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Experimental neurosis in the white rat.

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EXPERIMENTAL NEUROSIS

IN THE WHITE RAT

by

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I. Introduction

In the 25 years since the phenomenon of "experimental neurosis" was first observed in the dog by Pavlov, there has been a constantly increasing interest in the subject. To date, the literature on the subject includes reports on "experimental neurosis" in eight different species, including man. The reports cover aspects of the subject from initial studies of the etiology of the disturbance, to tentative attempts at therapy through the use of drugs.

The present experiments were initiated in an effort to investigate and cast further light on the factors which play a causal role in the appearance of "experimental neurosis" in the white rat . The white rat was chosen as the subject because it has been the standard experimental animal in many psychological investigations to date; yet, except for the very recent work of Cook and Maier, this animal had not yet been investigated as to its susceptibility to experimental neuroticism.

The method, as in all previous work on this problem, was to subject each animal to a series of problems of increasing difficulty until it reached a point where the problem was beyond its capacity. Forcing the animal to continue responding in such an unsolvable situation eventually elicited responses of an aberrant nature.

Two series of experiments were run, seven animals being used in the first and five in the second. Of the total twelve animals, two developed marked neurotic symptoms which were sufficiently intense to warrant labeling these animals as having definitely developed "experimental neurosis." The remaining ten animals all showed disturbances of varying degrees. In some,

these disturbances were minor and transitory in nature so that they can hardly be considered as anything but momentary emotional outbursts. In the others the degrees of aberrant behavior displayed showed gradations of intensity from the most intense to the least intense.

The work on these animals indicates that when faced with a continuing unsolvable situation, the white rat under certain specific circumstances will develop "experimental neurosis." The extent of this neurosis will depend upon the interaction of the animal's previous behavior repertoire, the nature of the experimental setup, the intensity of the conflict situation, and the length of time which the animal is subjected to it.

II. Survey of Literature

A. Historical

In 1912, Lashley (15), while investigating visual acuity and discrimination in the white rat stumbled upon a phenomenon in the behavior of his animals to which he gave only brief space in his report. What he had found was that one of his rats after having mastered a series of increasingly difficult discriminations came to a point where he could no longer discriminate. Subjection to an extended period of training on this "unsolvable" problem caused the animal not only to show "complete loss of attention" but also to lose the ability to respond adequately to the previously learned discriminations. In short, the animal lost the ability to respond adequately to a previously learned situation because of an intervening period of conflict.

A quarter of a century was to elapse before this same phenomenon was again studied in the white rat. In this period of time, however, other workers, beginning with Pavlov, stumbled across, and then deliberately and systematically investigated, similar types of behavior phenomena in several different species.

The history of experimental neurosis properly begins with the work of Pavlov. He it was who recognized the phenomenon for what it was, gave it the name of "experimental neurosis" and in large measure, established the direction in which most future investigation of the subject was to proceed.

Because of the quantity of material to be covered, it seems advisable to group it according to the type of organism which was used as subject; and since the original definitive work was done on the dog, it seems logical to begin with that animal.

1. Experimental Neurosis in the Dog.

a) Pavlov (28, 29, 30, 31, 41, 42, 43, 44, 45, 46, 47)

Pavlov's discovery of the phenomenon was quite accidental. One of his assistants (Erofeeva) (28) while working on the salivary conditioned response of three dogs discovered that his animals broke down, giving emotional responses and becoming quite unmanageable if the response to strong electric stimulus in one locus was attempted to be generalized to stimulation at new loci on the skin when the distance between these new loci and the original locus became too great.

Another one of his assitants (Shenger-Krestovnikova) (28) also found that an emotional outburst and disruption of behavior was evidenced by one of his animals when a differentiation between a circle and an elipse was pushed beyond the animal's limen.

Two other dogs (Experiment of Petrova) (28) broke down when the latent period which followed the presentation of the stimulus was stretched beyond the animal's ability to master it.

> When the delay of the reflexes reached two minutes the animal began to enter into a state of general excitation, and with a further prolongation of the delay to 3 minutes the animal became quite crazy, unceasingly and violently moving all parts of its body, howling, barking and squealing intolerably. (p. 294)

Still another dog (Experiment of Rosenkov) (28) broke down when a previously learned positive stimulus (24 tactual stimuli per minute) was made to follow a negative inhibitory stimulus (12 tactual stimulus per minute) without a time interval.

In one dog, (Experiment of Riokman) (28) neurotic behavior was precipitated when an attempt was made to transform an inhibitory response to a 60 beat metronome. The result here was a diminution and inhibition of the animal's responses to all other stimuli.

Finally, a sudden abolition and disruption of various conditioned reflexes was noted in several dogs which had experienced a very intense storm and flood during which the laboratory was inundated and the animals had had to be moved from their living quarters under extremely disturbing circumstances.

Cook (6) in reviewing Pavlov's findings shows that the results obtained in Pavlov's laboratory can be classified as having occurred in six types of situations:

> Situation 1 - Continued presentation of a conditioned stimulus which not only has the effect of establishing a new association but also results in the inhibition of a strong inborn reflex.
>
> Situation 2 - Presentation to the animal of similar conditioned stimuli to mutually exclusive behavior.
>
> Situation 3 - Delay of reinforcement of positive conditioned reflexes for a given period of time after the beginning of the conditioned stimuli.
>
> Situation 4 - Rapid transition from one conditioned stimulus to another, the two stimuli being conditioned to evoke antagonistic behavior.
>
> Situation 5 - Reinforcement of a conditioned stimulus which had previously had an inhibitory effect.
>
> Situation 6 - Occurrence of very strong or unusual stimuli. (p.1262)

Continuing, Cook further shows that the sumptoms displayed by Pavlov's dogs may be summarized as follows:

> 1. A loss of a previous habit, regardless of its strength, of making responses to certain conditioned stimuli ...
>
> 2. A loss of a previous habit of inhibitory responses to certain unreinforced conditioned stimuli regardless of how readily these inhibitions had been acquired.
>
> 3. A loss or impairment of the capacity to reacquire these lost habits as shown by the failure or difficulty of retraining efforts.

4. Various degrees of restlessness and excitement when brought into the experimental room, when put into the apparatus or when presented with certain conditioned stimuli.

5. Refusal to eat in the experimental situation.

(p. 1266)

b) Petrova (48, 49, 50, 51, 52, 53, 54)

Continuing the work on dogs originally begun under Pavlov, Petrova deliberately set about to obtain experimental neurosis in animals and then attempted treatment of those neuroses by means of bromides and caffein.

In one instance (51), a strong well-equilibrated dog contracted a "cyclic" experimental neurosis when, after having been accustomed for three years to delays between the conditioned and unconditioned stimuli of only 30 seconds, the experimenter lengthened the delay to two minutes. It was later found possible to completely cure this animal by administration of pottassium bromide combined with caffein.

In another similar instance, (53) in which the dog also developed a "cyclic" neurosis, behavior was normal for two days and abnormal for one. It was found possible to cure this animal by the administration of sodium bromide. Still another time (52) one normal and four castrated dogs broke down when an attempt was made to transform positive conditioned stimuli (beats of metronomes) into negative, and their corresponding negative differential conditioned stimuli into positive stimuli. The task proved too difficult, resulting in general lowering of excitability and in the appearance of an insensitivity to the specific stimuli used.

Finally (54) two castrated dogs fell into an experimental neurosis when they were given the task of transforming positive conditioned stimuli into negative and negative conditioned stimuli into positive.

Separate administration of doses of sodium bromide and caffein helped but little; a mixture of the two, however, was highly beneficial.

Altogether then, we see that Petrova obtained neurosis in dogs when:

(1) Those dogs were set the task of responding to a difficult stimulus with too long a delay.

(2) An attempt was made to transform a positive stimulus into a negative one.

The administration of sodium bromide cured the animal in some cases. In others, this proved insufficient, but when the bromide was administered together with caffein the mixture effected a cure.

c) Karn and Malamud (14)

These workers encountered one instance of experimental neurosis while training two dogs on the double-alternation temporal maze. One dog mastered this, the other developed an emotional disturbance "characterized by long pauses followed by extremely rapid movements, head turnings, body trembling and whining," when put into the maze for the control series. This, though the animal had responded adequately during the training series in which intermediate doors were used in the maze alleys.

The animal, after the behavior disruption, was still unable to adjust even when returned to the "training" situation which it had previously mastered.

d) Lindberg (39)

Lindberg noted that after partial extinction of a C.R. in a dog, the negative stimulus began to elicit the positive response. The

phenomenon is a form of the ultra-paradoxical phase of the C.R. which had been noted by Petrova in experimental neurosis disturbances.

e) Drabovitch and Weger (36)

In working with dogs, these experimenters noted reactions in two of their animals which they classified as experimental neurosis. The reaction of one of these animals corresponded with the conditions as described by Pavlov.

2. Experimental Neurosis in the Sheep.

Following the work of Pavlov and his successors in Russia, a group of investigators under Liddell at Cornell studied the phenomena of experimental neurosis in sheep. Liddell, collaborating at various times with Anderson (1, 2, 17, 18, 21), Bayne (16, 20), Curtis (21), Kotyuka (18), Hartman (17, 18), Parmenter (2, 20, 21), and Sutherland (20, 21) encountered aberrant behavior in sheep under the following circumstances.

One sheep broke down while being trained to build up a delayed conditioned response to a metronome (1).

> It seems ... as if the difficulty leading to the ... disturbances was the rapid and frequent transition from inhibition to excitation or from restraint to action. (p.340)

The neurotic behavior consisted of a disruption of the previously conditioned responses, resistance to being led into the laboratory, and "nervous movement of the foreleg during the rest period."

Another animal (1) developed neurotic behavior as a result of an attempt to force it to differentiate between a metronome beating at 120 beats per minute and one at 50 beats per minute. The animal proved incapable of mastering this and after 42 trials on the unsolvable problem, the neurotic symptoms appeared. It became difficult to handle, resisted

being caught and brought to the laboratory, hung from the suspension straps in the laboratory, gave erratic reactions to both the positive and negative stimuli and evinced increasing nervousness and excitement. The author further states that "No evidence of a complete and lasting recovery has been observed in the course of five years."

A third sheep (1) developed neurotic symptoms when after having successfully made adjustment to a series of difficult discriminations between the metronome beats at various rates, it was "subjected to a series of special tests of about two hours' duration each day" during which it was tested, serially, for each of the discriminations which it had previously learned. After several weeks, the animal's reactions to several of these stimuli "became gradually weakened and completely disappeared in a great many cases. This condition lasted for about one month and was followed by one characterized by excitement" during which the animal gave very violent positive responses to all the stimuli.

A fourth sheep (1) was set the problem of differentiating between two pure tones. These two tones (435 double-vibrations and 900 double-vibrations) were presented alternately at seven minute intervals. After a month of daily training, the animal had still not shown any sign of discriminating. "At this point, the sheep became restless and unmanageable, and almost immediately thereafter neurotic symptoms made their appearance." These were spontaneous movements of the test limb, at times preceded by a very slight trembling of the limb.

Liddell et al. (17, 18) also report some experimental results on the therapeutic aspects of experimental neurosis. It was found (17, 18) that subcutaneous injections of cortin effected an increase in the vigor of the conditioned response and at the same time decreased the spontaneous

movements. " The animals were quieted and became more cooperative both outside and inside the laboratory."

Repeated subcutaneous injection of adrenalin (solution 1:200,000) had an effect upon the sheep's behavior exactly opposite to that of cortin.

Cook (6) has summarized the disturbed behavior of Liddell's sheep as follows:

> 1. The animals previously willing to go to the laboratory, now vigorously resisted. Much cowering and trembling occurred when attempts were made to force them.
>
> 2. A stereotyped form of hyperirritability was evidenced when the animal was confined in the experimental apparatus. This included persistent tic-like movements, tremors of the left foreleg and sudden starts.
>
> 3. Conditioned signals with which no shock had been associated now evoked leg flexions.
>
> 4. The animals showed no capacity to give delayed reactions.
>
> 5. In contrast to the slight acceleration occurring in normal sheep, there was a marked acceleration of the pulse rate at the onset of the conditioned stimulus. Moreover, this acceleration persisted much longer after the shock than in normal sheep.
>
> 6. Respiration during the experimental period was quite irregular.
>
> 7. Daily neuromuscular activity as recorded by the pedometer watch was increased over normal.
>
> 8. The normal diurnal variations in activity was disturbed in that the animals were equally active day and night.
>
> 9. Pulse rate outside the apparatus as measured by a long distance stethescope was quite variable both day and night.
>
> (pp. 1271-1272)

As a result of his work on sheep Liddell concluded (1)

> . . . that when a serious problem of adaptation or adjustment is presented to the animal in the laboratory, nervous tension is repressed through training. If the difficulty is beyond the animal's powers of successful response a nervous breakdown ensues because the demands of the situation exceed the capacity of the nervous system for sustaining the required tension.
>
> (pp. 351-352)

Again (20)

> In the conditioned reflex laboratory, the animal learns to remain quietly on a platform. Limitation of freedom first imposed from without, but finally imposed by the animal upon itself, seems to be the fundamental cause of nervous strain, increase of which may later lead to neurosis. (p. 95)

These considerations led Liddell to hypothesize that work on an animal whose natural responses were characterized by resistance to restraint might throw a more direct light on the genesis of experimental neurosis. Following this hypothesis, he picked the pig as subject for further study.

3. Experimental Neurosis in the Pig.

Liddell (19, 22) collaborating with Sutherland and Davis (7) and Sutherland et. al. (20) attempted to train a pig to differentiate a continuous tone of 600 cycles from one of 750 cycles. Cessation of the first was the signal for the delivery of an apple which the pig was to retrieve from a covered box; cessation of the second tone was followed by a shock to the animal's foreleg. The animal thus had to learn to give an anticipatory leg withdrawal response to the second tone of 750 cycles and to open the box and receive the apple reward at the tone of 600 cycles. When this had been learned, the experimenters began to punish by shock all random opening of the food box. Thereupon the pig refused to open the box at all until he heard the dropping of the apple. When the experimenter then withheld the apple until the pig had opened the cover, the "pig soon developed a condition resembling the inhibitory type of experimental neurosis observed by Pavlov in the dog." (7) The animal's neurotic behavior was as follows: (22)

a) Its responses to the signal were extremely long delayed.

b) It maintained a rigid posture for many minutes at a time even remaining oblivious when a piece of apple was placed on its nose.

c) Its responses in the laboratory were impulsive, hurried, and inefficient.

d) Outside the laboratory the pig changed from a friendly and docile animal to a surly and pugnacious one.

4. Experimental Neurosis in the Cat.

Karn (13) describes the behavior of a cat which, after mastering the double alternation temporal maze to a criterion of 90 per cent correct responses, broke down. This breakdown consisted of whimpering and extended hesitation at choice points. Later its behavior was characterized by refusal to work, scratching at the doors and wire mesh which covered the apparatus and meowing and urinating at the choice points. Such disturbances had not been noted before the onset of the disruption of the learning. In addition, the cat's maze behavior reverted to a pattern that had appeared during the early stages of training and had finally given way to the double alternation response.

These responses, the author concludes,

> . . . indicate that, in the presence of a difficult problem, the normal relations between excitation and inhibition were so upset that the cat could no longer perform double alternation. Furthermore, the animal apparently attempted to resolve the conflict by regressing to a lower-order habit, persisting in this despite the fact that optimal conditions of adjustment did not result. (pp. 591-592)

5. Experimental Neurosis in the Bird.

Bajandurow (35) reports results obtained while working with birds. (Species unspecified in the reference) A harnessed bird was conditioned to give a leg extension response to show differentiation between the visual stimulus of a circle and an elipse. Differentiation was learned in progressively fewer trials as the experiment proceeded though the difference between the elipse and the circle was constantly

reduced. However, a point was reached at which the bird's behavior abruptly changed. It became extremely excited and was unable to differentiate even between previously mastered stimuli. Partial retraining was possible.

The author also notes that similar results were obtained with two other birds using as contrasting stimuli a circle and a polygon, the number of whose sides was progressively increased in succeeding parts of the experiment.

6. Experimental Neurosis in the Rat.

a) Lashley (15)

While attempting to determine the limits of visual discrimination in the white rat, Lashley had been making his animal discriminate between two stimulus cards, one of which displayed a horizontal line and the other a vertical line. He began by using lines of 2 x 60 mm. and then gradually equated the length and width of the stimulus figures until he reached a limit where the "line" was 20 x 30 mm. Up to this point, the animal learned the discrimination without undue difficulty.

> After the first day's work with the 20 x 30 mm. rectangles, when 18 out of 20 trials were correct, the form of the stimuli was changed as a control. With the new forms, there was 60 per cent of error, showing that perception of form was involved in the former reaction, but unfortunately this short interruption was sufficient to break up the association and in the next 300 trials there was 45 per cent of error with complete loss of attention. (p. 330)

Later attempts to retrain the animal to discriminate the figures which it had previously mastered proved unsuccessful.

Here then is a picture of an animal which had learned a specific behavior and then when faced by an unsolvable problem, that animal broke down. After this breakdown, it proved incapable of reacting adequately to habits previously mastered.

Unfortunately Lashley does not report just what the "new forms" of stimuli were which he substituted and which proved to be the crucial precipitating factor in the animal's breakdown.

To the best of the present author's knowledge, this report of Lashley's is the first recorded instance of behavior in any infra-human organism which can be described as experimental neurosis. However, it was evidently not recognized as such by Lashley or any of the workers that followed him. It was not until more than a score of years later that mention is made in the literature of experimental neurosis in the rat.

b) Hall (9)

Approaching the problem of abnormal psychology from the comparative psychologist's point of view, Hall, in 1933, proposed

> That there are neurotic rats can be attested to by every investigator in this field. Why then should not these neurotic rats give us some hint as to the causal factors involved in all neurotic behavior? (p. 1)

In order to illustrate his meaning, Hall describes five "neurotic" rats that he had observed whose neuroticism consisted of hesitancy and indecision when made to circumvent a wire mesh barrier in order to reach food. Other "normal" rats in the same situation accomplished this easily and with precision.

c) Hamilton and Krechevsky (10)

In an effort to study the phenomenon of "regression," these investigators trained their animals in a position habit. They then reversed the training and when partial reversal had begun they administered an electric shock (as an emotional situation). Most of their animals thereupon "regressed" to the previously learned position habit. The remaining animals fixated on a previously unnoted response.

Since "Regression may be defined as a reversion to an earlier,

well-established mode of behavior, and persistence in that mode despite the relative inefficiency of that behavior in solving the problem confronting the organism," it becomes evident that to all intents and purposes, these animals had developed experimental neuroses, since they evinced a disruption of learning following an intervening emotional conflict.

d) Cook (3, 4)

Adapting the Pavlov conditioning procedure to suit the work on an animal as small as the white rat, Cook strapped his animals to a stand which permitted no movement except that of flexing the right foreleg.

> Under certain conditions such a flexion was rewarded with a food pellet; under other conditions it was punished with an electric shock. Observations indicated that the animals experienced two principle stresses: the first, when they were required to delay the food-bringing flexion until they received a bright-light stimulus; the second, when they were required to make very difficult discriminations between a bright light stimulus which permitted a food-bringing flexion and a dim light stimulus which prohibited such a flexion on pain of shock. (p. 645)

Under these conditions, three of a group of six animals developed disorders of behavior. The patterns of behavior in each of those animals differed from one to the other, but all of them were sufficiently abberrant and maladaptive to be considered manifestations of an experimental neurosis.

e) Maier (25, 26, 27, 40)

Using the Lashley jumping technique, Maier (26, 40) trained his animals to discriminate between, and to jump to the larger of, two circles. After the discrimination became well established, the training procedure was altered so that neither card was consistently "correct." The jump to a card which had previously been correct might now prove to be correct or incorrect, the order of correctness being determined by a chance order sequence. The result of subjecting the animals to these situations was that they developed a rigidly fixed position habit. The animals were then

confronted with a single stimulus card and neither the initial discriminating behavior nor the position habit was rewarded so that what the animal was actually facing was a no solution problem. This situation resulted in the animal's developing a strong resistance to jumping. A blast of air on the stand from which the animal was to jump was then introduced to force the jumping response.

The result of this procedure was that some of the animals assumed unusual, stereotyped jumping patterns. Other animals "escaped" from the conflict situation by becoming neurotic. Such neurotic behavior consisted of leaping constantly from the test platform, falling to the floor, and becoming convulsive. In some instances, these spasms gave way to a passive state which seemed very similar to that usually described in humans as cerea flexibilitas. The animal would maintain odd impressed postures. The neurotic animals when returned to their cages and litter mates, behaved reticently and remained in the background.

In his Studies of Abnormal Behavior In The Rat (26) Maier presents detailed case histories of nine such rats which exhibited violently disturbed behavior.

7. Experimental Neurosis in the Ape.

a) Gellerman (8)

In conjunction with his report on tests of form discrimination that the author conducted on chimpanzees, Gellerman mentions that one of his chimpanzee subjects, when put to solving a discrimination harder than the one he had worked on "got just half of his 20 trials correct. He made a big fuss for about ten trials and attempted to tear the form frame apart. He took a long time to finish the series of trials."

b) Jacobsen, Wolfe, & Jackson (12)

While investigating the role of the frontal association areas in female chimpanzees, the author incidentally encountered, and reports, a case of experimental neurosis. In a test

> . . . of recent memory the animal was given an opportunity to observe the experimenter conceal a piece of food under one of two cups. An opaque screen was then lowered between the animal and the test object, and after an interval ranging from a few seconds to several minutes, the subject was permitted to choose between the two cups. (pp. 8-9)

The animal had no difficulty with the problem when the two cups were about thirty inches apart and presented before a variegated background. When the distance between the two cups was reduced to about ten inches and a uniform grey background introduced, the animal's behavior became markedly emotional.

