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ABSTRACT

THE ROLE OF LENGTH OF BLOCKING INTERVAL, MAGNITUDE OF INCENTIVE, AND RATE OF INGESTION IN THE FRUSTRATION EFFECT

by

John Lee Allen

Amsel and Roussel (1952) reported that following consistent reinforcement, the presentation of nonreinforced trials resulted in increased running speeds for a second goal. This phenomenon, the frustration effect, has since received a considerable amount of research interest (see Scull, 1973, for a review). Most of these studies, including the Amsel and Roussel study, have confounded frustrative nonreinforcement with frustrative blocking of an approach to a goal. A second confounding frequently encountered is demotivation due to reinforcement, which precludes the possibility of investigating the effects of magnitude of incentive. The present study used a procedure which involved only frustrative blocking and was not subject to demotivational confounding, thus making possible an analysis of the role of length of blocking interval, magnitude of incentive, and rate of ingestion in the frustration effect.

Twenty female Sprague-Dawley rats were used in the first experiment. The apparatus was a double alley with a start box, first alley, delay box, second alley, and

a goal box. Prior to training, subjects were divided into four equal-sized groups: Group 1-16-4, 4-16-4, 9-1-9, and 16-1-9, the first numeral designating the number of pellets (45 mg. each) given on each trial during training and the first phase of testing, the second numeral the number of pellets given on each trial during the second testing phase, and the third numeral the number given for third phase trials. Throughout training and testing, running times through a 30.48 cm. segment of alley two and ingestion times in the goal box were recorded. These times were converted to speed measures prior to statistical analysis. Each subject was given six training trials per day for a total of ten days. On each trial the subject was placed in the start box and allowed to traverse directly to the goal box without any obstructions. During the first 11 days of testing, Phase 1 subjects were given six trials per day, two 0 sec. delay trials (identical to training trials) and one each of four delay trials (4, 8, 12, and 20 sec.). The order of presentation of the six trials was randomized each day. The same intervals were used during Phases 2 and 3. Phase 2 testing consisted of six trials per day for 5 days during which Groups 1-16-4 and 4-16-4 were shifted up to 16 pellets and Groups 9-1-9 and 16-1-9 were shifted down to 1 pellet. Phase 3 was also 5 days in duration and involved shifting Groups 1-16-4 and 4-16-4 back down to 4 pellets and Groups 9-1-9 and

16-1-9 up to 9 pellets.

A significant frustration effect for mean running speeds was obtained for Group 4-16-4 in Phase 1, with the 4 sec. delay resulting in the fastest running speeds. The patterns of mean running speeds across delay intervals were very similar for all four groups in Phase 1. A significant frustration effect was also obtained for mean ingestion speeds in Group 4-16-4 with the 4 and 12 sec. delays resulting in significantly faster ingestion speeds than the 0 sec. delay. The 4 pellet incentive produced significantly faster ingestion speeds than the 9 or 16 pellet levels. The change in incentive level involved in Phase 2 tended to eliminate the frustration effect. In Phase 3, subjects were returned to incentive levels similar to that of Phase 1, which resulted in highly significant correlations between running speeds and ingestion speeds.

Ten Sprague-Dawley females were used in Experiment II. This experiment was identical to Phase 1 except for the fact that Phases 2 and 3 were deleted; a 45 sec. delay was substituted for the 20 sec. delay interval; and only one group was used, with a 9 pellet incentive. A significant frustration effect was obtained, with all blocking intervals resulting in significantly faster mean running speeds than the 0 sec. delay. The 4 sec. delay resulted in the fastest mean running speeds, with the 8 and 45 sec.

delays producing mean running speeds only slightly slower. No significant frustration effect was obtained for ingestion speed.

Experiment III involved 10 female Sprague-Dawley rats and was identical in design to the 4 pellet group in Experiment I, Phase 1. As in the first experiment, a significant frustration effect was obtained with a 4 pellet incentive. All delay intervals resulted in significantly faster mean running speeds than the 0 sec. delay with the 4 sec. delay producing the fastest running. Although no significant frustration effect was found for ingestion speeds, a plot of mean ingestion speeds across delay intervals was very similar to that obtained for mean running speeds.

THE ROLE OF LENGTH OF BLOCKING INTERVAL, MAGNITUDE OF INCENTIVE, AND RATE OF INGESTION IN THE FRUSTRATION EFFECT

By

John Lee Allen

A DISSERTATION

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DEDICATION

To my mother Thelma, my wife Marilyn,
and my son Kirk

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INTRODUCTION

Brown and Farber (1951) suggested that frustration is the result of hindering or preventing a response which has an above threshold excitatory tendency. Four specific manipulations were suggested as antecedents to frustration:

> (1) the introduction of partial or complete physical barriers;
> (2) the introduction of delay periods between the initiation and completion of a response sequence;
> (3) the omission or reduction of a customary reward on one or more trials;
> (4) variations in the organism's condition, environment, or training leading to the evocation of a response tendency that is incompatible with an ongoing one. [p. 481]

Frustration was presented by them as a hypothetical (defined) condition of the organism; anger or annoyance may be substituted for frustration. They further suggested that the vigor of the response resulting from frustration may be the result of frequent reinforcement for response vigor in frustration-eliciting situations in the organism's past.

Amsel and Roussel (1952) reported that following consistent reinforcement, the presentation of nonreinforced trials resulted in increased running speed for a second goal. This phenomenon, termed the frustration effect, was demonstrated with rats in a double alley apparatus consisting of a start box (SB), first alley (A_1), first goal box (G_1), second alley (A_2), and second goal box (G_2). During training a subject was held in the start box for 3 sec., after which the door was opened and the rat could traverse A_1 into G_1. The subject was held in G_1 while eating a .125 gm. pellet of food. After 30 sec. the door was opened and the subject was allowed to traverse A_2 into G_2, where it was held until it finished another .125 gm. food pellet. Subjects were run through this training procedure 3 trials a day for 28 days, a total of 84 training trials. During testing 3 trials per day were given for 12 days. Eighteen of the trials were rewarded (same as training trials), and 18 were frustration trials (no food in G_1). Three groups were used, each being exposed to a different length of confinement in G_1 on frustration trials, either 5 sec., 10 sec., or 30 sec. Results confirmed the hypothesis that following consistent reinforcement in G_1, the introduction of frustrative nonreward would result in faster running to G_2 than was observed on nonfrustration trials. No statistically significant difference was found between the three groups receiving different confinement intervals, although the 10 sec. group was consistently faster than the others.

Hull (1952) referred to the possible frustration of an anticipation and suggested that cessation of an anticipated reinforcement will result in an increase in reaction potential due to increased drive. Amsel and Hancock (1958) agreed that the frustration reaction includes a temporary increase in the strength of generalized drive. They invoked the "expectancy" construct from the Hullian system, the fractional anticipatory goal response (r_g-s_g), to explain the change in drive strength. The degree to which nonreward will increase drive strength depends on the degree to which conditions were favorable for the development of r_g during preliminary reinforced trials. Fractional anticipatory frustration (r_f-s_f) has also been conceptualized as resulting from classical conditioning and may be the inhibitory mechanism in nonreward (Amsel, 1958).

Since the first publication of research on the frustration effect, a great many studies have dealt with frustrative nonreinforcement. Amsel and Ward (1954) investigated the motivational properties of frustrative nonreinforcement. Seward, Pereboom, and Jones (1957) investigated the effect of prefeeding, a factor central to the demotivation hypothesis. The demotivation hypothesis suggested that subjects run faster after nonreinforced trials than after reinforced trials due to the demotivation caused by reinforcement. The inadequacy of the demotivation hypothesis was demonstrated when nonreinforced trials following a history of reinforcement produced faster running than nonreinforced trials which were not preceeded with reinforcement (Wagner, 1959). The effects of graded reduction of G_1 reward (Bower, 1962; Pattern, 1971) and partial reinforcement in G_1 (Amsel & Hancock, 1957; McCain & McVean, 1967) have been studied. Length of blocking interval and size of G_1 were investigated by MacKinnon and Amsel (1964). The effect of delay of reinforcement in G_1 has received considerable attention (Sgro, 1968; Sgro, Glotfelty, & Podlesni, 1968; Sgro, Showalter, & Cohn, 1971), and a recently published article has summarized the results of much of the research involving frustrative nonreinforcement (Scull, 1973).

Bower (1962) proposed a mechanism to explain many of the results mentioned without ascribing special properties to frustrative nonreward. He stated that when r_g is aroused in A_1 and is not satisfied with reward in G_1, it may perseverate and summate with the r_g in A_2, resulting in an increase in net incentive motivation. On those trials when reward is given in G_1, the r_g will dissipate.

Staddon (1970) offered another alternative to frustration as the mechanism for energized running in A_2. He suggested that the generalization decrement hypothesis used to explain fixed-interval schedule performance may apply. After continuous reward the aftereffects of reward should result in inhibition due to their continued pairing with slow responding early in the response chain. When reward is not given, generalization decrement results, increasing response speed in the first part of A_2.

The second manipulation to which Brown and Farber (1951) attributed frustration eliciting properties, namely introduction of a delay between the initiation and completion of a response sequence, has received very little attention. This neglect is especially perplexing, since frustration by delay appears to be confounded with the third mechanism, omission or reduction of a customary reward, in the Amsel and Roussel (1952) study and in subsequent studies using their technique. In short, is Amsel's "frustration effect" due to removal of an anticipated reward in G_1 or delaying the approach to the reward in G_2?

Several early studies investigated intramaze delay with mazes substantially different from that used in the frustrative nonreward studies and measured running speed only in the predelay section (Brown & Gentry, 1948; Cooper, 1938; Gentry, Brown, & Kaplan, 1948; Williams & Williams, 1943). The first study specifically designed to investigate the effects of varied intervals of delay in G_1 on the A_2 running speed of rats which were never reinforced in G_1 was conducted by Holder, Marx, Holder, and Collier (1957). During the 25 days of training, subjects were given one trial per day with a 1 sec. delay in G_1

and a .3 gm. incentive in G_2. Although mention is made of a switch activated by the opening of the start box door, no mention is made of how long the subjects were confined in the SB at the beginning of each trial. Testing consisted of one trial per day for a period of 10 days. One group of subjects was always delayed for 1 sec., a second group for 15 sec., and a third for 45 sec. The wooden doors of the delay box were closed during the delay interval. Both the 15 sec. and the 45 sec. groups ran faster than the 1 sec. group in A_2. Two alternative interpretations were mentioned for their results. The first suggested that a delay of reinforcement occurring in a chain of highly trained responses produces an aversive motivational state which is added to the ongoing motivational complex. The second stated that increased delay extinguishes competing responses and results in better goal orientation.

In another study the effects of delay were investigated in a light-tight, sound-deadened 18-ft. straight runway (Wist, 1962). The subjects were given one trial per day for 26 days. The subjects were held in the SB for 3 sec., after which the doors into A_1 were opened. The doors of the delay box were operated when the rat approached but no delay was involved. The subjects then traversed A_2 and were confined in G_2 for a 20-sec. drinking period (half of the subjects receiving an 8% sucrose solution and half a 32% solution). During testing one trial per day was given for 26 days with the two reinforcement concentrations, two delay intervals (3 and 45 sec.) and three positions of delay (2, 6, and 10 ft. from the goal) factorially combined. A decrement in running speed was found in the segment following the delay box and was proportional to the duration of the delay. The relation between three measures of consummatory behavior (number of licks, amount ingested, and duration of tube contact) and instrumental behavior was minimal. The author stated that the decrement in running speed was contrary to the implications of "frustration drive" models such as Amsel's. It is important to note that unlike the Amsel and Roussel study (1952), nonfrustration trials were not interspersed with frustration trials. Also many external auditory and visual cues were eliminated.

Uyeno (1965) suggested that one possible reason Wist (1962) did not find a frustration effect was that he used a between-subjects design. In Uyeno's exploratory studies he used both within- and between-subjects designs. He found no significant difference between blocked and non-blocked groups with the between-groups design. However, the within-subjects design yielded a significant difference between A_2 running speeds following blocked and non-blocked trials. On each of two training days the subjects were given 4 trials in which they were placed in the start box and allowed to traverse straight through to G_2 where a "pea sized" piece of food was waiting. All of the doors were left open, including the start box door, to prevent any frustration due to blocking. During testing 4 trials were given per day for 24 days. On 2 of the 4 daily trials the entrance into A_2 was blocked for 1 sec. by a glass door. Blocked and nonblocked trials were presented in all possible combinations. During the first few days of testing the rats ran slower on blocked trials than on nonblocked; subjects were investigating the door and continued to do so even after the door was raised. After the subjects started making a direct approach, they ran significantly faster on blocked than on nonblocked trials.

Ludvigson (1968) used a double alley apparatus to investigate the effects of level of incentive and length of blocking interval on running speed in A_2. Five groups were run with 12 rats in each group. Two of the groups were fed 20 45 mg. pellets in G_2; one of these groups was blocked for 15 sec. in the delay box and the other was not blocked. Three groups received 1 pellet in G_2; one of these groups was never blocked, one was blocked for 3 sec., and one for 15 sec. All subjects were given 3 daily trials for a total of 40 days. The start box door was opened after the subject had maintained an orientation toward it for 1 sec. Subjects in the nonblocked conditions were allowed unobstructed passage to the goal box. Delayed subjects were held in a delay box for the appropriate period of time. The results revealed a significant difference in running speed between the 1 and 20 pellet groups but no significant differences in A_2 running speeds for the different delay conditions. It is interesting to note that the delayed groups were not given any unobstructed training trials.

Williams and Ellis (1970) used a within-subjects design in an effort to resolve the discrepency between the Holder, et al. (1957) study and the Wist (1962) study. During training subjects were given 2 trials per day except for the last 2 training days on which they were given 3 each day, for a total of 25 trials. Subjects were placed in the start box of the V-shaped maze and held there for 5 sec. They then entered A_1 and traversed to the delay box where the closing of the retrace door opened the transparent plexiglass door to A_2. After traversing A_2 and entering the goal box, subjects were rewarded with 2 cc. of 26% sucrose solution. During testing 2 nondelay trials (same procedure as training trials) and 1 of the delay conditions (5, 20, 45, or 90 sec.) were presented on each day. The first trial each day was a nonblocked trial; the delay trial given on a particular day was assigned randomly to either the second or third trial. A total of 12 test days were involved with 3 exposures to each of the 4 delay intervals. Subjects were found to run slower as the length of delay increased, with the fastest running following the nonblocked (0 delay) condition.

