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## The effect of electroconvulsive shock and opaque guidance on the alternation of fixated behavior in the rat.

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THE EFFECT OF ELECTROCONVULSIVE SHOCK AND OPAQUE  
GUIDANCE ON THE ALTERATION OF FIXATED  
BEHAVIOR IN THE RAT

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THE EFFECT OF ELECTROCONVULSIVE SHOCK AND OPAQUE  
GUIDANCE ON THE ALTERATION OF FIXATED  
BEHAVIOR IN THE RAT

BY

David S. Palermo

Thesis submitted in partial fulfillment  
of the requirements for the degree of  
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## INTRODUCTION

Dissatisfied with the methodology of Pavlov, Anderson, Liddell, Karn and others in their studies of the neurotic pattern in animals, N. R. F. Maier in 1939 (18) took part of the conditioning method used by these earlier workers, and combined it with a simple discrimination procedure and thus developed a new method of producing abnormal behavior in animals. The Lashley jumping apparatus was used by Maier because it eliminated the unconditioned stimulus and the restricted movement of the halter in conditioning experiments while at the same time it possessed the feature of the conditioning process which produced the conflict and the resultant abnormal behavior, namely, the conflict between the necessity of responding and the inability to make a learned response.

With the development of this new methodology Maier and his students embarked upon a series of studies designed to analyze the neurosis-producing situation and to describe the experimentally produced neurosis in rats. This work led to attempts to determine why neurosis was produced and how it could be changed to more adaptive behavior. This broadening of the scope of study included the introduction of electroconvulsive shock (E.C.S.) as a procedure for changing the neurosis to more adaptive behavior. The inclusion of E.C.S. was brought about by

the recognition of the value of this procedure in clinical work with humans and by various findings of the effects of E.C.S. on animal behavior.

The present study was concerned with one aspect of eliciting more adaptive behavior through the use of guidance and E.C.S. Before a discussion of this problem can be fully understood, however, a more detailed review of the previous work must be made.



## HISTORICAL REVIEW

The review of the literature of this problem will include two areas of experimental investigation: experimental frustration of rats and the studies concerning the effects of E.C.S. on various types of animal behavior. It is necessary to begin with the studies of frustration first, and then introduce the E.C.S. as a special technique within the area of the frustration studies.

The publication of "Studies of Abnormal Behavior in the Rat" by Maier in 1939 (18) set forth the basic procedure and terminology that was used in subsequent experimentation with frustration on the Lashley jumping stand. This original work consisted of training animals to jump and make a discrimination on the Lashley jumping apparatus and then altering the procedure in various ways to discover what would occur. The procedure used will be discussed in detail in relation to experiments to be discussed later. The terminology, however, is important here.

The "neurotic pattern" or neurosis which occurred in many, but not all, animals as a result of a no-solution problem referred to specific, and sometimes violent, abnormal patterns of behavior in the rats. These behavior manifestations seemed to follow a continuous sequence of jumping off the stand away from the apparatus,



running wildly about in large leaps, convulsions, hopping movements, and tics followed by a passive stage consisting of inactivity, plasticity, and resistance to manipulation. A rat displaying the neurotic pattern often refused food and was retiring in his cage. This behavior was in contrast to, and not necessarily continuous with, the excessive nervousness seen in all the rats put in the no-solution problem situation. The latter condition was characterized by food refusal, chattering, excessive urination and defecation, crouching, and escape reactions.

"Resistance" was observed in all animals to some degree and by resistance, Maier referred to refusal to jump or respond to the experimental situation. This resistance or hesitation was characteristically much more pronounced in animals which had developed the neurotic pattern. It was overcome by a mild electric shock as will be described later.

"Frustration" occurred as a result of interference or blocking of an ongoing process. The animals were frustrated in two ways: 1) by conflict between responding or not responding and 2) by the conflict of making a choice in an insoluble problem. This frustration, Maier (18) postulated, resulted in the neurotic pattern which was marked by stereotyped or fixated behavior in the experimental situation.



Maier, Glaser, and Klee (19) did a study, following the original work of Maier, to determine and compare the relative occurrence of fixated responses under ordinary learning conditions and under conditions of frustration. In their experiment, as in others to be described later, the Lashley jumping apparatus was used. The rats were trained to jump  $8\frac{1}{2}$  inches from a stand through stimulus windows to a feeding platform behind the windows. Following the training period the animals were divided into three groups and each was trained to form a position habit. Group I was trained to jump to its preferred side by allowing one free jump, and then forcing the animal to jump to that side continually, by locking the door on the opposite side, on all future trials. Group II was trained to jump to the side opposite its preferred side by allowing one free jump and then forcing him to jump to the opposite side by the same procedure as used with Group I. Group III was trained to form a position habit by the no-solution problem technique. In this group either the left or right window was locked in random order. In all three cases the stimuli on the windows were randomly changed from side to side in an irregular sequence and only those animals with position habits were retained for the rest of the experimental procedure. The criterion for the establishment of a habit, or stereotypy, was 96%



consistency for 160 trials. Twenty trials were given each day. Thus two groups developed stereotyped behavior by reward and punishment while Group III developed stereotyped behavior by the frustration technique.

The test for determining the strength of the habit in each group consisted of presenting each group with a discrimination problem. One of the stimulus cards was made positive and whether it was on the left or right it was rewarded while the other card always led to punishment, i.e., the window was locked so that when the rat jumped to it he bumped his nose and fell into a new below. The three groups were given two hundred trials, twenty trials per day, to give up their position response and make the discrimination to a criterion of thirty consecutive errorless trials. Those animals which failed to make the discrimination in the two hundred trials were given another test which consisted of always placing the negative card on the side to which the rat reacted consistently. In other words these rats received 100% punishment if they persisted in their habit. This procedure was carried on for one hundred trials; ten per day.

The results of the experiment showed that 90% of Group I, the rats trained to their preferred side, 50% of Group II, the rats trained to their non-preferred side, and only 37% of the Group III, the rats in the insoluble



problem, broke their position responses to learn and practice the discrimina-response. The authors postulated that three levels of frustration were involved. The Group I animals were allowed their preference in the experimental procedure and thus little conflict was involved, and therefore little frustration. In short their behavior was easily modified to the new discrimination situation; thus modification of behavior being the measure of frustration or the strength of a fixated response. The animals in Group III were given no-solution to their problem with the result that a high degree of frustration occurred with its accompanying relatively strong persistence. The Group II animals lay in between Groups I and III, for while they were not allowed their natural preference neither was their problem insoluble. Thus, strength of the position responses or frustration was not so great as in Group III nor so little as in Group I and an intermediate number of animals was able to abandon their stereotyped response.

