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Age as a Variable Affecting the Protestant Ethic Effect

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AGE AS A VARIABLE
AFFECTING THE PROTESTANT ETHIC EFFECT

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Roger A. Laird

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AGE AS A VARIABLE

AFFECTING THE PROTESTANT ETHIC EFFECT

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AGE AS A VARIABLE

AFFECTING THE PROTESTANT ETHIC EFFECT

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Fourteen female rats divided into three age groups of 110, 160 and 240 days old were compared for amount of barpressing in the Protestant Ethic Effect choice situation. All subjects were maintained on a 23 hour water deprivation schedule and trained to barpress for a 10% sucrose solution. Training consisted of one 12 hour massed practice session then 15 daily training sessions followed by 5 days of testing. During testing the rats were placed in the center of the cage and allowed to obtain the reinforcer from either the drinking tube attached to the barpress mechanism or from an identical free drinking tube introduced at the beginning of testing. The amount of liquid consumed at the free liquid tube and barpress tube was recorded for each animal. A repeated measures analysis of variance showed that barpressing differences between the three groups and across the trials were statistically significant. However, the hypothesis that the younger rats would barpress for more reward than the older

rats was not supported. Older rats barpressed for more reward than the younger rats. It was suggested that the older less active rats may have spent their time barpressing while the active young rats may have spent more time exploring the cage environment.

Chapter 1

Review of the Literature

The term "Protestant Ethic Effect" (PEE) has been used by researchers to refer to an organism's preference to work (usually defined as running a maze, barpressing or manipulating a switch) for reward rather than obtain the same reward without work (e.g., Singh, 1970; Stephens, Metze & Craig, 1974). Generally, the reward used with animals has been food, and the environment has been arranged so that the animal has the option of emitting the motor task (work) for the reward or obtaining the identical reward via a free food dish (freeloading).

Havelka (1956) is generally considered to have been the first to observe the PEE. He trained 50 rats in a goal box with two cross-shaped barriers. By placing food in different angles of the two barriers he offered the rats two alternative routes to the same goal. One alternative offered a maze which contained a direct route to the goal whereas the other was a longer, more complicated path in which the location of the food goal varied from trial to trial. Havelka found that one-third of the rats chose a shorter, more direct route to the fixed goal. One-third chose the longer, more complicated route to the variable goal, and the remainder had no preference. Havelka explained these findings in terms of an intrinsic appeal for problem solving for the rats.

The next researcher to study the PEE was Jensen (1963) who hypothesized that rats may actually prefer to work rather than freeload for food. He trained 200 food deprived rats to barpress for 40, 80, 160, 320, 640, or 1280 reinforced responses to the barpress. Following the training sessions, the rats were placed in a two choice situation where they could eat freely from a food cup or obtain identical food by barpressing. The mean percentage of food obtained by barpressing was 36, 38, 45, 46, 50, and 75 percent, respectively. The amount of free food consumed by the rats was not measured. It was noted that only one of the 200 subjects ate 100% of its food from the free food dish. Jensen found that, in general, an increasing linear function could be used to describe the relationship between the number of rewarded presses during training and the number of pellets obtained by barpressing in the choice situation. That is, the more barpresses the rat made in training to receive food, the more barpresses he was likely to make to obtain food during testing. The results of the study indicated that a definite preference to earn food by barpressing existed. Jensen explained these results in terms of the intrinsic appeal or satisfaction that the rats received for earning the food rather than eating it freely from the food dish.

Instead of using barpressing as the work mode in investigating the PEE as did Jensen (1963), Stolz and Lott (1964) defined work as running to a goal box. Thirty-seven rats were randomly divided into four groups which were given different amounts of training, in an eight foot long straight alley, prior to testing. One group received 22 reinforced trials, a second group received 110 reinforced trials, the third group received 165 reinforced trials and the fourth group received no preliminary training before being placed in the test situation. The test situation consisted of placing a pile of food pellets halfway down a runway in such a manner that the rat would have to run over the pellets in order to obtain the single pellet reward in the goal box. It was found that the rats who were trained prior to the testing situation ran over the pellets in the runway in order to obtain the single pellet reward on significantly more trials than the rats without pretraining. Stolz and Lott concluded that training increases the tendency to go to the goal box but offered no explanation to account for the effects of training.

