CONTRAFREELOADING BEHAVIOR AS A FUNCTION OF DIFFERENTIAL EARLY REARING CONDITIONS

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CONTRAFREELOADING BEHAVIOR AS A FUNCTION

OF DIFFERENTIAL EARLY REARING CONDITIONS

An Abstract

Presented to

the Graduate Council of

Austin Peay State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

Barbara Gene Beighley

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ABSTRACT

Many studies have demonstrated that rats and children, given a choice, will elect to earn a large portion of their intake or reward rather than taking it freely. Other investigators have found evidence to oppose this "contrafreeloading" phenomenon. It has also been noted that subjects raised in enriched early environments perform better in learning tasks than do subjects raised in impoverished conditions.

One purpose of the current study was to determine the authenticity of contrafreeloading behavior. A second consideration was to determine what effects, if any, differential early environments had on such responding.

The findings were that roughly 30 per cent of all the subjects preferred to barpress in the presence of free food. Subjects raised in a deprived environment barpressed significantly more than both enriched and control animals. Results and behavioral observations suggest an increased exploratory drive in enriched animals and to a lesser extent in control animals. On the other hand, deprived animals explored less and showed heightened manipulatory behavior at the bar. Results also suggest a chemical explanation.

CONTRAFREELOADING BEHAVIOR AS A FUNCTION

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A Thesis

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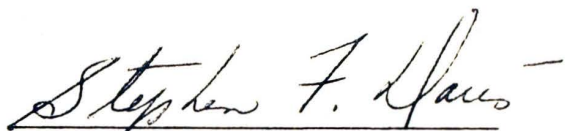of the Requirements for the Degree
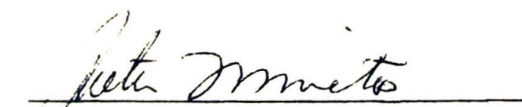
Master of Arts

by

Barbara Gene Beighley

August 1975

To the Graduate Council:

I am submitting herewith a Thesis written by
Barbara Gene Beighley entitled "Contrafreeloading Behavior
as a Function of Differential Early Rearing Conditions."
I recommend that it be accepted in partial fulfillment of the
requirements for the degree of Master of Arts, with a major
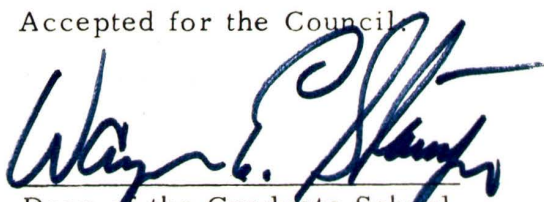in Psychology.

_____
Major Professor

We have read this thesis and
recommend its acceptance:

_____
Minor Professor
or
Second Committee Member

_____
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Accepted for the Council:

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Dean of the Graduate School

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Chapter I

INTRODUCTION

Recently, an increasing number of studies have been reported that support the hypothesis that certain animals prefer to work for reward as opposed to obtaining it freely. Explanations as to why animals will barpress or keypeck in the presence of free food and in which particular circumstances this phenomenon will occur appear myriad. G. D. Jensen (1963) was among the first to demonstrate that rats with a history of continuous reinforcement of barpress responding would obtain much of their food by operant responding even when free food was available in the experimental chamber. He proposed that the operant had an intrinsic appeal to the animals.

On the other hand, Tarte and Snyder (1972) have suggested on the basis of their findings that barpressing in the presence of free food is a function of deprivation. The animals in the longest deprivation group appeared "stimulus bound" to the bar. These investigators also felt that the motor activity at the bar, audio feedback from the microswitch and audio-visual feedback from the dropping pellet might act as secondary reinforcers associated with barpressing.

In contrast with Tarte and Snyder (1972) is the earlier work of Neuringer (1969) which showed that rats and pigeons will respond in the presence of free food and that they need not be deprived in order to do so. Neuringer (1969) cited other support for his view from Skinner (1948) who noted that animals respond even when rewards are not contingent upon specific responses. These findings suggest that the response can serve as its own motivation and therefore, as its own reward.

