THE EFFECTS OF ESCAPABLE AND INESCAPABLE SHOCK ADMINISTERED IN INFANCY UPON ADULT T-MAZE PERFORMANCE

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ABSTRACT

This study was conducted to test the hypotheses (a) that an inverse monotonic relationship exists between amount of stimulation in infancy and adult emotional reactivity and (b) that escapable shock administered in infancy is more stressful than inescapable shock administered in infancy.

Four groups of animals were used. One group received a minimum amount of stimulation in infancy, a second group received daily handling in infancy, a third group received handling and inescapable shock daily in infancy, and the fourth group received handling and escapable shock daily during infancy. Adult emotional reactivity was inferred from adult T-maze performance on an original task and from three consecutive reversal tasks.

The results did not support the hypothesis that adult emotional reactivity is inversely related to the amount of infantile stimulation, or the hypothesis that adult emotional reactivity resulting from inescapable infantile stimulation is greater than adult emotional reactivity resulting from escapable infantile stimulation.

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CHAPTER I

INTRODUCTION

Statement of the Problem

The purpose of this thesis was to vary escapable and inescapable stress in infancy and to determine its effect on adult emotional reactivity in the guinea pig. An additional objective of this study was to minimize transfer effects from the early experience situation to the adult test situation.

Of the few studies concerned with the effects of escapable and inescapable stressors administered in infancy the majority have failed to demonstrate any differential effects of these two forms of stress on emotional reactivity measured in adulthood. It is possible that any actual differences that might have existed were masked by the use of inadequate experimental designs and/or by the methods employed in these studies. For example, Gauron (1964) exposed infant rats of two strains to two types of infantile stimulation, either escapable or inescapable shock. A control group of animals was left undisturbed in infancy. Whether or not the treatment had an effect and the nature of this effect depended on the strain of the animal. Tegart (1966) criticized this study on two methodological points; first, the two shock groups received differing amounts of infantile shock, and second, both groups receiving shock were handled in infancy while the control group was not, making it difficult to conclude whether differences between shocked and control animals were due to shock or to handling.

Stanley and Monkman (1956), using mice, found no evidence for any general emotional or traumatizing effect of either escapable or inescapable infantile shock stimulation. It is possible that transfer effects from the early experience to the adult tests might have occurred as suggested by the authors. Furthermore, this study lacked a non-handled control group and it is possible that the effect of handling masked the effect of the experimental treatments since it had been demonstrated by Levine (1956) and Levine, Chevalier, & Korchin (1956) that handling of infant rodents, such as placing them in a box for as little as three minutes daily, affects adult emotionality.

Recently, Tegart (1966), using guinea pigs, varied escapable and inescapable shock in infancy and failed to demonstrate any difference in emotional reactivity as measured by adult avoidance conditioning performance and heart rate change in response to a conditioned aversive stimulus. The failure to demonstrate any differences in heart rate change between any of the groups was attributed to difficulties encountered in the technique used to obtain these measures. One explanation for the failure of avoidance conditioning performance to show any significant differences between the escapable and inescapable groups is the possibility that transfer effects between the early experience situation (a runway) and the adult testing situation occurred, masking any real differences between the infant shock groups that might have existed. For the escapable shock animals, locomotor activity was reinforced in infancy, by the termination of shock. If this infantile learning transferred to the adult shuttle avoidance conditioning situation, then this would tend to reduce response latency thereby facilitating the escapable group's performance. The low predicted performance of the escapable shock animals would then be better than expected, reducing the predicted difference between the shocked groups.

Historical Background

The deterministic viewpoint that early experience determines adult behavior was emphasized by Freud (1935), when he suggested that neurosis stems from traumatic experiences early in life. But not until the publication of D.O. Hebb's Organization of Behavior in 1949 did the effects of early experience come under extensive experimental investigation.

The term "early experience" (EE) has been used to denote a wide variety of experimental treatments administered before or shortly after weaning. Treatments administered after birth and prior to weaning have commonly been termed "infantile" stimulation. The types of stimulation used in this area of research have been classified as either physical (mechanical) or environmental (non-mechanical). Environmental treatments include varying litter size, exposure to enriched and deprived environments, and separation from the mother. Physical treatments would include electric shock, handling, and temperature variation.

The earliest studies concerned with the effects of EE on adult emotionality were done by Hall and Whiteman (1951) and Griffiths and Stringer (1952). Hall and Whiteman (1951), using infant mice, exposed one group to a high frequency bell. A control group received the same handling but were not exposed to the sound of the buzzer. At thirty days of age, the behavior of the two groups in an open-field test was compared. The experimental group had a higher defication rate and showed less locomotor activity. The authors concluded that the early stimulation treatment produced emotional instability in the adult mouse. Griffiths and Stringer (1952) exposed groups of rats during the first twenty-one days of life to either intense sound, electric shock, extreme temperatures, or rotation.

When compared with an unspecified control group on the Hall open-field test no differences were found. Contrary to the study by Hall & Whiteman (1951), the authors concluded that infantile experience did not decrease emotional stability. Neither of these studies included a non-treated control group. Furthermore, species differences might account for the apparent conflicting reports since one study used mice and other rats.

Levine, Chevalier, & Korchin (1956) carried out a study in which rats during the first twenty days of life were either shocked, handled, or ignored. The non-treated control animals performed significantly poorer than the two groups which had received stimulation in infancy, when tested in adulthood on avoidance conditioning. The authors interpreted the results as indicating that the non-stimulated animals were more susceptible to emotional disturbance which interferred with performance, or conversely, that the animals stressed in infancy were less emotionally reactive.

Two studies by Levine (1957, 1958) using amount of decrement in water consumption as an index of emotional reactivity led to further support of the hypothesis that adult emotional reactivity is inversely related to increasing infantile stimulation. In these two studies Levine handled, shocked or did not disturb rats between birth and weaning. The purpose of the first study was to determine the effects of infantile experience upon consummatory behavior before and after water deprivation. In adulthood there were no differences in water intake prior to deprivation, but the non-handled control drank less following the 18 hr. of deprivation. In the second study, rats shocked or handled in infancy showed less decrement in water consumption following electric shock in adulthood than non-handled animals. Levine (1958) interpreted his results as showing that the absence of extrinsic stimulation in infancy renders the non-handled animals more susceptable to emotional disturbance than the handled or shocked groups. It should be noted that noxious stimuli (water deprivation or shock) only temporarily creates emotional disturbance which affects drinking behavior (Levine 1958). Furthermore, Lindolm (1962) found that white rats shocked in infancy took significantly less time to initiate drinking, and that the differences in consummatory behavior could all be attributed to the latency to approach the water tubes. Levine's two studies (1957, 1958) did not show significant differences between the handled animals and the handled plus shock animals and, therefore, only partially supported the hypothesis that adult emotional reactivity is inversely related to increasing infantile stimulation.

Denenberg and his co-workers found evidence of decreased emotionality as a result of intense stimulation in infancy on a number of behavioral measures such as conditioned emotional responses in mice (Denenberg 1958), avoidance conditioning (Denenberg 1962), and open-field tests (Denenberg & Smith 1963). Evidence of decreased reaction to stress as a function of infantile stimulation has also been found in a number of physiologically related measures such as weight gain (Denenberg & Karas, 1959), and mortality (Denenberg & Karas, 1961; Levine & Otis, 1958). Some of these studies will be discussed in greater detail later.

The finding of decreased emotionality as a result of stressful stimulation has not gone unchallenged, as was pointed out by Tegart (1966). Levine (1962b) indicated that rats and mice stimulated in infancy may have greater, more immediate, physiological response to acute stress. The studies mentioned previously, involving physiologically related measures, dealt with reactions to chronic stress such as food deprivation or immobilization as adults. Lindzey, Lykken, and Winston (1960) reported increased emotionality in mice that were stimulated in infancy. This study and others which did not use an appropriate non-treated control group have since come under severe criticism (Denenberg, 1961; Levine, 1961). King & Eleftheriou (1959) and Gauron (1964) have also noted increases in emotionality as a result of stimulation during infancy.

These apparently conflicting reports may be due to the lack of parametric studies varying noxious stimulation in infancy. There are several studies (King & Eleftheriou, 1959; Lindzey, Lykken, & Winston, 1960; Levine & Wetzel, 1963; and Gauron 1964) which suggest that genetic factors may determine the eventual effect of infantile stimulation. A review of the literature indicates that there are several other factors which may influence the effects of early stimulation and which could explain conflicting reports.

Denenberg (1959) and Denenberg & Bell (1960) found that the intensity of stimulation in infancy was a relevant factor. The first study investigated the interactive effects of electric shock during infancy and adulthood upon avoidance conditioning. A significant interaction was found between infantile and adult shock levels indicating that early experience does not act in a simple additive manner but is partially dependent upon the characteristics of the adult testing situation. Denenberg & Bell (1960) found that the amount of shock given during infancy and adulthood, and the age at which shock occurred, were all found to have effects upon adult performances.

Stimulation during infancy facilitated performances at low adult drive level (shock intensity), but depressed performance at the high drive level.

The context in which the animal encounters the stressor is another possible factor. Stanley & Mondman (1956) hypothesized that the anxiety or emotional reaction of an animal to electric shock would be greater under conditions of arbitrary shock than under conditions which allowed the animal to terminate the shock by making an operant response. Mice were given one of three infantile treatments, stimulation with shock which the animal could terminate by crawling to the safe side of the apparatus (the response contingent group); stimulation with shock matched in duration to that received by the response contingent group; exposure to the shock apparatus for matched durations of time without shock. A non-handled control group was not used. An open field test of emotionality at 45 days revealed no differences in excretory behavior. Avoidance learning tests showed that the response contingent group had faster running times, which the authors attributed to infantile learning and concluded that no differences in emotionality existed.