After several basic studies had been done which supported the existence of the PEE (Havelka, 1956; Jensen, 1963; Stolz & Lott, 1964), researchers began to investigate variables which influence the phenomenon. Variables which have received attention include: prior training (Singh, 1970a; Tarte &

Snyder, 1973), rate of reinforcement (Singh, 1970b), intensity of the work demands (Carder and Berkowitz, 1970), effect of deprivation (Davidson, 1971; Tarte and Snyder, 1972; Chapman, Note 1), secondary reinforcers (Davidson, 1971; Alferink, Crossman & Cheney, 1973) and type of reinforcer (Carder, 1972; Knutson & Carlson, 1973).

Prior training. Singh (1970a) has reported a series of experiments investigating the effect of prior training on the preference for working over freeloading. In investigating this variable, Singh discussed Hull's (1943) concept of habit strength as it related to the prior training received by animals before they are placed in the choice situation. Singh explored the hypothesis that animals may prefer to barpress for food rather than eat from a free food dish when the habit strength for barpressing is higher than the habit strength for eating freely. In order to investigate this hypothesis, Singh devised an apparatus with two chambers. When the work condition was in effect for the animal, a retractable bar was present in one side of the apparatus and when the freeload condition was in effect a free food cup was present in the other side of the apparatus. On a given day rats obtained reinforcement either in the work chamber or in the no-work chamber, but never in both. Thirty rats were given five days of work and five days of freeload training before being placed in the choice situation. Throughout training, the rate of reinforcement on the freeload side was determined by the rate established by the rat on the work side. After training was completed, the divider between the two compartments of the apparatus was removed allowing the rat to move from the work side to the free food side at will. For preference testing, each rat was placed in the middle of the apparatus and the number of times the rat moved from one side to the other as well as the number of reinforcements obtained on each side was recorded. It was found that the rats obtained significantly more food from the work side than from the freeload side. Singh concluded that the concept of habit strength does not account for the animals' preference for barpressing over freeloading since equal amounts of training on both sides were provided.

The variable of prior training investigated by Singh (1970a) has also been investigated by Tarte and Snyder (1973). They hypothesized that the preference for earned food found in earlier studies may have been the result of the training procedure involving massed reinforced barpressing without an opportunity for free food consumption. In an attempt to equalize the amount of time spent in barpress training and free food consumption, six rats were alternately given four days of free food training and four days of barpress training lasting an hour a day for eight days. In the subsequent choice situation in which the animal could either barpress for food or eat from a free food dish filled with 300 pellets, it was found that the rats tended to obtain significantly more food from the free food dish than they did by barpressing. A similar preference for free food instead of earned food was found when the number of pellets obtained during the pre-choice training sessions by freeloading and by barpressing was equalized. The training procedure consisted of alternate days of barpressing on a CRF schedule for 150 pellets or consuming 150 pellets from the free food dish. Tarte and Snyder concluded that the difference between their research and that of Singh (1970a) might be due to the attractiveness of the free food. Singh (1970a) presented the free food pellets one at a time at the rate at which the animal had previously pressed for pellets, whereas Tarte and Snyder presented 300 pellets at one time in a dish.

Rate of reinforcement. Singh (1970b) investigated the possibility that rats preferred to work rather than freeload because they could obtain reinforcement at a faster rate on the work side than on the freeload side. Thirty-two rats were trained in the same two-choice chamber described in Singh (1970a). The rats were trained on a fixed interval schedule in which the first barpress response after a 30 second interval was reinforced. On the freeload side of the chamber, a single pellet was dispensed every 30 seconds. With this procedure, the possibility that the rat could receive reinforcement faster on the work side than on the freeload side was eliminated. All rats received 100 reinforcements on each of 10 days of training, five days on the no work side and five days on the work side. Following four days of preference testing, Singh found that the rats obtained significantly more food by working than by freeloading. In a third experiment, Singh provided free food in both training and testing at a faster rate than the rat could obtain it by working to determine if the preference for working would still be evident. Singh randomly divided the rats into three groups that obtained food on the freeload side at a 12.5, 25 or 50% faster rate than the rate of obtaining reinforcement on the work side. Each rat worked for 100 reinforcements on the work side on a fixed ratio-11 (FR-11) schedule in order to determine its base rate. It was found that the rats in the 12.5 and 25% faster rate of reinforcement groups obtained significantly more reinforcement by working while the rats in the 50% faster group obtained significantly more reinforcement by freeloading. Singh concluded that changing the incentive properties of freeloading altered the preference for barpressing.

