

RESISTANCE TO EXTINCTION AS A FUNCTION OF  
TYPE OF ACQUISITION EXPERIENCE

by

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## ABSTRACT

Twelve rats were divided into three groups on the basis of acquisition schedule; they were further divided and counterbalanced during acquisition such that half of each group received either food reinforcement first or positive brain stimulation first. Each S received both reinforcers at some time during training. Group (CF) was exposed to 100% food reinforcement during acquisition; Group (CS) received 100% ICS; Group (PF) received 100% food reinforcement plus 50% punishment; Group (PS) received 100% ICS and 50% punishment; Group (NF) received only 50% food reinforcement; while Group (NS) received 50% ICS. Each group was then given two ten-minute extinction trials.

Groups (PF) and (NF) were both more resistant to extinction than Group (CF). There were no significant differences in extinction rates between Groups (CS), (PS), and (NS). The results were interpreted in support of a commonality between the emotional consequences of punishment and partial reinforcement.

## INTRODUCTION

Research strongly suggests that, all other things being equal, resistance to extinction after partial reinforcement is greater than after continuous reinforcement. This finding has become known as the PRE or partial reinforcement effect (Lewis, 1960). Similarly, it has been shown that moderate punishment introduced during acquisition training also results in increased resistance to extinction (Miller, 1960; Logan, 1960; Brown and Wagner, 1964; and Karsh, 1964).

Amsel (1958, 1960), Spence (1960), and Wagner (1961, 1963), have argued for a mediating frustration response as an explanation of the PRE. When this "mediational" theory is compared to the theoretical interpretation of punishment offered by Miller (1959, 1960), it seems punishment and partial reinforcement may share a variety of characteristics in the instrumental reward situation.

Amsel (1958) outlines his theory of partial reinforcement as follows: (1) Fractional anticipatory reward responses ( $r_p$ ) develop with running to early rewards. Non-reward is assumed to have no particular effect during this initial stage. (2) After the development of  $S_a-r_p$ ,

nonrewards elicit frustration (implicit reaction elicited by nonreward after a number of prior rewards). (3) When nonrewards elicit frustration, the cues previously evoking  $r_R$  also begin to evoke anticipatory frustration responses ( $r_F$ ). (4) Since  $r_R$  and  $r_F$  cannot be elicited by differential cues in partial reinforcement, and since the temporary conflict in partial reward training is resolved in favor of running to the intermittently rewarding goal box,  $s_F$  becomes associated with the instrumental approach response, thus providing a mechanism for the partial reinforcement effect. When extinction is carried out, partially reinforced subjects have been trained to approach in the presence of antedating, frustration-produced stimuli, whereas the consistently reinforced subjects have not. In other words, partially reinforced subjects have built up a tolerance to frustration.

Miller (1960) has suggested a similar mechanism to account for the learning of resistance to punishment. He terms this "learning to advance to the cue of fear." His reasoning is that while  $s_F$  will at first elicit responses antagonistic to approach, it will finally become connected to approach tendencies. This theoretically comes about because the subjects continue to experience reinforcement during approach-avoidance training. Therefore, at some stage in the training situation,  $s_F$  will become part of a

stimulus complex evoking approach responses, and the earlier evidence of conflict disappears.

In other words, Miller and Amsel assume the decremental effects of fear and anticipatory frustration to be dependent upon their mediating responses which are incompatible with the ongoing instrumental behavior. Therefore, to the degree that Ss can be trained such that fear or anticipatory frustration will elicit responses compatible with the instrumental response, the emotional consequences of punishment or partial reinforcement should have less of a decremental effect.

Miller's (1960) results supported this hypothesis when he found that rats could be trained to resist stress such as pain or fear if punishment intensity is built up gradually over trials at the rewarded goal. Theoretically, Ss are rewarded during training for approaching in the presence of fear, so that increasingly intense fear can become a cue for approaching.

Miller (1960) also found that a similar gradually increasing series of shocks given outside of the rewarded conflict situation produced little, if any, effect. Ss receiving this treatment were similar to the nonshock controls and reliably poorer than those habituated to the shocks in the rewarded training situation. Apparently, mere exposure to tough treatment does not improve resistance to stress

in a different criterion situation. These results seem to strengthen the idea that the fear stimuli must somehow become connected to the stimulus complex evoking approach responses before resistance to fear can be learned.

Karsh (1964) found that animals which had received 100% food reinforcement plus 100% aversive foot shock during acquisition, took longer to extinguish than did animals who received only 100% food reinforcement during acquisition. Logan (1960) also showed that training with partial punishment and continuous reinforcement resulted in increased resistance to extinction.

Amsel (1958, 1960), Spence (1960), and Wagner (1961) have used practically the same argument as Miller to explain the fact that partial reinforcement produces increased resistance to extinction in instrumental reward situations. According to them, the intensity of frustration brought about by nonreinforcement should increase gradually during acquisition as anticipatory reward increases. Partially reinforced Ss should then be reinforced during acquisition for continuing to approach in the presence of at first weak, but then increasingly intense anticipatory frustration cues. Such Ss are, therefore, less likely to have avoidance responses elicited by these cues when they occur during extinction than are Ss which have not had this training.