Tegart (1966) used the same groups as the Stanley & Monkman (1956) study with the addition of a non-handled control group. In avoidance conditioning, the escapable and inescapable shock animals performed better than the non-handled control animals, but no differences were found between the inescapable and escapable shock groups. As mentioned earlier the possibility exists that as a result of infantile learning by the escapable shock animals, performance on avoidance conditioning would be facilitated and would result in better performance than that predicted. This would have the effect of eliminating the predicted difference in performance between escapable and inescapable shock groups which might otherwise have existed.

A study by Brady (1958) suggests, contrary to Stanley & Monkman's (1956) hypothesis, that avoidance training may increase the amount of stress for the animal required to make an operant response to terminate or avoid shock. This study consisted of two monkeys in "yoked" chairs, the "executive" monkey could prevent shocks to himself and his partner by pressing the lever. Both monkeys were thus subjected to the same physical stress, but only the "executive" monkey was under the psychological stress of having to press the lever to terminate or avoid shock. The executive monkey developed ulcers, the control did not. A second experiment using precisely the same procedure produced much the same results. This group difference was also found to be a function of the schedule of experimental and rest periods and has yet to be replicated.

Denenberg's (1964b) study in which rats were used as Ss adds support to the hypothesis that interacting with the environment to avoid the stressor produces an increase in the resulting stress. One group received daily avoidable shock from 60 to 69 days of age, while the other group, the unavoidable shock group, received the same amount of shock but were unable to avoid it. A third group of animals were neither shocked or handled. Under conditions of terminal deprivation the avoidable shock group died significantly sooner than animals in the other two groups. The unavoidable shock group survived approximately as long as the control group. Thus, the context in which the shock was encountered, not the shock itself, would seem responsible for the difference in survival time.

The studies by Sawrey & Weisz (1957), and Sawrey, Conger & Turrell (1957) also indicated that psychological factors, inherent in the conditions under which the physical stressor is encountered, is an important factor. In the Sawrey & Weisz (1957) study, two groups of hooded rats were used. The experimental animals were placed in a box with a wired grid floor and put on a 47-hr. hunger and thirst schedule of deprivation. A food cup was placed at one end of the box, water at the other end. The sections of the grid adjacent to the food and water were continuously charged, while the center part was not charged. If an animal approached either the food or water it was shocked. Thus, a strong and chronic approach-avoidance conflict was produced. The animals lived in this box throughout the 30-day course of the experiment. The shock was turned off for 1 hr. after 47-hr. deprivation, and the animals were allowed to eat and drink freely during this period. The control animals were simply placed on 47-hr. hunger and thirst drives for 30 days. The experimental animals developed gastric ulcers, while the control animals did not. These results show that shock, hunger, thirst, and conflict is sufficient to produce ulcers, but hunger and thirst alone are not sufficient. The authors hypothesized that the crucial factor producing the ulcers in this case was psychological conflict itself.

The aim of the Sawrey, Conger, & Turrell (1957) study was to separate out the relative contributions of the shock, hunger and thirst, and conflict per se to the production of ulcers in the study described by Sawrey & Weiz (1957). Nine experimental conditions were used. Group 1 was simply a replication of Sawrey & Weiz's (1957) original ulcer-producing situation. Group 2 was under the same conditions as Group 1 except they were not faced with the approach-avoidance conflict faced by Group 1 but did receive shock when a Group 1 animal was shocked. Group 3 animals were under the same conditions as Groups 1 and 2 but had water freely available, and hence was not under thirst drive. Groups 4 and 5 were similar to Group 3, except that in Group 4 hunger and thirst were present and shock was absent. In Group 5, thirst and shock were present, but animals were allowed to eat freely and hunger was absent. Animals in Groups 6, 7, and 8 were under conditions, respectively, of hunger alone without thirst or shock; thirst alone without hunger or shock; and shock alone without hunger and thirst. Animals in Group 9 were simply control rats living in the same physical surroundings as all other groups. They had food and water freely available and received no shock. The results indicate that conflict alone contributes significantly, hunger and shock together contribute significantly, and thirst alone does not contribute significantly to ulcer formation. As pointed out by the authors, this study leaves a number of questions unanswered. For example, there appears to be strain and possibly sex differences in the ulcer susceptability of rats. There also appears to be observable pre-experimental emotional differences within strains which are related to ulcer susceptibility of rats. Further, it appears that an animal's social experience, both in early life and in the testing situation may affect its ulcer susceptibility. The important finding of this study was that psychological conflict per se may contribute to stress as evidenced by ulcer formation.

Gauron (1964) not only varied escapable and inescapable shock in infancy but the strain of the animal as well. In avoidance conditioning there was a significant interaction between strain and type of trauma. Escapable shock animals made the most errors and non-shocked animals the least in the Sprague-Dawley strain, while the opposite was true for the Long-Evans hooded rats. As mentioned previously, this study was criticized on a number of points by Tegart (1966).

Other relevant factors considered in early experience studies affecting emotionality in adulthood include: the effects of duration of infantile stimulation (Denenberg, Morton, Kline, & Grota, 1962; Denenberg, Carlson & Stephens, 1962), the animal husbandry conditions during infancy (Denenberg & Whimbey, 1963), the age of testing in adulthood (Denenberg & Smith, 1963); the environmental complexity and social groupings (Denenberg & Morton, 1962).

A recent study by Reynolds & Meeker (1966) dealt with the physiological and biochemical mechanisms that result in an animal being less reactive to stress in later life. Sixty-day-old rats which had been raised with a minimum of stimulation were injected with thiosemicarbazide, a drug that lowers Gamma-aminobutyric acid (GABA) concentrations. GABA is a possible inhibitor of activity of some cells within the central nervous system. Fifteen minutes later the animals were given 30 mild electric shocks over a half hour period. Two weeks later they were tested for their resistance to gastric ulceration induced by immobilization for 48 hours without food and water. This drug-shock group showed a much greater resistance to stress that is, a lower incidence of gastric ulceration, than the drug-no shock, no drug-shock, no drug-no shock control groups. The effect was, therefore, produced by the combination drug-shock and not by any treatment alone. Thiosemicarbazide apparently stimulated the biochemical condition that prevails at an early age, because GABA is known to be low at this age. With this lowering of GABA concentration there is a corresponding reduced threshold for activation of the neural systems that are normally inhibited by GABA. The authors further theorized that if those neural systems in turn are normally implicated in the control of emotional responsiveness and of response to stress, they may be permanently and positively conditioned by stimulation during the critical period when threshold is low.

Two hypotheses drawn from the literature were under test in this thesis. The evidence presented by Brady (1958), Denenberg (1964b), and Gauron (1964) suggested that animals receiving shock terminable by an operant response would be stressed more than animals receiving an equivalent amount of shock and unable to influence its termination. The studies by Sawrey & Weiz (1957), and Sawrey, Conger, & Turrell (1957) would also indirectly support this hypothesis. How this hypothesis was tested specifically is presented in the procedure section.

The second hypothesis was derived from Denenberg's (1964a) paper which states, "emotional reactivity is reduced as a monotonic function of amount of stimulus input in infancy" (p. 338). This hypothesis has recently been partially supported by Tegart (1966). In the latter study, an inverted-U performance curve for avoidance conditioning was predicted. With one exception, the results of conditioning performance obtained were considered as supporting Denenberg's hypothesis. The group that received low stimulus input, the non-handled control, performed significantly poorer than groups receiving high stimulus input in infancy, the escapable and inescapable shock groups. The group that received a moderate amount of stimulus input, the handled control group, did not differ significantly from the groups which received either low or high amounts of stimulation, but consistently obtained scores between these two extremes. It is possible that the reason the handled control animals did not differ significantly from the other groups was because the amount of stimulus input difference administered in infancy between the groups was not great enough. With respect to the present study, it was hoped that by increasing the amount of early stimulation difference between the groups that significant differences in adulthood between all groups would be obtained. The group which theoretically received the highest level of early stimulation, the escapable animals, failed to show the decrement in performance as suggested by Denenberg's theory. As mentioned earlier this could have been due to transfer effects from the EE situation to the adult avoidance conditioning situation. The possibility of transfer effects of this type occurring in this present study were minimized as will be explained later.

Denenberg (1964a) further stated that on tasks involving some form of noxious stimulation, assuming that the more emotional animal is more motivated (Broadhurst 1957), highly emotional Ss should have the best performance when level of task difficulty is quite low while the least emotional subjects should be the best performers when task is very difficult. On an easy task adult performance would follow a positive monotonic relation with amount of early stimulation in infancy, for a difficult task the slope of the curve would be the opposite direction, and for a task of moderate difficulty an inverted-U function would prevail. This theory was based to a large extent on the study by Broadhurst (1957), and the Karas & Denenberg (1961) study.

Broadhurst (1957) designed a study to test the validity of the Yerkes-Dodson law which posits that the optimal level of motivation for a task decreases as task difficulty increases. Drive characteristics of emotionality in rats was also under investigation. Three levels of difficulty of an underwater discrimination, four levels of motivation deriving from different degrees of air deprivation, and two levels of emotionality defined in terms of defication scores on an open-field test were used. The Yerkes-Dodson law, as demonstrated by an appropriate interaction between difficulty and motivation, was confirmed. The prediction relative to the effects of emotionality on motivation was only partially fulfilled; higher drive level of emotional Ss, as shown by their swimming speed, was shown. The emotional Ss learned the easy discrimination faster than the nonemotional Ss and were also superior on the difficult task. In the Karas and Denenberg study (1961) the effects of infantile handling upon learning in an underwater discrimination maze under four different motivational levels was investigated. Rats handled for the first 10 or 20 days of life as well as non-handled controls were used. It was hypothesized that Ss handled for 20 days would have the lowest level of emotionality while the non-handled controls would be the most emotional. In addition, they assumed that spaced handling would result in greater emotional reactivity than massed handling. The experimental rats were either spaced-or massed-handled. The authors predicted that the most emotional Ss, the non-handled controls, would exhibit the best performance with a monotonic decline in performance as emotional reactivity decreased. Analysis of the swimming time scores found that the rank order of the five groups was as predicted, confirming the hypothesis. However, the mean differences among the groups were of relatively small magnitude.

