THE INFLUENCE OF STIMULUS SATIABILITY ON LEARNING IN TWO DIFFERENT TASKS

Thesis for the Degree of Ph. D. MICHIGAN STATE UNIVERSITY James Norman Allen 1963 THESIS

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Date June 3, 1963

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James Norman Allen

AT ABSTRACT

Submitted to Michigan State University in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Psychology

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ABSTRACT

The research problems of this dissertation arise out of implications of the "stimulus satistica" postulates of modern learning theorists. The theory most closely scrutinized is that of Denny and Adelman. The research was an attempt to determine if 'satiability' is a relatively stable characteristic of an organism, and also if the different organisms in a group could be differentiated one from another according to the degree to which they exhibited stimulus satiability. The second point of the research was, if individual differences in satiability existed, did they contribute to the differential ability of organisms to learn different kinds of mase problems. The specific problems under investigation were a simple 'I' mase in which the to-bo-learned discrimination was a turn in a particular direction, and a 5 choice point modified 'Y' mase in which the to-be-learned response was errorless passage from the start box, through the 5 choice points to the goal ber. In both learning problems, the motive was hunger and the revard was food pellets.

The Ss for the experiment were 40 male albine rate from the colony maintained by the Michigan State University Psychelegy department. All Ss were given the same number of trials (65 in the 'I' mase, 44 in the 'I' mase) in the learning problems which were run in a counter-balanced design with half the Ss running the 'E' mase first and the other half the 'I' mase first. After the Ss completed their trials on the first problem they were shifted to the second problem. In addition to the learning problems each S was exposed to a square mase exploration field for 6 minutes on 3 separate eccasions. It was the performance of the Ss in the exploration mass which yielded the 'satistion secres' which were converted into relative ranks, and compared with the relative rankings of the Ss for their performance in the 2 learning situations. In addition each S was weighed on each eccasion it explored the square mass.

These data provided the basis for all the comparisons in the experiment. The specific hypotheses tested were as follows:

- (1) The exploration measures will permit reliable ranking of the Ss from fast to slow satisters.
- (2) Slow satiators will be superior in performance to fast satiators in the simple 'I' mase.
- (3) Fast satisfiers will be superior in performance to slow satisfiers in the multiple choice point 'I' mase.

The analyses of the results by correlational techniques indicated that the first hypothesis was confirmed, the second hypothesis was partially confirmed, and the third hypothesis was not confirmed. Very few of the other comparisons attempted showed any significant degree of relationship, and as a result the discussion chapter consister mainly in an analysis of the deficiencies and imadequacies of the experiment.

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The general character of the results of the experiment were consistent with, though they provided no strong support for, the position that satiability is a fundamental characteristic of erganisms, and that the degrees of their satiability relates semewhat to their ability to learn, particularly in simple highly repetitive situations.

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By

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A THESIS

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DEDICATION

Since the doctoral dissertation serves as the keystone of anyones formal education, I respectfully dedicate this dissertation to the individuals who have had the greatest degree of influence upon me in the course of my formal education at all levels. To them must go a large measure of the credit for any of the good qualities of this work. For the inadequacies and/or deficiencies I reserve full responsibility to myself. In that light I dedicate this work to the following alphabetically listed individuals:

> S. H. Bartley M. R. Denny C. H. Hanley H. H. Holt A. L. Moore O. A. Smith

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ACKNOWLEDGEMENTS

The anthor would like to acknowledge the invaluable assistance given him at all stages of his formal graduate education by the members of his guidance committee, especially that of his major professor N. Ray Donny who has been a steadfast friend as well as educator. I would also like especially to thank Terrance Allen and Frank Restle. who were very helpful in the early development of this problem but who were unable to continue on the committee until the completion of the problem. Stanley Ratner, whose cautionary remarks were not always heeded (and perhaps should have been) was of great assistance both on the dissertation and as a significant force in shaping my formal training. Lastly, the two members of the committee who stepped into the breach created by the loss of the two aforementioned committee members Allen and Restle. Doctors Donald M. Johnson and Charles H. Hanley were gracious and kind in their willingness to aid in the successful completion of a problem in which they had no part of the early structuring, and no central interest in.

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INTRODUCTION AND STATEMENT OF THE PROBLEM

The present problem stems from the relatively recent interest in 'stimulus satiation' postulates in learning theory. The theoretical positions of Denny and Adelman (17), and of Glanzer (22) are particularly germane in this regard.

These postulates emphasize that, in responding to a particular stimulus, there arises not only an incremental strengthening of the tendency to respond in the same way to subsequent exposures to the stimulus but also the dynamic properties of the evoking stimulus for this particular organism are themselves altered in such a way as to bring about the opposite response in the organism. Thus, each response to a stimulus on the one hand brings an increase in the probability that the response to subsequent exposures to that stimulus vill be of the same kind, and on the other hand, the stimulus loses some of its power to elicit this particular response in this particular organism with each exposure of the organism to the stimulus. This can ultimately lead to the probability of the response being decreased.

A quote of one of the postulates will suffice to indicate the general manner of formulation. The postulate immediately following is from the learning theory of Denny and Adelman.

> "Post. 2 <u>Sensory Adaptation or Satiation</u> With continued or repeated presentation all stimuli lose or partially lose the property to elicit a response as a decay function of the duration or frequency of presentation.

The slope of this decay function varies with the nature and intensity of the stimulus, i.e., some stimuli (food for a hungry animal, shock, etc.) are more resistant to adaptation than are other classes of stimuli. With the passage of time stimuli recover their capacity to elicit a response.^{sl}

This postulate then allows the Denny-Adelman theory to handle decrements in performance which may occur, particularly under massed trial conditions. Note however the difference between the above postulate and the inhibitory potential' or 'work decrement' type of postulate. Clark L. Hull in <u>Essentials of Behavior</u> (30) relates the inhibitory process directly to response and labels it 'drive'.

> "... we find underlying it a variable of considerably wider application which is called <u>inhibitory potential</u> (I_r) . This is believed to be a residual or after-effect left, apparently, by all responses (E), which is in the nature of a negative drive akin to tissue injury fatigue, or "pain". It tends to inhibit the reaction potential, i.e. to prevent the occurrence of the response in question and possibly other responses.⁸²

The exact formulation of the first two parts of Hull's

postulate is as follows

"X. A. Whenever a reaction (**R**) is evoked from an organism there is left an increment of primary negative drive (I_r) which inhibits to a degree according to its magnitude the reaction potential (s^Er) to that response

2. Hull, C.L. <u>Essentials of Behavior</u>, Yale University Press, 1951, p. 73

Denny, M.R. and Adelman, H.M. "Elicitation Theory II: The Formal Theory", <u>Unpublished Theoretical Paper</u>, 1953, Michigan State University, p. 2

"X. B. With the passage of time since its formation, (I_r) spontaneously dissipates approximately as a simple decay function of the time (t) elapsed, i.e., I_r " I_r X 10^{-at}."³

The emphasis of these two theoretical systems is quite different. Hull focuses primarily on the response produced changes in the organism which inhibit further responding, and Denny-Adelman focus on changes in the dynamic qualities of the stimulus which elicit the response. It was not by accident that Denny-Adelman call their theory an 'elicitation' theory. In many ways the Denny-Adelman position is similar to that of Michotte in his experiments on the perception of causality (32). Michotte held, as a result of certain experiments he carried out that certain stimulus conditions elicited a direct perception of causal relations on the part of his subjects.

From the point of view of a behavioristic psychology the Denny-Adelman position seems preferable since it allows theoretical accounting for behavior without recourse to vague unspecifiable 'physiologizing' about internal states of the organism. For them, the fact that a stimulus may lose its elicitation potential is a given (that is to say it is a primitive assumption of the theory). As such their theory represents a fundamentally different sort of attempt to bring order into the relationships between the organism and its surrounds.

^{3.} Hull, C. L. <u>Essentials</u> of <u>Behavior</u>, Yale University Press, 1951, p. 74

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Denny and Adelman's theory however is not to be construed as wholly stimulus oriented; the organism brings something to the relationship also. Thus, the current experimental problem follows directly upon the assumption that all white rats do not satiate to the stimuli of their environment at the same rate, but rather vary along a continuum from rapid to slow satiaters. The distribution of their satiability is assumed to be normal¹/₂ Furthermore, Denny and Adelman's definition of stimulus includes the organism.

It is an assumption of the present research that the "satiability" of individual organisms to stimuli is a general characteristic of the organisms, one that they bring with them to any situation they may find themselves in. It is further assumed that while moment-to-moment variations in the satiability of an individual organism do exist, the variations in satiability <u>between</u> organisms are larger than the moment-to moment variations in satiability <u>within</u> any one organism. Also, it is assumed that by placing an organism in a standard physical situation an estimate of the satiability of that organism can be obtained. To accomplish this an Exploration task and an Exploration apparatus were devised by the present investigator.