> Violent temper tantrums after a mistake were not infrequent occurrences. She observed closely loading of the cup with food, and often whimpered softly as the cup was placed over the food. If the experimenter lowered or started to lower the opaque door to exclude the animal's view of the cups, she immediately flew into a temper tantrum, rolled on the floor, defacated and urinated. After a few such reactions during the training period, the animal would make no further responses to this test, although she responded eagerly if examined on different problems. Training on this situation was continued daily for three weeks. At the beginning, the animal had been eager to come to the experiment room, and when released from the living quarters ran to the transfer cage, opened the door and entered. But by the end of this period, it was necessary to drag the animal from the living cage, and in turn force it into the experimental cage. (p. 9)

It proved possible to retrain the animal to the experimental situation.

Repetition of the procedure after extirpation of one frontal area again resulted in an experimental neurosis. Again it was possible to retrain the animal, but when the animal, as a bilateral preparation, was again subjected to the same procedure, no emotional behavior could be elicited no matter how long it was subjected to the unsolvable problem situation.

8. Experimental Neurosis in Man.

a) Krasnogorsky (37, 38)

Krosnogorsky reports that Panferov produced a temporary disturbance or a so-called experimental neurosis in a normal child of six years when he attempted to develop a differential C.R. between a metronome of 144 beats and one of a slower tempo whose rate was gradually speeded up until it had reached a rate of 132 beats per minute. At this point, the child showed no trace of differentiation. In addition to this, the old differential C.R. to the easier problems was lost and the general behavior of the child was described as "rude, fights, disobedient, excited, yawns, closes eyes, falls asleep."

Similar findings are reported by Krosnogorsky as having been obtained by Siriatsky when the latter attempted to have a child differentiate between two close tactual stimuli. In the same paper, (36) Krosnogorsky reports that Halutina-Zinserling obtained a temporary disturbance in the behavior and the C.R. of a six-year old when the administration of food (the conditioning stimulus) was delayed longer than usual. A previously stable C.R. to a metronome with a five-second delay was disrupted when a 30-second delay was attempted. This was finally relearned, however, but when the delay was again increased to sixty seconds, the C.R. was again disrupted and the child refused to go to the laboratory or fell asleep.

b) Wolowick (55)

Wolowick observed, and recorded, findings comparable to that reported by Krosnogorsky on a ten-year old paralytic child who had been trained to give five different C.R.'s to as many different stimuli. A conflict situation elicited disruptions of, and modifications in the C.R.'s of the type that have been labelled the ultra-paradoxical phase of the C.R.

o) Lundholm (23)

Approaching the problem more from a psychiatric angle than the by now conventional experimental one, Lundholm records four instances of "laboratory neurosis."

(1) He had conditioned one subject to withdraw the finger from an electric contact on the flashing of a small lamp. A post-hypnotic suggestion was then given that the subject was to respond only to every fourth light signal and not to the intervening three signals. This the subject did. When questioned the subject explained his behavior by saying that he did not see the other light flashes.

This functional blindness the author interprets as a neurosis having a symptom of the hysterical type.

(2) Lundholm repeated the above situation but gave additional emphasis during hypnosis that the subject was going to see "the light flashes three times without feeling the shock." Post-hypnotically the subject gave the C.R. every fourth time. During the intervening three signals . . .

> He sometimes withdrew his finger, sometimes made an incipient withdrawal or a jerk, and sometimes did not respond at all. During the whole period of the experiment he showed in addition the most evident signs of discomfort (restlessness, perspiration, moaning). (p. 128)

In reference to this case he states that the . . .

> . . . experiment, if my interpretation is correct, is particularly interesting because it evokes in the human being a phenomenon similar to the one Professor Pavlov has produced in his dogs by setting up a conflict between excitatory and inhibitory stimulations. (p. 130)

(3) In a third subject, in whom it had not been possible to build up a conditioned finger withdrawal to the click of a sound hammer, it was suggested during hypnosis that he "pay strong attention" to the click. After waking he was instructed to ignore the click. The results were:

(a) "a general lowering of the vital level," dullness and indifference

(b) "a complete amnesia during the experimental period for the instruction given in the waking state. . . "

(c) ". . . a very peculiar rapid fading of the memory of the total experiment. . ."

(4) Five subjects had acquired a finger withdrawal C.R. to the flashing of a small lamp. A post-hypnotic suggestion was given to the effect that the C.R. was to be given to the click of a sound hammer. In all five subjects the C.R. was thus elicited by the click. Two of the five reported feeling the shock at the sound of the click, and one of these two even hallucinated the light flash.

The author likens this spontaneous hallucinating to that occurring in the various conditions of mental derangement.

d) Hamlin (11)*

Hamlin used nine institutionalized adult imbeciles with M.A.'s very close to five years. Four of these were trained on a differential discrimination problem in which a large black square and a small black square were gradually equated in successive experiments until a successful discrimination could no longer be made. Another four were both negatively and positively conditioned to the same situation. The ninth subject was put on a problem, the solution of which was never explained to him. From the report of the experiment, it would seem that the problem was never solved.

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* The inclusion of this material in the final draft is conditional upon the permission and approval of Mr. Roy Hamlin who was kind enough to send the present writer a copy of his unpublished paper, but with the proviso that it be not quoted except as he might permit after seeing the nature of the quotation.

In addition to the nine subjects used there were four subjects whose reactions were noted for control purposes.

Of the nine experimental subjects, three showed definite though minor behavioral disturbances. They were chronic to the extent that they continued throughout the experiment. Slight degrees of disturbances were shown by three others, while the last three subjects showed no, or almost no disturbances at all.

The mildness of the disturbances was in large measure due to the procedure itself since the experimenter, mindful of the fact that he was working with human beings, halted the experiment in any instance where the disturbance reaction became too marked or gross.

The reaction disturbances noted were found to be classifiable under four headings.

(1) Escapisms.

This included hurrying from the experimental room after sessions, reluctance to go to the experimental room, or outright refusal to continue with the experiment. Some of the subjects attempted to run away from the institution, complaining of illness which interfered with the session, or were overly sleepy before the experiments.

The controlled subjects showed fewer of these symptoms than did the experimental subjects.

(2) Restlessness and Uncertainty

This took the form of hesitancy, restlessness, fidgeting and continual hand-rubbing during the experimental sessions.

(3) Inefficiency

Three of the subjects showed poor performance toward the end of the experiment on tasks which they had performed well

towards the beginning. One subject, whose "mouth structure seemed partly responsible for a tendency to drool which he usually controlled," lost this control during two of the later sessions and drolled markedly.

(4) Specific Disturbance Symptoms

Increased tension, marked tremor of the hands, whining, grunting, yawning, swearing, decrease in responsiveness and cooperativeness and general exaggerated reactions were evinced by the subjects throughout the later experimental sessions.

B. Analysis of Literature

The material which has been presented in the preceding pages may be analyzed in one of two ways: by taking each of the studies reported and subjecting it to careful scrutiny and evaluation, or by an over-all analysis and subsequent synthesis of the findings of all the studies together. The latter is the method which seems more suitable for the present purpose.

The material will be examined under two headings:

1. Factors in the Etiology of Experimental Neurosis.

When all the preceding observations and experimental findings are examined, it is found that in all of them one basic similarity holds. The condition under which experimental neuroses appears is:

Subjection of the organism to a situation where it is forced to make one of two or more mutually antagonistic reactions in response to a stimulus which is either equivocal or multivalent in nature.

This epitomizing of the condition under which experimental neurosis occurs is not a mere rephrasing of those given by Cook (4), Liddell et. al. (21), Maier (26), and Pavlov (28, 30).* It defines the neurosis precipitation situation by specifically denoting the nature of the factors that enter into its make-up. It underscores the following aspects:

a) The animal must react.

b) It is permitted to make only one of several possible responses.

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* The following characterizations by the experimenters referred to are presented for the purpose of comparison.

c) The responses between which it must choose are mutually antagonistic.

d) The reaction-initiating stimulus is either equivocal (in that the animal cannot discriminate as to whether it is to give one or another response) or multivalent (in that it tends to elicit at the same time two or more antagonistic responses).

While the first three of these aspects have at one time or another been pointed out by previous workers, this definition attempts to synthesize the various factors that play causal roles in the experimental neurosis into one homogeneous and (it is hoped) comprehensive whole.

2. The Symptomatology of Experimental Neurosis.

In direct contrast to the comparative homogeneity of the neurosis-precipitating situation is the variety of reaction phenomena which have been reported as experimental neurosis. Not only has the nature of the responses

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Cook (4)

"When presented over a period of time with a single stimulus or simultaneous stimuli to mutually antagonistic responses, a certain proportion of white rats will develop an 'experimental neurosis' . . . It is necessary to the development of an 'experimental neurosis' that activity other than that of the responses utilized in the distressful situation be very limited." (p. 308)

Liddell et. al. (21)

" . . . experimental neurosis . . . develops in the course of conditioned reflex experiments because the conditioned animal cannot, through procrastination and evasion, avoid making difficult decisions." (p. 361)

Maier (26)

Points out that his animals exhibited violently disturbed behavior as a result of being forced to react after all available modes of reaction had been removed.

Pavlov (28)

"Broadly, we can regard these disturbances as due to a conflict between the processes of excitation and inhibition which the cortex finds difficult to resolve." (p. 302)

identified as "experimental neurosis " differed from species to species, but even in the same species it has been found (4) that "the symptoms of 'experimental neurosis' may assume a different form from one animal to the next." Because of this it becomes well nigh impossible to evolve a classification which will cover all the various reaction patterns and still keep each of these patterns intact. It is possible, however, to classify the specific segments of experimental neurosis behavior under the following catogories:

a) Excitement -- emotional outbursts, loss of normal control and inhibition.

b) Disruption of habitual or previously learned behavior.

c) Antagonistic attitude to the experimental setup.

d) Perseverative or stereotypic responses.

e) Hesitancy and indecision.

f) Lethargy.

An examination of all experiments presented in the first part of this section shows that every case of "neurotic" behavior, when carefully examined, can be included under one or more of the headings in the above classifications.* The one dubious exception is the case of "functional blindness" reported by Lundholm (23) and even this might with some justification be put in Group a.

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* It must be remembered that the behavior reactions dealt with in the classification can be rightly included only when they are "abnormal" in extent or mode of expression. As a criterion of abnormality no better can be presented in this connection than the triple one given by Cook (4) that:

> " Abnormal behavior must be maladaptive behavior . . . Abnormal behavior must, further, be behavior which involves a change in a given animal's responses . . . " and "abnormal behavior, finally, must also be behavior which persists at least as long as the animal is in periodic contact with the precipitating situation . . ." (p. 294)

One other aspect of the classification might be tentatively brought up. As presented, it gives not only a categoric subdivision of the various behavior segments but a possible delineation of the course of events in the development of an experimental neurosis. As reported by most workers, the animal which develops an experimental neurosis when first confronted with the crucial situation, usually first evinces a strong emotional outburst in which random behavior is very marked. This outburst, by its very nature, interferes with and finally disrupts the animal's more "normal" behavior patterns. Concommittant with this disruption the animal becomes negatively conditioned to the entire experimental situation since its responses bring it punishment. In an effort to find some adequate responses the animal may at this point either "ignore" all but one stimulus and consistently respond in a single stereotyped way or may vacillate between several possible responses showing hesitancy and indecision. Failing to solve (or resolve) the conflicting situation, the animal finally ceases responding to the stimuli altogether, remaining quiet and lethargic.

This tentative outline of the development of the experimental neurosis would seem to negate the previous statement, that the pattern of neurosis differs from animal to animal. Actually it does not. What is indicated here is that in the various cases reported, the experimental neurosis elicited was of differing degrees and intensity, terminating at different levels of the above-proposed scheme. In addition, the differences between the experimental setups in the various experiments permitted specifically different "random" and "neurotic" reactions to be called forth. Finally, the structural as well as behavioral differences between the different species worked with, as well as between individual organisms within even the same species, tended to make the reaction patterns of each organism unique and individual as regards the nature of the specific symptoms elicited.

III. Present Investigation

A. Statement of Problem

The present report consists of two experiments. Their purpose was to make a study of the etiology and development of experimentally-induced "neurotic behavior" in the white rat. Since Pavlov, and many investigators after him, had found that "experimental neurosis" resulted when an animal was forced to make a differential response to two stimuli in which the difference was beyond the animal's limen of differentiation, the writer decided to force his animals to make a response to differential visual stimuli up to and beyond each animal's ability to differentiate. An accurate and complete record of all the animals' behavior was kept. The aim was to obtain, insofar as possible, a quantitative record and analysis of each animal's behavior up to and during the period of the appearance of "neurotic behavior."

It is necessary, at this point, to define the term, "neurotic behavior," as used in this paper. Throughout, it refers to any behavior of the animal which is inadequate for the situation in which it finds itself when it has previously demonstrated its ability to react adequately in a similar situation. This definition, it seems, is not incompatible with those given by Cook (3,4,5,6), Maier (25) and Stogdill (33). It simply stresses the "aberrant" character of "experimental neurosis."

Since the two experiments considered here differed in many basic respects, they will be reported separately.

B. Experiment Number One

1. Subjects

The subjects used in this experiment were seven male albino rats. At the time that the experiment was begun (4/14/39) four of the animals, D-1, D-2, D-3, and D-4 (litter mates) were 17 weeks and one day old; two of the animals, E-1 and E-2 (litter mates) were 16 weeks and five days old; and the remaining animal F-1 was 14 weeks old. Those animals were raised on a normal Fox Chow diet at the Nutrition Animal Laboratory at Massachusetts State College and were derived from Wistar Institute stock.

From a week before the actual beginning of the experiment until its conclusion, the animals were cared for and handled by the experimenter solely. They were kept in a well ventilated, temperature-controlled room. Each animal had a separate wire mesh living cage. The animals were fed only during and immediately after each day's experimentation. Except as noted later, they remained well and healthy throughout the period of experimentation. The experiment lasted for 18 weeks.

2. General Method

Using a modified Lashley jumping apparatus, the animals were first trained to jump across a 9" gap and through a 6" X 6" aperture to a platform where they received a food reward. The aperture was then blocked with a white card having a black circle painted upon it and the animals were taught to jump across the 9" gap, against the card (which immediately snapped out of the way) and to the platform where they received a food reward.

It was then attempted to have each animal learn a differential response to a circle and a square presented successively (i.e. temporally) in random order. If the animal jumped at the aperture when the card bearing the circle was displayed, the card snapped automatically out of the way, permitting the

rat to land on the platform and receive a food reward. A jump when the card bearing the square was presented resulted in the rat's banging his nose against the blocked card and falling to a net below. It was desired that the animals learn to give a positive (i.e. excitatory) jump response to one stimulus -- a circle, and a negative (i.e. inhibitory) response to a second stimulus -- a square.*

This method was used for the first forty series of daily sessions (about five hundred trials). Throughout the period of training, none of the rats showed any evidence of being able to master the situation.** This approach was therefore abandoned.

For the following sixty sessions (nine hundred trials) an attempt was made to train the animals to differentiate between a circle and a triangle presented simultaneously. The animals were made to jump across a 10" gap to one of two apertures which were blocked by white cards with a circle figure on one and at first a square and later a triangle on the other. The positive and negative stimuli were shifted from left to right according to the chance order suggested by Gellermann (63). When the animal jumped at the aperture in which the card bearing the circle was displayed, the card snapped automatically out of the way, permitting the rat to land on the platform to receive a food reward. A jump at the aperture which was blocked by the card with the square or triangle upon it resulted in the rat's banging its nose against the card and falling to a net below.

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* Had the animals mastered this differentiation, which they never did, they would then have been made to differentiate between a circle and an hexagon, then a circle and an octagon, a circle and a decagon, etc., until the animals would no longer have been able to "tell the difference" between the circle and the multi-sided polygon.

** This corroborates Lashley's findings (15) to the effect that the albino rat cannot differentiate between a circle and a square of equal size and light intensity.

Experimentation with this group of seven animals was discontinued after the 100th session (about 1400 trials in all) since none of them showed any clear evidence of figure discrimination. The best any of them had accomplished was to discriminate between an aperture that was blocked by a stimulus card (regardless of the figure upon it) and an open unobstructed stimulus aperture.

Towards the end all but one of the animals showed various signs or symptoms of neurosis (which will be listed under "Findings") but since the procedure of training for differentiation was altered several times during the course of the experiment it was thought advisable to repeat the entire experiment with fresh animals and a more constant and carefully controlled experimental procedure.

3. Apparatus

The apparatus (See Fig. 1.), a modified form of the Lashley Jumping Apparatus, (66, 71) consisted of:

a) A Jumping Stand (J.S.) upon which was mounted a jumping box (J.B.).

One-half inch above the floor of this jumping box was a wire grid (J.B.G.) which was connected to the secondary coil of an Harvard inductorium (not shown in figure). The primary coil of the inductorium (set at 5 cm. coil-overlap-adjustment) was connected in series to a 1.55 volt Eveready dry cell and a knife switch the closing of which sent a tetanizing current through the jumping box grid. The entrance (En.) and exit (Ex.) of the jumping box were closed by two metal sliding "gates" (En.Ga. and Ex.Ga.). Mounted on the jumping stand, immediately above the jumping box, was a spotlight (S.L.) with a 60 Watt frosted bulb pointed directly towards the stimulus apertures in the stimulus stand. Except for the grid in the jumping box and the spotlight, the entire stand and box were painted a dead slate-black.

b) A Stimulus Stand (S.S.) in which two 6" X 6" stimulus apertures (S.A.)

Fig. 1. CONDITIONING APPARATUS

(See next page)

Fig. 1. CONDITIONING APPARATUS

(Modified after Lashley)

En. ------	Entrance to Jumping Box
En. Ga. --	Entrance Gate to Jumping Box
Ex. ------	Exit from Jumping Box
Ex. Ga. --	Exit Gate from Jumping Box
J. B. ----	Jumping Box
J. S. ----	Jumping Stand
J. B. G. -	Jumping Box Grid
L. P. ----	Landing Platform
M. -------	Mirror
N. G. ----	Net Guard
S. A. ----	Stimulus Aperture
S. L. ----	Spot Light
S. N. ----	Safety Net
S. N. G. -	Safety Net Grid
S. S. ----	Stimulus Stand
T. -------	Tunnel

(See text for explanation)

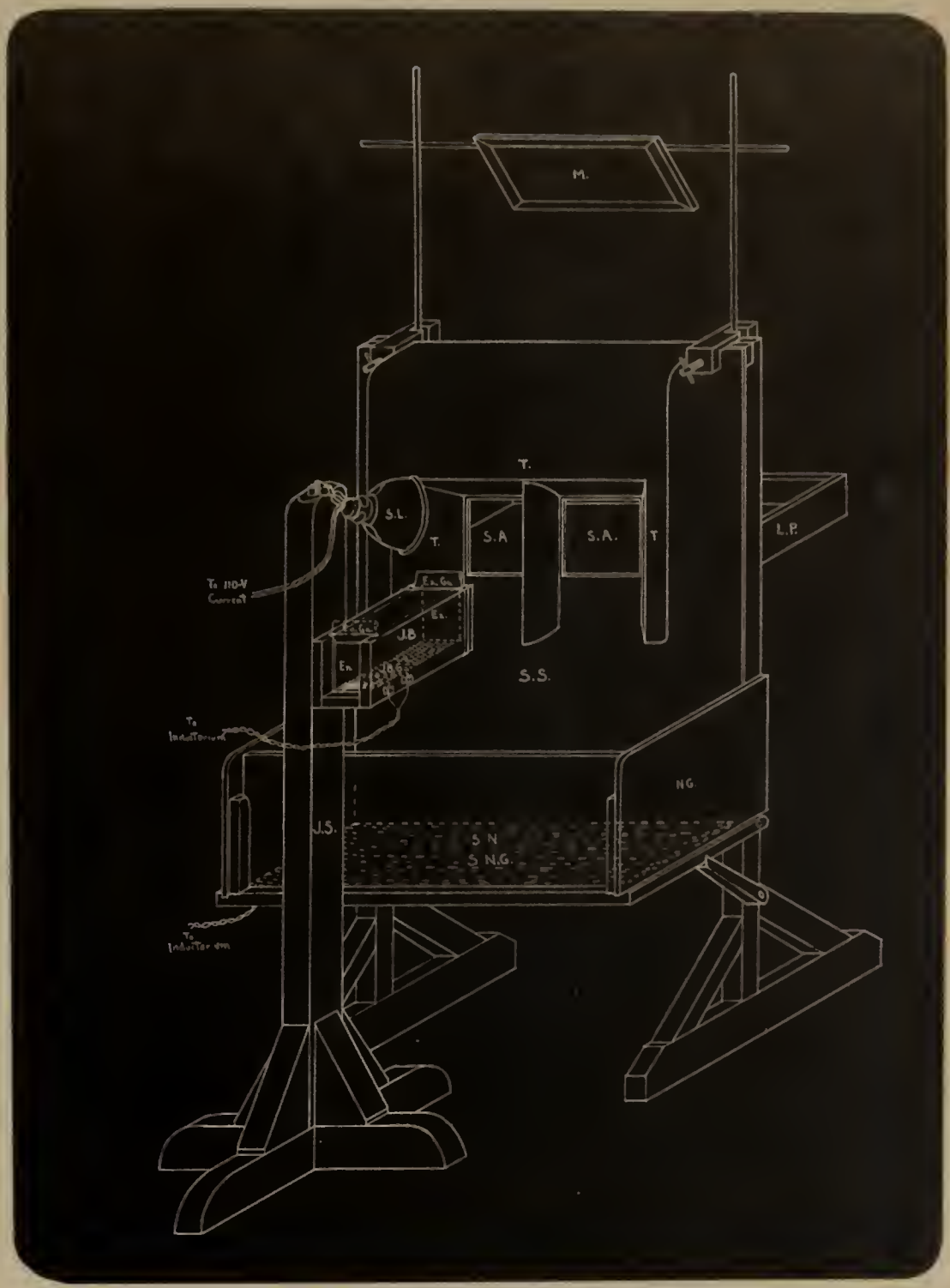


Fig. 1. CONDITIONING APPARATUS

were cut so that the bottom edges were at the same level as the jumping box. On the back of the composition board of which this stimulus stand was constructed, and immediately above each of the stimulus stand apertures, were fastened two small "L" shaped metal thumbs. At the top of the stimulus aperture frame, centrally placed above each of the stimulus apertures, was a hook-eye. To this hook-eye was fastened a rubber band from which the stimulus card was suspended. When in use, the stimulus card was pulled down to the stimulus aperture until the top edge of the stimulus card caught beneath the metal thumbs. Only a very slight pressure from the front was required to dislodge the stimulus card from underneath these metal thumbs which action immediately caused the stimulus card to snap up and out of the way of the stimulus aperture. If, however, it was required that the card should not snap out of the way when pressure was applied to it, a metal bar was placed behind it so that it was not possible to push the card out from beneath the metal thumbs.