That this persistence of one response is definitely a fixated response, as considered by Maier and his students, is shown by the results of the animals subjected to 100% punishment for their incorrect responses. In no case did any animal break under these conditions.

Further analysis of the data from this experiment has shown some other important characteristics of this



abnormal behavior. It was felt by the authors that this persistent behavior was an all or nothing response; that is, the animal either persisted in his fixation or positional response or he recognized and practiced the discrimination. This all or nothing hypothesis was first suggested by the fact that 100% punishment had no effect upon the fixated behavior, and secondly, the differences among the groups with relation to the number of trials they took to change to the discrimination habit. The animals in Groups I and II solved the discrimination problem and abandoned their position habits in approximately half the trials that it took the animals in Group III that solved the discrimination problem. However, all three groups broke long before the criterion of two hundred trials.

Further, it is to be noted that the groups differed in the manner in which they established their new discrimination. Group I took an average of 27.5 trials after abandoning its original response consistently to make the new response. Group II took 16.2 trials and Group III only 4.5 trials showing that the more difficult it was for the groups to abandon their old response the faster they learned the new one. This will be further explained below.

Proof that inability to solve the discrimination problem was not the reason for the fixation but rather,

learning of the discrimination was suppressed, was born out by two other facts within the data. Throughout the experiment resistance to jumping was overcome by an air blast directed at the rat. By a comparison of the amount of time the rats resisted jumping to the positive and negative cards the resistance or latency of response could be calculated. The results of this comparison showed that of those animals which persisted in their position habits, there was a highly significant difference between the amount of resistance to the positive and the negative window. The animals readily jumped to the positive window but showed considerable resistance to jumping to the negative window.

Additional evidence of this suppressed learning was seen in the manner in which the animals jumped to the two windows. When the positive window was on their fixated side they made the normal, forceful, head first jump which they had been taught during the training period. This was in marked contrast to the "abortive jumps" made to the negative window. In the latter case the rats protected themselves from being hurt by jumping so that they hit the window sideways, jumping to either side of the window, or by jumping so they hit very lightly and not adequately enough to open the window if it were unlocked.



Resistance to the negative window and abortive jumping to the negative window was not observed at any other time except during the discrimination part of the experiment with the exception of Group III which exhibited some abortive jumps during the frustration period when they were receiving 50% punishment.

Note should be made here of the fact that individual differences were obviously apparent in this experiment in that all the animals in Group III did not form fixations while 10% of the animals in Group I did form a fixation. The authors believed that frustration must reach a saturation point before it effects the individuals behavior and that this saturation point varied with the individual. Thus the saturation point of the fixated animals in Group I was easily reached while the saturation point of the animals in Group III which broke was not so easily reached.

Before examining other experimental data a brief summary should be made here because it is upon the findings of this experiment and its ramifications that all the latter studies are based. 1) Frustration leads to stereotyped or fixated behavior. 2) A discontinuous or bimodal distribution is found between the animals which do abandon their stereotype and those which do not. 3) Inability to learn the discrimination problem does not account for the

inability to learn the new habit. 4) Abandonment of a fixation occurs quickly, if at all, and consists of a new type of behavior. 5) Frustration tolerance or saturation is subject to individual differences.

Further study of these abnormal fixations was then carried on by Maier and Klee (20) to discover the permanence of the fixations and the effect of various types of treatment on the fixations. This study was a continuation of the previous study and thirty-one rats from that experiment were used. Data were complete for only 21 rats which survived the testing period. These twenty-one rats consisted of ten fixated animals and eleven non-fixated animals. The procedure consisted of giving the fixated and non-fixated animals: 1) Four months or more of vacation during which time they stayed in their cages and received no other tests; 2) A discrimination problem just as had previously been given them and to which the fixated animals responded with their position habit and the non-fixated animals had previously learned; 3) A one-window situation for ten days with ten trials per day. This had previously been shown by Maier (18) to contain "an element of conflict" since only one window was presented and the animals was forced to jump regardless of whether it was to the positive or negative card; 4) Vacation for 12 days as in condition one; 5) One window situation for five days as in procedure



three; 6) A mixed series for 30 days with ten trials per day. This consisted of three conditions: 2) the symbol-reward discrimination problem, b) the two window situation with identical cards (either two positive or two negative cards ) and c) the one window problem. In the thirty days each procedure was used for ten days; 7) a test period and metrazol injections which lasted for 32 to 49 days. Daily tests were given the fixated animals on the symbol reward discrimination problem and the non-fixated animals were tested on the one window problem. After thresholds were determined the rats received the metrazol injections every other morning while testing went on every afternoon. The number of injections per rat varied from four to thirteen because some of the rats died during the convulsions produced by the metrazol.

The results showed that despite these varied conditions, including the metrazol convulsions, seven of the ten fixated rats continued their position responses and abortive jumps. All three of the animals who did lose their position habit did so before the metrazol shock period (two during condition two, and one during condition six). Despite the fact that the tests favored the symbol reward discrimination response these animals continued to respond with their stereotypy demonstrating the highly permanent nature of these fixations. During all of these

stressful situations the non-fixated rats, with one exception, continued to practice their symbol reward response. One rat developed a position response for 90 consecutive trials during condition six and then returned to his previous response. This lack of variability might indicate that the previously non-fixated rats did become fixated to the symbol.

Maier and Klee concluded that these abnormal fixations were permanent in nature and were not lost through time, changes in the problem situation, or metrazol produced convulsions.

Maier and Klee (21) continued to analyze these abnormal fixations in another experiment designed to determine the relation of the pattern of punishment to the abnormal fixations. In the study, three groups of twenty rats each were used and each of these groups was subdivided into two groups of ten rats. All of the groups were first required to make a particular response 97% of the time in the last 160 trials. Then all of the groups were required to modify this acquired habit. Third, an insoluble problem was presented and lastly the animals were required, by 50% punishment for the old response, to make a response differing in kind from the one acquired under the previous condition. The three main groups were divided



in terms of the method by which the initial problem was presented for developing a particular habit. Group I was presented with an insoluble problem and developed their responding habit as a result of the frustrating situation. Group II was allowed one free trial and then by means of reward and punishment trained to go to that position on all future trials. Group III was similarly trained except that instead of a position habit they were trained to form a discrimination habit.

Each of these groups was then subdivided in the second step of the experiment. Groups IA, IIA, and IIIA were required to reverse their first acquired responses by the method of 100% punishment for the old response. Groups IB, IIB, and IIIB were required to shift to a new response by the method of 50% punishment for the old response. All other conditions were exactly the same for all six groups.