Alferink, Crossman and Cheney (1973) attempted to explain the "intrinsic appeal" of the operant which Jensen (1963) has cited as the basis for contrafreeloading behavior. With pigeons for subjects it was found that keypecking in the presence of free food can be controlled by the presence or absence of a hopper light. Responding was maintained only when responses produced the hopper light, suggesting that the light functioned as a conditioned reinforcer.

In an effort to explain why subjects will choose to earn a large portion of their intake rather than taking it freely, Carder (1972) offered the following hypothesis: lever pressing may be intimately related to the rats' consummatory response pattern for food since they often manipulate objects in their environment to obtain food. "The leverpress may enable the rat to engage in a more complete, and therefore, preferable, sequence of consummatory behavior than he would by merely eating free food."[1]

In the first of two experiments, Carder (1972) was able to show that rats preferred to press for a solution of sucrose (food), but preferred free water to earned. As another possible explanation he then suggested that perhaps the difference between sucrose and water was not the consummatory pattern, but rather a difference in the quality of the incentive and energy production required to obtain the incentive. Williams (1966) has shown that high quality reinforcers create more behavioral energy than do reinforcers of lower quality and Carder (1972) felt that leverpressing may be one way of discharging this energy.

Related to contrafreeloading behavior is the curious behavior of animals such as those in the Stolz and Lott (1964) study who ran down an alley over a pile of free food to the goal box where they would find a single pellet of food. These investigators marvelled at the persistence of the response after the single pellet in the goal area was removed. These results lend further support to the contra-freeloading phenomenon, especially as the setting was altered from the Skinner Box that has typically been employed.

Devendra Singh (1970) investigated the "preference for working" phenomenon with children and rats as subjects. Findings were that both groups prefer to work even though reinforcement could be obtained with little effort. Focusing on her work with children, it was noted that there were no significant sex differences

in the amounts of reward (marbles) obtained by working. Singh (1970) believes the preference for work shown by children cannot be explained by assuming that barpressing constitutes a problem-solving situation and therefore, is more interesting. She feels it can be safely assumed that by the end of the first day of testing the child would have solved the problem. Singh(1970) cites White's (1959) explanation that behavior is directed toward controlling the environment. Also, Kavanau (1967) suggested that "the most rewarding of several alternative outlets for activity presumably is the one that substitutes best for the spectrum of activity in the wild. However, when outlets are highly restricted, as is usual in laboratory situations, virtually any opportunity to modify environmental variables is exercised repeatedly. . ."[2]

On the other hand, several studies have offered evidence to oppose or show some limitations of the contrafreeloading phenomenon. For example, Koffer and Coulson (1971) demonstrated that at least one animal, the common cat, did not prefer to respond instrumentally for its food. All subjects in this finicky group ate all the free food before responding. The experimenters tried to maximize the probability of the animals obtaining food with the instrumental touch response by placing the animals in the chamber so that they were oriented toward the feeder and the contact plate with their backs to the free food. Koffer and Coulson (1971) put

forth the possible explanation that rats and pigeons forage for their food, usually obtaining small amounts of food periodically, while cats, being predators, usually obtain a large portion of food at one time. Thus, the authors suggest a species-linked interpretation of the cats' preference for free food based on "naturalistic food gathering and consummatory habits."

Another study which exposed a limitation of the contrafree-loading phenomenon was done by George Taylor (1972). He replicated the studies of Carder and Berkowitz (1970) demonstrating that rats prefer earned to free food and the part of Singh's study (1970) which used water as a reinforcer. The data from Taylor's (1972) experiment showed a mild preference for free food on Day 1. Subsequently, there was a steady increase in the preference for free food so that by the end of the experiment, the animals as a group consistently preferred not to work. Only three of the 25 animals (two males and one female) actually preferred to work for their grub. The results of the study using water as a reinforcer supported the notion that animals prefer free water to earned reinforcement. Taylor concluded, ". . . granting that three of the 25 animals in the food setting did prefer to work, the data of the remaining animals and the conclusiveness of the findings in the water setting suggest that, if the preference conclusion of the contrafree-loading phenomenon is sometimes proper, it is a principle that

lacks generality." [3] Other studies have failed to demonstrate the preference for work phenomenon. These include Lambe and Guy (1973) who reported that neither rats nor gerbils preferred to earn their food. Hothersall, Huey and Thatcher (1973) found that hooded rats in the majority of cases preferred to freeload.