DiLollo, Davidson, Hammon, and Donovan (1968) approached the possible confounding of frustration due to blocking and frustrative nonreward in a very different way. Subjects were trained and tested in an Amsel-type double alley with clear plastic doors. A total of 52 acquisition trials were given over 16 days. On each acquisition trial the blocked subjects were held in the start box for an undisclosed period of time and then allowed to traverse A_1 into G_1 where they received 4 20 mg. Noyes pellets. They were held in G_1 until they had eaten the pellets and faced the door leading to A_2. The door was then opened and the subjects traversed A_2 into G_2 where another 4 20 mg. pellets were eaten. Nonblocked subjects were run in the same manner except that the G_1 doors were never closed. During testing all subjects were shifted to 50% reinforcement in G_1 for 10 days with 4 trials per day. Rewarded trials were the same as acquisition trials for each group; however, on nonrewarded trials the blocked subjects were held for 5 sec. and the nonblocked never held at all. On the nonrewarded trials the blocked group ran faster in A_2 than the group which received frustrative nonreward but no blocking.

In the present study reinforcement was never given in the blocking box, thus preventing the confounding of demotivational and inhibitory variables. This procedure offered an excellent opportunity to study the effects of magnitude of incentive and length of blocking interval on the frustration effect. This study also investigated the contradictory findings of Wist (1962) which revealed a minimal relationship between consummatory measures for ingestion of a sucrose solution and running speed, and Deaux (1973) which demonstrated that water deprived rats run faster for .20 ml. of water dispensed over a 5 sec. period than the same amount dispensed over a 20 sec. period. The present study sought to discover the relationship between speed of ingestion of varied numbers of 45 mg. pellets and running speed, something heretofore uninvestigated.

EXPERIMENT I

Method

Subjects

The subjects were 20 experimentally naive female Sprague-Dawley rats obtained from Carworth, Inc., of Kalamazoo, Michigan. All subjects were approximately 90 days old at the start of the experiment. They were housed individually and maintained on a 22-hr. food deprivation schedule. Food given in the home cage was Allied Mills Mouse Breeder Blox.

Apparatus

The apparatus was very similar to that used by Wagner (1959), the major difference being the length of the alleys. The start box (SB) was 30.48 cm. long, 7.62 cm. wide, and 13.34 cm. deep, and painted flat black. The remainder of the apparatus was also 7.62 cm. wide and 13.34 cm. deep. Separating the SB from alley one (A_1) were two guillotine doors, one made of pressed board and painted black on both sides and one made of clear plexiglass. All other doors in the apparatus were also of the guillotine type. A_1 was 91.44 cm. long, painted flat black with a floor covered with a black rubber mat. Separating A_1 from the delay box (DB) was a single retrace door painted black on both sides. The DB was identical to the SB except that the pressed board door was painted white on the side facing the second alley (A_2). A_2 contained two photoelectric cells; one which started a time clock was placed 30.48 cm. from the door leading into A_2, and one which stopped the clock was placed 60.96 cm. from the same door. Both photoelectric cells were placed 3.81 cm. above the floor. The openings on both sides of the alley were covered with thin sheets of red plastic. A_2 was 121.92 cm. long, was painted white, and had a floor covered with 6.35 mm. mesh hardware cloth. The retrace door separating A_2 from the goal box (GB) was made of pressed board painted white on both sides. The GB had the same dimensions as the DB and was painted white with a white plastic food cup mounted in the center of the end wall at floor level. The maze was constructed of 1.90 cm. pine. A_1 and A_2 were covered with 6.35 mm. clear plexiglass, and the SB, DB, and GB were covered with hinged sections of the same type of plexiglass. The light sources used with the photoelectric cells were two Tensor model 5975 lamps. The photorelays were both Hunter model 330S photo contact relays. The relays were connected to each other and a 1/100 second Stolting model 22025-A clock by means of an Advanced Electric and Relay Co. model PC 2C115VA relay. Breaking the first photobeam 30.48 cm. from the door leading into A_2 started the clock, and breaking the second photobeam 60.96 cm. from the door stopped the clock. Ingestion time was measured with a hand-held model 918 1/10 sec. Chesterfield stopwatch.

The maze, light sources, relays, and clock were placed on a 2.44 m. long, 60.96 cm. wide, and 1.07 m. high table with the maze centered on the table. The table was centered against one of the walls of the laboratory.

Five holding boxes were situated on a table against the opposite wall of the laboratory. Each box was 30.48 cm. x 30.48 cm. x 20.32 cm., constructed of 1.90 cm. plywood, painted gray, and covered with 1.27 cm. mesh hardware cloth. Water was available at all times in the holding boxes.

The laboratory itself was 3.35 m. long, 2.13 m. wide, and 2.28 m. high. The walls and ceiling were covered with 12.7 mm. acoustical Celotex. The floor and both doors were covered with 6.3 mm. carpet tiles. The entire lab was illuminated by two translucent ceiling fixtures containing 65-watt bulbs. The laboratory was air-conditioned during the summer and heated during the winter.

<u>Procedure</u>

<u>Habituation</u>. Upon arrival from the supplier, subjects were randomly assigned into four equal-sized groups. Preliminary training consisted of 10 days during which a 22-hr. food deprivation schedule was established. Water was made available at all times in the home cage. These

days consisted of: 3 days during which each subject was handled for a 5 min. period before being fed for 1 hr. in an individual home cage; 3 days during which subjects were placed in a holding box for 15 min. before being fed; and 4 days during which subjects were allowed to explore the maze in groups of two for one 5 min. period each day. During these periods the photoelectric cells and the clock were operating to adapt the subjects to the noises associated with the apparatus. After the first three exploration periods each subject was allowed to eat five 45 mg. Noyes pellets scattered on the floor of the holding box and then was returned to its home cage. Following exploration on the fourth day, each subject was put into its holding box twice with two 45 mg. Noyes pellets separated by 25.4 mm. on the floor. On both occasions the time that elapsed between the subject's taking the first and second pellet into its mouth was recorded (pretraining ingestion time for one pellet). The fifth pellet was then placed on the floor and each rat was returned to its home cage when it had eaten it.

Training. The subjects were randomly assigned to four equal-sized groups, a 1-pellet group (Group 1-16-4), a 4-pellet group (Group 4-16-4), a 9-pellet group (Group 9-1-9), and a 16-pellet group (Group 16-1-9). The first numeral designates the number of pellets given in training and Phase 1; the second numeral designates the number given in Phase 2; the third designates the number given in Phase 3. The order in which the groups were brought to the laboratory was randomized each day, as was the order in which the subjects in each group were run. Each subject was given six 0 sec. training trials each day during the 10 days of training.

A 0 sec. delay training trial was initiated with the introduction of the subject into the SB. All doors from the SB to the GB were left open, allowing the subject to traverse the entire length of the maze unobstructed. The first time on each trial that the subject passed through both photobeams while maintaining its goal orientation, the time was recorded as the running time for that trial. If a subject broke only the first beam and then retraced, the clock was reset. If the subject broke both photobeams and then retraced (this happened a few times during early training trials), this time was recorded. As soon as the subject entered the GB, the retrace door was closed and the ingestion time was recorded. Each subject was removed from the GB as soon as it had ingested the food. Ingestion time was not recorded for the 1-16-4 pellet group.

Testing, Phase 1. Each of the 11 testing days consisted of 6 trials, 2 training trials and 4 trials on which each subject was held in the delay box for either 4, 8, 12, or 20 sec. The opaque door into A_2 was not opened following the delay intervals until the subject was oriented toward it. The plexiglass door was always left open. The order in which the intervals were presented was randomized each day with the stipulation that the 2 training trials could not follow each other. Running times and ingestion times were measured and recorded as in the training trials.

The minimum intertrial interval during both training and testing was 7 min. After each group was run, the subjects were placed in their home cages for 5 min. and then given access to food for a period of one hour.

Testing, _Phase_ _2_. Testing in this phase lasted for 5 days and was identical to Phase 1 except that Groups 1-16-4 and 4-16-4 were increased to 16 pellets, and Groups 9-1-9 and 16-1-9 were decreased to 1 pellet.

Testing, _Phase_ _3_. This 5 day testing phase was identical to Phase 2, with the exception that Groups 1-16-4 and 4-16-4 were decreased to 4 pellets and Groups 9-1-9 and 16-1-9 were increased to 9 pellets.

The procedure used to measure pretraining ingestion time was also used on the day following Phase 3. The results were designated the posttesting ingestion times.

Habituation, training, and testing were conducted in an air conditioned laboratory during the summer months between the hours of 9:00 a.m. and 1:00 p.m.

Results and Conclusions

Prior to the analysis of the data, all running and ingestion times were converted to speed measures to insure homogeneity of variance between groups. Running times were changed to feet per second and ingestion times to pellets per second. Whenever an analysis of variance or a Newman-Keuls analysis were used, ingestion speeds were multiplied by 100 to avoid working with extremely small decimals.

Since many of the differences obtained in this experiment were not significant, these findings have been relegated to Appendix E. Analysis of variance and Newman-Keuls tables for significant results are in Appendix F.

Pretraining Ingestion

Prior to any training two ingestion speeds were observed; the fastest speed for each animal was used in a between groups comparison. As anticipated, no significant differences in ingestion speeds were obtained ($F = 1.20$, $df = 3/16$, $p > .05$), indicating similarity between groups prior to training and testing.

Training

Running and ingestion speeds obtained from the last 5 days of training, after approach to the goal box had stabilized, were analyzed. No significant differences in running speeds between groups were observed ($F = .90$, $df = 3/16$, $p > .05$). However, a between groups comparison of ingestion speeds did reveal significant differences ($F = 7.34$, $df = 2/12$, $p < .01$). A Newman-Keuls analysis showed that Group 4-16-4, receiving 4 pellets, had a significantly faster ingestion speed ($p < .01$) than either

Group 9-1-9, receiving 9 pellets, or 16-1-9, receiving 16 pellets (see Appendix F for statistical analysis).

Daily correlations between running and ingestion speeds for each group were calculated in an effort to discover any possible relationships which might have existed between the two measures. Group 16-1-9 produced the greatest number of significant correlations (see Table 1).

Testing, Phase 1

A within groups analysis of variance for the second through the sixth days of testing revealed no significant differences across delay intervals (see Appendix E). This finding was expected. Since no blocking was involved in training, animals tended to investigate the door blocking their entrance into A_2 and continued to investigate it after it was raised. This exploratory behavior postponed direct approach to the goal box for several days, resulting in faster running speeds on the 0 delay (nonblocked) trials. Uyeno (1965) observed the same type of exploratory behavior when testing followed nonblocked training trials.

An analysis of the mean running speeds from the last five days of testing revealed great similarities across delay intervals for the four incentive levels (see Figure 1). However, a within groups analysis revealed that only the running speeds of Group 4-16-4 and the ingestion speeds of Group 9-1-9 resulted in a significant frustration effect. Results for those groups that did not reach significance are presented in Appendix E.

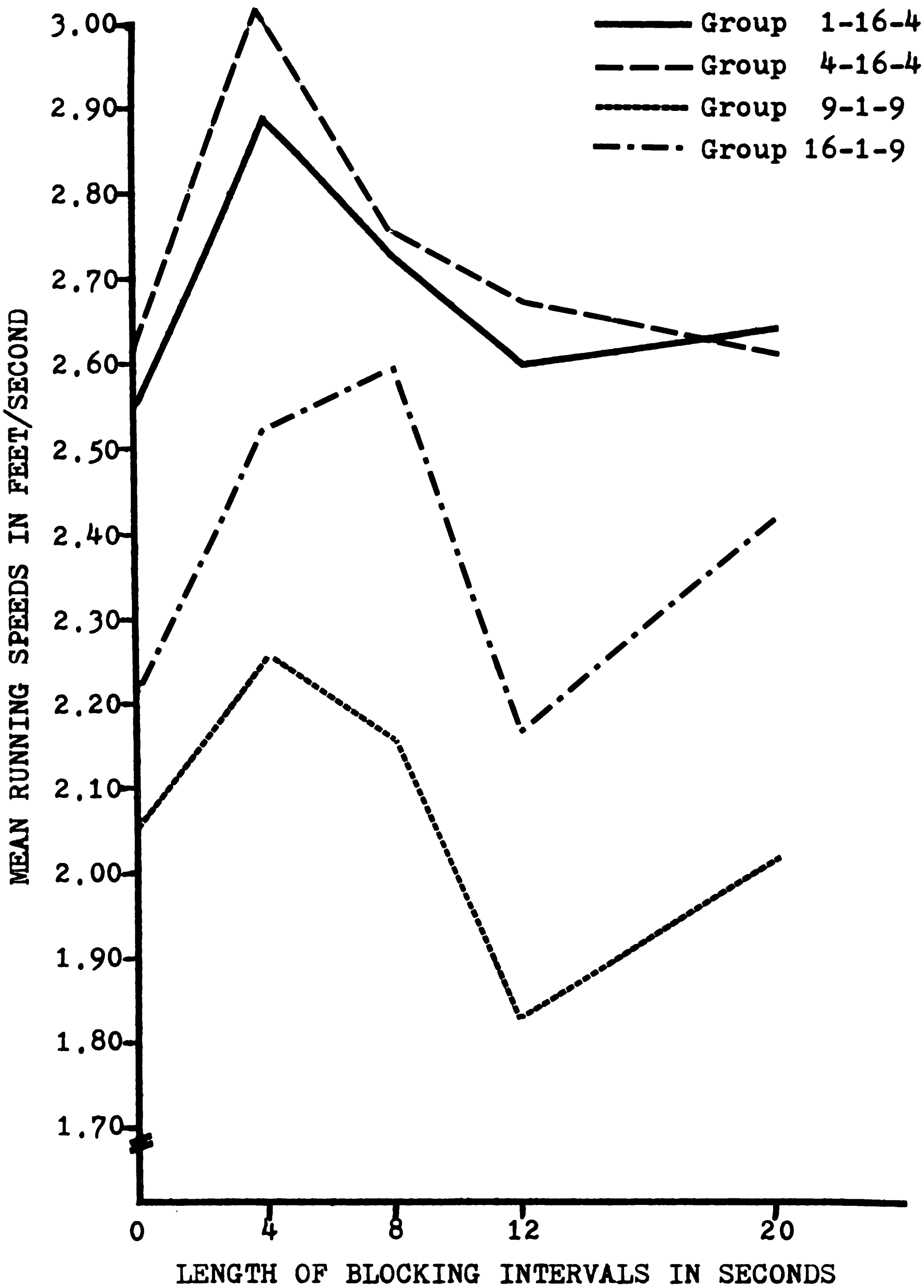

Figure 1. Mean running speeds on each blocking interval during days 7-11 of Experiment I Phase 1

The *F* for Group 4-16-4 was considered significant (F = 3.00, *df* = 4/16, critical *F* for *p* = .05 is 3.01); the 4 sec. delay interval running speeds were almost significantly faster than the 0 or 20 sec. when a Newman-Keuls analysis was applied. A *t* test between the 4 and 20 sec. running speeds was not significant (t = 1.75, *df* = 8, $p > .05$); however, it was significant when the 4 sec. delay running speeds were compared with the 0 sec. speeds (t = 2.35, *df* = 8, $p < .05$). This indicates a significant frustration effect for running speed in Group 4-16-4 (see Appendix F and Figure 2).

