

THE AVOIDANCE OF A STIMULUS SIGNIFYING
FRUSTRATION IN A REDUCED REWARD PARADIGM

A Thesis

by

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ABSTRACT

The Avoidance of a Stimulus Signifying Frustration
in a Reduced Reward Paradigm

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The present experiment was designed to test whether a light paired with a small reward in a reduced reward paradigm would acquire aversive properties and later motivate avoidance behavior in a dissimilar environment. If so, substantial evidence for Amsel's theory of conditioned frustration (τ_p) would be provided.

In Phase I, which lasted 28 days, 32 experimental Ss ran down a runway to a goal box containing 15 pellets of reward, one trial per day. Thirty-two control Ss received 1 pellet of reward in the goal box the same number of trials. Running times were recorded daily for each S.

Prior to Phase II experimental and control groups were both subdivided into two matched-subgroups each, based on mean running times recorded on days 26, 27, and 28 of Phase I. Both control subgroups were maintained on 1 pellet of reward and both experimental subgroups ran to either 15 pellets or 1 pellet of reward, designated on a random basis for 40 days. For the appropriate subgroups in both the experimental and control groups a light was paired with the 1 pellet reward on designated reduced reward trials.

Examination of mean running times recorded daily for each subgroup shows that the light had acquired aversive properties towards the end of Phase II.

In Phase III the motivational strength of the light was tested in a social-lure apparatus. Ss were allowed to run 4 times daily for 3 days to one of two social-lures, each stationed at the end of a pathway. In one of the pathways, designated on a random basis, a flickering light was turned on, prior to running. A significant difference in the number of avoidance responses made to the light by the experimental and control subgroups receiving the light in Phase II provides evidence that a stimulus paired with a reduced reward can motivate avoidance behavior.

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INTRODUCTION

The frustration theory of Amsel (1958, 1962) has within it many possibilities for systematic experimental studies of learning. One possibility is a study which extends frustration analysis to include reduced reward situations. According to frustration theory, expectation of reward followed by nonreward produces a primary motivational response of frustration (R_f), which serves as the unconditioned response for classical conditioning to neutral cues. Although this definition of frustration is in terms of a transition to zero reward, it is conceivable that a reduction in reward to a near-zero level may also produce frustration. If the extension of frustration theory to include shifts in reward to near-zero magnitudes is correct, cues paired with the new low reward should also elicit frustration in a manner typical of classical conditioning. Reduction in frustration, following escape from the cues, should provide the reinforcement for the learning of escape and avoidance responses. Wagner (1963) has demonstrated that rats would jump a hurdle to escape cues paired with nonreward. Similarly, a smaller than anticipated reward may also produce enough frustration to serve as the basis for learning new responses.

Past experimental efforts to extend the frustration theory from nonreward to reduced reward situations have used the double-runway

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technique and have led to inconsistent results. The first study reported (Bower, 1962) consisted of rats receiving 8 pellets of reward in both goal boxes of a double runway, 6 trials a day for 33 consecutive days. Following this acquisition period the testing phase began. Three designated experimental groups received 4, 1, or 0 pellets in the first goal box and 8 pellets in the second goal box. A group that had remained on the 8-8 pellet schedule served as the control group. Speed to the second goal was then measured for each group. Bower showed that the greater the reduction in reward in the first goal box the greater the speed to the second goal box. The group switched to 0 pellets in the first goal box ran faster to the second goal box than the 1 pellet group, which in turn ran faster than the 4 pellet group. As expected, all 3 of the experimental groups ran faster than the control group that had received 8 pellets in the first goal box. This result supports one of the properties assigned to R_f in the frustration theory, that is, the unconditioned response of frustration summates with the relevant motivation (hunger) to produce in S a heightened drive (Amsel and Rousell, 1952). Faster running speeds to the second goal is assumed to result from this elevated drive when a reduction in reward and thus frustration is experienced in the first goal box. In addition, the differences in speed as exhibited between experimental groups was taken to be an indication of the size of the frustration effect. In Amsel's theory the amount of frustration produced during nonrewarded trials is governed by the number of trials given, plus the quality and quantity of reward received

