Resistance to extinction in children as a function of N-length and number of different N-lengths

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The Capaldi stimulus modification theory accounting for resistance to extinction as a function of sequential variables is tested with human Ss in a lever pulling task. The sequential variables investigated were N-length and variety of N-lengths. Response measures were (a) attention time, (b) reaction time, and (c) a verbal report as to whether and when S "gave up." Neither attention nor reaction times differed in extinction. Verbal data, however, gave support to the Capaldi hypothesis that longer and multiple N-length groups yield greater resistance to extinction than shorter and less multiple N-length groups.

The usefulness of a theoretical formulation is ultimately determined by its empirical comprehensiveness. The first step in arriving at a theoretical breadth is to test the applicability of the formulation within its original empirical matrix, e.g., types of Ss, experimental contexts, and response measures. The present investigation addresses itself to the empirical generality of the Capaldi stimulus modification hypothesis (1966) in accounting for resistance to extinction (R_n). Though the hypothesis is well supported by studies specifically designed to test its implications (Capaldi, 1966), generality is limited to laboratory rats as Ss, runway apparatus as experimental context, and runway speed as an index to R_n . This study utilized elementary school children as Ss, a lever apparatus as experimental context, and runway speed as an index to R_n .

CAPALDI HYPOTHESIS

The Capaldi stimulus modification hypothesis states that sequential variables in acquisition schedules of reinforcement are the determining factors of partial reinforcement in extinction. Nonsequential variables, e.g., percentage of reinforcement (Spivey, 1967), are hypothesized to be but negligible factors in contributing to the extinction phenomenon. There are three basic variables relevant to the Capaldi position: (a) N-length (number of successive nonreinforced trials prior to receiving a reinforced trial), (b) the variety of N-lengths occurring in the sequence, and (c) the frequency of occurrence of each given N-length (habit strength). The present investigation addressed itself to the first two of these variables.

According to the Capaldi hypothesis both nonreinforced (N) and reinforced (R) trials evoke an internal behavior which provides a source of potent internal stimuli or cues, i.e., aftereffects which follow nonreinforcement, S^N , and those which follow reinforcement, S^R . Each successive N trial occasions a modification of the preceding stimulus aftereffect, S^N . As the number of successive N trials increases, the resultant modification of each successive S^N value decreases; hence, given a large number of N trials, modification approaches zero. Thus, as an N-length increases in size, the stimulus aftereffect, S^N , approaches more closely the limit of stimulus modification; hence, the S^N values further along the modification continuum are more alike than those which precede them, e.g., $S^{N_{30}}$ and $S^{N_{31}}$ are more alike than are S^{N_2} and S^{N_3} . When an R trial occurs, the preceding S^N value (e.g., S^{N_5}) becomes conditioned to the instrumental response. As a consequence of habit strength generalization, S^N values which follow the conditioned S^N value on the modification continuum also tend to become associated with the instrumental response. Hence, during extinction all S^N values

falling under the generalization gradient, with varying probability, tend to elicit the instrumental response. As there is less and less difference between successive modifications of S^N , the habit strength generalization gradients of longer N-lengths incorporate more S^N values of the stimulus modification continuum than do shorter N-lengths. Thus, as a longer N-length group incorporates (a) values of S^N further along the modification continuum, and (b) a greater number of S^N values under its respective generalization gradient than does a shorter N-length group, R_n is correspondingly greater in the longer N-length group. N-length was relevant to the present study.

Capaldi hypothesizes further that, given multiple N-lengths (a variable ratio schedule of reinforcement), the S^N values associated with each of the N-lengths are conditioned to the instrumental response. The habit strength generalization gradients of each S^N value summate such as to incorporate greater numbers of subsequent S^N values than any single N-length appearing in the reinforcement schedule (that is, assuming each of the S^N values has arrived at asymptotic habit strength). Thus, it is hypothesized that R_n is greater in multiple N-length groups than in singular or less multiple N-length groups. This variable also is relevant to the present study.

EXPERIMENTAL DESIGN

In the present study, there were three experimental groups and one control group. The first experimental group (GR12) included N-lengths of one and two, the second group (GR15) N-lengths of one and five, and the third group (GR125) N-lengths of one, two, and five. The control group (GRc) was placed on a continuous reinforcement schedule, i.e., all R trials. In Groups GR12 and GR15, R_n as a function of N-length was of concern; the values S^{N_2} and S^{N_5} were compared. Two N-lengths were employed in each of these two groups so as to avoid possible patterning often found in FR schedules of reinforcement. In Group GR125, R_n as a function of summation was of concern. As Group GR125 contained no N-length larger than S^{N_5} , any increase in R_n over GR15 could only be attributable to the summation of S^{N_1} , S^{N_2} , and S^{N_3} habit strength generalization gradients.

In all three experimental groups control for the following variables was provided: (a) percentage of reinforcement (50%), (b) number of acquisition trials (96), (c) patterning effects (by implementing a VR reinforcement schedule), and (d) habit strength for each S^N value (by adopting a criterion of asymptotic habit strength). There appears to be some evidence that number of trials to asymptotic habit strength is a function of phylogenetic position, e.g., fish require substantially more occurrences of each S^N value (e.g., Gonzales, Eskin, & Bitterman, 1963) than do rats which require some 10 occurrences of the same S^N values (Capaldi, 1964). There is evidence indicating that human Ss require yet fewer occurrences of each S^N value for arriving at asymptotic strength (e.g., Baumeister & Hawkins, 1966). On the basis of such evidence, it was assumed that six occurrences of each S^N value would be adequate for arriving at a level of asymptotic habit strength.