Atnip and Hothersall (1973) in order to be sure there was no difference in preference due to strain, replicated the Carder and Berkowitz (1970) study and used albino rats in this instance. Using seven rats and three schedules of reinforcement, continuous reinforcement (CRF) and fixed ratios 2 and 10 (FR 2 and FR 10), the investigators reported that five of the seven animals preferred to freeload and that this tendency increased as the schedules of responding became more demanding, (i. e. , the FR schedules.)

Tarte and Snyder (1973) attempted to explain why some animals prefer to freeload. In a series of experiments they showed that when subjects had had extensive barpress training they would continue to earn most of their food operantly, but that subjects with equal training time in each condition (barpressing and free food) preferred free food. Therefore, these investigators concluded that "prechoice" training was the critical factor. Jensen's (1963) results were similar to these, i. e. , responding in the presence of free food was a function of the number of reinforced prechoice responses.

Powell (1974) believes there is no question concerning the basic authenticity of this phenomenon and conducted a study to evaluate its generality using black rats and crows as his subjects. His results were not statistically significant but he felt they showed that "substantial responding was maintained when the animal could have attained far more than it normally consumed without respond-ing."[4] Powell (1974) endorses an incentive-motivation theory based on contiguity suggested earlier by Bolles (1972) The idea is that an animal will have either learned or innate R-S expectancies as in the case of the pigeon for whom food and pecking have been associated. Now the presentation of food brings about pecking although it is not required by the environment.

The present study is a modification of Tarte, Townsend and Vernon (1973) which was concerned with differential early environ-ments and their effects on barpress responding in the presence of free food. The bulk of evidence appears to support the presence of contrafreeloading behavior although there is sufficient evidence standing in opposition to make this determination a primary concern of the study. Moreover, a substantial number of subjects (27) will be used in this investigation which should yield rather convincing support to one side or the other.

Second, if we are correct in assuming the existence of contrafreeloading responding then another objective of this

experiment will be to clarify the effects that early housing conditions will have on this behavior.

Many studies have been conducted to uncover the effects of an enriched early environment on various behaviors of animals. Forgays and Forgays (1952) were able to show that animals reared in an enriched environment were superior to animals raised in standard cages on the Hebb-Williams test. In addition it was found that the presence of playthings benefitted the animals more than a large open field, although both conditions led to superior problem-solving ability.

Early work by Hebb (1947) on exploratory behavior demonstrated the lasting effect of early experience on problem-solving behavior. Hebb compared the performance of animals under two conditions of deprivation: animals reared with and without vision and between rats reared in small cages and those reared in a wider, richer environment. Both groups with sensory enrichment were clearly superior to the comparable deprived condition.

Hymovitch (1952) elaborated on the work done by Hebb (1947) explaining that the studies were conducted with a small number of subjects and without precise controls. His results concurred with those of Hebb (1947) as to the effects of an enriched early environment, but he was unable to demonstrate a significant difference between the early- and late-blinded subjects.

Bingham and Griffiths (1952) also replicated some of Hebb's (1947) work using larger groups of animals. These investigators raised subjects in differential early environments to determine whether these would have any measurable effects on learning, emotionality, discriminatory behavior, and susceptibility to sound-induced convulsions during adulthood. It was found that subjects raised in enriched conditions were superior in maze-learning; however, no significant differences were noted on the other three factors.

Riesen (1961) reared two chimpanzees in darkness and compared their performance with normal animals on discrimination tasks. He found that the deprived subjects were much slower in avoidance conditioning to a training disc than normals and that form discrimination appeared only after prolonged visual experience.