The results of the experiment showed that in the first condition, as was to be expected, all the animals formed either a position habit or a discrimination habit. Differences in the groups were quite marked for condition two however. Ignoring the punishment for a moment, it was found that 65% of the animals in Group I failed to change or modify their original habit in the 200 trials allotted them, while only 25% of the other two groups failed to do so.



This, once again, showed the lack of variability in animals trained by frustration as compared to those trained by motivation or reward and punishment.

When considering the type of punishment used to bring about modification of the old response it would be expected that 100% punishment for the old response would be far more effective than 50% punishment but this was not the case. This is indicative of the fact that 100% punishment is frustrating and therefore, as seen in other frustrating situations, causes stereotypy. This postulation was further emphasized when one considered the fact that of those animals which learned the new habit it took many fewer trials for the 100% punishment rats than for the 50% punishment animals. Thus the authors postulated that if the rats frustration tolerance was high enough so that he learned before he was frustrated, 100% punishment was a quicker method of breaking an old habit but 50% punishment was slower and surer.

All the animals which had not developed the new response in the 200 allotted trials were then given guidance to force them to the correct response until they reached the criterion of 97% responses in 160 trials. Guidance consisted of manually pushing the rat to face the correct window and preventing its jumping to the fixated window. Condition three was then begun: the no-solution



problem was presented to all of the Groups and this meant 50% punishment for all the animals. Under these conditions one would expect a disorganization of the responses learned in condition B but such was not the case. Only 10% of the animals made any change in their behavior while all of the rest persisted in their previous response. It was to be noted that no evidence was produced, that regression resulted from frustration since the animals did not return to their responses in Condition I but the habit in progress continued as a fixation.

Measurement of the fixations produced by this period of frustration were next in order to determine whether the responses manifest in condition three were actually fixations or whether they represented mere persistence because no alternatives were offered. Condition four thus was set up to see if, with 50% punishment, the animals would shift to a new response in a soluble problem. The results showed that 57.6% of the rats did fixate despite the fact that a solution was possible and recognized, by those rats which fixated, by their resistance to the negative card and their abortive jumping to the negative card. Interesting to note here was the fact that of the 57.6% of the fixated animals only 32.3% had previously been fixated in condition B and 67.7% had not been previously fixated, indicating that once fixated and then



cured a rat is less susceptible to fixations again; his frustration tolerance has been raised (or he has learned to handle his frustration).

The authors concluded that this experiment showed that punishment was both a ~~negative~~ incentive and a frustrating agent. Administered 50% of the time punishment was more effective in breaking stereotypy and less frustrating than administration of 100% punishment for wrong responses. Once a fixation was broken the rat was somewhat less susceptible to fixation again. Habits were more easily modified than fixations but habits may have become fixations when attempts were made to change them by punishment. Thus a distinction between habits and fixations was recognized. Maier defined a habit as a response which may be modified by reward and punishment, and a fixation as an unadaptive response which resists modification by reward and punishment.

A study by Maier and Feldman (23) continued this series of studies and was designed to throw light on whether the strength of fixations could be altered by the length of the frustration period or whether fixations were an all-or-nothing phenomenon. Three groups of rats were subjected to the usual frustrating insoluble problem for different lengths of time: eight days, sixteen days, and twenty-four days, at ten trials per day. Control groups



were given the usual reward-punishment position habit training for eight, sixteen, twenty-four days respectively. The strength of responses in all groups was measured by the resistance of the animals to changing their response in the usual soluble discrimination problem situation which followed. Alternation of manual guidance and trial and error trials was used during the soluble problem due to the fact that frustration is prohibitive to abandoning position habits.

Analysis of the results showed that the three motivated groups did not vary significantly in the number of trials it took them to abandon their position habit. This indicated that the period of practice did not influence the strength of the learned habit. Such was not the case with the frustrated rats. The difference in number of trials to abandon their position responses for each of these groups was significantly greater statistically than for the combined control groups. Equally important, the differences between the frustrated eight day group and both the frustrated sixteen and twenty-four day groups was statistically significant. The difference between the frustrated 16 day group and frustrated 24 day group was not significant. Thus the authors concluded that rigidity in the fixated rat was greater than in the rat with a learned habit and that there were at least two degrees of rigidity

in the fixated rat. Thus it was shown that the strength of the fixated response increased from eight days of frustration to 16 days of frustration but that beyond 16 days of frustration there was no increase in the strength of the fixation.

In each of these studies use was made of guidance for the purpose of breaking fixated responses. In the first study Maier, Glaser, and Klee (19) found that fixated rats, unable to make a discrimination response, could readily be made to practice the discrimination if they were forced to do so for several trials, i.e., if the compulsive response was broken by a few guided trials the rat could then practice the new response with no difficulty. This led Maier and Klee (22) to make a special study to determine the effectiveness of guidance on both habit and fixation response alteration. Two groups of animals were used in the experiment and each group was subdivided into two subgroups. Group I rats were given the usual training to form a stereotyped response by the insoluble problem technique while the Group II rats were trained in the same, previously used method, of forming a habit by reward and punishment. Subgroups IA and IIA were then given the usual 200 trial and error trials to learn the discrimination or symbol-reward response. Subgroups IB and IIB were given thirty trials of guidance to the correct window followed by



70 free trials, i.e., both windows unlatched followed by 170 trials of the ordinary trial and error procedure.

The results showed that, as was expected, only one out of 16 of the animals in Group IA, or the frustrated animals, broke in two hundred trials while eight out of 15 of the Group IIA, or the reward-punishment animals, broke. This showed that while the reward-punishment procedure appeared to frustrate a few animals, the insoluble problem is highly frustrating and the animals do not break under ordinary trial and error conditions. In Groups IB and IIB after 30 guidance trials and 70 free trials only three or 10.7%, all in Group IB, of the rats persisted in their old response. On the basis of the fact that during the 70 free trials all but two of the 30 animals reverted to their former position habit which guidance had previously forced them to leave, the authors contended that guidance did not teach the animals but merely broke the fixation. During the 170 trial and error trials however, all but three of the animals were then able to practice the correct response. Guidance broke the compulsion or fixation, but the animal learned only by trial and error.

The same study included a repetition of the experiment with but one change: Groups IB and IIB received 100 guidance and 100 trial-and-error trials alternately



instead of 30 concentrated guidance trials at the outset followed by 70 free trials and 170 trial and error trials.

In this case the results showed that 100% of the animals in both experimental groups were able to abandon their stereotypy and practice the new response. Under ordinary trial and error, nine out of 15 rats in the frustrated group and two out of 14 of the rats in the rewarded group continued with their fixations. Also worthy of note here was the fact that guidance was also found to break the stereotypy more quickly than the trial and error method but at the same time learning the discrimination was slower in the guided animals than in the trial and error animals. Thus we see that guidance is more effective than trial and error in breaking stereotypy. It breaks the stereotypy more quickly but it does not help the rat to learn the problem more quickly. This again pointed to the fact that guidance was an effective technique for breaking an old response but trial and error was necessary for learning a new response.