In the present study, the original task on a T-maze was used as an easy task. Bitterman (1965) found that the behavior of a decorticated rat was no different from that of a normal rat in spatial problems but differed for visual problems. Since the T-maze task was spatial in this case, support is obtained for the contention that the original task in the maze would be relatively easy. In addition to the original task, all animals that reached criterion on this problem were run through three consecutive reversals. Bitterman (1965) showed that for the consecutive reversals the rat's performance improved as the number of learned reversals increased. Fish showed no improvement. Assuming that a guinea pig is more like a rat than a fish, the third reversal should be a relatively easy task when compared with the first reversal which was considered as the difficult task in the present study.

The noxious element used in the present study was 80% water deprivation. Denenberg (1962a) and Denenberg & Karas (1960, 1961) used rat pups which were handled for 0 (control), 3, 5, 10, or 20 days in infancy. For Ss which did not receive avoidance training in adulthood, under conditions of terminal food and water deprivation, the controls lived longest, followed by Ss handled for 10 days with the 20 day group dying earliest. In other words, the data parallel the curve expected for performance on an easy task.

Three studies, (Denenberg, 1964b; Denenberg & Karas, 1960, 1961), suggest that water deprivation used as the noxious element in a learning situation would constitute a stressful element in which animals varying in emotional reactivity would react in a differential manner to this stress. Water deprivation has not been used as the stressor in the adult learning situation used to evaluate the effects of early stimulation on emotional reactivity. Thirst was used in the adult testing situation instead of shock in the present study in order to minimize the possibility of a transfer effect from the EE situation to the adult testing situation masking any differences between the shock groups. This assumes that responses such as locomotor activity by the escapable shock animals, which were reinforced by shock termination, would be less likely to transfer to the adult testing situation where water deprivation is the noxious element. Another precaution against the occurrence of transfer effects was the use of a right-left spatial discrimination task in adulthood instead of avoidance conditioning which requires a response very similar to that made by the escapable shock animals in the EE situation.

Since there is evidence that "handling" the infant animals produces less intense stimulation than electric shock (Denenberg & Smith, 1963), the four groups in the present experiment may be ordered in terms of the degree of infantile stimulation, ranging from least to greatest, as follows: the non-handled control group, the handled control group, the inescapable shock group, the escapable shock group. If Denenberg's hypothesis of a monotonic function between stimulus input in infancy and adult performance on an easy and on a difficult task is correct, and if escapable shock is more stressful than inescapable shock, predictions may be made about the relative performance of these groups on either an easy or difficult task. For a non-handled control group, the excessive emotional reactivity should facilitate performance on the original and 3rd reversal task, but interfer with performance on the 1st reversal. The escapable shock animals should perform poorly on the original and 3rd reversal tasks due to the low emotional reactivity (motivation) but well on the 1st reversal. The handled control and the inescapable groups should be between these two extremes on the original, 1st and 3rd reversal tasks with the handled controls performing better than the inescapable group on the original task and the 3rd reversal due to greater emotional reactivity and poorer on the 1st reversal for the same reason. In other words, for the easy tasks (the original and 3rd reversal tasks), a monotonic function paralleling amount of early stimulation should be obtained. For the difficult task (the 1st reversal task), a monotonic relation with the opposite slope as that for the easy task should be obtained.

The present review of the literature revealed conflicting and varying results regarding the effects of infantile escapable and inescapable shock on adult performance, and the effects of early stimulation on adult emotional reactivity. These conflicting results have been attributed to inadequate experimental designs, to the methods employed, and to transfer effects. The present study attempted to employ an adequate design and method, and to minimize transfer effects, in order to provide a meaningful investigation of the effects of infantile escapable and inescapable shock, and the relationship between early stimulation and emotional reactivity.

CHAPTER II

METHOD

Subjects

The Ss were 38 guinea pigs for the original task; and 31 for the three consecutive reversals since this was the number of animals which reached criterion on the original task. The guinea pigs were of the Abbysinian strain, bred in the animal colony maintained by the Psychology Department at the University of Manitoba. The initial stock had been obtained in late 1965 and early 1966 from the Lemberger Company, Oshkosh, Wisconsin.

The Ss remained with the mother for the first 16 days of life, housed in cages of sheet metal (15 1/2 x 9 1/2 x 8 in.) with a wire mesh front and floor. On the 17th day the animals were caged individually in smaller cages (8 1/2 x 9 1/2 x 8 in.) of similar construction. Each cage contained a food hopper and a water bottle. Food was available at all times. Water was available up to the 79th day from which time until the end of testing the animals were given 20% of their usual daily water consumption. The animals were left undisturbed except for experimental treatment, filling of food hoppers, presentation of water allotment, and changing of the dropping pan sawdust when needed.

Apparatus

The apparatus consisted of three early experience runways, and a T-maze.

The early experience runways were three wooden boxes of similar size and construction. These boxes were built and used by Tegart (1966). The internal dimensions of the runways were 36 x 4 1/4 x 5 in. The length of the runways could be varied by the use of a cardboard liner insert. The end zones of each liner were covered with 1/2 in. diagonal black stripes (see Fig. 1). All runways had grid floors made of 1/8th in. bronze rod, spaced parallel every 3/8 in. apart. In two of the runways, the grid floor could be electrified by a Grason Stadler Shock Generator (Model E1064GS) which supplied eight output leads to the escapable shock runway and eight to the inescapable shock runway. Onset, as well as termination, of shock was simultaneous in both runways. The third runway, not wired for shock, was used for the handled control animals. A film-strip timer using 16 mm. film (a) programmed an average intertrail interval of 10 sec. (range = 17 sec.) (b) turned the shock on simultaneously with a light in front of E to signal the start of the trail, and (c) started a Hunter Klock Kounter which measured the duration of shock to the nearest .01 sec. The shock could be terminated manually by E.

The T-maze utilized was constructed of 3/8 in. thick plywood. The straightaway was 20 in. long, the arms were 17 1/2 in. long, and the width was 4 3/4 in. throughout. The start box consisted of the first 9 1/2 in. of the stem, and the end boxes were the last 9 1/2 in. of each arm. Guillotine type doors separated the start box from the rest of the straightaway and each end box from the rest of the arm. The maze was covered with transparent plastic covers which could be opened manually (see Fig. 2). The guillotine doors could be opened by means of lines attached separately to each door.

Procedure

Early experience. At birth each animal was assigned to either group NHC (non-handled control), HC (handled control), IS (inescapable shock), or ES (escapable shock). When the litter size was three (the usual number), one animal from the litter was assigned to each of the three groups: HC, IS,