by the S during acquisition and testing. Extending the frustration analysis to include reduced reward situations, the experimental Ss differed in speeds to the second goal box because the quantity of reward given in the first goal box differed. In other words, receiving 1 pellet in the first goal box as compared to a 4 pellet reward is more frustrating to a S who is expecting 8 pellets. Consequently, the frustration theory predicted what the data revealed, viz., graded reductions in reward correlated with graded amounts of frustration. In Bower's study, however, no groups were added to control the possibility that speed to the second alley was depressed following high rewards in the first goal box. In order to demonstrate, for example, that a reduction from 8 to 4 pellets of reward results in a frustration effect, it must be shown that rats trained on 8 pellets of reward run faster following a reduction to 4 pellets than rats which have received only 4 pellets in the first goal box from onset of training. Since the only control group in Bower's study was the group that had remained on the 8-8 schedule, the effects that the quantity of reward may have had during acquisition and testing phases were not controlled. It is possible that the large 8 pellet reward caused satiation in the control group, thus decreasing running speeds (demotivation) to the second goal box and distorting the data in a way that made the experimental Ss appear "frustrated" (Seward, Perebroom, Butler and Jones, 1957). A later study employing the double runway (McHose and Ludvigson, 1965) included this control group to determine if demotivation could have

possibly accounted for Bower's results. McHose and Ludvigson concluded that only a complete reward reduction produced frustration whereas incomplete reductions produced running speeds at the control level. The Ss in their study trained to "expect" a large reward of 10 pellets performed no differently under the shift to 2 pellets than those trained at the onset to expect 2 pellets. This finding supports a demotivation rather than a frustration explanation. Other aspects of McHose and Ludvigson's procedure, however, may have led to some confounding in that no account was taken of the interactive effects of reward magnitude in the first and second goal box during acquisition (Daly, 1968). To clarify this point, it may be argued that the operations used in the double-runway technique are similar to those used in differential conditioning. In differential conditioning (Bower, 1961) two single runways are used, sharing a common start-box. Ss are trained concurrently in the two runways, with a large reward in one runway and a smaller reward in the other runway. Asymptotic performances are then compared with control groups which receive only one reward quantity in both runways. The results of such a design, and typical of other designs used in differential conditioning (Meyer, 1961; Schrier and Harlow, 1956; and Lawson, 1957), yield evidence that the net incentive produced by a small reward is diminished when that reward occurs in a situation where the S sometimes receives larger rewards. Thus, the reinforcing effect of a given amount of reward is not a static parameter but rather a function of the context in which that reward quantity occurs, namely, the range of alternative rewards

the S has received. Specifically then, experience with two different reward magnitudes results in a performance that is a function not of either reward separately but of their joint action when the smaller is contrasted with the larger. In Daly's (1968) study, which tested for these interactive effects in the double-runway, Ss receiving 6 pellets in the second goal box following 15 pellets in the first goal box performed slower in the second segment of the runway as compared to a control group that received 6 pellets in each goal box. This inhibitory effect in the second alley increased over trials. A group of Ss that had received a 1 pellet reward prior to the 6 pellet reward ran faster than the control Ss in the second alley, this effect increasing as trials progressed. The finding that the Ss had different performances in Alley 2 despite equal reward (6 pellets) is similar to those results obtained in differential conditioning. In addition, it is consistent with the frustration theory. The inhibition produced by the 15-6 pellet schedule during acquisition occurred in greatest magnitude nearest the second goal box, since primary frustration (R_F) occurred in that goal box and conditioned anticipatory frustration (r_F) presumably moved backwards from that locus during training. From frustration theory the occurrence of nonreward at a moment when a S is expecting a reward produced R_F which is conditioned to cues present at that moment. Through generalization, fractional parts (r_F) of R_F become conditioned in the classical manner to stimuli preceeding its elicitation. The farther away these cues are from the locus where R_F was elicited the

weaker their motivational properties. Greater inhibition nearest the frustrative goal would be expected to occur because it is at this goal that cues conditioned to R_F are in full strength and presumably are optimally aversive (Wagner, 1963). Consequently, running speeds decreased as the S approached the aversive second goal box. A demotivation interpretation would not have predicted this effect nor is it able to explain the increase of inhibition that occurred as trials progressed. Since the conditioning of cues to R_F is a learning process, this increase in inhibition is to be expected within the frustration analysis. In addition, the excitatory effect which occurred in Daly's 1-6 pellet group cannot be explained solely in terms of a "prefeeding phenomenon", which states that a small reward in the start-box of a single-runway "energizes" the S , resulting in faster running speeds to the goal box (Maltzman, 1952). The "prefeeding phenomenon", when applied to a paradigm such as Daly's, would predict that the excitatory effect should occur equally in magnitude in all segments of Alley 2, and should remain constant during training. In Daly's study, however, running speeds differed within Alley 2, that is, the excitatory effect occurred in greatest magnitude in the segment immediately following the first goal box. This finding provides additional support for frustration analysis since in this case the first goal box was the frustrative goal and the S s were presumably escaping from the aversive cues. In addition, the excitatory effect increased as trials progressed, indicating that a learning process was in effect.