Feldman (10) further investigated the elements of the guidance technique in an effort to determine what aspects of the procedure were effective in altering fixations and what stimuli in the frustrating situation were controlling the animal's fixated response. He employed a technique of allowing the rats to walk to the correct window on every other

trial in the soluble problem situation. The rats were induced to walk to the correct window along a run-way that extended from the jumping stand to the stimulus windows, to find out if the rats could abandon the fixated jumping response after successfully practicing the walking response. It was found that although the rats did learn to walk to the correct window they were still unable to abandon their jumping fixation when the walking pedestal was removed. Feldman concluded that the solution of a problem which utilized a different type of response was not effective in altering the original fixation. Further it was suggested that since no observable transfer was evidenced from the walking situation to the jumping situation the fixated rat was not responding in terms of the stimulus window, the position, or any other single aspect of the situation, but rather, the rat was responding to the total situation in which the rat was frustrated, that brought forth the fixated response.

Ellen (8) further studied the relationship of walking to the correct window and jumping to the correct window. In his experiment, after the animals had been frustrated and developed a fixation, they were trained on the walking platforms and then guidance was introduced. The rats were allowed to make a free jump, a walking response, a guided jump and then the series was repeated.



This was carried on for 400 trials. His results led him to conclude that some rats tend to generalize their jumping fixation to their walking behavior thus causing walking fixation, and that these two fixations are related because guidance on the jumping responses allows the walking as well as the jumping fixation to be broken. Thus it was concluded that the fixated rat was capable of some generalization but within a very limited area.

In order to verify further the conclusion that the rat was responding to the total situation Feldman and Newman (11) designed an experiment to determine the effect of guiding fixated rats under different stimulus conditions. In their experiment two groups of fixated rats were used in the soluble problem situation. One group was given transparent screen guidance, to the correct window on every other trial and the other group was given opaque screen guidance to the correct window on every other trial. Thus the rats receiving transparent screen guidance were able to see the total situation while they were forced to jump to the correct window; the rats receiving opaque screen guidance were able to see only the correct window to which they were forced to jump.

As was hypothesized on the basis of Feldman's (10) results, 100% of the transparent screen guided group were able to abandon their stereotyped response while only 35%



of the opaque screen guided animals were able to do so. This was found to be highly significant statistically. A further analysis of the effectiveness of the transparent-screen was made by giving the animals in the opaque screen guided group, who were still fixated at the end of the 200 trial soluble problem period, transparent screen guidance for further trials. All the animals were then able to abandon quickly their fixation. Interestingly these rats gave up their fixations in a significantly fewer number of trials than those animals which originally started with the transparent screen. The authors believed this suggested that the opaque screen guided animals learned something about the problem during the first 200 trials, but were unable to express this learning due to the compulsive nature of their stereotyped responses. Analysis of response latencies in the soluble problem situation for the correct and incorrect windows bore out the findings of previous studies that the rat did learn the discrimination but could not practice it despite opaque screen guidance in this case. The authors concluded that the reason why transparent screen guidance was so effective was that the rat was allowed to remain in the total situation and the guidance took place within the same context that the animal developed the stereotyped response. When guided outside the total situation, as with opaque screen



or on the walking platforms, the effectiveness was lost.

Newman (27) followed the above study with an investigation designed to determine the effect of these two types of guidance on the alteration of ordinary learned habits. The animals in this study were given the usual training on the Lashley apparatus and then given ten free trials to determine their preferred window. The preferred window was then designated as the correct window for the next 150 trials and the opposite window was made the incorrect one and locked on all trials. The habit was considered established at the end of the 150 trials and the habit alteration stage was then introduced. All of the animals were required to abandon their habit and practice a discrimination response. The animals were divided into two groups and one group was given opaque screen guidance on alternate trials, while the other group was given transparent screen guidance on alternate trials. This period lasted for 200 trials.

Newman's results showed that both guidance techniques were 100% effective in the alteration of these learned habits. A significant difference was found, however, in the number of trials it took the two groups to alter their responses. The transparent screen guided group took significantly fewer number of trials to break their habit than did the opaque screen guided group. This suggested



that transparent screen guidance was not only more effective than was opaque screen guidance in altering fixated responses, but also more effective than opaque screen guidance in the alteration of learned habits. In a comparison of the results of this study with those of the Feldman and Newman (11) study it was found that transparent screen guidance was more effective in breaking learned habits than in breaking fixated responses, and opaque screen guidance was as effective in breaking learned habits as transparent screen guidance was in breaking fixated responses. The author postulated that while a learned habit like a fixated response was a response to the total situation, the animals trained under ordinary learning processes were not as "situationally bound" as fixated rats and thus could generalize more readily from the guided to the non-guided trials. This ability to generalize more freely allowed the learned habits to be altered more readily by either transparent or opaque screen guidance.

Electroconvulsive shock (E.C.S.) has been used in numerous experiments to determine its effect on various aspects of the behavior of rats. Its use as a therapeutic technique for behavior disorders in humans is common knowledge. The relationship between the behavior of humans with mental disorders, and the behavior of the fixated rats discussed above is striking and for this reason

Neet and Feldman (26) considered it pertinent to investigate the effects of E.C.S. on fixated behavior of the rat.

A brief review of the results of other experimentation with rats involving E.C.S. should precede a discussion of the Neet-Feldman studies. It has been found that E.C.S. (2, 6, 7, 16, 25, 28, 29, 32) while it does not effect simple maze learning or retention, causes definite, immediate decrements in both learning and retention of more difficult tasks. Further study (3, 4, 5) has indicated that not only is the maze performance of rats impaired in terms of relearning trials, errors, time scores but this impairment is relatively permanent. Recently Hunt and Brady (1, 17) did a series of studies to determine the effects of E.C.S. on conditioned emotional response or "anxiety." They trained rats in a Skinner Box to press a lever to receive water and then the rats were conditioned with an auditory clicker and a mildly painful electric shock. The clicker was sounded for three minutes and the shock was given just before and just after the sound was turned off. The conditioned emotional response consisted of a marked reduction or cessation of the simple repetitive lever pressing response for the water reward. At the same time the rat was conditioned to crouch and defecate in this situation. Following the conditioning



procedure the rats were given 21 E.C.S. treatments, three per day. The rats were then tested for retention of the emotional response and it was found that the animals which had received E.C.S. no longer reduced their rate of bar pressing nor did they show any of the other emotional responses to the conditioned stimulus which the control animals continued to manifest during this period. The authors concluded that E.C.S. diminished or virtually eliminated conditioned emotional responses in this situation. Masserman et. al. (24) administered E.C.S. to neurotic cats and found that the neurotic patterns were broken up and the animals were capable of more normal adaptive behavior. A survey of the experimental findings of the effects of E.C.S. on animals has been made by Sachs (30).