Intensity of the work demands. Carder and Berkowitz (1970) explored the possibility that the intensity of the work demands (e.g., the number of presses required to earn a reinforcement) would influence the rats' preference for earned versus free food. Six rats, trained to barpress for food, were placed first on a FR-2 schedule and tested with free food presented in a free food dish filled with 300 pellets and then placed on a FR-10 schedule and tested in the same manner. Carder and Berkowitz found that on the FR-2 schedule the rats preferred to earn a significant amount of their food by barpressing, but when placed on the FR-10 schedule, the rats obtained a significant amount of their food by freeloading. An immediate return to a preference for barpressing was observed when the FR-2 schedule was reintroduced.

Effect of deprivation. The effect of deprivation on the PEE was studied by Davidson (1971) who replicated Carder and Berkowitz's (1970) study. He initially employed a deprivation procedure different from that of Carder and Berkowitz. Rats were maintained at 80% of their initial body weight and trained to press a lever in a choice situation with work demands set at FR-10. Following training the animals were placed in a choice situation. A preference for earned rewards was displayed, with almost all free consumption occurring during "time out" periods when a discrimination cue signaled that the lever was inoperative. After the initial testing session the animal's access to food was limited to one hour daily test session with 23 hour deprivation being otherwise maintained. Preference for earned rewards remained stable through 87 successive sessions. If the rats were fed prior to choice testing, 75% maintained equally high or higher preferences for earned rewards during choice testing. When given continuous access to food, 50% maintained equally high or higher preference for earned rewards during choice testing. Differences in initial deprivation methodology between Davidson's study and that of Carder and Berkowitz may have been an influential factor accounting for the discrepancies between the results of the two studies. Carder and Berkowitz, using timed deprivation, found that animals lost their preference for earned rewards at FR-10 while in Davidson's study, which used percentage body weight, the animals preferred earned rewards at FR-10.

Tarte and Snyder (1972), in a study using time deprivation, hypothesized that preference for barpressing was directly related to the number of hours of deprivation before being placed in the choice situation. In the training procedure, 28 rats were allowed to consume free food from a dish for three, daily one-hour sessions before being trained to press the bar for food in six, daily one-hour sessions. After the initial training, the rats were divided into seven groups and food deprived for 1, 12, 24, 36, 48, 72 or 92 hours before being placed in the test situation. Tarte and Snyder found that in general the longer the rat was deprived of food, the more food it obtained by barpressing rather than eating it freely from a dish.

Chapman (Note 1), in a study of the effects of deprivation techniques on body weight and propensity to perform an operant, divided 18 rats into equal groups which received three different food deprivation procedures: 23 hour deprivation, maintenace at 80% of pre-experimental weights, or fixed daily food allotments of 10 grams. The rats were then given two training sessions with an earned food source by pressing a lever. Following three days of choice testing Chapman found no significant differences between groups and concluded that deprivation methodology does not appear to be a significant factor influencing a rat's preference for earned rewards over identical free rewards.

Secondary reinforcers. The secondary reinforcing power of a light stimulus was investigated by Davidson (1971). Four rats were trained to barpress for food on a FR-10 schedule of reinforcement for 56 sessions. When the light in the chamber was on, pressing the lever produced food on the fixed ratio schedule. When the light was out, lever pressing did not produce a reinforcement. After 56 training sessions, free food was introduced into the chamber. The results indicated that the animals ate free food during time out when the light was out but, when the light was on, the rats continued to barpress for food. Davidson concluded that barpressing for food was under the control of the conditioned reinforcer in this situation and was not due to the intrinsic appeal of the barpress operant as suggested by Jensen (1963).

Alferink, Crossman and Cheney (1973), using pigeons as subjects, found results which supported Davidson's conclusion that the PEE was influenced by secondary reinforcers. In this study, two pigeons were trained to peck on a FR-300 schedule of reinforcement. After 300 pecks on the disk, the key went dark, the hopper light came on, and the food hopper opened up to give the pigeon access to free food for three seconds. With continuous access to free food from the hopper, the pigeons continued to peck the lighted key for food but at a slower rate. When the hopper light was no longer presented after the completion of the FR-300 schedule, the pigeons no longer responded on the schedule but ate the free food. Alferink et al. concluded that the hopper light was a conditioned reinforcer which controlled the responding of the pigeons in the presence of free food.