In Groups 1-16-4 and 4-16-4 the fastest running was observed on the 4 sec. delay intervals. Although Group 9-1-9 also showed maximum running speed at the 4 sec. delay, the slope between the 4 and 8 sec. intervals is not nearly as steep as in the first two groups. Group 16-1-9 had its fastest running speed on the 8 sec. delay. These findings suggest a gradual shift in the optimal blocking interval from 4 to 8 sec. as the magnitude of the incentive increased.

Group 9-1-9 yielded a significant difference in ingestion speeds across delay intervals (F = 7.21, *df* = 4/16, $p < .01$), mainly because of low variability. A weak but reliable frustration effect reflected in ingestion rather than in running was indicated, with both the 4 and 12 sec. delays producing significantly faster ingestion than the 0 sec. delay ($p < .01$). See Appendix F for statistical analysis.

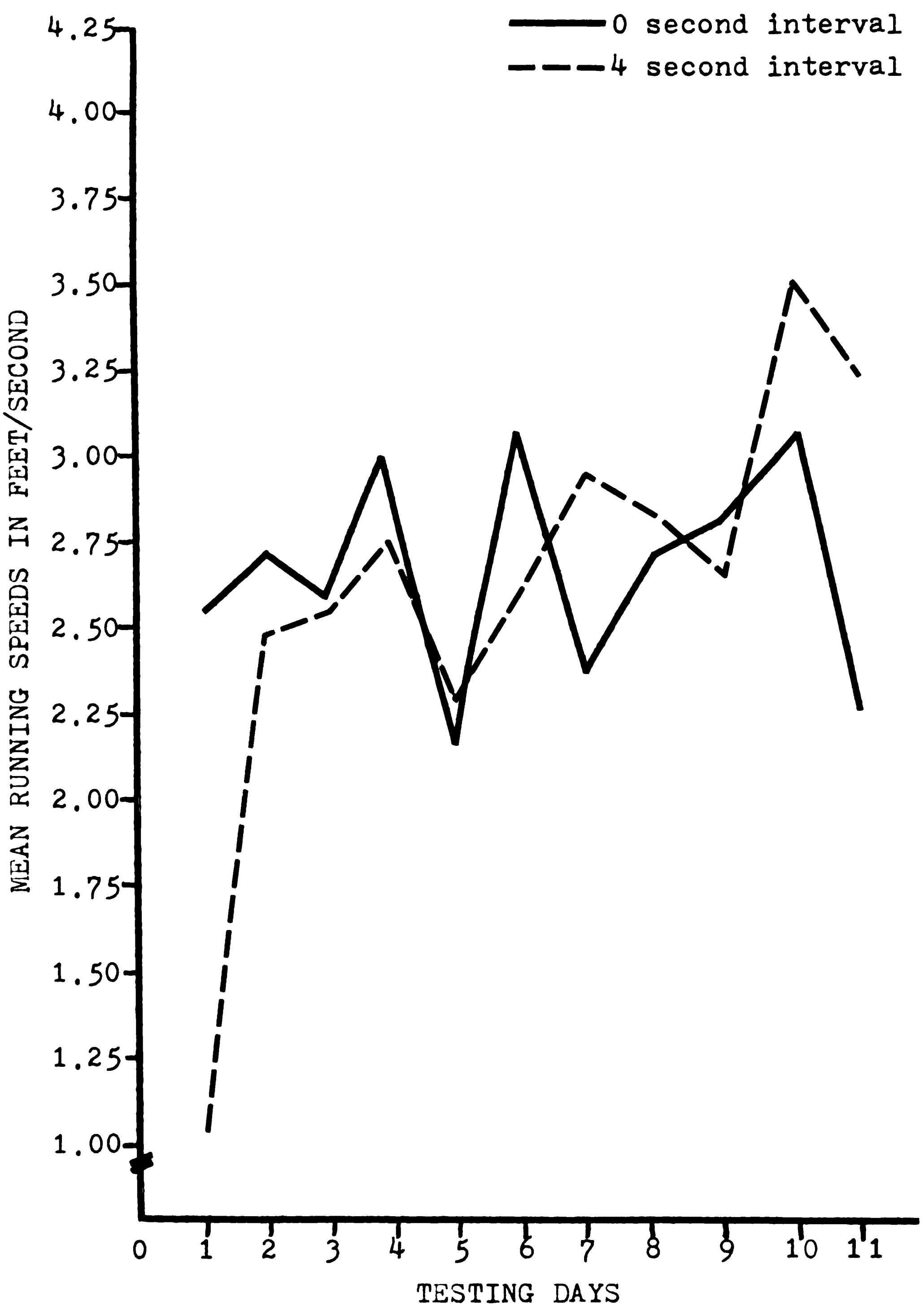

Figure 2. Mean running speeds on the 0 and 4 second blocking intervals of group 4-16-4 for each day of testing in Experiment I Phase 1

A between groups analysis of running speeds for all groups was conducted, and no significant differences were found (F = 1.50, df = 3/16, $p > .05$). As in training, a significant difference was obtained between ingestion speeds (F = 24.97, df = 2/12, $p < .01$). A Newman-Keuls analysis revealed that Group 4-16-4 had an ingestion speed significantly faster ($p < .01$) than either Group 9-1-9 or 16-1-9 (see Appendix F).

Correlations between running and ingestion speeds were, for the most part, not significant (see Table 2).

Testing, Phase 2

A single factor analysis of variance for repeated measures revealed no significant frustration effects for running or ingestion speeds for any groups, although Group 4-16-4 maintained its fastest running speed at the 4 sec. delay, as in Phase 1 (see Appendix E). The primary effect of the change in incentive level was a disruption of the similarity in the pattern of running speeds across delay intervals which was obtained in Phase 1 (see Figure 3).

A between groups analysis of running speeds was not significant (F = 1.50, df = 3/16, $p > .05$). A positive incentive contrast effect in ingestion was observed, with the mean ingestion speeds of Group 1-16-4 being significantly faster than those of Group 4-16-4 (t = 2.47, df = 8, $p < .05$).

Correlations between running speeds and ingestion speeds reached significance only in Group 4-16-4 (see

TABLE 1

PEARSON PRODUCT CORRELATIONS BETWEEN RUNNING AND INGESTION SPEEDS FOR EXPERIMENT I TRAINING

Day	Group 4-16-4	Group 9-1-9	Group 16-1-9
6	-.0215	-.0120	.5849**
7	.2052	.4799**	.1480
8	.2643	.1447	.4408*
9	.2716	.0518	.3619*
10	.5258**	.2412	.4095*

*$p < .05$

**$p < .01$

TABLE 2

PEARSON PRODUCT CORRELATIONS BETWEEN RUNNING AND INGESTION SPEEDS FOR EXPERIMENT I, PHASE 1

Day	Group 4-16-4	Group 9-1-9	Group 16-1-9
7	-.0385	.5137**	-.1396
8	-.3061	.2065	-.4256*
9	-.3881	.1173	-.1233
10	.2919	.0776	.0427
11	.3339	.4892**	.3232

*$p < .05$

**$p < .01$

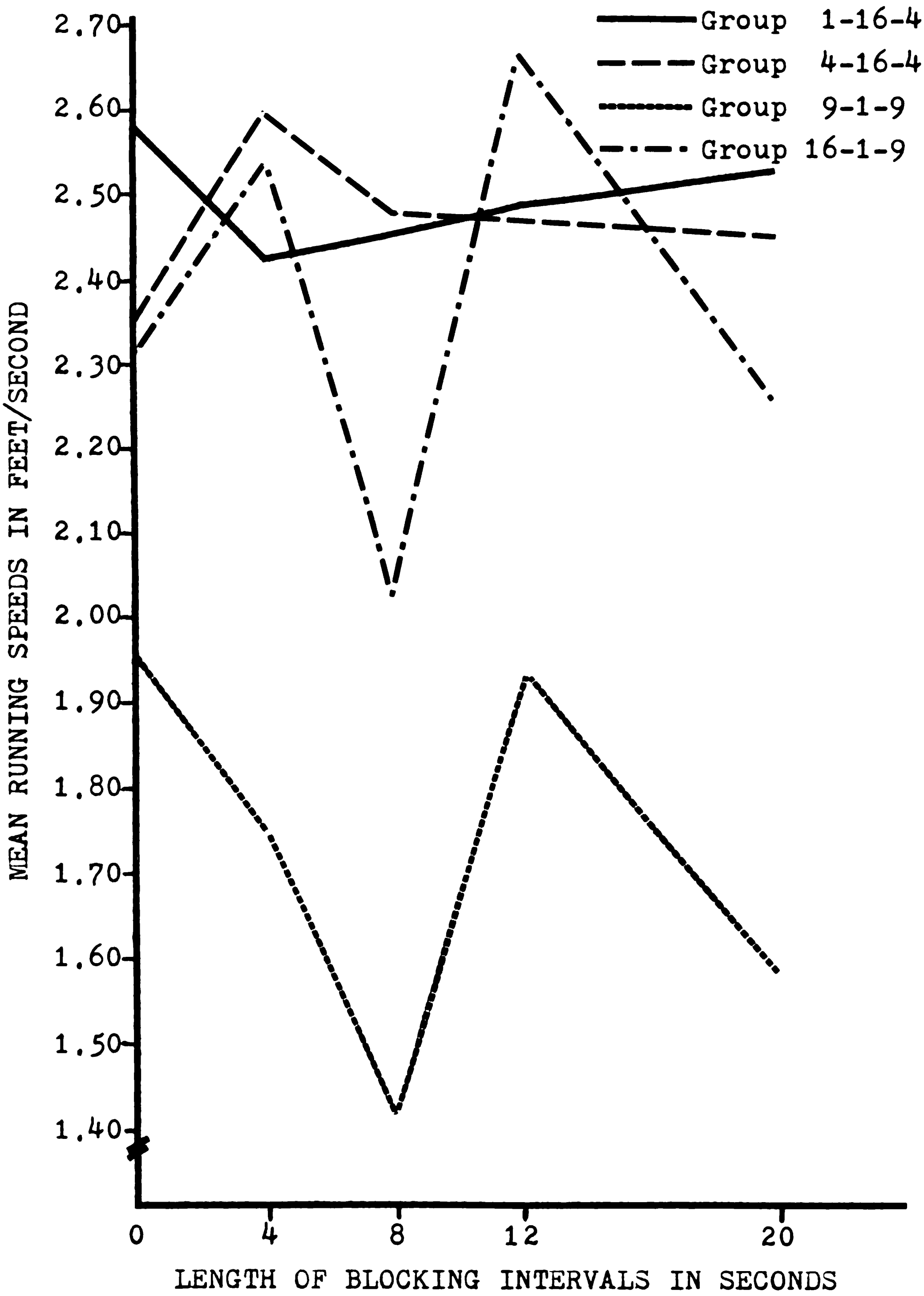

Figure 3. Mean running speeds on each blocking interval in Experiment I Phase 2

Table 3), that is, for the same incentive level that yielded the most significant correlations during training, namely, 16 pellets.

Testing, Phase 3

A single factor analysis of variance for repeated measures for all groups revealed no significant frustration effect (see Figure 4 and Appendix E).

No significant between groups differences were obtained for running speeds (F = .79, df = 3/16, $p > .05$); however, ingestion speeds did differ significantly (F = 14.04, df = 3/16, $p < .01$). As in Phase 1, the groups receiving 4 pellets (Groups 1-16-4 and 4-16-4) demonstrated significantly faster ingestion speeds ($p < .01$) than Groups 9-1-9 and 16-1-9 (see Appendix F).

Correlations between running and ingestion speeds were highly significant for Groups 1-16-4, 4-16-4, and 9-1-9 (see Table 4). For all three of these groups, Phase 3 involved a return to an incentive level which was either the same as or very close to that of Phase 1. Group 16-1-9, which did not yield any significant correlations, was given a Phase 3 incentive level 7 pellets below the Phase 1 level.