Wagner (1961) compared the effect of magnitude of reward on extinction rates in partially reinforced and continuously reinforced groups. He found that with larger rewards, partially reinforced subjects took longer to extinguish. Furthermore, there was less resistance to extinction of continuously reinforced Ss with large as compared to small rewards. These results would appear to be in accordance with Amsel's theory. Since the magnitude of anticipatory reward should be greater at the start of extinction with large than with small rewards, it is consistent that larger rewards should lead to a slower rate of extinction for partial reinforced Ss due to increased motivation, but should lead to a faster rate of extinction for continuous Ss owing to the greater vigor of the competing responses elicited by the more intense  $s_r$ .

According to Amsel, a necessary condition for resistance to extinction to occur is for  $s_r$  to become connected to the rewarded response. It would follow then, that the more secondary reinforcing stimuli present during both nonrewarded trials and rewarded ones, the stronger the PRE should be. Several studies support this hypothesis. Rubin (1953) found that when secondary reinforcement was minimized during partial reinforcement acquisition (generalization factors were also reduced from acquisition to extinction), continuous reinforcement groups were more

resistant to extinction than partial groups. Hulse and Stanley (1956), and Amsel and Hancock (1957), also reported a reliable PRE only when secondary reinforcement was present on every trial during acquisition. These findings are in accordance with the Miller (1960) study, mentioned previously.

Another implication of Amsel's view is that partial reinforcement acquisition will be more variable than continuous reinforcement acquisition in the early-middle (conflict) stages of training, when  $r_p$  and  $r_c$  are in competition. Amsel (1958) took latency, running speed, and, as a measure of "emotionality," urination data on both partial and continuous reinforcement groups. Both groups started out with approximately the same measure on the first day of training. Differences in variability became most noticeable on about the fourth day, and continued through the ninth day, and after this variability was not noticeable. The decrease in variability during the last few days of acquisition was taken to indicate that ~~Ss~~ had become conditioned to running.

Although there appear to be many parallels between partial reinforcement and punishment, relatively little data has been gathered which directly compares the two conditions. However, one such study which does support both theoretical interpretations, is an experiment conducted by Brown and

Wagner (1964). In their study, rats were exposed to one of three different conditions: Group N was given partial reinforcement on a 50% reward schedule; Group P was given gradually increasing punishment (foot shock) on a 50% schedule along with 100% food reward; Group C received only 100% food reward. Half of each group was then tested for the decremental effects of either nonreinforcement or of punishment. They found that both Group N and Group P were more resistant to extinction under each extinction condition than was Group C.

The purpose of the present study is to further investigate the similar effects which punishment and partial reinforcement may have on extinction. Specifically, it is designed to investigate possible differences which may exist between using food or positive hypothalamic brain stimulation as a reinforcer. Reasons for suspecting that differences do exist become evident within the following brief discussion of direct brain stimulation.

The nature of intracranial stimulation (ICS) has been intensively studied. Although there is no doubt brain stimulation can and does serve as a reinforcer (that is, an animal will learn to press a bar for it just as he will for food or water), what constitutes the reinforcing effect remains speculative.

Several basic differences between the ICS drive and the more conventional drives have been discovered. For one thing, deprivation is not a prerequisite for brain stimulation to be reinforcing; also, the rates of lever-pressing are very high, and reinforcement does not seem to be drive-reducing. For example, acquisition scores often range higher than 8,000 bar presses per hour when medial fore-brain stimulation is used as a reinforcer (Olds, Travis, Schwing, 1960); and it is not uncommon for an animal to respond steadily at a rate of 2,000 rph. for fifteen or twenty hours. After a period of sleep, it may resume responding at the previous rate for another period of hours (Olds, 1958).

In a bar-pressing situation, acquisition curves are as steep for ICS as they are for any reward. In fact, observations have indicated that learning to press for ICS may be even more rapid than it is for food. However, if self-stimulation is genuinely reinforcing, animals ought to learn a more complicated task than pressing a bar to obtain the reward. Results from experiments involving maze running to an ICS reward indicate that animals which press a lever for continuous reinforcement do not perform adequately in a simple maze or runway (Newman, 1961; Olds, 1956; and Seward, Uydea, Olds, 1960). Apparently, the immediate after-effects of self-stimulation contribute markedly to its efficacy as a positive reinforcer.

Extinction data also lend support to the idea that the immediate after-effects are very important. Whereas, extinction is slow for a food reward, it is quite rapid for self-stimulation. Olds (1955) discovered that when the voltage was turned off, animals with septal electrodes would stop responding immediately. Although extinction rates vary to some extent, depending on the electrode placement, response rates still tend to fall sharply during extinction (Seward, 1960; Sheer, 1961). Howard and Deutsch (1962) hypothesized that there is a rapid decay of the drive state when the electrical stimulus is switched off. They predicted that extinction should be a function of time since the last electrical stimulus, and would be independent of the number of unreinforced lever presses occurring in that time. This prediction is in contrast to extinction of the more usual kinds of lever-pressing habits which are little affected by a time interval between training and extinction. To test such a notion after training, the lever was removed from a Skinner Box for varying times, then replaced and normal extinction completed. They found that the number of extinction trials was a simple function of the time the lever was out of the box and not of the number of unreinforced trials as in normal extinction. One study, however (Kling and Matsumiya, 1960), indicates

that with stimulation in the posterior hypothalamus, extinction is slower than when food is used as a reinforcer.