A simple preliminary experiment with an N of 39 white rats indicated considerable individual variability in the rate at which,

^{4.} Personal communication from M. Ray Denny, Michigan State University

and the extent to which, the Ss explored a small alley maze. The task and apparatus were then incorporated as a part of the present experiment, the purpose of this task being to estimate the satiability of the individual Ss.

The next consideration was to relate satiability to successful performance of a given task. The successful completion of some tasks requires considerable persistence in repetitive activity, while other tasks require considerable variability in activity for their successful completion. This, obviously, is also a consideration in the acquisition of these various tasks. Thus, in learning a simple repetitive task such as a right or left turn in a "T" maze for food reward, a considerable amount of extremely similar activity involving very repetitious visualmotor stimulation of the organism is involved. Successfully carrying out this task involves turning the same way at the same choice point looking at the same alleys trial after trial after trial. And perhaps most important is the fact that all this takes place in an extremely limited space which by its very nature has a limited amount of possible differential stimulation in the first place.

Contrast this situation with a much larger and more complex mass, one with several choice points, a number of cul-de-sacs, and a relatively lengthy true path from start box to goal box. In the more complex situation the organism is required to engage

in quite variable behavior to "solve" the maxe. Indeed, it is in the entry into, and the withdrawal from the cul-de-sace in the maxe that the organism receives the greatest stimulus redundancy. Thus, the successful acquisition of these two habits would seem to call for two different kinds of reaction patterns. In the simple "T" maxe the most successful performer would be the S who persisted in repetitive activity in spite of a high degree of stimulus redundancy - an S who satiates slowly. On the other hand, in the complex maxe would this help at all? It was the observation of the present investigator that the most successful performer would be the S who satiated most rapidly to redundant stimulation, and therefore eliminated entries into cul-de-sace most rapidly.

We need look no further than the welter of studies of exploration (1,2,3,4,5,6,7,8,11,13,14,21,34,35,36,37,38,39,40,41,42, 50,56,57,58) to see what a prepotent eliciter of approach responses new and novel stimulus situations constitute for the organism. Indeed, several experiments (2,10,19,58) indicate that Ss will learn to perform some response solely for the "reward" of approaching new and novel, or varied stimuli. In addition, the results of the exploration studies generally indicate a decline in approach responses as the situation in which the Ss are placed loses its newness or novelty. Thus, there is ample evidence to show that novel situations do elicit approach responses from

various classes of organisms, and that behavior such as would be predicted on the basis of the Denny-Adelman Sensory Satiation postulate occurs with the prolonged or repeated exposure of the S to the same stimuli. The following experimental design and hypotheses were formulated in an attempt at an empirical validation of the above argument.

DESIGN AND HYPOTHESES

The first element of the experimental design to be discussed is the exploratory task. As was stated earlier, this particular method for estimating the variation in satiability from individual to individual was devised in a preliminary experiment in which the writer posed the question of how to measure the difference if it did in fact exist. It was also desirable that the method of estimation take as short a time as was practical. In the course of letting the first few Ss of the preliminary experiment explore the maze, I noted that after about 5-6 minutes in the maze the Ss seemed to do little or no moving about in the maze. so a cut-off time of 6 minutes was established and the remainder of the Ss were removed from the mase after that amount of time. The Ss were then ranked from fast to slow satiaters according to how long it took them to do 50% of the total exploration they carried out during the 6 minutes. This figure ranged from less than 1 minute to more than 4 minutes. Within any one minute the

number of units explored was assumed to be evenly spread throughout that minute. An S exploring 2 units in 1 minute was assumed to have explored 1 of the units in the first 30 seconds and 1 in the second 30; for 3 units in 1 minute, 1 in each succeeding 20 second period, and so on.

For the current experiment the procedure was the same as that outlined for the preliminary experiment, with the exception that each S explored the maze a total of 3 times over a 2 month period. The explorations were spaced about 1 month apart. The 3 rankings thus obtained were then compared using Kendall's Coefficient of Concordance (54). The final composite ranking thus obtained, derived from the sums of the 3 ranks, reflects the best ranking of the Ss in the "least square" sense.⁵ This derived ranking was then used in further correlational comparisons with the data obtained from the learning tasks in the experiment.

The 2 learning tasks were run in counterbalanced order, half the Ss running first on the simple learning task, the other half on the complex, and the tasks reversed for the 2 groups after 13 days of trials. This method assumes that the transfer effects will be in the same direction, and of close to the same magnitude from simple to complex task as they are from complex to simple task, and was adopted to economize on Ss by having each S serve as its own control. The specific hypotheses tested

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^{5.} Walker, H. M., and Lev, J. <u>Statistical Inference</u>, Henry Holt and Company, 1953, p. 286

in this experiment were as follows:

- (1) The exploration measures will permit a reliable ranking of the Ss from fast to slow satiaters.
- (2) Slow satiaters will be superior in performance to fast satiaters in the simple two choice discrimination task.
 (simple "T" maze)
- (3) Fast satiaters will be superior in performance to slow satiaters in the complex, multiple choice point, two choice discrimination maze. (multiple "Y" maze)

SUBJECTS

The Ss for this experiment were 45 male Albino rats from the colony maintained by the Michigan State University Psychology department. During the course of the experiment 4 of the Ss died, and 1 of them refused to run in the experimental masses. Thus the experimental data are based on an N of 40. All of the Ss were approximately 10 months old at the start of the experiment, and just beyond a year of age at its completion.

APPARATUS

There were 3 major pieces of equipment used in this investigation; 1 for the exploration tasks, and 2 for the learning tasks. In addition to the major equipment certain incidental equipment and supplies were utilized, and these will be listed at the end of this section.

Apparatus for the exploration tasks:

The exploration field for the Ss in this experiment was a simple alley maze constructed of white pine, fir plywood, and one-half inch hardware cloth. The alleys of the maze were constructed in the form of a square with fir plywood floors, white pine sides, and a hardware cloth top. The sides of the alleys were 5 inches in height, the inside width of the alleys was 3 inches, and the inside length of each side of the square, measured midway between the 2 alley sides, was 1 foot. There were ne culs in the mase. The hardware cloth top was a single piece of material hinged along one side of the mase to facilitate opening and closing it for the purpose of inserting Ss into, and removing them from, the mage. During the exploration tasks this mase was placed on a square table approximately 30x30x29 inches. Sufficient natural colored burlap, and also sufficient tar paper and black monk's cloth were used to drape the table completely around from a point about 9 feet off the floor to below the level of the table top. The apparatus was centered directly underneath

a 150 watt incandescent light bulb also suspended about 9 feet off the floor. The draperies, either the natural burlap, or the tar paper and monk's cloth, were tapered in such a manner that though they barely encased the lamp reflector at their upper attachment, they completely surrounded the table top just above their lower point of attachment thus providing a relatively homogeneous visual extra-maze universe for the experimental Ss. <u>Apparatus for the simple two choice discrimination task</u>:

The apparatus was a modification of a "T" maze in which the goal boxes at either end of the cross-bar of the "T" were pivoted through 90 degrees, and paralleled the initial arm of the maze. In outline the maze looked like an upper case "E". Six guillotine doors, 3 regular and 3 inverted (operating upward) and powered by rubber bands were used to close off various sections of the mage at the following locations: One regular gravity powered guillotine door separated the start box from the rest of the maze. One inverted rubber band powered guillotine door separated the initial stem of the "E" from the cross bar and the goal boxes. Continuous with the 2 sides of the initial stem of the "E" and in the cross bar were 2 inverted rubber band powered doors operating independently of each other which could separate either the left, or the right, or both halves of the cross bar from the rest of the maze. Finally, at either end of the cross bar was a regular gravity powered door which closed off the goal box

from the rest of the maze. For this experiment the alleys were left in natural wood finish. The alleys, start and goal boxes were constructed out of 1 inch white pine, and the guillotine doors out of $\frac{1}{4}$ inch fir plywood. The alleys and goal boxes were covered with $\frac{1}{2}$ inch hardware cloth, the start box with a hinged white pine cover. All alley sides were 5 inches high, and all alleys were 4 inches wide. The start box was 10 inches in length, the initial arm of the maze 12 inches, the total length of the cross bar 24 inches, and the goal boxes 10 inches in length. The food cups in the goal boxes were ordinary clear glass cups whose original purpose was to protect rugs, carpets or floors from permanent marring by the casters on the legs of heavy pieces of furniture.