Between Phases Comparisons

A between groups analysis of variance for running speeds for all 4 and 16 pellet conditions revealed no significant differences (see Appendix E). When the running

TABLE 3

PEARSON PRODUCT CORRELATIONS BETWEEN RUNNING AND INGESTION SPEEDS FOR EXPERIMENT I, PHASE 2

Day	Group 1-16-4	Group 4-16-4
1	-.0783	-.0524
2	.0996	.3900*
3	.1472	.0334
4	.0915	.5333**
5	-.0277	.2611

*$p < .05$

**$p < .01$

TABLE 4

PEARSON PRODUCT CORRELATIONS BETWEEN RUNNING AND INGESTION SPEEDS FOR EXPERIMENT I, PHASE 3

Day	Group 1-16-4	Group 4-16-4	Group 9-1-9	Group 16-1-9
1	.7296**	.5863**	.3953*	-.1178
2	.6889**	.2715	.4951**	-.2073
3	.6282**	.4715*	.6042**	-.3941
4	.7323**	.3867*	.4533*	-.0390
5	.6842**	.2391	.5616**	.1157

*$p < .05$

**$p < .01$

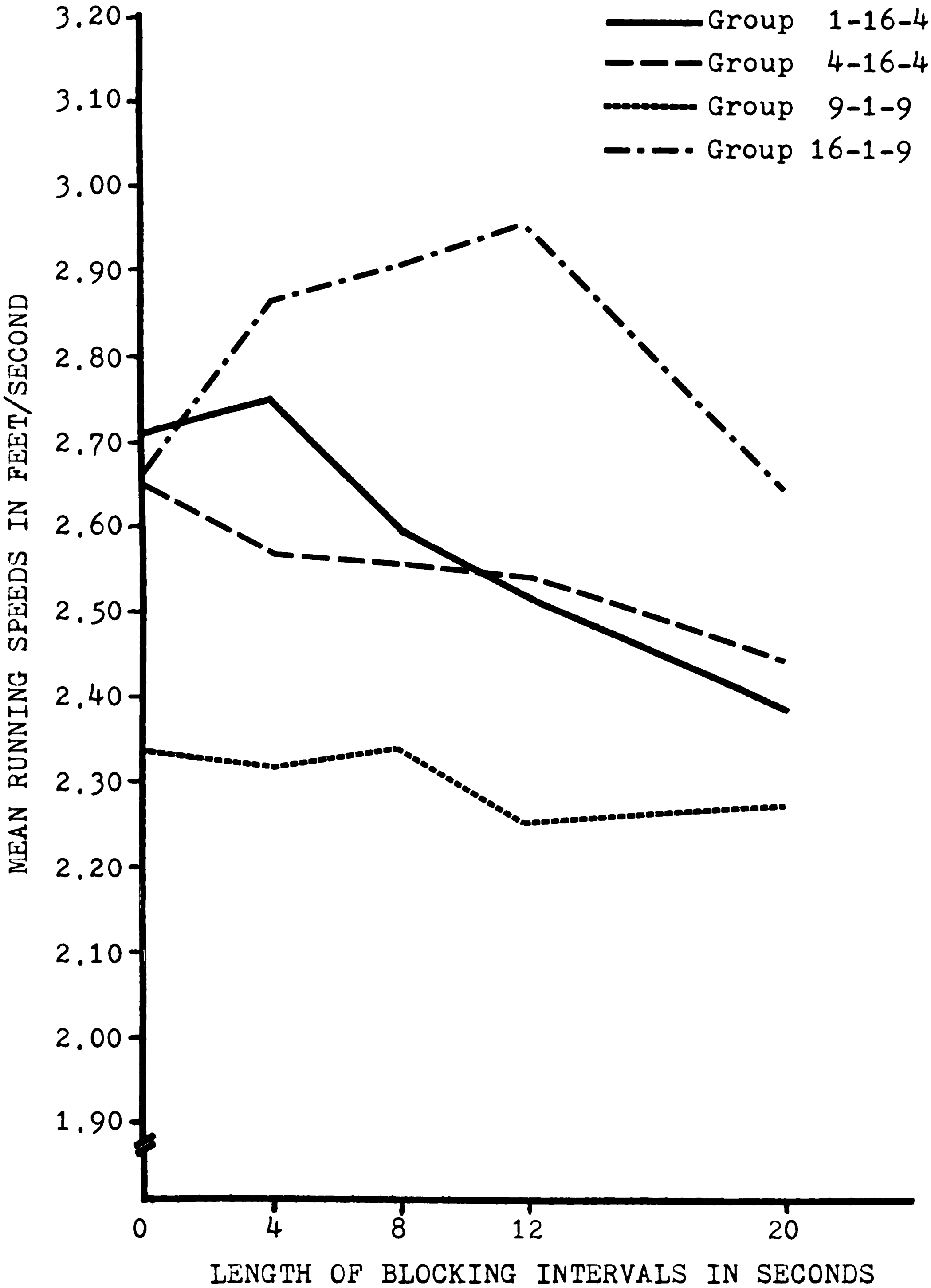

Figure 4. Mean running speeds on each blocking interval in Experiment I Phase 3

speeds of Groups 9-1-9 and 16-1-9 were compared for phases on which 9 pellets were given, a significant difference was obtained ($F = 6.55$, $df = 2/12$, $p < .05$). Contrary to the expected positive incentive contrast effect, Group 9-1-9 ran significantly faster in Phase 1 ($p < .05$) than it did in Phase 3 when increased from 1 back to 9 pellets (see Appendix F).

The expected negative incentive contrast effect was obtained for the 4 pellet ingestion speeds. A significant difference was found between the Phase 1 and 3 ingestion speeds of Group 4-16-4 and the Phase 3 ingestion speeds of Group 1-16-4 ($F = 20.24$, $df = 2/12$, $p < .01$). Phase 1 ingestion speed of Group 4-16-4 was significantly faster than that of Groups 4-16-4 and 1-16-4 in Phase 3 (see Appendix F).

The 16 pellet phases of Groups 16-1-9, 1-16-4, and 4-16-4 exhibited a significant positive incentive contrast effect for ingestion speeds ($F = 10.03$, $df = 2/12$, $p < .01$). Group 1-16-4 ingested significantly faster when increased to 16 pellets than either Groups 4-16-4 ($p < .05$) or 16-1-9 ($p < .01$) when they were on 16 pellets (see Appendix F). No significant difference in ingestion speeds was obtained between groups during their 9 pellet phases ($F = 2.27$, $df = 2/12$, $p > .05$).

Posttesting Ingestion

No significant differences were found between pretraining and posttesting ingestion speeds for either Group 1-16-4 or 9-1-9 (t = .42, df = 8, $p >$ .05; t = 1.35, df = 8, $p >$ .05, respectively). Groups 4-16-4 and 16-1-9 ingested faster during posttesting than during pretraining (t = 2.75, df = 8, $p <$ .05; t = 2.29, df = 8, $p <$ .05, respectively). The significant differences for these two groups are interesting to note since Group 4-16-4 (t = 2.75) demonstrated a significant frustration effect in Phase 1 and Group 16-1-9 (t = 2.29) obtained a nearly significant frustration effect. It is possible that frustration results in long term increases in ingestion speed.

The following conclusions are suggested by these results:

1. The frustration effect can be obtained for both running and ingestion speeds at some incentive levels with the blocking procedure used in this study. Most studies using only a blocking procedure have failed to find a frustration effect.
2. The maximum frustration effect is obtained with a 4 sec. blocking interval and a 4 pellet incentive.
3. The 4 pellet incentive produces the fastest ingestion speeds, which suggests a possible relationship between the level of motivation produced

by 4 pellets and the development of the frustration effect.

4. Very similar running speed patterns are observed for the various incentive levels with the primary difference being a gradual shift of the optimal blocking interval from 4 to 8 sec. as the incentive was increased to 16 pellets.
5. In 3 of the 4 groups running speeds in Phase 1 are faster for the 20 sec. delay interval than for the 12 sec. delay interval.
6. When the subjects are returned to an incentive level near their Phase 1 level after having experienced an increase or decrease in incentive, a highly significant positive correlation between running and ingestion speeds results.
7. Changes in the level of incentive, once the frustration effect has been obtained, eliminate the effect.
8. The expected contrast effects are obtained for ingestion speeds, but not for running speeds.

EXPERIMENT II

This experiment was prompted by the finding of an increase in running speed from the 12 sec. to the 20 sec. blocking intervals in Experiment I, Phase 1. A 45 sec. delay interval was substituted for the 20 sec. interval in an effort to discover if a longer delay would result in faster running speeds than the 4 sec. delay interval. A 9 pellet incentive level was used to allow a comparison of mean running speeds obtained, with those of Holder, *et al*. (1957) who used a .3 gm. incentive and 1, 15, and 45 sec. delay intervals. The Holder, *et al*., study used a between groups design and found that the 45 sec. delay yielded the greatest effect; the present experiment used a within subjects design.

Method

Subjects

The subjects were 10 experimentally naive female Sprague-Dawley rats approximately 90 days old. They were housed individually and maintained on a 22-hr. food deprivation schedule. Subjects were obtained from the same supplier as the subjects in Experiment I, and the same brand of food was used.

Apparatus

The apparatus was identical to that used in Experiment I.

Procedure

Habituation and training were identical to that used in Experiment I. Testing differed in that all subjects received nine 45 mg. Noyes pellets in the GB, and a 45 sec. blocking interval was substituted for the 20 sec. interval. Phases 2 and 3 were not run. The animals used in this experiment were designated Group 9. This experiment was conducted during the fall between 11:30 a.m. and 2:00 p.m.

Results and Conclusions

A single factor analysis for repeated measures revealed a significant difference between running speeds on the various blocking intervals (F = 2.33, df = 9/36, $p < .05$). A Newman-Keuls analysis showed that all four blocking intervals resulted in significantly faster running speeds than the 0 sec. interval, the 4, 8, and 45 sec. intervals being significantly faster at the .01 level and the 12 sec. at the .05 level (see Appendix F). Although the frustration effect was observed for all blocking intervals, the 4 sec. interval, as in Experiment I, seemed to produce the maximum running speed. These findings do not contradict those of Holder, Marx, Holder, and Collier (1957) in which they used 1, 15, and 45 sec. delay intervals and observed a direct relationship between running speed and length of delay interval. The present experiment reveals a similar relationship between running speed and the 0, 12, and 45 sec. delay intervals (see Figure 5). However, the present results suggest that the optimal blocking interval lies between 0 and 12 sec., an area not investigated in the Holder, et al., study. A day by day comparison of the mean running speeds on the 0 and 4 sec. delay intervals is presented in Figure 6.

No significant differences between ingestion speeds across delay intervals was observed ($F = 1.32$, $df = 9/36$, $p > .05$). Correlations between running and ingestion speeds for the last 5 days of testing are given in Table 5.

The following conclusions are suggested by the results of this experiment:

1. A very strong frustration effect (all blocking intervals resulting in significantly faster running speeds than the 0 sec. interval) can be obtained with a 9 pellet incentive.
2. The 4 sec. delay interval, as in Experiment I, results in the fastest running speeds. The 8 and 45 sec. intervals produce running speeds very nearly as fast as those obtained with a 4 sec. delay.
3. The obtained results are in agreement with those of Holder, et al.; however, they indicate strong

effects for blocking intervals not investigated in their study.

4. Contrary to the results obtained in Experiment I, Phase 1, for Group 9-1-9, no significant frustration effect for ingestion speed is obtained.

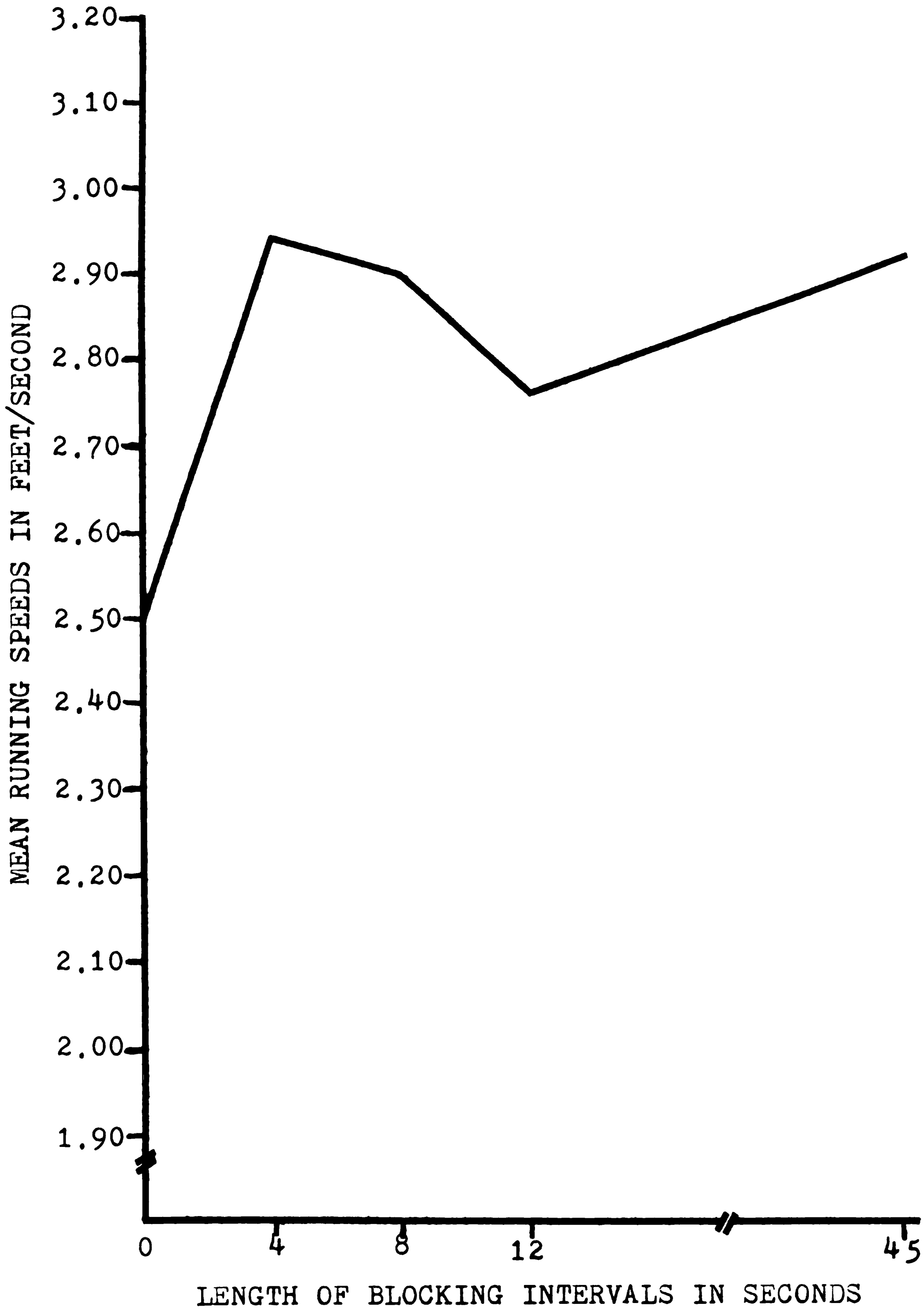

Figure 5. Mean running speeds on each blocking interval during days 7-11 of Experiment II