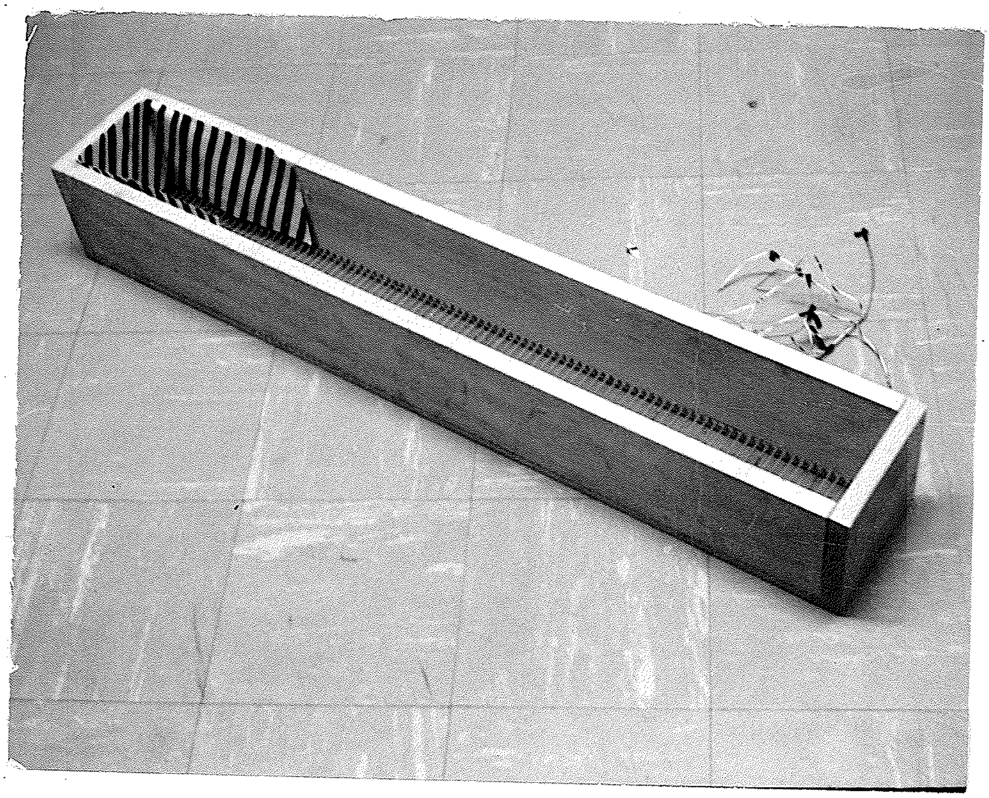

Figure #1

Early Experience Runway

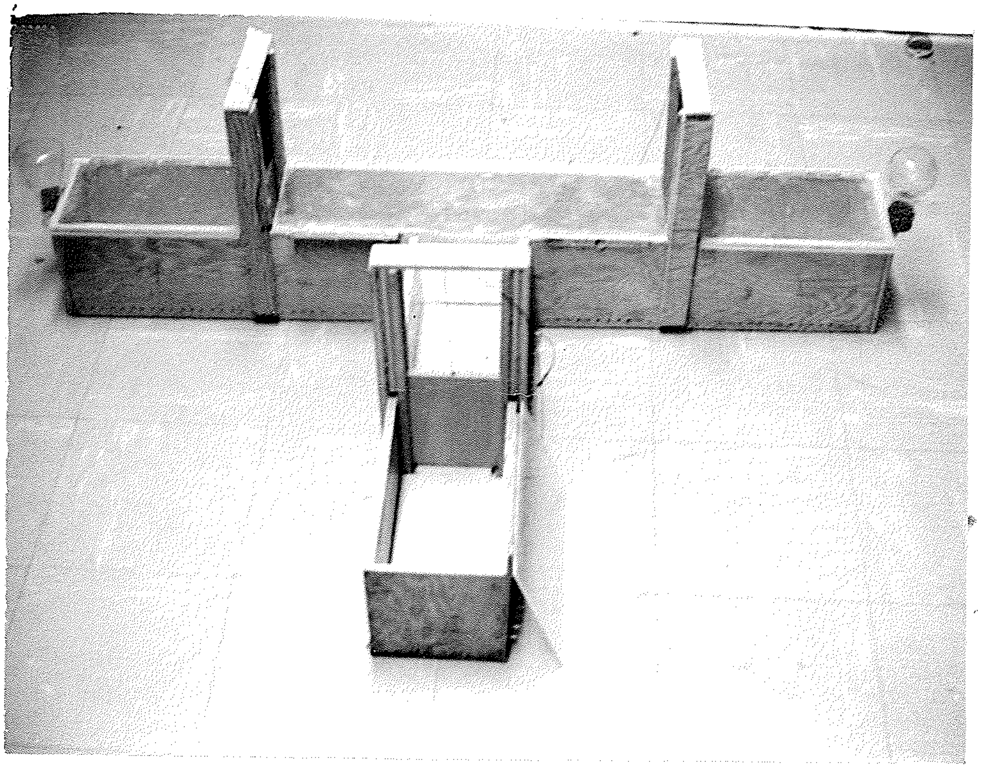

Figure #2

T-maze Apparatus

and ES. When the litter size was more than three, the excess animals were assigned to one of the control groups. Animals from litters of less than three were usually assigned to one of the control groups also. The first six animals born were assigned to the NHC group since the shock apparatus was not operational at the time of birth of these animals. The NHC animals were earpunched on the 16th day while all other animals were earpunched within the first 24 hours of birth.

Ss form the HC, IS, and ES groups were placed in the EE runways daily from the 2nd to the 16th days of life. Ss in the NHC group were left undisturbed in the home cage during this period. In a given session, one S from the ES group and the two yoked control animals, from the IS and HC groups, were run simultaneously. The Ss were placed in the EE runways and a stopwatch was started to record the total time in the EE situation. One HC animal was run two days later than the animals with which it was yoked. This animal was put in the EE runway daily for a period corresponding to the total daily testing time of the IS and ES animals with which it was yoked. As stated previously the shock supplied to ES and IS animals came on automatically with a signal light which indicated to E that shock was applied to the grid. The shock was terminated by E when the ES animal reached the opposite end zone of the runway. This response completed one trial. E then recorded the duration of shock. There were 25 daily trials for each animal. The length of the runways was varied by the use of cardboard liners. On day 1, the runways were 14 in. long. They were increased to 20 in. on days 2 through 7, and were full length (36 in.) on days 8 through 15. The shock intensity was 1.3 ma. on days 1 through 10, but increased to 1.6 ma. for the last five days.

Therefore, in this present study the amount of stimulus input difference between the groups was greater than in Tegart's (1966) study. The HC, IS, and ES groups were in the EE situation for a longer period of time (25 daily trials compared to 15) and the shock groups received more shock (more trials) and of greater intensity (1.3 ma. compared to 1.2 ma.).

The yoking of the two shock groups assured equivalence of both duration and temporal distribution of infantile shock. A handled control group was necessary to control for the effects of handling the shock animals daily during infancy. The only difference then between the shock groups and the HC group was, therefore, shock. By including a non-treated group the effects of the apparatus and handling on adult performance could be determined.

T-maze tasks. The average daily water consumption was determined by measuring 24-hr. water consumption on days 74 through 78. The highest and lowest values were not used. An average of the three remaining values was taken as an indication of an animals daily water consumption. From the 79th day until the end of testing each animal received 20% of its daily average. Each animal was assigned to one of eighteen half-hour testing periods and was given its daily water ration at the end of its testing period. On the 81st day the animals were started on the original T-maze task. Each daily session consisted of 15 trials. The S was placed in the start box. The start of a trial was marked by the opening of the start box door. A pilot study showed that guinea pigs tend to balk when put in the maze. It was, therefore, decided that the end of a trial would be determined by a balk, a correct response or an incorrect response. If an animal spent two minutes in the start box or two minutes in any other part of the stem then this was called a balk. If the animal made a complete turn leading into the reinforced end box then this was called a correct response. A correct turn with the animal entering the end box was reinforced by leaving the animal for 6 sec. at the water spout with water. If the animal entered the wrong end box it was left there for 10 sec. with a water spout without water. If the S made a turn and remained there for two min. without entering the end box or if the animal turned in one direction and then turned in the other direction the trial was terminated. The end box door was closed if the animal made a complete response or if it made more than one turn. In the case of more than one turn the door was closed before the animal could enter the end box. The time that elapsed between the opening of the start box door and the animal's response of leaving the start box, and the time from the opening of the start box door until the animal entered an end box were used as measures of latency and running time respectively. On each trial E recorded the response made (balk, correct, or wrong), the start box latency and the total time if a balk did not result. If the animal made more than one turn, E recorded the first turn made with the additional notation DT (double turn). If the animal made a turn and remained in the arm for two minutes the response was recorded with the additional notation NAW (not all the way). A pilot study showed that some guinea pigs never respond at a high enough rate to learn the task. It was, therefore, decided that if an animal made more than six balks on the 15th or 16th day, six or more on the 17th or 18th day, four or more on the 19th or 20th day, then testing would be ended.

Once an animal reached criterion on the original task it was started on the first reversal the next day. A S was started on the next reversal the day after it reached criterion on the preceding reversal task. The procedure used for the reversals was the same as that described for the original task.

CHAPTER III

RESULTS

The mean and variance of each group on each task were calculated for the following measures: running time (total time - start box latency), total number of balks, total number of errors, trials to criterion of seven consecutive correct responses and, trials to criterion of thirteen correct responses on one day. The mean was plotted against the variance for each group on each task and for each measure to determine if transformations were required. The variance was found to be proportional to the mean for all measures with the exception of running time. The data for all measures, with the exception of running time, were transformed using the formula $X' = \sqrt{X} + \sqrt{X + 1}$ (Winer, 1962, p. 220).

The running times, total number of balks, total number of errors, trials to criterion of seven consecutive correct, and trials to criterion of thirteen correct on one day, were analyzed by an analysis of variance referred to by Lindquist as Type I (Lindquist, 1953; p. 267-273). The analyzed data were from those Ss which reached the task criterion of thirteen correct on one day on the original task. Three Ss from the non-handled control group, two from the handled control group, and one from each of the inescapable and escapable shock groups failed to reach this criterion. The statistical analysis was done on seven Ss in the non-handled control group and eight Ss in each of the three remaining groups. The analysis was, therefore, on the same Ss in each group on the different tasks. The analysis of the balk scores involved only the original task and the first reversal since the total number of balks was zero or near zero for all groups on the second and third reversals. The analysis of the other three measures involved all four tasks.

The results of the analysis of: trials to criterion of seven consecutive correct, trials to criterion of thirteen correct on one day, total number of errors, running time, and total number of balks are shown in Tables 1 to 5 respectively.

TABLE 1

Analysis of Variance of Number of Trials on a Task Required to Reach Criterion of Seven Consecutive Correct

Source	df	Mean Square	F
Groups	3	11.63	1.17
Subjects within Groups	27	9.92	
Tasks	3	19.99	3.52**
Groups X Tasks	9	9.33	1.64
Subjects within Groups X Tasks X Groups	81	5.68	

** significant at .01 level

TABLE 2

Analysis of Variance of Number of Trials on a Task Required to Reach Criterion of Thirteen Correct on One Day

Source	df	Mean Square	F
Groups	3	1.79	N.S.
Subjects within Groups	27	10.67	
Tasks	3	113.13	7.62**
Tasks X Groups	9	4.02	N.S.
Subjects within Groups X Tasks X Groups	81	14.84	

** significant at .01 level
N.S. not significant

TABLE 3

Analysis of Variance of Task Total Number of Errors Per Animal

Source	df	Mean Square	F
Groups	3	1.86	N.S.
Subjects within Groups	27	8.00	
Tasks	3	21.50	5.94**
Tasks X Groups	9	3.62	N.S.
Subjects within Groups X Tasks X Groups	81	3.91	

** significant at .01 level
N.S. not significant

TABLE 4

Analysis of Variance of Mean Task Running Time

Source	df	Mean Square	F
Groups	3	47.56	N.S.
Subjects within Groups	27	105.70	
Tasks	3	1355.05	38.54**
Groups X Tasks	9	41.69	1.19
Subjects within Groups X Tasks X Groups	81	35.16	

** significant at .01 level
N.S. not significant

TABLE 5

Analysis of Variance of Task Total Number of Balks Per Animal

Source	df	Mean Square	F
Groups	3	47.65	1.84
Subjects within Groups	27	25.83	
Tasks	1	821.47	45.71**
Groups X Tasks	3	34.86	1.94
Subjects within Groups X Tasks X Groups	27	17.97	

** significant at .01 level

All five analysis showed a significant Tasks effect, ($p < .01$) a non-significant Groups (treatment) effect and a non-significant Tasks X Groups interaction. The value of F for Group effects was less than unity in the analysis of running time, trials to criterion of thirteen correct on one day, and total number of errors. The relatively small differences between groups, the significant overall task differences, and the lack of Tasks X Groups interaction are illustrated graphically for all five measures in Fig. 3 to 7 in which the group means on the various tasks are plotted.