Apparatus for the complex two choice discrimination learning task:

The apparatus used for this part of the experiment was a modification of a maze originally constructed by Jensen in 1957 (31) as an apparatus for the study of latent learning, and further modified by Allen in 1958 (2) for the study of exploratory behavior. As modified for this experiment, the maze contained 5 different 2 choice, choice points, and a wrong choice at any 1 of the choice points leads the S into a cul-de-sac. Entry into a cul blocked further progress through the maze until the S retraced his steps to the choice point and took the other arm. This maze is best described as a modified multiple "Y" maze. "Modified" because, rather than having the straight arms of the ordinary "Y" maze, the arms leading from each choice point were bent in the middle. (Each arm was formed from alleyways which were originally the two adjacent arms of a hexagon.)

The maze was constructed of white and yellow pine used in the alley sides, 3/4 inch fir plywood for the floor, and $\frac{1}{2}$ inch hardware cloth used to cover the tops of the alleyways. The sides of the maze were 5 inches in height, the interior of the alleys were $3\frac{1}{2}$ inches wide and each segment of the alley was 1 foot long measured along a line midway between the 2 sides. For this experiment the entire maze was left in natural wood finish.

Incidental equipment:

Incidental equipment for the experiment consisted of a stop watch for timing Ss, paper and pencil for recording their choices of path in the mazes. All the apparatus was housed, and the experiment was carried out in a single large brick walled room about 20x30 feet in size, illuminated by 6 large windows and 4 150 watt incandescent reflectored bulbs.

PROCEDURE

The general features of the experiment were as follows. Each S took part in 3 exploration tasks and 2 learning tasks in the following order: First, 1 of the 3 exploration tasks; second, the second of 3 exploration tasks; third, 1 of the 2 learning tasks; fourth, the second of 2 learning tasks; and last, the third of 3 exploration tasks. A more detailed account of the procedure, including a more elaborate description of the experimental tasks is given below.

After the Ss were selected from the colony they were removed from the breeding and rearing area and placed in the experimental room in cages containing 5 animals each (except for 2 cages, 1 of which contained 4 and the other 6 animals). This was done to permit the Ss some time to accustom themselves to their new surroundings. The number of animals in a cage was fortuitous in that it represents the number ordinarily reared in 1 cage, and all animals were left in the cages in which they were reared to eliminate the necessity of their undergoing a social reorganization along with their acclimatization to the experimental room. After the Ss had spent about 1 week in the experimental room the investigator commenced handling the animals. For 2 days the Ss were placed, 1 cagefull at a time on a bare table top about 30 inches square for about $\frac{1}{2}$ hour. Handling of the Ss consisted of accustoming them to being picked up and replaced on the table. This, incidentally, was their first experience outside their home cage for any length of time, and thus served to somewhat accustom them to being put in novel surroundings. During these 2 one-half hour handling sessions, the Ss were marked for positive identification. After the 2 days of handling the first experimental task was begun.

The first experimental task was an exploratory task. The exploration maze described in the apparatus section was placed on a small, square table positioned directly underneath 1 of the 150 watt light fixtures which provided general illumination for the experimental room. Natural colored burlap was then draped from 2x4 wood supports at the level of the light fixture (about 9 feet off the floor) down around all 4 sides of the table. This provided fairly homogeneous visual surrounds for the animal while it was in the maze. During all 3 of the exploration tasks the 150 watt light was left on at all times to provide a reasonably uniform level of illumination in all parts of the maze.

Ss were then introduced into the maze singly, and allowed to explore for a 6 minute period, after which they were removed from the maze. The observation undertaken during the exploration period was a minute-by-minute account of the number of "units" of the maze explored by the S. Thus, the data for this part of the experiment (and for all other exploration tasks) consisted of a set of 6 numbers signifying, for each of the 6 minutes spent in the maze, the number of "units" explored by the S. On the

basis of these data the Ss could be differentiated 1 from another and placed along a continuum of satiability from fast satiaters to slow.

After each S explored the mase it was weighed on a balance scale accurate within 1-2 grams, and the base weight of the S was recorded. The actual carrying out of the exploration measures took 2 days because the investigator wanted to restrict the span of time over which the exploratory behavior was measured to minimize the individual differences which might occur due to changes in general activity level resulting from the well known diurnal activity cycle of the rat. After the 2 day period spent in measuring the explorations of the Ss, all Ss were placed on a reduced diet of 10 grams of Wayne Lab Blox per animal/per day for about 30 days, with water available <u>ad lib</u> throughout all phases of the experiment. It was during this 30 day period that 3 of the Ss died.

After 30 days of a reduced diet during which time the Ss lost an average of around 15% of their basal weight, the Ss were again introduced into the exploration maze. For their second (and also for their third) exposure to the mase the alleys of the mase were lined with black smooth textured construction paper, and the burlap drape was replaced by a drape of black tarpsper on 3 sides and black monk's cloth on the fourth. Other than these changes the procedure for the second exploration (and for the third) were identical to the procedure used in the first.

During the later stages of the deprivation period the regular diet of Wayne Lab Blox was partially replaced each day by the pellets later used as rewards during the learning tasks. After the second exploration task was completed all Ss were fed additional numbers of these pellets in the goal boxes of the two apparatus! used in the learning tasks. Each S was fed 10-15 minutes in each of the 3 goal boxes involved. Completion of this part of the experiment took an additional 2 days, and then the Ss were started on the first learning task. Also at this time the daily ration of the Ss was raised to 12 grams of Wayne Lab Blox per animal/ per day where it remained for the rest of the experimental period.

The 42 surviving Ss were split into 2 groups by randomly assigning <u>cages</u> of animals to 1 task or the other, and on the completion of 13 days trials in 1 experiment the 2 groups were switched and run for 13 days on the opposite task. On the third day of the learning part of the experiment the fourth death occured among the Ss, and a fifth S was discarded for failure to leave the starting box of the complex maze. At this time the final size of the experimental groups was reached, and data from the 40 remaining Ss are complete for all phases of the experiment.

The 2 learning tasks, and the manner in which they were carried out was as follows. Task 1 was a simple 2 choice discrimination in a modified "T" (or an "E") maze described fully in the apparatus section. The alleys were left in natural wood finish, and the discrimination to be learned was a simple left

(or right) turn at the choice point for a food reward. On the first trial for each S the food cups of both goal boxes were loaded with the standard reward consisting of two .03 gram food pellets. On all subsequent trials the correct response was to whichever side the S visited on the first trial in the maze. Ss were given 4 trials a day spaced as nearly as possible 15 minutes apart for the first 12 days of the task (a total of 48 trials). On day 13 each S was given 20 massed trials spaced as closely together as picking the S out of the goal box, reloading the food cup, replacing the S in the start box, and raising the door between the start box and alley permitted. The data collected for this part of the experiment was solely in terms of errors, that is, incorrect choices at the choice point. Time scores were not obtained. A non-correction technique was used on all trials on all 13 days, and Ss were left in the goal box after an error for 30 seconds.

The basis for the choice of which arm of the maxe would be correct was as follows. The investigator expected differences in the performance of Ss according to whether they were relatively rapid, or relatively slow satiaters at the exploration task. It was hypothesized that these differences would favor more entries into incorrect alleys by rapid satiaters than by slow satiaters during the course of the experiment. The procedure of selecting the side visited by the S on the first trial as the subsequently correct side anticipated a possible criticism that

these "errors" occuring at a later time merely represent a visit by the S to the preferred side. Insofar as a single trial could be considered a measure of innate or strongly learned preferences on the part of the Ss, then visits to that side of the maze and/or turns in that direction were rewarded as a matter of procedure. The errors expected to occur later would thus result from a visit by the S to the "unpreferred" side, or a turn in the "unpreferred" direction. At the completion of 13 days trials, a 2 day rest period was introduced during which time the Ss were maintained en a deprivation diet of 12 grams of Wayne Lab Blox per animal/ per day. After the two day rest period the second learning task using the modified multiple "Y" mage was begun. In this task each S was given 2 trials per day spaced as nearly as possible 20 minutes apart for the first 12 days, and on the 13th day a total of 20 trials massed as closely as possible together. A modified correction technique was used for all trials in this maze as follows. Once the S left one "Y" of the maze, and progressed to the next "Y", he was barred from regressing to a previously visited "Y" by stiff cardboard blocks inserted downward into the alleyway at the choice point it had just quit. However, if the S should choose the incorrect arm at any "Y" it was allowed to come back out of the cul-de-sac and enter the correct arm of the "Y", indeed, so long as it did not pass the next choice point it could turn around and reenter the cul-de-sac once more, or for that matter he could repeat this several times so long as

the S remained within one "Y" of the maze. In this manner every S ultimately reached the goal box on every trial and was allowed to consume a food reward of three .03 gram pellets identical to those used as rewards in the simple learning task. The data collected in this part of the experiment consisted of error scores for each S on each trial. An error consisted of an entry into a cul-de-sac at least beyond the depth of the shoulders, and multiple errors at any choice point on any trial were possible. They were, however, infrequent.