The landing platform (L.P.) was mounted behind the stimulus apertures (i.e. facing away from the jumping box) and at the same level as their lower edges. It was on this platform that the animal landed after each successful jump through one of the stimulus apertures and it was on this that it found the food reward in a small glass tray. The food reward was bread steeped in fresh, whole milk.

Mounted in front of the stimulus apertures (i.e. facing towards the jumping box) was a tunnel-like guard (T.) which discouraged the animal's jumping to a side or above the stimulus aperture. Also in front of the stimulus aperture, and 20 inches below their lower edge was the safety net (S.N.) into which the animal fell after each unsuccessful jump. After the first 52 sessions, this net was wired with a grid (S.N.G.) connected to a Harvard inductorium (Set at 0 cm. coil-overlap adjustment and energized by

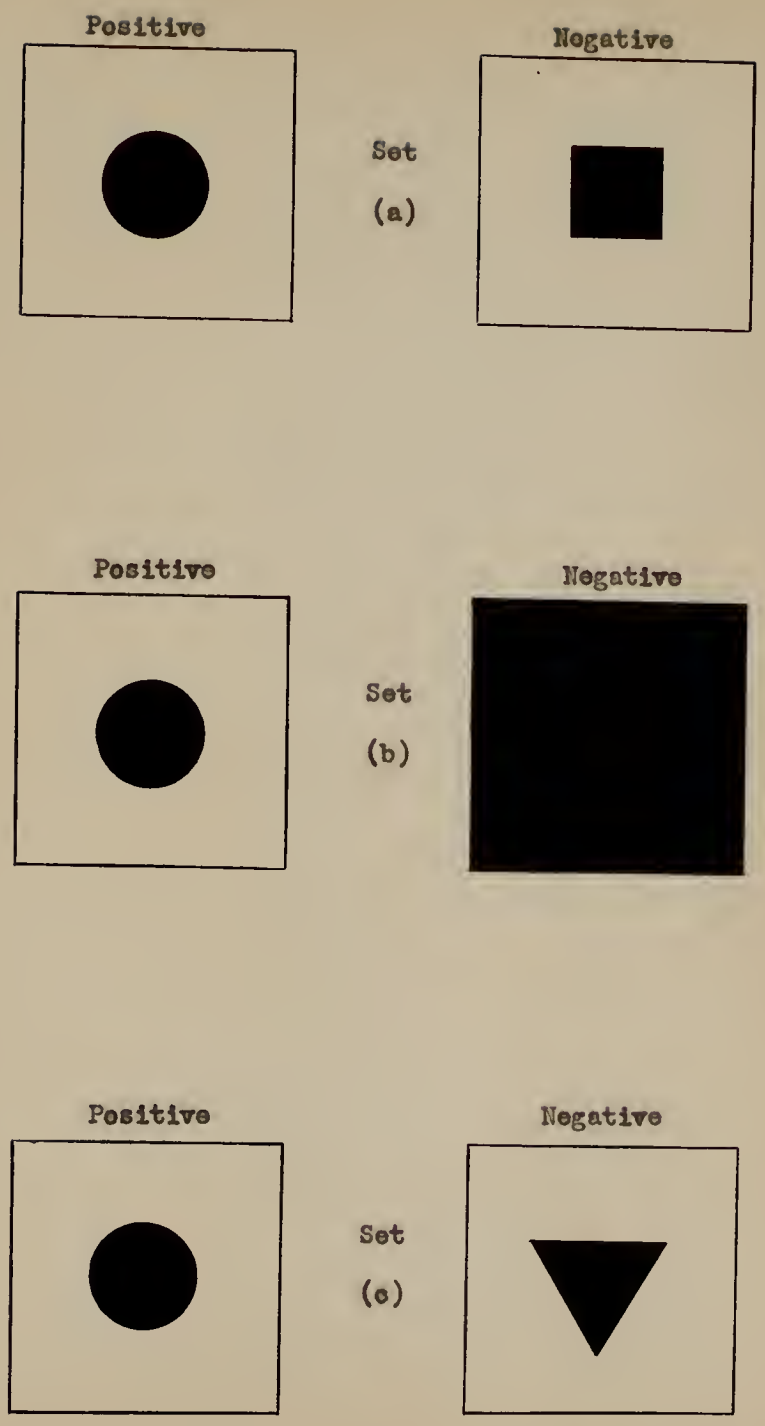
a 1.55 volt Eveready dry cell.) Thus an unsuccessful jump was punished not only by falling to the net but, in addition, by a two-seconds shock when the animal landed in the net. In order to prevent the animal from jumping or falling off the edge of the safety net, it was protected by three ten-inch high net guards (N.G.). At the top of the stimulus stand a mirror (M.) was mounted so that the experimenter, standing behind the jumping stand, could view the animal on the landing platform without himself being seen. The entire stimulus stand, except for the wires of the safety net grid, was painted a dead slate-black.

c) Stimulus Cards were each made of heavy weight bristol board and measured $6\frac{1}{2}$ inches in width and $7\frac{1}{4}$ inches in height. Each was suspended from the center of its top edge by a rubber band. The stimulus figure was drawn upon the card with black India ink and was so placed that when the card was placed behind the 6" X 6" aperture in the stimulus stand, the center of the stimulus figure was at the center of the stimulus aperture. Each stimulus figure, whether circle, square, or triangle had the same area -- four square inches. Each stimulus card had a positive stimulus upon one side and the negative stimulus upon its other side. It was thus possible to change from a negative to a positive stimulus by simply reversing the same card, and also eliminated the possibility of the animal's responding to olfactory cues. The stimulus figures used are illustrated in Fig. 2.

d) Miscellaneous

A metronome set at 60 beats per minute was kept going throughout the time that the animal was in the experimental laboratory. This metronome beating served two purposes: one, it tended to drown out any incidental noises; and two, it enabled the experimenter to time the various steps in the procedure by subvocally counting the metronome beats.

The experiments were carried out in a room which was fairly well darkened, the only illumination coming from the spotlight on the stimulus



Scale: 1" = 4"

Fig. 2. STIMULUS FIGURES

Used in Experiment No. 1.

stand and a lowered desk lamp on the table to the side of the apparatus.

4. Procedure

a) Sessions No. 1 to 40

(1) Preliminary Behavior Tests

Each animal was first taken from its living cage, placed on a scale, and weighed. The extent of:

(a) Its Activity On the Scale, as well as its weight was noted and immediately recorded. It was then placed in a carrying case (which was used to transport the animals from their living cages to the laboratory) and taken to the laboratory. In the laboratory, the animal was;

(b) Placed On Its Back in the experimenter's right hand for five seconds and the extent of its activity noted;

(c) Taken From the Carrying Case and its degree of activity, while being removed from the carrying case noted;

(d) Held In the Left Hand and restrained by cupping-over with the right hand for five seconds, and the degree of resistance noted;

(e) Held (suspended) By The Tail for five seconds, and the extent of its thrashing and struggling noted;

(f) Placed On The Landing Platform (of the stimulus stand) directly over the food tray and its eating behavior noted for five seconds. The food tray was then removed and the extent of the animal's

(g) General Activity for the next fifteen seconds on the platform was noted. During these fifteen seconds, the experimenter recorded the extent of activity in tests (b) to (g). The animal was now removed from the landing platform and placed in the jumping box preliminary to the

first trial of the experiment proper.

(2) Familiarization With Experimental Situation

The first day's session was limited to the giving of the above preliminary behavior tests (b) to (g) at the conclusion of which each animal was permitted to eat to satiety and was then returned to its living cage. The succeeding sessions were directed towards the:

(3) Mastery of the Jumping Technique (towards one stimulus-aperture only)

The jumping stand was so placed that the exit opening of the jumping box was immediately opposite and three inches distant from the right stimulus aperture which was entirely unobstructed. A wide metal strip was placed across the three inch gap bridging the distance between the jumping box and the stimulus aperture. The exit gate was closed.

(a) The animal was placed in the jumping box through the entrance and the entrance gate was closed behind it.

(b) The animal was left for fifteen seconds in the closed jumping box so as to quiet down after being handled by E.

(c) The exit gate was then opened and the animal granted three seconds in which to move out of the jumping box, across the bridge, on to the landing platform, and so to the food tray.

(d) If, after the lapse of three seconds, the animal had not moved from the jumping box then the primary circuit of the inductorium was closed giving the animal a tetanizing shock. The current was left on until the animal left the box, crossed to the landing platform, and on to the food tray.

The number of seconds which the animal remained in the box was recorded.

(e) The animal was permitted to eat for about five seconds and was then lifted from the landing platform and placed in the jumping box, preliminary to the next trial. (A trial thus included the animal's behavior from the point when it was placed in the jumping box to the point when it was removed from the platform to be again placed in the jumping box preparatory for the next trial.) Each animal was run 15 trials daily.

(f) When the animal had mastered the problem of walking across the bridge <u>within</u> three seconds after the opening of the exit gate on three successive trials, the bridge between the jumping box and the stimulus aperture was removed. The animal now had to walk across the gap without the bridge. The criterion of learning was three successive trials in which the rat left the box within the first three seconds after the lifting of the exit gate.

(g) Mastery of the above problem was followed by having the animal learn to go across the 3½ inch gap, then a 4 inch gap, etc., until the animal had learned to jump across a gap of 9 inches or better.

(h) When the animal had learned to jump across a nine-inch gap towards the unobstructed stimulus aperture, it was next trained to jump at and through the aperture when the circle stimulus card was in position. This was accomplished by repeating steps (a) to (e) above with the difference that now the animal had to jump across a nine-inch gap and through an aperture which was gradually closed by placing the stimulus

card in such a way that, in successive trials, it obstructed more and more of the aperture. Mastery of the jumping technique was followed by training the animals toward:

(4) Differentiation Between Positive and Negative Stimulus Figures (presented separately in random temporal order)

The jumping stand was placed with the jumping box exit nine inches distant from the right stimulus aperture. The exit gate was closed.

(a) While the animal was left for fifteen seconds in the closed jumping box to quiet down after being handled by E., E. placed the stimulus card in position and clicked the aperture bar several times, regardless of whether the positive (circle) or negative (square) figure was presented. This last precaution was to prevent the animal's using the sound of the bar clicking as a cue indicating that the stimulus aperture was barred.

(b) The exit gate of the jumping box was then opened.

If, when the positive stimulus was exposed, the animal had not jumped after the lapse of three seconds, it was given an electric shock until it jumped against the stimulus card, through the aperture, and on to the food reward; thus completing that trial.

When the negative stimulus was exposed, the animal was granted ten undisturbed seconds either to jump or not jump. If it jumped, it bumped its nose against the barred stimulus card and fell to the net below thus ending that trial. If the rat had not jumped after the lapse of the ten seconds, it was removed from the jumping box, placed near the food tray on the landing platform and permitted to eat for about five seconds.

b) Sessions No. 41 to 101

(1) Preliminary Behavior Tests

Each animal was put through the same seven behavior tests as noted and described under Session No. 1 to 40, except that the order in which they were given was altered somewhat and that instead of describing the degrees of activity verbally, they were recorded by making a check mark on a six-point scale for each test.

(2) Conditioning towards differentiation between positive and negative stimuli (presented simultaneously)

The exit of the jumping stand was placed ten inches from and equidistant between the stimulus apertures. The exit gate was closed.

(a) While the animal was left for fifteen seconds in the closed jumping box so as to quiet down after being handled by E., E. recorded the degree of the animal's resistance to being placed in the jumping box (on a three-point scale), adjusted the stimulus cards in position and clicked the aperture bar several times in both directions before finally barring the negative stimulus card. This extra clicking of the aperture-blocking bar was a necessary precaution against the animal's utilizing the sound of the clicking as a cue to the direction of the negative stimulus.

(b) The exit gate of the jumping box was then opened and the animal granted three seconds (this was increased to five seconds after the 63rd session,) in which to choose and jump either towards the left or right stimulus card.

If the animal jumped at the positive stimulus figure, the card automatically snapped out of the way permitting the animal to

get to the food reward. After five seconds at the food, the animal was removed from the landing platform and placed in the jumping box preparatory to the next jump.

If the animal jumped at the negative stimulus figure, it bumped its nose against the barred stimulus card and fell to the net below, thus ending that trial.

(c) If after the lapse of three seconds (five seconds after the 63rd session) the animal had not moved from the jumping box, it was given electric shock punishment through the jumping box grid until it jumped from the box.

(d) At the conclusion of each jumping trial, the experimenter recorded the number of seconds the rat spent in the box from the time the exit gate was opened to the time the animal jumped, the direction of the animal's jump, whether the animal made a successful jump and ate (or unsuccessful jump and fell), and any other miscellaneous observations of activity that seemed noteworthy.*

5. Findings

The findings in this experiment are presented here in non-quantitative form since the procedure as well as the controls were changed several times during the experiment and since it was followed by Experiment Number 2 in which these controls were kept more constant.

a) Animal Number D-1

(1) Preliminary Test Behavior

This animal's "General activity on scale" varied considerably from session to session, the ratings ranging from "Slight" to "Extreme". There seemed to be no evident relationship between this fluctuation in

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*The Method of Recording all data in the experiment is presented in detail in the Appendix.

activity and any of the other observed factors. Its "General activity when taken from case" varied somewhat for the first 25 sessions. After that the reaction became markedly stabilized at a rating of "Much" with only very infrequent fluctuations to "Moderate" or "Extreme". The animal seemed to have adopted a standardized anticipatory approach reaction upon the appearance of E. The "Resistance to being held in hand" varied somewhat only for the first 10 sessions after which the animal's reaction became stabilized at a very low level of activity, rating "Slight" to "Little". The animal seemed to have become entirely acclimated to handling by E.

Its "Resistance to being held on back" showed that the animal never became completely accustomed to restraint. Its reactions from day to day varied unpredictably, rating "Slight" to "Much". When held by the tail the animal's reaction usually rated about "Moderate" or "Much", but varied from day to day. Its response to the test for "Amount eaten on platform" was almost constant throughout the experiment. The animal's eating usually ranked "Moderate" and occasionally "Much". Its "General activity on platform" also remained fairly constant at about "Moderate" or "Much". During the last 20 sessions, however, this activity fell to a rating of "Little" or "Moderate".

(2) Miscellaneous Behavior Noted

(a) As the experiment progressed there was an increased amount of resistance shown by the animal to being placed in the jumping box.

(b) The animal tended (during the latter 60 sessions) to form position habits and to keep on jumping regardless of whether it was rewarded or punished. These recurrent position

habits were predominantly to the right though the animal would often form a left-position habit after it was forced out of the right-position habit.

(3) Behavior Suggesting Neurosis

(a) Whereas during the earlier sessions the animal ate well and heartily after every successful jump, during the last 20 sessions, its eating was inhibited and disturbed. It would land on the platform after a successful jump, nibble slowly at the food for one or two seconds, then hesitantly walk off to another part of the platform. It must be remembered that the animal was hungry and had not eaten for 24 hours.

(b) Whereas the animal had been comparatively quiet and docile during the earlier sessions, it attempted to bite E's hand during the preliminary behavior tests of Sessions No. 83, 97, and 98.

b) Animal Number D-2

(1) Preliminary Test Behavior

There was a general diminution in this animal's degree of activity in all the tests as the experiment went on. This was most marked in its "General activity on platform" in which the animal had shown considerable exploratory activity during the early experimental sessions. Beginning with the 20th session, the animal began to show less tendency to be active when placed on the platform and in Sessions No. 65, 66, 68, 69, 70, 75, 84, 90, 95, 97, 98, and 100, the animal remained completely motionless when placed on the platform. In most of the latter 40 Sessions, the extent of activity on the platform was either "Slight" or

"Little".

The least marked diminution in amount of activity was in "General activity when taken from cage." The scoring in this fluctuated slowly from "Much" to "Little" and back to "Moderate" as the experiment went on.

The degree of activity in all of the tests fluctuated unpredictably from day to day. The general trend, however, was, as stated, downwards.

(2) Miscellaneous Behavior Noted

(a) The animal seemed unable to master the anticipatory jump response so as to avoid getting the shock. Throughout the experiment, it waited for the electric shock before it would jump. Yet it did show evidence of anticipating the shock since it would often squeal <u>just before</u> the shock was given.

(b) The jumping record seems to indicate that the animal had become negatively conditioned to the stimulus figure regardless of its form, and responded accordingly for the rest of the experiment. It tried every conceivable trick to avoid jumping at the stimulus card, from attempting to climb down the jumping stand, to jumping directly to the landing net. The most predominant reaction was to attempt to jump and hold on to the partition between the two stimulus appertures.

(c) By the time a record was begun to be kept of the resistance to being placed in the jumping box, (Session 41), the animal had developed strong resistance to being put in the box by E. This resistance gradually diminished so that by the 59th session the predominant resistance score was "Moderate". By the 73rd session (at which time the animal was making fairly adequate jumps) its resistance to the box was less than "Moderate" but greater than "Slight" only to again go up to

"Moderate" when the animal made 100 per cent incorrect responses. The resistance remained at this level to the end.

The negative conditioning due to punishment in the landing net evidently became generalized so as to include the apparatus as a whole.

(3) Behavior Suggesting Neurosis

(a) The aspect of this animal's behavior which most closely approached "experimental neurosis" was its inability to respond correctly to the no-card vs. black card discrimination in the 94th session after disruption of its jumping behavior by the introduction of the circle-figure card vs. the black card discrimination. This though the animal had responded adequately to the no-card vs. black card in Sessions No. 81 to 90.

(b) The general diminution of the amount of the animal's activity points to a "lethargy" of the type described by Meier.

c) Animal Number D-3

(1) Preliminary Test Behavior

The animal's behavior during the tests remained fairly constant till the introduction of the "Square" stimulus card in Session 44. Up to this point, the animal was very active and resistive when taken from the cage and when held on its back. Holding in the hand or Suspension by the tail gave only "Little" or "Moderate" resistance. On the platform the animal ate hungrily and explored moderately. In the 44th session (after previous days run in which the animal had made only one successful jump) the animal's behavior in all tests increased in intensity and remained fairly active thereafter till about the last 30 sessions during which the extent of activity gradually diminished. In Session 98 to 100, the animal showed only "Moderate" "General activity when taken from case" and "Amount eaten on platform". All the other tests scored either "Little" or "Slight."

In retest Session 101, taken a week after the discontinuation of training, the animal evinced "Much" activity in its "General activity on scale", "General activity when taken from scale", "Amount eaten on platform" and "General activity on Platform." The tests for "Resistance to being held in hand" and "on back" evoked "Little" activity; while the animal's activity when "Held by tail" was "Moderate". This activity during the retest, it will be noted was very close to the animal's reactions during the earlier experimental sessions.

(2) Miscellaneous Behavior Noted

(a) Unlike the other animals, this animal never evinced any particular resistance to being placed in the jumping box.

(b) The animal easily mastered the anticipatory jump response rarely waiting for the shock before jumping. Even towards the end, when the unsolved problem brought punishment again and again after each incorrect jump, the animal still spent little time in the jumping box after the opening of the exit gate.

(3) Behavior Suggesting Neurosis

None of the minor disturbances noted in this animal lasted for any length of time but the following are of interest:

(a) In Session 34, after about 80 unsuccessful trial attempts to solve the circle vs. square stimulus (jump-no-jump) discrimination, the animal began to run around in circles chasing its tail each of three times it fell in the net after an incorrect jump. This behavior was never noted again.

(b) Toward the end, though still eating well on the platform, the animal's eating <u>after</u> the session became very limited and inhibited. The animal was quiet and somewhat lethargic in its movements. This lethargy was even more marked when the

animal was put back into its living cage after the experimental session, during the latter sessions.

d) Animal Number D-4

(1) Preliminary Test Behavior

After the initial diffidence and unresistive responses in the first few sessions, the animal adopted a fairly constant response to each of the tests, except that in all of them its extent of activity would increase after any session or sessions in which it received an excess amount of punishment due to incorrect jump responses; and that in the last twenty sessions, all of the animal's preliminary test responses tended to become less and less intense. Its average mode of response was a "Moderate" degree of activity in the tests for "General activity on scale" and "General activity when taken from case", "Little" or "Slight" resistance to "Being held in hand" and "Being held on back", "Little" or "Moderate" kicking when "Held by tail", and "Much" "Eating on platform".

(2) Miscellaneous Behavior Noted

(a) In addition to the stimulus-avoidance response of diving down to the net ~~(described in Appendix B)~~ the animal at various times attempted to avoid jumping at the stimulus aperture by jumping either above or to the side of the aperture even though this always resulted in its falling to the net and receiving a shock.

(b) The time spent in the jumping box was rarely more than the 3 and later 5 seconds given between the opening of the jumping box gate and the administration of the shock.

(c) The resistance to being placed in the jumping box varied considerably being always greatest after the animal had encountered difficulty (and punishment) in any session or sessions.

