

**THE EFFECT OF PRIOR LARGE - REWARD
TRAINING ON FRUSTRATION - ODOR BASED
DOUBLE - ALTERNATION RESPONDING IN RATS**

SHARON HAKE PETERSEN

THE EFFECT OF PRIOR LARGE-REWARD TRAINING ON
FRUSTRATION-ODOR BASED DOUBLE-ALTERNATION
RESPONDING IN RATS

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Sharon Hake Petersen
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ABSTRACT

Previous research has indicated that laboratory rats, upon receipt of nonreward in the presence of stimuli previously associated with reward, excrete odors shown to be aversive to subsequent test animals. Frustration theory (Amsel: 1958, 1962) has been used most frequently to provide a theoretical basis for this type of olfactory research. According to Amsel's definition of primary frustration, aversive odors result from the hypothetical emotional reaction of frustration to nonreward of a previously rewarded response. This theory further predicts that the greater the reward expectancy, the greater the primary frustration produced by nonreward.

Research has shown that rat subjects can develop a frustration-odor-based double-alternation response pattern of running fast on R-trials and slow on N-trials. A recent study by Bramlett (1979) has demonstrated that: (1) minimal (one pellet) reward on "nonreward" events is sufficient to eliminate the production of odors of frustrative nonreward, and (2) duration of goalbox confinement on nonreward trials does not influence the production of odors of frustrative nonreward. These findings are not completely in accord with frustration-theory predictions. For example, frustration would be predicted in those subjects that received the minimal "non-reward" event. Hence, odors should have been produced and their effect on behavior noted. Also, detaining subjects in the empty goalbox (i.e., a situation conducive to the production

of frustration) should have resulted in greater odor production than allowing subjects to be immediately removed. It did not. On the other hand, the procedure of employing the double-alternation schedule of reward-nonreward throughout the entire experiment from its inception may have lessened the development of frustration somewhat. Thus, the apparent contradictions to frustration theory might be explained by the possibility that some type of adaptation lowered the levels of frustration, and hence, reduced odor production.

The present experiment investigated the possibilities that lessening adaptation could: (1) induce patterning by subjects receiving the minimal (one pellet) nonreward and, (2) result in stronger patterning by subjects in relation to longer duration of goalbox confinement on nonreward trials. To achieve this end all four groups of subjects in Phase 1 received 80 large-reward trials before introduction of the double-alternation reward-nonreward schedules. Upon receipt of the double-alternation reward-nonreward sequence in Phase 2, two groups received the minimal (one pellet) nonreward, while the other two groups received zero pellets on nonreward trials. In addition, two of the four groups experienced immediate removal on nonreward trials while the other two groups were subjected to 30-second confinement on nonreward trials. The shift from continuous large reward to double-alternation should have resulted in high levels of frustration,

and thus, odor production. Although appropriate patterning should have developed in all four groups regardless of confinement duration and/or occurrence of minimal "nonreward", such responding did not develop in all groups.

The results, supportive of the Bramlett (1979) findings, indicated that: (1) goalbox confinement duration on nonreward trials did not influence the production of odors of frustrative nonreward, and (2) despite the prior phase of large-reward trials, minimal one-pellet nonreward was sufficient to eliminate the production of frustration odor. These findings indicate a need for clarification and/or modification in the frustration-theory account of the odor phenomenon. Future research might well be indicated in the areas of: (1) quantity and/or quality of frustration necessary to produce odor and (2) relation of confinement to frustration, odor, and double-alternation patterning.

LIST OF FIGURES

Figure	Page
1. Mean Start Speeds - Groups 12-1(i) and 12-1(D)...	28
2. Mean Start Speeds - Groups 12-0(i) and 12-0(D)...	30
3. Mean Run Speeds - Groups 12-1(i) and 12-1(D).....	32
4. Mean Run Speeds - Groups 12-0(i) and 12-0(D).....	34
5. Mean Goal Speeds - Groups 12-1(i) and 12-1(D)....	36
6. Mean Goal Speeds - Groups 12-0(i) and 12-0(D)....	38

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FRUSTRATION-ODOR BASED DOUBLE-ALTERNATION
RESPONDING IN RATS

A Thesis
Presented to
the Graduate Council of
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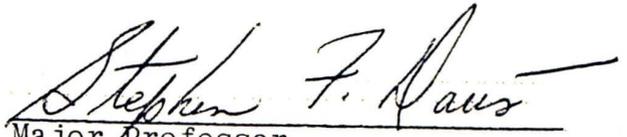
In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

by
Sharon Hake Peterson

June 1979

To the Graduate Council:

I am submitting herewith a Thesis written by Sharon Hake Petersen entitled "The Effect of Prior Large-Reward Training on Frustration-Odor Based Double-Alternation Responding in Rats". I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.


Major Professor

We have read this thesis and recommend its acceptance:


Second Committee Member


Third Committee Member

Accepted for the Council:


Dean of the Graduate School

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TABLE OF CONTENTS

	Page
LIST OF FIGURES	ix
Chapter	
I. INTRODUCTION	1
II. METHOD	11
Subjects	11
Apparatus	11
Procedure	11
III. RESULTS	14
IV. DISCUSSION	18
REFERENCE NOTES	22
REFERENCES	23
APPENDIX: FIGURES	26

CHAPTER I

INTRODUCTION

There have been numerous experiments showing that animals do have some sort of expectancy for specific goal-objects. One of the earliest reward expectancy studies, carried out by Tinklepaugh (1928), may serve to exemplify. In this experiment, a monkey was allowed to see a banana placed under one of two containers. After a few seconds delay, the monkey was given access to the two containers, at which time he displayed his memory by accurately choosing the container placed over the banana. Of special interest is the next step when, after a banana had been hidden under one of the cups, the experimenter, out of the monkey's view, replaced the banana with a lettuce leaf. Upon choosing the correct container this time, the monkey showed frustration by rejecting the lettuce leaf and engaging in definite searching behavior, as if looking for the banana.