This completed the learning tasks of the experiment, and all Ss were then given 2 days rest during which time the deprivation diet continued. Following the 2 day rest all Ss were given the third and last exploration period in the square maze. The last exploration task was carried out with the identical apparatus and procedure used in the second exploration task, egain consuming a total of 2 days time.

The section of the procedure dealing with the 2 learning tasks has described it in correct order for only half the Ss. The other half received the two tasks in the reverse of the order described above.

RESULTS

In reporting the results of this experiment, the writer would like first of all to focus upon the exploratory task. In placing the same Ss in the same task situation several times and measuring their performance again and again we are in effect asking a two-fold question: first, is the performance in question stable or changeable from instance to instance, and second, to what degree is the instrument chosen a reliable measure of performance? If the performance of each S is identical from occasion to occasion you can infer that not only is the performance remarkably stable, but that the instrument used is perfectly reliable for measuring this performance. On the other hand, if your findings are more usual, and the performance of individual Ss differs from occasion to occasion, the question of the reliability of the instrument and/or the stability of the performance is more complicated. Changes in measured performance may be the result of using an unreliable measuring device, or they may be the result of instance to instance differences within individuals in the measured performance. Perhaps more likely what is involved is the measurement of an imperfectly stable performance with an imperfectly reliable instrument. The writer has assumed that "satiability" is a characteristic of organisms which is relatively stable, and that one can properly describe certain organisms as "rapid" satiaters and other organisms as "slow" satisters. Fundamental to this assumption is the assertion
that, for a given number of organisms (N) it should be possible to order them from 1 to N as to their satiability if you possess the proper mensurational device. No measurement device is now known which reliably measures this aspect of organismic performance. This experiment then is at least as concerned with an attempt to assess the usefulness of one such proposed device for this task as it is in attempting to relate the satiability of organizate to other aspects of their performance. The method of assessing the satiability of the Ss was described in detail in the procedure chapter. Essentially, it involved the Ss! exploring a rather limited field on 3 separate occasions. The degree to which the Ss tended to explore the field in the same manner from occasion to occasion would indicate the stability of this satiability. The degree of association of the 3 sets of satiation rankings was assessed statistically by using Kendall's "W", or Coefficient of Concordancel. The results of this statistical treatment are summarized in Table 1 on page 32. The results indicate that there was a significant relationship between the 3 separate rankings of Ss for satiability. From the discussion by Siegel² of Kendall's "W", it is clear that the best estimate of the "true" rank-order is obtained by ranking the sums of the 3 ranks for each S from 1 to N, thus creating

^{1.} Siegel, S., <u>Nonparametric</u> <u>Statistics</u>, McGraw-Hill, 1956, pp. 229-238

^{2.} ibid. pp.229-231

a composite ranking for all Ss based on their performance on 3 separate explorations of the field. Accordingly this was done.

In addition to differing in satiability, the Ss differed on 2 other dimensions on which they could be ranked, general activity, and weight loss. It was thought that individual differences along these two dimensions might contribute some of the variance in the 2 learning situations, and accordingly, they were analysed in a manner similar to the analysis carried out on the satiation rankings.

General activity is defined, in this experiment, as the total number of units of the maze entered in a 6 minute period. Since satiation ranks are based on the percentage of this same 6 minute period that it takes an S to go through $\frac{1}{3}$ of the total . units that the S enters into, it is quite possible that the 2 dimensions of satiation and general activity may be highly related, though it is not necessary that they be related at all. In a preliminary experiment with an N of 39 Allen (3) concluded that general activity and satiation were essentially independent (rho-.05). To determine whether in the present experiment the same independence of the 2 dimensions was observed the relationship between them was statistically analysed by a Spearman rankorder correlation³: In addition, the degree of relationship between the 3 separate rankings for general activity was assessed

Siegel, S. <u>Nonparametric Statistics</u>, McGraw-Hill, 1956, pp. 202-213

in the same manner as was the relationship between the 3 separate sets of satiation ranks. The results of analysing the relationship between the 3 general activity rankings are summarized in Table 1 on page 32 and the results of correlating the satiation rankings and the activity rankings are summarized in Table 2 on page 33.

The significant relationship between the 3 separate general activity rankings indicates, just as it did in the case of the satiation rankings, that the best estimate of the "true" ranking for general activity is obtained by ranking the sums of the 3 separate ranks for each S, and thus creating a composite ranking of the Ss from 1 to N on the general activity dimension based on the results of all 3 explorations of the field.

In Table 2 on page 33 are the r_s's obtained from correlating the rank-order for satiability with the rank-order for general activity. The Ss were ranked on these 2 dimensions according to the following plan. In the satiation rankings the most rapid satiater was ranked number 1, and in the general activity rankings the most active 5 was ranked number 1. The obtained correlations thus indicate that for every exploration of the mase rapid satiation was associated with low activity levels. While the magnitude of the obtained correlations indicated a certain degree of relatedness between the dimensions of satiation and general activity there is no support for the contention

that they are unidimensional. The obtained correlations are far too modest to support any such contention. At this point then we were possessed with 2 related but separate dimensions of organismic performance, either or both of which might be related to the ability of the organism to learn.

On each occasion that the Ss explored the square maze they were also weighed, and we thus possessed measurements over 2 periods of time of the amount of weight lost by each S. This measurement has obvious possibilities as a determiner of the Ss performance in a learning situation via its relation to possible differences in motivational level. That is, an S who had lost but 10% of its body weight might be said to be less highly motivated than an S which had lost 20% of its body weight. This might be a rather academic relationship if all Ss had lost about the same amount of weight after corresponding deprivation periods, but in point of fact they did not. There was a considerable range from the least percentage of base body weight lost to the greatest percentage lost. For the first weight loss period, that is, the period just prior to starting the discrimination learning problems, the range of base body weight lost was from 3.49% to 22.43%. For the second period, that is, until just after the completion of the discrimination learning tasks the range was from 11.63% to 38.32%. A further finding of interest was the result of correlating the percentage of weight lost in period 1 with the percent lost in period 2. The obtained

rank-order correlation of .069 indicates no relationship between the relative amounts of weight lost during the 2 periods. Because of this lack of relationship between the percentage of weight lost during the 2 periods no attempt was made to devise a composite ranking. Weight loss rankings for the first period which ended just prior to commencing the first learning task were compared to performance on the first learning task. Weight loss rankings for the second period which ended just after the completion of the second learning task were compared with performance on the second task. The only significant correlations indicated in the results of comparing weight loss rankings with other measures of performance (Table 3 page 34 were between weight loss rankings and "Y" maze performance on the first learning task, plus a single significant correlation between weight loss rankings and general activity rankings. This also occured during the first weight loss period.

As for the remaining statistical tests, very few correlations attain statistical significance. The correlations between satiation rankings and "E" maze performance are in the predicted direction of more errors by rapid satiaters, but only 1 is high enough to be statistically significant. Regarding the relationship between satiation and "Y" maze performance, none of the correlations attain statistical significance, and all of them excepting 1 are in the opposite direction from that predicted.

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The activity ranking had no significant relationship to any aspect of performance in the 2 learning situations, but was related to weight less rankings for the first period, the obtained rank-order correlation of .405 was significant beyond the .01 level.

In Table 4 on page 35 appear the results of the analysis of the transfer effects found in this experiment. A Chi-square analysis⁴, indicated significant degrees of positive transfer from "I" make to "I" make, and significant negative transfer from "I" make to "I" make, the Chi-squares of 12.1 and 4.9 being significant beyond the .01 and between the .05 and .02 levels respectively. An inspection of the mean error scores for the appropriate groups indicates clearly that these transfer phenomena are not merely the result of the particular direction adopted on trial 1 in the "I" make, but represent other aspects of their make performance.

It might be argued that what the anthor has called "transfer effect" are really nothing of the sort. It is possible at least at first glance to propose as the main factor involved nothing more than a sampling error in assigning Ss to one or the other group and thms, since one group is superior on both tasks, and the other inferior one need not invoke the concept of transfer at all to explain the results. This seems unlikely, and the results summarised in Table 5 on page 36 indicate that an explanation as simple as sampling error is not enough. If one

group is composed of superior subjects, and the other inferior, it would seem predictable that the performance of the Ss in a group on the two tasks would be significantly correlated. In fact neither of the two correlations are significant which indicates that the performance of Ss in the 2 situations is unrelated.

Table 6 on page 37 indicates that the clearest difference between rapid and slow satiaters in the "E" maze occurs in the last half of the trials. This is precisely the place where they were expected to appear as indicated in the introductory chapter. A Ohi-Square analysis with a median or above split in errors, and a median split in satiation ranking yielded a Ohi-Square of 4.9 with 1 degree of freedom which is significant at between the .05 and .02 levels. An analysis of the same portion of the trials for the "Y" mase indicates no significant difference between rapid and slow satiaters.