The inhibitory and excitatory effects produced in the double runway are important factors to consider in testing the effects of a reduced reward. The implication of the interactive effects of different reward magnitudes for any study attempting to test reward reductions is that experimental groups receiving different reward magnitudes during acquisition will experience frustration and therefore will not provide nonfrustrated experimental data prior to the shift. In Daly's study, the design of which is shown in Table 1, the experimental Ss shifted from 15 to 6 pellets in the first goal box did not reach the level of the 6-6 pellet control group in the second alley. As Daly pointed out, the inhibitory effect produced during acquisition continued to exist in the testing phase, resulting in the Ss running more slowly to the second goal box. Furthermore, using experimental groups which receive equal reward magnitudes in the two goal boxes does control frustration effects but produces an additional problem. Such a procedure does not allow the control groups to shift to the reduced reward magnitude experienced by the experimental Ss because the number of pellets received by the control groups must remain constant during both phases. Consequently, appropriate control groups cannot be run in the double runway for shifts to nonzero magnitudes.

In a study designed to remedy the problems encountered in the employment of the double runway, Daly (1969) tested male hooded rats in a single runway and adjoining hurdle-jump box. In this experiment no reward interactions were possible since all groups received only

TABLE 1
NUMBER OF PELLETS GIVEN IN THE FIRST AND
SECOND GOAL BOXES OF A DOUBLE RUNWAY USED IN DALY'S EXPERIMENT

	Control	Experimental
Acquisition	6-6	15-6
Testing	6-6	6-6

one reward per trial. Phase I consisted of the experimental group receiving 15 pellets in the goal box 6 trials daily for 60 days. There were four control subgroups, two of which received 1 pellet in the goal box and two that received 0 pellets. All four subgroups were run the same number of trials as the experimental group. After Phase I was completed Phase II began. The experimental group was subdivided into 4 subgroups, two of which were shifted to 1 pellet in the goal box, the other two subgroups being shifted to 0 pellets. One subgroup from each pair of experimental subgroups received in addition a light to serve as a stimulus of frustration (S_p) with the 1 or 0 pellet reward. The control subgroups in Phase II continued to receive the designated 1 or 0 pellets in the goal box. In addition, from each pair of control subgroups receiving the same amount of reward, one subgroup received a light with the 1 or 0 pellet reward. The remaining experimental and control subgroups received no light, i.e., no S_p . Phase II lasted 3 days, for a total of 18 trials. Phase III began the following day with hurdle-jumping training. The S_s were placed in the goal box and allowed to jump into an adjoining box, escaping the light presumably conditioned to frustration for the designated subgroups. The results of the study supported the frustration theory and its extension, i.e., both nonreward and reduced reward led to faster hurdle-jumping as opposed to the control groups whose reward was held constant throughout the experiment. Specifically, the findings were that the experimental S_s receiving zero reward in the shift phase jumped significantly faster than the

experimental \underline{S} s that had received 1 pellet reward who in turn jumped faster than the control \underline{S} s. All S_F subgroups jumped significantly faster than the no S_F subgroups.

There arises, however, a need for a better design in testing the frustrative effects of a reduced reward. In Daly's study all three phases of the experiment were conducted in the same environment (the start-box of the hurdle-jump apparatus was previously the goal-box of the runway). This was done because it is generally accepted that the compound stimulus of both a goal box and a S_F produces more motivation than a goal box or S_F presented alone (McAllister and McAllister, 1962). Consequently, Daly used this concept to enhance the motivational properties of frustration for the hurdle-jump phase of her experiment. As predicted by Daly, the subgroups that had received the S_F in the goal box (start-box of the hurdle-jump apparatus) jumped significantly faster than the no S_F groups. This finding provides clear evidence that the S_F served as a conditioned stimulus for frustration by having been paired with the reduced reward and therefore, with the primary motivational response of frustration (R_F). Jumping the hurdle, permitted the \underline{S} to escape from the S_F , thereby reducing conditioned frustration (r_F). Presumably, it was this reduction of r_F that reinforced the hurdle-jump response. It is not clear, however, if r_F alone was motivating the hurdle-jump response. Since the start-box of the hurdle-jump apparatus was previously the goal box R_F may still have been occurring. The start-box of the hurdle-jump apparatus may still have been

eliciting an expectancy of reward and each placement in the start-box elicited R_F because of the discrepancy between reward expectance and no reward present. If this is the case the hurdle-jump response was reinforced by a reduction in R_F in addition to a reduction in r_F . Hence, it is not clear if conditioned frustration alone can motivate an avoidance or escape response.