In early analyses, nonreward was generally considered to be only passive in nature. Specifically, in Tolman's (1932) sign-learning theory it was assumed that nonreward simply served to weaken reward expectancy. According to Hull's (1943) theory, nonrewarded trials were conceived as permitting inhibitory factors to build up without being offset by a corresponding increase in habit strength (H) or incentive motivation (K). More recently, Abram Amsel (1958, 1962), a

prominent neo-Hullian, introduced his well-known theory of frustration which has subsequently stimulated much research. Amsel's theory views nonreward of a previously rewarded response as an actively aversive event, much like punishment, which results in a hypothetical emotional reaction, frustration. Frustration is typically inferred from behavioral changes. Amsel's theory of primary frustration (R_F) predicts that, in general, the greater the expectation of reward ($R_r - S_r$), the greater the R_F produced by nonreward. Inherent to this theory is the supposition that $R_r - S_r$ must attain an unspecified but necessary strength before nonreward produces R_F . Further, the frustrative reaction principally results in avoidance responses, but these responses may be modified through training.

In recent years there has accumulated a large body of data indicating that, at least in the case of rat subjects, the receipt of nonreward for previously rewarded responses not only produces R_F but may also result in the excretion of a unique frustrative odor. The presence of such characteristic and influential frustrative odors has also been inferred from observed behavioral changes. (See, Taylor, Note 1, for a discussion of attempts to chemically analyze these odors.) Independent studies, reported by McHose and Ludvigson (1966) and Spear and Spitzner (1966) indicated that, at least in runway-type studies, initial rat subjects laid down distinctive odors which elicited differential responding from subsequent animals. Implicit from this data is the suggestion that rats

reluctant to approach a goal may have left an odor, which, in turn, resulted in unconditioned avoidance responses in subsequent rats approaching the goal. Another runway study, based on the above data and carried out by Ludvigson and Sytsma (1967), sought to establish conditioned responses by systematically arranging reward and nonreward odors to be followed consistently by reward and nonreward goal events, respectively. These conditioned responses were established by administration of a double-alternation pattern of reward (R) and nonreward (N). Contrary to previous data which indicated that the rat could not learn this pattern, Ludvigson and Sytsma (1967) reported the development of a clear pattern of running fast on R trials and slow on N trials. Moreover, this patterning was confined to the goal section of the apparatus where logic would dictate that frustration and hence odor would be strongest.

The emphasis, at least initially, of many odor studies was to investigate the possibility that odors may well have been a source of contamination in previous studies using rats as subjects. In other words, are the results of past decades of research attributable to the treatments that were administered or to uncontrolled odors laid down by preceding subjects? For example, Morrison and Ludvigson (1970) showed that a nonreward odor laid down by a donor rat at the choice point of a T-maze may serve as a discriminative stimulus for a left or right turn in the maze. In addition to serving as discriminative cues, it has also been suggested that odors of reward and non-

reward may elicit unconditioned approach and avoidance responses, respectively (e.g., Collerain & Ludvigson, 1972; Mellgren, Fouts, and Martin, 1973; Wasserman & Jensen, 1969). In a study concerned with double-alternation patterning, Davis, Prytula, Harper, Tucker, Lewis, and Flood (1974) found that odors exuded by odor-donor animals were used as discriminative cues by runway subjects only when the deprivation states of both sets of animals coincided. Thus, the general picture that emerges from odor research is this: (a) differential odor cues are exuded on R and N events, (b) odor cues appear to act as mild unconditioned stimuli, (c) under appropriate experimental conditions odor cues may be established as discriminative stimuli, and (d) the utilization of such odors by subsequent animals is deprivation state dependent.

More recently, the emphasis of odor research has shifted from demonstration experiments to studies developed to provide a theoretical basis for the phenomenon. For example, Collerain (1978), and Collerain and Ludvigson (1972, 1977) have reported studies attempting to relate classic frustration theory (Amsel; 1958, 1962) and odor production. More specifically, in a T-maze study using odor-donor subjects, Collerain and Ludvigson (1972) reported that as few as 2-4 reinforced trials were sufficient to elicit frustration odors on subsequent nonrewarded trials. Subjects traversing the T-maze avoided an arm containing these odors significantly more than an arm containing either the odor

of reward or a neutral odor. Collerain and Ludvigson (1977) assessed the aversiveness of such frustration odors in the hurdle-jump apparatus. Hurdle-jump (escape) speeds of naive subjects were measured following different amounts of training for odor-donor subjects. In this situation, as many as 12 rewarded odor-donor trials were required before nonreward produced frustration odor sufficient to maintain stable escape responding in the test subjects. The authors suggested that the difference in number of rewarded trials required to elicit an odor on the nonreward event may be attributed to the different tasks involved, i.e., simple withdrawal in the T-maze (Collerain & Ludvigson, 1972) versus hurdle-jump behavior (Collerain & Ludvigson, 1977). Additionally, both studies indicated that the aversion response to the odor of nonreward habituated during the course of training. Recently, Collerain (1978) reported a series of three experiments designed to specifically evaluate trial-to-trial odor production as measured by the hurdle-jump-escape response. The results of these studies indicated that such responding: (a) may serve as "a sensitive measure of changes in the production of frustration odor", and (b) that as few as four rewarded trials may be needed before a subsequent nonreward event produces an effective frustration odor. Differences in habituation to the hurdle-jump apparatus were felt to have contributed to the discrepancy between the Collerain and Ludvigson (1977) and Collerain (1978) studies, regarding the number of rewarded trials required

before nonreward served to elicit an effective frustration odor. Further, Collerain (1978) indicated that one viable use of such studies relating the production of frustration odors and hurdle-jump-escape behavior "would be to assist in a further articulation of Amsel's (1958, 1962) frustration theory." For example, achievement of hurdle-jump responding in the presence of frustration odor elicited after only four rewarded trials is supportive of Brooks' (1969) frustration interpretation of the limited trial partial reinforcement extinction effect (LTPREE).