The Neet-Feldman experiments were set up and carried out to investigate the effect of 10 day and 25 day E.C.S. on fixated behavior of the rat. The first experiment consisted of producing abnormal fixations in a group of rats by the regular insoluble problem technique described above. The experimental animals were then given one electroconvulsive shock per day for ten days while the control group was allowed to rest for ten days. All of the animals were then retested for fixation and it was found that E.C.S. did not effect the fixations. The second

experiment was an exact repetition of the first with the exception that 25 days of E.C.S. instead of ten days E.C.S. instead of ten days E.C.S. was administered to the experimental group. Their results again showed that the E.C.S. was ineffective in altering the fixated behavior.

A summary of the significant findings of these studies and those in the previous section led to the consideration of the present problem. It has been found that:

(1) When rats were placed in an insoluble problem situation they fell into a stereotyped behavior response.

(2) This stereotyped behavior was, in the majority of cases, an abnormal fixation as indicated by the rats inability to alter his behavior in a soluble problem situation.

(3) The inability of the rat to alter his behavior was a loss in behavior variability not an inability to solve the problem as indicated by the rats abortive jumps to the incorrect window and the greater resistance to jumping to the incorrect window.

(4) Learned habits were not subject to the same conditions of persistence as fixated responses as is shown by the ease with which learned habits were altered by ordinary trial and error.



(5) One-hundred per cent punishment was more frustrating than 50% punishment as shown by the fact that more fixations were produced by 100% punishment.

(6) Guidance was the only technique so far which has proven successful in altering fixated responses.

(7) Transparent screen guidance was more effective than opaque screen guidance in breaking fixations because the rat remained in the total situation in which he developed the fixation while he was being guided to the correct response.

(8) Both transparent screen guidance and opaque screen guidance were more effective in breaking learned habits than in breaking fixated behavior.

(9) Twenty milliamperes E.C.S. administered for as many as 25 days following frustration had no effect in altering fixations.

It is to be noted that in the Neet-Feldman experiments discussed above, the animal was removed from the frustrating situation for the shock periods and then returned again to the soluble problem. If the rat were responding in terms of the total situation it is conceivable that the administration of the E.C.S. was too far removed from the testing situation to be effective in altering behavior in that situation. If this were the case, had a series of E.C.S. been administered during the

same period that the rat was placed in the soluble problem situation, there might have been a greater effect on behavior in the testing situation.

Feldman and Neet (12) did a study to determine the effect of E.C.S. on the alteration of frustration instigated responses in rats when transparent screen guidance was used during the soluble problem situation. They frustrated their rats, administered E.C.S. for ten days to the Experimental Group while the Control Group rested, and then put the animals in a soluble problem situation with transparent screen guidance on alternate trials. Their results showed no differences between the groups. The authors thought that the transparent screen guidance was too effective and, as a result, concealed the differences between the shock and non-shock groups.

It is suggested that since the value of opaque screen guidance in the soluble problem situation is known to be less than the value of transparent screen guidance, the efficiency of opaque screen guidance might be increased if administered concomitantly with E.C.S.



THE EXPERIMENTAL INVESTIGATION

## GENERAL PROBLEM

Clinical evidence has suggested that electroconvulsive shock is an effective therapeutic procedure for altering some abnormal human behavior. This evidence is not conclusive, however, since the patient usually receives some type of psychotherapy or sociotherapy (possibly "guidance") at the same time he receives the E.C.S.. The question arises as to whether it is the E.C.S. alone, the guidance (psychotherapy or sociotherapy) alone, or the two in combination which alter the abnormal behavior.

In animal studies of abnormal behavior in rats Feldman and Newman (11) showed that transparent screen guidance was 100% effective in the alteration of fixated responses while opaque screen guidance was only 35% effective. Neet and Feldman (26) found that ten or 25 days of electroconvulsive shock given after fixation but not simultaneously with the soluble problem situation failed to alter fixated behavior. The question arises; would not E.C.S. administered in a closer time relationship with the problem situation be more effective in the alteration of these fixations? At the same time would not the E.C.S. administered concomitantly with guidance be more effective than guidance alone in breaking fixations?



Since transparent screen guidance was found to be so very effective and since E.C.S. has not as yet proved its worth in breaking fixations it appears that if E.C.S. were of any value in the proposed situation the value might not be revealed if the two were combined. With this in mind and the knowledge of the fact that opaque screen guidance is only 35% effective in breaking fixations the present study was set up to test the hypothesis that:

Electroconvulsive shock given concomitantly with opaque screen guidance will be more effective than opaque screen guidance alone in the alteration of fixated responses in the rat.

### SUBJECTS

The subjects used in this experiment were 24 male albino rats of the Wistar strain, purchased from the Charles River Breeding Laboratories, Boston, Massachusetts. The animals were 75 to 90 days old at the beginning of the experiment.

### THE APPARATUS

The apparatus used in this study was a modified semi-automatically controlled Lashley jumping stand (9)

(see figure 1, p. 35). This stand consisted of a jumping platform (7" x 5 $\frac{1}{2}$ ") from which the animal jumped in making its responses; a screen (49" x 59") with two windows (6" x 6") in which the discrimination stimuli were located; a feeding platform (23 $\frac{1}{2}$ " x 19") behind the screen, upon which the animal received its reward when it made a correct response; and a canvas net (14" x 37") below the screen into which the rat fell when making an incorrect response. Thus, the animal was placed on the platform and was required to jump eight and one half inches to either of the two windows. When a correct response was made the animal pushed open the hinged stimulus window by jumping at it and landed on the platform behind the window where it was rewarded with food. An incorrect response resulted in the rat bumping its nose against the locked window and falling 39 inches into the net below.

The stimulus windows were made of plexiglass and were illuminated by 100 Watt electric light bulbs placed over them, and behind the screen. These bulbs were shielded by metal shields to throw maximum light on the windows. The experimenter could, by throwing a switch, illuminate one of the windows and not the other, thereby presenting a bright and dark stimulus for discrimination. Either window could be locked or unlocked by throwing another switch. An electric shock administered through the





Figure 1. The Modified Semi-Automatically Controlled Lashley Jumping Stand

grid which was the floor of the jumping platform was used to induce the animal to jump. This shock was supplied by passing 1.5 volts from an ordinary dry cell through an automobile ignition coil and a Ford type condenser, thus building up the voltage to approximately 3000 volts. Amperage was kept quite low. The animals received approximately one shock every two seconds. The number of shocks was controlled by a simple make and break push-button switch located on the control panel which the experimenter operated. Response latencies were measured by means of an electric timer on the experimenter's desk. This timer had a 100 second sweep with markings for each fifth of a second. The timer was started when the animal was placed on the jumping platform and stopped as soon as the animal jumped.

