss*) tended to continue pressing for a short period following extinction onset with little change in rate. *Ss* receiving the longest training (180 min) emitted a very brief burst of a few responses, paused for an interval of from 30 sec to 3 min, then emitted another short burst, *etc.* The 60-min animals reacted to extinction onset with a longer, sustained burst, tending to be at a relatively higher rate than both 15- and 180-min animals.

## *EXPERIMENT II*

The following study is a replication of Exp I, and includes response duration as an additional measure of response topographical change induced by the extinction operation.

### *Subjects*

Eighteen experimentally naive, male albino Sprague-Dawley rats, 70 to 90 days old at the beginning of the experiment were used.

### *Apparatus*

The apparatus used in Exp I was also employed here. In addition, a Standard Electric Timer, accurate to .01 sec, was used to measure the length of time the contacts on the telegraph key-lever were held closed during each press. The lever was adjusted so a

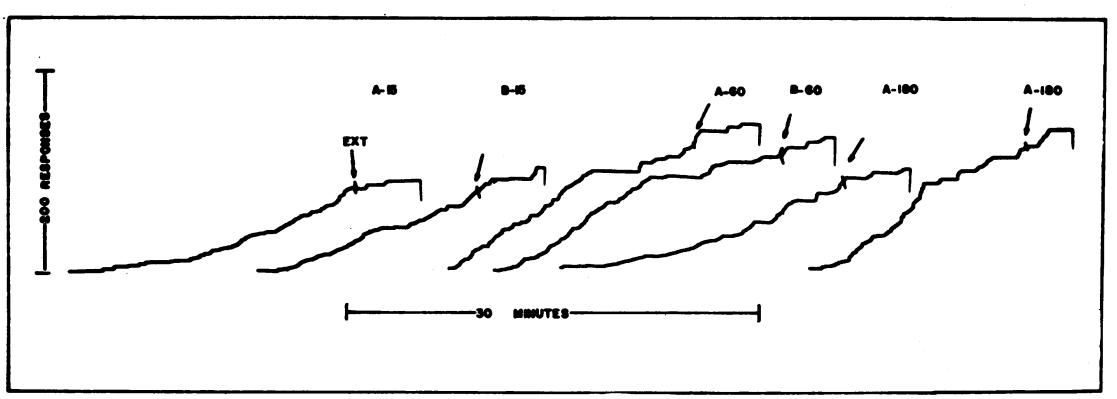


Fig. 2. Cumulative lever press records for rats A-15, B-15, A-60, B-60, A-180 and B-180, receiving 15, 60 and 180 min of CRF training prior to extinction (Exp I).

minimum of 10 grams of pressure was required to close the contacts. Both duration and number of presses were cumulated over 1-min intervals.

*Procedure*

Pretraining was the same as in Exp I. The 18 animals were randomly assigned to six groups with each group receiving a different amount of training before the extinction test session. The animals received 20, 40, 60, 80, 120 and 140 min of CRF at 20 min per session, before a 5-min extinction period.

## RESULTS

Response frequency extinction inflection ratios were calculated as in Exp I, and are presented graphically in Fig. 1. As in Exp I, the EIR curve reaches its peak at 1 hr of training and drops off sharply on either side of this point.

EIRs for response duration followed a very similar course, showing a marked increase in EIR (also calculated using a 2-min interval) after 60 min, dropping off to values of +.35 after 120 min and −.29 following 140 min in the situation (Fig. 1). Figure 3 presents the mean response duration per minute for periods of 5 min before and after the onset of extinction. The parameter for each function is the duration of CRF training prior to extinction. In all cases except the 20-min group, there is a rise in mean duration of lever pressing immediately following extinction onset above the duration immediately preceding extinction. In the 120- and 140-min groups the increase in duration lasts only 1 to 2 min as compared with durations well above the pre-extinction base durations in the 40-, 60- and 80-min groups for 4–5 min after extinction onset.

As a first approximation to the generality of this extinction effect, Exp III was conducted using children as subjects and recorded music as reinforcement.

# *EXPERIMENT III*

## METHOD

*Subjects*

Seven boys and eight girls, chronological age 62 to 69 months, selected by their teacher from a class at the University of Minnesota Institute of Child Development Nursery School, were randomly assigned to five training groups.

*Apparatus*

The manipulandum was an unpainted brass rod, approximately 6 in. long, spring-mounted in a blue-green plywood panel, 24 by 18 in. The lever was attached so that pushing or pulling it in any direction parallel to the panel would close microswitches bolted to the underside of the panel. This panel was placed on a larger, flat black table, 3 ft long by 2 ft wide, with the top slanted slightly toward *S*, who was seated facing the apparatus. A small, enclosed loudspeaker, delivering auditory reinforcers, was mounted on the under side of the table. An automatically controlled tape recorder in an adjacent room provided the auditory reinforcers. The control apparatus was programmed to reinforce the subject on a schedule, in which a response was followed by 10 sec of taped music and/or story, which then timed-out until another response was made. The tape was made from the narrated side of "Peter and the Wolf", 33⅓ rpm, Everest recording LPBR6043.