Since no overall groups effect was found and no Tasks X Groups interaction was significant a Duncan's Multiple Range test on the group means for any particular task was not performed. Since significant task differences were found and were predicted a Duncan's Multiple Range test[1] (Duncan, 1955; Kramer, 1956) was done on the task means for all measures except balks. The analysis of the balk totals involved only two tasks and, therefore, a Duncan's Range test was not necessary. The results of the Duncan's Range test for the overall task means on the various measures are presented in Table 6 with the means that do not differ significantly ($p > .05$) underlined with a common line. The mean running time on the original task differed significantly ($p < .05$) from all three reversals and the first reversal differed significantly ($p < .05$) from the third reversal. For mean number of errors, the first reversal differed significantly ($p < .05$) from the third reversal. For trials to criterion

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[1] For comparisons involving the original task, a Duncan's Multiple Range test for unequal N's (Kramer 1956) was used. For comparisons not involving the original task, a Duncan's Multiple Range test (Duncan, 1955) was used.

of thirteen correct on one day, the original task differed significantly ($p < .05$) from the second and third reversals. For trials to criterion of seven consecutive correct, the first reversal differed significantly ($p < .05$) from the original task.

The mean and variance (untransformed) for each group on each task and for each measure is presented in the Appendix.

TABLE 6

Results of Duncan's Multiple Range Test
For Task Means

Measure	Tasks			
Trials to Criteria				
	R_1	R_2	R_3	R_o
Seven consecutive correct	8.33	7.27	7.15	6.37
	R_o	R_1	R_3	R_2
Thirteen correct on one day	13.26	10.54	9.37	9.06
	R_1	R_o	R_2	R_3
Total number of errors	8.41	7.10	6.73	6.57
	R_o	R_1	R_2	R_3
Mean running time	19.02	10.90	5.86	4.35