(3) Behavior Suggesting Neurosis

The one bit of the animal's behavior that was symptomatic was a general inactivity and almost lethargy that it developed after each session during the last seven sessions. When food was placed beside it, the animal, though still hungry, ignored it.

e) Animal Number E-1

(1) Preliminary Test Behavior

After the initially "timid" and unresisting behavior of the first week's experimentation, the animal developed a fairly standard response for each of the preliminary tests. Its "General activity on scale", "Activity when taken from case", and "Activity on platform," were usually "Moderate" in degree. Its eating was voracious and was scored under "Much". It offered "Slight" or "Little" resistance to "Being held in the hand" or "Being held on its back." It evinced much kicking and flexing activity when held by the tail. Variations in these reactions showed themselves following those sessions in which the animal encountered difficulties in its jumping trials. After such "difficult" sessions, all of the animal's reactions to these tests rose in intensity. These fluctuations, however, were only temporary in nature. The most marked long-time trend in the animal's reactions was noted during the last 25 sessions. The animal here had been unsuccessfully attempting to solve the circle vs. triangle differentiation. During this period, the degree of intensity of the animal's reactions to the behavior tests consistently diminished. By the 80th session, its eating behavior had become hesitant and "fearful". Its general activity on the platform was scored at "Little" and its resistance to being held either in the hand or on its back was only "Slight". By the 87th session, it had stopped eating on the platform entirely, squatting motionless over the food tray in which it showed no interest. Its general activity when placed on the scale or when taken from the case was "Little" or "Moderate". By end of the experiment it was evincing no

eating or activity on the platform, only "slight" turning of the head when held on the hand or on its back, "Little" activity on the scale or when taken from the case and "little" or "moderate" kicking when held by the tail.

(2) Miscellaneous Behavior Noted

(a) Up to and including the 65th session, the animal consistently showed almost no resistance to being placed in the box. During the 65th session, it made a moderate resistance each time it was placed in the box. This moderate resistance continued consistently until the 73rd session. In this and the next two sessions in which it solved the circle vs. black card discrimination, its resistance to being placed in the jumping box again vanished. The subsequent subjecting of the animal to what proved to be the unsolvable circle vs. triangle discrimination immediately caused the animal to show consistent moderate resistance in all the trials that followed.

(b) Throughout the last 60 sessions of the experiment, the animal reacted in a manner which showed that it had formed an extremely strong position habit to the right. This evidently was the result of the right stimulus apperture only having been used in the first 40 Sessions.

(3) Behavior Suggesting Neurosis.

(a) The behavior of this animal most symptomatic is its gradual diminution and final cessation of eating on the landing platform during the preliminary tests. Concomitant with this development was a diminution in the animal's eating after each successful trial jump. Whereas at first the animal ate hungrily when it landed on the platform after each jump; during the later

20 sessions, the animal would usually land on the platform, nibble at the food, look around hesitantly and then slowly nibble again. In the last seven sessions, the animal sometimes even walked away from the food tray after nibbling at it and then remained motionless in one corner of the landing platform.

(b) As indicated above, all of the animal's activities during the preliminary behavior tests diminished during the last 25 sessions of the experiment. This diminution was most marked in its activity on the landing platform. Here from a "normal" moderate exploratory activity, it finally reached the point where it sat motionless and cringing, disregarding the food tray even though it had not eaten for the previous twenty-four hours.

f) Animal Number E-2

(1) Preliminary Behavior Tests

This animal's eating behavior on the platform was very variable during the first forty sessions. During Sessions No. 34, 35, and 36, after the animal had been having difficulty with the jump vs. no-jump discrimination problem, its eating on the platform stopped altogether. For the rest of the sixty sessions, its eating behavior was usually "Moderate". The animal responded with a fairly constant intensity to the several tests: Its "General activity on scale", "General activity when taken from the case," was usually "Moderate" or "Little"; its resistance to "Being held in hand", "Being held on back" and "Held by tail" was most usually "Little" or "Slight"; and its "Amount eaten on platform" and "General activity on platform" was most usually "Moderate" or "Little".

Toward the end, there was a general diminution in the extent and intensity of activity so that in all but the first test the animal most

frequently showed only "Slight" activity. Its general activity on scale remained the same -- "Moderate."

When retested at the end of the experiment after the elapsing of one week's rest, the animal's response reverted to the more "normal" degree noted above.

(2) Miscellaneous Behavior

At first, the animal easily mastered and held to the anticipatory jump response so that it jumped before it was given a shock, but as the experiment progressed and the problem became beyond its capacity, it continued to wait for the shock before it would jump. Towards the end, this occasionally became exaggerated so that in Session No. 88 and 89, the animal took a fifty-second and forty-second shock before it quitted the jumping box. In addition to this, there were several occasions where the animal's eating after a successful trial jump became disturbed due to the negative conditioning of earlier unsuccessful trials.

This animal displayed a recurrent position habit to the right. This seems easily explainable on the basis of its first forty sessions of training.

(3) Behavior Suggesting Neurosis

There was none noted here besides the general diminution in degree of eating and degree of preliminary behavior activity towards the latter thirty sessions of the experiment.

g) <u>Animal Number F-1</u>

(1) Preliminary Behavior Tests

The animal was initially a very quiet and docile one. Its response to the behavior tests during the earlier session was "Moderate". As it became completely accustomed to the experimental setup, it adopted a standard pattern of behavior which seemed to constitute a

norm. From this norm, its behavior varied as the difficulty of the problem varied. Its standard degree of "General activity on scale," and "General activity when taken from case" was "Little" or "Moderate". Its resistance to "Being held in the hand" and "Being held on the back" was either "Slight" or none at all. When "Held by the tail," its flexion and kicking response was either "Little" or "Moderate". The intensity of its reaction to all of these increased somewhat during the three sessions when it was making adequate response to the experimental situation but as the experiment progressed, the intensity of these response dropped. Towards the end, the animal's "General activity on the scale" diminished markedly; its "General activity when taken from case" and the kicking reaction to being "Held by tail" were most frequently noted as "Slight" in intensity; and resistance to "Being held on back" were either "Slight" and even more frequently "None." Variations in the animal's "Amount eaten on platform" and its "General activity on platform" deserve special notice.

Its eating behavior on the platform during the preliminary behavior tests showed some interesting fluctuations. During the first ten sessions, the animal learned to eat the food on the tray. However, as it encountered difficulty its eating greatly decreased and from Sessions No. 11 to 47, it ignored the food tray during the preliminary behavior tests. In Session No. 47 however, coincidental to its adequate reaction to the problem situation, it again began to eat during the preliminary behavior tests. This continued until the end of Session No. 64 when it again stopped eating during the preliminary behavior tests. It failed to eat during the subsequent sessions. The animal's general activity on the platform also showed the interesting trend to score "Slight" or no activity during the early forty sessions. It subsequently jumped to "Moderate" and "Much"

during Sessions No. 47 to 56 after which it dropped down to "Slight" again and from Session No. 64 to the end of the experiment was either "Slight" or even more frequently none at all. In this latter instance, the animal remained perfectly motionless on the platform in exactly the position in which the experimenter placed it even when the animal's snout was immediately over the food. The most descriptive term that can be offered for the animal's state is lethargy.

(2) Miscellaneous Behavior

(a) Time in Box

The animal almost always remained in the box after the opening of the exit gate longer than the three or five seconds which were allowed before it was given electric shock. The animal never mastered the anticipatory response. In several instances this waiting in the box became exaggerated. Thus in the first six trials of Session No. 43, the animal remained 42, 49, 50, 20, 49, and 16 seconds in the box after the beginning of the shock punishment. In the first three trials of Session No. 61, it took 34, 60, and 58 seconds of shock and in trials 1 to 4 of Session No. 64, it took 23, 60, 17, and 20 seconds of shock. The impression given from this was that the animal had built up a strong negative conditioning against jumping in each of these instances. No significant trend in this factor was noted during the course of the experiment.

(b) Position habits

The animal showed a very strong negative position habit against jumping to the right stimulus aperture. This habit showed itself in the animal's displaying a very strong position habit to the left. This position habit reappeared again and again.

(c) Resistance to box

The animal's resistance to the box was very closely associated with the amount of success that it met in its jumping behavior. During Session No. 44 to 48, it showed only "Moderate" resistance to being placed in the box. In the ensuing sessions however, its struggling become strong and marked each time E. placed it in the jumping box. Towards the end, there was a general diminution in the animal's resistance.

(d) Miscellaneous observations

From early in the experiment the animal began to squeal in the jumping box just after the opening of the exit gate and before the administration of the shock. This would seem to indicate that the animal had learned to anticipate the shock but just did not learn to respond by jumping so as to avoid it. This squealing became much aggravated during those sessions when the animal was encountering special difficulty. In contrast to this the animal took the punishment shock in the net quietly without squealing or any undue activity.

(3) Behavior Suggesting Neurosis

The most outstanding evidence of neurotisism this animal showed was in Session No. 61 to 63. Here the animal was given the problem of jumping to the unobstructed aperture when the other was blocked by a stimulus card, with a circle upon it. During these sessions, the animal was unable to respond adequately to the situation. Yet prior to its being subjected to the unsolvable square vs. circle discrimination, the animal had been able to give 100 per cent correct responses to this identical situation during Sessions No. 45 to 48. The indication would seem to be that the habit which it had learned had been disrupted by the

intervening unsolvable problem. Add to this the animal's taking of long shock periods in the jumping box during Session No. 61 and its cessation of eating during the preliminary behavior tests during those sessions when it was faced with an unsolvable problem and we have a fairly convincing picture of neurosis.

h) Summary of Findings

Though none of the animals in the experiment was able to master either the first or second differentiation problem, each exhibited various kinds of responses which are significant in the present consideration. Following the classificational outline of neurotic behavior presented in part II B of this paper, the responses observed may be summarized as follows:

(1) Excitement and emotional outbursts.

All the animals showed excitement of one sort or another after receiving punishment for incorrect responses. This, however, can hardly be called "abnormal." Two instances, however, merit attention. Animal D-3, after an extended number of unsuccessful responses in one experimental session, began to run around in circles chasing its tail, each of three times it fell to the net. This latter behavior was specifically broken up by electric shock punishment. Animal D-1, although generally quiet and docile in the earlier sessions became difficult to handle; and as the experiment progressed, and its difficulty with the problem situation increased, it attempted on three occasions to bite E's hand during the preliminary behavior tests.

(2) Disruption of habitual or previously learned behavior.

Every one of the seven animals showed some disruption of its eating behavior which seems directly traceable to the difficulty encountered in the problem situation. In one animal (E-2), the eating behavior was temporarily disrupted when a new problem was set before it, but its eating again

increased after a while even though the problem remained unsolved. Animals D-2 and F-1, concommittant with their lethargic attitude when placed on the platform (in the preliminary behavior tests), remained perfectly motionless even though placed with their noses immediately over the food tray. D-3 and D-4 showed a disruption of their eating behavior in the feeding after the trial jumps. The animals, though still hungry, would ignore food placed beside them. Animals D-1 and E-1 showed the most complete disruption of feeding behavior. The first of these animals, though eating well in the earlier sessions, would in the last 20 sessions land on the platform, nibble hesitantly at the food for a moment and then "timidly" retire to a corner of the platform where it would cower. In E-1 this disruption was even more marked. The animal, in the last eighteen sessions, would land on the platform and squat motionless near the food tray in which it showed no interest.

Three of the animals showed loss of previously learned behavior when a period of unsolved problem-situation intervened between the original learning of this behavior and the succeeding retest. In animals D-2 and F-1, the behavior lost was the adequate jumping response to the open apperture, this though the animals had shown complete mastery of this response in earlier sessions. Retraining was possible, however, Animal E-2 showed an interesting "regression" to an earlier, less adequate mode of reaction as the experiment progressed. Though it had early mastered the anticipatory response aspect of the experimental situation and usually jumped from the box before the administration of shock during the earlier sessions, during the latter sessions the animal lost this ability and would consistently wait for the shock before jumping. This occasionally became exaggerated so that the animal sometimes took long stretches of shock

before quitting the jumping box.

(3) Antagonistic attitude.

Two of the animals (D-1 and E-1) showed a considerable increase in the amount of resistance displayed to being placed in the jumping box as the experiment progressed. In contrast to this it should be pointed out that animal F-1, which evinced an increase in amount of resistance to being placed in the jumping box each time it was introduced to a new problem, showed a general decrease in amount of resistance towards the end even though the problem was still unsolvable for it at this point.

Animal D-2 evinced an antagonistic attitude to the experimental situation as a whole, struggling and whimpering when brought to the laboratory.

(4) Perseverative or stereotypic responses.

Though receiving punishment each time it did so, animal D-1 again and again continued to jump to the top of the stimulus apperture cowling (or "Tunnel"). It took a long series of extra punishment to make the animal abandon this behavior. Another such behavior manifestation was shown in its continued jumping at the center partition between the two stimulus appertures. Even D-4's continued attempt at escaping the choice situation by jumping directly to net probably belongs here though electric shock punishment brought a quick disruption of this behavior.

(5) Hesitancy and indecision.

All the animals showed hesitancy and reluctance to jump after meeting with punishment for incorrect responses but in animal D-4 this showed itself in an habitual response of looking and swaying from side to side before jumping.

(6) Lethargy

To a greater or lesser extent, every one of the animals showed a decrease in the amount of activity as the experiment progressed. In animals D-1 and E-2, this decrease was moderate and gradual and is probably sufficiently well explained by the animal's becoming <u>used to</u> the experimental situation. In animals D-2, E-1, and F-1, however, this diminution of activity was extreme, the animals remaining completely motionless when placed on the platform by E. as well as showing but slight activity in the other preliminary tests. Animals D-3 and D-4 showed a lethargic slowness of movement not during the experimental session, but <u>after</u>. When food was placed near them they ignored it; when put back in their living cages they displayed a marked inertia.

C. Experiment Number Two

1. Subjects

The subjects used in this experiment were five male albino rats, G-1, G-2, G-3, G-4, and G-5. At the time that the experiment was begun (8/8/'39), the animals were 12 weeks and six days old. They all came from one litter. These animals were raised on a normal Fox Chow diet at the Nutrition Animal Laboratory at the Massachussetts State College and were derived from Wistar Institute stock.

These animals, from their birth to the time the experiment was completed, were cared for and handled solely by the experimenter. They were kept in a well-ventilated, temperature-controlled room. Each animal had a separate wire mesh living cage. The animals were fed only during and immediately after each day's experimentation. They remained well and healthy throughout the period of experimentation except that animal G-3 developed a slight "cold" several times which showed itself in a sniffling sort of breathing. This condition was transitory and seemed to have no influence on the animal's behavior in the laboratory.

The experiment lasted for eleven weeks and six days.

2. General Method

Using a modified Lashley set up, the animals were first trained to jump across a ten-inch gap and through the open one of two 6" x 6" apertures when the other aperture was blocked by a totally black card.

The right-left position of the positive and negative stimuli in successive trials was in "chance order."

As soon as this technique was mastered, (all animals did so within the first 15 trials), the animals were made to jump towards, and through, the stimulus aperture bearing a white card with a one-half-inch wide, horizontal black line upon it. The negative stimulus was still a black card. A jump towards the horizontal line stimulus card resulted in the card's snapping automatically out of the way, permitting the rat to land on the platform and receive the food reward. A jump at the black card resulted in the rat's banging his nose against the blocked card and falling to the net below where he received a mild electric shock punishment. This also all the animals mastered easily.

The animals were next made to differentiate between a one-half-inch wide horizontal black line, (positive stimulus) and a one-half-inch vertical black line (negative stimulus). When, and if, the animals mastered this differentiation, they were made to differentiate between a horizontal and a vertical rectangle in which the ratio between the width to length approached closer and closer to 1:1 as the experiment continued. When the animal jumped at the aperture in which the card bearing the horizontal rectangle was displayed, the card snapped automatically out of the way, permitting the rat to land on the platform and receive a food reward. A jump at the aperture which was blocked by the card with the vertical rectangle upon it resulted in the rat's banging his nose against the card and falling to a net below.

Each animal was tested on each of the differentiation steps in this procedure until it succeeded in responding correctly 14 out of 15 successive trials.

The animals were run for a total of 1,050 trials.

3. Apparatus

The apparatus, a modified form of the Lashley Jumping Apparatus consisted of:

a) A Jumping Stand as described under part III B 3 a, (p. 33) except that the inductorium to which the jumping box grid was connected, was not set at a constant shock intensity but was incorporated in a

b) Shock Control Unit (see Fig. 3) which consisted of the inductorium, a 1.55 volt Eveready dry cell, a two-prong knife switch, and a device for easily varying the extent of overlapping between the primary and secondary coils. The primary coil of the inductorium, the dry cell, and one element of the knife switch, were connected in series. The closing of the knife switch completed the circuit in the primary coil sending an induced current through the jumping box grid that was connected to the secondary coil. The secondary coil was movable and had attached to it a ratchet bar which rested upon a lever. This lever was so arranged that each time it was pressed down once, it pushed the secondary coil 1 cm. further over the primary coil. (An elastic band pulled the lever back into position for the next shock increase.) In this way it was possible to increase the strength of the shock in the jumping grid by simply depressing the shock-increasing lever.

The other element of the double knife switch was connected in series with a dry cell energizing the primary coil of an inductorium (not shown in figure) that was connected with the landing net grid.

c) A stimulus Stand as described under part III B 3 b (pp. 33-37) except that the safety net was electrically wired <u>from the beginning</u> of the experiment so that any incorrect jumps were punished by both a fall and a two seconds shock from the start of the experiment.

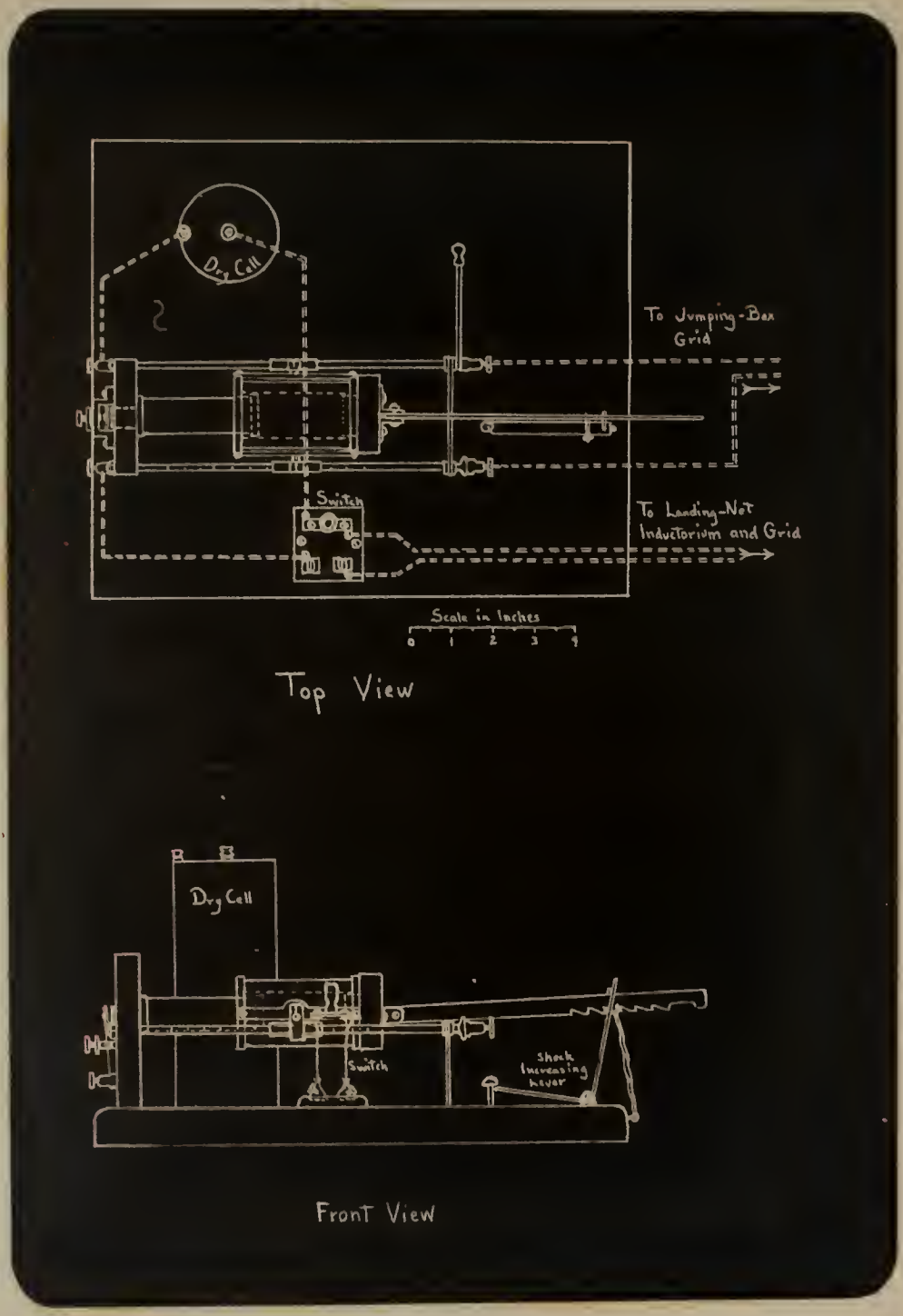

Fig. 3. SHOCK CONTROL UNIT

(For explanation see text)

d) Stimulus Cards as described under part III B 3 c (p. 37) except that each stimulus card had the positive horizontal stimulus figure on one side and the negative vertical stimulus figure upon its other side. The stimulus figures used are illustrated in Fig. 4.

e) Miscellaneous

Metronome and laboratory conditions as described under III B 3 d (p. 37).

4. Procedure

a) Handling of Animals and Preliminary Behavior Tests

Each day animals G-1, G-2, G-3, and G-4 were removed from their living cages and were each placed in one of the four compartments of the carrying case that was used to transport them to and from the laboratory. Their extent of:

(1) "Expectant" Activity in Cage was noted and immediately recorded:*

Each of the animals was then weighed and its weight and degree of

(2) General Activity on Scale noted and recorded:

The four animals were then carried to the darkened laboratory where a five to ten minute period for adaptation to the darkness was permitted before work with the animals was continued. The carrying case was then opened and the first animal (G-1) was put through the remaining preliminary behavior tests. First the animal's response to

(3) Prodding In Carrying Case, when it was prodded in the caudal region for ten seconds, was noted; next its

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* The Method of Recording all data in the experiment is presented in detail in the Appendix.

