# EFFECTS OF INCENTIVE VALUE AND PERCENTAGE OF REINFORCEMENT ON AQUISITION AND EXTINCTION OF AN INSTRUMENTAL RESPONSE IN CHILDREN

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ABSTRACT

EFFECTS OF INCENTIVE VALUE AND PERCENTAGE OF REINFORCEMENT ON ACQUISITION AND EXTINCTION OF AN INSTRUMENTAL RESPONSE IN CHILDREN

By

Andrew Ralph Gilpin

Forty kindergarten children were each assigned to one of four treatment groups formed by simultaneously manipulating incentive value (high, i.e. toy, vs. low, i.e. no toy) and reinforcement schedule (random 50 percent, i.e. PRF, vs. 100 percent, i.e. CRF). The children first pulled a lever to receive marble rewards for 60 trials, and then made 30 additional responses during which no rewards were given. Latency and duration of each response were noted.

Results suggested that boys and girls reacted differently: in general, boys responded faster. However, the sex variable interacted with other variables. The partial reinforcement acquisition effect (PRAE) was observed, but not the partial reinforcement extinction effect (PRE). Girls who received the high incentive treatment had longer latencies than girls who received the low incentive treatment, and than boys in either incentive condition, but only during the acquisition phase. Latencies of high incentive Ss (regardless of sex) who had experienced CRF did not differ from those of low incentive Ss who had experienced PRF at the beginning of the extinction phase, but by its end, the former had longer latencies. While there were no overall sex differences in movement duration at the beginning of the extinction phase, by the end of the phase girls had longer durations than boys.

Methodological implications for future research were discussed. Theoretical interpretation emphasized the utility of cognitive dissonance theory.

Accepted [signature]

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By

Andrew Ralph Gilpin

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DEDICATION

For my mother, who taught me how to write, and my father, who taught me to read what I had written.

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# INTRODUCTION

The partial reinforcement acquisition effect (PRAE), the phenomenon of superior asymptotic performance level of an instrumental response by subjects (Ss) receiving partial reinforcement schedules to that of Ss receiving continuous reinforcement, has been noted frequently in studies where children performed a lever pull task (Chertkoff, 1968; Nakamura, 1969; Pederson, 1970; Ryan, Orton, & Pimm, 1968; Ryan, Strawbridge, & Watters, 1969; Ryan & Watson, 1968; Semler & Pederson, 1968). On the other hand, the partial reinforcement effect (PRE) refers to greater resistance to extinction in Ss reinforced on a random partial reinforcement schedule (or PRF, henceforth assumed to be 50 percent unless otherwise indicated) during acquisition compared with those Ss who received 100 percent or continuous reinforcement (CRF).

The PRE has been successfully demonstrated with a variety of infrahuman species (Bitterman & Schoel, 1970); but attempts to demonstrate the PRE in children with the lever apparatus have often been unsuccessful, when the dependent variable was latency, duration, or amplitude of response (Bruning, 1964; Holton, 1961; Rosenbaum & Bruning, 1966; Ryan & Voorhoeve, 1966. These variables are not all highly correlated: cf. Cantor & Kubose, 1970). However, as Ryan and Voorhoeve (1966) pointed out, when rate of lever pulling (responses per unit time) or trials until the child quit responding have been measured, the PRE has been observed (Baumeister & Hawkins, 1966; Bijou, 1957; Chertkoff, 1968; Fattu, Mech, & Auble, 1955; Kass, 1962; Kass & Wilson, 1966; Lewis, 1960; Nakamura, 1969). One study, reported by Chertkoff (1968), found that regardless of whether Ss were required to continue responding, or were free to quit whenever they wished, movement speeds did not reveal the PRE; but more Ss who had received CRF during acquisition quit before completing 30 extinction trials than did Ss who had received PRF.

Thus, while it is clear that the PRAE can be demonstrated in children using lever pull speed as a measure of performance, the status of the PRE in this context is less clearcut.

Incentive value is another variable which has been found to influence children's performance, particularly in probability and discrimination learning tasks, where investigators have frequently found that increased incentive level facilitates performance (e.g., Bisett & Rieber, 1966; Brackbill & Jack, 1958; Offenbach, 1964), although in some cases, low incentive groups did better (Miller & Estes, 1961; Stevenson & Hoving, 1964; Stevenson & Weir, 1959). Efforts to extend such findings to a lever apparatus, using marbles as rewards, have been generally unsuccessful. Ryan (1965) asked kindergarten children to rank six toys prior to a series of lever pulls. He told half of them that if they "won the game" they would receive their most-preferred toy; he told the other children that if they won, they would receive their least-preferred toy. In addition, half of each group received a PRF schedule; the other half received CRF. Although Ryan did find evidence of the PRAE, incentive value did not influence response level.

Ryan and Moffitt (1966) performed a study similar to Ryan's, but made three modifications. First, only one lever was involved (Ryan, 1965, used two levers). Second, in addition to kindergarteners, preschool Ss were included. Third, the incentives were a ten-cent toy (high) and a piece of string (low). Ryan and Moffitt found that for kindergarteners, there was no Schedule X Incentive interaction for starting (reaction) speeds. For preschoolers, the PRF low incentive group performed faster than the PRF high incentive group; there were no differences between CRF groups. With respect to movement speeds (speed of response completion once begun), there was no significant Schedule X Incentive interaction for either age, but low incentive Ss increased speed over trials faster than high incentive Ss (cf. Watson, 1967).

Sheikh (1968) manipulated goal distance at which delay of reward was introduced when kindergarten children pulled a lever. He used two incentive conditions: high (preferred toy) vs. low (a balloon), and found no differences in either starting speed or movement speed as a function of incentive.

None of the above studies reported significant main effects for the incentive manipulation. Possible explanations of the failure to obtain reliable differences due to varied incentive value are that differences between low and high incentive conditions were not great enough, or that the task itself, which was invariably presented as a game, was intrinsically so interesting that it masked the effect of incentive differences (Ryan, 1965; Sheikh, 1968). The latter possibility is supported by studies successfully demonstrating the PRAE or the PRE where marbles could not be redeemed for a toy at the end of the session (Chertkoff, 1968; Ryan, et al., 1968; Ryan, et al., 1969), as well as by the positive results obtained in learning tasks.

An issue closely related to incentive value is the function served by marble rewards. The early experiments in the lever pull task frequently provided that marbles could be redeemed at the end of the experiment for a prize (Ryan & Watson, 1968), and when this is the case, marbles are true token reinforcers. However, in at least one study, children kept the marbles they had won (Chertkoff, 1968). In other instances, Ss could only see the marbles (e.g., Nakamura & Ellis, 1964; Ryan, et al., 1968; Ryan, et al., 1969). In these instances it is possible that the marbles served only an information function, i.e. they indicated to S that he was playing the game well (despite the fact that reward contingencies were independent of response level). The distinction is particularly important in view of Watson's (1970) speculation that Ss may be either "reinforcer-oriented" or "solution-oriented."

Since in some sense Ss who participated in experiments where prizes were given presumably experienced higher incentive motivation than Ss who participated in studies where no prizes were given, some experimenters have implicitly used a high incentive condition, and others have used a low incentive condition. All have made the tacit assumption that whether or not marbles were tokens was independent of such phenomena as the Frustration Effect, the PRAE, and the PRE. This assumption is consistent with failure to find differences due to incentive value, as well as with studies which did not use marble rewards but nonetheless demonstrated the PRAE (e.g., Bruning, 1964; Ryan & Watson, 1966; Watson, 1967). But it is difficult to reconcile with Ryan and Moffitt's (1966) finding of an Incentive X Schedule interaction in preschoolers, as well as with Terrell's (1958) work with discrimination learning and Walters and Foote's (1962) work with probability learning: in both of the latter instances, performance was better for children who received token reinforcers than for children who received rewards that were merely informative.

While incentive value manipulations have been attempted within the context of the Frustration Effect (Ryan, 1965), the PRAE (Ryan & Moffitt, 1966), and goal distance (Sheikh, 1968), the possible interaction between incentive value and reinforcement schedule as they affect resistance to extinction has not received empirical attention vis a vis lever pull studies with children. Equally important, since the situation where there is no prize at the end of the experiment constitutes the most extreme instance of a low incentive condition, its inclusion in the present study provides the most rigorous possible test of the theory that previous studies did not include a sufficiently wide range in incentive value.