Experiments which have varied schedules of reinforcement also indicate that the drive for self-stimulation decays very rapidly between times of stimulation (Brady, 1958; Brodie, et al., 1960; Sidman, et al., 1955). In general, ratios higher than 7:1 can be maintained only by very slow and gradual training. This is to be compared with ratios of 100:1 or more that are not uncommon in reinforcement schedules involving food.

If extinction occurs so rapidly with ICS, and if it is a function of time since the last electrical stimulus rather than number of nonreinforced trials, one would predict that partial reinforcement would not be as effective in increasing resistance to extinction, as it is with other reinforcers.

Since hypothalamic stimulation and aversive foot shock will be paired for one group of Ss in the present study, the reports that ICS modifies aversive states seem particularly pertinent. In working with humans who were receiving central stimulation of the septal area, Heath (1963) discovered that such stimulation caused immediate relief from intractable pain. Valenstein (1965) found that animals would seek out aversive central stimulation so long as it was paired with hypothalamic stimulation.

Furthermore, several investigators have shown that animals will take an avoidable foot shock in order to obtain hypothalamic stimulation (Olds, 1961; Valenstein and Beer, 1962; Cox and Valenstein, 1965). Cox and Valenstein (1965) also found that animals did not discriminate between hypothalamic stimulation alone and hypothalamic stimulation which was paired with foot shock. This indicates that such stimulation decreases the aversive properties of foot shock. If such is the case, then one would not expect an animal which has had ICS paired with foot shock to build up sufficient tolerance to frustration to have resistance to extinction increased.

## STATEMENT OF THE PROBLEM

The present study is designed to further investigate the effects of punishment and partial reinforcement on extinction. Two different reinforcers (food and positive brain stimulation) will be used during acquisition training. Specifically, the hypothesis to be tested is that both partial reinforcement and punishment will increase resistance to extinction when food is used during acquisition, but when ICS is used, neither partial reinforcement nor punishment will increase resistance to extinction.

## METHOD

### SUBJECTS:

Subjects were twelve hooded rats from the University of Arizona laboratory. They were approximately three months old when electrodes were implanted. They were tested one month after implantation.

### ELECTRODES:

The bipolar electrodes used to obtain self-stimulation were each of 0.01 inch diameter, stainless steel wire, insulated except at the tips.

The electrodes were soldered to copper wire loops, to which leads from the stimulator could be attached by small alligator clips. The assembly was embedded in a block of dental acrylic material.

### OPERATIONS:

Operations to implant the electrodes were performed under nembutal anesthesia. A Stellar-Krause stereotaxic instrument was used. The electrode block was fixed firmly to the skull by means of dental acrylic and stainless steel optical screws.

The coordinates used were 3.5 mm posterior to bregma, 1.5 mm lateral to the midline, and 8.5 mm deep

from the skull surface. The approximate site, located in the medial forebrain bundle, had been reported by Olds, Travis, and Schwing (1960) to yield strongly rewarding effects.

#### GROUPS:

Ss were divided into three groups on the basis of acquisition experience: Group C received 100% reinforcement; Group P received 100% reinforcement and 50% punishment; Group N received only 50% reinforcement. Each group was further divided and counterbalanced during acquisition such that half of each group received either food first as a reinforcer or brain stimulation first. The schedule of reinforcement remained constant for each subject. In other words, if a subject received 100% food during the first test period, it would receive 100% brain stimulation during the second period.

One subject died after completing only half of the experiment, and another S refused to press for brain stimulation after it had already pressed during the food reinforcement condition.

#### APPARATUS:

A 12x12x12-inch plastic Skinner-type Box with a grid floor and a bar manipulandum was used. A food cup

was permanently fastened 0.75 inches to the left of the bar. It protruded 1.0 inch into the box. Two holes were bored into the top of the apparatus so that the electrode wires could move freely with the animal.

A Gerbrands ratio timer was used in order to deliver either brain stimulation, food reinforcement, or foot shock on a random 50% schedule. Two Hunter timers were also used to deliver either foot shock or brain stimulation for a fixed 0.2 sec. duration. If the animal was to receive both a foot shock and a brain stimulation at the same time (as would be the case for Ss in Group P with brain stimulation as a reinforcer), the brain stimulus and foot shock occurred at exactly the same time as the bar was depressed, and both lasted for the same period of time.

Reinforcement consisted of either 45 mg. Noyes rat pellets, or positive brain stimulation. Central stimulation consisted of 0.2 sec. trains of 100 per sec. biphasic rectangular pulses which were 0.5 msec. in duration. Intensity varied among subjects, with a range of 8.5 to 25.0 volts. Polarity was randomized except in a few cases where an animal would only press for a specific polarity. The reason why this should make a difference was not determined.

Central stimulation was administered by means of a Grass S-5 stimulator, and the waves were monitored on an oscilloscope.

A foot shock was delivered through the grid floor by a four-line scrambling device which had its own power source. Each shock consisted of 90 volts lasting for a period of 0.2 seconds. Although the exact intensity was not determined, it is certain that the maximum intensity was below 0.5 ma., because this is the maximum the scrambler could deliver at 100 volts.