Type of reinforcer. Carder (1972) investigated the effect of type of reinforcer on the PEE by using both water and food as reinforcers. In this study, eight food deprived rats were trained to barpress for a 10% sucrose solution (food) and six water deprived rats were trained to barpress for water. The subjects in both groups were then placed in a test situation where they had free access to a 10% sucrose solution. The results indicated that the rats deprived of food earned 83% of their total consumption by barpressing while the rats deprived of water earned only 26% of their total water intake by barpressing. In order to test the hypothesis that sucrose was an incentive of higher quality than water, Carder conducted a second experiment in which the sucrose solutions, both earned and free, were adulterated with increasing concentrations of quinine. The same rats used in experiment 1 were given 3 days of barpress training for a sucrose solution containing 60 mg/liter of quinine sulphate. They then received 2 days of choice testing in the presence of a free tube, which contained the same adulterated solution. Following this, the quinine concentration was doubled and the cycle repeated until a level of 960 mg/liter was reached. Results indicated that the quinine adulteration reduced the preference for the earned solution to below their initial level for the 10% sucrose solution. Carder concluded that the differences between food and water reinforcers in maintaining responding in the presence of a free reinforcer may be a difference in quality and in energy production.

In contrast to the Carder (1972) study in which the results suggested differential effects in responding due to the type of reinforcer, Knutson and Carlson (1973) found that both groups preferred to work for the reinforcement in the presence of free reinforcement. In this study, the researchers randomly divided 12 rats into two groups. One group was trained to press the bar for access to water from a dipper. Before being placed in the choice situation, both groups were given five daily 30 minute sessions of CRF with free access to the reinforcer during the last two sessions. The results indicated that both groups preferred to work for the reinforcement in the presence of free reinforcement.

Age of the animals as a variable affecting PEE. The PEE studies reviewed have investigated a variety of variables which affect the PEE. However, one variable, age of the rats, has been ignored. Several authors failed to report the age of the rats used in their studies, (Carder, 1972; Neuringer, 1969; Tarte & Snyder, 1972). Most of the other studies used rats in two general age groups, 90-110 days old, (Carder & Berkowitz, 1970; Havelka, 1956; Singh, 1970; Stolz & Lott, 1964), and 180 days old, (Stephens, Metze & Craig, 1975; Tarte & Snyder, 1973). Jensen (1963) reported using rats 68-148 days old, but did not report any age-related results. While a number of studies reviewed did not report the ages of rats in their experiments, the body of the PEE literature rests upon a rather narrow age range, that of mature-young rats from approximately 90 to 180 days old. The PEE seems to occur consistently in this age category, and the researchers apparently consider this age category to be representative of all rats in general. However, recent studies (Valle, 1971; Bronstein, 1972; Goodrick, 1971) have shown age differences in the behavior of rats.

Valle (1971) studied the rat's performance in an open field as a function of age. Thirty-six rats, ages 50, 90, and 150 days old, were placed individually in an open field for 10 5-minute tests. The open field was a square white board 1.22 meters on a side, divided by black lines into 16 equal squares. The results showed a decrement in activity as age increased. Group 50 was more active than both Group 90 ($p < .05$) and Group 150 ($p < .01$), and that Group 90, in turn, was significantly more active than Group 150 ($p < .01$). Valle also found that following an initial decrement in activity over the first two blocks of tests, Groups 50 and 90 showed an increment in activity over the last three blocks of tests, whereas Group 150 failed to show a recovery in activity following the initial decrement. Valle concluded that rats show decreasing amounts of locomotor activity from 50 to 90 to 150 days of age and that older rats show more of a decrement in locomotion as a function of repeated tests than do younger rats.

Bronstein (1972) in two experiments published together found two age-related patterns of adaptation to a novel environment. In the first experiment 13 female albino rats 31, 40, 70, and 110 days old were placed in an open field painted flat black except for white lines that divided the floor into 16 squares. Each animal was placed in a corner of the open field, facing into that corner, and the number of squares entered was recorded. Results showed a daily increase in activity among the animals in the two younger age groups, while the animals placed in the apparatus when 70 or 110 days old failed to show any daily activity increments. Bronstein suggested that between the ages of 40 and 70 days some process of maturation occurs which results in a different type of adaptation to novel environments. In the second experiment Bronstein (1972) conducted a longitudinal study of activity in rats. He hypothesized that older subjects simply require more apparatus experience than the juveniles prior to displaying an activity increment. Two groups of female rats, 30 and 110 days old, were handled for 10 days and tested on the same apparatus described in experiment 1. They received daily 5-minute exposure to the test situation for 60 consecutive days. The results showed the juveniles to be significantly more active than the adults. The juveniles increased their daily activity significantly during the first 30 trials, following which they maintained their high level of activity over the next 30 days. At no time during the 60 trials did the adults show increases in activity. Bronstein suggests that younger mammals are more curious than adults and react to moderately increased stimulus novelty by approach or exploratory behavior, while older subjects tend to withdraw from more novel stimuli.