The present study was designed to accomplish several ends: (1) to provide a more sufficient manipulation of incentive value than previous research; (2) to extend study of the incentive variable to an extinction phase; (3) to provide additional evidence with regard to the issue of whether the PRE can be observed using response speed as a dependent variable, under conditions where S is required to continue responding; and (4) to resolve the methodological issue of whether or not allowing Ss to exchange marbles for a prize affects the PRAE, the PRE, or both.

## Method

### Subjects

Forty kindergarten children (Mean CA=5 years 6 mo., SD=5 mo.), 23 boys and 17 girls, were each assigned to one of four groups according to incentive value (high vs. low) and schedule (CRF vs. PRF). Ten Ss were assigned to each of the groups. Assignment to schedule condition was random. In order to prevent low incentive Ss from being aware that some other children were winning prizes, all Ss in each of two classes were assigned to the same incentive value. Subjects from a third class were randomly assigned to the two conditions, but all those designated as low incentive Ss were tested before their high incentive classmates.[1]

Apparatus

The apparatus has been described elsewhere (Davidson & Fitzgerald, 1970). In the present study, the second and third levers of the Davidson and Fitzgerald triple lever console were removed and their slots covered flush with the surface.

The basic unit was a console approximately the height of an elementary school desk. The lever was mounted on the front panel, which measured 22 in. by 30 in.. The lever moved from right to left along a 16 in. slot, located toward the rear of the console; it protruded approximately six inches above the surface of the console, and had a plastic handle. A small green arrow located directly in front of the initial position of the lever acted as a cue for lever movement. The S was seated on a chair in front of the console, the height of which could be adjusted so that the lever was in easy reach.

When the arrow lighted up (it was controlled by a switch on the control unit, described below), signalling the start of a trial, a timer was started automatically. This timer, which measured latency of response, was contained in a control unit connected to the console by a cable; one E operated this unit and recorded data. Initial

[1]The project was approved by the school board, the principal, and teachers. Parents were sent a letter explaining the study; only children who returned permission slips were used as Ss. Each child was asked if he wished to participate prior to the session; two did not and were not run as Ss. Data sheets were coded so that anonymity was ensured.

movement of the lever activated a magnetic reed switch, which stopped the latency timer and started a second timer (movement duration). When the lever was moved to the end of its slot, this second timer was automatically stopped. Hence measures of latency and movement times were available for each response.

Mounted on the left side (as S faced the apparatus) of the console was a plastic tube down which a second E manually dispensed marbles on rewarded trials. The tube terminated in a small metal cup. The second E sat behind the console, facing S; when E dropped a marble down the tube his hand was hidden from S's view by a shield. The child took the marble and deposited it in a goal box located on his right. The goal box was essentially a painted cigar box with a hole in the top; it prevented S from examining the accumulated marbles between trials, and controlled for the goal distance factor sometimes found in such studies (Holton, 1961; Pederson & McEwan, 1970. Ryan & Voorhoeve, 1966, suggested the use of such a box.).

Other materials included clear glass marbles of different colors, a variety of inexpensive toys such as small cars and modelling clay, a stopwatch for timing intertrial interval, a counter used by E to record trial number, and a set of pictures of Disney cartoon characters.

## Procedure

Subjects were tested individually in a room provided by the school. The E briefly interacted with S and then gave one of the following directions:

(Low Incentive Condition) "Do you like to play games, ____? Well, you can play our game here today. But first I have some pictures I'd like to show you. Maybe you recognize some of them -- is there anyone you know? Which is your favorite? (The child chooses from the cartoon pictures) I like that, too. But now let's play the game. To play you sit with your hands in your lap and watch this arrow. As soon as it lights up (demonstration), you move this lever all the way over to the end of the slot. Do you think you can do that? When you move the lever, sometimes you'll get a marble -- it'll roll down this tube into the cup here. When you get one, pick it up and drop it into this box. If you can get enough marbles, then you'll win the game."

(High Incentive Condition) "Do you like to play games, ____? Well, you can play our game here today. But first I have some toys I'd like to show you. If you can win the game, you may keep one of these toys. Which is your favorite? (The child chooses) All right. We'll put that over here (next to goal box), and if you win, you may keep it. But now let's play the game. To play, you sit with your hands in your lap and watch this arrow. As soon as it lights up (demonstration), you move this lever all the way over to the end of the slot. Do you think you can do that? When you move the lever, sometimes you'll get a marble -- it'll roll down this tube into this box. If you can get enough marbles, then you'll win the game and you can keep the toy."

Low incentive Ss looked at the pictures to control for social interaction experienced by high incentive Ss while they chose their toys. The E who interacted with S and administered marble rewards was always male (there were four such Es).

All Ss were then asked, "Do you understand? We'll try a couple of practice times first, and then start to play. Remember, watch the arrow, and as soon as it lights up, move the lever. Ready?" The "Ready?" was actually a cue to the second E running the controls, telling him to turn on the arrow light. After two rewarded trials (more if S seemed confused), the acquisition phase began. All Ss received 60 acquisition trials, spaced eight to ten seconds apart starting from completion of lever movement. After rewarded trials, S deposited the marble in the goal box during this period; E returned the lever to its initial position. Onset of each trial was signalled with "Ready?"; if S was not orienting to the arrow, "Watch the arrow!" was added.

For the PRF condition, the 60 trials were composed of 15 blocks of four trials each, with two rewards in each block; order within blocks was random. All Ss received the same schedule: RNRN,RRNN,RNRN,RNNR,RNRN,NRNR,RRNN,NRNR,NNRR, RNRN,NNRR,RRNN,NNRR,NNRR,RRNN. All CRF Ss received a marble after each of the 60 responses.

After S received the 60 trials of the acquisition phase, the extinction phase began. All Ss received 30 extinction trials, with no rewards administered. On the last trial, the response resulted in delivery of a final marble. Then

E told all Ss they had won the game. High incentive Ss received their toys. The Ss were accompanied back to their classrooms.

After the session had begun, E responded to Ss' comments only by saying "That's the way the machine works;" no other comments were made by E. Because of the potential social reinforcement involved (cf. Ryan & Watson, 1966), a record was kept of all such comments.[2] When all experimental Ss had been run, toys were given to children who had not already received them.

## Results

Because of the possibility of contradictory conclusions arising from the use of speed versus time measures in a skewed distribution (Edington, 1960), prior to analysis a logarithmic transformation was performed on raw data, which were expressed in units of hundredths of a second. In an effort to reduce some of the error variance, the analysis treated sex as an independent variable. Because in three of the four Incentive X Schedule cells there were six boys and four girls, data from boys were discarded (along with that of one girl) randomly so that four boys and four girls remained in each cell (i.e., total N = 32). It was felt that since this approach necessitated a rather complex analysis, and since only the beginning and end trials of the two phases, acquisition and extinction, were really of

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[2] A one-way Analysis of Variance (Winer, 1962, p. 55) of the numbers of comments in each of the eight Incentive X Schedule X Sex cells failed to reveal significant differences [$F(7,24)=1.56$, $p>.10$].

relevance in testing the hypotheses of interest, data from intervening trials in each phase could be omitted without invalidating the results (Obviously, this procedure precluded any examination of the shape of performance curves, e.g. with respect to linear vs. quadratic trend.).

Hence the means of trials 1 through 4; 57 through 60; 61 through 64; and 87 through 90 -- i.e., the first and last four trials of acquisition and extinction -- were treated as the "raw" data, prior to transformation. Separate analyses were performed for the two phases, and latency and movement times were treated separately. The Analysis of Variance design used in all four instances was an extension of a Lindquist (1953, pp. 281-284) Type III mixed design, with repeated measures on Factor C (Trials). The design involved Between-S effects for A (Incentive Value), B (Schedule), D (Sex), AXB, AXD, BXD, and AXBXD; Within-S effects were C (Trials), AXC, BXC, CXD, AXBXC, AXCXD, BXCXD, and AXBXCXD (2x2x2x2 levels).