The present experiment was an attempt to clearly determine if r_F alone can motivate avoidance behavior. If frustration is a drive that is aversive and can be produced by a reduction in reward magnitude then a S_F (flickering light) paired with the reduced reward should elicit r_F in an environment dissimilar to the one used during conditioning. In this experiment the motivational strength of the S_F was tested in both a single runway and another apparatus involving a "social-lure" situation. It has been shown by Casey (1963) that social motivation exists for satiated white albino rats, that is, rats desire to be in close proximity with other rats. From this conception of social motivation the present experiment attempted to determine if experimental \underline{S}_s , given the S_F on reduced trials and later placed in a situation where they may choose one of two pathways leading to a social-lure, would avoid a pathway containing the S_F more often than control \underline{S}_s . If this happened, substantial and uncontaminated evidence for extending the frustration analysis to include S_F accruing to reduced reward situations would be provided.

Unlike Daly's experiment all \underline{S}_s ran down a single runway only 1 trial per day to control for possible satiation that may have

occurred during the repeated trials in her experiment. During Phase I the experimental Ss received 15 pellets of reward, the control Ss, received 1 pellet. In Phase II both the experimental and control groups were subdivided into two subgroups. Both control subgroups remained on the 1 pellet schedule and on designated days the experimental subgroups also received 1 pellet of reward. On the days not designated "reduced reward trials" the experimental subgroups were given the normal 15 pellets to maintain a large reward expectancy. One experimental subgroup (E-S_F) and one control subgroup (C-S_F) receiving the 1 pellet reward on designated days received in addition a flickering light in the goal box of the runway. The other experimental and control subgroups (E-NS_F and C-NS_F) never received the light in Phase II. This design is shown in Table 2. This flickering light was turned on for these subgroups before the reduced reward trial began. During this phase discrimination between normal or reduced reward trials before a S entered the goal box was made possible by the absence or presence of the S_F. If this S_F becomes conditioned to the unconditioned response of frustration (R_F), as frustration theory predicts, then a reduction in speed to the goal box may occur on the designated trials as the result of the presence of S_F.

In Phase III all subgroups were tested in a "social-lure" situation. Specifically, two pathways extending from a rectangular box containing a start-box both led to a social-lure stationed at the end of each pathway. In one of the pathways, designated on a random basis, a flickering light was turned on, prior to running. This light

TABLE 2
 AMOUNT OF REWARD GIVEN
 DURING TRAINING

	Experimental		Control	
Phase I	15 pellets		1 pellet	
Phase II	E-S _F	E-NS _F	C-S _F	C-NS _F
	15 pellets or 1 pellet and S _F	15 pellets	1 pellet and S _F	1 pellet

was located directly above the entrance to the designated pathway.

METHOD

Subjects

Ss were 64 naive male Sprague-Dawley rats, 60 to 80 days old, weighing 230-280 gm. They were obtained from the colony maintained at Texas A&M University. Subjects were housed in groups of 8 with water available ad libitum.

Apparatus

The apparatus consisted of two sections, a single runway and a rectangular box with two extensions. The runway section consisted of a 10-in. start-box painted white, an 8 ft. runway (grey) and a 10-in. goal box painted black, all 4 3/4 in. high and 5 1/2 in. wide. A start-box door which opened vertically controlled the start of each trial, activating a microswitch connected to a Meylan stopclock (Model Y). Interruption of a photobeam 8 ft. from the start-box door stopped the timer, thereby measuring running times. A goal box door prevented retracing. Ss received the designated number of pellets in a food dish located on the floor of the goal box. Dry, non-salted, Spanish peanuts were cut into pellets, weighing approximately 80 mg. Directly above the dish a flickering light was placed on the back wall of the goal box, 4 in. above the floor. On appropriate trials the flickering light was turned on prior to the S's departure from the start-box. Sanded plexiglass covered the entire runway section.

The social-lure section of the apparatus consisted of a rectangular box and extensions shown in Figure 1. The rectangular box was painted grey and was 2 1/2 ft. long, 18 in. wide, with a depth of 15 in. On the back wall of the box was located two 3 1/2 in. wide, 4 in. high openings to the pathways. Directly above each opening, a 28 v. light was placed. A 5 in. partition was placed between the two openings. The pathways were 8 in. long, 3 1/2 in. wide, with a black social-lure cage at the end of each, 6 in. long, 3 1/2 in. wide. Wire mesh (3/4 in. diameter) divided each pathway from the social-lure cage. At the opposite end of the rectangular box was placed a white start-box 6 in. long, 3 in. wide. A guillotine door made of wire mesh allowed S to see the S_P from inside the start-box. Sanded plexiglass covered the social-lure apparatus.