The electro-convulsive shocks were administered using the University of Massachusetts modification of the Pittsburgh Electroshock Apparatus and each shock consisted of a current of 20 milliamperes for 0.83 seconds. Battery clips with round, silver plated, cup shaped electrodes (9 mm in diameter) were clipped on the rat's ears for application of the shock. Burdick electrode paste was used on the electrodes to insure uniform electrical contact. An opaque masonite screen of trapezoid shape, 13 inches along the base, 13 inches high at the outer edge and 8 inches



high at the inner edge was used for guidance. Figure 2 shows the opaque screen in place and a rat on the stand ready to jump. The screen was placed so that the animal could not see the incorrect window and had no choice other than to jump to the correct window. The rats were fed Purina Fox Chow meat meal immediately after they completed their tenth jump during the experimental period. Each rat was allowed approximately 25 minutes to eat in an individual cage and then was returned to his home cage. This was the only time the rats were fed during each 24 hour period of the experiment.

#### PROCEDURE

The following steps were involved in the procedure:

1. All the animals were given a preliminary period to familiarize them with the apparatus. This consisted of feeding the animals on the feeding platform until they became familiar with the situation and went to the food readily. The animals were divided into groups of five and were allowed to spend about 30 minutes on the stand each day. This familiarization period lasted three days at the end of which time the animals would go to the food and eat readily.



Figure 2. Rat In Position To Jump  
Guided By Opaque Screen



2. The animals were trained to jump from the platform to the windows in the screen. This was accomplished by placing the platform within an inch of the screen so that the animals could step from the jumping platform to the feeding platform. The jumping platform was moved back approximately one inch each day until the animals were jumping eight and one half inches, the maximum jumping distance. Ten trials were given each rat each day. After eight days the rats were accustomed to jumping the maximum distance and then the experimenter gradually started to close the windows a little each day until the rats were jumping through closed windows. This took three days. In this phase the windows were not locked at any time so that by jumping the rat could push open the window and reach the food on the feeding platform. In order to prevent position habits or preferences during this stage the animals were manually guided on alternate trials. That is, the animal had one free trial and then a guidance trial to the opposite window.

3. In this stage the grid shock was introduced. The animal was permitted to stay on the stand thirty seconds before the shock was given to induce jumping if the rat had not already done so. Ten trials per day were given during this period, and this period lasted four days.

During this time the bright and the dark windows were shifted in random order from one side to the other. Neither window was locked. If the animal made the same response three times in succession it was manually guided to the opposite side on the following trial.

4. At the conclusion of this training period, which lasted a total of 18 days, all of the animals were subjected to a no-solution problem for 16 days at the rate of ten trials per day. This insoluble problem consisted of locking the windows in random order so that neither a brightness habit nor a position habit would be systematically rewarded or punished. In such a situation there was no response which would permit consistent escape from punishment. Refusal to jump was overcome through use of the grid shock at the 30 second limit. This sixteen day period was determined as optimum for frustration by Maier and Feldman (21). This frustration resulted in stereotyped responses by the animals either to a position, left or right, or to a brightness, dark or light. At the end of this stage the animals were matched and divided into experimental and control groups on the basis of the type of the stereotyped responses the animals made and the number of times they made that response. For example, if two rats jumped to the left for 148 trials one was put in the control group and one was put in the experimental group.



5. The animals were next required to abandon their fixated responses and learned a discrimination response. All the animals which had developed a jumping habit to the left, right, or dark window were required to change to the bright window. The two groups, experimental and control, were required to learn under different conditions as follows:

Experimental: This group was given opaque screen guidance to the correct window on every other trial. These animals were unable to see both windows but were forced to jump to the correct window on those guided trials (see figure 2, p. 38). In addition, this group was given one electroconvulsive shock approximately 12 hours before its daily trial.

Control: This group was given opaque screen guidance in exactly the same manner as the experimental group but they received no electroconvulsive shock.

The procedure for the administration of E.C.S. was as follows: The animal was removed from his home cage and held by the experimenter while the electrodes were clipped on the animal's ears. The rat was then placed with his legs down on a pillow with the experimenter's gloved hand cupped over the animal's back. This procedure was used to prevent fracturing the animal's back when it

Table 1

Summary of Procedure

Stage	Procedure	Preliminary familiarization with apparatus	Training to jump	Introduction of grid shock	No- solution problem	Alteration of stereotype by guidance and shock	Experimental Group	Control Group
							Opaque screen guidance to correct window on every other trial. E.O.S. 12 hrs. before trial periods	Opaque screen guidance to correct window on every other trial.
No. of rats		24	24	24	*20		11	9
No. trials per day		-	10	10	10		10	10
No. of days		4	7	4	16	Training continued until rats abandoned stereotyped habit and learned new one to criterion or for a maximum of 200 trials.		

\*Four rats died during this period.



convulsed as a result of the current applied. The current was applied by throwing a switch on the apparatus as soon as the animal was quiet on the pillow. As soon as the current was applied the rat went into a convulsion similar to the one described by Braun, Russell and Patton (3). The rat gave a start, arched its back, and extended its legs straight down into the pillow and then ~~ventrally~~ <sup>back</sup> in a flexed position. The rat remained in this rigid position for several seconds and then went into tonic convulsions which consisted largely of twitching of the legs. Following this stage the rat became flaccid and completely lost its rigidity. Upon regaining consciousness the animals appeared to be poorly orientated, weak, and highly sensitive to touch and sound. Defecation, ejaculation, and a small amount of bleeding in the eyes was common during the convulsive stages. Each rat reacted in a slightly different manner to the shock but all followed the same general pattern as described.

All animals were given ten trials a day until they had learned the new response or for a maximum of 200 trials. The criterion for learning was no more than one error in three consecutive days.

## RESULTS AND DISCUSSION



The results of this experiment will be discussed with regard to the differences between the groups of animals and the differences between the animals in each group which were able to break their fixations in the soluble problem situation.