It is interesting to note, however, that the majority of the studies either demonstrating the production and influence of frustration odor (e.g., Bloom & Phillips, 1973, Ludvigson & Sytsma, 1967; Pratt & Ludvigson, 1970; Prytula & Davis, 1974, 1976), or attempting to relate frustration odor and frustration theory (e.g., Collerain, 1978; Collerain & Ludvigson, 1972, 1977) have employed a nonreward condition consisting of confinement in an empty goal box. On the other hand, a number of studies dealing with runway performance as a function of simultaneous or successive receipt of contrasting reward magnitudes (e.g., large versus small) have been reported. For example, Bower (1961) demonstrated that performance to small reward (S-) in one situation (e.g., a white alley), was depressed, relative to that of subjects receiving only small reward, when large reward (S+) was concurrently received in a

second situation (e.g., a black alley). This phenomenon has been termed the "negative contrast effect" (NCE). As frustration theory has been employed to account for such behaviors (see, Bower, 1961; Ludvigson & Gay, 1967), it would seem reasonable to anticipate the occurrence of frustration odors in situations involving contrasting reward magnitudes. Consistent with this view, it is interesting to note that the original data calling attention to the possible influence of frustration odor (McHose & Ludvigson, 1966) were collected in a study investigating differential reward conditioning. These investigators observed that nondifferentially reinforced control subjects ran slower when preceding differentially reinforced animals had received small reward. This effect was tentatively attributed to the presence of the odor of nonreward exuded by the differentially reinforced animals. Unfortunately, no systematic investigation of frustration odor was made in that experiment. A study investigating the effects of contrasting R and N reward magnitudes on odor production has been reported by Bramlett (Note 2). This experiment tested runway performance under a double-alternation schedule of reward and nonreward, a procedure which has been shown to be sensitive to frustration odors (see, Davis et al., 1974; Davis et al., 1976; Ludvigson & Sytsma, 1967; Prytula & Davis, 1974, 1976; Seago, Ludvigson, & Remely, 1970). It was conjectured that according to frustration theory, receipt of large reward on R trials should lead

to the development of R_r-S_r . Consequently, the receipt of small (one-pellet) reward on "nonreward" trials should result in R_F . Unlike the Bower (1961), Ludvigson and Gay (1967), and McHose and Ludvigson (1966) studies, no discriminative S+/S- cues were provided. Bramlett proposed that the effective R_r-S_r might be some average of the individual R and N expectations. Since, Collerain (1978) had previously demonstrated the production of odors following as few as four rewarded trials using 10, 35-mg. pellets as reward, it was proposed that the average expectancy developed over a larger number of trials would be of sufficient strength to elicit R_F and its attendant odor on N trials. Hence, Bramlett (Note 2) predicted that odor-based patterning would be shown by the animals receiving the one-pellet reward on N trials.

To directly investigate a point originally raised by Collerain and Ludvigson (1972), and elaborated more recently by Collerain (Note 3), two distinct goalbox-confinement durations, immediate removal and 30-sec. confinement, were employed in the Bramlett (Note 2) study. Succinctly stated, Collerain and Ludvigson (1972) and Collerain (Note 3) have suggested that amount of subject movement may be related, in some manner, to scent production and/or utilization. However, as no avoidance differences were shown between subjects exposed to odors exuded by more active neutral-placement odorant animals and less active rewarded-placement odorant animals, Collerain and

Ludvigson (1972) concluded that excreted odors appeared to be a function of the treatment received and not subject activity. On the other hand, Collerain (Note 3) has recently suggested that behavioral effects attributed to frustration odor may simply reflect detection of different spatial distributions of natural animal odor on R and N events. As more activity is typically observed on N (as compared with R) trials, one would expect more uniform distribution of such odors throughout the goalbox on N trials. Thus, the distribution of animal odor, rather than some unique odor produced by frustration, may be the effective cue controlling behavior of subsequent animals in the test situation. Assuming the correctness of this position, immediate removal of animals from the goalbox on N trials should preclude the development of double-alternation patterning. If unique odors are generated by frustration, then it would seem reasonable to anticipate the development of patterning under both goalbox-removal conditions.

Findings of the above mentioned research (Bramlett, Note 2) demonstrated that: (1) goalbox-confinement duration on non-reward trials does not influence the production of odors of frustrative nonreward, and (2) minimal (one-pellet) reward on "nonreward" events is sufficient to eliminate the production of odors of frustrative nonreward. To account for the lack of patterning by the subjects receiving the one-pellet reward on N trials in the Bramlett (Note 2) study, two assumptions might be entertained. First, it might be assumed that frustration was present in both groups, but, for some reason, odors were

not exuded. Obviously, this alternative would require revisions and/or modifications in the proposed relationship between frustration theory and odor production. On the other hand, the assumption that the experimental conditions employed in the Bramlett (Note 2) study were simply not sufficient to elicit the frustrative reaction and its attendant odors would appear more parsimonious.

If one assumes that the discrepancy between the average reward expectancy ($R_r - S_r$) and the receipt of one pellet on N trials was not sufficient to elicit frustration, then experimental manipulations resulting in greater contrast should produce results consistent with the initial predictions. One technique for producing such contrast would be to establish a greater expectation prior to the introduction of the double-alternation schedule. Thus, the shift to one-pellet reward on N trials when the double-alternation schedule is introduced should result in the elicitation of frustration (i.e., odors) and the development of appropriate patterning. It was the purpose of the present study to establish such an expectancy. To accomplish this end, all subjects were administered 80 large-reward trials prior to double-alternation training. The double-alternation phase of the experiment replicated the conditions employed in the Bramlett (Note 2) experiment. It should be noted that the above-mentioned predictions, originally offered by Bramlett (Note 2), would also be applicable to the present situation.