The effects of experiential deprivation were investigated by Fuller (1967) using several breeds of puppies as subjects. He postulated that behavior deficits seen in dogs after isolation was the result of "stress of emergence." When removed from isolation, the animals were inundated by a variety of unfamiliar stimuli which is assumed to cause an "overload" in the neural systems, according to Fuller. The effect of early experience would serve to habituate the animal to the environment so that it can direct its attention to one or two significant stimuli. The "stress of emergence" hypothesis

is optimistic for deprived subjects, suggesting the possibility of later recovery.

Two important considerations are pointed out by Woods, Fiske and Ruckelshaus (1961) concerning differences between subjects raised in enriched (EC) and deprived (IC) conditions. They question if the superior performance shown by enriched subjects reflects more intelligence and/or maze-solving ability than restricted animals or if the poorer performance of the deprived animals can be explained by an exaggerated exploratory drive. Woods et al (1961) prefer the later explanation on the basis of their findings. Their procedure employed two high drive states (food deprivation and electric shocks) to conflict with and reduce exploratory behavior. Specifically, they found that both high drive groups (EC and IC) made fewer errors than the low drive groups and there were no differences within categories. They quoted Zimardo and Montgomery's (1957) hypothesis ". . . that perhaps the superiority in problem-solving ability for subjects with "rich" early experience . . . may arise as a result of the relatively decreased novelty of the test situation for the free-environment subjects." [5] Therefore, subjects in which the testing situation arouses less exploratory drive (up to a point) should be better learners.

Konrad and Bagshaw (1970) have also concluded that the novelty of the test situation has considerable effect on restrictedly-

reared animals. Their findings were that restricted feline subjects spent less time in play and more in approach and exploring behaviors than did a group of normally reared cats. In a second experiment, it was found that the same restricted animals had larger autonomic responses than the normal subjects. The authors observed that the restricted animals did not struggle while wearing the autonomic measuring apparatus but that the normal or control animals did all through the testing. Konrad and Bagshaw (1970) suggest that, "Confrontation with the procedure when the level of habituation to novel elements is low might produce a state of behavioral passivity . . . while confrontation at higher levels of habituation might leave the subject free to take appropriate action, e. g. , attempt to escape the uncomfortable apparatus."[6]

Another more plausible explanation of the restricted animals' passivity is their _high_ level of habituation to being contained and restricted. Being restricted is novel to the control subjects but not to the restricted ones.

The evidence reported by Konrad and Bagshaw (1970) would seem to support the results of Zimbardo and Montgomery (1957) if the alternate explanation of the animals' passivity is accepted. Zimbardo and Montgomery (1957) found that rats raised in enriched conditions explored less than normally reared animals with normal, female subjects exploring the most. The decreased novelty

of the test setting for the EC subjects should cause them to re-spond less to irrelevant stimuli, thereby reducing any prolonged exploratory behavior.

Krech, Rosenzweig, Bennett and Diamond have authored many studies concerning the effects of enriched environments on various brain measures. Bennett, Rosenzweig, Diamond, Morimoto and Herbert (1974) were particularly interested in the persistence of several cerebral changes, and specifically looked at a group of animals who had been raised in enriched conditions (EC) for either 30 or 80 days and which were subsequently placed in an impover-ished environment (IC). These investigators have found in past experiments a stable measure of EC·IC difference in the ratio of cortex weight to the rest of the brain weight. This was again noted, however the difference was less in animals transferred from EC to IC. Again, as in the past studies, they found acetocholinesterase (AChE) / weight values to be significantly lower in the cortex of the EC animals than in the IC equivalents. This difference was noted in both the EC·EC vs. IC·IC and the EC·IC vs. IC·IC comparisons. The authors felt these two conclusions could be drawn from their results: 1) the differences in cerebral changes brought about by differential early environments begin to dissipate when the animals are placed in a common environment (this case, IC) however, 2) significant differences still exist after the animal has been

removed from the inducing conditions.

Krech, Rosenzweig, and Bennett (1962) have shown significant differences in ability to deal with discrimination reversals between animals raised in EC and IC for 30 days. They have also noted "substantial and significant correlations between two indices (cortical-subcortical ratios of ChE activity and of weight) of brain morphology and biochemistry and the animal's problem-solving ability."[7] However, they believe the CS ratios of cholinesterase activity and weight are not immutably fixed after a 30 day exposure to either kind of environment.