Design

Using a table of random numbers 64 Ss were assigned randomly to two groups. The experimental group ran to 15 pellets, the control, one pellet (Phase I). During Phase II the experimental and control groups were each subdivided into two matched-subgroups. Average running times for the last 3 days of Phase I were calculated for each subject, providing the basis for the matching of subgroups within the experimental and control groups. Both control subgroups were maintained on one pellet reward and the experimental subgroups ran to either 15 pellets of reward or one pellet, designated on a random basis. For the appropriate subgroups in both the experimental

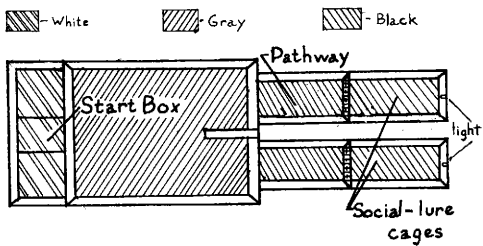


Figure 1. Social-lure apparatus used during Phase III.

and control groups, a flickering light was paired with the one pellet reward on the designated reduced reward trials. Phase III consisted of all subgroups being tested in a social-lure situation. Number of responses made to the designated pathway containing the S_F in the social-lure apparatus was used for statistical analysis. A two factor design with repeated measures on one factor was employed to test any significant difference between subgroups in Phase III.

Procedure

A 23 hr. deprivation schedule was started seven days prior to adaptation in the runway. Each day at the start of the 24th hr., S_s were allowed to eat for one hour. On the eighth day, adaptation began. S_s in groups of four were placed in the runway 15 minutes for two successive days, followed by two additional days of S_s being placed individually in the runway for 10 minutes. On the following day Phase I of the experiment began. S_s were taken from their home cages and placed in a restraining-carrier cage in groups of 8 S_s . After a S had faced the start-box door 5 sec. the door was raised, allowing the S to run down the runway to the goal box. When the photobeam was broken and the S had entered the goal box the goal box door was closed. The S was then removed from the goal box after 90 seconds had passed and returned to the restraining cage. When all S_s in the group had finished running they were returned to their home cages 15 minutes later and were fed Purina biscuits for 45 minutes.

Phase I consisted of 1 trial per day for 28 days. Running times were recorded for each S daily during Phase I.

In Phase II the experimental subgroups ran to either 15 pellets or one pellet on a random basis for 40 days. According to a table of random numbers, on trials 1, 2, 4, 5, 7, 9, 10, 12, 13, 16, 17, 19, 21, 22, 25, 26, 27, 38, 30, 31, 33, 34, 36, 39, and 40 one pellet was given. Concurrently, the control subgroups continued to receive one pellet of reward. For the designated experimental and control groups the flickering light was paired with the one pellet reward. In total, the S_f was presented on 25 trials. During Phase II adaptation to the social-lure apparatus began. On days 33 through 37 Ss were allowed to explore in groups of 4 the rectangular box and pathways containing social-lures for 15 minutes a day. On the next two days, the Ss were placed in the apparatus individually for 10 minutes. This adaptation procedure was conducted after the Ss had finished eating in the home cages. After Phase II was completed the 23 hr. deprivation was terminated and Ss were fed ad libitum in their home cages for the remainder of the experiment.

During Phase III, a S was placed in the start-box of the social-lure apparatus, and after 5 sec. the door was raised, allowing the S to run to one of two social-lures. Each S ran four trials a day for 3 days. The order in which the S ran was held constant throughout Phase III. The position of the light was determined on the first trial by a random sequence and alternated on the three remaining trials to insure an equal number of trials to each side.

RESULTS

Phase I

Running times for the experimental (15 pellets) and control (1 pellet) groups are shown in Figure 2. From this figure it can be seen that throughout the 28 day training phase the experimental Ss ran faster than the control Ss, the greatest difference in running times occurring on days 6-10. With the exception of this 5 day period, however, it is apparent that differences in running times between the two groups are very small, considering the large difference in reward magnitude given. In addition, both groups reached their asymptotic performance level on day 22. Differences in running times on training days 26, 27, and 28 were .26, .38, and .38 sec., respectively.