R_o - original task

R_1 - 1st reversal

R_2 - 2nd reversal

R_3 - 3rd reversal

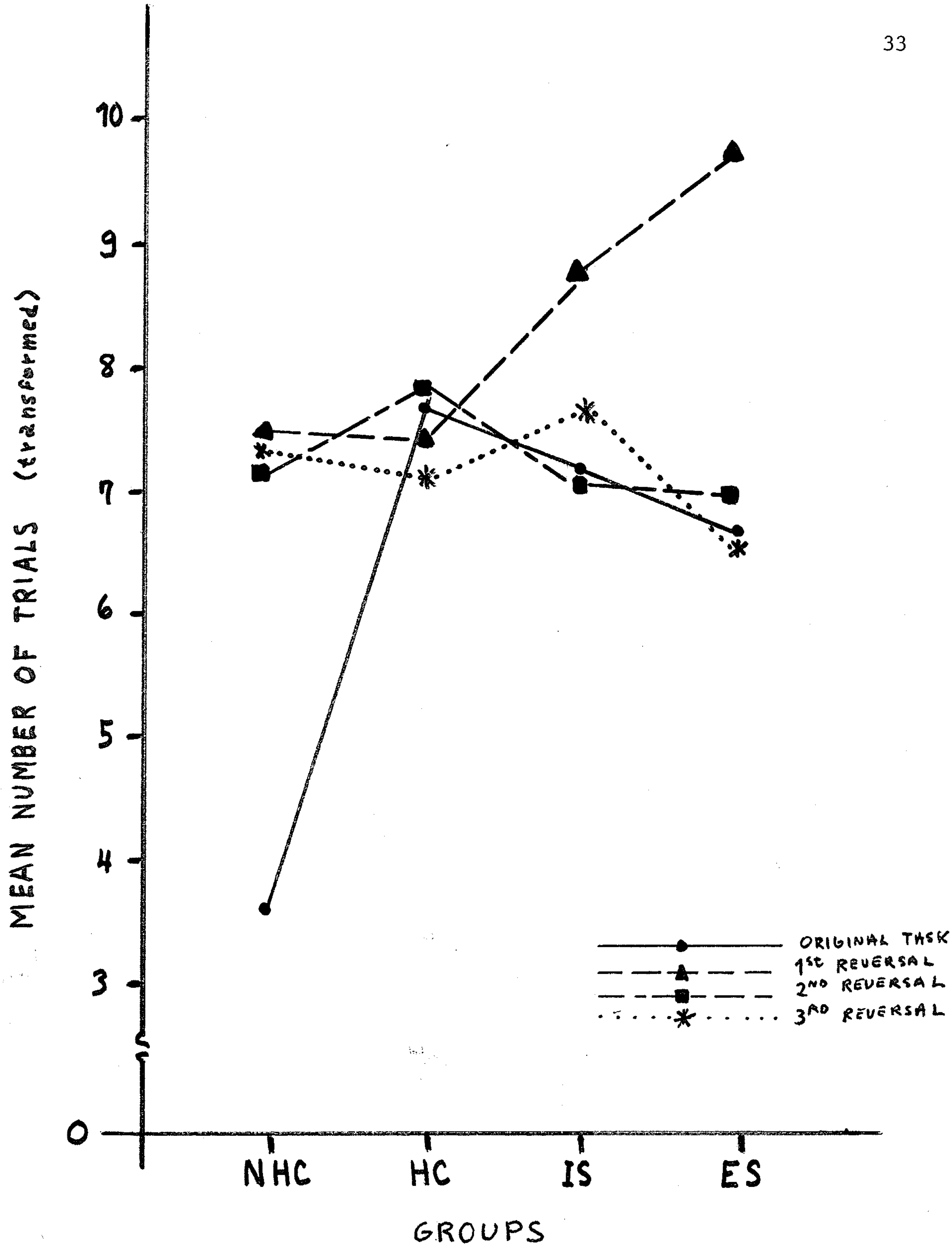

FIGURE 3

TRIALS TO CRITERION OF SEVEN CONSECUTIVE CORRECT

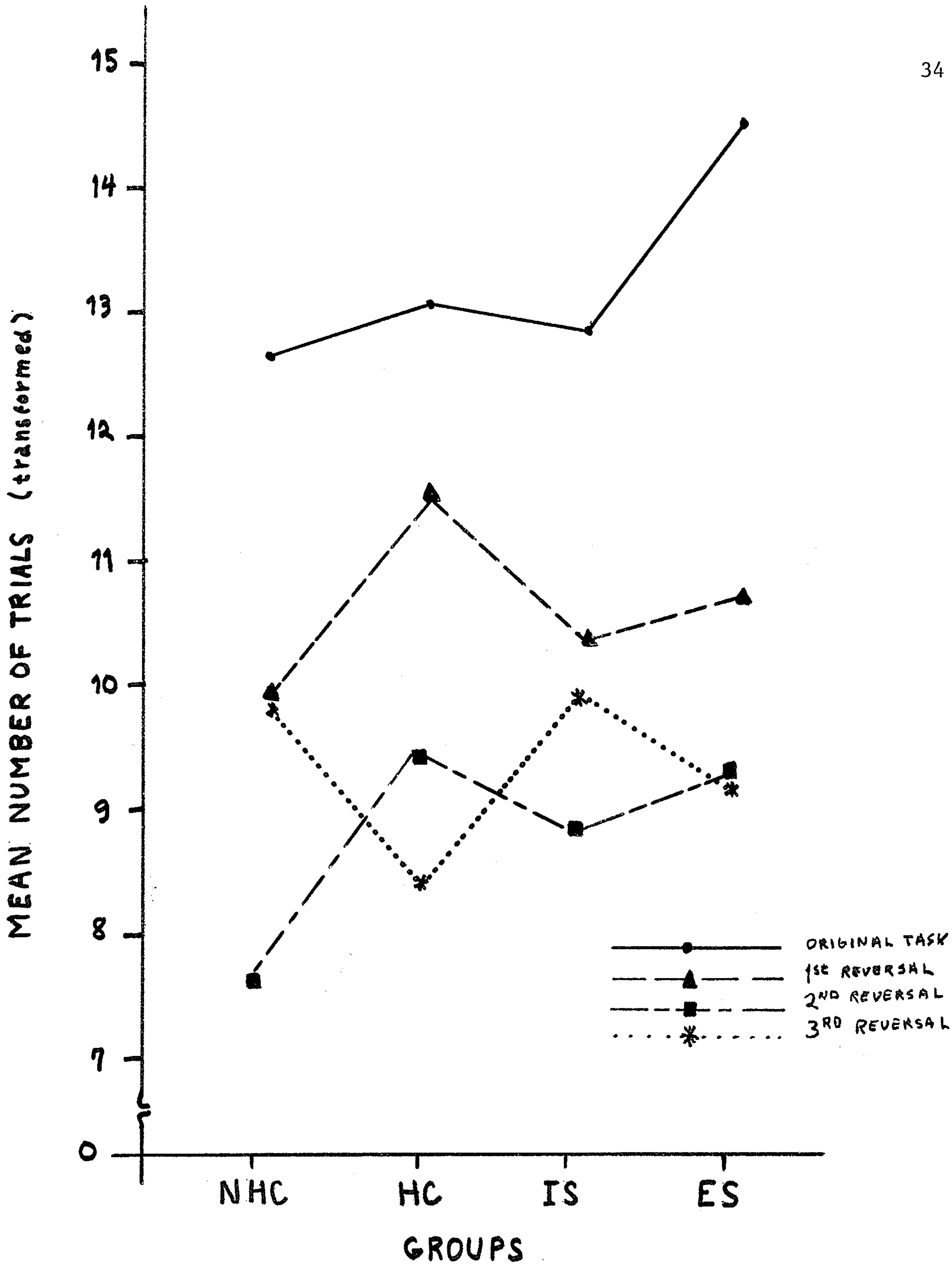

FIGURE 4

TRIALS TO CRITERION OF THIRTEEN CORRECT ON ONE DAY

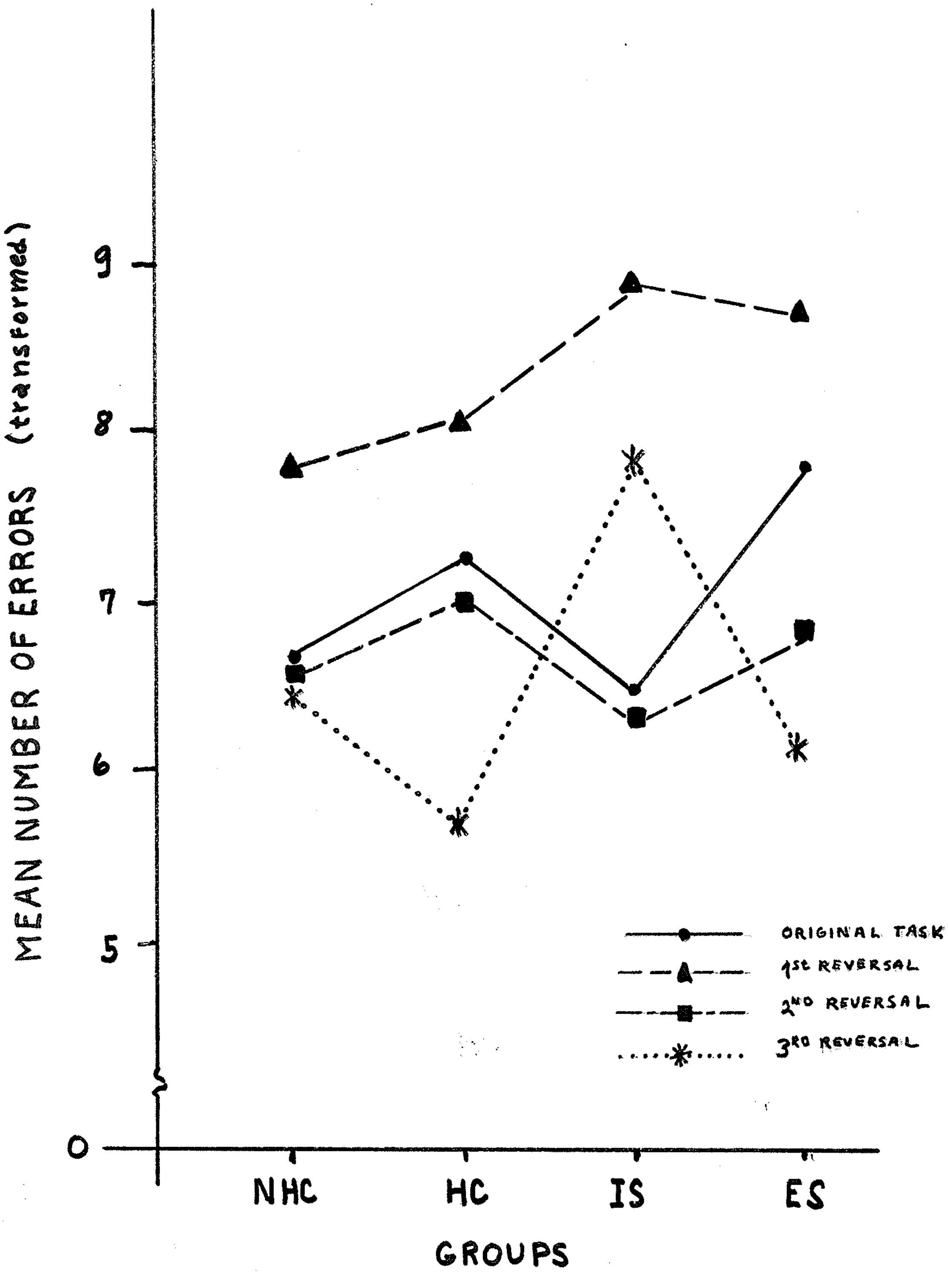

FIGURE 5

TOTAL NUMBER OF ERRORS

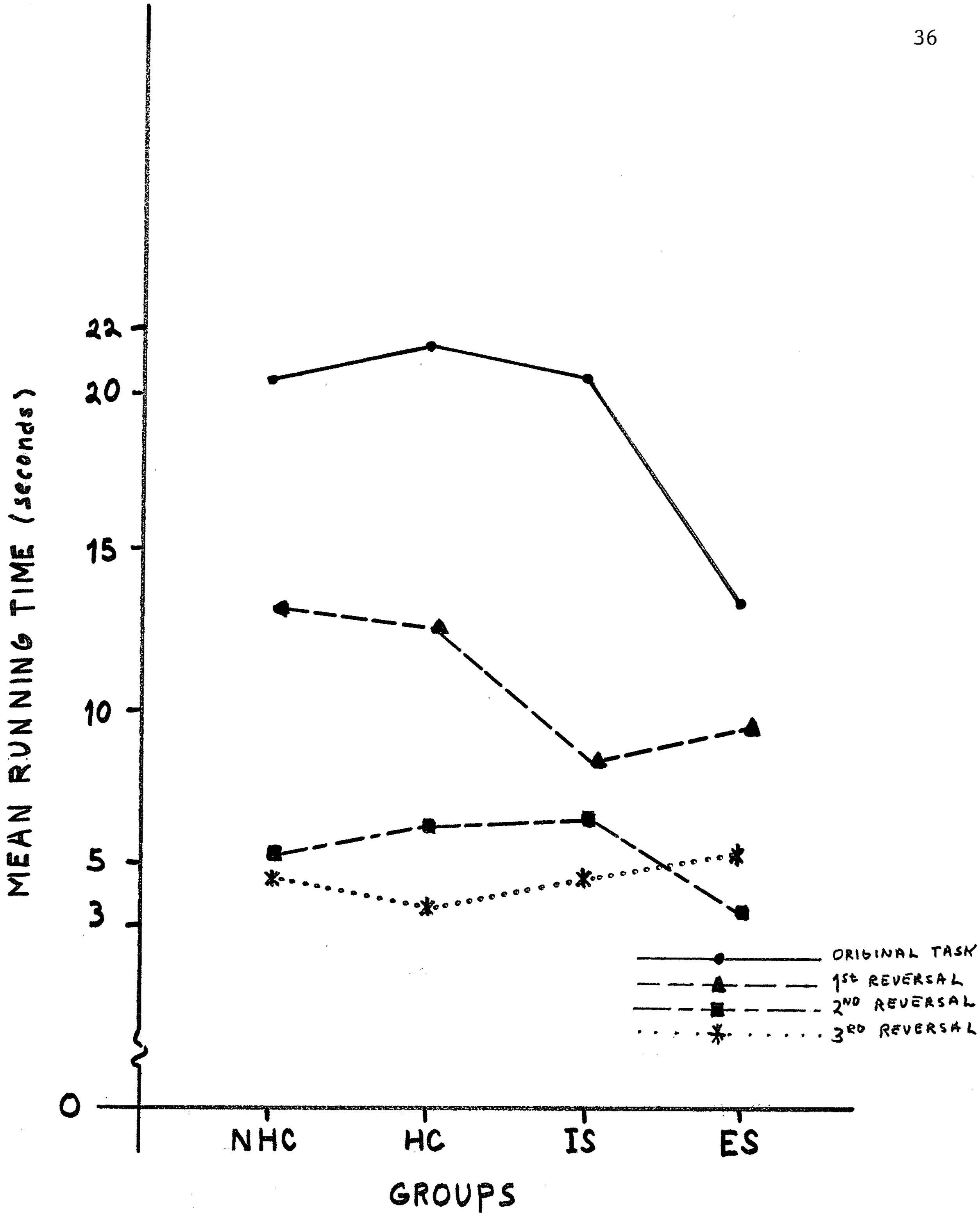

FIGURE 6

MEAN RUNNING TIME

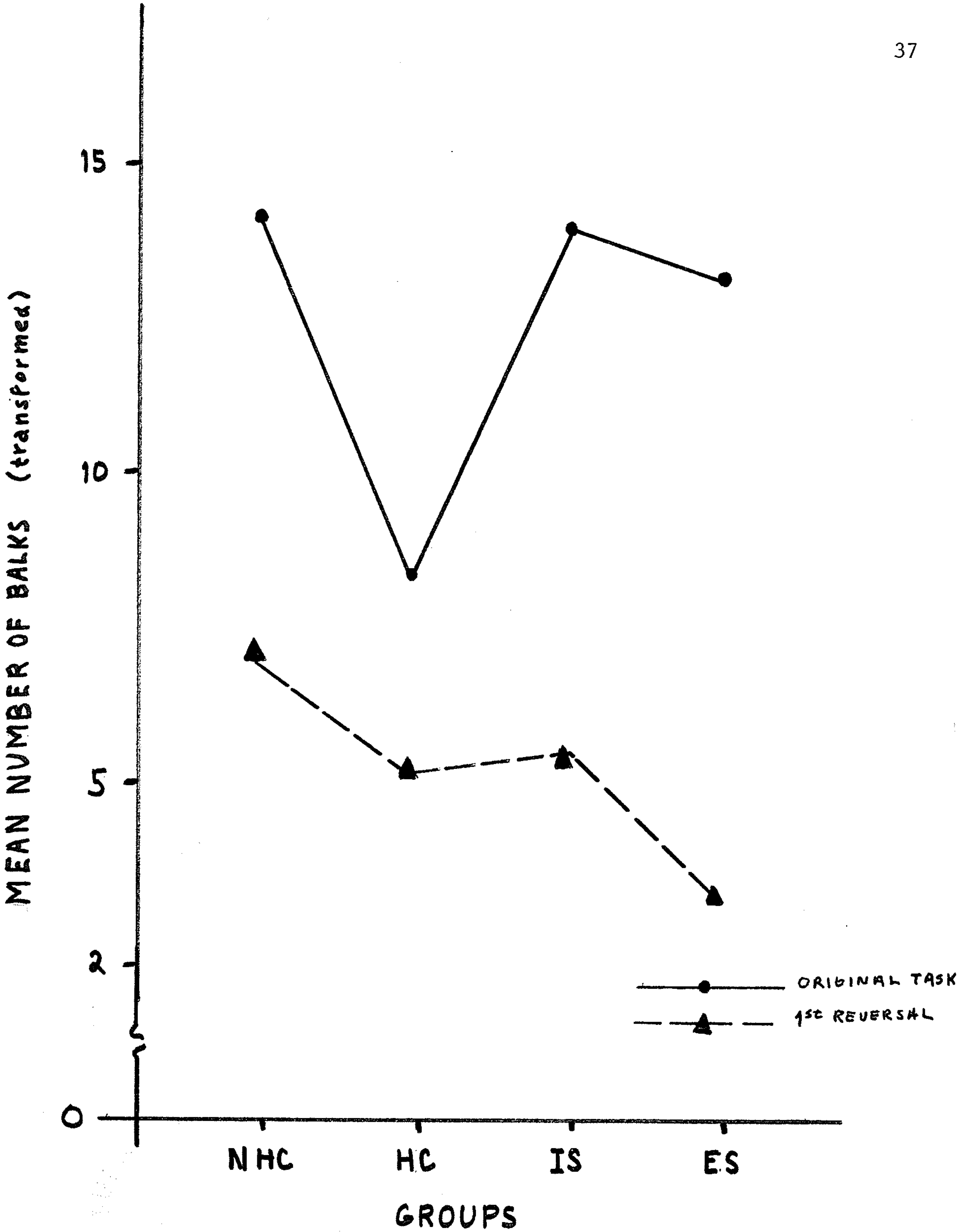

FIGURE 7

TOTAL NUMBER OF BALKS

CHAPTER IV

DISCUSSION

The analysis of variance of the five measures: trials to criteria of either seven consecutive correct responses or thirteen correct responses on one day, errors, balks, and running time all yielded the same results. No Groups (treatment) effect or Groups X Tasks interaction was significant but the Tasks effect was significant. Since no overall Groups effect and no interaction effect were found, it is evident that no reliable treatment differences existed on any particular task. The obtained results, therefore, do not support the hypothesis that animals exposed to stress terminable by an operant response (the escapable shock group) in infancy are less emotionally reactive or motivated in adulthood than animals exposed in infancy to an equivalent amount of inescapable stress (the inescapable shock group). Furthermore, the general hypothesis that a monotonic relationship exists between infantile stimulation and adult emotional reactivity or reaction to stress is similarly not supported by the results of this study. Any differences in emotional reactivity between the NHC, HC, IS, and ES groups that might have existed as a result of varying amounts of early stimulation should have been reflected in T-maze performance. The important problem presented by the data is that there were no differences between _any_ of the treatment groups on any of the tasks. It is not surprising that the ES group did not differ in performance from the IS group since no differences in performance were obtained between the control groups (NHC, HC) or between any control group and any shock group.

Tegart (1966) using guinea pigs found significant differences between the NHC group and the ES and IS groups. No differences were found between the two shock groups or between the two control groups. Tegart suggested that the reason the HC animals did not differ significantly from the other groups on avoidance conditioning performance, was because the amount of stimulus input difference administered in infancy between the groups was not great enough. The possibility of this happening in the present study was minimized by increasing the difference in stimulus input administered in infancy to the four groups. For example, the EE situation consisted of 25 daily trials for the first 15 days and not 15 trials as was used by Tegart. Furthermore, the shock groups received 1.3 ma. shock intensity on days 1 to 10 whereas Tegart used 1.2 ma. The HC, IS, and ES groups were, therefore, in the EE situation for a longer period of time, and the shock groups received more shock of greater intensity than the groups in Tegart's (1966) study. In addition, the NHC group experienced approximately the same amount of early stimulation. Since the amount of stimulus input difference between the treatment groups was as great and presumably greater in this study than that which existed for the same groups in Tegart's (1966) study, some differences in performance between the groups in the present study should have been found as was the case in Tegart's study. It is still possible, although unlikely, that group differences were not significant because of a lack of a great enough difference in early stimulation input between the groups and consequently in adulthood the groups did not differ enough in emotional reactivity to be detected by T-maze performance.

The major difference between this study and Tegart's (1966) study is that the present study measured performance on T-maze tasks with 80% water deprivation as the noxious element whereas Tegart measured performance in avoidance conditioning with shock as the noxious element.

It is possible that the nature of the noxious element or stressor used in the learning situation is an important factor in revealing differences in emotional reactivity. For example, the results of the Sawrey, Conger, & Turrell (1957) study showed that thirst did not contribute to ulcer formation. Shock interacting with hunger did contribute to ulcer formation. It would appear from these results that thirst is not as great a stressor as shock or as hunger. It is, therefore, possible that thirst is not a sufficient stressor to differentiate groups varying in their reaction to stress. This could have been a contributing factor to not obtaining any group differences but it is doubtful that this was the sole factor since all animals lost weight, an indication of stress, when put on water deprivation.

Another possibility is that the type of drive employed in the learning situation determines whether or not groups differing in motivation will differ in performance as indicated by time independent measures such as: errors, percentage correct, and trials to criterion. There is considerable experimental evidence which indicates that when food or water deprivation is used as the source of motivation for learning a task and time independent measures are used as indicants of learning, no differences are found between groups differing in hours of deprivation (motivation). For example, Teel (1952), trained rats on a single unit enclosed T-maze under one of four motivational conditions - 1, 7, 15, or 22 hr. of food deprivation. Analysis of the learning data (original) task revealed no significant differences in the number of trials required to reach the criterion of eight successive correct choices. The analysis of trials to extinction showed no significant group differences.