#### PROCEDURE:

Approximately five days after the electrodes were implanted, each s was given minimal shaping to the bar for self-stimulation, in order to determine whether or not it would press for stimulation. Ss were not run in the experiment until at least three weeks later.

One day prior to acquisition training subjects were allowed fifty reinforced bar presses. The reinforcement used was the same that they would receive first during acquisition training.

Ss were given four days of acquisition training, consisting of 100 bar presses per day. On the fourth day, after s had pressed 100 times, it was removed from the Skinner Box for a period of one minute. It was then

returned to the box for the first extinction period.

Extinction consisted of nonreinforcement and was the same for all groups. There were two days of extinction. Each extinction period lasted for ten minutes.

Following the first extinction procedure, S was reshaped to the second reinforcement condition. Ss followed the same acquisition and extinction procedures as they previously had.

During acquisition, recordings were made of the time it took each S to complete 100 presses on each day. Extinction was measured in terms of number of responses per minute during each extinction period of ten minutes.

## RESULTS

### ACQUISITION:

A t-test was performed on the mean minutes per 100 responses on the last day of acquisition between the continuous food reinforced group (CF) and the continuous food reinforced 50% punishment group (PF). There was no significant difference between these groups ( $t=1.44$ ,  $df=6$ ,  $P < .10$ ). Even though there was no significant difference between these groups, Table 1 shows that all Ss in the PF group were responding at a slower rate than those in the CF group except for one s which responded faster than any s in the CF group.

A similar t-test was performed on the acquisition rates between the continuous stimulation reinforced group (CS) and the continuous stimulation reinforced, 50% punishment group (PS). There was a highly significant difference between these two groups ( $t=8.29$ ,  $df=5$ ,  $P < .005$ ), indicating that punishment had a decremental effect on speed of acquisition.

In order to determine if the self-stimulation groups responded at a faster rate than the food reinforced groups, another t-test was performed on the last

day acquisition means between the CF and CS groups. As would be expected, there was a highly significant difference between these groups ( $t=10.25$ ,  $df=6$ ,  $P < .005$ ).

Acquisition curves for all six groups are shown in Figures I and II. The groups are: continuous-food (CF), punishment-food (PF), partial reinforced-food (NF), continuous-stimulation (CS), punishment-stimulation (PS), partial reinforced-stimulation (NS).

#### EXTINCTION:

A Winer (1962) three-factor design with repeated measures (Case II) was used to analyze extinction data. The results of this analysis are summarized in Table 2.

The difference between extinction rate for food vs. stimulation reinforced groups was highly significant ( $F=71.28$ ,  $df=1/16$ ,  $P < .001$ ). The Ss which received ICS during acquisition were almost completely extinguished during the first five minutes of extinction. There was not a significant difference between the continuous, punishment, and partially reinforced groups ( $F=3.55$ ,  $df=2/16$ ,  $p > .05$ ). An  $F=3.63$  was necessary for  $P < .05$ .

As one would expect, extinction periods had an effect due to reduction in frequency of response with continued extinction ( $F=25.52$ ,  $df=3/48$ ,  $P < .01$ ).

In this analysis, a mean score was inserted in each extinction trial which had an unequal n. However, the df's for the unequal groups were unchanged. It was believed that this procedure may have been one reason no significant difference was found between the schedules of reinforcement. Therefore, a separate two-factor analysis of variance for repeated measures was used to analyze the extinction rates between the food groups; and a similar analysis of variance designed for unequal groups was used to analyze the data for the stimulation groups. The results of these two analyses are shown in Tables 3 and 4.

Again, the only significant difference was between extinction periods due to a reduction in response rate as extinction continued.

A t-test was performed on the mean total extinction responses between the CF and PF groups, and between the CF and NF groups. A significant difference was found for the CF vs. NF groups ( $t=2.45$ ,  $df=6$ ,  $P<.025$ ), and for the CF vs. PF groups, ( $t=2.32$ ,  $df=6$ ,  $P<.05$ ).

Table 1  
Min/per 100 Responses on Last Acquisition Trial

N	CF	NF	PF	CS	NS	PS
1.	12	9	20	3	4	21
2.	11	19	18	4	6	14
3.	14	8	20	2	2	18
4.	16	9	10	4	-	-

Table 2  
Summary of Analysis of Variance of Responses to Extinction

Source	df	MS	F	P
Between Ss	21			
(A) Type of Reinforcement	1	9126.00	71.28	.01
(B) Reinforcement Schedule	2	457.83	3.55	
AXB	2	220.91	1.73	
Error (b)	16	128.03		
Within Ss	66			
(C) Extinction Periods	3	924.18	25.52	.01
AXC	3	37.42	1.03	
BXC	6	72.55	2.00	
AXBXC	6	41.74	1.15	
Error (w)	48	36.22		
Total	87			

Table 3  
 Summary of Analysis of Variance of Responses to Extinction  
 when Previously Reinforced with Food

Source	df	MS	F	P
Between Ss	11			
(A) Reinforcement Schedule	2	656.40	2.67	
Error (b)	9	245.94		
Within Ss	36			
(B) Extinction Periods	3	495.08	8.91	.01
AXB	6	52.51		
Error (w)	27	55.54		
Total	47			

Table 4  
 Summary of Analysis of Variance of Responses to Extinction  
 when Previously Reinforced with Brain Stimulation