Tables 7, 8, and 9, on pages 35, 39, and 40, summarize the results of the correlations between weight loss, activity, and satiation rankings with performance in both the "E" mase and the "Y" mase. In all these tables there were 3 significant correlations, one reflecting the superiority of the slow satiaters of one of the two groups over the fast satiaters of the same group in "E" mase performance. This difference was indicated far better by the results of comparisons which were summarised in Table 6, as the comparisons in Table 7 included errors made on all trials of the

learning task, and thus included errors made during the very early trials when any S regardless of satiability would be necessarily be making errors.

The remaining 2 mignificant correlations occur in Table 9 ans occur in correlations of weight loss with errors in the "Y" mase for the group running the "Y" mase first. The argument for the relevance of these two correlations in the overall picture is involved and derivative but, it seems to the author valid. The argument centers around the results of a number of the size-ofreward studies. Typically they show that varying size-of-reward affects performance in complex learning situations but not in simple, and the direction of the effect is for larger rewards to yield better performance. In this experiment it is true that we did not have different sizes of reward but there were differences in the amount of weight lost by individual Ss. The next link in the argumentative chain is that because of differing weight less among Ss we have differing motivational levels and for this reason the rewards, while not differing in physical size would be functionally different in size because of the differing motivational levels. It is tempting to speculate on the relationship between this argument made for subhuman organisms and the results of experiments with human children as 5s in which the experimental task was estimating the size of coins. The poorer and presumably more deprived (in a monetary sense) children typically show greater positive size distortions (estimate the coin size as larger) than do the children

of economically more well off families.

While a disappointingly small number of the comparisons attained statistical significance, the general character of the results of the experiment were consistent with the position that satiability as a fundamental characteristic of organisms is related to performance in a learning task, at least in simpler situations, and that slow satiaters do perform significantly better in "I" mass learning tasks than do rapid satiaters.

TABLE I

CORRELATIONS FOR SATIATION, ACTIVITY, AND WEIGHT LOSS

	N	r or r _s	x ²	Sig.
Kendall's "W" for 3 Satiation Bankings	40	•501	60.12	.05 > .025
Kendall's "W" for 3 Activity Rankings	40	•C#7t	77.28	.01 > .001
r for Weight Loss 1 and Weight Loss 2	40	•069		x.s.

TABLE II

CORRELATIONS BETWEEN SATIATION RANKINGS AND ACTIVITY RANKINGS

	I	r	# t #	81g.
First Exploration	40	544	4.05	beyond .001
Second Exploration	40	503	3.63	beyond .001
Third Exploration	40	350	2.32	.05 >.02
Composite Rankings	40	538	3.98	beyond .001

TABLE III

CORRELATIONS BETWEEN WEIGHT LOSS AND ACTIVITY

AND WEIGHT LOSS AND SATIATION (For the Second and Third Explorations)

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	x	r	Sig.
Between Weight Loss and Activity			
Second Exploration	40	.405	.01 > .001
Third Exploration	40	.060	¥.S.
Between Weight Loss and Satiation			
Second Exploration	40	•230	N.S.
Third Exploration	40	.068	Y.S.

TABLE IV

CHI-SQUARES FOR ERRORS """ (FIRST AND SECOND GROUPS) AND BRRORS "Y" (FIRST AND SECOND GROUPS)

	x	x ²	đſ	Sig.
Total Errors "E"	40	12.1	1	beyond .01
Total Errors "Y"	40	4.9	1	.05 > .02

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TABLE V

CORRELATIONS BETWEEN TOTAL ERRORS "E" AND TOTAL ERRORS "Y"

			N	r	Sig.
	GROUP				
"B"	First - "Y"	Second	20	.164	N.S.
#T#	First - "E"	Second	20	.321	1.5.

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TABLE VI

CHI-SQUARE FOR MERCORS "E" (MEDIAN OR ABOVE) AND SATIATION RANKING (ABOVE AND BELOW MEDIAN)

X	x ²	đſ	Significance
40	4.9	1	.05>.02

TABLE VIII

CORRELATIONS BETWEEN RANKINGS FOR ACTIVITY

AND ERRORS IN LEARNING TASKS

GROUP RUNNING "Y" MAZE FIRST	N	r	Sig.
Irror Free Trials in "Y" Mase	20	164	N.S.
Spaced Trial Errors in "Y" Mase	20	117	N.S.
Massed Trial Errors in "Y" Mase	20	117	r.s.
Total Errors in "Y" Mase	20	125	N.S.
GROUP BUINNING "Y" MAZE SECOND			
Error Free Trials in "Y" Mase	20	•03 9	N.S.
Spaced Trial Errors in "Y" Nase	20	158	N.S.
Massed Trial Errors in "Y" Mase	20	203	N. 8.
Total Errors in "Y" Mase	20	18 6	¥. 5.
GROUP RUNNING "E" MAZE FIRST			
Total Errors in "E" Mase	20	.181	N.8.
GROUP RUBNING "E" MAZE SECOND			
Total Errors in "E" Mase	20	.019	N.S.

DISCUSSION

As was reported in the Results chapter, the number of statistically significant findings was rather small. For this reason any discussion of the experiment must include consideration of the faults, flaws, or inadequacies of the research. That is, of course, true of almost any research undertaking but it is of particular importance in an experiment which yields so few positive results. Therefore, in the main, the experiment will be discussed as to its inadequacies for demonstrating the validity of the propositions which were derived from the theoretical framework of the Denny-Adelman elicitation theory.

Exploratory behavior as a test of the sensory satiation postulate:

Berlyne (6), Glanser (22), and Denny and Adelman (17), all refer in their theories in some form to the positive relationship between novel stimuli and approach responses. Elsewhere, this writer has pointed out reasons that seem to make the Denny-Adelman position preferable, and they will not be recapitulated here, but <u>all</u> of these theorists have as a consequence of their theory, taken the position that exploration of the environment is an exceedingly prominent behavior in the economy of the organism. In addition, all of the theorists mentioned above take theoretical account of the self limiting character of exploratory behavior. Denny and Adelman do so with their postulate of sensory satiation. The rapidity with which this process of satiation occurs in an

individual organism is not, however, to be taken as a constant decay function for all members of a particular species. It. like any number of other population variables is distributed over a range of different values. Denny assumes that the frequency distribution of these values follows a Gaussian function¹. This being the case, a standardized situation in which the physical characteristics of the environment are kept as nearly as possible constant should enable the investigator to determine the degree of this satiability in each member of any sample of organisms he chooses to expose to the standardized environment. Indeed, this is precisely the rationale given at an earlier point in the paper for adopting the procedure that was adopted. However, there exists virtually no empirical evidence for this proposition. It is true that Allen (3) in an earlier unpublished experiment discovered a rather wide range of what he called "satiability scores" were obtained from a group of 39 albino rats. These rats were allowed to explore a small mase for a short time with the mase, exploration time, and scoring procedure identical with those used in the present experiment for the exploratory task. On the basis of this earlier experiment, and considering the lack of information about the stability of this satiability factor over time, the decision was made to collect data on the satiability of the same Ss to highly similar environments over a somewhat extended period of time. At

^{1.} Personal communication from M.R. Denny, Michigan State University

the time it was realized by the writer that this might <u>possibly</u> be a weakness in the experimental procedure, but it was adopted as a simplified procedure to the alternative of attempting to standardize a large number of small mases and provide a new and different mase for each occasion on which exploration was measured.

When one takes into account the principle of stimulus generalization, it is perhaps inappropriate to consider any sitnation that an organism with any appreciable sensory past encounters to be completely novel in the fullest sense of the word. It is, however, perfectly proper to speak of the greater or lesser degree of novelty that a stimulus complex is likely to possess for a given organism. If novel stimuli decline in their approach-eliciting value as stimulus novelty is lost, then any program which includes multiple exposures to essentially the same field necessarily involves a progressive decline in the novelty, and in the approach-eliciting value of the stimuli from occasion to occasion. Denny and Adelman hold forth the possibility that the full amount of the approach-eliciting value of the stimulus is potentially recoverable if the interval of non-exposure is long enough, but their own research typically shows persistence of some loss in eliciting power over rather extended perieds of time. Specifically then, any further experiments along the lines of the present investigation could benefit from

the use of a number of distinctly different maxe situations to assess the satiability of the Ss.

There is still another problem in this area which deserves some comment. The mass chosen for use in this experiment was of square configuration with 4 serially connected, equal length arms joined at right angles. The mass used had no choice points in it, and no cul-de-sacs. This layout was different from the layout of the maxes used in the learning part of the experiment in that they had both choice points and culs. Informal observation of fairly large numbers of rats by the author has convinced him that the behavior of individual animals confronted with the blank wall at the end of a cul-de-sac is as variable. relatively speaking, as it is likely to be in any one of numerous other occasions. Since this variability in behavior was not systematically investigated, there remains the strong possibility that it might have had a discernible effect on the rated satiability of an individual S. The inclusion of mases shaped like a cross, or like a "I", both of which would have choice points and cul-de-sacs, as well as the inclusion of a circular runvay. which would lack not only choice points and cul-de-sacs, but even the corners possessed by the square maze, would be adviseable in future attempts to arrive at the satiability quotient of individual organisms.