*Procedure*

The different groups were treated alike by the experimenter (*E*) except that each received a different number of reinforcements before the beginning of extinction. The reinforcement mechanism was shut off manually by *E* after the 6th, 15th, 30th, 45th or 60th reinforcement. The following instructions were used: as *S* was led into the experimental room, *E* said: "This is a new game we're going to play (pointing to the apparatus). In this game you can hear a story and music, but it's up to you to figure out what you have to do to make the story begin. I have to go next door for a minute but I'll be right back. Then we'll begin the game." With this, *E* went to the control room to turn on the recorder motor, response and reinforcement switches, and returned to the experimental room, saying: "Now we can begin."

In most cases, the *S*s responded within 1 min. If *S* obviously misunderstood the instructions, *E* would repeat them once. In the event that *S* was still clearly confused, *E* would suggest: "Perhaps that thing sticking out of

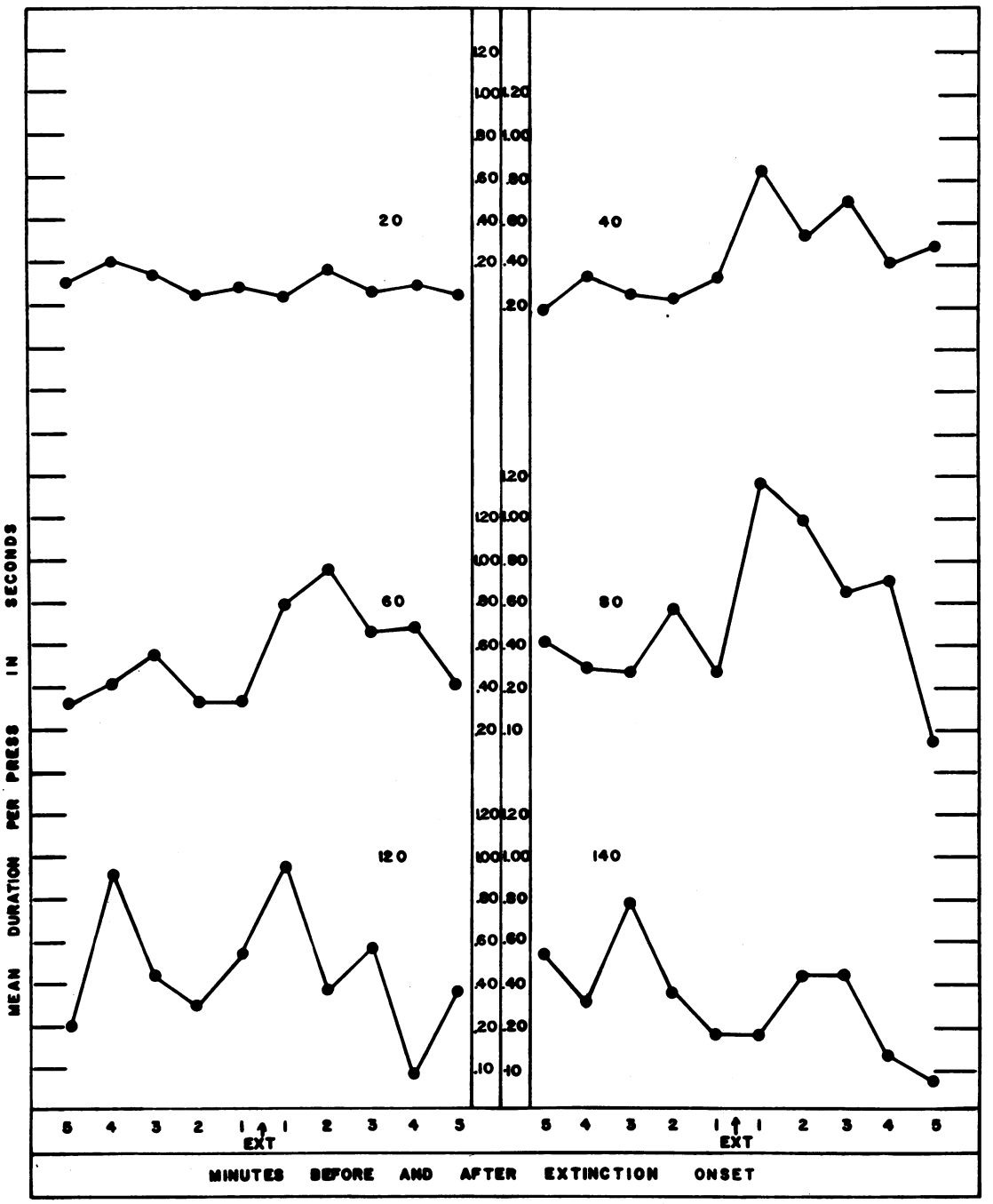


Fig. 3. Mean lever press durations per minute for 5 min before and after extinction onset, for rats receiving 20, 40, 60, 80, 120 and 140 min of CRF training prior to extinction (Exp II).

