

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

ProQuest Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600

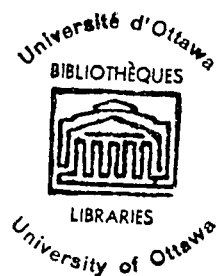
UMI[®]



THE EFFECTS OF PERCEPTUAL DEPRIVATION ON EXPLORATORY
AND PROBLEM-SEEKING BEHAVIOR OF THE ALBINO RAT

by Arthur M. Blank

Thesis presented to the School of
Graduate Studies of the University
of Ottawa as partial fulfillment of
the requirements for the degree of
Doctor of Philosophy



Ottawa, Canada, 1973

UMI Number: DC52515

INFORMATION TO USERS

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleed-through, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

UMI[®]

UMI Microform DC52515
Copyright 2007 by ProQuest LLC
All rights reserved. This microform edition is protected against
unauthorized copying under Title 17, United States Code.

ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106-1346

ACKNOWLEDGMENTS

This thesis was prepared under the supervision of Dr. Henry Edwards, Ph.D., Associate Professor of Psychology. The writer gratefully acknowledges his advice and continued interest in the project.

The writer also wishes to thank Dr. William Barry, Ph.D., Professor of Psychology, and Dr. Robert Stelmack, Ph.D., Assistant Professor of Psychology for their advice, and Mr. E. Achorn and Mr. R. Spratt, R.E.T., for their technical assistance.

CURRICULUM STUDIORUM

Arthur M. Blank was born in Montreal, Quebec, on February 23, 1942. He received the Bachelor of Science degree from McGill University, Montreal, in 1963. From 1963-1966 he persued graduate studies in psychology at California State University at Long Beach.

TABLE OF CONTENTS

| Chapter | page |
|--|------|
| INTRODUCTION. | vii |
| I.- REVIEW OF THE LITERATURE. | 1 |
| 1. Problem-Seeking Behavior | 2 |
| 2. Exploratory Behavior | 11 |
| 3. Perceptual Deprivation Effects on Behavior | 22 |
| 4. Summary and Hypotheses | 39 |
| II.- EXPERIMENTAL DESIGN | 43 |
| 1. The Sample | 43 |
| 2. The Apparatus | 43 |
| 3. Experimental Procedure | 49 |
| 4. Statistical Analysis | 54 |
| III.- PRESENTATION AND DISCUSSION OF RESULTS. | 57 |
| 1. Results of the Tests of Significance | 57 |
| 2. Discussion of Results | 64 |
| SUMMARY AND CONCLUSIONS | 75 |
| BIBLIOGRAPHY. | 78 |
| Appendix | |
| 1. PRE AND POST-DIFFERENTIAL REARING PROBLEM-SEEKING AND EXPLORATORY BEHAVIOR SCORES OF RATS MAINTAINED IN THE NORMAL ENVIRONMENT. | 85 |
| 2. PRE AND POST-DIFFERENTIAL REARING PROBLEM-SEEKING AND EXPLORATORY BEHAVIOR SCORES OF RATS REARED IN THE PERCEPTUALLY DEPRIVED ENVIRONMENT | 86 |
| 3. ABSTRACT OF <u>The Effects of Perceptual Deprivation on Exploratory and Problem-Seeking Behavior of the Albino Rat.</u> | 87 |

LIST OF TABLES

| Table | page |
|---|------|
| I.- Comparison of Pre-Test and Post-Test Exploration and <u>PS</u> Scores Obtained from Rats Reared in Perceptually Deprived and Normal Environments for Thirty Days | 58 |
| II.- Comparison of Mean Change Scores of Exploratory and <u>PS</u> Behavior of Rats Reared in Perceptually Deprived and Normal Environments for Thirty Days | 60 |
| III.- Comparison of Mean Changes in Exploratory and <u>PS</u> Scores of Rats Reared in a Perceptually Deprived Environment for Thirty Days when the Animals have been Divided into High and Low Groups According to their Pre-Test Exploratory or <u>PS</u> Scores. | 62 |
| IV.- Comparison of Mean Changes in Exploratory and <u>PS</u> Scores of Rats Maintained in a Normal Environment for Thirty Days when the Animals have been Divided into High and Low Groups According to their Pre-Test Exploratory or <u>PS</u> Scores | 63 |