Lastly, with regard to the general problem of relating ex-

ploratory behavior to behavior in a learning situation. Allen in 1958 (2) commented upon the confounding of real exploration of an environment with locomotion through that same environment. Some exploration situations require by their very nature a great deal of point-to-point locomotion just to traverse, while others, such as the exploratory field used by Welker in 1957 (57) require but little point-to-point locomotion, and concentrate on a highly varied visual-tactual environment. In actual fact the mase used by the author as an exploratory field was <u>smaller</u> than that used by Welker in the experiment cited above, but there is a great deal of difference in the emphasis of the two fields. The Allen maze requires point-to-point locomotion even though in a limited field, there being little emphasis on variegated environment. In fact the attempt was to make the physical surrounds as uniform as possible. Welker, on the other hand, in a field only slightly larger, obviously emphasized variegated textures, shapes, and brightnesses in his exploration field. In this experiment the decision to use the type of exploration field that was used was predicated on the assumption that it more nearly duplicated the conditions of the learning problem whose outcome we were interested in predicting. Obviously, there is no logical necessity that this be the case. It is just as logical to predict the satiability of individual animals on the basis of the rate at which they cease to explore a highly diversified field as it is to predict on the basis of how quickly they cease to explore a highly uniform field. It is

perhaps likely that the satiation rate will be slower because of the increased richness of the visual/tactual environment, and that the assessment of the satiability of an individual S might be somewhat more elaborate, but any significant improvement in the rating of Ss satiability would be well worth a more complicated procedure.

The possible effects of prolonged reduced food regenins:

In this experiment the Ss were on a severely reduced diet for two months from start to finish. It is quite possible that the lengthy period of reduced diet so increased the saliency of the hunger motive that it diminished the importance of the satiation variable, thus obscuring the effect of the variable ostensibly under investigation, the T (comment). The author feels that a much milder deprivation diet would obviate this situation but is unable at this time to do more than speculate that this procedure will indeed increase the effect of stimulus satiation on the mase learning performance of the Ss.

The possible effects of increasing the number of experimental animals:

The number of Ss with which this experiment began was a rather modest 45, the N with which it finished an even more modest 40. Since the main variable under investigation is assumed to follow a Gaussian frequency distribution in the population, it is possible that attempting to select 35 to 40 Ss from the extremes of a much larger population which had been rated for satiability would enable the investigator to secure a sample more extreme in their satiability than was actually obtained in this experiment. If, as is possible, such factors as hunger tend to mask some of the satiation effects in a learning situation, selection of extreme individuals from the population might allow a larger residual of the effect to show up. The drawback to this procedure is the uneconomical use of experimental animals and of time. Also there is the possibility that no matter how slowly, or how rapidly, an S satiates under conditions in which it is being fed ad lib, <u>any</u> deprivation diet might wash out the effect nearly completely. Nevertheless, it is a procedure which might be extremely useful, and ought at least to be tried.

The possible effects of undifferentiated alleys and choice points in the discrimination maxes:

The implicit assumption of the writer about the discriminatory power of rapid as against slow satiaters in the planning of this experiment was that the rapid satiater was more sensitive to smaller differences in its environment. In fact, this was thought to be the essential difference between them. For this reason the decision was made to leave all the alleys in the mase in a natural wood finish. The thinking behind this decision was that the fast satiaters would be affected more by the minute differences in stimuli throughout the mase, and they would thus be more affected by the relative differences in the novelty of stimuli. Because of this their behavior would be more variable than the behavior of the slow satiaters who were

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not so sensitive to these small differences. It is possible however that the discriminatory power of the animal is not related, or is only slightly related, to its satiability. If this is the case then mames in which the stimulus values of the different arms are made more discriminently different would perhaps allow the satiation variable to show to greater effect. If in addition to turn direction the Ss also had available the cue of brightness difference (as they would have if 1 arm at each choice point were painted white and the other black) the learning task would have been easier because of the multiple cues all pointing the same direction. Also, with greater physical difference in the stimuli, the novelty of an arm not recently entered would have greater saliency, and thus greater approacheliciting value.

This procedure must be viewed with caution however since it might also, in an experiment in which each 5 served as its own control as they did in this experiment, tend to increase the already considerable and unwelcome interaction effects. This could well have the effect of further obscuring an already difficult interpretation even further.

One last change in the physical environment of the learning mazes would seem desirable. The surrounds of these mazes ought to be made more homogeneous in the same manner that the surrounds of the exploration mazes were. That is, a system of drapes skirting around the periphery of the maze ought to be erected.

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Some of the lack of positive results might well be attributable to the fact that the rapid satiaters, who in general did not perform as expected, failed to do so because, satiating rapidly to the redundant stimulation of the interior of the mase, they turned for stimulus variety to the relatively rich and uncontrolled extra mase environment.

Transfer phenomena:

One of the findings of this experiment was that there was positive transfer from the 'I' maze to the 'E' maze, and negative transfer from the 'E' maze to the 'Y' maze. The positive transfer from 'I' to 'I' was so great that 3 of the Ss run through the 2 learning tasks in that order did not make a single mistake in a total of 68 trials, and 2 more Ss made but a single error. This seems to result as a function of 2 interacting circumstances, first, the adoption of the procedure of making the correct arm of the 'E' maze uniformly correspond to the side of the maze visited by the S on its first trial in the maze, and second, the speed of running through the alleys that the S had built up over 144 trials in the multiple 'Y' maze. The running time of many of the Ss who had the 'E' maze problem second did not exceed 2 or 3 seconds on their very first trial in the mase and further every S was well accustomed to consuming the food reward immediately upon entering the goal box. This combined with the fact that which ever way they went on trial 1 was the correct way, the extremely short time interval between the

critical turn response and the receipt of the reinforcement could well explain the rapidity with which learning took place.

SUMMARY AND CONCLUSIONS

The research problem examined in this dissertation stems from the recent interest in what might be termed "stimulus satiation" postulates by modern learning theorists. The particular theoretical position from which this problem is examined is that of Denny and Adelman (17). The essential point of the theory under investigation deals with the theoretical postulate on sensory satiation which states that the approach eliciting value of a stimulus complex is lessened for an organism with continued exposure of the organism to a particular stimulus complex and that the speed of this satiation varies in the population according to a Gaussian function.

The argument is put forth that in performing different kinds of tasks it may at times be advantageous if the organism satiates rather slowly, and that at other times a rapidly satiating organism may have the advantage. The specific test of this argument was accomplished by rating the Ss for satiability on an exploratory task in a simple small maze, then having the Ss perform in 2 different learning situations in counterbalanced order. One of the learning tasks was a simple turn response in an 'Z' maze, the other was a complicated maze problem using a 5 unit modified multiple 'Y' maze.

The Ss for this experiment were 45 male Albino rats from the Michigan State University Psychology department colony, with

the final H for the experiment shrunk to 40 because of 4 deaths and 1 refusal to run.

Three pieces of apparatus were used in the experiment, an exploration mase, and 2 different mases for the 2 learning problems. The exploration mase was shaped like a square, with 4 alleys each a foot long connected by 90 degree corners. One of the learning mases was an "E" mase (a "T" mase with the goal boxes reflected 90 degrees from the cross bar on the "T" and parallel to the initial stem of the mase), and the second mase was a modified "Y" mase with 5 choice points in a E,L,E,E,L pattern. The particular modification of this "Y" mase is attributable to its origins as a multiple hermgonal mase. Each arm of the "Y" consisted of 2 adjacent arms of the original hermgons and was bent in the middle, whereas in a conventional "Y" mase each arm is straight.

All Ss were permitted to explore the square maxe 3 times, 6 minutes each time, at approximately 1 month intervals. On the basis of their composite performance they were rated individually along a continuum from fast satisfiers to slow. Their ranking on this continuum was then compared, using Spearman rank order correlations, with their performance in each of the 2 learning tasks.

The 2 learning tasks were run in counterbalanced order, half the Ss starting with the 'E' mass problem, and half starting with the multiple 'Y' mass problem. After 13 days of trials all Ss were switched to the opposite problem. Of the 13 days of trials

the first 12 days were all relatively spaced trials (4 per day in the 'Z' maxe, and 2 per day in the 'Y' maxe). The last day in either maxe consisted of 20 trials massed as closely together as possible. All Ss were then ranked according to the number of errors made on the problem, and these rankings constituted the second variable in the correlations referred to in the previous paragraph.