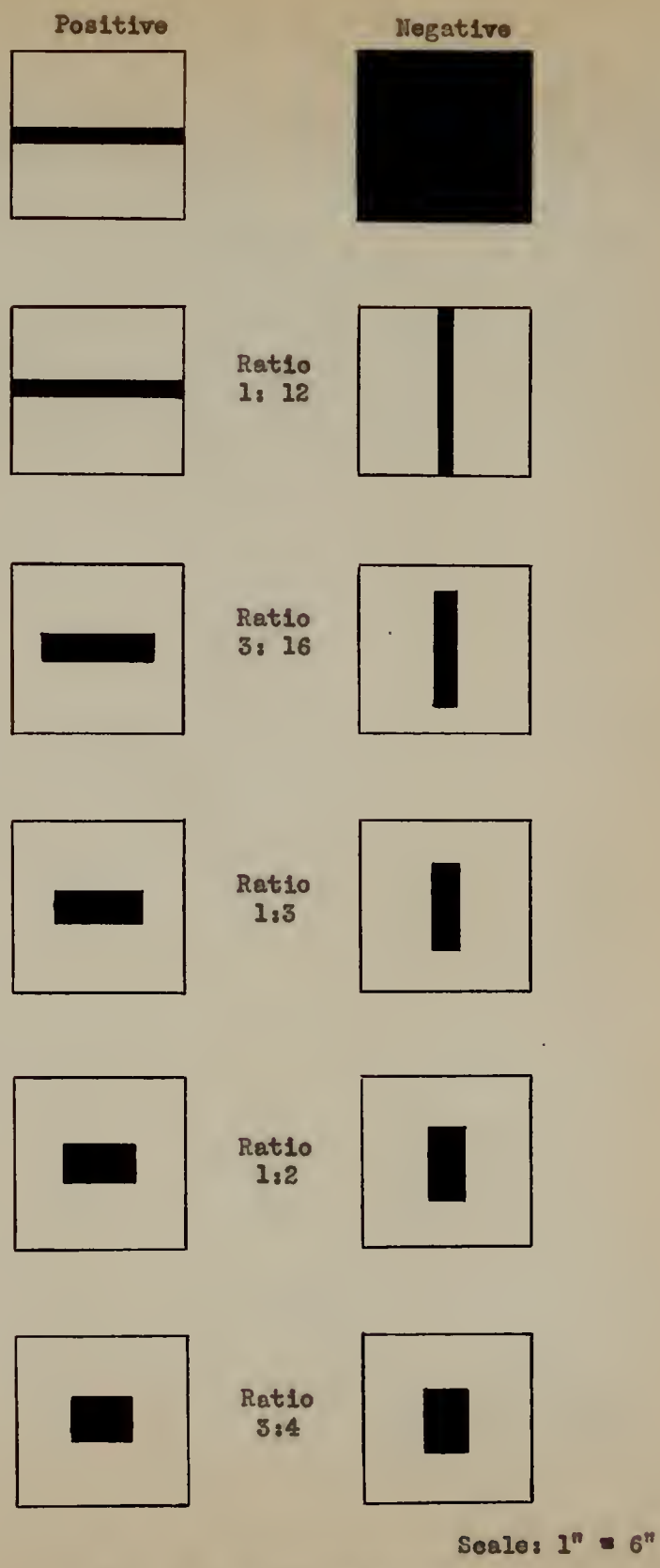


Fig. 4. STIMULUS FIGURES

Used in Experiment No. 2.

(4) Resistance to Being Held in Hand, when it was placed in the experimenter's left hand and held down with the right hand for five seconds, was noted; then its

(5) Resistance to Being Held on Back, when held on its back in the experimenter's right hand for five seconds, was noted. After this the animal's activity when

(6) Hold (suspended) by Tail for three seconds was noted. The animal was then placed on the landing platform right near the food container and permitted to remain undisturbed for twenty seconds during which time E., observing the animal through the mirror, noted the

(7) Amount Eaten on Platform, and recorded the animal's previous response to the preliminary behavior tests 3 to 7 inclusive.

At the end of the twenty seconds on the platform, the food container was removed and the animal's behavior on the platform observed for twenty seconds longer. This

(8) General Activity on Platform was immediately recorded.

After this the animal was placed in the jumping compartments through the entrance gate preliminary to the first jumping trial of the experiment proper. (See parts b) to e) that follow.)

At the completion of the 15 trials of each daily session, the animal was replaced in the carrying case and a container of food placed with it. The food remained with the animal for an hour to 1½ hours, during which time the animal was permitted to eat to satiety.

When animals G-1, G-2, G-3, and G-4, in the order given, had been thus "put through their paces", G-1 and G-2 were returned to their living cages. (G-3 and G-4 remaining in special cages in the

laboratory to complete their hour of feeding.) The degree of their

(9) After-run activity in Cage was immediately recorded after each animal was replaced in its living cage.

G-5 was then taken to the laboratory for its tests and training sessions.

b) Familiarization with Experimental Situation

For each of the first three days, in order to familiarize the animals with the laboratory set up, they were put through the procedure described above for the preliminary behavior tests. They were not, however, placed in the jumping compartment. Training was begun on the fourth day.

c) Acquisition of the Jumping Technique

The apparatus was adjusted as follows:

(1) One of the apertures was blocked by a black card, the other aperture containing no card at all. (A large, illuminated white card ~~bar~~ was placed at the back of the landing platform since it was desired to condition the animal to the lighter of the two apertures and it was discovered that otherwise, the black card, illuminated as it was by the lamp above the jumping box, actually was lighter than the open aperture.)

(2) The jumping compartment was at a point six inches from, and equidistant between the stimulus apertures. The gap between the compartment and the open, no-card aperture was bridged by a wide strip of metal.

(3) The successive left-right positions of the blocked and open aperture as well as the metal bridge were in random order.

After the animal had been in the jumping compartment for from 15 to 20 seconds, the opening gate of the jumping compartments was lifted at the same time that the inductorium switch was closed. The animal thus immediately received a slight shock to induce it to jump as soon as the opening gate was lifted. After four seconds, the Shock Increasing Lever was depressed once; thus increasing the strength of the current in the jumping compartment by one unit; three seconds later the lever was again depressed, again increasing the current; and so on -- the Shock Increasing Lever being depressed each three seconds until the animal moved from the jumping box.

If the animal made a correct response, going to the open aperture, the inductorium switch was immediately lifted and the animal was permitted twenty seconds on the platform in which to eat. During this time, E. made his recordings of the animal's responses for that trial. Immediately upon completion of the twenty seconds, the animal was lifted from the platform and placed in the jumping compartment preliminary to the next jumping trial.

If the animal made an incorrect response it banged its nose against the blocked black card and fell to the net below. The inductorium switch was left on for two seconds after the animal landed in the net so that the animal received two seconds of punishment shock in the net. E. then made his recording and immediately placed the animal in the jumping compartment for the next trial.

As soon as the animals had learned to run across the metal bridge to the open aperture the bridge was eliminated and they were taught to jump across the six-inch gap to the open aperture. Mastery of the six-inch jump was followed by a series of eight-inch jumps and this in turn was followed by a series of ten-inch jumps.

d) Differential Conditioning

(1) When the animal had learned to jump a ten-inch gap to the open aperture to a criterion of 93 per cent correct, it was trained to respond positively to a white card with a one-half inch wide horizontal black line. The negative stimulus still remained the totally black card. The jumping distance in this and all subsequent trials remained ten inches. All five animals gave 93 per cent or better correct responses the first day that they were put on this problem.

(2) In the following session, the black card was replaced by a white card having a one-half inch wide vertical black line upon it so that now the animal had to differentiate between the two white cards, one having a horizontal black line as the positive stimulus and the other a vertical black line as the negative stimulus.

e) Equating of Differential Stimuli

When an animal had learned to differentiate between an horizontal line, one-half inch wide and six inches long, from a similar vertical line so that it had run three separate series of 15 trials each with an accuracy of 93 per cent correct responses or better, it was made to attempt a differentiation between two contrastingly placed rectangles, one of which had its longer dimension horizontal (positive stimulus) and the other had its longer dimension vertical (negative stimulus). The dimensions of the rectangle in the sequence in which they were used were as given in the following table.

Table 1.

DIMENSIONS OF STIMULUS RECTANGLES USED IN THE SUCCESSIVE EQUATING OF DIFFERENTIAL STIMULI			
Width	Length	Area	Ratio of W. to L.
3/4"	4"	3 sq. inches	3:16
1"	3"	" "	1:3
1¼"	2 4/10"	" "	1:2
1½"	2"	" "	3:4

When the animal had learned to differentiate between the first two contrastingly placed rectangles (width-to-length ratio 3:16) to a criterion of 93 per cent correct responses or better, it was advanced to the next pair of stimuli (width-to-length ratio 1:3), and so on, until the animal no longer was able to differentiate between the two rectangles.

It is to be noted that the area of the rectangles used remained constant throughout the experiment.

5. Findings

The findings in this experiment are presented here in Tables 2 to 6 and Graphs I to V that follow. Each of these tables was arrived at by first tabulating in full the responses of each animal throughout the seventy experimental sessions. These preliminary tables were then condensed into the tables as given by grouping the data for successive experimental sessions which fell naturally together. The grouping was determined by such factors as changes in the type of stimulus used, significant changes in the animal's behavior, and the special ruling that no single group of data should encompass the material of more than seven experimental sessions.

The figures presented in these tables under the heading "Preliminary Behavior Tests" refer to the rating of the animal's behavior intensity for each of the nine tests which are presented in detail in the Appendix. The method of rating the animal's "Resistance to Box" and amount of "Shock Taken" are also given in the Appendix.

The graphs presented are pictorial schematizations of the tables which they follow. The reason for their inclusion is that they enable one to see quickly the interrelationship between the various behavior patterns of each of the animals as well as the trend of reaction changes throughout the duration of the experiment.

(It should be noted that in these graphs the time lines for the first eight preliminary behavior tests are staggered one-half a session backwards. This seemed advisable since each of these eight tests preceded the actual jumping trials during any given session and hence were more related to the previous day's jumping trials than those that followed it in the same session.)

a) Animal G-1

(1) Learning Behavior

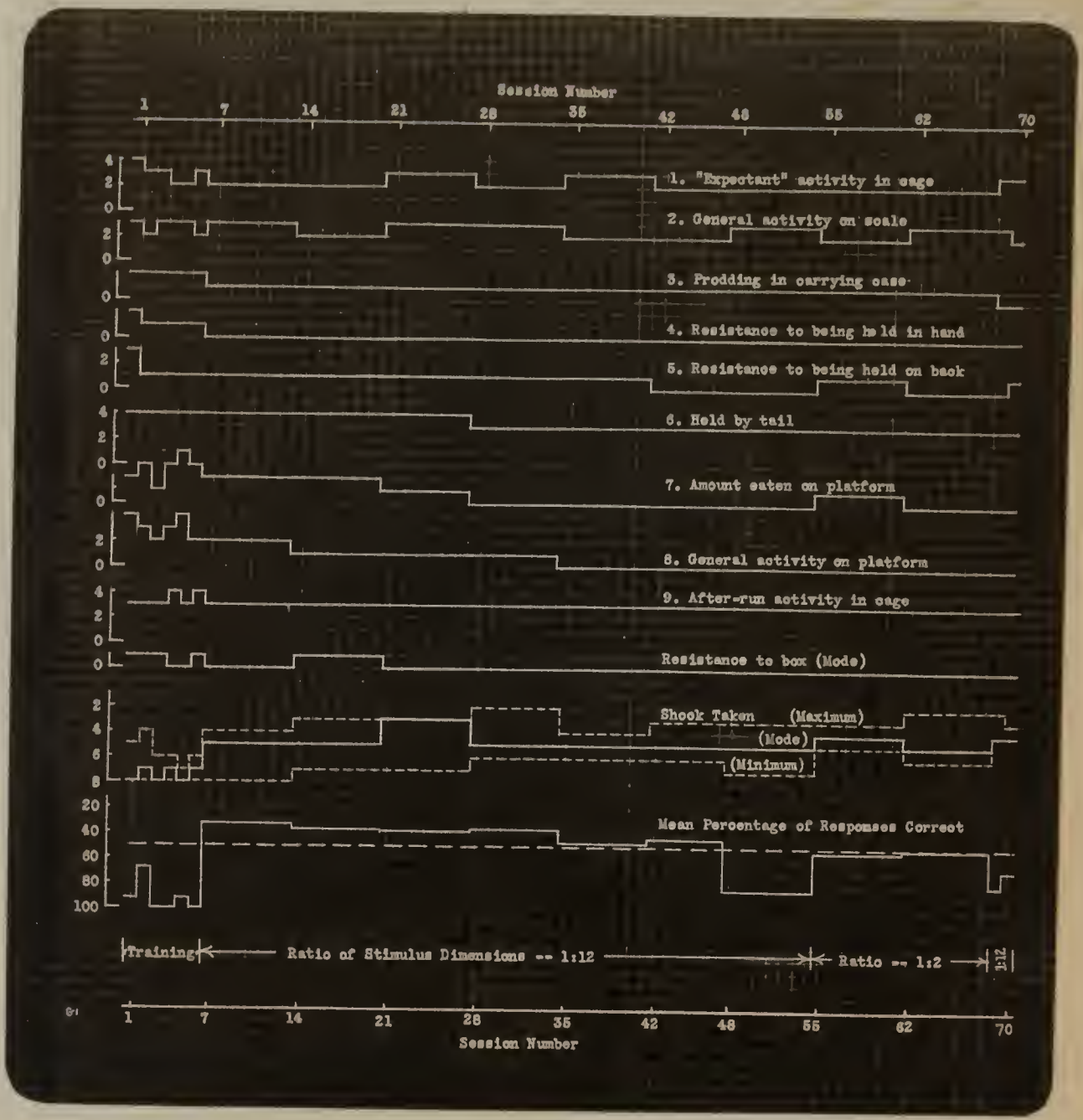
As is shown in Graph I, the animal learned quickly the preliminary technique of jumping. However, the introduction of a horizontal vs. vertical line discrimination immediately caused the animal to adopt a strong position habit to the left. This position habit persisted up to the end of the 47th session. During this period, the experimenter attempted to make the animal break this position habit and because of the method used, the animal's "Mean Percentage of Responses Correct" for this period fell below the "chance level" of fifty. In Sessions No. 48 to 55, the animal finally mastered this initial differentiation.

TABLE 2 SUMMARY OF BEHAVIOR OF ANIMAL G-1

Session No.'s	Trial No.'s	Stimuli	Preliminary Behavior Tests (Modes)									Resistance Box (Mode)	Shock Taken			Position Habit	Mean % Correct	Miscellaneous
			1	2	3	4	5	6	7	8	9		Mode	Min.	Max.			
P 1-3			3	2	2	2	3	2	2	3								No eating on L.P.
1	1-15	B-N;Br.	4	3	2	2	3	4	2	4	3	1	8	8	5		93	Little eating on LB
2	16-30	B-N; 6"	3	2	2	1	1	4	3	3	3	1	7	8	4		67	Uncertain eating
3	31-45	" "	3	3	2	1	1	4	1	2	3	1	8	8	6		100	Helped to food
4	46-60	B-N; 8"	2	3	2	1	1	4	3	3	4	0	7	8	6		100	Toward right on L.P.
5	61-75	B-N;10"	2	3	2	1	1	4	4	4	3	0	8	8	7		93	Helped to food
6	76-90	B-L;10"	3	2	2	1	1	4	3	2	4	1	7	8	6		100	To right on L.P.
7-13	91-195	1:12	2	3	1	0	1	4	2	2	3	0	5	8	4	L	33	Squealed; Bit own tail; Dived to net
14-20	196-300	" "	2	2	1	0	1	4	2	1	3	1	5	7	3	L	38	Motionless at food Jump between cards
21-27	301-405	" "	3	3	1	0	1	4	1	1	3	0	3	7	3	L	39	Jump between cards
28-34	406-510	" "	2	3	1	0	1	3	0	1	3	0	5	6	2	L	37	Jump between cards; Hesitant jumping.
35-41	511-615	" "	3	2	1	0	1	3	0	0	3	0	5	6	4	L	47	Jump between cards; Ate after jump.
42-47	616-705	" "	2	2	1	0	0	3	0	0	3	0	5	6	3	L	43	Jump between cards; Hesitant jumping.
48-54	706-810	" "	2	3	1	0	0	3	0	0	3	0	5	7	3		84	Jump between cards.
55-61	811-915	1:2	2	2	1	0	1	3	1	0	3	0	4	5	3		52	Bit tail in net; Attacked net wire.
62-68	916-1020	" "	2	3	1	0	0	3	0	0	3	0	5	6	2		51	
69	1021-1035	1:12	3	3	0	0	0	3	0	0	3	0	4	4	2		80	Hesitant jumping.
70	1036-1050	" "	3	2	0	0	1	3	0	0	3	0	4	4	3		67	

TABLE 2.

GRAPH I



SUMMARY OF BEHAVIOR OF ANIMAL G-1

(For explanation see pp. 72-73 in text)

The animal could not solve the horizontal vs. vertical differentiation in which the ratio between the width to length of the rectangles was 1:2.

Returning the animal in the last two sessions to the original horizontal vs. vertical line differentiation resulted in its giving responses that were 80 and 67 per cent correct.

(2) Preliminary Test Behavior

In none of the preliminary activity tests was there any clear evidence of relationship between the amount of activity displayed and the animal's responses to the differentiation problem. Thus in tests (1) "Expectant activity in cage" and (2) "General activity on scale", the extent of its behavior fluctuated somewhat throughout the seventy sessions, but those fluctuations bore little relationship to any of the other activities. Its response to (3) "Prodding in carrying case", (4) "Resistance to being held in hand", (6) "Held by tail", (8) "General activity on platform" and (9) "After-run activity in cage" showed a gradual diminution in extent as the experiment progressed, but the most significant aspect of the time lines is the fact that the animal's activity, on the whole, in these last-mentioned five tests was astonishingly constant.

Test (5) "Resistance to being held on back" and (7) "Amount eaten on platform" also showed a gradual diminution in extent of activity but here the amount of change over the experimental period was greater than in the other tests. It is of interest to note that in both these tests, the extent of the animal's behavior rose at the introduction of the new and harder problem of discriminating between the 1:2 ratio rectangles.

(3) Miscellaneous Behavior Noted

(a) The animal's "Resistance to box" was markedly constant throughout the experiment.

(b) The amount of shock taken by this animal reflects very clearly the difficulties which the animal met in the differentiation problems as the experiment progressed. As the comparison of the two lowermost time lines of the graph show, a rise in the number of errors is accompanied by a similar rise in the strength and amount of shock taken. However, in Session No. 48 to 55, when the animal's errors dropped considerably, it did not show a commensurate reduction in the shock punishment taken. This would seem to indicate a certain perseveration of the avoidance reaction induced by the difficulty encountered in the preceding trials.

(c) Throughout the experiment, the animal, when faced with a difficult problem, attempted to avoid the whole choice situation by jumping at the partition between the stimulus apertures. Even when it jumped at the card, it would do so by going towards the inside edge of the perture. In addition to that, the animal displayed a distinct hesitancy in most of the jumps. Every once in a while, it would get ready as if to jump, then draw back, get ready again, draw back and then finally jump.

(4) Behavior Suggesting Neurosis

Three times during the experiment, this animal showed a type of behavior that is worthy of notice. In Session No. 10, after having encountered extreme difficulty in the preceding three sessions during which it

was first introduced to the differentiation problem, the animal, after landing on the net began nibbling its own tail and did so to the extent that the tail bled. This behavior did not recur again until the 56th session which was the second session during which the animal was first introduced to the 1:2 ratio rectangle differentiation. In this session, the animal after falling to the net because of an unsuccessful leap, started circling in the net, snapped at its own tail and again started biting it. In both these instances, the experimenter deliberately broke up this habit by immediately giving the animal an electric shock each time it attempted this behavior.

Another similar response was noted three sessions later (Session No. 59). This time the animal, after falling to the net and receiving its shock punishment, made several vicious attacks at the wiring in the net -- clawing and biting at it. This happened in three successive trials. After receiving shock punishment each time it did so, the animal abandoned this behavior.

When the animal was returned in the last two sessions, to the previously solved 1:12 ratio differentiation, its response indicated that it had not lost its ability to differentiate these stimuli even though its behavior had been disrupted in the other ways noted.

In terms of the definition of neurosis as given at the beginning of this paper, this animal was not neurotic. However, the sum of the aberrant reactions which it evinced, as well as the specific nature of each of them, would seem to suggest an incipient "neuroticism".

b) Animal G-2

(1) Learning Behavior

The learning curve for this animal is almost ideal from a learning experiment viewpoint. It learned the initial jumping technique within the first five sessions. When put on the 1:12 width-to-length ratio differentiation, it started with a little lower than chance percentage of correct responses and gradually by Sessions No. 25 to 30 showed that it had mastered that differentiation. Advancing the problem so that the animal had to differentiate between the rectangles with a width-to-length ratio of 3:16 brought a drop in the percentage of correct responses during the first session, but it immediately rose in the following session to 93 per cent. Succeeding sessions (No.'s 33 to 46) showed that the animal was transferring its adjustment to differentiating between the 1:12 and 3:16 ratio stimuli to the 1:3 and 1:2 ratio stimuli to which it was introduced. In the 47th session, however, for no evident reason, its responses were reduced to chance, but in Session No. 48, it again gave 93 per cent correct jumps. When confronted in the following session (No. 49) with the original 1:12 ratio stimuli, it again gave a 93 per cent correct set of responses.

In Session No. 50, it was confronted with the 3:4 ratio stimuli and since it showed no evidence of solution it was kept on this problem till Session No. 69. Its responses throughout this period were little better than chance.