Armus (1958) trained two groups of rats, 21 1/2-hr. and 3 1/2-hr. food deprivation, on a single unit T-maze. The non-correction training procedure used was very similar to that of the present study. The animals were run on an original task and on one reversal task. There were no differences in the number of correct turns over the eight original task training days between the groups under high and low drive. There were also no group differences in mean number correct on the reversal. Of particular interest to this study is that the groups under the same amount of food deprivation as on the original task failed to show a significant difference on the reversal. This was the case in the present study where drive level (80% water dep.) was constant during all four tasks. Meyer (1951) and Miles (1959) using monkeys as Ss, have obtained results similar to those just cited.

The findings of Teel (1952), Armus (1958), Meyer (1951), and Miles (1959) provide evidence that drive level or motivation does not affect performance as shown by time independent measures. Acording to Denenberg (1964b), the more emotionally reactive an animal the more motivated the animal. It is possible to compare this study with the four studies cited above. The NHC, HC, IS, and ES groups can be compared in terms of motivation with the groups employed in the above studies. The NHC group (the minimum early stimulation group) corresponds to a maximum motivation or drive group; the ES group (the maximum early stimulation group) corresponds to a minimum motivation group. The HC and IS groups would fall between the NHC and ES groups, with the HC group being more motivated than the IS group. The results of the analysis of errors, trials to criterion of seven consecutive correct, and trials to criterion of thirteen correct on one day, failed to demonstrate significant differences in performance between treatment groups on either the original or any of the three reversal tasks. It would appear that if real differences did exist in emotional reactivity and motivation between the groups then they would not be detected by time independent measures as was the case in the studies by Teel (1952), Armus (1958), Meyer (1951) and Miles (1959). In studies which did show differences in performance between drive groups, using comparable measures, shock was usually used as the noxious element. It would appear that the use of different stressors in the learning situation, shock employed by Tegart (1966), and 80% water deprivation in the present study, was responsible for the different findings of these two studies.

Denenberg (1964a) stated that on tasks involving some form of noxious stimulation, highly emotional Ss should have the best performance when task difficulty is quite low while the least emotional Ss should be the best performers when the task is very difficult. On an easy task, adult performance would follow a positive monotonic relation with emotional reactivity. The order of performance from best to worst would, therefore, be NHC, HC, IS, and ES. On the difficult task the slope of the curve (the order of performance) would be the reverse of that for the easy task. The slope or shape of these curves are based on the Yerkes-Dodson law which posits that the optimal level of motivation for a task decreases as task difficulty increases. It was predicted in this study that the original task would constitute the easy task, the first reversal a difficult task, and the second and third reversals would be progressively easier than the first reversal. The Duncan's Multiple Range test on overall task means showed that the mean number of errors on the first reversal was significantly greater than for the third reversal. The mean number of errors on the original task was less than that for the first reversal but the difference was not significant. For trials to criterion of seven consecutive correct the average number of trials was significantly greater for the first reversal as compared to the original task. The means for the second and third reversals were lower than for the first reversal but not significantly. These results support the assumption that the original task would be relatively easier than the first reversal. However, trials to criterion of thirteen correct on one day revealed that the mean for the original task was greater than for the first reversal. This finding is probably attributable to the high number of balks per animal on the original task as compared to the first reversal. It was, therefore, more likely that an animal would respond at a high enough rate to reach the criterion of thirteen correct on one day on the first reversal than on the original task. The high rate of balks would tend to increase the criterion mean on the original task. Even though there were apparent differences in task difficulty the results for all measures failed to show a Groups X Tasks interaction. This is contrary to the predictions of Denenberg (1964a) based on the Yerkes-Dodson law as discussed earlier. This failure to substantiate the Yerkes-Dodson law is in accord with the findings which indicate that the law does not hold under all circumstances.