LIST OF FIGURES

| Figure | page |
|-----------------------------------|------|
| 1.- Exploration Maze. | 45 |
| 2.- Problem-Seeking Maze. | 46 |

INTRODUCTION

Experiments have indicated that rats can be classified according to problem-seeking tendencies. An explanation of this behavior has been put forth which attests to its being distinct and different from exploration.

It is the purpose of the present thesis to investigate the effects of perceptual deprivation on problem-seeking behavior. The findings, it is hoped, will shed some light on the relationship between problem-seeking behavior and environmental experience. Further, the validity of the differentiation made between exploratory behavior and that of problem-seeking will be investigated.

The first chapter of this thesis presents a review of pertinent literature. Two parts review studies concerned with problem-seeking and exploratory behavior. The third section reviews investigations pertaining to the effects of perceptual deprivation on exploratory behavior. The chapter ends with statements of the experimental hypotheses.

The second chapter describes the subjects and apparatus used in the experiment. In addition the experimental procedure and statistical analyses utilized to test the research hypotheses are related.

The third and final chapter presents the statistical results of the experiment and discusses their significance.

CHAPTER I

REVIEW OF THE LITERATURE

Numerous psychological theories in the past have postulated that all behavior is motivated by biological drives such as hunger and thirst. Numerous recent studies using lower animals have investigated behaviors that cannot be adequately explained in terms of these drives and as a result other theoretical positions have been put forth. Research has brought evidence supporting a view of the elicitation of behavior from exteroceptive sources.

One of the behaviors that appears to be independent of the primary drives has been termed Problem-Seeking¹ and a method for its quantitative measurement has been developed at McGill University. A theoretical treatise has been offered in an attempt to explain why rats exhibit this behavior. In addition, PS has been shown to be distinct and different from exploration. Although the literature is replete with studies delving into the causes and concomitant of exploratory behavior, there is a dearth of investigations that have attempted to deal similarly with PS behavior. Considering this, it would be of interest to determine the influence of environmental experience, specifically that

¹ Hereafter PS will denote Problem-Seeking.

of perceptual deprivation on PS behavior. The relationship between PS and exploratory behavior will be re-examined as will the effects of perceptual deprivation on exploration.

The present study is the first of a series of investigations on PS behavior of the albino rat, that hopefully, will eventually culminate with human subjects.

This chapter reviews pertinent literature related to the present study under the headings of Problem-Seeking Behavior; Exploratory Behavior; and Perceptual Deprivation Effects on Behavior. The chapter ends with a statement of the hypotheses tested in the present study.

1. Problem-Seeking Behavior.

In this section the writer wishes to review the studies dealing with PS behavior and its quantification.

Krechevsky², in attempting to determine the effects of cortical lesions upon variability of behavior in a situation where no learning was required and, therefore, no errors were possible, discovered what has subsequently been termed PS behavior.

Eighty-one male rats ranging in age from 90 to 120 days were divided into two operated and two normal groups.

² T. Krechevsky, "Brain Mechanisms and Variability", Journal of Comparative Psychology, Vol. 23, 1937, p. 139-163.

In the former groups the operations were performed under deep ether anesthesia and cortical tissue was destroyed by electrical cauterization after which followed a two week recuperative period. All animals were confronted with a preference situation between a constantly varying and non-varying path to food. For two of the groups, one operated and one normal, the varying pathways were an average of 17.9 inches longer than the non-varying route. No learning was necessary as the situation confronting the rats demanded only a preferential choice, the consequences of which were similar in that feeding time and kind of food found in both goal boxes were identical.