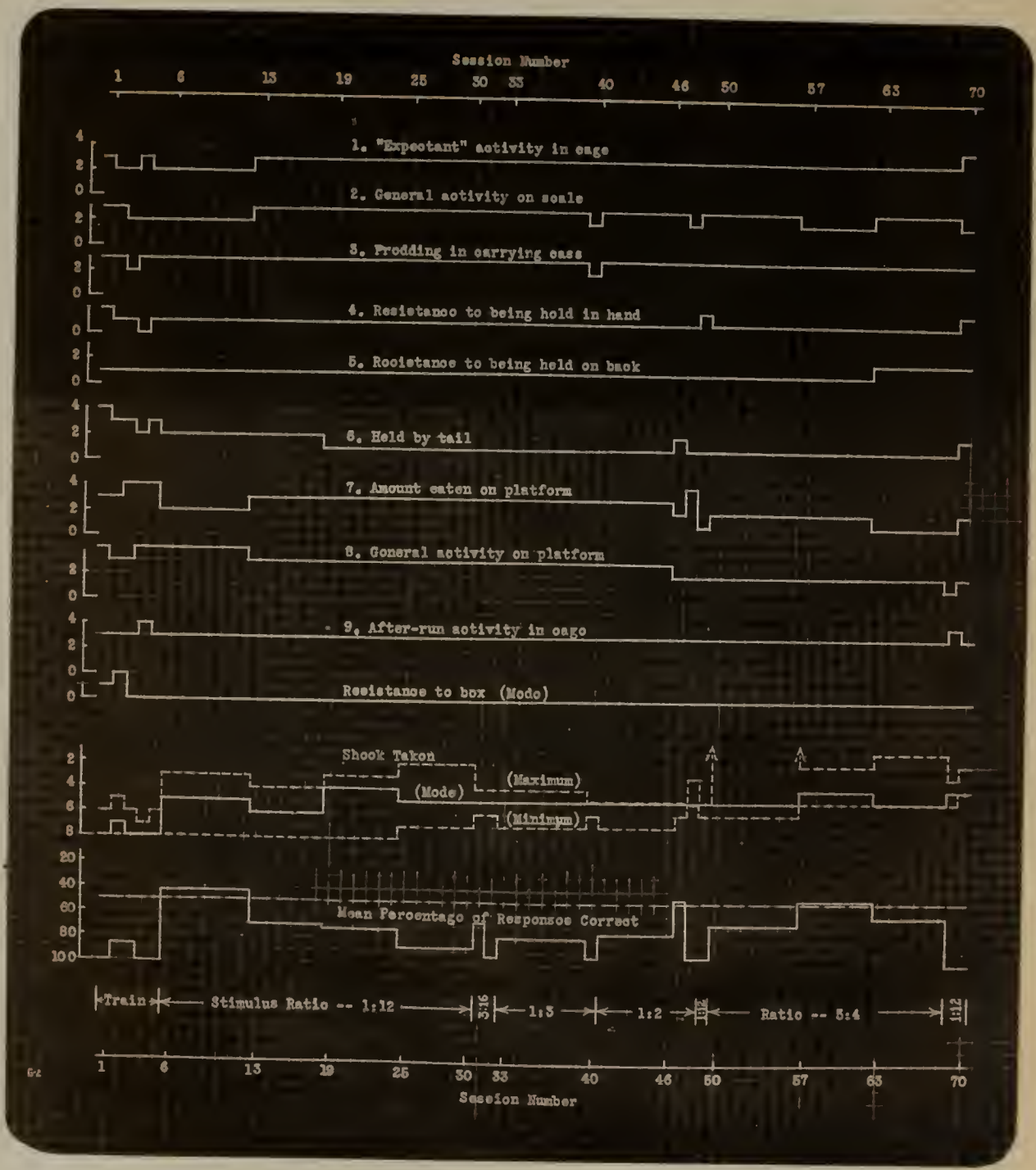
When in Sessions No. 69 and 70, it was returned to the original 1:12 ratio differentiation, it gave perfect responses in all thirty trials.

TABLE 3 SUMMARY OF BEHAVIOR OF ANIMAL G-2

Session No.'s	Trial No.'s	Stimuli	Preliminary Behavior Tests (Modes) 1	2	3	4	5	6	7	8	9	Resistance Box (Mode)	Shock Taken Mode	Min.	Max.	Position Habit	Mean % Correct	Miscellaneous
P 1-3				3	2	1	2	3	2	3								
1	1-15	B-N;Br.	3	3	3	2	1	4	3	4	3	1	8	8	6		100	Slight eating.
2	16-30	B-N; 6"	2	3	3	1	1	3	3	3	3	2	7	8	5		87	
3	31-45	B-N; 8"	2	2	2	1	1	3	4	3	3	0	8	8	6		87	Helped to food.
4	46-60	B-N;10"	3	2	3	0	1	2	4	4	4	0	8	8	7		100	
5	61-75	P-L;10"	2	2	3	1	1	3	4	4	3	0	8	8	6		100	
6-12	76-180	1:12	2	2	3	1	1	2	2	4	3	0	5	8	3		42	Much random act.
13-18	181-270	" "	3	3	3	1	1	2	3	3	3	0	6	8	4		70	Looked from s. to s
19-24	271-360	" "	3	3	3	1	1	1	3	3	3	0	4	8	3		72	Looked from s. to s. Ate well after jump.
25-30	361-450	" "	3	3	3	1	1	1	3	3	3	0	5	7	2		88	
31	451-465	3:16	3	3	3	1	1	1	3	3	3	0	5	6	4		67	Ate well after jumps.
32	466-480	" "	3	3	3	1	1	1	3	3	3	0	5	6	4		93	
33-39	481-585	1:3	3	3	3	1	1	1	3	3	3	0	5	7	4		79	
40	586-600	" "	3	2	2	1	1	1	3	3	3	0	5	6	5		93	
41-46	601-690	1:2	3	3	3	1	1	1	3	3	3	0	5	7	5		74	
47	691-705	" "	3	3	3	1	1	2	2	2	3	0	5	6	5		47	
48	706-720	" "	3	2	3	1	1	1	4	2	3	0	5	3	3		93	
49	721-735	1:12	3	3	3	2	1	1	1	2	3	0	5	6	5		93	
50-56	736-840	3:4	3	3	3	1	1	1	2	2	3	0	5	6	1-		68	Little squealing at shock #1
57-62	841-930	" "	3	2	3	1	1	1	2	2	3	0	4	5	2		49	
63-68	931-1020	" "	3	3	3	1	2	1	1	2	3	0	5	5	1		61	Squealed
69	1021-1035	1:12	3	3	3	1	2	1	1	1	4	0	4	5	3		100	
70	1036-1050	" "	4	2	3	2	2	2	2	2	3	0	4	4	2		100	

TABLE 3.

GRAPH II



SUMMARY OF BEHAVIOR OF ANIMAL G-2

(For explanation see pp. 72-73 in text)

(2) Preliminary Test Behavior

This animal's responses to the preliminary behavior tests also showed little relationship to its jumping behavior during the trials. Its responses to test (3) "Prodding in carrying case", (4) "Resistance to being held in hand", (5) "Resistance to being held on back and (9) "After-run activity in cage" remained almost constant throughout the entire period of experimentation. Its responses to test (1) "Expectant activity in cage" showed a slight upward trend. Test (2) "General activity on scale" was fairly constant except that it became less each time the animal's percentage of correct responses fell to chance level. This diminution in activity when the animal was encountering difficulty was not very marked. Its resistance to (6) "Being held by the tail" showed a gradual drop and seemed to indicate that the animal came to accept this part of the test as the experiment progressed. The (7) "Amount eaten on platform" fluctuated widely, decreasing each time the animal had trouble with the problem. However, no permanent eating impairment remained since each time the animal's adjustment to the differentiation problem improved its "Amount eaten on platform" also increased. The animal's (8) "General activity on platform" showed no evident relationship to its other activity and again reflects a gradual downward trend.

(3) Miscellaneous Behavior Noted

(a) The animal's "Resistance to the box" was practically constant throughout the experiment.

(b) The amount of shock taken by this animal corresponded closely to the "Mean Percentage of Responses Correct". As the animal's problem difficulty increased so did its reluctance to leave the

jumping box. This was most markedly shown when it was introduced to the 3:4 stimulus ratio differentiation. Here in Session No. 55, it remained in the jumping box for as long as 44 to 84 seconds taking the shock rather than the jump.

(c) This animal evinced reluctance and hesitancy in jumping each time the problem was made more difficult, by putting its head out of the box and, after almost jumping in one direction, swaying to the other direction. In later sessions, it would merely turn its head from side to side. (It is quite possible that the animal was not only hesitating, but also trying to fixate the stimulus figures more clearly.)

(4) Behavior Suggesting Neurosis.

None noted.

c) Animal G-3

(1) Learning Behavior

This animal had some difficulty in learning the initial jumping technique but mastered it by the end of the seventh training session. When introduced to the 1:12 stimulus ratio discrimination, the animal developed unstable position responses and thus its "Mean Percentage of Responses Correct" fell below chance level. In the 37th session, this percentage suddenly rose to 93. In the sessions that followed, the mean percentage of correct responses again fell as low as 66, but then rose gradually till Session No. 53 when it again gave 93 per cent correct jumps. The introduction of the 1:2 ratio stimuli at this point caused the animal's percentage of responses to fall back to chance.

Returning the animal in Sessions No. 69 and 70, to the 1:12 ratio stimuli elicited responses which were 87 and 93 per cent correct,

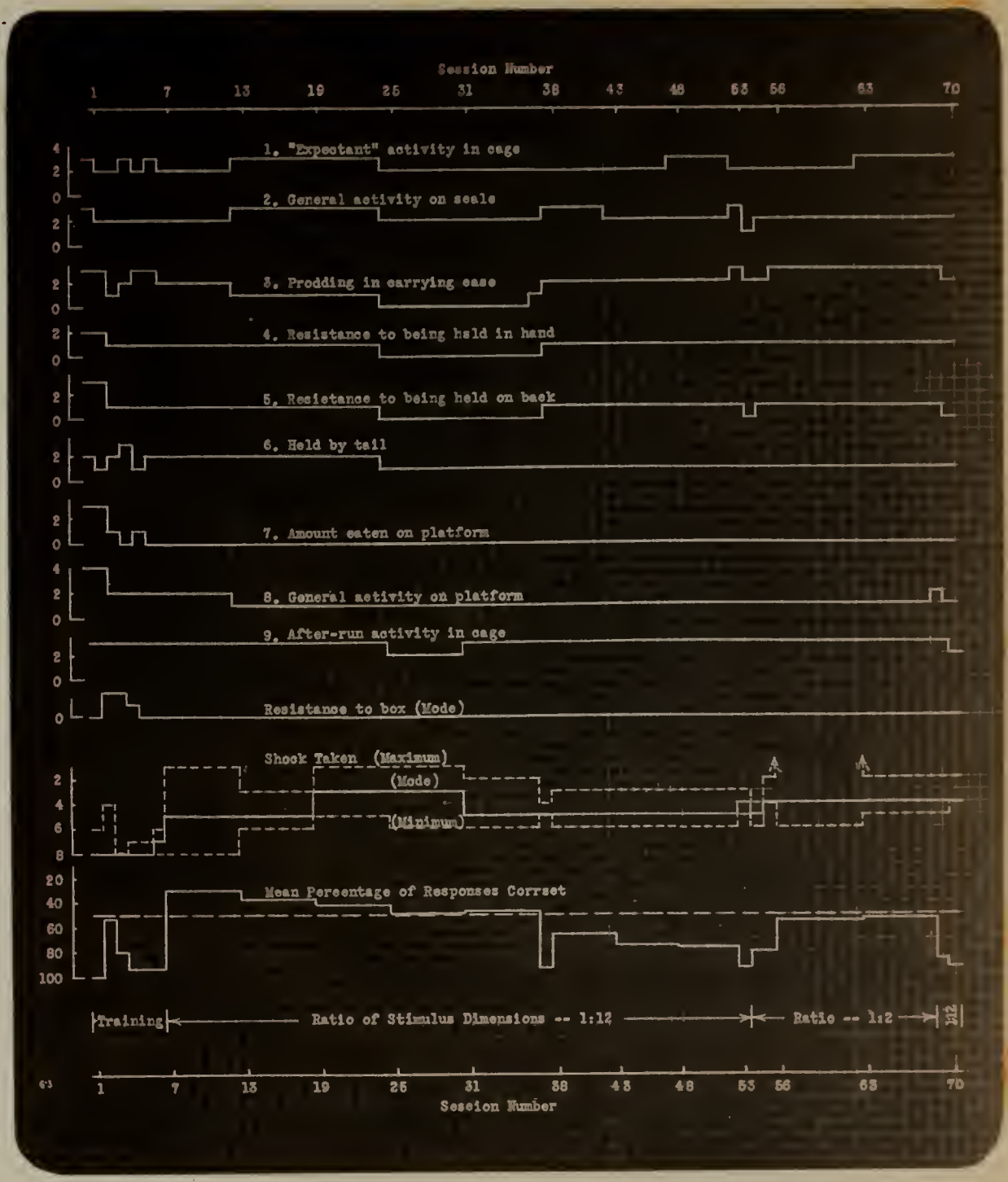
TABLE 4 SUMMARY OF BEHAVIOR OF ANIMAL G-3

Session No.'s	Trial No.'s	Stimuli	Preliminary Behavior Tests (Modes) 1	2	3	4	5	6	7	8	9	Resistance Box (Mode)	Shock Taken Mode	Min.	Max.	Position Habit	% Mean Correct	Miscellaneous
P 1-3				3	1	2	4	3	2	4								
1	1-15	B-N;Br.	3	3	3	2	3	2	3	4	3	0	8	8	6		100	Slight eating.
2	16-30	B-N; 6"	2	2	3	2	3	1	3	4	3	2	8	8	4	L	53	Helped to food.
3	31-45	" "	2	2	1	1	1	2	1	2	3	2	8	8	8		80	
4	46-60	B-N; 8"	3	2	2	1	1	3	0	2	3	1	8	8	7		93	Low moan in box.
5	61-75	B-N;10"	2	2	3	1	1	1	1	2	3	0	8	8	7		93	Moan after handled.
6	76-90	B-L;10"	3	2	3	1	1	2	0	2	3	0	7	8	6		93	Occasional moan.
7-12	91-180	1:12	2	2	2	1	1	2	0	2	3	0	5	8	1	R-L	30	No eating; moaning Defecated on net.
13-18	181-270	" "	3	3	1	1	1	2	0	1	3	0	5	6	3	R	38	No eating, moaning.
19-24	271-360	" "	3	3	1	1	1	2	0	1	3	0	3	5	1	R	42	No eating; Defec.
25-30	361-450	" "	2	2	0	0	0	1	0	1	2	0	3	6	1		49	N.E.; Ran to corner
31-36	451-540	" "	2	2	0	0	0	1	0	1	3	0	5	6	2		48	N.E.; Sway from side to side.
37	541-555	" "	2	2	1	0	0	1	0	1	3	0	5	5	4		93	
38-42	556-630	" "	2	3	2	1	1	1	0	1	3	0	5	6	3		66	Slight eating.
43-47	631-705	" "	2	2	2	1	1	1	0	1	3	0	5	6	3		75	Some eating.
48-52	706-780	" "	3	2	2	1	1	1	0	1	3	0	5	6	3		77	
53	781-795	" "	2	3	3	1	1	1	0	1	3	0	4	5	3		93	Toward right on L.R.
54	796-810	" "	2	1	2	1	0	1	0	1	3	0	5	6	4		80	
55	811-825	1:2	2	2	2	1	1	1	0	1	3	0	4	4	2		80	
56-62	826-930	" "	2	2	3	1	1	1	0	1	3	0	4	6	1-		55	Nibbled tail in net; Sway from side to s.
63-68	931-1020	" "	3*	2	3	1	1	1	0	1	3	0	4	5	2		53	*Resisted removal
69	1021-1035	1:12	3	2	3	1	1	1	0	2	3	0	4	5	2		87	Occasional eating
70	1036-1050	" "	3	2	2	1	0	1	0	1	2	0	4	4	2		93	

Note: From trial 420 to end of experiment the animal hardly ate at all after each successful jump but ran to right corner of landing platform and remained motionless.

TABLE 4.

GRAPH III



SUMMARY OF BEHAVIOR OF ANIMAL G-3

(For explanation see pp. 72-73 in text)

(2) Preliminary Test Behavior

This animal's responses to almost all the preliminary behavior tests seemed to have little to do with its adjustment to the problem situation. There are some marked exceptions to this rule, however. Test (7) "Amount eaten on platform" dropped to zero (on the average) after the sixth session and remained at that level throughout the remainder of the experiment. (Occasional eating does not show up on the graph since only the modal amount of eating is plotted.) In a similar manner, test (8) "General activity on platform" dropped quickly in the first thirteen sessions from a high point to a constant low level for the remainder of the experiment. In all the other preliminary behavior tests, there is one fluctuation which shows up very markedly. In the 25th session, there was a diminution in amount of activity and resistance in all the tests. This decrease continued for various lengths of time in the several tests. There seems to be no reasonable explanation in the data to account for this phenomenon.

The indication from test (7) "Amount eaten on platform" and (8) "General activity on platform" is that once having gone through the long series of unsuccessful sessions, the animal became negatively conditioned to either eating on the platform or to its exploratory behavior on the platform.

(3) Miscellaneous Behavior Noted

(a) Its "Resistance to the box" after an initial rise dropped quickly to a base level of zero and remained thus throughout the experiment.

(b) The amount of shock that this animal took closely corresponded to the difficulty that it encountered in its differentiation problem. An interesting (apparent) exception to this is found

in its responses in Session No. 37 when its "Mean Percentage of Responses Correct" rose to 93. The modal point of the amount of shock taken remained at the same level that it had been in the session immediately preceding, but when we examine the maximum and minimum shock taken during that session we discovered that the animal gave fewer extreme responses to the shock in the jumping box when it was meeting with success in the problem situation than otherwise. This even though the modal point of the amount of shock it took seemingly remained constant.

(c) This animal, when encountering special difficulty, would defecate and urinate in the jumping box preliminary to jumping from it.

(4) Behavior Suggesting Neurosis

(a) The aspect of this animal's behavior which seems most indicative is its reaction to the food on the platform. In most cases, after a correct jump, it would land on the platform, nibble at the food tray for just a second, and then run to a corner of the landing platform. Each time that the problem became more difficult, even this eating would cease and the animal would avoid the food tray completely. Two other instances of behavior are especially noteworthy.

(b) In Sessions No. 58 and 59, the animal, after unsuccessful jumps, landed in the net and began to nibble its own tail. This the experimenter immediately punished with electric shock and the animal thereupon abandoned this behavior.

(c) Before Sessions No. 66 and 67, the animal actively resisted being taken from its living cage, backing away and cowering when the experimenter came for it.

d) Animal G-4

(1) Learning Behavior

This animal learned more slowly than any of the other four. After the initial six sessions of training, it was introduced to the horizontal vs. vertical stimuli (ratio, 1:12). It was not until the 57th session that this animal succeeded in giving 93 per cent correct responses. During this period, it occasionally developed position habits which had to be broken before work could be continued. In Session No. 58, it was introduced to the 1:2 ratio stimuli. By the 69th session, it had still not shown any evidence of differentiation. Its responses in Sessions No. 69 and 70, when it was returned to the initial 1:12 ratio stimuli differentiation, were 80 and 93 per cent correct.

(2) Preliminary Test Behavior

In only two of the preliminary behavior tests, did this animal's extent of activity show any real relationship to its adjustment to the problem situation. The animal's response to (3) "Prodding in carrying case" remained fairly constant for the entire experiment except in the period including Sessions No. 28 to 35, when it suddenly became almost completely non-resistant and quiescent. It was during this same period that the animal showed the least degree of activity in (7) "Amount eaten on platform". Having originally begun with an extremely high level of eating, it dropped during this period to no eating at all. The animal's general responses during this particular period were almost lethargic.