All means reported are in units of $Log_{10}$(seconds x 100). Thus, for example, the mean latency value over all Ss and trials was 2.101, and the mean for duration was 1.716; their antilogs are 1.262 seconds and 0.520 seconds respectively.

Acquisition Phase, Latency

Table 1 and Figures 1 and 2 present the mean latency scores; the analysis appears in Table 2. As can be seen, there was a significant sex effect: boys responded faster than girls. There was also a significant Incentive X Sex interaction. *A posteriori* comparisons by use of the Newman-Keuls procedure (Winer, 1962, pp. 80-85; 210) revealed that girls in the high incentive condition had significantly ($p<.01$) longer latencies than girls in the low incentive condition, or boys in either incentive condition; the latter three groups did not differ significantly from one another. The main effect for trials was significant: latencies were shorter at the end of the acquisition phase than at the beginning. There was a quadruple interaction between incentive, schedule, trials, and sex, appearing in Figure 1. Most of the differences represented were not reliable. Analysis by means of the Newman-Keuls procedure revealed that the only significant differences occurred among certain high incentive groups: PRF males at the end of acquisition had significantly shorter latencies than CRF females at the beginning of acquisition ($p<.01$), the PRF females at the beginning of acquisition ($p<.05$), and the PRF girls at the end of acquisition ($p<.05$). No other differences were significant. In addition, there was a trend toward shorter latencies for low incentive *S*s compared with high incentive *S*s, but it failed to reach statistical significance.

Because there was substantial *a priori* evidence predicting the PRAE, several planned comparisons were performed on the Schedule X Trials interaction, despite the low statistical significance level for the effect itself (For a defense of this technique, see Winer, 1962, p. 85). The data appear in Figure 2. There was no significant difference

Table 1. Acquisition Latency Means for Significant Effects.

| Level(s) | Mean [In Log(sec's x 100)] |
|---|---|
| Effect: D(Sex) | |
| Males | 2.080 |
| Females | 2.145 |
| Effect: AXD(Incentive X Sex) | |
| Low, Males | 2.085 |
| Low, Females | 2.100 |
| High, Males | 2.076 |
| High, Females | 2.190 |
| Effect: C(Trials) | |
| Trials 1-4 | 2.133 |
| Trials 57-60 | 2.093 |
| Effect: A(Incentive) | |
| Low | 2.092 |
| High | 2.133 |

Note.--See Figures 1 and 2 also.

Table 2. Acquisition Latency Analysis of Variance.

| Source | df | MS | F |
|---|---|---|---|
| Between Ss | 31 | | |
| A(Incentive) | 1 | 0.02646832 | 3.364[a] |
| B(Schedule) | 1 | 0.00256676 | 0.326 |
| D(Sex) | 1 | 0.06715022 | 8.534** |
| AXB | 1 | 0.00063693 | 0.081 |
| AXD | 1 | 0.03830930 | 4.868* |
| BXD | 1 | 0.00789463 | 1.003 |
| AXBXD | 1 | 0.00208131 | 0.264 |
| Error | 24 | 0.00786883 | |
| Within Ss | 32 | | |
| C(Trials) | 1 | 0.02588495 | 7.011* |
| AXC | 1 | 0.00023289 | 0.063 |
| BXC | 1 | 0.00499422 | 1.353 |
| CXD | 1 | 0.00136490 | 0.370 |
| AXBXC | 1 | 0.00015912 | 0.043 |
| AXCXD | 1 | 0.00142479 | 0.386 |
| BXCXD | 1 | 0.00465070 | 1.260 |
| AXBXCXD | 1 | 0.02059552 | 5.578* |
| Error | 24 | 0.00369202 | |

[a] .05<p<.08
*p<.05
**p<.01

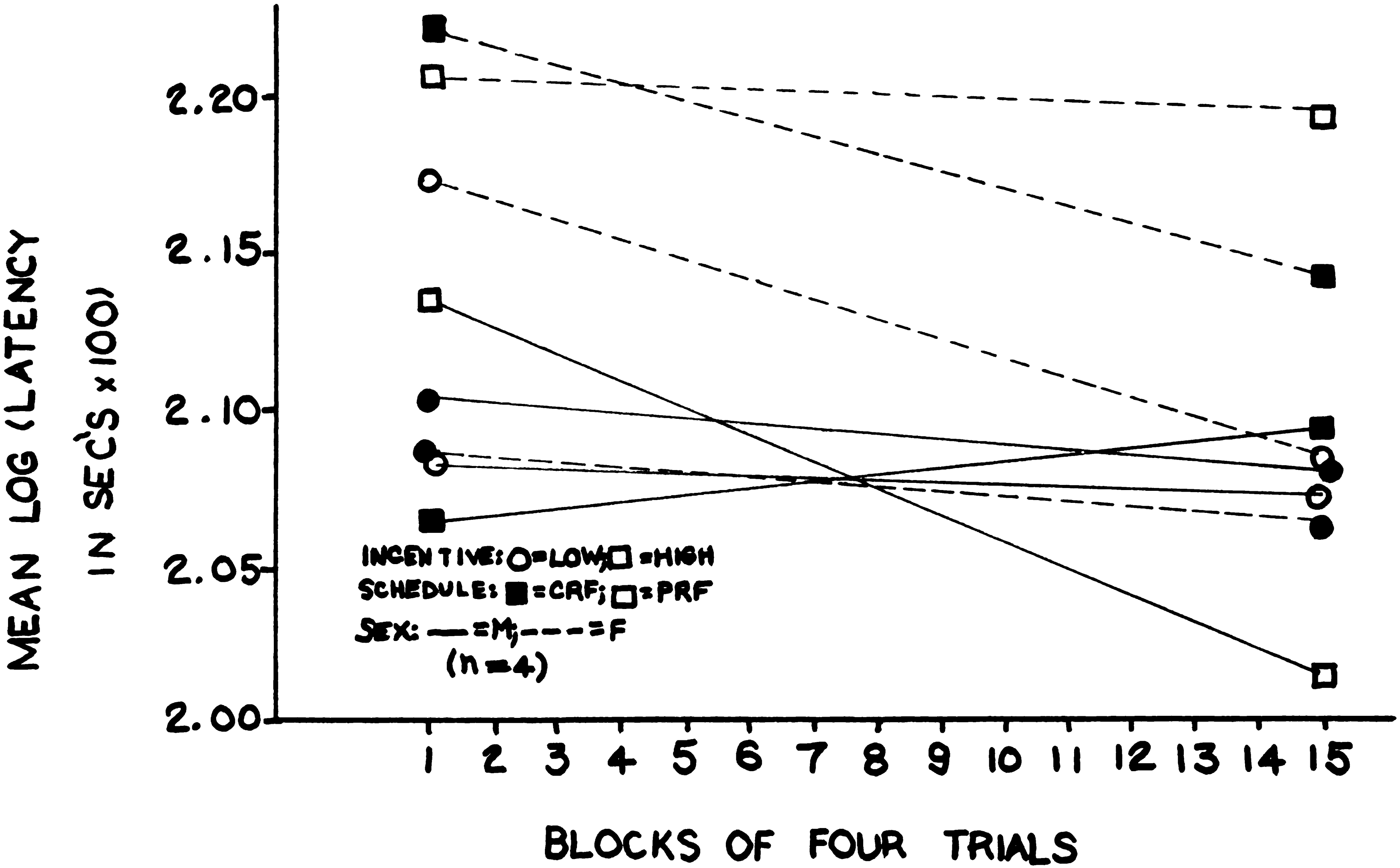


Figure 1. Mean acquisition latency as a function of incentive, schedule, sex, and trials.