Phase II

The results of Phase II are recorded in Table 3 where each score represents mean running time for a group's performance on a particular day. From this figure several factors can be recognized that are of importance in analyzing the data. First, examination and comparison of the control subgroups' mean running times show that the light was aversive when presented during the first 14 days, that is, C-S_F ran slower than C-NS_F on those days when the light was presented. This factor weakened as days progressed and was nonexistent after day 14--apparently the time required for the C-S_F Ss to adapt to the light. This light aversion factor is

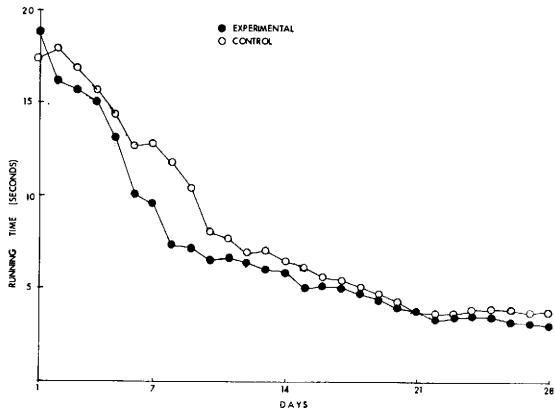


Figure 2. Training results based on running times.

TABLE 3
 MEAN RUNNING TIMES RECORDED DURING PHASE II

Days	EXPERIMENTAL			CONTROL		
	Pellets	E-S _P (3.26)	E-NS _P (3.28)	Pellets	C-S _P (3.57)	C-NS _P (3.59)
1*	1	5.16	3.33	1	10.58	3.62
2*	1	6.46	4.23	1	8.81	3.65
3	15	4.57	4.62	1	4.12	3.64
4*	1	4.15	3.82	1	5.79	3.63
5*	1	5.68	4.46	1	4.86	3.62
6	15	4.42	4.55	1	3.81	3.64
7*	1	4.41	3.81	1	4.81	3.69
8	15	4.50	4.66	1	3.61	3.71
9*	1	4.44	4.18	1	4.99	3.60
10*	1	5.68	5.23	1	4.44	3.65
11	15	5.71	5.53	1	3.63	3.63
12*	1	4.42	4.41	1	4.29	3.71
13*	1	5.88	5.91	1	4.11	3.62
14	15	6.11	6.84	1	3.58	3.62
15	15	4.69	5.21	1	3.64	3.71
16*	1	4.29	4.15	1	3.69	3.73
17*	1	5.63	5.18	1	3.64	3.70
18	15	5.51	6.12	1	3.58	3.68
19*	1	4.50	5.14	1	3.48	3.71
20	15	4.58	6.65	1	3.30	3.70
21*	1	4.49	5.58	1	3.28	3.63
22*	1	5.95	6.67	1	3.38	3.57
23	15	4.88	7.68	1	3.41	3.71
24	15	3.68	6.64	1	3.40	3.68
25*	1	3.81	5.60	1	3.26	3.64
26*	1	4.87	5.96	1	3.22	3.62
27*	1	5.69	6.81	1	3.46	3.69
28*	1	8.91	8.48	1	3.45	3.73
29	15	5.11	9.11	1	3.29	3.61
30*	1	5.68	7.92	1	3.33	3.66
31*	1	7.84	7.96	1	3.30	3.64
32	15	4.61	8.41	1	3.61	3.58
33*	1	6.05	7.42	1	3.51	3.62
34*	1	8.62	7.63	1	3.69	3.81
35	15	3.98	8.40	1	3.57	3.64
36*	1	7.91	7.01	1	3.54	3.68
37	15	4.11	7.43	1	3.36	3.67
38	15	3.21	6.91	1	3.59	3.64
39*	1	7.14	6.42	1	3.64	3.67
40*	1	9.12	7.11	1	3.51	3.69

* Days when light was presented to S_P subgroups.

also responsible for slower running times in E-S_F, although the effect is not as large. On day 1 of Phase II, for example, a comparison between E-S_F and C-S_F shows a difference of 5.45 sec., despite a much smaller difference (.31 sec.) in mean running time prior to the start of Phase II. Apparently, the habit of running to the goal box was much stronger for the experimental Ss who had received a larger reward in Phase I. Consequently, running times were not altered as much for E-S_F by the presence of the light. Because the only variable introduced in Phase II for C-S_F was the light, the light-aversion factor in all probability did not influence C-S_F nor E-S_F running times after day 14.

Second, examination of the experimental subgroups' scores reveals a factor that exists throughout Phase II. For E-S_F and E-NS_F running times for any particular day was governed by the amount of reward the Ss had received the day before. More precisely stated, if the experimental Ss had received 1 pellet on day X running times for day Y were slower than day X. In addition, running times on day Y were faster than day X whenever the Ss had received 15 pellets on day X. To illustrate this point, on day 20, E-S_F and E-NS_F received 15 pellets and had running times of 4.58 and 6.65, respectively. The next day (day 21) both subgroups ran faster (4.49 and 5.58) to the goal box because of the large reward received on day 20. On day 22 both subgroups ran slower to the goal box (5.95 and 6.67) since they had received only 1 pellet on day 21. It is readily apparent from observing other E-S_F and E-NS_F scores that this factor

influenced running times for both subgroups during Phase II.