CHAPTER II

METHOD

Subjects

The subjects were 28 experimentally naive male albino rats purchased from Holtzman Co., Madison, Wisconsin. At the start of the experiment the subjects were 90 days of age. All animals were housed in individual cages with water available on an ad libitum basis.

Apparatus

The experimental apparatus consisted of a single straight runway divided into a 38.10-cm grey startbox, a 91.44-cm black run section, and a 30.48-cm black goalbox. Two masonite guillotine doors separated the start and run sections, and the run and goal sections, respectively. Three photoelectric beams located 15.20 cm, 92.40 cm, and 116.80 cm beyond the start door, in conjunction with a microswitch located on the start door and three Lafayette (Model 54015) digital timers, yielded start, run, and goal latencies. A plastic receptacle, recessed into the distal end of the goalbox, served as the goal cup. To prevent the dissipation of odors, a thin sheet of transparent plastic was attached to the entire top of the runway.

Procedure

The 28 subjects were randomly divided into four equal groups (n=7). Subsequently, the groups were randomly assigned

to the four experimental treatment conditions to be described. One week prior to the start of pretraining, all subjects were placed on a food deprivation schedule designed to maintain them at 85% of their free-feeding body weight.

A four-day pretraining phase immediately preceded the inception of experimental testing. On Pretraining Days 1 and 2, all subjects received one minute of handling and taming, and habituation to the 45-mg Noyes reward pellets in the home cage. All subjects received a five-minute exploration period in the experimental apparatus and subsequent pellet habituation in the home cage on Pretraining Days 3 and 4.

During Phase 1 of experimental testing, all subjects received the same treatment, 80 large reward trials. This phase was 11 days in length. On the first two days all subjects received four trials to allow for acclimation; thereafter, for the remaining nine days, all subjects received eight daily trials. During Phase 2 all subjects received eight daily trials (four R and four N) in a double-alternation sequence (RRNRRNN). During both phases, an R event consisted of 12, 45-mg Noyes (Formula A) pellets. On all R trials subjects were removed from the goalbox as soon as the last pellet was taken into the mouth.

During Phase 2, subjects in Groups 12-1(i) and 12-1(D) received 1, 45-mg Noyes pellet on N trials, while subjects

in Groups 12-0(i) and 12-0(D) were confronted by an empty goalbox on N trials. Subjects in the groups designated (i) were removed immediately after consuming the one-pellet reward [$\bar{\text{Group 12-1(i)}}$] or breaking the last photoelectric beam in the goalbox [$\bar{\text{Group 12-0(i)}}$] on N trials. Subjects in the groups designated (D) were confined to the goalbox for 30 seconds on N trials regardless of the goal event encountered. Phase 2 was 15 days (120 trials) in length.

In both phases, subjects were run in a fixed order (1-7) within each respective group on all days. Within each group, Trial 1 was administered to all subjects before Trial 2, etc. All eight daily trials were completed by a group before additional groups were run. The order for running groups was cyclic from day to day. To prevent the dissemination of odors between trials, the entire apparatus was swabbed prior to each running of subject 1 in all groups. Maintenance of the deprivation schedule for all subjects took place following each daily experimental session.

CHAPTER III

RESULTS

Prior to analysis, all latencies were reciprocated and multiplied by the appropriate constant to yield speed scores in meters per second. As Subject 1 in each group was always tested in a clean (swabbed) runway and served as an odor donor for subsequent animals, their data were not included in either statistical analyses or graphical presentations. Group mean start, run, and goal speeds for Phases 1 and 2 are shown in Figures 1-6. In all cases, Dunn's New Multiple Range Test was employed to evaluate contrast effects.

Phase 1

Analysis of variance was performed over the speed scores for the last five days of Phase 1. As no significant Groups effects were found in any measure \bar{L} start, $F(3,20) = .75$, $p < .25$; run, $F(3,20) = .47$, $p < .25$; and goal, $F(3,20) = .86$, $p < .25$, the assumption of group equality prior to the start of Phase 2 was deemed appropriate.

Phase 2

Prior to analysis, composite R_1 , N_1 , R_2 , and N_2 scores were calculated for all trials for each subject by averaging the four consecutive doublets of the daily eight-trial double-alternation sequence. These composite scores were, in turn, subjected to analysis of variance procedures.

Day 1. To ascertain any initial effects produced by the introduction of the double-alternation pattern, analyses of variance, incorporating N-Event (0 or one pellet) and Non-reward Removal (immediate or delayed) as between-subjects factors, and R versus N effects as a within-subject factor were performed on the start-, run-, and goal-measure speed data from Day 1. The results of these analyses indicated that the R versus N factor was significant in all three measures [\bar{F} start, $F(3,60) = 4.32, p < .01$; run, $F(3,60) = 25.11, p < .01$; and goal, $F(3,60) = 33.91, p < .01$]. Additionally, the R-N by Nonreward Confinement interaction was found to be significant in the run [$\bar{F}(3,60) = 7.78, p < .01$], and goal [$\bar{F}(3,60) = 3.40, p < .05$] measures.

Simple main effects analyses of the run-measures interaction indicated that significant R versus N differences existed only within the Delayed Nonreward Removal (30 sec.) condition, $F(3,60) = 29.56, p < .01$; and that R_2 speeds were significantly, $F(1,80) = 9.31, p < .01$, faster for the Immediate Removal subjects than for the Delayed Removal subjects. Contrast effects indicated that within the Delayed Removal condition, R_1 and N_1 speeds were significantly ($p < .01$) faster than N_2 and R_2 speeds, and that N_2 speeds were significantly ($p < .01$) faster than R_2 speeds.