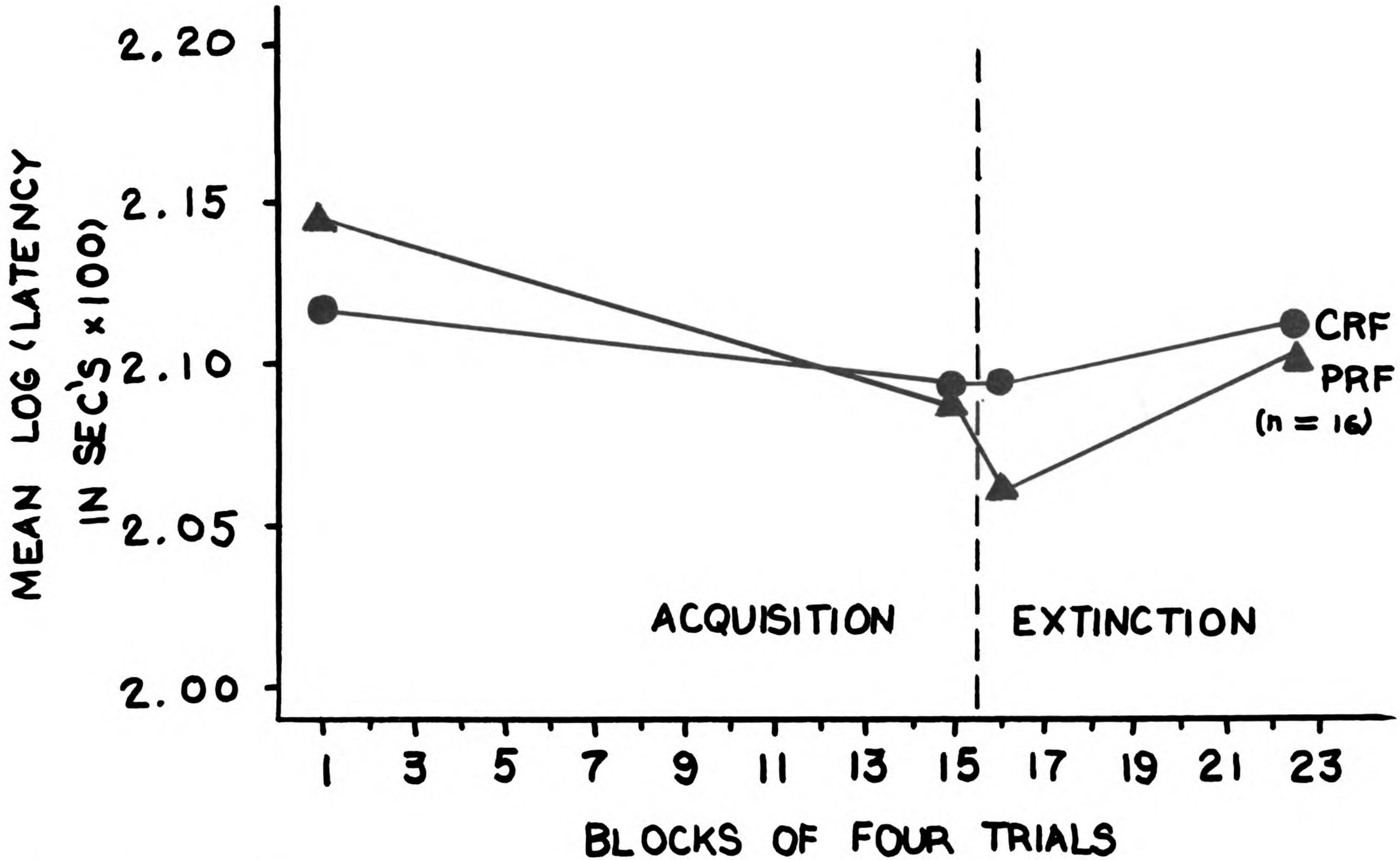


Figure 2. Mean latency as a function of schedule and trials.

between CRF and PRF Ss at the beginning of acquisition [F(1,24)=1.99] ; there was no significant difference between the two groups at the end of acquisition [F(1,24)=0.54]; there was no significant difference in the interaction defined by magnitude of the decrease in latency over the phase for the two schedule groups [F(1,24)=1.35] . That is, the PRAE was not obtained using latency as the dependent variable.

Acquisition Phase, Movement Duration

The analysis appears in Table 3. The only effect approaching significance was the Schedule X Trials interaction, represented in Figure 3. Again, planned comparisons were performed. While schedule groups did not differ significantly at the beginning of acquisition [F(1,24)= 0.30] , by trials 57-60 CRF Ss had longer movement durations than PRF Ss [F(1,24)=6.62, p<.05], and the interaction defined above and indicated in Figure 3 was significant [F(1, 24)=4.95, p<.05] . The PRAE was obtained using this measure.

Extinction Phase, Latency

Latency data appear in Table 4 and Figures 2 and 4; the analysis appears in Table 5. As was true for the acquisition phase, there was a trend toward shorter latencies among Ss in the low incentive condition than for those in the high incentive group, but it fell short of statistical significance.

Again, while the expected overall Schedule X Trials interaction was not observed planned comparisons were performed. There was no significant difference between PRF

Table 3. Acquisition Movement Duration Analysis of Variance.

| Source | df | MS | F |
|---|---|---|---|
| Between Ss | 31 | | |
| A(Incentive) | 1 | 0.07131194 | 2.226 |
| B(Schedule) | 1 | 0.03182726 | 0.994 |
| D(Sex) | 1 | 0.05669062 | 1.770 |
| AXB | 1 | 0.00342583 | 0.107 |
| AXD | 1 | 0.01591697 | 0.497 |
| BXD | 1 | 0.00015366 | 0.005 |
| AXBXD | 1 | 0.04355784 | 1.360 |
| Error | 24 | 0.03202889 | |
| Within Ss | 32 | | |
| C(Trials) | 1 | 0.02666921 | 1.724 |
| AXC | 1 | 0.03139146 | 2.023 |
| BXC | 1 | 0.07560439 | 4.888* |
| CXD | 1 | 0.00591433 | 0.382 |
| AXBXC | 1 | 0.00861612 | 0.557 |
| AXCXD | 1 | 0.00580087 | 0.375 |
| BXCXD | 1 | 0.01939288 | 1.254 |
| AXBXCXD | 1 | 0.00231386 | 0.150 |
| Error | 24 | 0.01546849 | |