Krech, Rosenzweig and Bennett (1960) employed three levels of environmental complexity comparable to those used in the present study: 1) ECT - an enriched environment with training, 2) SC - social control with three animals per standard cage and 3) IC - isolated control with one animal per cage. These investigators were concerned with chemical measures and found consistent and significant differences of cortical and subcortical ChE activity. The ECT group had the lowest cortical ChE activity: SC an intermediate amount and IC the highest level of activity. The opposite condition occurred in the subcortex. As they conclude, "The more complex the environment, the lower the cortical-subcortical ratio of cholinesterase activity."[8]

The same investigators attempted to isolate what features of the complex environment contributed to the change in ChE activity. They ruled out the effects of handling and locomotor activity as playing any role in the chemical change and pointed out the need for further investigation. Although the present study will not conduct any chemical measures, it is possible the data may yield behavioral correlates of these bio-chemical findings.

The study by Tarte et al (1973) mentioned earlier, predicted that stimulus enriched animals would barpress more than deprived and control subjects. However, their findings were that control animals had the greatest percentage of operant responses and that the EC animals preferred to freeload. Stimulus deprived subjects barpressed least of all the groups. Tarte et al (1973) suggest an inverted U - function in which exploratory behavior is related to the amount of difference between the home environment and the test setting. Control animals, therefore, would have a large exploratory drive due to a large difference in novelty and EC animals would have a lower exploratory drive. However, according to Woods et al (1961) the heightened exploratory drive should result in more errors and poorer performance contrary to what Tarte et al (1973) suggest.

The present study was conducted to clarify the results of the Tarte, Townsend and Vernon (1973) study. One criticism of

this investigation was the small number of subjects in each group

(as few as 2 subjects!). To overcome this possible limitation,

9 subjects will be used in each of 3 groups: stimulus enriched,

stimulus deprived and control. Similar to Tarte et al (1973) one

might expect superior performance on the part of the EC animals

based on the previously reported studies of Hebb (1947), Fuller

(1967), Riesen (1961) and Bennett et al (1974).

Chapter II

METHODS

Subjects

Twenty-seven male albino rats, purchased from the Holtzman Company, Madison, Wisconsin, served as subjects. Twenty days old upon arrival, they were randomly assigned to three equal groups: two experimental groups and one control group.

Apparatus

A 6' x 4' x 1' unpainted plywood box with hardware cloth covering the top and half the floor housed the enriched group (EC). The box was equipped with a sandpile, tunnels, an activity wheel, wooden blocks, balls and colorful plastic playthings. Three water bottles were attached to the wall of the box and food was placed on the floor of the enclosure.

The stimulus deprived (D) group was housed in standard laboratory cages (18 cm x 18 cm x 24 cm) which had been partitioned down the middle with a piece of plywood, thus housing one rat to each compartment. To prevent food manipulation subjects in this group ate ground food from glass-jar containers attached

to the front of the cage. The control animals (Group N) lived in pairs in standard laboratory cages with no restriction.

Testing was conducted in a standard operant-conditioning chamber, 26.67 cm x 23.8125 cm x 26.035 cm, within a sound-masking, ventilated chamber. A Davis Scientific Instruments Pellet Dispenser, Model PD-104, delivered a 45 mg Noyes pellet after each barpress. Free food was available in a dish containing 250 pellets attached to the box on the side opposite the bar.

Procedure

All subjects remained in their respective environments for 63 days, including 11 days of testing. For identification purposes all animals were color-coded. On Day 46, one week before prechoice testing began, the animals were placed on a food-deprivation schedule which permitted them access to food for 45 minutes per day.

The 11-day testing procedure was similar to that employed by Tarte et al (1973) and Carder and Berkowitz (1970) except that the time inside the operant chamber was reduced from one hour to 30 minutes. Free food was available to the subjects on the first three days with the bar removed. During the next six days all subjects were trained to barpress on a CRF schedule and could receive food in the chamber only via the operant. The last two days (choice)

allowed the subjects to either eat freely from the free food dish or barpress to obtain food. The number of pellets taken through each method was recorded. After each daily testing session, the subject was removed to a feeding cage for 45 minutes and then returned to its proper environment. As subjects in Group D were housed individually, they were allowed to eat their daily ration in the home cage.