Lastly, mean running times for E-NS_F generally increased as trials progressed in Phase II, as more reduced reward trials were experienced in the goal box. Apparently, the goal box was becoming aversive to E-NS_F Ss after having been paired with frustration on previous trials.

The most pertinent data in Phase II is the running times recorded for E-S_F. Examination of E-S_F scores shows that beginning on day 28 E-S_F Ss had begun to discriminate between normal or reduced reward trials by the absence or presence of the light. A graph portraying the last 12 days of Phase II is found in Figure 3. For E-S_F it is clear that the absence or presence of the light governed running times, exerting more motivation than the factor of which reward the Ss had received the previous trial. On day 28, for example, E-S_F Ss had a mean running time of 8.91 sec. with the light present. The following day and with the light absent E-S_F Ss ran much faster (5.11) despite the fact that they had received only 1 pellet on day 28. A comparison of E-NS_F mean running times on the same days shows that the factor of which reward the Ss received the day before was still influencing running times. This provides additional evidence that the light was aversive to E-S_F Ss, since their running times were faster on day 29 despite the 1 pellet reward received the day before.

In Figure 3 an overall comparison between the four subgroups shows that both control subgroups continued to perform near the

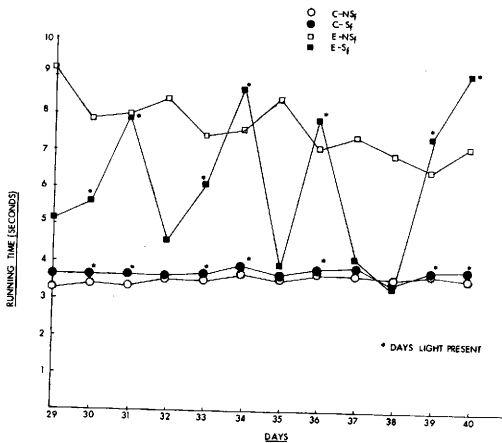


Figure 3. Graph showing last 12 days of Phase II in which E-S_f Ss were discriminating between normal or reduced rewarded trials by the absence or presence of the light.

asymptotic performance level reached in Phase I and that E-S_F and E-NS_F's running times differed greatly on those days when the light was absent. Because the goal box had apparently become aversive to E-NS_F Ss in Phase II, running times were high. Consequently, their scores approximated those scores exhibited by E-S_F on days when the light was presented.

Phase III

The results of Phase III are shown in Table 4. It is apparent that the number of avoidance responses recorded for E-NS_F and C-NS_F is virtually identical for both subgroups during the testing phase of the experiment. The reader should note upon observation that neither of these two subgroups were exposed to the light in Phase II, consequently any differences between E-NS_F and C-NS_F Ss can only be accounted for by individual differences. The main focus in Phase III is the difference in the number of avoidance responses between E-S_F and C-S_F, and of secondary importance, E-S_F versus E-NS_F or C-NS_F. It can be seen from Table 4 that E-S_F has the highest number of avoidance responses with C-S_F having the lowest number. From Table 5, the overall F test comparing these four subgroups is significant, $F(3,60) = 4.71, P < .01$. A follow-up using a least significant difference (LSD) test shown in Table 6 established a significant difference between E-S_F and C-S_F but no significant differences between the other combinations of subgroups.

TABLE 4
 NUMBER OF AVOIDANCE RESPONSES MADE BY EACH
 SUBGROUP DURING THREE CONSECUTIVE DAYS IN PHASE III TESTING

EXPERIMENTAL						CONTROL					
E-S _F			E-NS _F			C-S _F			C-NS _F		
1	2	3	1	2	3	1	2	3	1	2	3
45	48	47	38	40	38	30	34	34	37	42	37

TABLE 5
 ANALYSIS OF VARIANCE ON THE NUMBER OF AVOIDANCE
 RESPONSES MADE BY EACH SUBGROUP DURING PHASE III

SOURCE	SS	df	MS	F
Between <u>Ss</u>	98.04	63		
Treatment	18.64	3	6.21	4.71**
Error _b	79.40	60	1.32	
Within <u>Ss</u>	63.33	128		
Days	1.76	2	.88	1.73(NS)
Treatment x Days	.66	6	.11	(NS)
Error _w	60.91	120	.51	

** F (3,60) = 4.13, P < .01.

TABLE 6
DIFFERENCES BETWEEN SUBGROUP MEANS IN PHASE III

	E-S _F (3.92)	E-NS _F (3.42)	C-S _F (3.04)	C-NS _F (3.40)
E-S _F		.50	.88*	.52
E-NS _F			.38	.02
C-S _F				.36
C-NS _F				

*L.S.D. (60) = .68, $P < .05$.