*p<.05

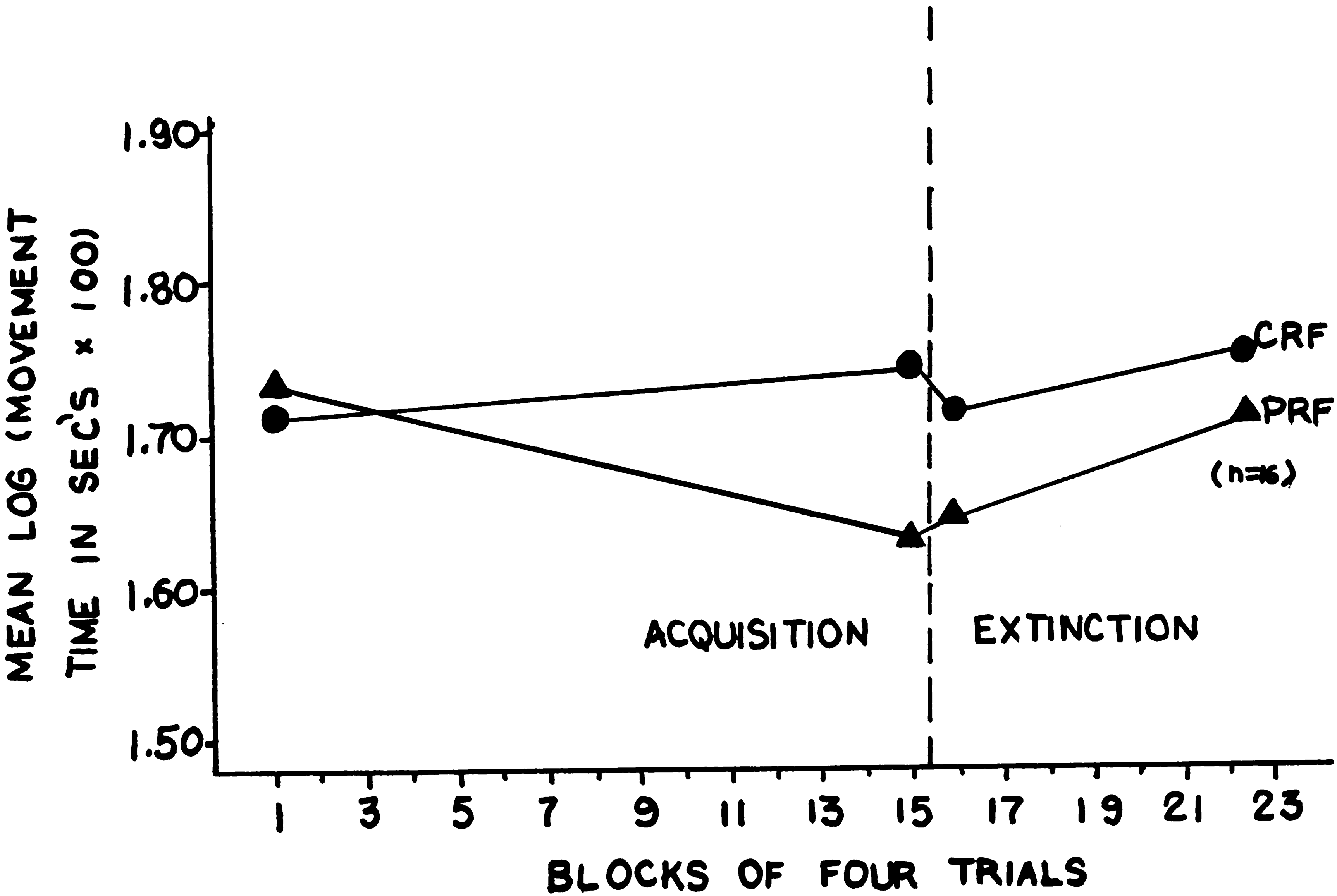


Figure 3. Mean movement duration as a function of schedule and trials.

Table 4. Extinction Latency Means for Significant Effects.

| Level(s) | Mean [In Log(sec's x 100)] |
|---|---|
| **Effect: A(Incentive)** | |
| Low | 2.063 |
| High | 2.124 |
| **Effect: AXBXC(Incentive X Schedule X Trials)** | |
| Low, CRF, Trials 61-64 | 2.103 |
| Low, CRF, Trials 87-90 | 2.058 |
| Low, PRF, Trials 61-64 | 2.021 |
| Low, PRF, Trials 87-90 | 2.070 |
| High, CRF, Trials 61-64 | 2.088 |
| High, CRF, Trials 87-90 | 2.170 |
| High, PRF, Trials 61-64 | 2.100 |
| High, PRF, Trials 87-90 | 2.139 |
| **Effect: BXCXD(Schedule X Trials X Sex)** | |
| CRF, Trials 61-64, Males | 2.115 |
| CRF, Trials 87-90, Males | 2.079 |
| CRF, Trials 61-64, Females | 2.076 |
| CRF, Trials 87-90, Females | 2.148 |
| PRF, Trials 61-64, Males | 2.016 |
| PRF, Trials 87-90, Males | 2.078 |
| PRF, Trials 61-64, Females | 2.104 |
| PRF, Trials 87-90, Females | 2.130 |

Note.-- See Figures 2 and 4 also.

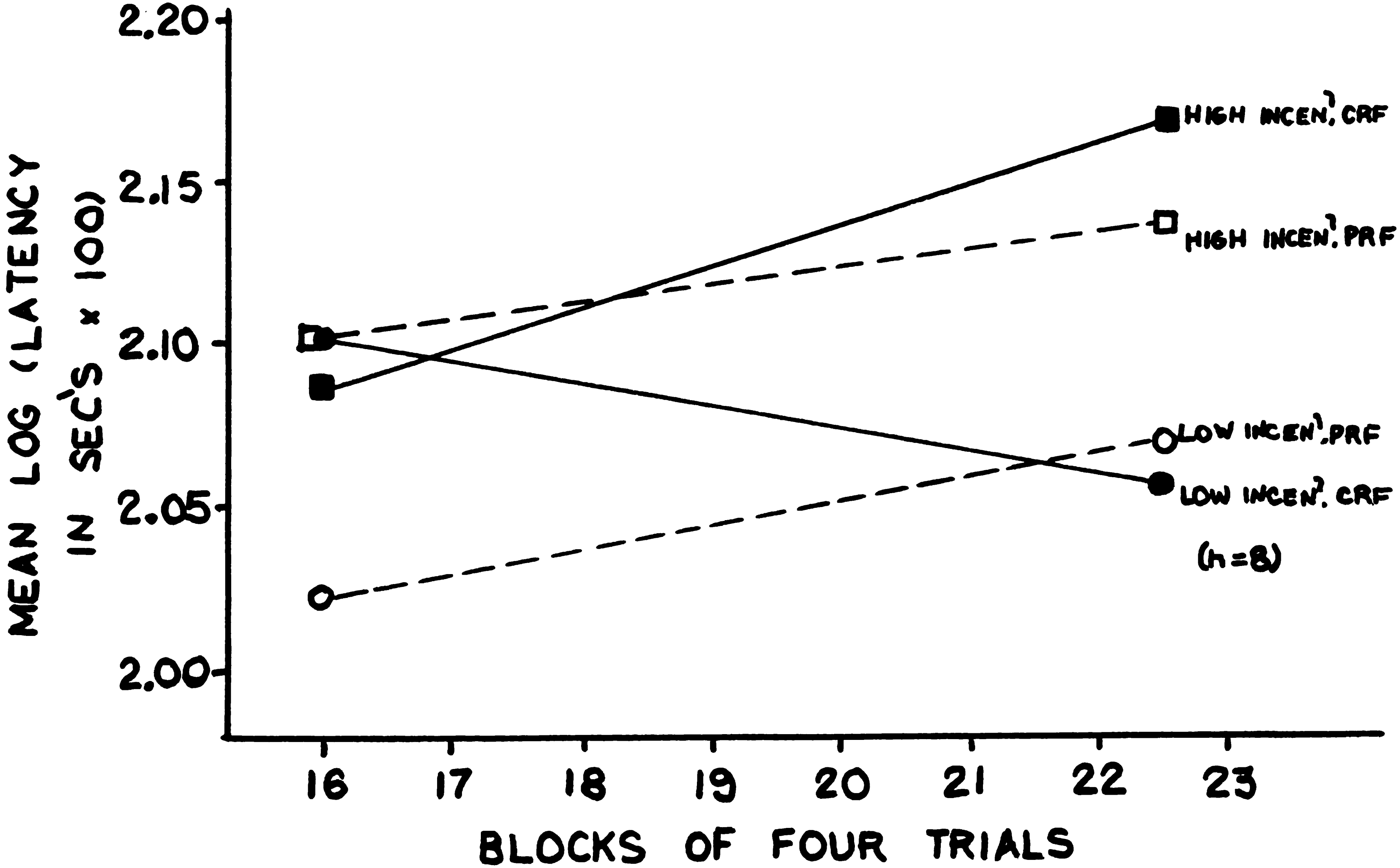


Figure 4. Mean extinction latency as a function of schedule, incentive, and trials.

Table 5. Extinction Latency Analysis of Variance.

| Source | df | MS | F |
|---|---|---|---|
| Between Ss | 31 | | |
| A(Incentive) | 1 | 0.05989738 | 3.078[a] |
| B(Schedule) | 1 | 0.00807361 | 0.415 |
| D(Sex) | 1 | 0.02895994 | 1.488 |
| AXB | 1 | 0.00265048 | 0.136 |
| AXD | 1 | 0.02898389 | 1.489 |
| BXD | 1 | 0.01200553 | 0.617 |
| AXBXD | 1 | 0.00980676 | 0.504 |
| Error | 24 | 0.01946085 | |
| Within Ss | 32 | | |
| C(Trials) | 1 | 0.01546142 | 2.909 |
| AXC | 1 | 0.01382103 | 2.600 |
| BXC | 1 | 0.00262565 | 0.494 |
| CXD | 1 | 0.00506895 | 0.954 |
| AXBXC | 1 | 0.01902879 | 3.580[b] |
| AXCXD | 1 | 0.00727563 | 1.369 |
| BXCXD | 1 | 0.02094406 | 3.940[c] |
| AXBXCXD | 1 | 0.01476914 | 2.779 |
| Error | 24 | 0.00531510 | |

[a] $.05 < p < .10$

[b] $.05 < p < .08$

[c] $.05 < p < .06$

and CRF Ss at the beginning of the extinction phase [F(1, 24)=1.87], or at the end of the phase [F(1,24)=0.14]; nor was the interaction defined above significant [F(1,24)= 0.49]. That is, the PRE was not observed.