Source	df	MS	F	P
Between Ss	9			
(A) Reinforcement Schedule	2	18.20	3.20	
Error (b)	7	5.69		
Within Ss	30			
(B) Extinction Periods	3	382.86	12.33	.01
AXB	6	49.96		
Error (w)	21	31.05		
Total	39			

## DISCUSSION

### ACQUISITION:

Figure I presents mean time in minutes required to make 100 responses for each of the acquisition groups over the four successive days of training. As may be seen, there was a difference in speed of responding between the groups receiving stimulation reinforcement and those receiving food as reinforcement; a t-test run between the CF and CS showed  $t=10.25$ ,  $P < .005$ . Rate of responding was faster for the CS and NS groups than for any other group. These results are not surprising in view of the fact that animals often respond to self-stimulation at rates of 2,000 rph. (Olds, 1958 and Olds, 1962).

The learning curve for CS, shown in figure I, indicates that rate of responding remains about the same over the four-day period. It is difficult to say whether this might mean that learning is faster for self-stimulation than it is for food, or if the response rate has simply reached an asymptote on the first day even though learning continues to take place.

Rate of responding increased slightly with training for the NS group. On the first day of training, animals in this group tended to stop responding altogether when a

number of presses went unrewarded. Since reinforcement for the partial reinforcement groups was on a random 50% schedule, it was not uncommon for there to be three or four nonrewarded trials in a row. For the stimulation group, four nonrewarded responses at a time was almost enough to cause extinction unless a priming stimulus was inserted during this time. The fact that the NS group responded more slowly with partial reinforcement would be in accordance with the data from schedules of reinforcement for self-stimulation (Brady, 1958, Brodie, et al., 1960, Sidman, et al., 1955). By the last day, however, Ss in the NS group were responding at asymptotic level.

Although the PF group continued to take longer to respond than did either the CF or NF groups, a t-test between the CF and NF group was not significant,  $t=1.44$ ,  $P < .10$ . Logan (1960), Wagner (1961), Brown and Wagner (1964), and Karsh (1964) also report that as training proceeds, the decremental effects of punishment seem to have less of an effect. These findings would appear to be in accordance with Miller's data (Miller, 1959, and Miller, 1960); i.e., the animals seem to build up a tolerance to punishment.

Perhaps of most interest, as far as either punishment group is concerned, is the slow rate of responding for the PS group. A t-test between the PS and CS groups was

highly significant,  $t=8.29$ ,  $P < .005$ . This indicates that brain stimulation did not modify the aversive effects of foot shock. In fact, there is some indication that the punishment was more decremental to the brain stimulation group than it was for the food group, especially since the CF and PF groups did not differ significantly in their rate of responding and the CS and PS groups did. Apparently, the animals never could build up a tolerance to the punishment. These findings are in direct opposition to those reported by Valenstein (1965), Heath (1963), and Cox and Valenstein (1965), Valenstein and Beer (1962). This difference cannot be attributed to the fact that the shock used in this experiment was more punishing than that used in the others, because Cox and Valenstein (1965) used a shock of .68 ma. and Valenstein and Beer used a shock of 1.5 ma.: the shock in this experiment was less than .5 ma.