In its responses to most of the other preliminary behavior tests, the animal showed a gradual diminution during the early part of the experiment and a leveling off during the latter sessions. The one excep-

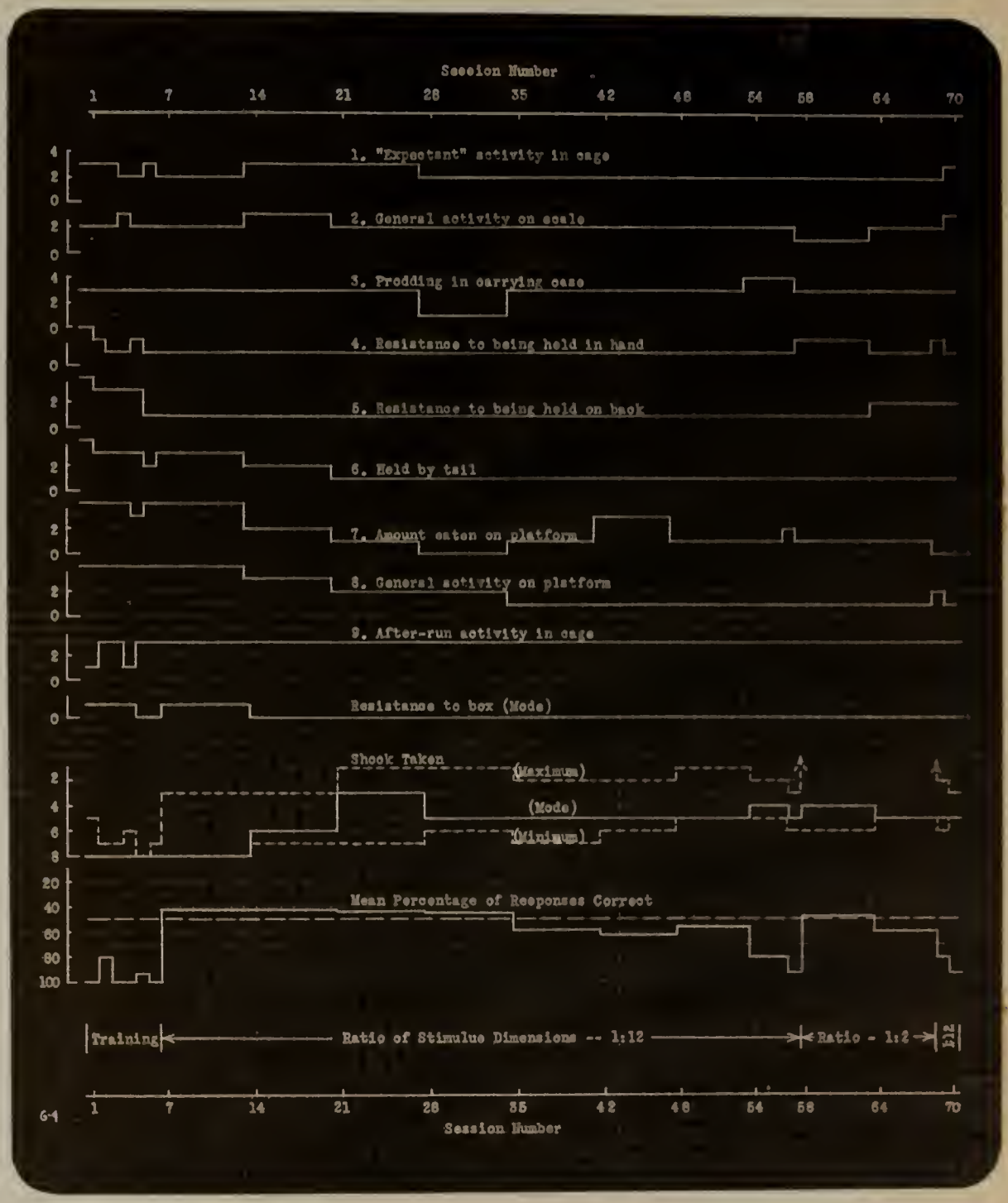
TABLE 5 SUMMARY OF BEHAVIOR OF ANIMAL G-4

Session No.'s	Trial No.'s	Stimuli	Preli-inary Behavior Tests (Modes) 1	2	3	4	5	6	7	8	9	Resistance Box (Mode)	Shock Taken Mode	Min.	Max.	Position Habit	Mean % Correct	Miscellaneous
P 1-3				3	3	2	3	4	3	3								
1	1-15	B-N;Br.	3	2	3	3	4	4	4	4	1	1	8	8	5		100	Slight eating.
2	15-30	B-N; 6"	3	2	3	2	3	3	4	4	3	1	8	8	7		80	Helped to food.
3	31-45	" "	3	2	3	1	3	3	4	4	3	1	8	8	7		100	Ran to corner with food -- Ate.
4	46-60	B-N; 8"	2	3	3	1	3	3	4	4	1	1	8	8	6		100	
5	61-75	B-N;10"	2	2	3	2	3	3	3	4	3	0	8	8	8		93	Ate fairly well.
6	76-90	B-L;10"	3	2	3	1	1	2	4	4	3	0	8	8	7		100	Ate-ran corner-ate Defecated in net
7-13	91-195	1:12	2	2	3	1	1	3	4	4	3	1	8	8	3	L-R	42	
14-20	196-300	" "	3	3	3	1	1	2	2	3	3	0	6	7	3	L	42	Twist jump; ate
21-27	301-405	" "	3	2	3	1	1	1	1	2	3	0	3	7	1	L	44	Twist jump; Ran to corner w. food--NE.
28-34	406-510	" "	2	2	1	1	1	1	0	2	3	0	5	6	1	L	45	Grabbed food--N.E.
35-41	511-615	" "	2	2	3	1	1	1	1	1	3	0	5	7	2		59	Twist jump.
42-47	616-705	" "	2	2	3	1	1	1	3	1	3	0	5	6	2		62	Looked left-right.
48-53	706-795	" "	2	2	3	1	1	1	1	1	3	0	5	5	1		57	Jumped down to net.
54-56	796-840	" "	2	2	4	1	1	1	1	1	3	0	4	5	2		80	
57	841-855	" "	2	2	4	1	1	1	2	1	3	0	5	6	3		93	Twist jump.
58-63	856-945	1:2	2	1	3	2	1	1	1	1	3	0	4	6	1-	L	49	Extreme squealing.
64-68	946-1020	" "	2	2	3	1	2	1	1	1	3	0	5	5	1-		60	Much squealing.
69	1021-1035	1:12	2	2	3	2	2	1	0	2	3	0	5	6	2		80	Twist jump.
70	1036-1050	" "	3.	3	3	1	2	1	0	1	3	0	5	5	3		93	

Note: From Trial No. 180 onward the animal either looked from left to right before jumping or made a left to right twist jump.

TABLE 5.

GRAPH IV



SUMMARY OF BEHAVIOR OF ANIMAL G-4

(For explanation see pp. 72-73 in text)

tion to this is the (9) "After-run activity in cage" which, beginning at a low level, quickly rose and remained at a high level throughout the remainder of the experiment.

(3) Miscellaneous Behavior Noted

(a) The animal's "Resistance to box", like that of all the other animals, was almost constant, remaining at a minimal level throughout the experiment.

(b) With some exceptions, the strength and amount of shock taken by this animal correspond fairly closely to the "Percentage of Responses Correct" in the differentiation problem. However, though its responses to the problem situation improved slightly between Sessions No. 35 to 58, the animal still took a considerable amount of shock during this period before jumping. It is interesting to note that it is the line of "Maximum" shock taken rather than the "Mode" that shows greatest correspondence with the line of "Mean Percentage of Responses Correct". (Graph No. IV) Between Sessions No. 58 and 69, the animal took many shocks at maximum intensity which exceeded 24 seconds in duration.

(4) Behavior Suggesting Neurosis

(a) Early in the experiment, the animal developed a mode of jumping which was unique. It would begin its jumping as if it were heading for the right stimulus aperture and then twist and jump to the left aperture. This response persisted throughout the experiment though it met with punishment 50 per cent of the time.

(b) In its eating behavior, the animal after the few unsuccessful jumps during the earlier sessions adopted a mode of behavior that was never noted in any of the other animals. After a suc-

cessful jump and landing on the platform, it would "grab" a bolus of food in its forepaws and run to the corner of the platform to eat it. During the sessions nearest mastery, the animal would sometimes return for a second bolus of food after having eaten the first. But what was even more interesting was that during Sessions No. 21 to 35, as well as Sessions No. 64 to 68, (when it met with the most difficulty in the discrimination problem) the animal would grab a bolus in its forepaws and sometimes a mouthful of food, run to the corner of the platform and stand there motionless without eating the food in its forepaws, or chewing or swallowing the food in its mouth.

e) Animal G-5

(1) Learning Behavior

This animal, after the first six training sessions, learned very quickly. By the end of the 20th session, it had learned to differentiate the first pair of contrasting stimuli (ratio 1:12). It was not placed on the next 3:16 stimulus differentiation until Sessions No. 26 and 27. Its responses then showed a marked transfer effect and it was therefore next put on the 1:3 ratio stimulus differentiation. Its percentage of correct responses immediately fell to 64. By Session No. 35 the percentage of correct responses had again risen to 93.

In Session No. 36, the animal was placed on the 1:2 ratio stimulus differentiation and kept there up to the 69th session. Throughout this period, its percentage of responses was on a "chance level" except that in Sessions No. 63 to 69, the animal developed position habits and hence its percentage of correct responses fell to less than chance.

In Sessions No. 69 and 70 the animal's ability to differentiat the 1:2 ratio stimuli was tested. Now, however, it was unable to

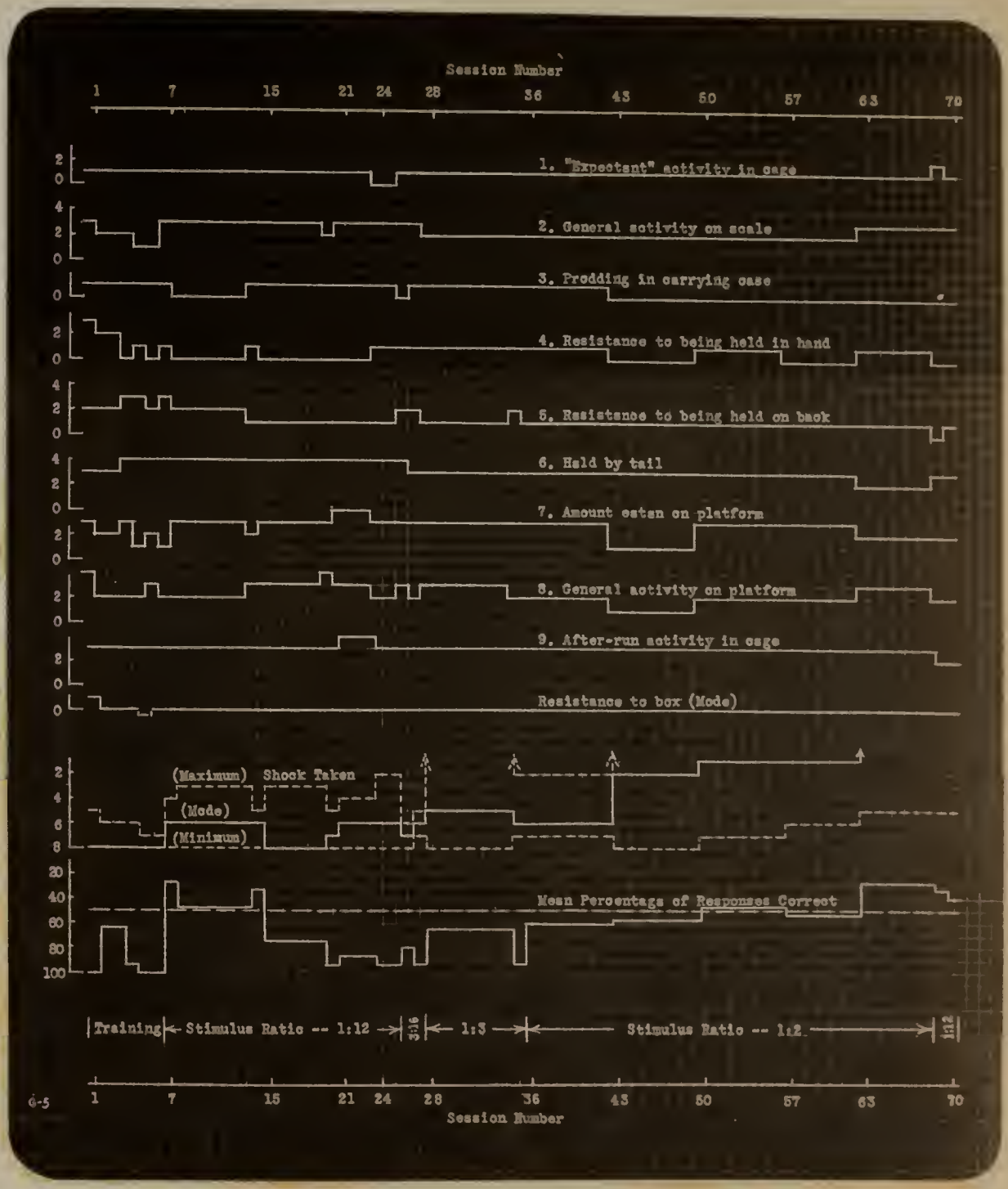
TABLE 6 SUMMARY OF BEHAVIOR OF ANIMAL G-5

Session No.'s	Trial No.'s	Stimuli	Preliminary Behavior Tests (Modes) 1	2	3	4	5	6	7	8	9	Resistance Box (Mode)	Shock Taken Mode	Min.	Max.	Position Habit	Mean % Correct	Miscellaneous
P 1-3				3	2	4	2	4	2	4								
1	1-15	B-N;Br.	1	3	1	3	2	3	3	4	3	1	8	8	5		100	Slight eating.
2-3	16-45	B-N; 6"	1	2	1	2	2	3	2	2	3	0	8	8	6		63	Helped to food.
4	46-60	B-N; 8"	1	2	1	0	3	4	3	2	3	0	8	8	6		93	
5	61-75	B-N;10"	1	1	1	1	3	4	1	2	3	-	8	8	7		100	Adient to box.
6	76-90	B-L;10"	1	1	1	0	2	4	2	3	3	0	8	8	7		100	
7	91-105	1:12	1	3	1	1	3	4	1	2	3	0	6	8	4	L	27	
8-13	106-195	" "	1	3**	0	0	2	4	3	2*	3	0	6	8	3		48	
14	196-210	" "	1	3	1	1	1	4	2	3*	3	0	6	8	5	R	33	
15-19	211-285	" "	1	3	1	0	1	4	3	3*	3	0	8	8	3		75	
20	286-300	" "	1	2	1	0	1	4	3	4*	3	0	7	8	5		93	
21-23	301-345	" "	1	3	1	0	1	4	4	3	4	0	6	8	4		87	
24-25	346-375	" "	0°	3	1	1	1	4	3	2**	3	0	6	8	2		93	°Asleep in cage
26	376-390	3:16	1	3	0	1	2	4	3	3**	3	0	7	8	6		80	
27	391-405	" "	1	3	1	1	2	3	3	2	3	0	6	7	5		93	
28-34	406-510	1:3	1°	2	1	1	1	3	3	3*	3	0	5	8	1-		64	Took shock quietly °Asleep in cage
35	511-525	" "	1	2	1	1	2	3	3	2*	3	0	6	7	2		93	
36-42	526-630	1:2	1	2	1	1	1	3	3	2*	3	0	6	7	2		60	
43-49	631-735	" "	1	2	0	0	1	3	1	1*	3	0	2	8	1-		57	Took shock quietly tho vincing
50-56	736-840	" "	1	2	0	1	1	3	3	2*	3	0	1	7	1-	L-R	48	Slight squeaking
57-62	841-930	" "	1	2	0	0	1	3	3	2*	3	0	1	6	1-	L	53	
63-68	931-1020	" "	1	3	0	1	1	2	2	3	3	0	1-	5	1-	L-R	28	Jumped down Some squealing
69	1021-1035	1:12	2	3	0	0	0	3	2	2	2	0	1-	5	1-		33	Jumped down Nibbled own tail!
70	1036-1050	" "	1	3	0	0	1	3	2	2	2	0	1-	5	1-		40	

*Defecated; **Urinated

TABLE 6.

GRAPH V



SUMMARY OF BEHAVIOR OF ANIMAL G-5

(For explanation see pp. 72-73 in text)

differentiate these stimuli, its percentage of correct responses in Sessions No. 69 and 70 being 33 and 40.

(2) Preliminary Test Behavior

With one marked exception, it is hard to detect any clear relationship between the animal's extent of activity in the various behavior tests and its successive adjustments to the problem situation. This one exception occurred during the period including Sessions No. 43 to 49 when the animal was having considerable trouble with the problem situation. During this period, its responses to (3) "Prodding in carrying case," (4) "Resistance to being held in hand", (7) "Amount eaten on platform", and (8) "General activity on platform" all dropped to a level as low as, or lower than, this animal's responses during any other period throughout the experiment.

(3) Miscellaneous Behavior Noted

(a) "Its resistance to box" was low throughout the experiment. In fact, during the sixth session, the animal displayed a strong "adient" attitude while being placed in the jumping box by the experimenter.

(b) The amount of shock taken by this animal is very indicative of its reactions to the problem situations as it encountered them. In general, the amount and intensity of shock taken by this animal decreased as it made adequate adjustment to the differentiation problem and increased when it met with difficulty. After Session No. 35, this increase in the amount of shock taken was very marked.

Beginning with Session No. 43, the animal frequently remained in the box long after the shock it was getting was at maximum intensity and frequently it had to be removed from the box

because it refused to jump even after getting 60 seconds of shock at maximum intensity.

(o) Throughout the experiment and especially during the "difficult" sessions, the animal would frequently defecate on the platform during the preliminary behavior tests.

(4) Behavior Suggesting Neurosis

This animal was the only one of these five which showed undoubted and definite symptoms of neurosis.

(a) In Session No. 69 and 70, as just pointed out, this animal when confronted with a problem, of which it had previously shown complete mastery, proved incapable of adequately reacting to it after it had been subjected for an extended period to an unsolved problem situation. This inability to adjust corresponds completely to the definition of neurosis as presented in the early part of this paper.

(b) During the latter session, the animal, because of its lack of adjustment frequently had to take considerable shock punishment. Yet its usual response to this punishment was to take it quietly or to squeal very little. This, though the intensity of the shock was sufficient to prove painful even to the experimenter. That the animal was receiving the shock was shown by the fact that though the animal took it quietly, it would wince each time that the punishment was administered.

(c) In Session No. 69, the animal, when confronted with a problem which it could now no longer solve, attempted to "escape" the whole situation by jumping directly to the net. When this was followed by the usual punishing shock, the animal attacked its own tail and bit it.

f) Summary of Findings

With the procedure of this experiment more carefully controlled and the initial problem set well within the ability of the white rat to master,* it proved possible in this experiment to have each of the animals master at least the first discrimination between the vertical vs. horizontal-line stimuli. With this basic differentiation mastered, it was later possible to obtain a check on the disruption of previously learned responses after an intervening period of stress.

As in the earlier experiment, it was found that all of the animals evinced "aberrant" behavior of one type or another to a greater or lesser degree; and here again each of the animals showed individual differences in the specific responses brought forth. Yet each of these responses falls nicely into the neurotic behavior classification presented earlier.

(1) Excitement and emotional outbursts.

All five animals showed some sort of emotional outbursts as they encountered difficulty in the discrimination problems. In G-2 this showed itself only in a temporary increase of random activity. In the other four animals it took the form of excessive defecation and urination. In addition, one animal (G-1) after a prolonged period of unsuccessful trials made a vicious attack on the electric grid wires of the net, actually biting the wires in half. This animal, as well as animals G-3 and G-5 after encountering difficulty in the problem situation pounced upon, and bit the tips of their own tails to the point of bleeding.

(2) Disruption of habitual or previously learned behavior.

Eating disruptions were noted in all animals. These were mild and temporary in animals G-2 and G-5. In G-1 the eating response almost

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*As has been shown by the work of Lashley (14), Fields (58, 59, 60, 61), and Munn (69, 70, 71).

vanished completely towards the end. G-3's reaction to the food on the platform was to cautiously nibble at the tray for just a second, and scurry "fearfully" to a corner. Each time that the problem became harder even this slight eating would cease, the animal avoiding the food tray completely.

Early in the experiment G-4 had developed the habit of seizing a quantity of food in its paws or its mouth and running with it to a corner to eat. As the difficulty of the problem increased the animal still continued to do so but now, more and more often, upon arrival at the corner of the platform, it would just stand motionless, neither eating the food in its paws nor even chewing the food in its mouth. The animal even offered no resistance when the experimenter removed this food from its paws and mouth.

Only one of the animals (G-5) showed a definite loss of a response previously mastered. This animal after an extended subjection to a differentiation problem beyond its ability to master and after developing most of the other aberrational responses, proved incapable upon retest of differentiating between the initial problem stimuli which had been so definitely learned before.

(3) Antagonistic attitude.

Some indication as to the genesis of the escape reactions may be found in the responses given by animals G-1, G-4, and G-5. On several occasions when the problem proved too difficult each of these animals sought to escape the differentiation problem by diving directly down to the net. This met with punishment, yet it recurred, though infrequently. The animals had evidently begun to react negatively to <u>both</u> the stimuli. In G-4 this negative attitude spread to the food

tray and then to the food itself for, as shown, the animal lingered near the tray only long enough to seize some food in its paws or mouth and then scurried to a corner to eat, and in later sessions didn't even consume the food which it had seized. In Animal G-3 this negative attitude evidently spread to the entire experimental set-up since on two occasions it actively resisted being taken from its living cage preliminary to bringing to the laboratory.

(4) Porsevarative or stereotypic responses

Discounting the repeated position habits developed by these animals since, as has been shown by Pearce (72), they occur "in the course of all difficult problems" and ipso facto, vanish at the problems' solution, there still are at least two marked behavior patterns evinced by these animals which properly belong here.

Animal G-1, during the difficult problem sessions, developed a response which persisted throughout the rest of the experiment. In an effort to avoid the entire choice-response situation, the animal would jump at the partition between the stimulus appertures. Even when it jumped at the card it would do so by going towards the inside edge of the apperture.

In a similar way G-4 developed a unique mode of jumping. It would begin its jump as if going towards the right stimulus apperture and then twist, seemingly in mid-air, and jump to the left apperture. This response persisted throughout the experiment though it met with punishment half of the time.

(5) Hesitancy and indecision

Every one of the animals showed some indication of hesitancy and indecision. In Animal G-1 this took the form of repeated overt hesitations before a jump. The animal would get ready as if to jump, draw

back, get ready again, draw back again, and then finally jump. In the other four animals the indecision showed itself in the animal's putting its head out of the box and then turning or swaying from side to side prior to jumping. (Another possible explanation of this behavior is that the animal was trying to fixate the stimulus figures more clearly*) .

(6) Lethargy

The activity of all the animals decreased somewhat as the experiment progressed. But this cannot be considered abnormal since it was gradual and seemed to reflect the animals adaptation to the experimental situation rather than a maladaptation. Two of the animals, however, showed a condition concomittant with their disrupted eating behavior, which was strongly suggestive. Animals G-3 and G-4 after hurrying from the food tray, would stand or squat quietly in a corner sometimes swaying slightly from side to side. At such times they paid no attention to the experimenter when he came to pick them up for the next trial. It was ani al G-5 that showed the most convincing picture of lethargic responses. On two separate occasions it was actually asleep in the cage when the experimenter came for it and though all the other animals showed increased inhibition of jumping response as evidenced by the increased length of stay in the jumping box and submission to stronger and longer periods of shock prior to jumping, this animal was the only one which accepted extremely strong shocks quietly, offering no vocal protest and only showing by a muscular "wincing" that it was receiving the punishment.

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* As has been shown by Lashley (14) and Munn (71), the focal range of the albino rat is from 7.5 to 8 cm. Since the opening of the jumping box was slightly over 25 cm. (10 inches) from the stimulus cards, the animal's sticking its head out of the box would materially help to bring the stimulus figure into clearer focus.