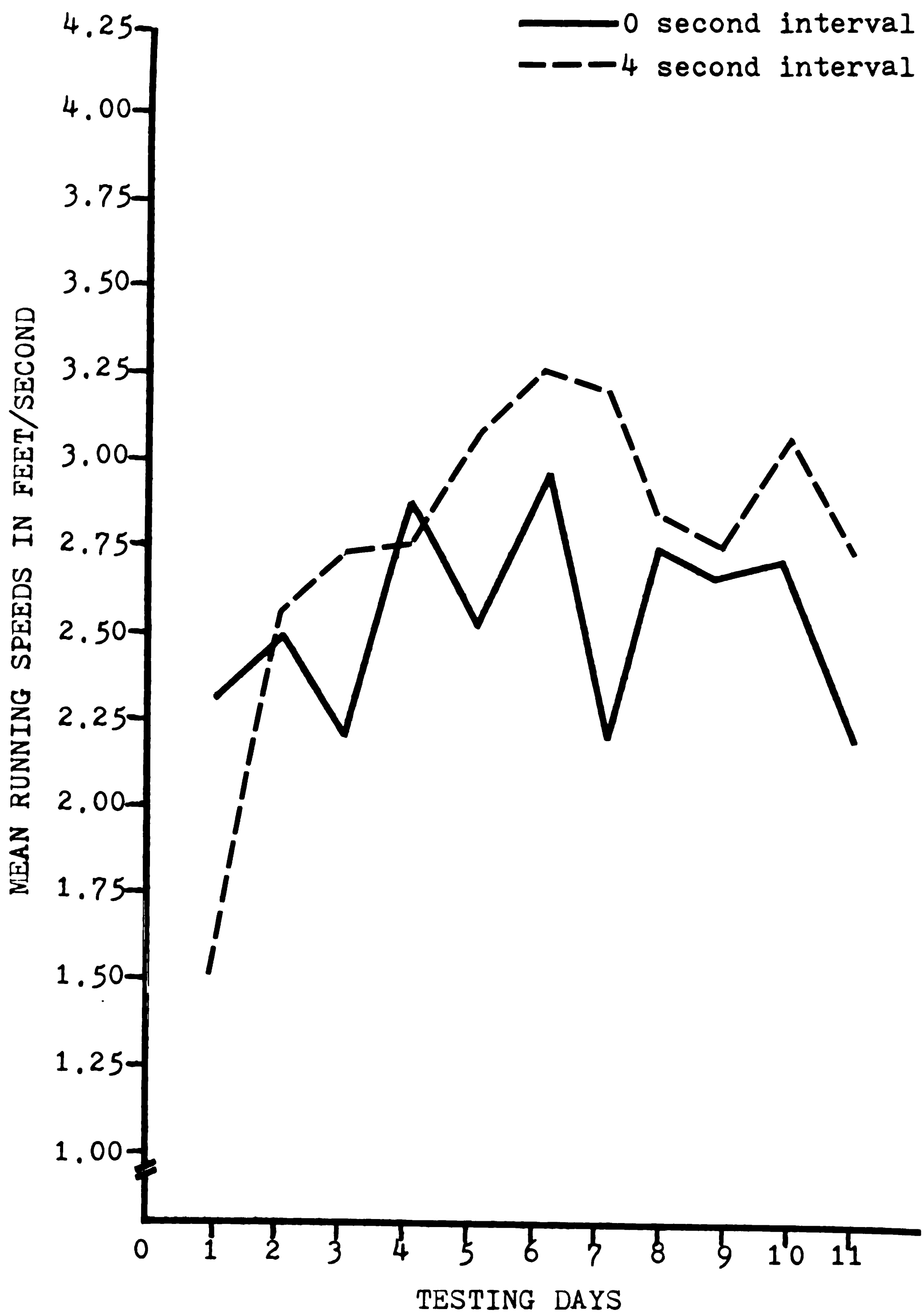

Figure 6. Mean running speeds on the 0 and 4 second blocking intervals for each day of testing in Experiment II (9 pellets)

TABLE 5

PEARSON PRODUCT CORRELATIONS BETWEEN RUNNING AND INGESTION SPEEDS FOR EXPERIMENT II TESTING

Day	Group 9
7	.2839*
8	.1259
9	.1710
10	.3221*
11	.2718*

*$p < .05$

EXPERIMENT III

This experiment is essentially a replication of Group 4-16-4 in Experiment I, Phase 1, the primary difference being an increase in the number of subjects.

Method

Subjects

Ten experimentally naive female subjects approximately 90 days old were used, but they were smaller than those used in the previous two experiments. They were obtained from the same supplier as those in Experiment I, and were housed and deprived in the same manner.

Apparatus

The same apparatus as used in Experiment I was used in this experiment.

Procedure

Habituation and training were carried out in the same manner as in Experiment I. Testing was identical to that given to Group 4-16-4 in Phase 1 of the first experiment. The animals in this experiment were designated as Group 4. This experiment was conducted between the hours of 11:30 a.m. and 2:00 p.m. during the fall months.

Results and Conclusions

Running speeds across delay intervals differed significantly (F = 3.33, df = 9/36, $p < .01$). The overall F in this experiment (4 pellet incentive) was more significant than the F obtained in Experiment II (9 pellet incentive). In addition, all of the delay intervals, 4, 8, 12, and 20 sec., with the 4 pellet incentive, resulted in significantly faster running speeds ($p < .01$) than the 0 sec. delay (see Appendix F). The plot of mean running speeds across delay intervals for this experiment (see Figure 7) is similar to that obtained for Group 4-16-4 in Experiment I, Phase 1, which also demonstrated a frustration effect. In both experiments the 4 sec. delay interval is optimal and the slope between the 4 and 8 sec. delay intervals is steep when compared to subjects given a 9 pellet incentive. The only place where the curve of the 4 pellet group in Experiment I, Phase 1, differs from the 4 pellet group of this experiment is between the 12 and 20 sec. delay points, with the 4 pellet group in Experiment I, Phase 1, showing a higher mean running speed on the 12 sec. delay interval than on the 20 sec. delay, exactly opposite of what was observed in Experiment III.

A day by day comparison of the mean running speeds on the 0 sec. and 4 sec. intervals is given in Figure 8.

Although a significant delay effect was found for ingestion speed (F = 2.36, df = 9/36, $p < .05$), differences

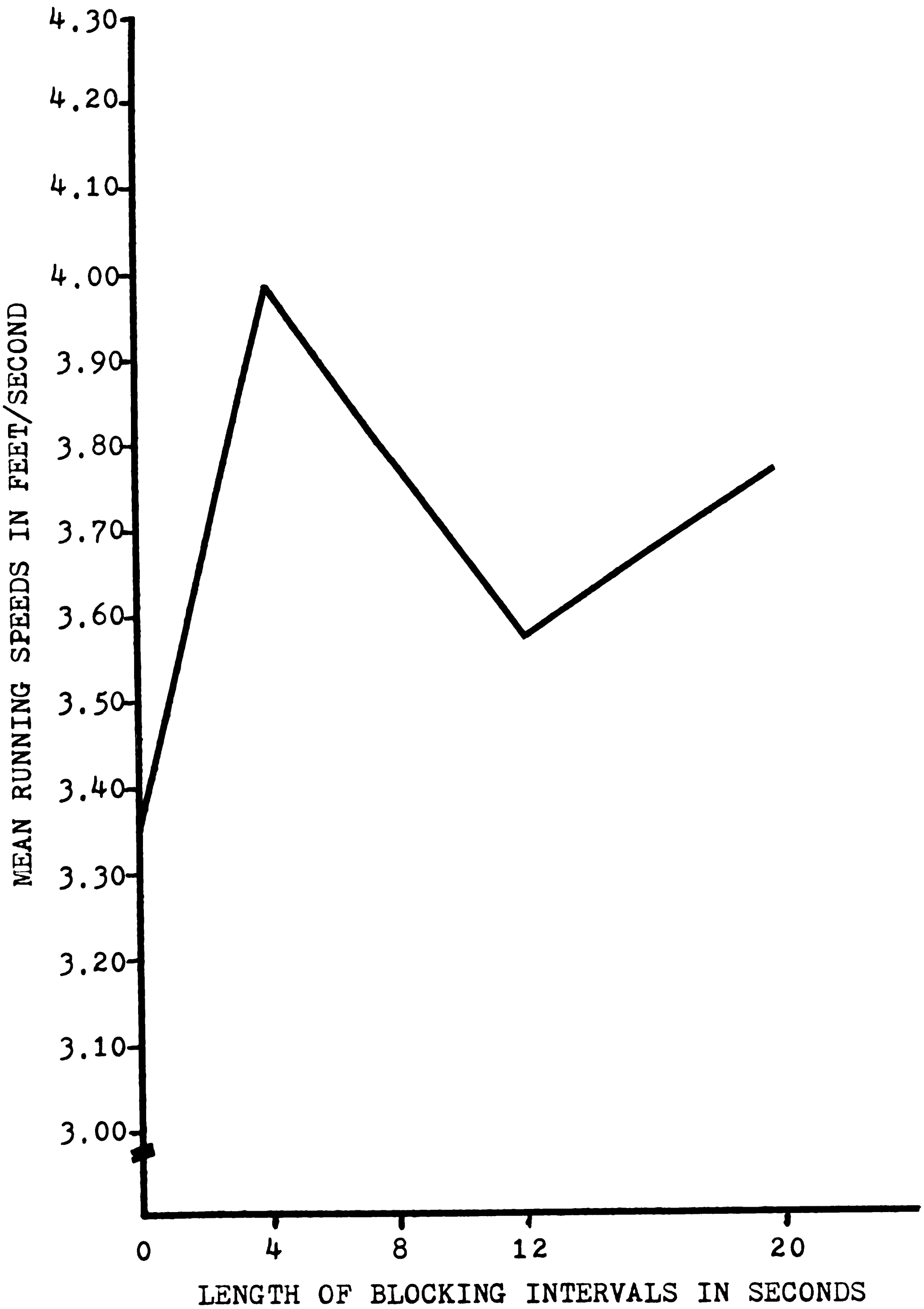

Figure 7. Mean running speeds on each blocking interval during days 7-11 of Experiment III

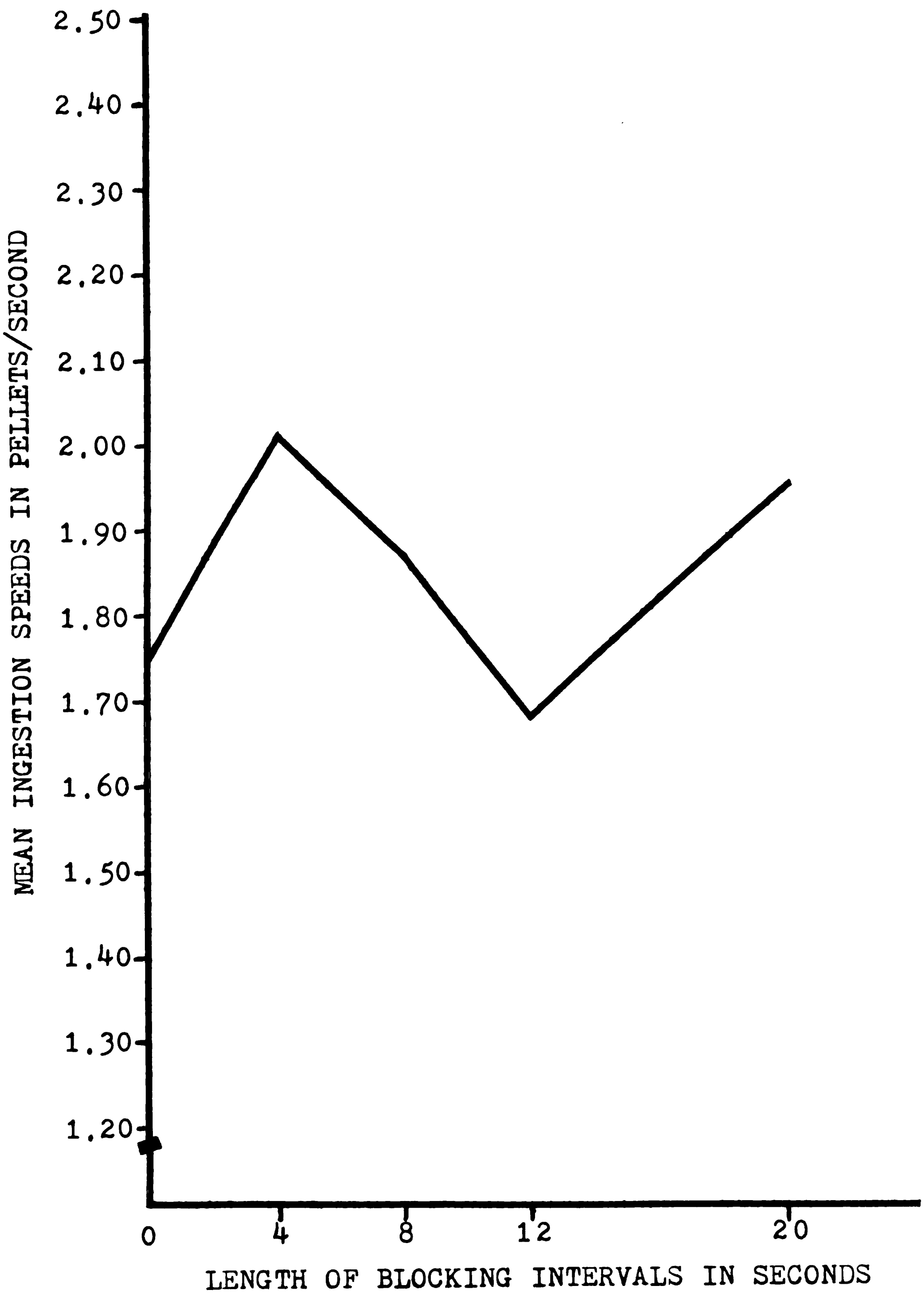

Figure 8. Mean ingestion speeds on each blocking interval during days 7-11 of Experiment III

between intervals by Newman-Keuls analysis only approached significance (see Appendix F). It is interesting to note that the plot of running speeds across delay intervals is quite similar to that obtained for ingestion speeds (see Figure 9). None of the daily correlations between running and ingestion speeds proved to be significant.