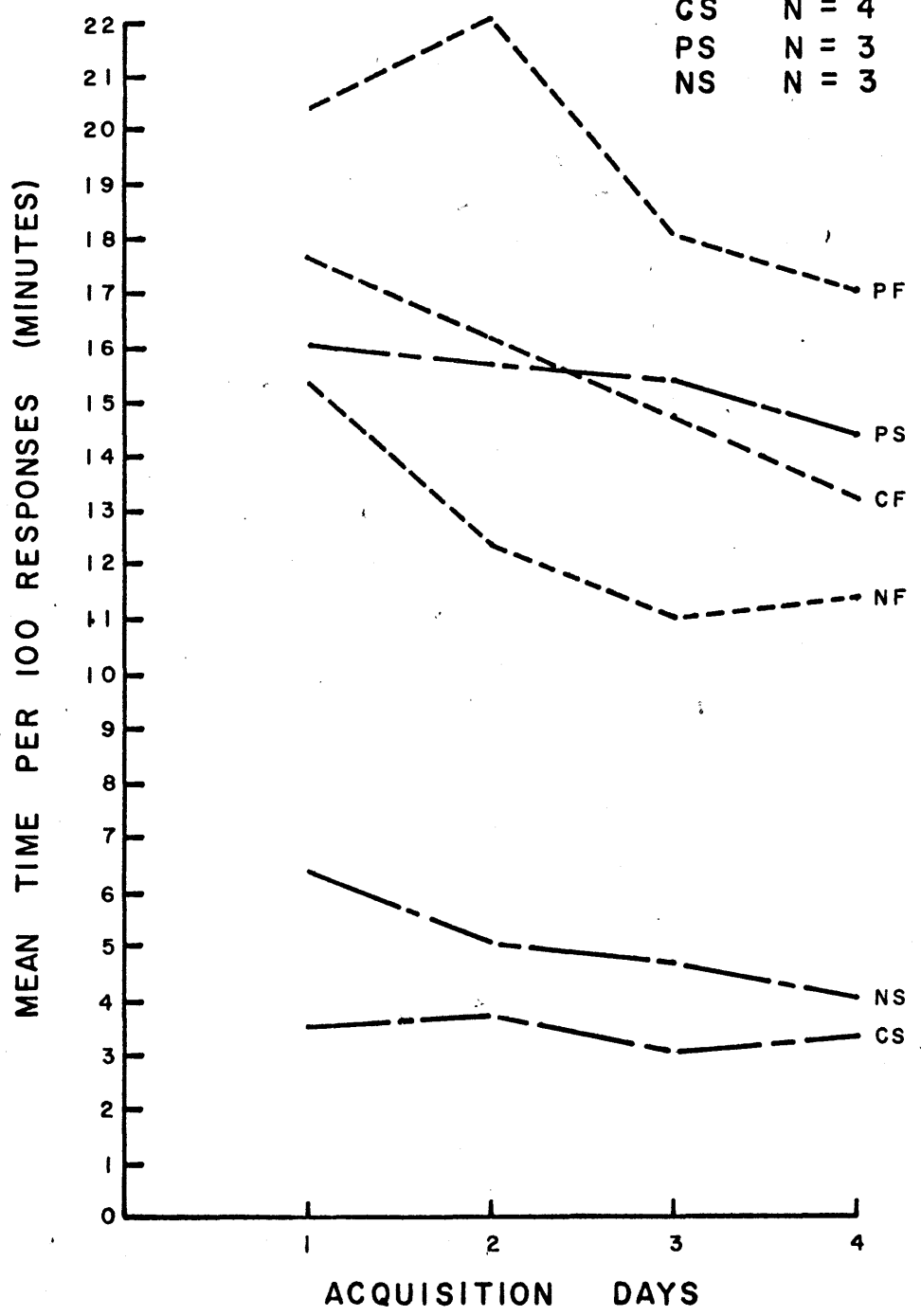
It has been hypothesized that separate neural systems elicit approach and escape behavior, and that these systems somehow interact (Olds and Olds, 1962; Valenstein, 1965). Most of the data has been concerned with stimulating the negatively reinforcing dorsomedial tegmentum and the positively reinforcing hypothalamic areas. Olds and Olds (1962) suggest that stimulation of the dorsal tegmentum is aversive because it results in an inhibition of spontaneous

activity in reinforcing areas. Presumably, stimulation of the hypothalamic areas would counteract this inhibitory influence. Valenstein (1965) found that temporal order was important. The activation of either a positive or aversive neural system made it more difficult to subsequently activate the opposing system. This may indicate that the two systems have a mutually inhibitory effect on each other, and that whichever system is activated first will tend to dominate. Contrary to this notion, Cox and Valenstein found that whether foot shock or hypothalamic stimulation came first was irrelevant. In either case, the brain stimulation seemed to mask the effects of the foot shock. There was no masking effect in the present study. These results are not in accordance with any of the other studies of this nature. Why this should be the case is not at all clear.

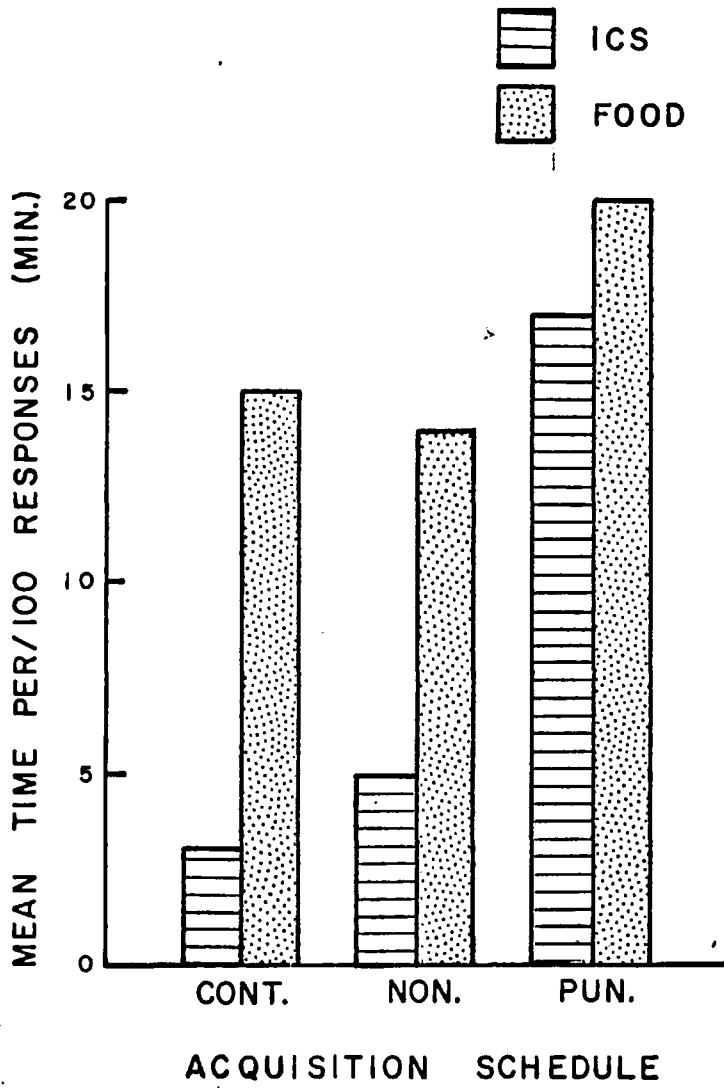
EXTINCTION: Although figure III indicates that punishment and partial reinforcement increase resistance to extinction, an analysis variance performed on these groups was not significant,  $F=3.55$ ,  $P > .05$ . Nor was an analysis of variance performed separately on the food and stimulation groups significant. A t-test between the CF and NF groups was significant,  $t=2.45$ ,  $P < .025$ , indicating that partial reinforcement did increase resistance to extinction. Also,