Goodrick (1971), in a series of four experiments, investigated age differences of rats as a function of test complexity and found no significant age differences between groups of 6 and 27 months old rats tested in a straight runway and one choice and four choice mazes. In the first experiment two groups of female rats 8 and 27 months old ran a straight runway to obtain a (condensed milk-10 mg. sucrose/100 ml) reward solution. Age differences for four timed trials each day on four consecutive days were not statistically significant. To slightly increase test complexity over experiment 1, Goodrick in experiment 2 ran 16 rats, 8 and 27 months old, in a T-maze for the same reward solution defined above (Goodrick, 1971). On the initial trial both goal chambers contained the reward solution. The initial choice chamber was correct on all subsequent trials with an empty container in the alternate goal chamber. Five trials on each of four consecutive days showed no significant age differences in the time to reach the reward solution. In the third experiment Goodrick increased the test complexity to four 4-choice maze problems. Twenty rats 8 and 27 months old ran four trials in a maze problem for four consecutive days to obtain the same milk reward described above. A different problem was randomly assigned on each day. Results showed that the only significant difference between the groups occurred during trial 1 of series 4. Goodrick concluded that this one difference could not be directly attributed to age differences. In the fourth experiment a 14-unit T-maze was used to represent a very complex test situation to study age differences in rats. Sixteen rats 6 and 26 months old were tested for one trial daily in the 14-unit maze for 20 trials. Results showed that on the initial trials, differences (in mean errors and time to run the maze) between mature-young and aged groups were not statistically significant. On trials 16 to 20 mature-young rats made significantly fewer errors and also had lower time scores than aged rats. Mature-young rats made perseverative errors on 47.1% of the possible occasions.

Chapter 2

Statement of the Problem

Many of the studies of the PEE have not reported the age of the subjects used. All but one study (by Jensen, 1963, who did not analyze the data for age differences) reported ages for subjects within the 90 to 180 day range. This is a narrow age range from which to generalize findings for rats of all ages. Rats older or younger than the above age range could respond differently to the PEE choice situation because of activity differences associated with age. Recent studies by Valle (1971), Bronstein (1972), and Goodrick (1971) indicate that age differences affect a variety of behaviors in rats (e.g., activity, exploratory, learning). It is reasonable to expect that these age differences will affect PEE behavior.

Generalizing from these studies (Bronstein, 1972; Goodrick, 1971; Valle, 1971) it is reasonable to assume that age differences will affect the PEE. The purpose of the present study was to determine if age differences affect the PEE in rats. Specifically, the dependent variable examined in this study was the percent of total reinforcer earned by barpressing (work), and the independent variable was the age of the rat. There were three levels of the independent variable, i.e., three groups of rats 110, 160 and 240 days old. It is hypothesized that the younger rats, which have higher activity and exploratory levels, will work for more of the reinforcer than the older rats.

Chapter 3

Method

Subjects

Fifteen experimentally naive female rats from the Western Kentucky University animal colony were used as subjects. The animals chosen represented the widest age range available at the time this study was conducted. The animals were 110, 160 and 240 days old at the beginning of training. One animal died during the training sessions, leaving a total sample of 14. Subjects were placed on a 23 hour water deprivation schedule for seven days prior to training and were maintained on the deprivation schedule throughout the training and testing sessions.