Results indicated that, in this free choice situation in which a normal animal was allowed to choose between a constant fixed versus a varying pathway to food in a situation where no errors were possible, it showed "...no tendency to fixate the constant path even though the constant path is slightly shorter than the variable path..."³ This led the author to conclude that a basic characteristic of a normal animal is variability of performance even when it may be less efficient. A more efficient response would likely have been to choose the shorter, non-varying pathway.

³ Krechevsky, Op. Cit., p. 155.

Similar results have been cited by Hebb and Mahut⁴ in two experiments using a modified form of a closed field maze. Their study was concerned with the rat's motivation in problem solving, relating this to factors of perceptive novelty. Specifically, they questioned whether an animal allowed to choose between two routes to food, one short and direct, the other longer and indirect and necessitating the bypassing of barriers, would choose the latter route. Their apparatus was so constructed that barriers could be placed in different positions, each different arrangement constituting a separate problem. A rat was able to choose either of two routes to food, one leading directly to food and avoiding the barrier arrangement altogether, the other necessitating travelling through the barriers prior to reaching the goal area.

Twenty-eight rats performed 150 choice trials, five trials per day. For one group the problem remained constant; for the other, a new problem was presented at each trial. A significant difference between the two groups was found, the latter group having chosen the problem route significantly more often ($p < .001$).

⁴ D.O. Hebb and H. Mahut, "Motivation et Recherche du Changement Perceptif Chez Le Rat et Chez l'Homme", Journal de Psychologie Normale et Pathologique, Vol. 52, 1955, p. 209-221.

In their second experiment, the authors attempted to eliminate the problem factor and put in its stead a novelty situation in order to determine whether the rats would still prefer the longer route if, inside the field, a rearrangement of objects was found which did not constitute a problem. Three groups of five rats each, answered this query in the affirmative.

The experimental results showed that motivation by food need is not the only factor operating in rat problem solving. Another element involved seems to be PS for its own sake indicating that a familiar situation is less attractive than a new problem.

Mahut⁵, in 1953, designed an experiment to isolate new variables concerned with the problem of exteroceptively determined behavior. Her study was based on Hebb's theory that cerebral events play an important role in the determination of an organism's response to afferent stimulation. Hebb⁶, suggested that central determinants of behavior consist of persistent, organized and directed cerebral activities called phase sequences. He proposed that the phase

⁵ H. Mahut, "Nature of Rats' Motivation in Problem-Solving", Read at the Canadian Psychological Association Meetings, May 1953.

⁶ D.O. Hebb, The Organization of Behavior, John Wiley and Sons Inc., New York, 1949, p. 222.

sequence continually needs new input to maintain its organization and persistence, accounting for the organism's tendency to seek a certain amount of stimulus variety. Based on this, Mahut hypothesized that a rat confronted with a long versus a shorter pathway, would tend to choose a more varied problem offered along the longer pathway, but that it would prefer the shorter pathway should the problem remain unchanged. Her hypothesis held for only a proportion of her animals, and only within certain limits of problem complexity. This experiment did not analyse variables that might be responsible for the difference between the tendency of some rats to take a short route and of others to follow a longer, more varied pathway.

In order to investigate the nature of PS behavior, Havelka⁷ designed an experiment to study the tendency of rats to seek novel stimuli, and also to distinguish between PS and exploratory behavior. Fifty naive Hooded rats from 90-110 days of age were used. Two problem boxes were designed to measure the animals' tendency to seek a variable goal. The first was constructed in the form of a complex T maze with an x-shaped cross barrier placed in each goal arm. For half the animals the fixed goal (food) was located

⁷ J. Havelka, "Problem Seeking Behavior in Rats", Canadian Journal of Psychology, Vol. 10, 1956, p. 91-97.

within one of the angles of the right cross barrier, the variable goal being any one of the four angles on the left. The position of food on the variable goal was changed randomly for each trial, while food was always presented in the same position at the fixed goal. Both goals thus contained food at every trial.