Two higher order interactions involving the schedule and trials variables were also suggested by the analysis, viz. an Incentive X Schedule X Trials interaction, and a Schedule X Trials X Sex interaction. Since in neither case did the significance level exceed p=.05, the performance of a posteriori comparisons must be considered theoretically tenuous.

With regard to the Incentive X Schedule X Trials interaction (see Figure 4), the only significant difference [Newman-Keuls, p<.01] was between high incentive, CRF Ss at the end of the extinction phase and low incentive, PRF Ss at the beginning of the phase: the latter performed faster. Upon examination, the Newman-Keuls analysis of the Schedule X Trials X Sex interaction failed to detect any differences that were significant [at p<.01; the difference between CRF girls at the end of the phase and PRF boys at the beginning was significant at p<.05, but should probably be discounted under the circumstances].

Extinction Phase, Movement Duration

As indicated in Tables 6 and 7, there was a significant trials effect; Ss took longer to perform the response at the end of the phase than at its beginning. Although the Schedule X Trials interaction was not significant, the relevant planned comparisons were nonetheless performed. At the

Table 6. Extinction Movement Duration Analysis of Variance.

| Source | df | MS | F |
|---|---|---|---|
| Between Ss | 31 | | |
| A(Incentive) | 1 | 0.00827719 | 0.344 |
| B(Schedule) | 1 | 0.04626373 | 1.921 |
| D(Sex) | 1 | 0.02323168 | 0.965 |
| AXB | 1 | 0.01465444 | 0.608 |
| AXD | 1 | 0.05469780 | 2.271 |
| BXD | 1 | 0.00458385 | 0.190 |
| AXBXD | 1 | 0.08106047 | 3.366[a] |
| Error | 24 | 0.02408298 | |
| Within Ss | 32 | | |
| C(Trials) | 1 | 0.04936328 | 5.435* |
| AXC | 1 | 0.00216980 | 0.239 |
| BXC | 1 | 0.00534268 | 0.588 |
| CXD | 1 | 0.04756499 | 5.237* |
| AXBXC | 1 | 0.00008242 | 0.009 |
| AXCXD | 1 | 0.00625628 | 0.689 |
| BXCXD | 1 | 0.01762162 | 1.940 |
| AXBXCXD | 1 | 0.00217910 | 0.240 |
| Error | 24 | 0.00908316 | |

[a] $.05 < p < .08$

*$p < .05$

Table 7. Extinction Duration Means for Significant Effects

| Level(s) | Mean In [Log(sec's x 100)] |
|---|---|
| **Effect: C(Trials)** | |
| Trials 61-64 | 1.678 |
| Trials 87-90 | 1.733 |
| **Effect: CXD(Trials X Sex)** | |
| Trials 61-64, Males | 1.686 |
| Trials 61-64, Females | 1.669 |
| Trials 87-90, Males | 1.687 |
| Trials 87-90, Females | 1.780 |
| **Effect: AXBXC(Incentive X Schedule X Sex)** | |
| Low, CRF, Males | 1.773 |
| Low, CRF, Females | 1.699 |
| Low, PRF, Males | 1.635 |
| Low, PRF, Females | 1.669 |
| High, CRF, Males | 1.636 |
| High, CRF, Females | 1.821 |
| High, PRF, Males | 1.701 |
| High, PRF, Females | 1.709 |

Note.-- See Figures 3 and 5 also.

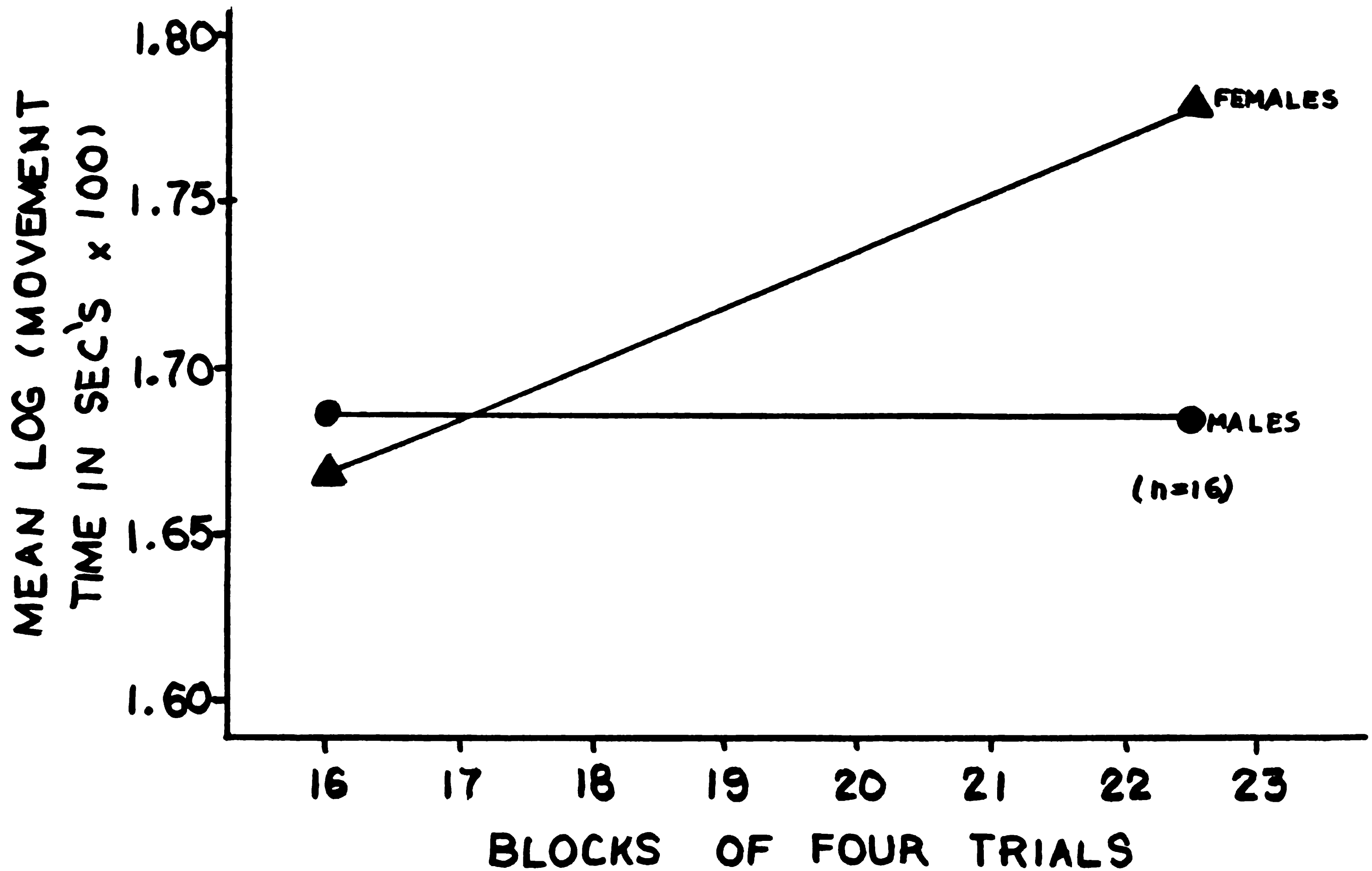


Figure 5. Mean extinction movement duration as a function of sex and trials.

beginning of extinction, PRF Ss performed significantly faster (shorter duration) than CRF Ss [$F(1,24)=4.58$, $p<.05$; see Figure 3]. This presumably represents a continuation of the performance levels at the end of the acquisition phase. By the end of extinction, there was no significant difference between schedule groups [$F(1,24)=1.11$]; also, the interaction as defined above was not significant [$F(1,24)=0.59$].