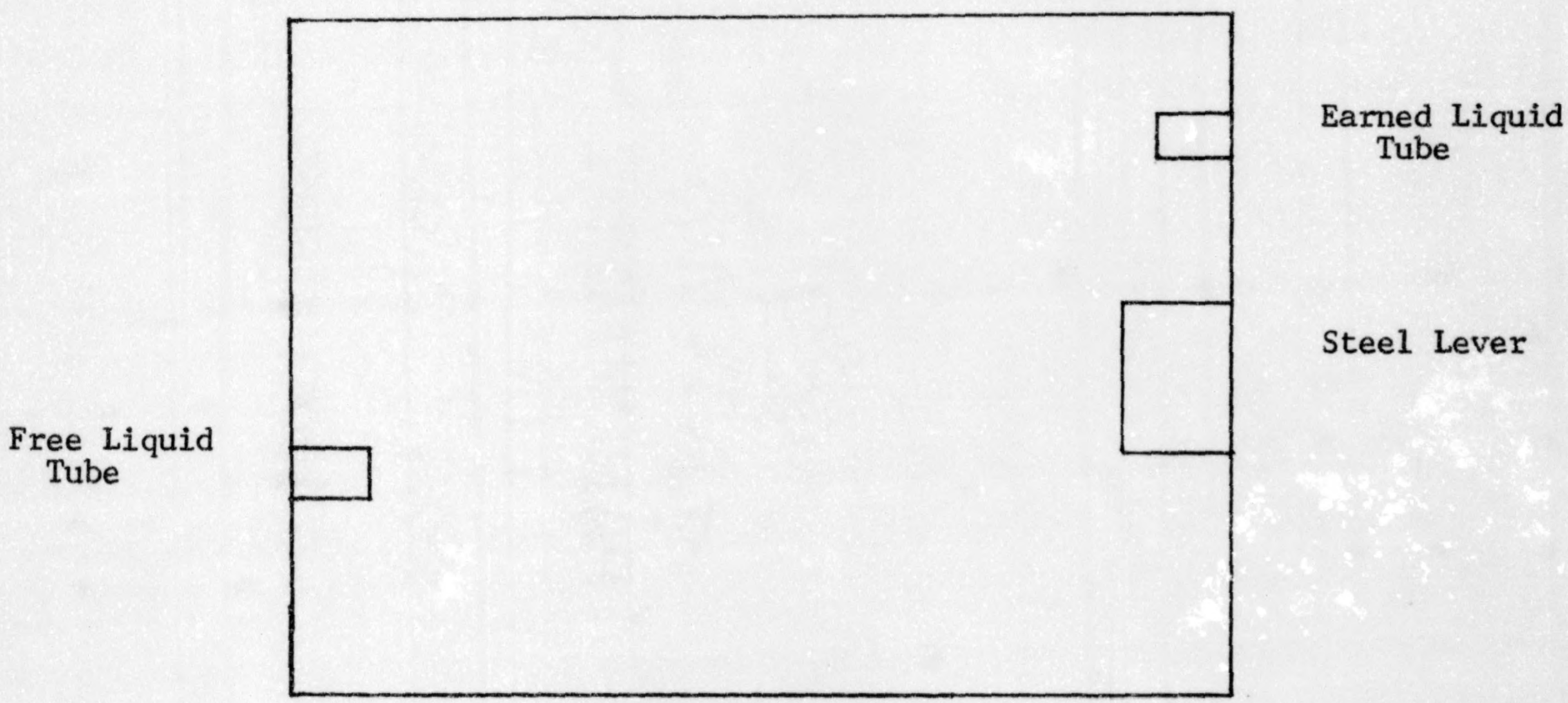
Apparatus

Four cages (21.0 cm x 25.0 cm) were used as the training and testing environment. A steel lever 5.0 cm wide projected 1.8 cm through the rear wall 5.0 cm from the floor of the cage (see Figure 1 for location). The steel lever released 1.0 cc of a 10% sucrose (1000 ml water/100g sugar) solution from a drinking tube extending through the rear wall of the cage. The drinking tube was located 13.5 cm from the top of the cage and 3.8 cm from the left hand wall of the cage.

Figure 1

Experimental Training and Testing Chamber

Indicating Location of All Apparatus Introduced to Subjects



During choice testing, an identical drinking tube was extended through the front wall of the cage and freely dispensed the sucrose solution from a large reservoir. Subjects remained in their home cages except for barpress training and choice testing.

Design

A factorial design representing one repeated measure and one between subjects variable was used in the study. The between subjects variable was age. The repeated variable was days of choice testing. The percent of total liquid earned by barpressing was measured under these conditions.

Procedure

All animals received one 12 hour massed practice session, prior to 15 daily 15 minute training sessions. For two rats in the initial massed practice session the bar was non-operative; therefore, they were given a second 12 hour practice session. During the shaping and training sessions the animals received continuous reinforcement for barpressing. During shaping and training the free liquid tube was not present. Each animal was allowed 30 minute access to water in its home cage following all training and choice testing sessions. Following the training sessions five daily 15 minute choice testing sessions were conducted. During choice testing, the free liquid tube was present and functioning. The amount of liquid earned by working and by free-loading was recorded at the end of each trial. Cages were counterbalanced during training and testing.