The results of this experiment suggest that the following conclusions are warranted:

1. The conclusions in Experiment I that the 4 pellet incentive produces a significant frustration effect for running speed is confirmed. All delay intervals used produced running speeds significantly faster than the nonblocked condition.
2. That the F obtained in this experiment is significant at the .01 level and that obtained in Experiment II with the 9 pellet incentive is significant at the .05 level suggests that the 4 pellet incentive produces a more reliable frustration effect than the other incentive levels tested. This was also observed in Experiment I, Phase 1.
3. The 4 sec. blocking interval tends to produce higher mean running speeds than the 0, 8, 12, and 20 sec. intervals.
4. As in Experiment II no significant frustration effect is observed for ingestion speeds.

5. The various delay intervals have similar effects on the running and ingestion speeds.

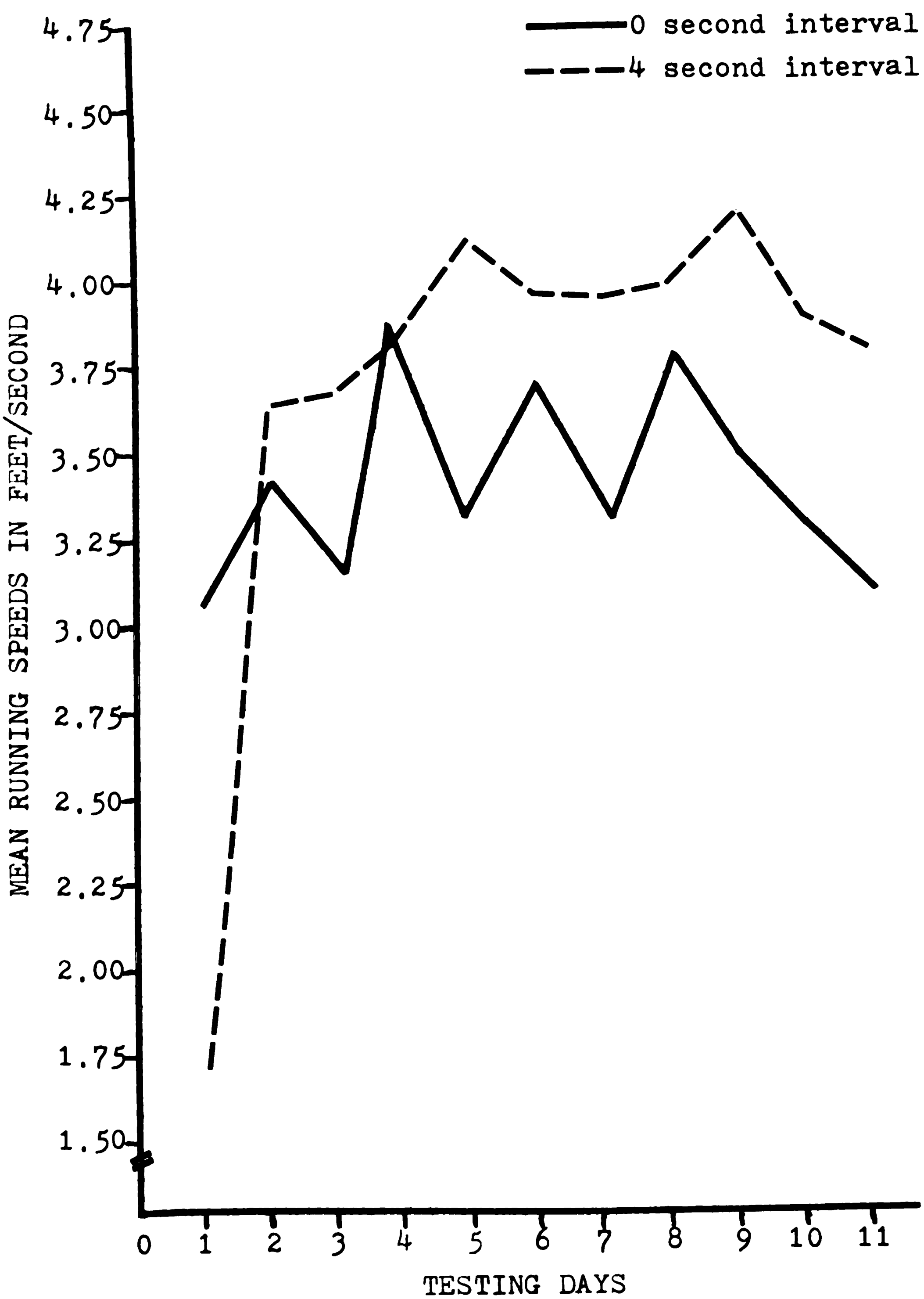

Figure 9. Mean running speeds on the 0 and 4 second blocking intervals for each day of testing in Experiment III (4 pellets)

DISCUSSION

The data from all three experiments indicate that the frustration effect is obtainable with the blocking procedure used. Other blocking studies which have failed to obtain a frustration effect have used different procedures. Wist (1962) and Williams and Ellis (1970) confined their subjects in the SB at the beginning of each trial. Ludvigson (1968) failed to administer unobstructed trials to his blocked groups, thus failing to maintain an expectation for a clear path to the goal. Holding the subjects in the SB at the start of training trials may prevent an expectation of a nonblocked approach from developing.

Of the various delay intervals used in this study, the 4 sec. delay produced the fastest mean running speeds in all groups except Group 16-1-9 of Experiment I, Phase 1. The 16 pellet condition for this group produced the fastest mean running speeds with an 8 sec. delay. The 4 sec. delay appears to be long enough to increase motivation and short enough to prevent competing responses. Subjects tended to be much more tangentially active, turning and scratching, with longer delays. When rats were more tangentially active during a blocking interval, their approach to the goal was slower. The subjects with the fastest approaches tended to maintain their goal orientation with their noses at the bottom of the unopened A_2 door. It is also interesting to note that as the delay intervals were increased to 20 or 45 sec., the mean running speeds again increased to a level approaching that obtained with the 4 sec. delay, suggesting a possible cyclic change in motivation level.

The 4 and 9 pellet incentive levels both resulted in significant frustration effects, with the 4 pellet incentive being the only level in Experiment I, Phase 1, to do so. Since the 4 pellet level also resulted in a frustration effect for the 4, 8, 12, and 20 sec. delay intervals in Experiment III, it seems to be at or near the optimal level for obtaining a reliable frustration effect. The 4 pellet incentive also resulted in the fastest mean ingestion speeds. This sort of relationship is supported by the fact that mean ingestion speeds plotted across delay intervals produce curves which are very similar to those obtained for running speed. This suggests that the frustration induced increase in motivation had a similar effect on both running and ingestion, but was reduced enough in the ingestion situation to prevent a significant difference between delay intervals from developing.

Correlations between running speeds and ingestion speeds were significant beyond the .01 level only when incentive levels were increased or decreased and then returned to an amount at or near the original level. That is, once the rat has been exposed to both high and low incentive levels and is returned to the original level, that level through contrast is now nicely specified and affects performance accordingly.

The present study is similar to the Amsel and Roussel (1952) study in that both obtained a significant frustration effect. However, they are quite different in that the present study used only frustrative blocking while Amsel and Roussel's involved both frustrative blocking and frustrative nonreinforcement. Although this suggests the possibility that at least part of the frustration effect observed in the Amsel-Roussel study is due to blocking, the techniques used in this study, namely, no holding in the SB and truly nonblocked training trials, plus other experimental data, cast suspicion on this interpretation.

Most of the studies which have held subjects in the SB on training trials (as was done in the Amsel-Roussel study) have failed to find a frustration effect when only blocking was used during testing for the frustration effect (Ludvigson, 1968; Williams & Ellis, 1970; Wist, 1962). The fact that Amsel and Roussel did find a frustration effect suggests that frustrative nonreward by itself was strong enough to energize the running speeds in A_2. In any case, the present set of experiments have demonstrated in a way different from Wagner (1959) and Tortora (1973) that demotivation can be eliminated as an alternative explanation for the frustration effect.

The procedure employed in this study allowed for an "expectancy" to develop during training and maintained it during testing. On nonblocked trials the fractional anticipatory goal response (r_g) increased as the subject approached the goal. When the subject was blocked, the r_g may have intensified and resulted in a facilitation of relevant responding.

The results of Experiment II suggest that future research on the role of blocking in the frustration effect may find it profitable to investigate blocking intervals longer than 45 sec. in duration, since the 45 sec. delay yielded mean running speeds which approached that of the 4 sec. delay.

Although the procedure used in this study clearly led to a frustration effect, a change in the apparatus may lead to more significant results. In the straight alley apparatus used in this study, subjects on nonblocked trials not only ran to escape the "conditioned aversive stimulus," black, but also had a clear view of a conditioned reinforcer, white. Blocked trials had to increase motivation enough to surpass the speed developed from the start box in the direct approach elicited on nonblocked trials. An L-shaped maze would prevent the subjects from seeing the door or the white alley until they had turned the corner and entered the delay box, mitigating the inertia effect of the unblocked trial.

APPENDIX A

APPENDIX A

TABLE A1

PRETRAINING INGESTION SPEEDS

Subjects	Group 1-16-4	Group 4-16-4	Group 9-1-9	Group 16-1-9
1	2.00	2.00	1.11	1.43
2	1.67	1.25	2.50	1.25
3	.77	.67	1.25	1.25
4	1.67	1.67	1.67	2.00
5	1.25	.91	3.33	.83

TABLE A2

POSTTESTING INGESTION SPEEDS

Subjects	Group 1-16-4	Group 4-16-4	Group 9-1-9	Group 16-1-9
1	2.50	3.33	2.50	3.33
2	1.67	5.00	5.00	2.50
3	.77	3.33	1.43	3.33
4	2.50	2.50	3.33	1.67
5	.83	3.33	2.50	1.25

APPENDIX B

APPENDIX B

TABLE B1

MEAN RUNNING SPEEDS ON EACH TRIAL FOR THE LAST FIVE DAYS OF TRAINING IN EXPERIMENT I

	TRIALS					
Subjects	1	2	3	4	5	6
Group 1-16-4						
1	1.79	3.20	3.34	3.80	3.38	3.61
2	1.99	3.78	2.83	3.37	3.06	3.33
3	.56	1.55	1.84	1.89	1.84	1.69
4	4.04	4.50	4.82	4.55	4.08	3.41
5	1.87	1.91	1.84	1.84	1.70	1.83
Group 4-16-4						
1	1.03	3.35	4.01	3.81	3.80	3.52
2	1.40	2.02	2.61	2.39	2.26	2.60
3	2.62	3.20	3.72	3.49	3.83	3.82
4	1.86	2.64	2.74	2.67	2.73	2.18
5	2.59	3.46	3.54	3.77	3.47	4.68
Group 9-1-9						
1	1.73	2.17	2.66	2.60	2.20	2.63
2	1.27	1.70	1.83	1.78	1.64	1.92
3	1.13	2.05	2.38	2.38	2.36	2.66
4	2.02	2.26	2.85	2.58	2.82	2.65
5	1.72	3.05	3.35	2.94	3.24	2.57

TABLE B1 (cont'd.)

	TRIALS					
Subjects	1	2	3	4	5	6
Group 16-1-9						
1	2.03	2.86	2.93	2.87	2.70	2.69
2	1.90	2.04	2.86	2.40	2.55	2.17
3	3.14	3.33	3.27	3.66	3.80	3.49
4	2.29	2.69	2.19	1.84	2.70	1.92
5	1.93	2.41	2.41	2.39	2.33	2.14

TABLE B2

MEAN INGESTION SPEEDS ON EACH TRIAL

FOR THE LAST FIVE DAYS OF TRAINING IN EXPERIMENT I

	TRIALS					
SUBJECTS	1	2	3	4	5	6
Group 4-16-4						
1	.82	1.33	1.16	1.01	.98	1.09
2	.37	.34	.34	.40	.36	.38
3	1.21	1.16	1.30	1.19	.96	1.06
4	.29	.42	.35	.40	.41	.53
5	.29	.33	.31	.34	.36	.40
Group 9-1-9						
1	.15	.19	.18	.18	.18	.16
2	.18	.21	.20	.19	.17	.17
3	.22	.21	.20	.20	.19	.20
4	.18	.21	.19	.19	.25	.21
5	.25	.22	.23	.22	.22	.21
Group 16-1-9						
1	.14	.18	.18	.18	.18	.16
2	.16	.19	.18	.17	.17	.17
3	.16	.18	.17	.17	.16	.18
4	.12	.14	.13	.12	.14	.12
5	.15	.16	.16	.15	.15	.15

TABLE B3

MEAN RUNNING SPEEDS ON EACH DELAY INTERVAL

FOR THE LAST FIVE DAYS OF EXPERIMENT I, PHASE 1

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 1-16-4					
1	2.90	2.59	2.74	2.48	2.54
2	3.16	4.27	3.23	3.60	3.02
3	1.10	1.39	1.62	1.14	1.43
4	3.57	3.97	4.15	3.90	3.92
5	2.02	2.24	1.95	1.84	2.24
Group 4-16-4					
1	2.62	2.79	2.64	2.61	2.62
2	2.63	3.25	2.64	2.78	2.78
3	2.46	2.89	2.76	2.34	2.08
4	2.47	3.50	3.12	3.12	3.16
5	2.89	2.67	2.57	2.48	2.36
Group 9-1-9					
1	1.74	1.96	1.92	1.83	1.60
2	1.75	2.04	2.07	1.85	2.04
3	2.32	2.36	2.12	2.06	2.15
4	2.00	2.43	2.05	1.63	1.88
5	2.39	2.47	2.61	1.72	2.38

TABLE B3 (cont'd.)