There was a significant Trials X Sex interaction (see Figure 5), which was unanticipated. A Newman-Keuls analysis revealed that at the end of extinction, girls were taking longer than they did at the beginning of that phase, or than boys at either beginning or end of extinction [all significant at $.01<p<.05$]; there were no other significant differences. There was also a trend toward an Incentive X Schedule X Sex interaction, but this was not significant. A Newman-Keuls analysis failed to find any differences significant at $p<.05$.

## Discussion

The major purposes of the present study were (1) to demonstrate the PRAE and the PRE, (2) to determine whether incentive value *per se* affects response speed, and (3) to evaluate any interaction between the schedule and incentive variables. Briefly, the results indicated that (1) the PRAE was successfully shown, but the PRE was not observed; (2) while evidence was inconclusive, incentive value did affect response speed for some Ss, and (3) the schedule and incentive variables did interact. More specifically, girls who received the high incentive treatment had longer latencies than girls who received the low incentive treatment, and than boys in either incentive condition, but only during the acquisition phase. Latencies of high incentive Ss (regardless of sex) who had experienced CRF did not differ from those of low incentive Ss who had experienced PRF at the beginning of the extinction phase, but by its end, the former had longer latencies. While there were no overall sex differences in movement duration at the beginning of the extinction phase, by the end of the phase girls had longer response durations than boys.

In general, the status of sex differences in lever pull performance has been ambiguous. Ryan and Voorhoeve (1966) found no sex differences in a parametric study of the PRAE and PRE with kindergarteners. Ryan and Watson (1966) reported similar findings using social reinforcement instead of marble tokens. Indeed, in reviewing the frustrative nonreward literature dealing with children, Ryan and Watson (1968) omitted sex effects from their discussion of individual differences that had been found to influence lever pull behavior. Interestingly enough, none of the previous researchers manipulating incentive value with children pulling levers (viz. Ryan, 1965; Ryan & Moffitt, 1966; Sheikh, 1968) bothered to report possible interactions with sex, despite the fact that all used Ss of both sexes.

Nevertheless, recent evidence suggests that the lack of a sex effect may be confined to children less than six years of age. Ryan, Orton, and Pimm (1968), in an investigation of developmental changes in instrumental lever pulling behavior, employed Ss ranging from kindergarten age to 75 years, and found that at all levels except kindergarteners, movement speed was faster for males than for females. The results obtained in the present study suggest that the sex effect may also be present for kindergarteners, when latency of response is measured. This interpretation is supported by comments made by several boys, who expressed the desire to pull so fast "the lever will break."

Within the lever pull context, there is no report of a differential sex effect on the PRAE or the PRE in children (sex may interact with magnitude of reward and interresponse interval; cf. Nakamura, 1969; Nakamura & Ellis, 1964; Pederson, 1970). The results of the present study suggest that future researchers should look more closely at the sex variable, since there were a variety of interactions between sex and both reinforcement schedule and incentive value.

Nakamura (1966), who had children manipulate a joystick, found an interaction between magnitude of reward (relative number of marbles per reward) and sex as they affected lever activity (rate of response) during extinction (cf. Nakamura & Ellis, 1964). While the relation of this finding to the present study is somewhat unclear, the theoretical model which Nakamura used to explain his results may be relevant. He interpreted his findings in terms of cognitive dissonance, based on previous research (Nakamura & Ellis, 1964) which indicated that girls were more persistent than boys (responded longer during extinction), following high magnitude of reward.

Lawrence and Festinger (1962) applied cognitive dissonance considerations, derived from personality research, to rats running alleys under partial reinforcement conditions. The essence of their position, as they stated it, is that "If an organism continues to engage in an activity while possessing information that, considered alone, would lead it to discontinue the activity, it will develop some extra attractions for the activity, or its consequences, in order to give itself additional justification for continuing to engage in the behavior."(Lawrence & Festinger, 1962, p. 156). These extra attractions involve "drives and motivations" which are subordinate to the drive which is prompting the response; extra attractions refer more to competing motives than to competing responses, though the latter are presumably involved somehow. Thus, while a rat runs an alley primarily to obtain food, it could also satisfy other motives than hunger, perhaps the most obvious of which is a need for stimulus variation. Similarly, while a child may pull a lever to win a marble, he might also do so for other reasons, for instance, to please <u>E</u> or because playing the game is inherently pleasurable (rather than frustrating).

A child who experiences CRF, however, will not develop dissonance or extra attractions under Lawrence and Festinger's model. Receiving a marble after each response is consistent with the cognition that one is working hard pulling the lever. In contrast, a S who experiences a PRF schedule does develop dissonance. If he wishes to win the game, he must amass many marbles, and the only way to do this is to continue responding. When he experiences a non-rewarded trial, he realizes that (1) he has just expended effort, and (2) he has no marble to show for it. These cognitions are mutually contradictory and hence S experiences dissonance. One can reduce dissonance best by omitting the behavior in question, but as pointed out, this will not win the game. But if S can find other reasons to continue responding, his dissonance will also be reduced.

Lawrence and Festinger predicted that asymptotic acquisition performance should be higher for CRF Ss than for PRF Ss. This is consistent with the then (1962) available studies with animals, but stands in opposition to the PRAE observed with children. Bitterman and Schoel (1970) suggest that the PRAE occurs under massed trials, with relatively large numbers of trials, and this finding may provide a means of extending dissonance theory. Lawrence and Festinger assumed that speed of response increases as a function of the number of rewarded trials during acquisition. If this effect is supposed to reach an asymptote after some number of massed rewarded trials, then eventually a PRF group would "catch up" to the CRF group. Extra attractions might then explain the PRAE. At any rate, this extension does not alter the dissonance explanations of extinction.

Lawrence and Festinger were chiefly concerned with the

PRE; they suggested that PRF Ss would be able to maintain high performance levels during extinction because of the availability of extra attractions. CRF Ss would essentially start "from scratch" in that they would experience dissonance for the first time during extinction (the same is true for frustration under Amsel's 1958, 1962 theory). Moreover, continued responding would not result in rewards, whereas it did in the case of PRF Ss during acquisition. The best way to reduce dissonance for CRF Ss is to stop responding: while S won't win the game this way, at least no effort is expended. Thus PRF Ss should show more resistance to extinction than CRF Ss.

While the present study does not provide a means of pitting cognitive dissonance theory against its chief rivals, sequential learning theory (Capaldi, 1966, 1967, 1970) and frustration theory (Amsel, 1958, 1962), in any systematic way, it does present certain findings amenable to a dissonance interpretation. One important finding emerging from Nakamura's (1966) work is that the relative value (in terms of its exchange value) of a marble reward increases when expected rewards are not forthcoming (similar findings are reported by Knott, Nunnally, & Duchnowski, 1967, and Lewis, 1964; they follow directly from the position that extra attractions are developing). While it is difficult to predict how this phenomenon would affect incentive value, it does illustrate the fact that an effective manipulation of the latter may not be reflected in the reinforcing value of a particular marble reward.

According to Spence's (1956) theory, both the reinforcing value of the marbles and overall incentive value should have the same effect on motivation. Insofar as the incentive value manipulation of the present study was actually represented in Ss' performance, the trend toward faster speeds for low incentive Ss (significant for girls during the acquisition phase) seems to cast doubt on the veridicality of that theory. But while this finding is difficult to explain within a frustration framework, dissonance theory does predict it.

One might postulate that low incentive Ss experience some dissonance regardless of their reinforcement schedule: they are exerting effort for comparatively small payoff, at least compared with high incentive Ss. The latter can justify their effort with the cognition that continued responding can result in their obtaining a toy. Extra attractions could develop in the low incentive group, resulting in their responding faster relative to high incentive Ss. This explanation is also in accord with the findings of Ryan and Moffitt (1966) that whereas movement speeds of high incentive Ss remained stable during acquisition, those of low incentive Ss increased as a function of trials.

Ryan and Moffitt explained their finding in terms of an anger hypothesis, viz. that low incentive Ss were angered when, having rated the string vis a vis the toy, they were required to play for the former, thus operating under increased drive level. Sheikh's (1968) low incentive Ss were unaware of the existence of more desirable incentives, and did not respond faster than high incentive Ss; Ryan and Moffitt claimed this as evidence for their contention. However, Sheikh's low incentive prize was a balloon, probably more desirable than a piece of string. At any rate, the anger hypothesis is rendered untenable by the present study. Low incentive Ss were unaware of the possibility of winning toys, and yet responded either at the same speed or faster than high incentive Ss.