Chapter 4

Results

Barpressing differences among the groups on the last day of training were analyzed in order to ascertain whether the subsequent effects were due to training. There were no statistical differences in barpressing among the groups at the end of training. The percent of total liquid earned by barpressing for the five test sessions was analyzed by an analysis of variance and is summarized in Table 1. The data are graphically represented in Figure 2. There was a significant interaction between groups and trials, $\underline{F}$ (8,50) = 2.22, $P < .05$. The interaction was due to the fact that barpressing for Groups 240 and 160 increased on trial 2 then fell off on trials 3, 4 and 5 while barpressing for Group 110 fell off on trials 2, 3 and 4 then increased on trial 5. The number of barpresses averaged across all age groups increased on trial 2 but fell off on trials 3, 4 and 5 and was reflected in a significant trials effect, $\underline{F}$ (4,50) = 6.04, $P < .001$. Barpressing differences between the three groups were significant, $\underline{F}$ (2,11) = 9.11, $P < .005$, with Groups 110, 160 and 240 barpressing for 19, 37 and 47%, respectively, of their total liquid consumption. It appears that as age increased barpressing increased also.

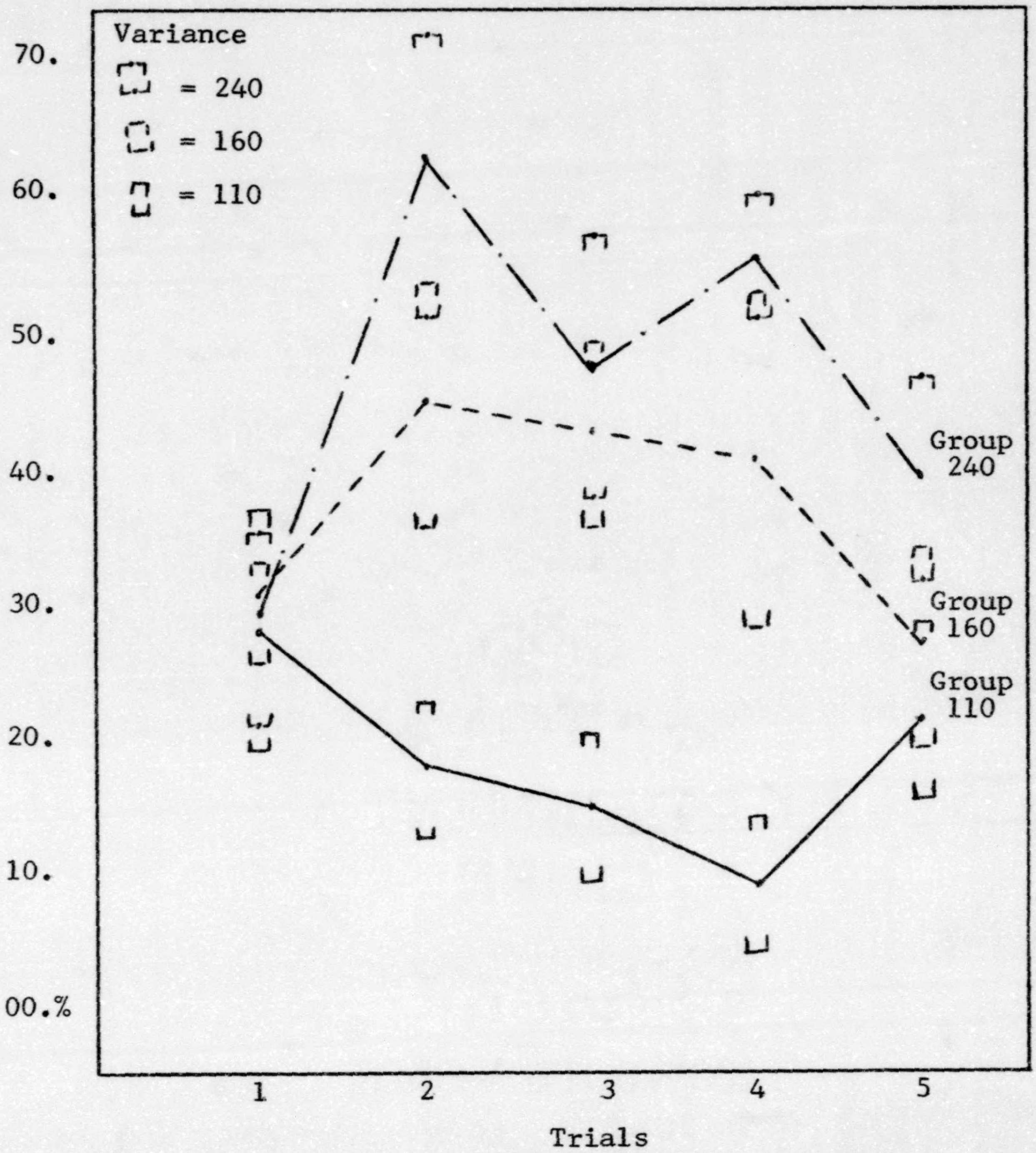
Table 1

Summary Table of

Analysis of Variance

Source	SS	df	ms	F
Age	109040.7	2	54520.4	9.11(.005)
Error	65895.3	11	5987.2	----
Trials	93452.6	4	46726.3	6.04(.001)
Trials X Age	68654.1	8	17163.5	2.22(.050)
Error	386607.3	50	7732.1	----
Total	723650.0	69	----	----