One additional measure was taken, the amount of weight lost after 2 different length intervals of a deprivation diet. All Ss were weighed each time they explored the square mase, thus data was obtained as to the Ss weight on 3 different occasions (1) The base weight, or weight prior to any time on a deprivation dist; and (3) The weight of each S at the completion of the experiment approximately 1 month after the second weighing. All Ss were ranked for the percentage of their base body weight lost for each interval. This then constituted the third major variable considered in the experiment. It was considered important because of its possible relationship to motivational level differences which might lead to increased variance in performance of the Ss in the learning tasks. From the results of the analysis it is apparent that the presumptive motivational difference contributed more perhaps than any other variable to the performance variance of the Ss.

A disappointingly low number of the correlations and other analyses attained statistical significance, weight loss and satiation being the only significant variables, and these only partially so. As a result, the discussion of the results consisted mainly in an analysis of the deficiencies and inadequacies of the experiment. Basic to the design of the experiment was the assumption of consistent transfer effects, and the experiment did not yield consistent transfer effects. The transfer from multiple 'Y' to 'E' was positive, while the transfer from 'E' to sultiple 'Y' was negative. Also the positive transfer from 'Y' to 'E' was more substantial than the negative transfer from 'E' to 'Y'.

The general character of the results of this experiment however are consistent with, though providing no strong support for, the position that satiability is a fundamental characteristic or organisms, and that satiability is related to their performance in a learning task, at least in the simple 'E' maze, in the predicted direction. Except for autocorrelations the significant correlation between errors in the 'E' maxe and satiability ranking was the highest attained in the experiment.

APPENDIX 'A'

In discussing the historical background of this problem, three lines of research will be of primary importance; (1) Spontaneous activity studies as they relate to learning, (2) Genetic studies investigating the inheritance of 'intelligence' in rate, and (3) Exploration studies. Other studies which seem relevant to the problem will also be reviewed, but not as extensively. One of the latter sort of studies was a paper in 1942 by B. Kuppuswamy (33), who studied a single 'backward' rat quite intensively, hoping to discover if the backwardness of this rat was all-pervasive, or if perhaps he might be able to find some area in which this animal equalled or exceeded the average performance of his fellows. He discovered no such area of performance, this one S being in every respect inferior to all other Ss tested.

Insofar as correlational studies of the performance of Ss have been carried out at all, they appear to be correlations between performances in quite similar situations, and all the correlations are positive and quite high. Cummins, McHemar and Stone in 1932 (12) report a correlation of .6 between abilities to learn several kinds of complex mases (multiple 'T', multiple elevated 'T', etc.). Tryon in 1931 (51) reports a correlation of .8 for errors made by Ss in two different 'T' mases. There was no attempt here to assess the learning ability of the Ss in two fundamentally different situations. This is also true of the

genetic studies on inheritance of intelligence (24, 25, 26, 46, 52). In all of these experiments the test situation was the per-

Heron and various others have, however, reported several measures of functioning in rate other than the acquisition of a response in their long term program studying the inheritance of intelligence. Heron and Yugend in 1936 (29) reported that the Heron 'bright' strain of rate had a higher EMR than the Heron 'dull' strain. Heron in 1940 (27), and Heron and Skinner, also in 1940 (28) found that Heron's mase bright animals extinguish a learned habit faster than the mase dull animals.

Heron, in a 1935 article (26) reported the following procedure used in the creation of the two strains of rats he created. He first tested a randomly selected group of animals in the Heron automatic mase, then, selecting the best and worst performers in the mase, he inbred them, best to best, and worst to worst. The offspring were also tested in the same mase, and the best performers in the 'best' group were bred to each other, with the worst performers in the 'worst' group also being treated analougously. This procedure was followed for several generations (best bred to best, and worst bred to worst) until at last there was virtually no overlap in the performance of the 'bright' and 'dull' groups. The important thing to note from this study so far as the <u>present</u> problem goes is that the original group, selectëd randomly, contained individuals nearly as

extreme in their performance as the Ss in the selected groups after several generations of inbreeding.

Heron was also involved in the genetic investigation of other traits in the rat, such as activity. Rundquist and Heron in 1935 (45) reported the results of a comparison of the mase learning abilities of two groups selectively bred, using procedures analogous to those outlined in the preceeding paragraph. to produce an factive' and an finactive strain. Individuals from these two strains as well as animals from the 'bright' and 'dull' strains were tested in the Heron automatic maze. with the following experimental outcome. The 'active' and the 'bright' strains were comparable in their ability to learn the maze, though the 'bright' animals were somewhat better than the 'active' animals. Both of these groups were better than either the 'inactive' of the 'dull' Ss. In this particular experiment the bright-dull strains were in the fourth generation of the breeding program, and the active-inactive strains were in the seventeenth generation.

Activity measures have not always shown such a consistent relationship to learning ability however. Liddell in 1925 (35) using lambs as Ss and a simple maze as an apparatus for a learning experiment found that spontaneous activity, measured by means of a pedometer attached to the loreleg of the lambs showed no relationship to maze learning ability. The activity measures

were taken over periods of various lengths between four and thirty-seven days. Shirley, in 1928 (47) found maze learning to be only slightly related to activity, but Tuttle and Dykshorn, also in 1928 (53) found activity level and learning ability to be closely allied. Tuttle and Dykshorn were actually studying the effects of certain physiological changes, brought about in the rate by operative techniques, on spontaneous activity and learning ability. One must be cautious in comparing their results to other experiments of the same general type because of the extensive changes wrought in the physiology and behavior of the Ss due to the castration eperation.

Lee and VanBuskirk also studied this problem in 1928 (34), and concluded that the spontaneous activity level of their Ss was unaffected by the changes in BME brought about by the thyroidectomy which they performed on their Ss. There is possibly an interesting relationship between the research of Lee and Van Buskirk, the research of Heron and Yugend and that of Rundquist and Heron. Heron and Yugend found the Heron 'bright' strain had a higher BME than the 'dull' strain, Rundquist and Heron found that the 'active' and the 'bright' strains were fairly comparable in mass learning ability, and Lee and VanBuskirk found that EME and activity were not related. There is thus a possibility that the findings of Heron and Tugend regarding the higher BME of the 'bright' strain are entirely
fortuitous.

Allen in 1959 (3) in some unpublished research also determined that, for animals fed a normal diet, stimulus satiation and general activity are not related. A rank-order correlation between general activity in a small maze (defined in terms of the number of arms visited in a standard time interval), and stimulus satiation (defined in terms of the rate at which the animals slowed up and/or ceased their movement through the mase), was -.05 with an I of 39. This last experiment by Allen was important to the overall planning on the design of the experiment carried out in the present problem for it strongly indicated a possible method of differentiating Ss along lines which are theoretically related to individual differences in ability to learn, and further, this method is apparently not confounded with differing general activity levels. A fuller discussion of the possible effects of confounding these two variables is contained in Allen's 1955 unpublished NA thesis (2). Essentially, the possible effect is as follows: In small mages such as the one used by Welker in 1957 (57), not much locomotion is required in the exploration of the maze, while in large mazes, such as the one used in Allen's MA thesis, or in Dashiell's classroom demonstration maze developed in the twenties and reported in 1925 (14), a great deal of point-to-point locomotion is required for the exploration of the maze. Thus, when large maxes are used to evaluate stimulus

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satiation, the satiation measure may be confounded with differences in general activity level among the Ss which will lead to more or less movement through the maze, and these differences in movement through the maze need not be at all related to stimulus satiation as such.

There are also differences in the maxe behavior of animals related directly to their motivational state, the extremely comnon experimental procedure of depriving animals of food for some period of time to motivate them to learn the mase for a reward of food being an obvious example of this fact. When, however, we remove reward from the situation and do an experiment in exploratory behavior instead of one in learning, evidence does not support the contention that the resultant behavior of the Ss is so directly related to their motivational state, primarily because of the confounding of exploratory behavior and locomotive behavior mentioned in the preceeding paragraph. Montgomery. in 1953 (39), and Alderstein and Jehrer in 1955 (1), also Fehrer in 1956 (21) came to distinctly different conclusions about the interrelations of these variables. Alderstein and Tehrer, and Tehrer, concluded that food deprived animals explore much more than animals fed ad lib, while Montgomery concluded exactly the opposite of this. To quote Montgomery, his study gives evidence that exploratory 'drive' is a ". . primary drive which undergoes a decrement in the presence of other primary drives." To cite

^{1.} Montgomery, K. C. "The Effect of Hunger and Thirst Drives upon Exploratory Behavior", Journal of Comparative and Physiological Psychology, 1953, vol. 46, p. 319

Fehrer, hunger <u>increases</u> exploratory drive, "... in the sense that hungry animals are more likely than sated ones to leave familiar foodless territory."²

The most important variable operating to produce these differences seems to be the maze itself. Montgomery typically used a simple 'I' mase of limited areal extent, and Fehrer used a much larger mase with considerably more locomotion required to traverse it. Montgomery himself was apparently aware of this difference since he says in one of the many papers in which he concluded that satiated animals explore more than deprived animals, that <u>in a</u> larger mase the deprived animals would explore more, though he does not attempt to explain why this would be so. It is interesting to note that one experiment by Thompson in 1953 (50) indicated no differences in exploration rates attributable to the motivational state of the Ss, and in this experiment the maxe used as exploration ground for the Ss was intermediate in size to Nontgomery's small 'Y' maze, and Fehrer's very large maze.