Basically, for the same reason that no group differences were found significant on any of the tasks, no differences in the slope of the tasks curves as indicated by a Group X Tasks interaction were found. As measured by time independent measures the motivation or drive level of the S does not affect performance. With few exceptions (Broadhurst 1957) where a relationship has been found between motivation and task difficulty the noxious agent has been shock. Broadhurst (1957) used a correction method which might account for his results. The Miles (1959) study is an example of the findings when the Yerkes-Dodson law is tested using a noxious agent other than shock. No interaction between group curves was found using a difficult and an easy task with food as reward. The lack of divergence of the learning curves for the three deprivation conditions indicate that degree of deprivation (motivation) had no appreciable influence on performance at either level of discrimination difficulty. In the text Motivation: Theory and Research, Cofer and Appley state, "We are not aware of any experiments in which the Yerkes-Dodson law has clearly been verified when appetitive drives alone has been used" (p. 523).

The running time measure also failed to reveal any apparent differences in motivation between the groups as would be expected if real differences in emotional reactivity between the groups existed. Hillman, Hunter & Kimble (1953) used an elevated T-maze and ran their rats under either 2- or 22-hr. thirst. During the 10 acquisition trials, the 22-hr. group ran considerably faster than the 2-hr. group. (There were no differences in the number of errors made). Apparently for time dependent measures such as running time, drive level or motivation has an effect. It would then be expected that the NHC would have the lowest running time, the ES group the highest running time, the IS group the second highest, and the HC the second lowest running time. One possibility for the lack of any significant group differences in running time (running speed) is that transfer effects from the EE situation to the adult T-maze situation masked any real differences that might have existed. For example, the ES group was rewarded for locomotor activity in the EE situation which would tend to lower the otherwise high running time expected if this early learning transferred to the adult test situation. The effects of early experience per se could have affected running time for the NHC group. This group was relatively restricted in the opportunity to make co-ordinated locomotor activity since they were confined to small cages during infancy and adulthood. This lack of locomotor experience would tend to raise running times for the NHC group.

The significant task effect and subsequent Duncan's Multiple Range test showed that running time decreased markedly with time, i.e., from the original task to the third reversal. This was probably the result of increased familiarity with the maze, better co-ordinated locomotor activity and reduction in fear of the maze. This increase in running speed with time in the maze could also be due to the extinction of competing responses which, as suggested by Cotton (1953), could also explain the lack of group differences in running time on the reversals. Cotton (1953) trained rats to traverse a runway under each of several drive levels, (0-, 6-, 16-, 22-hr. food deprivation). His results, as expected, showed a relationship between speed and deprivation time. The relation was monotonic, with the fastest speeds occurring for the longest deprivation and the slowest for the shortest deprivation period. However, there was no relation between deprivation time (motivation) and running speed when only trials on which there were no competing responses such as face washing, scatching, biting, and exploratory behavior were considered. In the present study, at least for the reversals, the animals would usually run directly to one of the end boxes (general observation). This lack of competing responses may explain why no group differences in running speed were found.

The total number of balks per animal was analyzed for the original and first reversal tasks. The average number of balks on the original task was significantly greater than for the first reversal task. Balks decreased considerably, to practically nothing for all groups, on the second and third reversals. Once again, no significant group differences were found. Seven animals did not make the task criterion of thirteen correct on one day. These animals were discarded when they failed to respond at a predetermined rate after 14 days on this task. Three animals in the NHC group, two in the HC group, and one in each of the IS and ES groups failed to make the original task criterion. It is difficult to say what causes or determines a balk but it would appear that a balk is a freezing response or fear reaction to the apparatus. If this be the case, then a positive monotonic relationship would be expected between number of balks and emotional reactivity. This situation is analogous to the situation where groups which purportedly differ in emotional reactivity are placed in the open field and activity rate or locomotor activity is recorded. Results of such studies (Denenberg & Smith, 1963; Denenberg & Morton, 1962; Denenberg, Carlson & Stephens, 1962; Denenberg, Morton, Kline, & Grota, 1962; Denenberg & Whimbey, 1963) reveal that activity in the open field is inversely related to emotional reactivity (early stimulation). The fact that balks were originally very frequent for all groups and then dropped to practically nothing after the first reversal would appear to support the contention that a balk was an emotional response to the maze. The frequency of animals taken off training would also support this point since a positive monotonic relation exists between amount of early stimulation and frequency of animals terminated. More data are needed to confirm this finding.

On the original task the mean number of balks for the shock groups was considerably higher than what might be expected. Transfer effects from the EE situation to the adult testing situation could account for the higher than expected balk means for the shock groups and the lack of significant group differences. For example, the shock groups could have had emotional responses conditioned to the EE apparatus. These responses, when transferred to the T-maze apparatus, could possibly raise the balk means for the shock groups. On the first reversal the balk means for the shock groups dropped considerably as compared to the two control groups with the result that an apparent positive monotonic relationship obtained between balks and treatment groups (see Fig. 7). The lack of significant group differences could again be attributed to an equalizing effect of transfer effects. The possibility of such transfer effects were presumably reduced in this study by employing a different type of stress in the adult testing situation as was used in the EE situation, i.e., thirst instead of shock, and by the use of a different type of task, i.e., a spatial task instead of an avoidance task. As discussed earlier, there are also the differential effects of the EE situation per se. For example, the groups differed in their opportunity for locomotor activity in infancy. These two factors, transfer effects and the effects of the EE per se, cannot be completely eliminated in a study which is designed to test the effects of early experience on adult performance, and could mask any real differences in emotional reactivity that might have existed between the groups.

CHAPTER V

SUMMARY AND CONCLUSIONS

Thirty-eight infant guinea pigs were assigned randomly to one of four groups shortly after birth. From the 2nd to the 16th days of life, animals in one group received escapable shock daily while a second group received inescapable shock. A third group was merely placed in the early experience apparatus daily but not shocked, and a fourth group remained undisturbed in the home cage during this time. From the 79th day until the end of testing each animal received 20% of its average daily water consumption. On the 81st day all animals were started on the original T-maze task. Those animals which reached the task criterion were then run on three consecutive reversal tasks.

It was hypothesized that the original task would constitute an easy task and that a positive monotonic relationship would exist between amount of early stimulation and performance. The first reversal was the difficult task and it was predicted that an inverse monotonic relationship would be obtained.

On all indices of learning, a tasks effect, no groups effect, and no Groups X Tasks interaction were found. Consequently there were no group differences on any particular task. Not only did the escapable shock group fail to differ in performance from the inescapable shock group but the controls did not differ from each other or from any of the shock groups.

The results were interpreted as not supporting Denenberg's (1964a) hypothesis of decreased reactance to stress as a function of increased stimulation in infancy, or the hypothesis that escapable shock in infancy would be more stressful than inescapable shock administered in infancy. The lack of a Tasks X Groups interaction effect failed to confirm the prediction that the slope of the task curves are dependent upon task difficulty (the Yerkes-Dodson law).

The type of noxious element employed in the adult testing situation would appear to be an important factor in differentiating groups of animals presumably varying in emotional reactivity and motivation. Transfer effects from the early experience situation to the adult testing situation is a problem which is inherent in a study of this nature and could possibly mask any differences in emotional reactivity that might exist.

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APPENDIX A

The Means and Variance of the Untransformed Data for Each Measure on Each Task

ORIGINAL TASK

MEASURE	MEAN and VARIANCE	GROUP			
		NHC	HC	IS	ES
TRIAL TO CRITERIA					
7 consecutive correct	mean	12.60	18.00	15.00	13.13
	variance	60.53	220.25	117.50	89.61
13 correct on one day	mean	40.86	45.30	44.88	55.60
	variance	220.12	422.94	902.61	682.61
TOTAL NUMBER OF ERRORS	mean	11.14	13.75	10.63	15.50
	variance	21.55	48.94	13.98	32.00
RUNNING TIME	mean	20.52	21.72	20.56	18.19
	variance	108.39	88.25	41.64	116.96
TOTAL NUMBER OF BALKS	mean	55.86	25.00	57.38	48.25
	variance	1114.12	864.25	1432.98	827.18

REVERSAL NO. 1

MEASURE	MEAN and VARIANCE	NHC	HC	IS	ES
TRIAL TO CRITERIA					
7 consecutive correct	mean	13.86	14.10	20.0	25.00
	variance	31.55	124.11	135.00	211.75
13 correct on one day	mean	25.00	36.00	26.90	28.40
	variance	144.61	545.75	105.36	206.73
TOTAL NUMBER OF ERRORS	mean	14.86	17.87	23.63	20.88
	variance	43.83	149.36	473.98	198.36
RUNNING TIME	mean	13.37	12.89	8.20	9.36
	variance	82.45	120.94	22.24	33.77
TOTAL NUMBER OF BALKS	mean	18.00	11.13	9.25	3.13
	variance	44.57	187.61	109.44	11.61

REVERSAL NO. 2

TRIAL TO CRITERIA					
7 consecutive correct	mean	12.10	15.00	13.50	13.12
	variance	14.69	35.75	44.77	35.61
13 correct on one day	mean	19.57	22.20	19.30	21.30
	variance	133.36	50.44	35.65	51.00
TOTAL NUMBER OF ERRORS	mean	11.29	13.00	10.00	11.75
	variance	34.20	47.50	23.00	22.68
RUNNING TIME	mean	5.59	6.43	6.45	5.96
	variance	19.66	21.17	68.55	15.79
TOTAL NUMBER OF BALKS	mean	0.43	11.50	0.38	0.00
	variance	0.36	7.00	0.56	0.00

REVERSAL NO. 3

TRIAL TO CRITERIA					
7 consecutive correct	mean	13.60	13.40	15.10	11.50
	variance	63.67	60.50	71.11	49.73
13 correct on one day	mean	23.90	17.70	23.30	21.50
	variance	485.68	1.31	124.44	50.75
TOTAL NUMBER OF ERRORS	mean	11.29	8.25	16.25	9.50
	variance	78.20	15.00	80.18	25.75
RUNNING TIME	mean	4.66	3.47	4.27	5.06
	variance	5.33	6.23	9.45	49.31
TOTAL NUMBER OF BALKS	mean	1.43	0.13	3.14	0.00
	variance	4.85	0.21	52.93	0.00