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 16-1-9					
1	2.11	2.73	2.59	2.58	2.79
2	1.82	1.76	2.09	1.58	1.96
3	2.46	2.71	2.68	2.67	2.32
4	2.49	3.10	3.40	2.37	3.04
5	2.14	2.18	2.17	1.63	1.94

TABLE B4

MEAN INGESTION SPEEDS ON EACH DELAY INTERVAL

FOR THE LAST FIVE DAYS OF EXPERIMENT I, PHASE 1

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 4-16-4					
1	1.42	1.27	1.39	.98	1.34
2	.87	1.28	.74	1.01	1.04
3	1.21	1.36	1.79	1.17	1.56
4	.79	1.03	1.03	1.08	1.29
5	.41	.49	.45	.41	.47
Group 9-1-9					
1	.19	.20	.18	.20	.18
2	.19	.19	.19	.20	.17
3	.21	.23	.22	.24	.21
4	.20	.24	.21	.23	.20
5	.22	.25	.26	.28	.25
Group 16-1-9					
1	.16	.16	.16	.16	.17
2	.18	.19	.18	.18	.16
3	.17	.18	.18	.18	.18
4	.15	.15	.15	.14	.15
5	.16	.16	.16	.16	.16

TABLE B5

MEAN RUNNING SPEED ON EACH DELAY INTERVAL

FOR ALL FIVE DAYS OF EXPERIMENT I, PHASE 2

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 1-16-4					
1	3.03	2.62	2.64	2.86	2.81
2	2.65	2.58	2.52	2.43	2.42
3	1.26	1.38	1.38	1.42	1.39
4	3.58	3.19	3.35	3.39	3.53
5	2.45	2.36	2.43	2.36	2.47
Group 4-16-4					
1	2.89	2.71	2.49	2.22	2.64
2	2.63	2.98	3.17	3.05	3.00
3	1.63	1.71	1.52	1.95	1.72
4	2.29	3.18	3.06	2.84	2.96
5	2.32	2.35	2.10	2.28	1.86
Group 9-1-9					
1	2.01	1.64	1.57	1.73	1.28
2	1.68	1.83	1.58	1.80	1.72
3	2.04	1.56	1.40	1.65	1.41
4	1.93	1.57	1.29	2.16	1.55
5	2.07	2.14	1.19	2.27	1.96

TABLE B5 (cont'd.)

Subjects	Delay Intervals in Seconds				
	0	4	8	12	20
Group 16-1-9					
1	2.26	2.17	1.96	2.58	2.24
2	2.48	2.35	1.92	2.62	2.69
3	2.35	2.21	1.88	2.28	1.50
4	2.64	3.97	2.35	3.89	3.32
5	1.84	1.97	1.98	2.10	1.66

TABLE B6

MEAN INGESTION SPEED ON EACH DELAY INTERVAL

FOR ALL FIVE DAYS OF EXPERIMENT I, PHASE 2

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 1-16-4					
1	.19	.22	.19	.19	.18
2	.22	.23	.23	.22	.23
3	.23	.22	.20	.23	.20
4	.22	.22	.22	.24	.23
5	.24	.21	.21	.21	.21
Group 4-16-4					
1	.20	.22	.18	.18	.19
2	.21	.20	.21	.19	.23
3	.20	.20	.20	.17	.20
4	.19	.18	.18	.20	.20
5	.14	.15	.15	.14	.14

TABLE B7

MEAN RUNNING SPEEDS ON EACH DELAY INTERVAL FOR ALL FIVE DAYS OF EXPERIMENT I, PHASE 3

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 1-16-4					
1	3.40	3.32	3.03	2.90	2.80
2	2.51	2.58	2.59	2.49	2.39
3	1.50	1.63	1.42	1.55	1.19
4	3.56	3.42	3.37	3.23	3.18
5	2.59	2.74	2.51	2.44	2.50
Group 4-16-4					
1	3.16	3.07	2.68	2.85	2.53
2	2.74	2.74	2.71	2.85	2.98
3	2.56	2.13	2.06	2.01	2.12
4	2.50	3.14	3.23	3.03	2.90
5	2.33	1.76	2.18	2.03	1.82
Group 9-1-9					
1	1.92	1.79	1.63	1.82	1.78
2	2.02	2.05	2.05	1.96	2.05
3	2.71	2.42	2.57	2.34	2.34
4	2.48	2.56	2.68	2.44	2.50
5	2.47	2.72	2.66	2.72	2.70

TABLE B7 (cont'd.)

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 16-1-9					
1	2.75	3.34	3.18	3.58	2.86
2	2.68	2.57	2.56	2.40	2.22
3	2.63	2.42	2.83	2.65	2.41
4	2.97	3.39	4.04	4.14	3.74
5	2.30	2.57	2.05	2.05	2.12

TABLE B8

MEAN INGESTION SPEEDS ON EACH DELAY INTERVAL

FOR ALL FIVE DAYS OF EXPERIMENT I, PHASE 3

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 1-16-4					
1	2.43	2.64	2.35	2.10	2.28
2	1.40	1.54	1.46	1.42	1.28
3	.61	.75	.74	.58	.67
4	1.49	1.74	1.59	1.55	1.66
5	1.10	.98	1.10	1.09	.93
Group 4-16-4					
1	1.68	1.46	1.44	1.40	1.25
2	.89	1.07	.99	.96	1.25
3	1.16	1.13	1.16	1.09	1.03
4	.98	1.20	1.09	1.24	.87
5	.51	.58	.63	.53	.53
Group 9-1-9					
1	.21	.21	.18	.20	.22
2	.21	.19	.20	.22	.20
3	.24	.24	.25	.23	.23
4	.22	.23	.22	.25	.21
5	.29	.29	.32	.31	.29

TABLE B8 (cont'd.)

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 16-1-9					
1	.18	.17	.18	.15	.18
2	.21	.22	.22	.21	.21
3	.22	.22	.23	.20	.25
4	.17	.17	.18	.18	.18
5	.18	.19	.18	.19	.20

APPENDIX C

APPENDIX C

TABLE C1

MEAN RUNNING SPEEDS ON EACH TRIAL

FOR THE LAST FIVE DAYS OF TRAINING IN EXPERIMENT II

	Trials					
Subjects	1	2	3	4	5	6
Group 9						
1	1.57	1.84	1.86	2.13	2.09	1.82
2	3.03	4.51	4.24	4.33	4.80	3.93
3	1.99	3.73	3.43	3.47	3.60	3.22
4	2.26	3.11	3.27	3.25	3.08	2.91
5	1.66	2.86	3.08	2.89	2.48	2.79
6	2.76	4.33	3.59	3.17	3.22	4.11
7	2.52	4.25	4.20	4.53	4.56	4.29
8	1.95	2.58	3.05	2.44	2.89	2.90
9	2.71	4.63	4.24	4.73	4.51	4.11
10	1.82	2.42	2.47	2.40	2.40	2.59

TABLE C2

MEAN INGESTION SPEEDS ON EACH TRIAL

FOR THE LAST FIVE DAYS OF TRAINING IN EXPERIMENT II

	Trials					
Subjects	1	2	3	4	5	6
Group 9						
1	.16	.21	.20	.21	.21	.19
2	.30	.33	.30	.29	.27	.28
3	.23	.25	.25	.24	.24	.22
4	.25	.22	.23	.24	.21	.23
5	.23	.24	.26	.26	.20	.22
6	.20	.25	.23	.22	.23	.23
7	.19	.23	.24	.24	.23	.22
8	.23	.25	.25	.25	.25	.24
9	.22	.26	.24	.26	.25	.26
10	.23	.24	.22	.24	.22	.23

TABLE C3

MEAN RUNNING SPEEDS ON EACH DELAY INTERVAL

FOR THE LAST FIVE DAYS OF EXPERIMENT II

	Delay Intervals in Seconds				
Subjects	0	4	8	12	45
Group 9					
1	1.60	2.05	2.17	2.22	2.17
2	2.98	3.83	3.74	2.88	4.11
3	2.71	2.99	3.22	3.20	3.37
4	2.41	2.80	2.37	2.40	2.41
5	1.79	2.25	2.27	2.24	2.37
6	2.92	3.49	3.80	3.39	3.18
7	3.47	3.61	3.08	3.17	3.13
8	2.19	2.59	2.45	2.33	2.37
9	3.19	3.40	3.83	3.50	3.52
10	1.79	2.29	2.06	2.21	2.46

TABLE C4

MEAN INGESTION SPEEDS ON EACH DELAY INTERVAL

FOR THE LAST FIVE DAYS OF EXPERIMENT II

	Delay Intervals in Seconds				
Subjects	0	4	8	12	45
Group 9					
1	.21	.22	.22	.22	.20
2	.29	.30	.30	.32	.28
3	.21	.23	.21	.21	.20
4	.22	.23	.26	.23	.21
5	.22	.22	.23	.21	.19
6	.21	.23	.21	.22	.23
7	.23	.24	.22	.23	.25
8	.26	.26	.25	.26	.26
9	.26	.26	.26	.25	.25
10	.21	.24	.23	.26	.17

APPENDIX D

TABLE D1

MEAN RUNNING SPEEDS ON EACH TRIAL

FOR THE LAST FIVE DAYS OF TRAINING IN EXPERIMENT III

Subjects	Trials 1	2	3	4	5	6
Group 4						
1	1.43	1.89	2.02	2.22	2.36	2.52
2	4.36	5.07	5.76	4.91	5.78	6.28
3	3.80	5.52	5.60	5.93	5.68	5.73
4	2.23	2.63	2.96	2.80	3.16	3.28
5	3.68	5.28	7.02	6.58	5.98	5.31
6	2.46	3.60	4.41	4.64	4.65	4.53
7	3.01	4.32	4.33	5.05	4.09	4.72
8	4.55	5.43	5.98	5.35	5.98	5.48
9	3.07	5.19	4.90	4.75	4.48	4.91
10	3.42	4.53	4.48	4.72	4.63	4.52

TABLE D2

MEAN INGESTION SPEEDS ON EACH TRIAL

FOR THE LAST FIVE DAYS OF TRAINING IN EXPERIMENT III

	Trials					
Subjects	1	2	3	4	5	6
Group 4						
1	1.05	1.07	.89	.90	.99	1.06
2	1.78	1.65	1.77	1.82	1.74	1.78
3	1.93	1.54	1.89	1.81	1.88	1.94
4	1.87	2.16	2.19	2.30	2.16	2.04
5	1.93	2.02	1.58	1.83	2.01	2.24
6	2.15	2.22	2.33	2.16	2.15	2.52
7	1.96	2.36	1.56	1.95	1.77	1.65
8	1.76	2.40	2.26	2.42	2.19	1.77
9	.66	.59	.53	.60	.42	.56
10	.99	1.13	1.03	1.08	1.16	1.12

TABLE D3

MEAN RUNNING SPEEDS ON EACH DELAY INTERVAL

FOR THE LAST FIVE DAYS OF EXPERIMENT III

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 4					
1	2.54	3.81	3.67	3.55	3.14
2	3.48	3.40	3.32	3.23	3.13
3	4.10	4.69	4.44	4.34	5.80
4	2.66	3.03	2.76	2.82	2.54
5	3.90	4.52	4.69	4.13	4.54
6	3.13	4.01	3.64	3.69	3.58
7	2.86	3.91	3.18	3.09	3.71
8	3.98	4.33	4.59	4.47	4.46
9	4.01	4.92	4.00	3.86	4.06
10	2.93	3.21	3.46	2.81	2.84

TABLE D4

MEAN INGESTION SPEEDS ON EACH DELAY INTERVAL FOR THE LAST FIVE DAYS OF EXPERIMENT III

	Delay Intervals in Seconds				
Subjects	0	4	8	12	20
Group 4					
1	1.27	1.64	1.47	1.43	1.56
2	2.34	2.72	2.44	1.84	2.45
3	1.87	2.42	2.12	2.02	2.44
4	2.05	2.40	2.09	1.89	2.30
5	1.67	1.91	1.86	1.86	1.74
6	2.16	2.56	2.36	2.21	2.38
7	1.74	2.07	1.88	1.78	2.42
8	2.04	1.93	1.92	1.96	2.44
9	1.01	1.09	1.10	.91	.82
10	1.31	1.40	1.50	.84	1.50

APPENDIX E

APPENDIX E

NONSIGNIFICANT RESULTS FROM EXPERIMENT I

Testing, Phase 1

A within groups analysis of variance revealed that running and ingestion speeds for the second through the sixth days of testing were never significantly faster following any delay interval than following the 0 sec. interval. Thus, no significant frustration effect was obtained (see Figure E1).

A within groups analysis of running speeds revealed a nonsignificant delay effect for Group 1-16-4 ($F = 1.13$, $df = 4/16$, $p > .05$). Group 9-1-9 reached significance ($F = 4.33$, $df = 4/16$, $p < .05$) with the 4 sec. and 8 sec. delay intervals resulting in significantly faster running ($p < .05$) than the 12 sec. delay. Significance was also reached by Group 16-1-9 ($F = 3.40$, $df = 4/16$, $p < .05$); however, differences between delay intervals only approached significance.

A within groups analysis of ingestion speeds revealed nonsignificant delay effects in Groups 4-16-4 and 16-1-9 ($F = 1.40$, $df = 4/16$, $p > .05$; $F = .39$, $df = 4/16$, $p > .05$, respectively).

The difference between pretraining and Phase 1 ingestion speeds for Group 4-16-4 was nonsignificant ($t = .96$, $df = 8$, $p > .05$).