#### FRUSTRATION PERIOD

It will be recalled that during this period the bright and dark windows were alternated on the left and the right sides in a random order and that the left or right window was locked in random order. The problem was insoluble because no matter what kind of a consistent response the rat made he was punished 50% of the time. As in previous experiments the rats in this experiment, after some variability, persisted in making one response and continued to practice that response throughout the non-solution or frustration period. Table 2 shows how the animals responded in terms of the four possible stereotypes, i.e., the number which had bright, dark, left and right fixations. It can be seen from Table 2 that all of the responses were practiced approximately the same number of times and as found in previous experiments position habits were the most commonly developed stereotype in this situation.

Table 2  
Summary of Responses Developed in the Frustration  
Period

Number of Rats	Response	Average Number of trials Response Practiced	Average Percentage of total trials
13	Position (left)	140.8	88.0%
5	Position (right)	144.4	90.2%
2	Discrimination (dark)	152.0	95.0%
*			

\* None of the rats developed a bright response.



On the last day of this period the animals were divided into the Experimental and Control Groups according to the type of response developed during this period and the number of trials this response was practiced. The results of this matching procedure are summarized in Table 3. This table shows the type of response developed in the frustration situation, the number of trials the response was practiced and the percentage of total trials the response was practiced. It can be seen that there was approximately the same number of animals in each group with each type of response, and the average number of trials each response was practiced was also approximately equal for the animals in the experimental and the control groups.

#### SOLUBLE PROBLEM PERIOD

In this stage the rats were required to abandon their responses, which were developed in the frustration period, and adopt a bright or a dark discrimination response. Both groups were given opaque screen guidance during this period. The experimental group was given E.C.S. approximately 12 hours before they were put in the problem situation. The shock was administered on the first ten days of this period and then the treatment for both

Table 3

Number of Animals with Each Type of Response in  
the Experimental and Control Groups

	Control				Experimental		
	Opaque Screen Guidance				Opaque Screen Guidance & E. C. S.		
Response	Number of Rats	Average Number of Trials Response Practiced	Per- centage of Total Trials		Number of Rats	Average Number of Trials Response Practiced	Per- centage of Total Trials
Left	6	139.8	87.4%		7	141.6	88.5%
Right	2	144.5	90.3%		3	144.3	90.2%
Dark	1	156.0	97.5%		1	148.0	92.5%



groups was exactly the same. There were four factors of particular<sup>importance</sup> with respect to the differences between the groups to be considered in relation to the results of the behavior of the animals in this study. They were: 1) the number of animals in each group which broke their fixation and learned the new problem; 2) the number of trials it took each group to break; 3) the number of trials it took each group to reach criterion\*, i.e., to learn the problem, and 4) the differential number of trials between the breaking and learning scores for the two groups, i.e., the number of trials it took the animals to reach criterion after they broke their fixation. Tables 4 to 6 summarize these data and in addition give the ranges, the standard deviations, and t scores for these different categories.

It can be seen from these tables that all of the rats in the Experimental Group broke their fixation and subsequently learned the discrimination responses. The mean breaking score for this group was 73 trials with a range of 23 to 163 trials and a standard deviation of 38.76. The mean learning score was 103.6 trials with a range from 50 to 190 trials and a standard deviation of 36.35. This group had a mean of 30.6 trials between breaking and learning

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\* The criterion for learning was not more than one error on free trials for three consecutive days.

Table 4

A comparison between experimental and control groups of the mean number of trials to change to the discrimination response (to break the fixation)

	Experimental Group	Control Group
Number of rats	11	9
Number of rats breaking	11	6
Average number of trials to break	73.0	37.7*
Range	23-163	11-115*
Standard Deviation	38.76	35.11*
Fisher's <u>t</u> score		1.81

\* Does not include the animals which did not solve the discrimination problem because these data concern only the differences between those animals which broke in each group. We are concerned here with the variation of the behavior between those animals which broke their fixation with guidance and those which broke their fixation with E.C.S. and guidance.



Table 5

A comparison between experimental and control groups of the mean number of trials to reach criterion in learning the discrimination response

	Experimental Group	Control Group
Number of rats	11	9
Number of rats learning	11	6
Average Number of trials to learn	103.6	80.0*
Range	50-190	40-150*
Standard Deviation	36.35	35.59*
Fisher's <u>t</u> score		1.20

\* Does not include the animals which did not solve the discrimination problem because this data concerns only the differences between those animals which broke in each group. We are concerned here with the variation of the behavior between those animals which broke their fixation with guidance and those which broke their fixation with E.C.S. and guidance.

Table 6

A comparison between experimental and control groups of the mean differential number of trials between changing to the discrimination response and reaching criterion

	Experimental Group	Control Group
Number of rats	11	9
Number of rats breaking and learning	11	6
Average Number of trials between breaking and learning	30.6	42.33
Range	21-57	29-71
Standard Deviation	9.18	14.92
Fisher's $t$ score		1.61



with a range of from 21 to 57 trials and a standard deviation of 9.18.

In the Control Group only six of the nine animals broke and learned the discrimination problem. The mean breaking score for these six animals which broke was 37.7 trials, with a range of 11 to 115 trials, and a standard deviation of 35.11. The mean learning score was 80.0 trials with a range of 40 to 150 and a standard deviation of 35.59. These six animals had a mean of 42.33 trials between breaking and learning with a range of 29 to 71 and a standard deviation of 14.92.

Since the number of animals was so small and since 100% of the animals in the Experimental Group solved the problem, Fisher's t test could not be used for determining the statistical significance between the groups in the number of animals which broke their fixation. Instead use was made of Snedecor's (31, p.4) tables and it was found that, within 95% confidence limits, there was such a large overlap in the levels of significance between the six out of nine animals which broke in the Control Group and the 11 out of 11 animals which broke in the Experimental Group that this difference may have been due to chance alone or to sample variation.

Use was made of Fisher's t test for determining the significances between the means of the other three



factors mentioned above. When applied to the significance between the groups, it was found that the number of animals which broke in each group yielded a  $t$  value of 1.05 for 17 degrees of freedom. This was significant between the 10 and 50 per cent levels (13). Applied to the difference between the mean number of trials, which each group took to break their fixation, this test yielded a  $t$  value of 1.81. This was significant between 10 and 5 per cent levels, at 15 degrees of freedom. The differences between the means of the group learning trials yielded a  $t$  value of 1.20 which, with 15 degrees of freedom, was significant between the 50 and 10 per cent levels. The differences between the mean differential number of trials of the two groups between breaking and learning yielded a  $t$  value of 1.61 which with 15 degrees of freedom was significant between the 50 and 10 per cent levels. In general  $t$  values which are not at the 5% level or less are not accepted as highly significant (14) indicating that although some of these values approached statistically significant differences, none of them actually fell in that category. Thus, from a statistical point of view the hypothesis that opaque screen guidance given concomitantly with ten E.C.S. is more effective than opaque screen guidance alone was not substantiated.