Montgomery in particular went to great lengths to try and separate 'exploratory drive' from other motivational states of the organism. In one study in 1953 (38) he concluded that exploratory drive is separate from activity drive. In another study by Montgomery and Monkman in 1955 (40) a distinction between exploratory drive and fear motivated responding is the

^{2.} Jehrer, E. "The Effects of Hunger and Familiarity of Locale on Exploration", Journal of Comparative and Physiological Psychology 1956, vol. 49, p. 551

point at issue. Further studies by Montgomery in 1952 (36), and in 1953 (37), examined exploratory drive in relation to spontaneous alternation, and to stimulus generalization, respectively.

Berlyne (6), Glanzer (22), and Denny and Adelman (17), have taken theoretical account of stimulus satiation in somewhat similar fashions. The relevant aspects of Denny and Adelman's theoretical position were quoted in the first chapter of this dissertation on account of their more direct relationship to the formulation of this problem, but a quote here of Berlyne's two postulate system might serve to illustrate its similarities to, and differences from, the theoretical position of Denny and Adelman. Notice that the section of Denny and Adelman's theory

> "Postulate 1. When a novel stimulus affects an organism's receptors, there will occur a drive-stimulus producing response which we shall call curiosity.

"Postulate 2. As a curiosity-arousing stimulus continues to affect an organism's receptors, curiosity will diminish" 3

which deals with the recovery of eliciting value by stimuli as a result of the passage of time during which the organism is not exposed to the particular stimulus, is only hinted at rather weakly in Berlyne's second postulate, and that solely by implication and not direct statement. From other articles generated by Berlyne's theory, it is apparent that some recovery of curiosity does occur with periods of non-exposure in spite of his theoretical silence

^{3.} Berlyne, D. E. "Novelty and Curiosity as Determinants of Ex-Ploratory Behavior", British Journal of Psychology, 1950, vol. 51 P. 70.

on that point. Berlyne in 1955 (7) states that complex environments arouse curiosity more readily than do more simply structured environments. Also in this experiment, Berlyne's results indicate that the satiation of curiosity is related to previous exposure to the stimuli, the massing of the exposure trials, and exposure time within a trial.

Whether we conceptualize the relevant theoretical positions in terms of novel stimuli bringing about a drive-stimulus producing response called curiosity, or in terms of the elicitation of approach responses being a prepotent property of novel stimuli which diminishes in petency with prolonged or repeated exposure to the stimuli, and recovers some (perhaps all) of its potency with the passage of time during periods of non-exposure, exposure to novel stimuli has a powerful effect on the behavior of organisms so exposed. Berlyne and Slater in 1957 (8) carried out an experiment which showed that rats have a definite preference for entry into the arm of a 'T' make leading into a more complex mase which they are allowed to explore as opposed to entering a plain 'T' mase arm where they receive a small amount of food reward. Denny in 1957 (19) performed an experiment in which Ss were rewarded for visiting either arm of a 'T' maze with dissimilar arms (black-natural). Two trials per day spaced thirty minutes apart were given to all Ss, and the trials were so arranged that by forcing the S to respond in one direction, every S visited one side of the mase twice as often as the other (one

half of the Ss visited the black arm twice as often, the other half visited the natural arm twice as often). The result of this treatment was that the Ss came to take slightly more than 90% of their 'free' choices toward the less often visited side. This remember, in spite of being rewarded with food regardless of their choice of arm. A quote from the discussion of his experimental results by Denny is useful in illustrating how his theory deals with such events.

> "According to this (Denny's) position the responses prepotently elicited in a situation are the ones that become conditioned to this situation. In the present instance an avoidance reaction is assumed to be consistently elicited by the more frequently experienced stimuli and thus conditioned to them."

The important result of the Denny experiment which justified this treatment was that Denny's Ss persisted in choosing the less often visited arm of the maze in a series of two free trials given after an intervening one week interval. Thus, to Denny, novel/familiar stimuli elicit approach/avoidance responses which are as effective mediators of learned patterns of responding as are food for an hungry S or water for a thirsty S.

Butler in 1953 (10), and again in 1954 (11) showed that rhesus monkeys will learn to correctly choose one of two alternatives for the reward of being allowed to peek out of the enclosed box in which the discrimination is made through a small 4. Denny, M. R. "Learning Through Stimulus Satiation", <u>Journal</u> of <u>Experimental Psychology</u>, 1957, vol. 54, p. 63 window which allows the S to look out of his small box into a larger room.

Lastly, the typical picture of the laboratory rat busily exploring each new stimulus to which he is exposed may at least partly derive from the fact that while not exactly domesticated, he has had countless generations to accustom himself to man with his often strange ways. Barnett, whose personal bravery may well surpass that of the average experimental psychologist, in 1955 (4) used trapped mature wild rate in an exploratory task and compared their performance to that of typical laboratory animals. He found that in contrast to the lab animals who did busily explore the novel environment in which they were placed, the wild animals exhibited 'neophobia', or extreme fear of their novel surrounds. This finding would certainly embarrass Berlyne, but not Denny, who could simply say that the response for the class of organisms including wild rats which is most prepotently elicited by exposure to novel stimuli of the sort encountered in the laboratory is of the class of escape, withdrawal, or fear responses.

APPENDIX "B"

This appendix contains the raw data of the experiment, including the weight of Ss at each exploration, the exploration scores, and the error scores in each learning situation. A particular S has the same number throughout the appendix.

Subject	Weight First	Weight Second	Weight Third
Fumber	Exploration	Exploration	Exploration
1.	535	- 460	340
2.	545	480	395
3.	430	415	380
4.	530	445	377
5.	460	410	395
6.	535	415	330
7.	475	425	360
8.	435	380	326
9.	435	410	360
10.	490	390	373
11.	515	1445	413
12.	455	335	302
13.	505	460	405
14.	490	J1)tO	372
15.	J J	405	360
16.	450	410	305
17.	465	430	400
18.	530	480	380
19.	и но	420	331
20.	490	360	370
ฮ.	495	470	363
22.	475	450	370
23.	420	390	335
24.	455	390	295
25.	525	475	380
26.	490	445	400
27.	470	430	378
28.	490	јі і ю	340
29.	490	445	367
30.	525	475	375
31.	5 2 5	500	393
32.	490	jhji O	330
33.	490	450	400
34.	470	410	350
35.	490	445	370
36.	485	455	377
37.	400	380	345
38.	450	415	370
39•	430	410	365
40.	525	480	413

THREE EXPLORATION SCORES AND COMPOSITE RANKING

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Y' MAZE ERRORS AND ERROR-FREE TRIALS

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g.	+	23	7	10 7 4 3 6	27
9.	+	63	4	10 14 12 20 11	15
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28.	i	52	22	\$ 15 0 20 1/	12
29.	i	57	10		
30.	i	56	14	13 14 6 19 18	17
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32.	+	34	14	6 5 6 15 17	14
33.	+	43	16	11 6 5 28 9	11
34.	+	17	5	84253	30
35.	+	38	6	9 8 8 9 10	25
36.	I	46	6	5 16 5 12 14	19
37•	I	43	9	9 14 5 8 16	17
38.	I	37	10	9 12 6 6 14	19
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PATTERN OF 'E' MAZE RESPONSES

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Subject	Running Order De	Response Pattern Massed Trials
10.		
19.		No mistake on any trial
20.	!	+ + + + + + + + + + + + + + + 0 + + + +
21.	+	$\begin{array}{c} + & + & 0 & + & + & + & + & + & + & + &$
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Subject No.	Running Order Day	Response PatternNassed Trials1 2 3 4 5 6 7 8 9 0 1 2on Day 13
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29.	+	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
30.	÷	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
31.	!	No errors except on Trial 2, Day 1
32.	!	$\begin{array}{c} + & + & + & + & + & + & 0 & + & + & + &$
33.	!	No errors except on Trial 3, Day 1
34•	!	No errors on any trial.
35•	!	No errors on any trial.
36.	+	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
37•	+	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
38.	+	$\begin{array}{c} \div &+ & 0 & 0 &+ &+ &+ &+ &+ &+ &+ &+ &+ &+ &+ &+ &+ $

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Subject	Running	Response Pattern														Massed Trials										
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+ = Ran 'E' maze first ! = Ran 'E' maze second

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