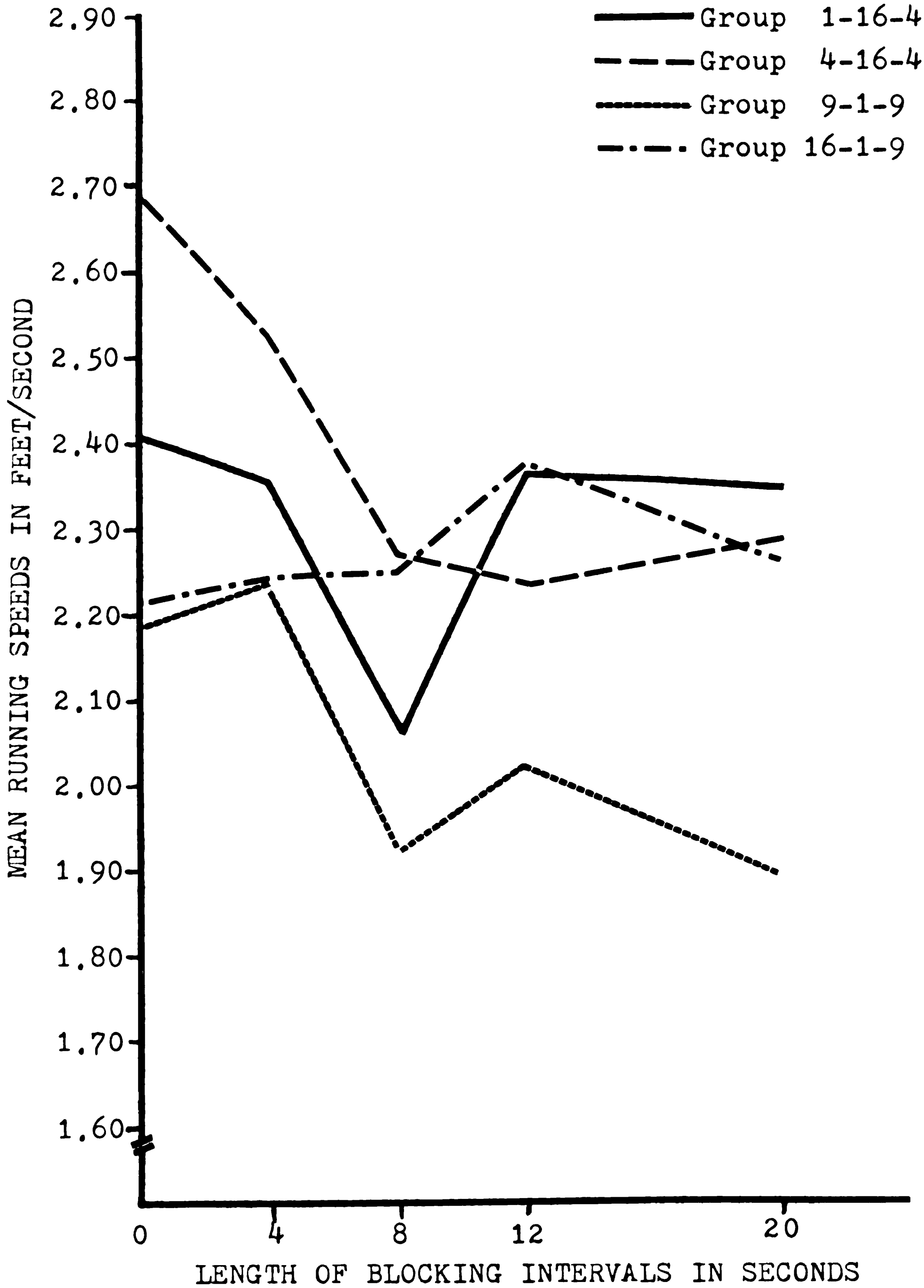

Figure E1. Mean running speeds on each blocking interval during days 2-6 of Experiment I Phase 1

Testing, Phase 2

A single factor analysis of variance for repeated measures revealed no significant differences between running speeds on delay intervals in Group 1-16-4 (F = 2.00, df = 4/16, $p > .05$), Group 4-16-4 (F = .65, df = 4/16, $p > .05$), or Group 16-1-9 (F = 2.75, df = 4/16, $p > .05$). Group 9-1-9 reached significance (F = 5.00, df = 4/16, $p < .01$). The 0 and 12 sec. delay intervals resulted in significantly faster running ($p < .05$) than the 8 sec. delay; however, no significant frustration effect was obtained.

Within groups analysis of ingestion speeds for Groups 1-16-4 and 4-16-4 were not significant (F = .87, df = 4/16, $p > .05$; F = 1.32, df = 4/16, $p > .05$, respectively).

Testing, Phase 3

A within groups analysis of running speeds was nonsignificant for Group 4-16-4 (F = .33, df = 4/16, $p > .05$), Group 9-1-9 (F = .19, df = 4/16, $p > .05$), and Group 16-1-9 (F = 1.11, df = 4/16, $p > .05$). Group 1-16-4 reached a significant level (F = 9.00, df = 4/16, $p < .01$). A Newman-Keuls analysis did not reveal a significant frustration effect. Both the 4 and 0 sec. delay running speeds were significantly faster than the 12 sec. interval delay speeds ($p < .05$) and the 20 sec. interval delay speeds ($p < .01$).

No significant within groups differences in ingestion speeds were observed: Group 1-16-4 (F = 2.48, df = 4/16, *p* $>$ .05); Group 4-16-4 (*F* = .43, *df* = 4/16, *p* $>$ .05); Group 9-1-9 (*F* = .55, *df* = 4/16, *p* $>$ .05); Group 16-1-9 (*F* = 2.24, *df* = 4/16, *p* $>$ .05).

No significant between groups difference was obtained for running speeds (*F* = .79, *df* = 3/16, *p* $>$ .05).

Comparisons of the mean ingestion speeds of Groups 1-16-4 and 4-16-4 with their mean pretraining ingestion speeds were not significant (*t* = .88, *df* = 8, *p* $>$ .05; *t* = .16, *df* = 8, *p* $>$ .05, respectively).

Between Phases Comparisons

When Group 1-16-4 in Phase 2 was compared with Group 16-1-9 in Phase 1, no significant incentive contrast effect was found for running speed (*t* = .45, *df* = 8, *p* $>$ .05). Group 16-1-9 in Phase 2 did not display a significant negative contrast effect for running speed when compared with Group 1-16-4 in Phase 1 (*t* = -.59, *df* = 8, *p* $>$ .05).

Comparisons of the running speeds of Groups 1-16-4 and 4-16-4 during the phases on which they received 4 pellets did not reveal any significant difference (*F* = .06, *df* = 2/12, *p* $>$ .05). No significant difference was found between Phase 1 running speeds of Group 16-1-9 or Phase 2 running speeds of Groups 1-16-4 and 4-16-4 (*F* = .12, *df* = 2/12, *p* $>$ .05).

APPENDIX F

APPENDIX F

TABLE F1

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS FOR TRAINING INGESTION SPEEDS IN EXPERIMENT I

Source of Variation	SS	df	MS	F	P
Incentive	7,748.13	2	3,874.07	7.34	<.01
Error	6,336.80	12	528.07		
Total	14,084.93				

Groups		16-1-9	9-1-9	4-16-4	
	Totals	79	98	329	
16-1-9	79		19	250*	
9-1-9	98			231*	
4-16-4	329				
q.95 (r,12)			3.08	3.77	
$\sqrt{n\ MSerror}$ q.95 (r,12)			158.25	193.70	*P<.05

TABLE F2

ANALYSIS OF VARIANCE OF RUNNING SPEEDS

FOR GROUP 4-16-4 IN EXPERIMENT I, PHASE 1

Source of Variation	SS	df	MS	F	P
Between rats	.99				
Within rats	1.42				
Interval	.59	4	.15	3.00	$<.05$
Error	.82	16	.05		
Total	2.42				

TABLE F3

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS FOR INGESTION SPEEDS FOR DELAY INTERVALS IN EXPERIMENT I, PHASE 1

Source of Variation	SS	df	MS	F	P
Between rats	138.16				
Within rats	47.60				
Interval	30.56	4	7.64	7.21	<.01
Error	17.04	16	1.06		
Total	185.76				

Intervals		0 sec.	20 sec.	8 sec.	4 sec.	12 sec.	
	Totals	101	101	106	111	115	
0 sec.	101		0	5	10*	14**	
20 sec.	101			5	10*	14**	
8 sec.	106				5	9	
4 sec.	111					4	
12 sec.	115						
$q_{.95}$ (r,16)			3.00	3.65	4.05	4.33	
$\sqrt{n\ MSerror}\ q_{.95}$ (r,16)			6.90	8.40	9.32	9.96	*P<.05
$q_{.99}$ (r,16)			4.13	4.78	5.19	5.49	
$\sqrt{n\ MSerror}\ q_{.99}$ (r,16)			9.50	10.99	11.94	12.63	**P<.01

TABLE F4

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS

FOR INGESTION SPEEDS IN EXPERIMENT I, PHASE 1

Source of Variation	SS	df	MS	F	P
Incentive	22,910.40	2	11,455.20	24.97	<.01
Error	5,505.20	12	458.77		
Total	28,415.60				

Groups		16-1-9	9-1-9	4-16-4	
	Totals	83	107	509	
16-1-9	83		24	426**	
9-1-9	107			402**	
4-16-4	509				
q.99 (,12)			4.32	5.04	
$\sqrt{n \text{ MSerror}}$ q.99 (r,12)			206.88	241.36	**P<.01

TABLE F5

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS FOR INGESTION SPEEDS IN EXPERIMENT I, PHASE 3

Source of Variation	SS	df	MS	F	P
Incentive	55,103.35	3	18,367.78	14.04	<.01
Error	20,928.40	16	1,308.03		
Total	76,031.75				

Groups		16-1-9	9-1-9	4-16-4	1-16-4
	Totals	97	117	524	707
16-1-9	97		20	427**	610**
9-1-9	117			407**	590**
4-16-4	524				183
1-16-4	707				

q.99 (r,16)	4.13	4.78	5.19	
$\sqrt{n\,MSerror}$ q.99 (r,16)	333.99	386.56	419.72	**P<.01

TABLE F6

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS

FOR 9 PELLET RUNNING SPEEDS

Source of Variation	SS	df	MS	F	P
Incentive	2.61	2	1.31	6.55	<.05
Error	2.36	12	.20		
Total	4.98				

Groups		Phase 3 16-1-9	Phase 3 9-1-9	Phase 1 9-1-9	
	Totals	10.17	11.48	15.11	
Phase 3 16-1-9	10.17		1.31	4.94*	
Phase 3 9-1-9	11.48			3.63	
Phase 1 9-1-9	15.11				
q.95 (r,12)			3.08	3.77	
$\sqrt{n\ MSerror}$ q.95 (r,12)			3.08	3.77	*P<.05

TABLE F7

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS

FOR 4 PELLET INGESTION SPEEDS

Source of Variation	SS	df	MS	F	P
Incentive	75,085.20	2	37,542.60	20.24	$<.01$
Error	22,258.80	12	1,854.90		
Total	97,344.00				

Groups		Phase 3 4-16-4	Phase 3 1-16-4	Phase 1 4-16-4	
	Totals	524	707	1349	
Phase 3 4-16-4	524		183	825**	
Phase 3 1-16-4	707			642**	
Phase 1 4-16-4	1349				
q.99 (r,12)			4.32	5.04	
$\sqrt{n\ MSerror}$ q.99 (r,12)			416.02	485.35	**P$<$.01

TABLE F8

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS

FOR 16 PELLET INGESTION SPEEDS

Source of Variation	SS	df	MS	F	P
Incentive	68.80	2	34.40	10.03	<.01
Error	41.20	12	3.43		
Total	110.00				

Groups		Phase 1 16-1-9	Phase 2 4-16-4	Phase 2 1-16-4	
	Totals	83	93	109	
Phase 1 16-1-9	83		10	26**	
Phase 2 4-16-4	93			16*	
Phase 2 1-16-4	109				
q.95 (r,12)			3.08	3.77	
$\sqrt{n\ MSerror}$ q.95 (r,12)			12.75	15.61	*P <.05
q.99 (r,12)			4.32	5.04	
$\sqrt{n\ MSerror}$ q.99 (r,12)			17.88	20.86	**P<.01

TABLE F9

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS FOR RUNNING SPEEDS ON DELAY INTERVALS IN EXPERIMENT II

Source of Variation	SS	df	MS	F	P
Between rats	16.25				
Within rats	3.26				
Interval	1.27	9	.14	2.33	<.05
Error	1.98	36	.06		
Total	19.51				

Intervals		0 sec.	12 sec.	8 sec.	45 sec.	4 sec.	
	Totals	25.05	27.54	28.99	29.09	29.30	
0 sec.	25.05		2.49*	3.94**	4.04**	4.25**	
12 sec.	27.54			1.45	1.55	1.76	
8 sec.	28.99				.10	.31	
45 sec.	29.09					.21	
4 sec.	29.30						
q.95 (r,36)			2.88	3.46	3.82	4.07	
$\sqrt{n\ MSerror}$ q.95 (r,36)			2.22	2.66	2.94	3.13	*P<.05
q.99 (r,36)			3.86	4.41	4.75	4.99	
$\sqrt{n\ MSerror}$ q.99 (r,36)			2.97	3.40	3.66	3.84	**P<.01

TABLE F10

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS

FOR RUNNING SPEEDS ON DELAY INTERVALS IN EXPERIMENT III

Source of Variation	SS	df	MS	F	P
Between rats	9.62				
Within rats	1.90				
Interval	.92	9	.10	3.33	$<.01$
Error	.98	36	.03		
Total	11.52				

Intervals		0 sec.	12 sec.	8 sec.	20 sec.	4 sec.	
	Totals	33.59	35.99	37.75	37.80	39.83	
0 sec.	33.59		2.40**	4.16**	4.21**	6.24**	
12 sec.	35.99			1.76	1.81	3.84**	
8 sec.	37.75				.05	2.08	
20 sec.	37.80					2.03	
4 sec.	39.83						
$q_{.95}(r,36)$			2.88	3.46	3.82	4.07	
$\sqrt{n\, MSerror}\ q_{.95}(r,36)$			1.58	1.90	2.10	2.24	*$P<.05$
$q_{.99}(r,36)$			3.86	4.41	4.75	4.99	
$\sqrt{n\, MSerror}\ q_{.99}(r,36)$			2.12	2.42	2.61	2.74	**$P<.01$

TABLE F11

ANALYSIS OF VARIANCE AND NEWMAN-KEULS ANALYSIS

FOR INGESTION SPEEDS ON DELAY INTERVALS IN EXPERIMENT III

Source of Variation	SS	df	MS	F	P
Between rats	187,755.68				
Within rats	58,934.00				
Interval	21,859.28	9	2,428.81	2.36	<.05
Error	37,074.72	36	1,029.85		
Total	246,689.68				

Intervals		12 sec.	0 sec.	8 sec.	20 sec.	4 sec.
	Totals	1674	1746	1874	2005	2014
12 sec.	1674		72	200	331	340
0 sec.	1746			128	259	268
8 sec.	1874				131	140
20 sec.	2005					9
4 sec.	2014					
q.95 (r,36)			2.88	3.46	3.82	4.07
$\sqrt{n\ MSerror}$ q.95 (r,36)			292.26	351.12	387.65	413.02

LIST OF REFERENCES

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