I. MEAN TIME PER/100 RESPONSES AS A  
FUNCTION OF ACQUISITION LEVEL

CF N = 4  
PF N = 4  
NF N = 4  
CS N = 4  
PS N = 3  
NS N = 3



II. MEAN TIME PER/100 RESPONSES AS A  
FUNCTION OF ACQUISITION SCHEDULE  
AND TYPE OF REINFORCEMENT



a t-test between the CF and PF groups yielded significance,  $t=2.32$ ,  $P < .05$ . Table 5 shows the total number of responses during extinction for the three food groups. As can be seen, only one S in either the PF or NF group responded as slowly as subjects in the CF group.

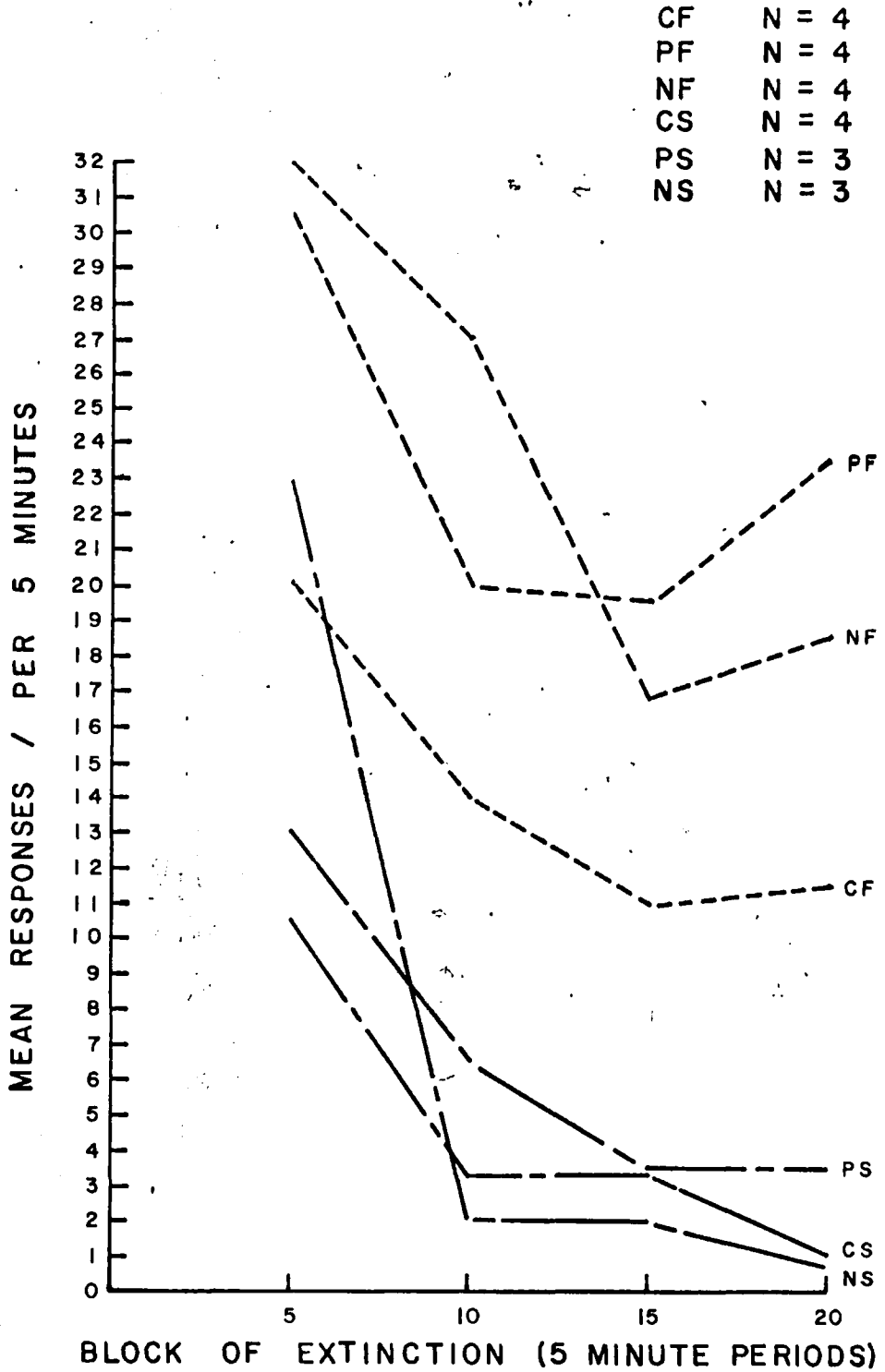
Table 5  
Total Responses during Extinction for Ss  
Previously Reinforced with Food