During acquisition, in accord with previous research findings with children (Ryan & Watson, 1968), partial groups were predicted to arrive at higher asymptotic levels of performance than GRc. In accord with the Capaldi position, R_n for each group was predicted to be least to most in the following order: GRc, GR12, GR15, and GR125.

METHOD

Forty-eight children, ages 7 to 9, were randomly selected from the second and third grades of Sitton Elementary School in the North Portland School District.¹ Twelve Ss were randomly assigned to the three experimental and the control groups. Each group was equated for sexes.

A modified version of a lever pulling apparatus, designed by Pederson (1967) to measure frustration effects in acquisition, was utilized. At the onset of a light, S released a button and pulled down a lever. This lever action provided access to a small door which when opened revealed either a reward or nonreward stimulus card (blue or white). Ss were immediately rewarded small M&M candies on reward trials. The candies were placed by E in a small plastic sack which S had in his possession. Response measures included attention time (onset of light and release of button), reaction time (button release, lever pulling, and door opening), and a verbal report as to whether and when the S "gave up" during extinction.

The procedure consisted of two experimental sessions with each S. On Day 1, Ss (a) received instructions and a few practice trials, (b) were given 10 more practice trials for establishing a base rate, and (c) were given 72 acquisition trials. On Day 2, Ss were given 24 acquisition trials and 50 extinction trials. Each S was run at the same hour on successive days. All 48 Ss were run in a random order irrespective of group membership; hence, groups did not differ in respect to their order of testing. Both acquisition sessions were initiated and terminated with R trials. All N-lengths were presented in random order, though each S in a given group was presented the same order. The number of R trials in succession varied randomly between one and seven depending upon the group in question.

RESULTS AND DISCUSSION

The analysis of variance on reaction time acquisition data yielded a significant main effect between groups ($F = 4.21$, $df = 3/44$, $p < .01$) and a significant main effect within groups over 13 blocks of eight trials ($F = 14.48$, $df = 12/528$, $p < .01$). A Newman-Keuls post hoc analysis showed each of the partial groups to reach a higher level of asymptotic performance than GRc ($p < .01$), but showed no significant differences among partial groups. This finding is in accord with the literature recently reviewed by Ryan & Watson (1968). The analysis of variance on attention time acquisition data, however, yielded no significant effects.

Analysis of reaction time extinction data showed no significant effects. Relevant to the question of why extinction was not evidenced, a combination of the following possibilities is suggested: (a) reaction time may be a poor index of Rn as well as being insensitive to reward pattern; (b) an insufficient number of extinction trials may have been employed; and (c) performance data may well have been a function of instructional variables.² First, by the very nature of the task, S had no alternative but to continue responding in the presence of all values of S^N . Second, responses elicited by frustration were perhaps "forced," as a consequence of instructional set, to yield facilitatory rather than interference effects. Rats, for example, in maze apparatus are free to respond to frustration by not responding or by engaging in some competing response. Ss in the present study were required to respond by E

regardless of outcome. The verbal data which follows provides considerable weight for Part c above.

Following the extinction session each S was asked if he had expected to receive further reward stimulus cards. If S's answer was affirmative he was assigned a score of 4, indicating that he had not "given up." If S's answer was negative he was then asked if he "gave up" at the beginning, middle, or end of the session. Scores 1, 2, and 3 were assigned to verbal reports beginning, middle, and end, respectively. An analysis of variance ($F = 8.75$, $df = 3/44$, $p < .01$) and a Newman-Keuls post hoc analysis yielded significant differences in the predicted direction as follows: (a) $GR12 > GRc$ ($p < .05$); (b) $GR15 > GRc$ ($p < .03$); (c) $GR125 > GR12$ ($p < .01$); and (d) $GR125 > GR15$ ($p < .04$). Though there were no significant differences between GR12 and GR15, the means were ordered in the predicted direction ($\bar{X}_{15} > \bar{X}_{12}$). It should be noted, however, that GR15 received three scores of 4, whereas GR12 received no scores of 4. A score of 4 does not provide information as to when an S might have "given up" in a more extended extinction phase. Hence, Rn differences between GR12 and GR15 may have been necessarily diminished as a function of having to group all Ss who did not "give up" into the same classification category. As a whole, the verbal measure yielded data well in support of the Capaldi hypothesis: $GR125 > GR15 >$ (but not significant) $GR12 > GRc$. This finding is significant in its implications for a greater empirical comprehensiveness of the stimulus modification theory in accounting for resistance to extinction.

In summary, the following results were obtained: (a) differential asymptotic levels of performance in acquisition as in accord with previous frustration research with children, (b) lack of correspondence between performance and verbal extinction measures, and (c) verbal data in support of the Capaldi position.

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NOTES

1. The authors are indebted to Mr. W. Moore, Principal of the Sitton School, for his personal interest in the project, and to the teachers and children who participated in the study.

2. D. R. Pederson, in a personal communication, indicated that he also found response speed measures to be insensitive to reward pattern (Department of Psychology, University of Western Ontario; London, Canada).