Simple main effects analyses of the goal-measure interaction indicated that R versus N differences were significant

within both the Immediate Removal, $F(3,60) = 9.39$, $p < .01$; and, Delayed Removal, $F(3,60) = 27.92$, $p < .01$, conditions. As in the run measure, R_2 speeds for the Immediate Removal subjects were found to be significantly faster, $F(1,80) = 9.32$, $p < .01$, than the R_2 speeds of the Delayed Removal subjects. Contrast effects indicated that R_1 and N_1 speeds were significantly ($p < .01$) faster than R_2 and N_2 speeds within both Nonreward Removal conditions. Additionally, the N_2 speeds of the Delayed Removal subjects were significantly faster ($p < .01$) than their R_2 speeds.

Days 8-15. Analyses of variance incorporating N-Event and Nonreward Confinement effects as between-subjects factors, and R versus N and Days as within-subjects factors were performed on the start-, run-, and goal-measure speeds for Days 8-15 (the point at which appropriate double-alternation patterning appeared to have been established). Measure-by-measure summaries of these analyses will be considered.

Although Figure 2 suggests the development of rational patterning in the start-measure for Group 12-0(i), analysis of the start-measure speeds failed to yield any statistically reliable effects. Run-measure analysis yielded significance for the N-Event by Nonreward Confinement by R-N interaction, $F(3,60) = 4.53$, $p < .01$. Subsequent simple main effects analyses indicated that significant ($p < .01$) R versus N effects were shown only by those subjects

entering an empty goalbox and experiencing immediate removal on N trials [(i.e., Group 12-0(i))]. Contrast effects indicated that the N_1 and N_2 speeds for these subjects were significantly ($p < .01$) slower than their R_1 and R_2 speeds and the R_1 , N_1 , R_2 , and N_2 speeds of all other groups.

Goal-speed analysis yielded significance for the R versus N factor, $F(3,60) = 34.86$, $p < .01$, and R-N by N-Event interaction, $F(3,60) = 17.38$, $p < .01$. Simple main effects analyses indicated that significant ($p < .01$) R versus N differences existed only for those subjects entering an empty goalbox on N trials, including both immediate and delayed removal groups. Contrast effects indicated that the N_1 and N_2 speeds of these subjects were significantly ($p < .01$) slower than their R_1 and R_2 speeds, and the R_1 , N_1 , R_2 , and N_2 speeds of the subjects receiving the one-pellet reward on N trials.

CHAPTER IV

DISCUSSION

The most pertinent question to be addressed involves an interpretation of the failure of those subjects receiving the one-pellet reward on N trials to develop double-alternation patterning. The results of the second phase of the present study, identical to those of the Bramlett (Note 2) experiment, are supportive of the conjecture that minimal one-pellet reward on "nonreward" events is sufficient to eliminate the production of odors of frustrative nonreward. In the Bramlett (Note 2) study, the double-alternation schedule of reward-nonreward was in effect from the inception of the experiment. To evaluate the possibility that lack of patterning in that study may have accrued from some type of adaptation to frustration, the present study provided an initial phase of large-reward training. Logically, the 80 large-reward trials given in Phase 1 of the present experiment should have produced a high $\underline{R}_R - \underline{S}_R$ and should have resulted in high levels of frustration (i.e., odor) upon inception of the double-alternation schedule in Phase 2, regardless of whether the N-Event consisted of zero or one pellet. Common sense would seem to dictate that the one-pellet reward, given to food-deprived subjects accustomed to daily large-reward trials, would not be sufficient to satisfy their reward expectancy. If one is to accept the

logic of classic frustration theory (Amsel, 1958, 1962), in which it is proposed that the greater the reward expectancy the greater the frustration upon nonreward receipt; then, it must be assumed that frustration was, indeed, present regardless of the one- or zero-pellet nature of the N-Event. Further, if frustration was present upon the occurrence of both types of N-Events, why did it not result in odor production for both events? Finding it untenable to assume that one pellet is sufficient to eliminate frustration, and at the same time giving credence to frustration theory, the possibility asserts itself that, while a one-pellet N-Event is not sufficient to extinguish frustration, it may be sufficient to preclude odor production. Perhaps, odor is produced only in the extreme event (confinement to the empty goalbox), and as such, is a functionally adaptive signal of no reward, not just of smaller reward.

One point of special interest in the present experiment is the development of double-alternation patterning in both the run and goal measures by Group 12-0(i). This finding may be compared to Bramlett's (Note 2) study in which patterning was shown only in the goal-measure for a comparable 12-0(i) group. Although an apparent contradiction, this discrepancy fits nicely with the theory of primary frustration (Amsel, 1958, 1962). This theory predicts that the greater the $R_r - S_r$, the greater the R_f produced by nonreward; and

further that $\underline{R_r-S_r}$ must reach a necessary strength before non-reward produces $\underline{R_f}$. It would seem safe to conclude that $\underline{R_f}$, and hence odor production, developed sooner in the present study, than in the Bramlett (Note 2) study, due to the theoretically greater build up of $\underline{R_r-S_r}$ during the 80 multiple-pellet reward trials of Phase 1.