N	CF	NF	PF
1.	54	75	86
2.	72	106	98
3.	83	142	118
4.	83	147	167

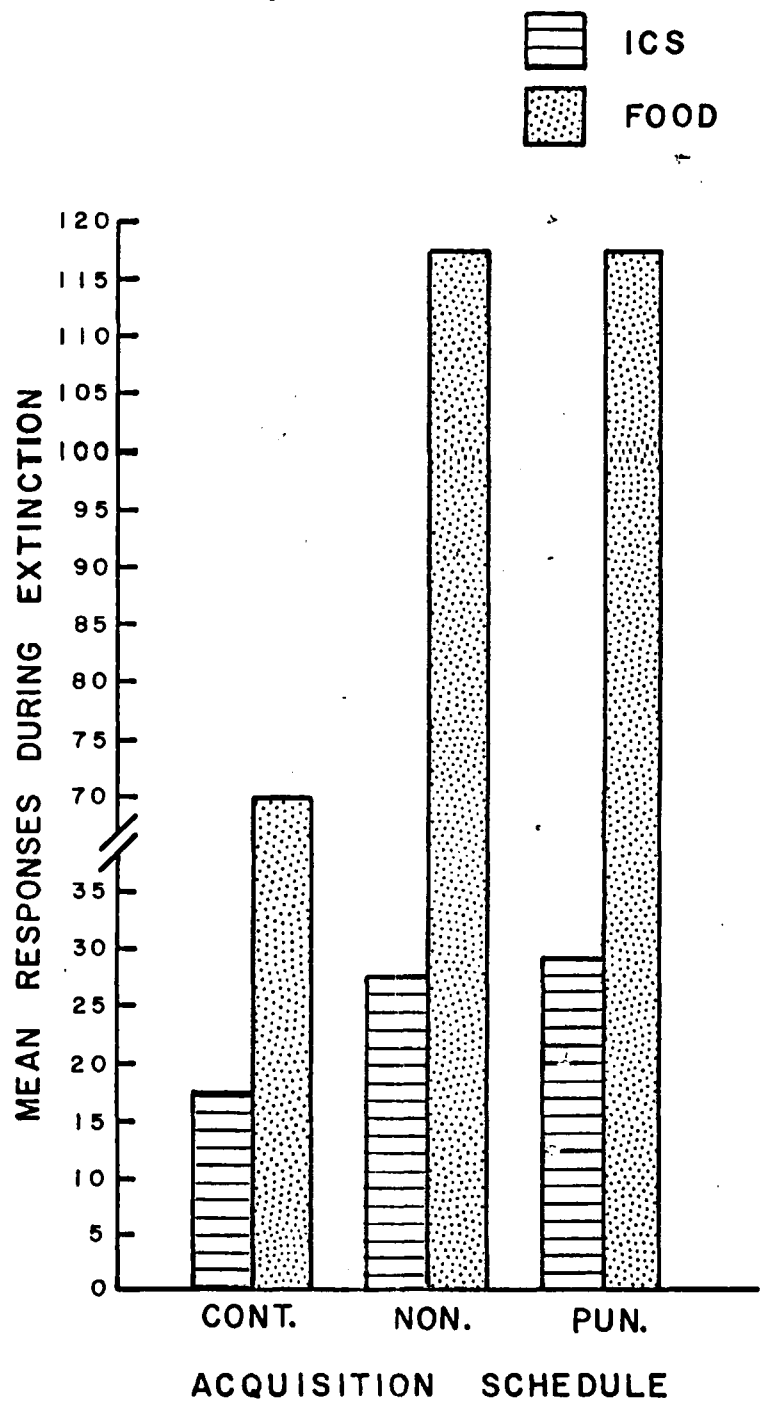
Extinction rates were so rapid for the stimulation groups that it is impossible to determine whether or not punishment and partial reinforcement had an effect on resistance to extinction. If there is any effect on extinction it would have been in the first few minutes of the extinction period, and this study is not designed to get at that data. The rapid extinction of the stimulation groups are in accordance with all extinction data gathered on brain stimulation.

In summary then, it would appear that partial reinforcement and punishment do have similar effects on resistance to extinction when a conventional reward is used as a reinforcer during acquisition. Much more research is needed, however, in order to better determine whether or not there is more than a conceptual similarity between the emotional responses of fear and anticipatory frustration.

III. MEAN RESPONSES PER/5 MINUTE BLOCKS  
OF EXTINCTION PERIODS



IV. MEAN RESPONSES DURING EXTINCTION AS  
A FUNCTION OF ACQUISITION SCHEDULE  
AND TYPE OF REINFORCEMENT



## SUMMARY

The hypothesis that both partial reinforcement and punishment will increase resistance to extinction when food is used as a reinforcer during acquisition, but will have no effect when ICS is used, was investigated.

Subjects were trained to one of three acquisition schedules: 100% reinforcement, 50% reinforcement, or 100% reinforcement plus 50% punishment. Each group was further divided and counter-balanced during acquisition such that half of each group received either food first as a reinforcer or ICS first. The schedule of reinforcement remained constant for each subject.

All groups were extinguished with nonreinforcement. Extinction was measured in terms of number of responses per minute during two extinction periods of ten minutes.

The results confirmed the predictions. Punishment and partial reinforcement increased resistance to extinction when food was used as a reinforcer; there were no differences in extinction rates when ICS had been the reinforcer.

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