Chapter III

RESULTS

Figure 1 shows the mean per cent of pellets taken via the bar by each group on the choice days. A repeated measures analysis of variance was performed on these percentage scores. (see Table 1). The results of these analyses indicated a significant difference, $F_{(2, 24)} = 4.95$, $p < .05$, was obtained for the groups factor. An a posteriori comparison of the group means was conducted using the Newman-Keuls procedure. Results of this analysis indicated that group D barpressed significantly ($p < .05$) more than both Groups N and EC, and that there was no significant difference between the last two groups.

Although a significant effect was obtained, the data show that of all the animals, only eight obtained 50 per cent or more of their total intake on the choice days via the bar. This is roughly 30 per cent of the total sample.

The behavioral results of the groups in this study coincide with the chemical measures obtained by Krech et al (1962). The deprived animals in that study showed a high level of cholinesterase activity in the cortex, the control group an intermediate amount and the enriched group had the lowest level. The same ordering of the groups occurred in the present study concerning their barpressing performance.

Chapter IV

DISCUSSION

As has been previously noted, there are many studies (e. g., Jensen, 1963; Singh, 1970; Neuringer, 1969) which have demonstrated contrafreeloading behavior in humans and animals and several investigations which have failed to do so (e. g., Taylor, 1972; Atnip and Hothersall, 1973). The present study, a modification of Tarte et al (1973), was concerned primarily with the effects of differential early environments on contrafreeloading behavior.

The results of this investigation are in conflict with those of Tarte et al (1973). The subjects in the deprived group barpressed most in the present study and least of all the groups in the Tarte et al (1973) investigation. Also, in direct opposition to what Tarte et al (1973) found, no significant difference was found between the enriched and control groups. Indeed, the small number of subjects employed by these investigators must be reiterated.

Moreover, the present results cast some doubt on the explanation offered by Tarte et al (1973) that the difference between the groups in barpress responding is related to the amount of difference between the rearing and the test environments. The present results suggest a negative linear relationship rather than the inverted U proposed by Tarte et al (1973).

Woods et al (1961) have hypothesized that the poorer performance of deprived subjects in various learning tasks is the result of an exaggerated exploratory drive, which causes them to be less selective to relevant cues. It was observed, although not documented, in the present study that the EC animals spent more time exploring, sniffing and rearing in the Skinner Box than did the subjects in Group D. Not only did more D subjects barpress than their EC and N equivalents, they also appeared bound to the bar. Their home environments were completely void of any opportunity for manipulation, including food manipulation. It is possible, therefore, that exploratory drive was low for these subjects and that manipulatory behavior (barpressing) increased as a result.

As mentioned, the present ordering of the groups' barpress performances (D > N > EC) was identical to that obtained by Krech et al (1962) on the cortical cholinesterase measure. No conclusions can be drawn from this bit of information, but it lends evidence to a chemical cause of the differences in performance.

Finally, even though a significant F ratio was obtained on the environment factor, it must be noted that most of the animals in this study preferred to freeload. Taylor's (1972) reservation about the generality of the contrafreeloading phenomenon must be accepted. However, as Powell (1974) points out, one must say