Consistent with the Bramlett research (Note 2), the present data indicate that goalbox-confinement duration on nonreward trials does not influence the production of odors of frustrative nonreward. This finding is in opposition to that which would logically be predicted according to frustration theory (Amsel, 1958, 1962). According to frustration theory, it would be expected that $\underline{R_f}$ would develop sooner and/or more strongly in those subjects confined to an empty goalbox (certainly a situation thought to be conducive to frustration) than in those subjects under the immediate-removal condition. In fact, however, an approach-avoidance reaction as shown by the double-alternation patterning of running fast on R trials and slow on N trials developed sooner in the instrumental-response chain in those subjects not delayed in the goalbox. Subjects under the immediate removal condition [i.e. Group 12-0(i)] developed patterning in the run-measure; whereas, subjects confined to the empty goalbox [i.e. Group 12-0(D)] displayed patterning only in the goal-measure. The present data also contradicts the

notion put forth by Collerain (Note 2) that the spatial distribution of characteristic animal odor, rather than a unique "frustration odor," controls the behavior of subsequent animals. Obviously, those subjects that were immediately removed from the goalbox [$\bar{\text{Groups 12-0(i) and 12-1(i)}$] did not have the opportunity to "distribute" odor and should not have patterned. On the other hand, those subjects experiencing 30-second confinement in the goalbox on N trials [$\bar{\text{Groups 12-0(D) and 12-1(D)}$] were afforded an ample opportunity to distribute such odors throughout the goalbox. Consequently, both groups should have developed patterning. However, as already noted, Group 12-0(D) did pattern, and Group 12-1(D) did not pattern. Thus, the spatial-distribution hypothesis would appear untenable. Indeed, it is tempting to speculate that, in some manner, confinement may have delayed the development of double-alternation responding.

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APPENDIX: FIGURES

FIGURE 1. Mean Start Speeds - Groups 12-1(i) and 12-1(D).

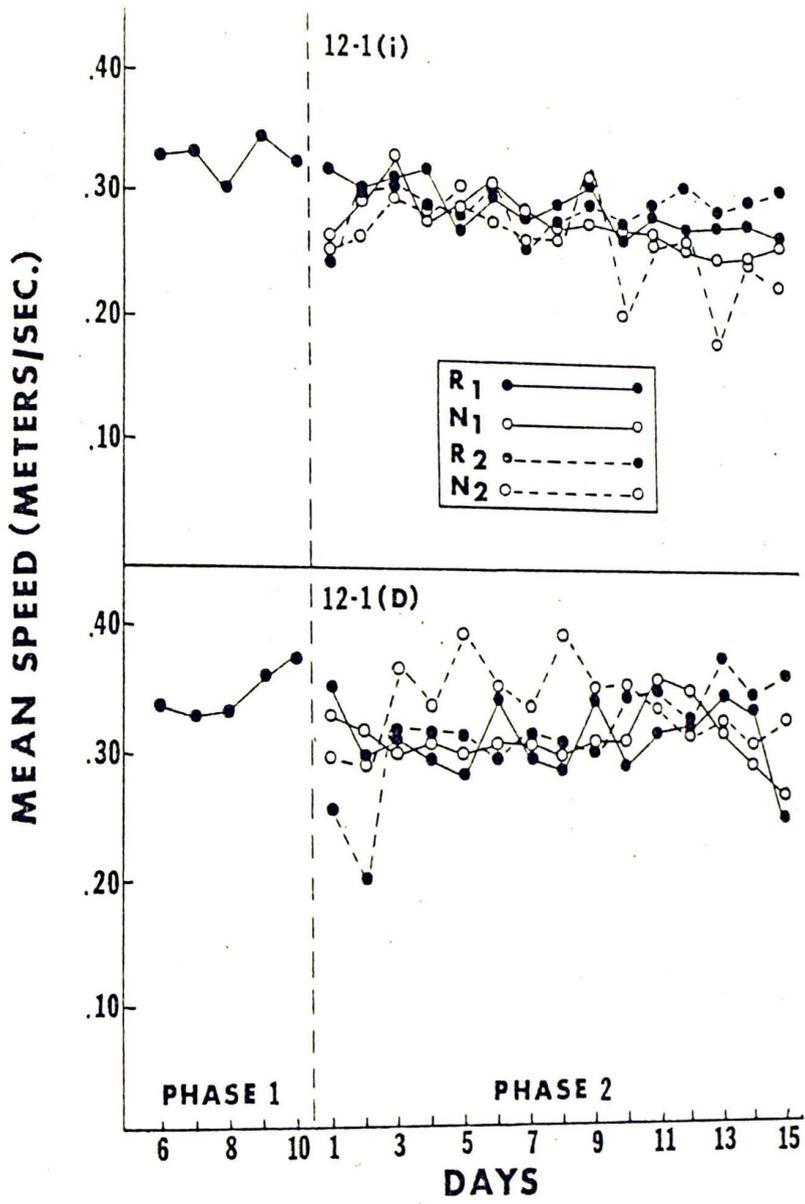


FIGURE 2. Mean Start Speed - Groups 12-0(i) and 12-0(D).

MEAN SPEED (METERS/SEC.)