When considering this experiment in the light of past experimentation, there are two factors which stand



out pointing to the possibility that too small a sample i.e., too few rats in each group, was used causing sampling variation, and that perhaps the trends seen in the results of this experiment can be considered to be more conclusive than the statistics indicate. The first point will be considered in relation to the Feldman-Newman study and the second point with reference to the Neet-Feldman studies.

It will be remembered that in the Feldman and Newman study half of their animals after frustration were given opaque screen guidance while the other half were given transparent screen guidance. It was found in this experiment, which made use of 20 animals in each group, that 35 per cent of the opaque screen guided animals broke their fixations and learned the new discrimination problem. The conditions for the Control Group in the present experiment were exactly the same as those in the opaque screen guided group in the Feldman-Newman study. It seemed reasonable to assume that the results of this study should have been comparable, but such was not the case. The Control Group in this study had 66 per cent of its animals break, which in terms of percentages was twice as many as the Feldman-Newman study, but which in terms of animals was only between two and three animals difference. This difference may have represented sampling variations in the



small sample.

In the Neet-Feldman studies (26) E.C.S. was administered to the rats for periods of 10 and 25 days prior to allowing the animals to return to the soluble problem. In both Neet-Feldman studies, despite 25 days of E.C.S. in one, no significant difference was found and as a matter of fact, the experimental and control groups were almost equal with respect to the few animals which broke. In the present experiment, quite in contrast to the Neet-Feldman studies, 100 per cent of the experimental animals broke and since opaque screen guidance was probably in the vicinity of 35 per cent ~~of~~ effective the E.C.S. had shown itself to be more effective in that case.

These two points shed a somewhat different light on the results of the present experiment. Certainly a repetition of this experiment is necessary before any definite conclusions can be made. Such experimentation may bear out the trends seen in the data here.

Feldman and Neet showed that E.C.S. given between frustration and the soluble problem situation had no effect on fixations. Feldman and Neet (12) found no difference between groups given E.C.S. for ten days and then transparent screen guidance in the soluble problem. The present experiment in which E.C.S. was administered at the same time the animal was in the soluble problem situation did



indicate that E.C.S. was helpful in breaking fixations, at least when it was combined with opaque screen guidance. One might postulate that here again we were dealing with the problem of trying to bring about a cure within and outside of the total situation. In the Neet-Feldman studies the E.C.S. was in effect not closely related temporally to the jumping problem because the rat was entirely removed from the problem while receiving the shock. The Feldman and Neet (12) study indicated that effectiveness of the E.C.S. may not have been apparent due to the transparent screen guidance. In the present study; however, the rat received the E.C.S. each day, was given time to recover, and then on the same day was put back in the problem situation. As a result, the immediate effect of the shock may have resulted in the variable behavior of the rat leading to the solution of the problem.

At the same time it can be postulated that since metrazol shocks were ineffective in the Maier and Klee (20) experiment this may have been due to the fact that the animals received only three or four convulsive shocks and this was not enough to effect the fixations. One can not overlook the possibility, however, that the shock alone is ineffective, and that it only helps to improve the effectiveness of opaque screen guidance which was not used by Maier and Klee. Another point to be considered is the



fact that the mean breaking score of the Experimental animals is significantly (8 per cent level) greater than that of the Control Group. A possible explanation for this is the knowledge of the fact that in past experimentation rats which had not been frustrated to their "saturation point" (19) broke rather quickly in the soluble problem while others did not break at all. (In the present problem no test for fixation was made to be sure that all of the animals were fixated, so it is possible that certain of the Control animals were not fixated. Then, if it is assumed that opaque screen guidance assists only non-frustrated or mildly frustrated animals, the Feldman-Newman (11) study would tend to confirm this point.

These data might be looked upon as supporting the Hayes (15) theory that the convulsive treatment causes confusion and as a result is effective in breaking fixations. Since it has been shown in past studies that once the animal breaks his fixated response he is generally able to leave it for more adaptive behavior, we may postulate that the E.C.S. has caused enough confusion here to cause the rat to jump to a window other than the one to which he is fixated. Having done this the rat is then capable of more adaptive behavior and responds correctly to the discrimination problem.

The question immediately arises, however, as to



why the shock does not cause confusion in the learning period, and if continued beyond the learning period would shock eventually cause the animal to confuse what he has learned? These questions can only be answered by further experimentation. The effectiveness of E.C.S. in this situation may be explained in another manner. According to the anxiety-reduction theory an animal in a frustrating situation builds up a great deal of anxiety, which is reduced only by escaping from the situation, in this case jumping. If the animal escapes, his anxiety is reduced and his mode of behavior for escaping is reinforced so that the next time in the same situation he will continue to use the same mode of escape from the stress. Thus we can see that in the soluble problem situation the rat continues his fixated behavior because it has been so strongly reinforced that he has lost his ability to vary his behavior. Since the rat is able to vary its behavior when given E.C.S. we might postulate that E.C.S. reduces anxiety so that the animal is once again able to express adaptive behavior variability.

Still another alternative explanation is possible for explaining the effectiveness of shock. It was thought by Feldman and Newman (11) that rats guided by the opaque screen were unable to generalize from the guidance trials and therefore were unable to benefit from the opaque screen

guidance. We might postulate that in this study E.C.S. helped make opaque screen guidance more effective because the rats could generalize more readily after shock.

None of these postulations can be settled, however, without further experimentation. It is necessary to find out whether it is the shock, or the shock in combination with the opaque screen which is responsible for breaking the fixations. Also one might postulate that if the E.C.S. were given one, two, or five hours before testing it might be more effective.



## SUMMARY

This study was designed to compare the effect of E.C.S. and opaque screen guidance given concurrently with the effect of opaque screen guidance alone on the fixated behavior of the albino rat.

A group of 20 rats was frustrated in an insoluble problem situation on the Lashley jumping stand. The animals were then divided into ~~matched~~ groups of nine and eleven animals respectively. All animals were then required to abandon their stereotyped response. On every other trial all animals were given opaque screen guidance to the correct window. The eleven Experimental animals in addition to being given opaque screen guidance, received an electroconvulsive shock approximately 12 hours before the testing period for the first ten days of the soluble problem situation.

All eleven animals in the Experimental Group abandoned their fixations. Only 6 out of 9 of the Control Group abandoned their fixations in 200 trials. These results, in themselves, were inconclusive, but tended to support the hypothesis that E.C.S. administered concomitantly with opaque guidance is more effective than opaque guidance alone in altering fixated behavior.

Several possible explanations for the probable effectiveness of E.C.S. in combination with guidance for breaking fixated behavior in rats, have been suggested.



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