the table might have something to do with it." In the remaining cases, *S* began responding within 1 min. *E* remained in the room for two reinforcements, then said: "You can listen as long as you like. I'll be next door if you want me." *E* returned then to the control room. At the end of the extinction period, *E* entered the experimental room and told *S* that the machine had stopped working and that "we had better return to your class room."

## RESULTS AND DISCUSSION

The EIRs were calculated using the number of responses during 30 sec following extinction onset minus pressing during 30-sec pre-extinction onset, divided by the pre-extinction presses. For all *S*s an increase in rate was observed, with EIRs ranging from +.43 to +11.00 with a median of +2.00. An examination of Fig. 4 permits a comparison of training effect on the EIR with that obtained using rats. It can be seen that there is a peak early in training (15 reinforcements) and another increase later on (60 reinforcements).

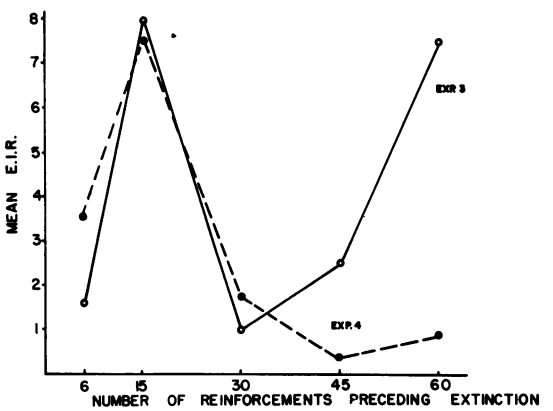


Fig. 4. Mean Extinction Inflection Ratios for children receiving 6, 15, 30, 45 and 60 music reinforcements prior to extinction (Exp III and IV).

A direct quantitative comparison of the rat and child experiments is rendered impossible because of the differences in baselines (number of reinforcements *vs.* time in the situation), differences in kind of reinforcers and motivational conditions, and differences in the measuring indices. However, certain qualitative comparisons in terms of the relative degree of acquisition of the two operants in question can be made.

It is clear from a comparison of Fig. 1 and 4 that the rise in EIR late in training distinguished the child data from that obtained in Exp I and II. A possible explanation for this effect may lie in the kind of material used as reinforcement for the present study; *i.e.*, the recording was a story building up to a definite climax. As successive reinforcements approached the climax, the reinforcing value of each 10-sec reinforcement apparently changed by some unknown value. To determine whether this may account for the difference in the shape of the rat and child curves, another study was conducted using heterogeneous material tape recorded for reinforcement purposes, with no inherent cumulative continuity.

## *EXPERIMENT IV*

### *Subjects*

Nine boys and six girls, chronological age 53-63 months, selected by their teacher from a class at the University of Minnesota, Institute of Child Development nursery school, were randomly assigned to five groups.

### *Apparatus and Procedure*

The apparatus and procedure were identical to that in Exp III except a different recording was used for reinforcement. The recording was a 33⅓ rpm Golden Record, GLP-25, consisting of a series of short children's songs.

## RESULTS

As in Exp III the EIR was based on a 30-sec interval before and after extinction onset. The data (Fig. 4) resemble those obtained in the first child study in that the maximum effect of nonreinforcement was obtained early in training (following 15 reinforcements). However, the rise seen later in training in Exp III was absent.

## GENERAL DISCUSSION

Notwithstanding the difficulties in quantitative comparisons of the rat and child data, comparability in terms of general qualitative trends can hardly be overlooked. The overall shapes of the EIR-frequency curves are very similar for the two rat studies and the second child study. This similarity suggests a common, underlying relationship between the amount of training and response to non-reinforcement.

In general, the studies described and the data presented here lead to the conclusion that the length of training differentially affects the tendency of animals to react to extinction onset by responding faster and for longer periods per response. In addition, the amount of variability in extinction response frequency and duration is differentially related to the

amount of prior training on regular reinforcement. The relationship takes the following form: (1) little or no change in frequency, duration and variability during the very earliest stages of conditioning, (2) a great increase in response frequency and duration, and in variability of frequency and duration in the early acquisition of the operant, and (3) progressive decrement in the tendency to increase frequency, duration and variability following extinction onset, with continued training beyond the stable asymptotic CRF response rate.

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