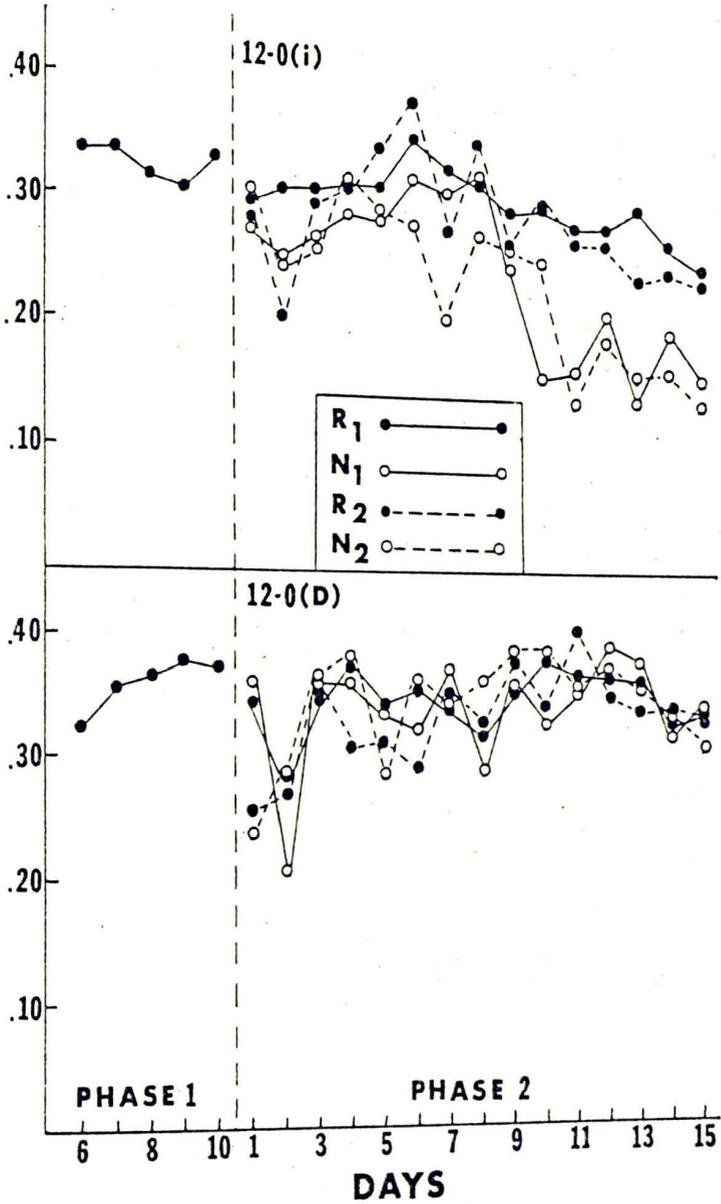


FIGURE 3. Mean Run Speeds - Groups 12-1(i) and 12-1(D).

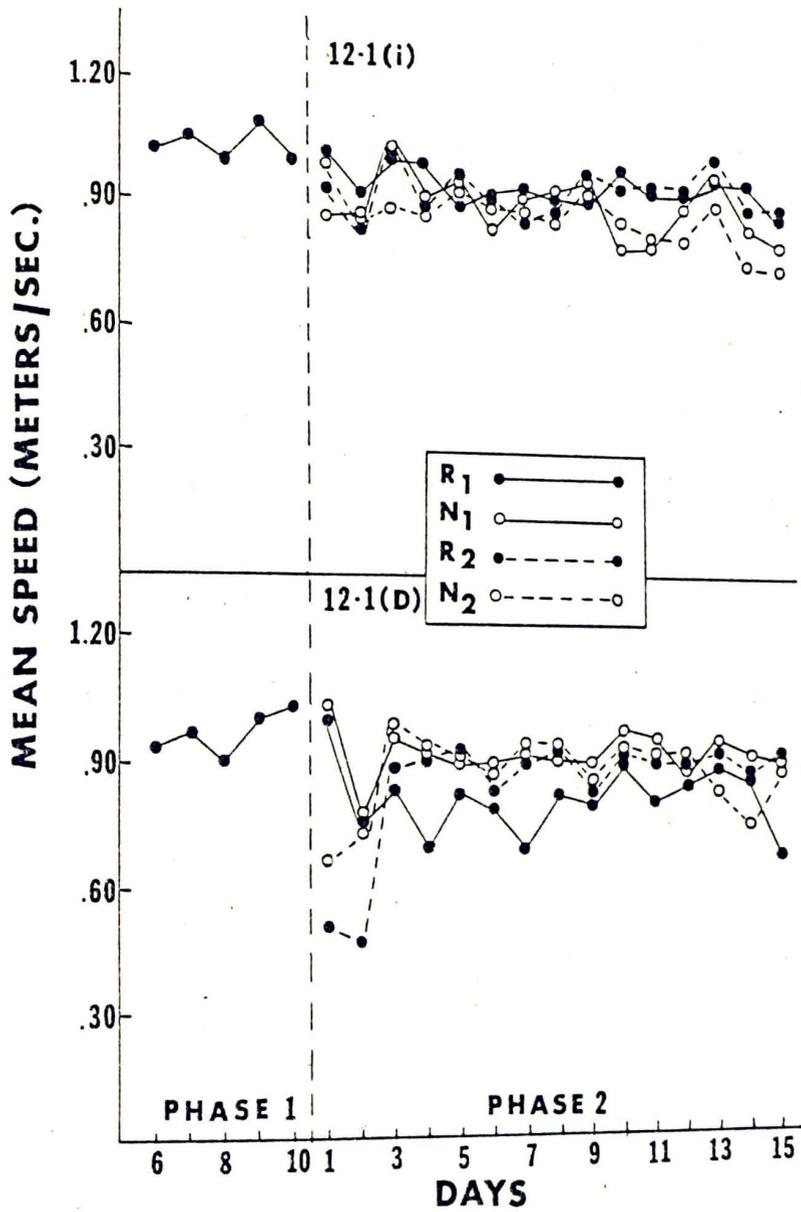


FIGURE 4. Mean Run Speeds - Groups 12-0(i) and 12-0(D).