One other point should be underscored here. Though in no one animal were all the above types of "aberrational behavior" noted nor to the same degree as in each of the other animals, it does seem significant that the extent to which any given animal displayed such aberrant behavior seems to be roughly proportional to the length of time that the animal was subjected to, and to the apparent intensity of the unsolvable or "conflict" situation.

IV. Discussion of Results

In the original planning of the experiments, it was desired that the animals quickly learn a stable, measureable discrimination and that the stimuli used in this discrimination be such that it would be possible to equate them towards one another. The final adoption of the horizontal vs. vertical line stimuli was based on this fact and the previous findings by Lashley (15) that the white rat was capable of differentiating this type of contrasting stimuli. In a similar manner, the choosing of the Lashley jumping technique (66) and the use of electric shock punishment (56, 57, 64, 65) was dictated by the consideration of desiring a quickly established differential C.R.

These basic procedural elements must be kept in mind when evaluating the specific responses called forth in the animals. The fact that several changes in procedure were made during the first experiment, might explain why the behavior elicited in that group of animals wasn't even more markedly neurotic; the use of electric shock punishment and the individual variation in resistance of each animal to electric stimulation (57, 64) might in large measure explain some of the differences in reaction noted in all the animals.

One characteristic of the procedural setup which definitely played a part in the results obtained was that the experiments were specifically planned so that maladaptive behavior of any sort was punished rather than favored, the experimentor consistently punishing any aberrant behavior which the animals displayed. This was done because the experimenter felt that no behavior could be considered truly neurotic which might possibly be due to reinforcement during the course of the experiment. Thus when the animals displayed "temper tantrums", attacking the wiring in the net, or attempting to inhibit the jumping responses by remaining in the box,

they received strong electric shock punishment. It is quite conceivable that some of these aberrant responses would have become strongly fixated and would have given a very convincing picture of "neurosis" if the procedure just outlined had not been followed. Such, however, was not the aim of the experimenter.

One other point is of interest here. In the original setting up of the experiment, it was hoped that a careful continuous record of several representative responses of the animals would prove illuminating in the consideration of the genesis of experimental neurosis. The results here, as reported under "Findings", were rather disappointing. There seemed to be very little relationship between the amount of preliminary behavior responses of the animals and the development of the experimental neurosis. Though the general amount of activity decreased in all the animals as the experiment progressed, it would seem that this diminution in activity in most cases was probably due to gradual acclimatization of the animal to the experimental procedure rather than any neurotic tendency. However, those instances where the reduction in activity was very marked can be safely ascribed to neuroticism.*

During the course of experimenting with the animals it became evident that frequently when the animals evinced behavior of the type called "experimental neurosis" by previous workers, such behavior seemed to arise not as a sudden unexplainable occurrence, but rather to develop in a manner similar to that noted in normal learning behavior. Thus for instance the behavior of "escaping" the discrimination situation by jumping to the net was initially a manifestation of the animal's random behavior

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* Incidentally, the possibility that the animals' response decrease to the punishing shock was due to a weakening of the dry cell was eliminated by frequently checking the strength of the drycell with a galvanometer which showed no perceptable diminution in current.

in its attempt to find a mode of response adequate to the particular situation which it faced. The behavior became fixated when, from the animal's point of view, it served to get the animal away from the situation where it received the punishing bump on the nose upon banging into the blocked stimulus cards. To the animal, jumping to the net was not a maladaptive but very definitely adaptive behavior.* That such was the case is pointed shown by the fact that the animal quickly discontinued this behavior when a jump to the net was immediately punished with an electric shock.

Again, the behavior evinced by the animals in stopping or decreasing their eating during the experimental session also seemed to arise in a manner which indicates that we are dealing here with just another instance of learning -- negative learning, it is true, but learning nevertheless. To be more specific; the animals at first learned to eat from the food tray on the platform, however, the conditioning procedure was such that the punishment shock received when the animal did not jump fast enough from the jumping box as well as the excitement following the 10-inch jump, made the animal become negatively conditioned to the food tray It is not hard to understand how this negative conditioning, as well as the generalized negative attitude to the experiment as a whole (built up in the animal as a result of the punishment after incorrect responses), would in the end cause the animal to avoid the food tray and the food even though it had not eaten during the preceding 24 hours.

In spite of the above considerations the results obtained corroborate the positive findings of Lashley (15) Cook (3, 4) and Maier (25, 26, 27, 40). White rats can, and did develop experimental neurosis under certain conditions.

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*In this connection Maier (67) has pointed out,
"Often it is claimed that some animals fail to learn in a situation. Instead of failure to learn it is more likely that such animals learn something other than the experimenter intended." (p. 249)

V. Conclusions

The neurotic behavior phenomena noted in this experiment and the circumstances under which they were elicited make possible the following conclusions:

1. White rats develop abnormal behavior or "experimental neurosis" when subjected to conflict situations where they are:
   a) Forced to respond,
   b) Permitted only one of all possible responses,
   c) When the responses between which they must choose are mutually antagonistic or exclusive, and
   d) When the stimulus to the response is either equivocal or multivalent.
2. The "experimental neurosis" developed by white rats is an "individual" neurosis and differs from animal to animal in regard to the specific behavioral aberrations displayed.*

   These differences are probably a function of two factors:
   a) the native and pre-experimentally acquired behavior repertoire of the animal, and
   b) the form and nature of the experimental setup and apparatus which serve to determine and limit the responses that can possibly be called forth.

From this viewpoint it would probably be more correct to speak of "experimental neuroses" than "neurosis." However,

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* Thus Cook (4) notes:
"...each rat exhibited a reaction pattern quite different from that of the others." (p. 305)

3. The "experimental neurosis" developed by white rats shows a basic similarity from animal to animal. * Variations here are probably a function of

a) the intensity of the conflict situation and

b) the length of time that the animal is subjected to it.

This basic si ilarity is in part indicated by the finding that it is possible to include all the behavior aberrations in the following six-part classification:

a) Excitement -- emotional outbursts, loss of normal control and inhibition.

b) Disruption of habitual or previously learned behavior.

c) Antagonistic attitude to the experimental setup.

d) Perseverative or stereotypic responses.

e) Hesitancy and indecision.

f) Lethargy.

hat is even more indicative is that in each of the animals in which neurotic behavior was observed the sequence in which each type of behavior appeared roughly corresponded to the above classification. That not all the "aberrational behavior" corresponded to this pattern is probably explainable by the operation of the two factors named under each of the last two conclusions above.

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* Liddell (22) made a similar observation when he stated:

"Our sheep, regardless of the diversity of circumstances responsible for the development of the experimental neurosis, show a remarkable uniformity in their disturbed behavior." (p. 1037)

VI. Evaluation

Such are the results which were obtained and the conclusions arrived at in the present investigation. What is their significance? What value have they? What is the purpose in conducting an investigation of this sort?

The various workers from Pavlov to Maier have justified their work by giving purposes which implied various degrees of hopod-for utilization of their experimental data in extending the knowledge of real neuroses in human beings. Pavlov (30, 45), the first worker in this field, made some daring comparisons between the behavior of his animals and the behavior observed in clinical cases of neurosis. Later workers were more cautious. Thus Cook (5) takes the position, "that analogies drawn between lower and higher species on the basis of specific symptoms are likely to be misleading."

Three main reasons and final justifications for investigating "experimental neurosis" in infra-human subjects can be formulated.*

1. The study of experimental neurosis in animals has an intrinsic value and interest in itself. Aside from possible extrapolated implications there is ample justification in investigating any behavior phenomenon displayed by an organism, whether that organism be human or infra-human.

2. The study of experimental neurosis in animals serves to cast light on the etiology of neurosis in human beings. Since it is usually impractical and (with rare exceptions) almost always impossible to study these phenomena in humans, the investigator is left with the alternative of either using animals or abandoning research in this field altogether. This need not necessarily mean that the results obtained and the behavior observed in

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* Adapted from classification by Cook (5)

animals can be wholely and indiscriminately applied to humans -- nor is such the purpose of the investigator. As in other biological sciences, however, it does mean that parallelisms between organisms of different species can be utilized as significant indicators or "leads" in the formulation of hypotheses for the study of various phenomena. As stated by Hall (9)

> A neurotic rat and a neurotic human display homologous behavior patterns. In fact it is this similarity of behavior . . . which consists of persistent maladjustments to a given situation . . . that has led the comparative psychologist to classify certain rats as neurotic. (p. 1)

3. As has been implicitly indicated by the work of Pavlov (47), Petrova (48, 49, 50, 51, 53, 54) and Liddell et. al. (17, 18), as well as explicitly stated by Cook (5), studies of abnormal behavior in animals provide a means by which investigators can test proposed therapeutic agents on animals. This is directly in line with the practice in other of the medical sciences of obtaining standard "animal preparations" upon which proposed "cures" can be tested. This eliminates the necessity of making dangerous tests upon human beings.

If for this reason alone, work on infra-human organisms would be entirely justifiable.

In conclusion it should be pointed out, however, that in the present stage the results which have been obtained by investigators do not yet justify the extended extrapolation of results from animal experimentation to their equivalent or parallel manifestations in human beings. Whether such application of findings will ever be safely possible will in large measure depend on the findings which future work in this field will disclose.

Appendix

Method of Recording Data

Method of Recording

A detailed description of the forms used in the recording of the data is here presented to show how they were used and to indicate the nature of the response reaction scales on which each animal was rated daily.

1. Experiment Number One

a) Sessions No. 1. to 40.

Standard, mimeographed forms (Fig. 5.) were used at each session for recording all the data for each animal. The items included were as follows:

(1) Series No. -- each successive day's experimental session was here numbered so that any future error as to the time sequence of experimental sessions was eliminated.

(2) Order Used -- the order in which each of the animals was run was here recorded each day. Throughout the 100 sessions in which these animals were run, on each successive day each animal was run in a different order in relation to the other six animals. Thus, for example, if on a certain day animal D-3 was the fifth one of the animals to be run, on the next day's session it would be the fourth, the following day, third, then second, first, seventh, sixth, and finally on the eighth day it would again be fifth in order. (By this means it was hoped to cancel any possible effect which the enforced waiting to be taken from the cage to the laboratory might produce on the animals.)

(3) Rat No. -- the identifying Letter-Number of the animal was here recorded.

Experimental Neurosis - Trial Record

Series No._____ Order Used_____ Rat No._____

Date_____ Time: from_____to_____ .M. Weight_____gms.

Stimulus Used: R_____, W_____. Distance_____

Preliminary Behavior Tests.

1. Taken from cage:_____
2. Placed on its back:_____
3. Held in hand:_____
4. Held by tail:_____
5. In jumping box:_____
6. On platform:_____
7. _____
8. _____

Trial		Right Stimulus		Wrong Stimulus		Comments
No.	R-W	Seconds in Comp.	Recoil	Seconds in Comp.	Recoil	

Fig. 5. RECORDING FORM
Used in Sessions 1 to 40 of Experiment Number 1

(4) Date -- the date was here recorded as another check on the time sequence of the experimental sessions.

(5) Time -- the exact time each animal's run was begun and ended was here recorded lest future analysis reveal any differences between normal and neurotic rats. It was later found that differences here were mostly due to the experimenter rather than the subjects and hence analysis of this item was pointless.

(6) Weight -- each animal's weight was taken and recorded primarily as a rough measure of the animal's state of health.

(7) Stimulus Used -- whether a stimulus card was used and the stimulus figure upon it was here recorded.

(8) Distance -- the distance of the exit gate opening from the stimulus aperture was here recorded.

(9) Preliminary Behavior Tests -- in all of these the degree of the animal's activity was judged subjectively and recorded as either: none, slight, little, moderate, active, or very active.

(10) Experiment Proper (In columns 1 to 7)

(a) Trial No. -- the number of each trial was here recorded.

(b) Trial: R-W -- whether a positive (R - right) or negative (W - wrong) stimulus was used in each jumping trial was here recorded.

(c) Right Stimulus: Seconds in Comp. -- the number of seconds the animal remained in the jumping box after the exit gate was opened was here recorded for each trial in which no card or a positive stimulus card was placed in the aperture.

(d) Right Stimulus: Recoil -- not used.

(e) Wrong Stimulus: Seconds in Comp. -- the number of seconds the animal remained in the jumping box after the exit

gate was opened was here recorded for each trial in which a negative stimulus card was placed in the stimulus aperture.

(f) Wrong Stimulus: Recoil -- not used.

(g) Comments -- here were recorded any miscellaneous observations, such as the animal's manner of jumping and eating after landing on the platform.

b) Sessions No. 41 to 100.

For each of the last 60 sessions the animal's responses were recorded on the form shown in Fig. 6. Each of the items was recorded as follows:

(1) Series No. --- Same as in sessions 1 to 40.

(2) Order Used --- " " " " " " "

(3) Rat No. ------ " " " " " " "

(4) Date --------- " " " " " " "

(5) Time --------- " " " " " " "

(6) Weight ------- " " " " " " "

(7) Stimuli ------ whether stimulus cards were used and the stimulus figures upon them was here recorded.

(8) Distance ----- Same as in sessions 1 to 40.

(9) Preliminary Behavior Tests -- the extent of activity for each test was rated on a six point scale and checked as follows:

(a) General activity on scale (while being weighed)

0-None -- Complete immobility.

1-Slight -- Head turning.

2-Little -- Slow body turning - less than one complete turn.

3-Moderate -- More than one but less than two complete turns.

4-Much -- More than two complete turns but no agitation.

5-Extreme -- Agitation.

Experimental Neurosis - Trial Record

Series No._____ Order Used_____ Rat No._____

Date_____ Time: from _____ to_____ A.M. Weight_____ gms.

Stimuli _____, _____ Shock No._____ Distance_____ in.

Preliminary Behavior Tests:

	0 Nor.	1 Cl.	2 L.	3 Ag.	4 Wic.	5 Ex.
1. General activity on scale:						
2. Gen. act. when taken from cage:						
3. Resistance to being held in hand:						
4. Resistance to being held on back:						
5. Held by tail						
6. Amount eaten on platform:						
7. General activity on platform:						
8.						
9.						

Trial No.	Circle Stim.		Resistance to Box			Seconds in Box		Jump to		Ate	Fell	Comments
	L.	R.	0	3	5	BS	AS	L.	R.			

Fig. 6. RECORDING FORM
Used in Sessions 41 to 100 in Experiment Number 1.

(b) General activity when taken from case

0-None -- Complete passivity.

1-Slight -- Head turning.

2-Little -- Slow movement.

3-Moderate -- Prompt movement.

4-Much -- Overflow of activity

5-Extreme -- Nipping E's hand.

(c) Resistance to being held in hand.

0-None -- Complete passivity.

1-Slight -- Sniffing and head turning.

2-Little -- Slow body twisting.

3-Moderate -- Strong body twisting.

4-Much -- Squirming and strugling.

5-Extreme -- Vicious strugling.

(d) Resistance to being held on back

Same as (c) above.

(e) Held by tail

0-None -- Hanging limply.

1-Slight -- Very slight twisting or squirming.

2-Little -- Slow, unhurried twisting and squirming.

3-Moderate -- Deliberate twisting or kicking.

4-Much -- Strong and quick twisting or kicking.

5-Extreme -- Strong kicking and climbing up own tail.

(f) Amount eaten on platform

0-None -- None.

1-Slight -- Hesitant tasting.

2-Little -- Lengthy pausing between nibbles.

3-Moderate -- Only slight pausing while eating.

4-Much -- Steady eating.

5-Extreme -- Hurried "wolfing" of food.

(g) General activity on platform

0-None -- Complete immobility.

1-Slight -- Head turning.

2-Little -- Hesitant step or two.

3-Moderate -- Slow walking.

4-Much -- Fast walking.

5-Extreme -- Scurrying about and running.

(10) Experiment Proper (in columns 1 to 8)

(a) Trial No. -- Same as in sessions 1 to 40.

(b) Circle stim. -- a check was placed under "L" or "R" as the positive circle figure was displayed in the left or right aperture.

(c) Resistance to box -- a check was placed under 0, 3, or 5, depending on whether the animal showed no resistance, moderate resistance, or extreme struggling and avoidance activity when E. essayed to place it into the jumping box.

(d) Seconds in Box -- under B.S. was recorded the number of seconds the animal remained in the jumping box before the current was turned on in the jumping box; under A.S. was recorded the number of seconds, if any, the animal remained in the jumping box after the current was turned on.

(e) Jump to: -- a check was placed under "L" if the animal jumped to the left aperture, under "R", if to the right aperture. A jump towards the center partition was recorded by an "X" on the appropriate part of the line between "L" and "R". In a similar manner a jump above or to the side of the

stimulus apertures was recorded by an "x" in appropriate parts of the two squares under "L" and "R".

(f) Ate -- a check was placed here if the animal jumped to the correct apperture, landed on the platform, and ate.

(g) Fell -- a check was placed here if the animal fell to the net as a result of an incorrect jump (i.e. towards the negative stimulus) or an imperfect jump (i.e. to a side, or too high, or too low).

(h) Comments -- here were recorded any miscellaneous observations such as the animal's manner of jumping and eating responses.

2. Experiment Number Two

Standard Mimeographed forms (Fig. 7.) were used at each session for recording all the data for each animal. The items included were as follows:

a) Series No. -- Same as in Experiment Number One.

b) Date -- " " " " " "

c) Rat No. -- " " " " " "

d) Stimuli -- the particular stimulus figure used for that session was here recorded.

e) Time -- Same as in Experiment Number One.

f) Weight -- " " " " " "

g) Preliminary Behavior Tests -- the extent of activity for each test was rated on a five point scale* and scored as follows:

(1) Expectant activity in cage

Q-None -- Indifferent at approach of E.

1-Slight -- Looked toward E.

---

* It was found that the sixth point on the scale used in Experiment No. 1 was superfluous and hence the rating scale was here condensed to a five-point one.

Experimental Neurosis - Trial Record

Series No._____ Date_____ Rat No._____

Stimuli _____,_____ at_____ Time_____ .M. Weight_____gms.

Preliminary Behavior Tests:

	0 Non	1 Sl.	2 Lit	3 Mod	4 Mu.
1. "Expectant" activity in cage					
2. General activity on scale					
3. Proding in carrying case					
4. Resistance to being held in hand					
5. Resistance to being held on back					
6. Held by tail					
7. Ammount eaten on platform					
8. General activity on platform					
9. After-run activity in cage					
10.					

Trial No.	Horiz. Stim.		Resistance to Box			Time in Box		Jump to		Ate	Fell	Comments
	L.	R.	0	1	2	No.	+	L.	R.			

Misc. Note:_____

Fig. 7. RECORDING FORM

Used in Experiment No. 2.

2-Little -- Moved slowly toward E.

3-Moderate -- Climbed up on side of cage (rampant).

4-Much -- Agitated; climbed up on side of cage repeatedly.

(2) General activity on scale

0-None -- Limp, motionless.

1-Slight -- Slight turning.

2-Little -- Slow walking around (2 or 3 steps).

3-Moderate -- Deliberate exploring around (1 to 3 complete circuits of scale).

4-Much -- Hurried running; climbing down.

(3) Prodding in carrying case

0-None -- Limp, motionless.

1-Slight -- Turned head; non-resistant.

2-Little -- Retreated; crouched in corner.

3-Moderate -- Turned around

4-Much -- Deliberately approached E's hand; climbed up hand.

(4) Resistance to being held in hand

0-None -- Limp, motionless.

1-Slight -- Twitched vibrasae; slight head turning.

2-Little -- Deliberate head turning; no limb movement.

3-Moderate -- Head turning and movement of forelimbs.

4-Much -- total body struggling.

(5) Resistance to being held on back

Same as (4) above.

(6) Held by tail

0-None -- Hung limp.

1-Slight -- Very slight movements.

2-Little -- Slow, unhurried movement.

3-Moderate -- Deliberate Movements.

4-Much -- Extensive struggling.

(7) Amount eaten on platform

0-None -- Complete avoidance.

1-Slight -- One or two nibbles.

2-Little -- Either very slow, fearful eating or eating for about half the time.

3-Moderate -- Deliberate eating with two or less pauses.

4-Much -- Quick, hurried "wolfing" of food for entire period.

(8) General activity on platform

0-None -- Remaining motionless as placed by E.

1-Slight -- Turning of head but no body motion.

2-Little -- Slow deliberate steps, not more than two or three.

3-Moderate -- Energetic but unhurried exploration not further than to side of platform and back to food tray.

4-Much -- Hurried, frantic rushing about.

(9) After-run activity in cage

0-None -- Remaining motionless as placed.

1-Slight -- Slight movement, no more than one or two steps.

2-Little -- Taking two or three steps and settling down.

3-Moderate -- Deliberate walking around in cage

4-Much -- Rampant on cage wall or running about.

h) Experiment Proper (in columns 1-8)

(1) Trial No. -- Same as in Experiment Number One.

(2) Horiz. stim. -- A check was placed under "L" or "R" depending on whether the horizontal line or rectangle (positive stimulus figure) was displayed in the left or right stimulus aperture in any given trial.

(3) Resistance to box -- A check was placed under 0, 1, or 2, depending

upon whether the animal showed no resistance, moderate resistance, or extreme struggling and avoidance activity when E. essayed to place the animal into the jumping box through the opening.

(4) Time in Box -- Here was recorded the number of positions which the secondary coil of the inductorium had been advanced by the successive depressions of the Shock Increasing Lever at the time that the animal jumped from the jumping box. This gave a measure in terms of three-second periods of the time the animal had spent within the jumping box between the experimenter's opening of the exit gate and the animal's jump. Under "+" was recorded the extra one to three seconds between the last depressing of the Shock Increasing Bar and the animal's jump from the box.

(5) Jump to -- Same as in Sessions 40-100 of Experiment Number One.

(6) Ate -- Same as in Sessions 40-100 of Experiment Number One except that the various degrees of eating by the animal were identified by coded symbols.

(7) Fell -- Same as in Sessions 40-100 of Experiment Number One.

(8) Comments -- Same as in Sessions 40-100 of Experiment Number One.

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