The relationship between the two goals in the second problem box was near-far, rather than right-left, all other aspects remaining identical with the first problem box. The fixed goal was always located within the near barrier position, the variable goal thereby necessitated a longer and more variable route to food. The choice in both problem boxes was between the variable and fixed goals.

Ten consecutive choice trials daily for eight days were administered to the animals in both problem boxes. The fifty rats made choices such that it became possible to divide them into three groups with no overlap. Eighteen preferred the variable goal (problem-seekers), sixteen chose the fixed goal (non problem-seekers), and sixteen rats indicated neither PS nor non-PS tendencies by choosing the two goals a comparable number of times. The choice of the variable goal was found to be highly reliable: the product-moment correlation coefficient between the first and last thirty choices was .80, ($p < .001$). Therefore, each group's preference was manifested from the beginning of the

experiment and tended to hold up in both problem boxes even though, in the latter test situation, the choice of the variable goal entailed bypassing the fixed goal and travelling further to reach the variable goal area. The rats, thus, "...exhibited typically different behavior tendencies with reference to a variable goal situation."⁸

To measure the exploratory behavior in these animals Havelka⁹ used a simple T maze. The stem and each arm were 30 inches long with walls $5\frac{1}{2}$ inches high and 3 inches wide all covered with a wire screen. To measure exploratory behavior, each animal was placed in the foot of the stem of the T maze and for ten minutes each traversal of the different arms of the maze were recorded separately for each one hundred second period. The results showed that PS and non-PS rats could not be differentiated by an exploratory measure.

Havelka's main explanation of PS behavior was in terms of perceptual elaboration which refers to the capacity and tendency of organisms to develop organized systems of cerebral activity after repeated contact with environmental stimuli which in turn constitute determinants of behavior.

8 Havelka, Op. Cit., p. 94

9 J. Havelka, "On the Motivation of the Rat in Problem Solving", unpublished masters thesis presented to the Graduate Faculty of McGill University, Montreal, 1954, 1-28 p.

The data suggested that if rats do develop these behavioral determinants, they have different capacities for doing so. In this way the preferences of the PS rats were assumed to be a function of a more complex perceptual organization than that of non-PS rats. In addition, it seemed evident that, with practice, dispositions were subject to progressive development.

The difference between exploration and PS behavior was also explained in terms of perception, and arousal by novel stimuli. In exploration, however, as the organism adapted to these stimuli, exploration diminished and eventually terminated. PS on the other hand, also a function of perception, is aroused by a continually varying relationship between barriers and a food goal. The organism in this case, does not become adapted to this kind of changing pattern,

...but seeks progressively more commerce with it. Thus, the two types of behavior are a function of different conditions: exploration being a reaction to fixed sets of novel stimuli in the absence of any particular goal, while problem-seeking behavior involves a reaction to a variable means as related to a specific goal.¹⁰

The difference between the two behaviors was supported by the fact that there was no correlation found between them. Thus, the variable goal situation constituted

¹⁰ Havelka, Op. Cit., p. 15.

a continuing problem for the rat as the means to the food was unpredictable from trial to trial. Eighty further trials were given in the second problem box but with the food fixed in both goals. When the factor of unpredictability was withdrawn by fixing the food location the PS rats terminated their PS behavior and began to choose the goal nearer the starting box.

Apart from unpredictability, Havelka cited other possible determinants of PS behavior such as barriers, delay, complexity of environmental stimulation as well as summation of habit strength which may have played a part in the development of the variable goal preferences.

It seemed reasonable to consider the disposition to seek problems as a motivational variable. Thus, the behavior of the rats might be characterized in terms of modes of adjustment in which various cognitive principles and motivational variables are specified. Although these adjustment dispositions are affected to some extent by experience and learning, the evidence presented seems to point to the fact "...that they are potentially given in various degrees in any particular individual."¹¹

This section reviewed the important studies dealing with PS behavior. They have shown that PS is part of a

¹¹ Havelka, Op. Cit., p. 19.

rat's repertoire of behavior, distinguishable from exploratory behavior, and, as shown by Havelka, amenable to quantitative measurement.