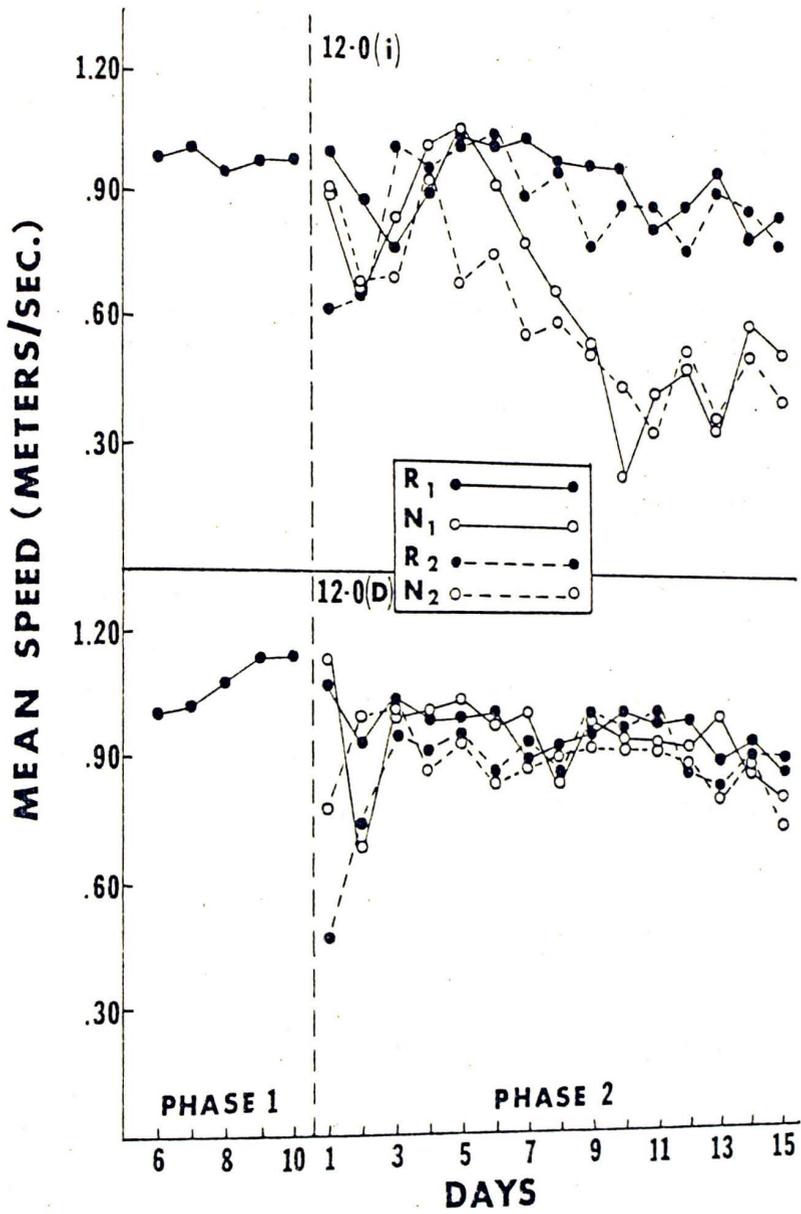


FIGURE 5. Mean Goal Speeds - Groups 12-1(i) and 12-1(D).

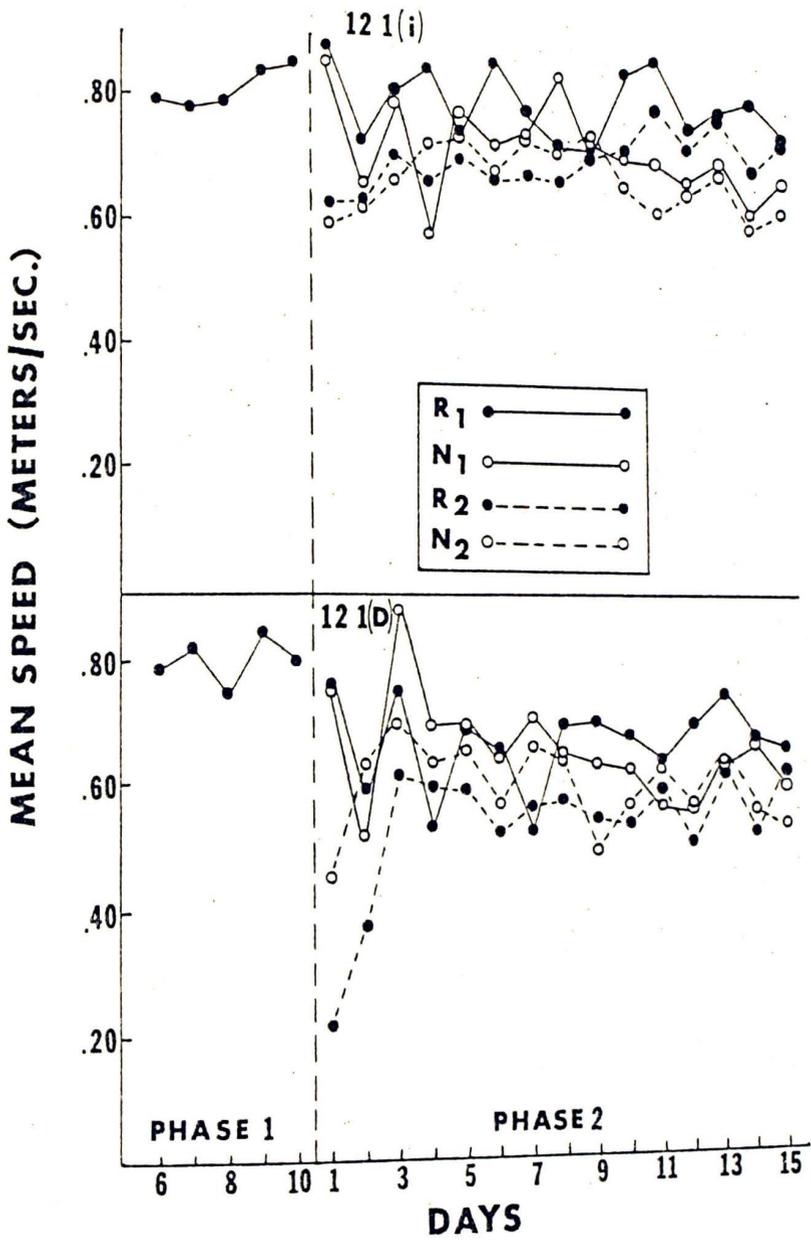


FIGURE 6. Mean Goal Speeds - Groups 12-0(i) and 12-0(D).

MEAN SPEED (METERS/SEC.)