One way to test the dissonance interpretation of incentive value effects would be to replicate Ryan and Moffitt's study, but in addition asking Ss to rank the string and the toy after performance of the lever pull task. If the low incentive Ss developed extra attractions, one might expect that the string would become relatively more desirable (the "sour grapes" phenomenon might depress the value of the toy, but this would also follow from dissonance theory.).

With regard to extinction, one might expect from a dissonance position that both variables -- schedule and incentive -- would operate so that the most resistance to extinction should occur for low incentive Ss who received PRF during acquisition, and the least for high incentive Ss who received CRF. This is precisely what was observed in the Schedule X Incentive X Trials interaction for extinction latencies. Ryan (1965) made the prediction that nonreinforcement would be more frustrating under high incentive than under low incentive treatments. The frustration prediction would then be that response speed would be highest for a high incentive, PRF group and lowest for a low incentive, CRF group, and presumably this relation would continue during extinction. Clearly this prediction derives little support from either Ryan and Moffitt's study or the present investigation.

Another phenomenon which the dissonance model predicts is the finding that the PRE occurs where S responds voluntarily (e.g., Chertkoff, 1968; Kass, 1962; Kass & Wilson, 1966). The present study is in accord with previous work using speed of response, where S had to continue responding whether he wanted to or not, in that there was no clearcut evidence of the PRE. Ryan and Voorhoeve (1966), in considering this problem, pointed out that two circumstances in their study could have constituted constraints on extinction. First, marbles acquired during acquisition were on display during extinction and might have distracted S. This explanation is ruled out by the present study, where accumulated marbles were not visible to S. Second, complete extinction might have been prevented by E's instructions to S that he (S) was to pull the lever every time the stimulus light came on. This is merely a variation of the hypothesis that extinction is enhanced when responding is voluntary, and it seems than enough evidence exists to tentatively accept it as veridical. While it does not actually contradict frustration theory, it can be derived from the frustration position only if one assumes that frustration is enhanced when S has the opportunity to avoid frustration but does not choose to do so.

However, a variety of evidence derived from research on personality theory suggests that dissonance is increased when Ss dissonance-arousing behavior is voluntarily emitted (Shafer, 1968); hence, development of extra attractions might be facilitated, and a greater PRE observed. (Indeed, some dissonance theorists would insist that volition is necessary for dissonance to develop, for example, Brehm & Cohen, 1962. The present author disagrees, as does Kiesler, 1968.)

The findings of interactions between incentive value and the other variables suggest that it may be inappropriate to equate results found in studies where marbles served as token reinforcers with those of studies in which no toy prize was involved. That is, the PRAE and PRE may exist only under particular incentive conditions, and if so, token reward may be an important variable.

Most previous experiments with children pulling levers under varied schedules of reinforcement have found that movement speeds or times were more stable measures of responsivity than latency, presumably due to the effects of competing responses on the latter (Cantor & Kubose, 1970; Ryan & Cantor, 1962). The present study suggests that this may be true only when the child is free to ignore the "ready" light. When the trial is not begun until S is orienting to the light, more reliable results are obtained. However, latencies did not reveal the PRAE. Moreover, the procedure necessitated E's sitting facing S, and the resulting possibility of a confound with social reinforcement probably outweighs the advantages of this technique. Since the lever in the present study was not spring-loaded, E had to return it after each lever pull, which was another reason for his position; however, this could easily be corrected (as has generally been done in such studies).

The observed increase in movement duration, interpreted as extinction, may have been due in part to the effects of fatigue. The kindergarten Ss made a total of 90 responses spaced only eight to ten seconds apart, which would seem likely to tax the endurance of children of that age. The fatigue interpretation cannot be firmly discounted in the absence of control groups which continued to receive acquisition reward contingencies over the 30 trial extinction phase, and any extensions of the study should employ such controls. However, there is some evidence suggesting that the effects of fatigue may not have been so great. First, Ryan and Voorhoeve (1966), using such control groups, found no differences between them and the extinction groups except toward the end of the 30 extinction trials; if fatigue were a confounding variable, such differences should have disappeared. Unfortunately, Ryan and Voorhoeve's Ss made only 70 total responses. Using slightly older Ss (6- and 7-year-olds), Kass and Wilson (1966) found that many Ss who were responding voluntarily made as many as 240 responses before quitting. Regrettably, previous work (Kass, 196[illegible]) indicates that younger Ss (4-year-olds) make far fewer voluntary responses than the older group. However, if Ss in the present study were becoming fatigued, it is likely that latencies would have shown an equal or greater increase than did movement duration, yet there was no indication of this.

In short, while fatigue may have been a factor for some *S*s (and may have contributed to interactions involving sex during extinction, if girls were more susceptible to it), it is unreasonable to attribute failure to obtain the PRE to its effects. All *S*s made the same number of responses.

## Summary

The results of the present study suggest that future researchers in this area must pay attention to the sex of their *S*s as a possible confounding variable. They must also consider carefully whether or not to use a toy as an incentive; cognitive dissonance theory may be useful in regard to this issue, which is rather peripheral to the frustration theory typically applied in such studies. Low incentive *S*s sometimes respond as though they were under higher motivational level than "high" incentive *S*s.

While the veridicality of the PRAE in this context is well established, the use of a procedure where *S*s respond voluntarily seems advisable in studies involving the PRE. This also seems well explained by dissonance considerations.

# LIST OF REFERENCES

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# APPENDIX

APPENDIX

Table 8. Number of Experimenter Comments to Subject.

| Incentive | Schedule | Sex | Mean No. of Comments | Mdn. No. |
|---|---|---|---|---|
| Low | CRF | M | 1.00 | 0.00 |
| Low | PRF | M | 1.00 | 0.50 |
| High | CRF | M | 1.25 | 0.00 |
| High | PRF | M | 0.75 | 0.50 |
| Low | CRF | F | 0.75 | 0.50 |
| Low | PRF | F | 0.75 | 0.00 |
| High | CRF | F | 1.00 | 0.00 |
| High | PRF | F | 1.25 | 1.00 |

Note.--n=4 Ss per cell.

Table 9. Analysis of Variance of Experimenter Comments

| Source | df | MS | F | p |
|---|---|---|---|---|
| Condition | 7 | 4.30 | 1.52 | $>$.10 |
| Error | 24 | 2.82 | | |

Letter to Parents

A copy of the letter sent to parents of potential Ss follows.

MICHIGAN STATE UNIVERSITY, East Lansing 48823

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Department of Psychology - Olds Hall

Dear Parent:

One of the most pressing questions facing teachers and parents today is how to reward the child when he is performing some task well. Must the child be rewarded after every correct response, or is this only necessary part of the time? What kind of reward works best; is the knowledge that he is doing well sufficient, or must the child be given some sort of tangible incentive such as a new toy?

We are trying to answer these questions by examining types of rewards and frequencies they are given. We would like very much for you to allow your child to participate in this study with the other children in his class.

Each child devotes about half an hour, during which time he plays a game in which he pulls a lever to receive marbles; at the end of the session, he can exchange the marbles for a small toy. He will take part in only one session, and the study will not detract from his work in the classroom. This does not involve any sort of personality or intelligence test; our pilot work has shown that children really enjoy participation in the experiment. The game fascinates them and the toy is of course welcome.

The Holt School District Superintendent and the School Principal have already given their approval to the project. Please use the form below to indicate whether or not you consent to your child's being included in the study (Your child cannot be included unless the form is returned to the teacher). If you need more information please contact Mr. Gilpin (tel. #) weekdays in the evening.

We appreciate your prompt consideration for cooperation in this study. On request, an interpretive summary of the results will be sent to you at completion of the project.

Sincerely,

Dr. Hiram E. Fitzgerald
Mr. Andrew R. Gilpin

---

Please check one of the following alternatives:
___I wish my child to be included in the study described.
___I do not wish my child to be included in the study.

Parent______________________

Date______________

Child's Name______________

(PLEASE RETURN THIS COMPLETED FORM AS SOON AS POSSIBLE)