DISCUSSION

The results of the present experiment provide evidence that reward reductions produce frustration which can serve as the basis for motivating avoidance behavior. Towards the latter part of Phase II E-S_F Ss ran much slower to the goal box on the days when the light was present. In addition, running times in general for E-NS_F became much slower after Phase II began, compared to the average running time established at the end of Phase I. Both of these findings are to be expected within Amsel's frustration theory, which states that stimuli paired with frustration acquire aversive properties. For E-S_F, the light had become aversive to the Ss by having been paired with the 1 pellet reward. The light, then, towards the end of Phase II caused slower running to the goal box. The other experimental Ss (E-NS_F), who never received the light in Phase II and consequently could not discriminate between normal or reduced rewarded trials before entering the goal box, ran slower to the goal box. From Amsel's theory, this occurred because the goal box had acquired aversive properties over trials, the result being slower running to the goal box on all trials. It is equally important that running times for E-NS_F and running times for E-S_F on the days when the light was presented were much slower than the running times recorded for C-S_F and C-NS_F, despite the fact both control subgroups received only 1 pellet throughout Phase I and Phase II. This is additional evidence that Ss trained with a large reward and later put into a situation where they sometimes receive

a small reward will experience more frustration than Ss who have been trained with a small reward.

A consideration of the experimental design is most important in determining whether or not the light could motivate avoidance behavior in an environment dissimilar to the one used in Phase II. Because the experimental and control subgroups differed significantly in the social-lure situation there is evidence that it can. One might argue, however, that the light had acquired positive reinforcing properties for C-S_F Ss during Phase II, and that these Ss might have been moving to some degree towards the light in Phase III thereby inflating the difference between groups E-S_F and C-S_F. Therefore, the significant difference between E-S_F and C-S_F would not be a true indication that the light could motivate avoidance behavior in group E-S_F in Phase III. This interpretation is possible within the experimental design, although it cannot be deduced from the results of Phase II. If running times would have been faster on those days when the light was presented one could conclude that the light had acquired positive properties. Yet, an examination of C-S_F's performance in Phase II shows that running times approximated asymptotic performance level on all trials after day 14, regardless of whether the light was present or absent. This result, that the light had no noticeable effect on running times in Phase II, suggests that the light was probably motivationally neutral. At the same time, however, running times on all trials after day 14 for C-S_F Ss approximated the asymptotic running times established at the end

of Phase I. This implies that regardless of the light being present or absent C-S_F Ss were running as fast to the goal box as they ever did in the experiment. A genuine positive reinforcing stimulus, then, probably could not have motivated faster running for C-S_F Ss within this experimental design. Thus, it is impossible to determine if the light had acquired positive properties from the results of Phase II.

What was needed in this experiment to supplement the interpretation that the light could motivate avoidance behavior in a new environment was a significant difference between E-S_F and one or both of the subgroups (E-NS_F, C-NS_F) which never received the light in Phase II. Because these subgroups were not adapted to the light, however, the number of avoidance responses made because of the light were high--resulting in a distribution of scores which made a significant difference impossible. If the subgroups had been adapted to the light prior to Phase III the number of avoidance responses would have been significantly less, raising the possibility that a significant difference could have been established. In addition, a comparison of C-S_F with these subgroups could have determined if the light was positively reinforcing for C-S_F, since the light for E-NS_F and C-NS_F would have been motivationally neutral after adaptation. Consequently, if C-S_F Ss differed significantly from E-NS_F Ss in Phase III it could be concluded that the light had acquired positive reinforcing qualities.

In summary, there is substantial evidence from the scores recorded during Phase II that reduced reward situations lead to frustration and the conditioning of frustration to cues present at that moment. At least during the last 12 days of Phase II E-S_F Ss were discriminating between normal or reduced reward trials by the absence or presence of the light. What was not clearly determined in this experiment, however, is whether the light could motivate avoidance behavior in a dissimilar environment. This flaw was the result of the experimenter not including adaptation to the light for E-NS_F and C-NS_F subgroups, prior to Phase III.

Nevertheless, since asymptotic performances for C-S_F Ss during Phase I and Phase II were virtually identical and because E-S_F and C-S_F's asymptotic performances were similar at the end of Phase I, it is apparent that any differences in running times after day 14 of Phase II between E-S_F and C-S_F are differences produced by frustrative reduced reward situations. Because there were large differences, it is extremely likely that the significant difference found between E-S_F and C-S_F in Phase III was caused solely by E-S_F Ss avoiding the light.

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