something about those animals who barpressed for a percentage

of their food when it all could have been freely taken.
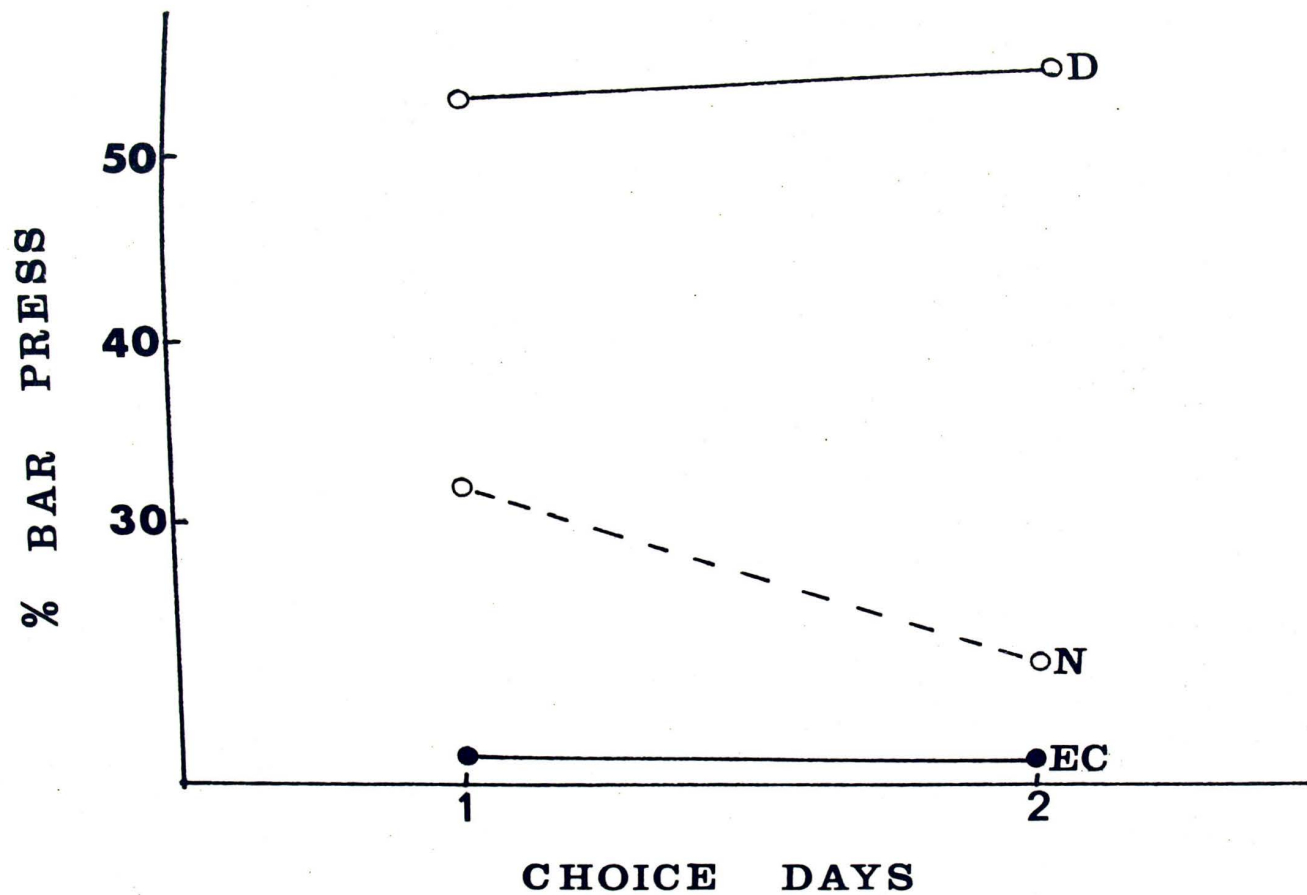
APPENDIX: FIGURE AND TABLES

Figure 1. Mean Percentage of Pellets Taken via the Operant on Choice Days

TABLE 1

Mean Percentage Scores of Pellets Taken Via the Operant

on Choice Days

GROUPS	DAY 10	DAY 11
D	53.33	55.33
N	31.88	22.88
EC	16.88	15.32

TABLE 2

Summary of Percentage Barpress Analysis

Source	SS	df	MS	F
1 Between subjects	47,909.71	np-1=26		
2 A(type of environment)	13,992.926	p-1=2	6996.463	4.9508*
3 Subj w. groups	33,916.28	p(n-1)=24	1413.1783	
4 Within subjects	3,043.5	np(q-1)=27		
5 B(periods of time)	140.166	q-1=1	140.166	1.31685
6 AB	348.85	(p-1)(q-1)=2	174.425	1.6387
7 B x subj w. groups	2,554.56	p(n-1)(q-1)=24	106.44	
8 Total	50,953.21	npq-1=54		

*.01 < p < .05

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