Figure 2



Percent of Total Liquid Earned by Barpressing

Chapter 5

Discussion

While barpressing differences among the three groups were significant, the pattern was different than predicted. It was hypothesized that in the PEE choice situation younger rats would barpress more than the older rats. The results obtained were in the opposite direction from that which was hypothesized. The older rats barpressed for significantly more reward than did the younger rats. Differences in the rate of barpressing over the five days of testing, as well as the interaction effect, were not hypothesized. These results seem to be in conflict with the findings of activity studies previously reviewed (Goodrick, 1971; Valle, 1971; Bronstein, 1972); however, the differences may simply be a matter of definition.

In the present study, activity was defined as barpressing (a goal-directed behavior) which may be only indirectly related to activity defined as open field behavior (a non-goal-directed behavior) commonly reported in the literature (e.g., Goodrick, 1971; Valle, 1971; Bronstein, 1972). An activity study usually employs an open field or a maze as the test environment. In these environments, activity has been defined as distance traveled in the open field or time to reach the goal in a maze. Rats that are active in an open field may not spend their time barpressing simply because they are involved in exploring the cage environment. Although activity is high, barpressing may not be a frequent behavior. High non-goal-directed activity may be detrimental to the PEE choice situation. If this argument is true, then the results of the present study can be construed as consistent with the literature concerning activity in rats. The older rats may have spent more time barpressing and less time exploring than the middle age group which could have in turn spent more time barpressing and less time exploring than the younger rats who spent the least amount of time barpressing of all groups. This possibility could be investigated by replicating the present study and directly measuring the activity of the rats while in the testing cage. By dividing the floor of the test cage into a grid, the number of squares crossed by each rat during choice testing could be measured as an index of locomotion. In addition to measuring locomotion, other responses such as rearing and degree of wall hugging might also be sensitive indices of rats' open field behavior.

By using various measures of locomotion investigators in early studies of open field behavior (e.g., Furchgott, Wechkin & Dees, 1961; Goodrick, 1965, 1966, 1967; Werboff & Havlena, 1962) found that a linear decrease in activity with increasing age is a consistent pattern in rats. These age differences were interpreted (Goodrick, 1968) in terms of the responsiveness of the sympathetic nervous system. Old rats were considered less reactive than young rats to their environment and therefore would explore less than young rats. The young rats being more active in their environment may have spent less time barpressing than older less active rats.

The present study uses the terms old and young rats only in a limited sense. The age range was rather narrow. The youngest rats used in this study were as old as the oldest ones used in some other studies (Bronstein, 1972). In future studies on the relationship between age and activity, it would be advantageous to use a wider age range to fully explore the variable. However, even the narrow age range used in the present study was found to be related to barpressing behavior in the rats.

Previous studies of the PEE have not analyzed the relationship between barpressing and age. In reviewing studies on the PEE it seems likely that age related activities may partially account for barpressing differences between the studies by Stephens, Metze and Craig (1975) and Jensen (1963). In the study by Stephens et al., seven of eight rats, 180 days old, worked for more than 50% of the pellets they consumed while Jensen, using rats from 68-148 days old, found that only 88 out of 200 worked for more than 50% of their pellets consumed. Davidson's (1971) failure to obtain identical results to those of Carder and Berkowitz (1970 in his replication of their study also may have been related to age differences. While Davidson does not report ages of the rats used in his study, if Carder and Berkowitz used rats of a different age range, age differences in the activity of rats (as found in the present study) could account for the different findings of the two studies.

One way of studying the differences in barpressing among PEE studies would be by replicating those studies using different age groups of rats. Such replications could be expanded to study the effect of adaptation on activity levels for different aged rats. Various age groups of rats could receive extended testing in the PEE choice situation. Across a large number of trials, adaptation to the testing environment may affect barpressing in such a way that significant differences between age groups may disappear.

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