2. Exploratory Behavior.

This section reviews relevant studies in the area of exploratory behavior.

The forerunner of much research on exploratory behavior was Dashiell¹², who noted that when rats were returned to an elevated nest box they paid little or no attention to available food even though they were unfed for the previous twenty-four hours. Instead, they explored their surroundings for awhile. Yoshioka¹³, in 1929, similarly observed that rats hesitated at a spot in a familiar maze when a new visual detail was present. Since these early studies, the area of exploratory behavior has been heavily researched. Many studies attempted to prove that, without any apparent motive or reinforcement presented by the experimenter, animals would readily respond to various stimuli in a variety of test situations which seemed to

12 J.F. Dashiell, "A Quantitative Demonstration of Animal Drive", Journal of Comparative Psychology, Vol. 5, 1925, p. 205-208.

13 J.G. Yoshioka, "Is Vision Useless for the Rat in a Familiar Maze", Journal of Genetic Psychology, Vol. 36, 1929, p. 342-343.

evoke tendencies to explore.

A. Novelty.

It has been demonstrated that animals respond to novel stimuli, that is, to a change of impinging stimuli. In 1956, Kivy, Earl and Walker¹⁴ showed that animals will reliably choose the changed or novel part of a T maze. They permitted twelve naive albino rats to explore the starting stem and choice part of a T maze. During this initial period both arms were either completely white or black and glass doors prevented the animal from entering the goal arms. Each animal was tested at three exposure intervals of one minute, fifteen minutes and thirty minutes. The test trial involved a free choice with one of the two arms converted to the opposite of the exposure colour. The results indicated a significant tendency to avoid the exposure colour and choose the novel part of the T maze.

Further studies similarly indicated that animals respond to novel stimuli. Dember¹⁵ exposed twenty albino rats to the goal arm of a T maze but prevented them from

¹⁴ P.N. Kivy, R.W. Earl, E.L. Walker, "Stimulus Context and Satiation", Journal of Comparative and Physiological Psychology, Vol. 49, 1956, p. 90-93.

¹⁵ W.N. Dember, "Response by the Rat to Environmental Change", Journal of Comparative and Physiological Psychology, Vol. 49, 1956, p. 93-95.

entering by the use of glass partitions at the choice point. With the initial exposure one arm was black and the other white or vice versa, but upon re-exposure the animals were permitted a choice in which both arms were either black or white. Even though the animals were required to choose between two equally familiar brightnesses they reliably chose the changed arm. Fowler¹⁶, as well as Woods and Jennings¹⁷, replicated Dember's original study using a T and a Y maze respectively and, utilizing a similar experimental procedure, obtained similar results.

Studies measuring time spent in exploration are in general accord with the results obtained from studies utilizing choice procedures. Williams and Kuchta¹⁸, investigated the exploratory behavior of rats in simple Y mazes with dissimilar alternatives. Two experiments were done, in the first of which, the animals were introduced to the dissimilar alternative, a white arm, on their fifth exposure to the maze. In the second experiment a dissimilar

¹⁶ H. Fowler, "Response to Environmental Change: A Positive Replication", Psychological Reports, Vol. 4, 1958, p. 506.

¹⁷ P.J. Woods and S. Jennings, "Response to Environmental Change: A Further Confirmation", Psychological Reports, Vol. 5, 1959, p. 560.

¹⁸ K.D. Williams and J.C. Kuchta, "Exploratory Behavior in Two Mazes with Dissimilar Alternatives", Journal of Comparative and Physiological Psychology, Vol. 50, 1957, p. 509-513.

alternative contained numerous novel objects. Results indicated that an alternative path was explored more when it was new in relation to other alternatives, and a maze containing the different objects was explored more than the empty arms. In both experiments, therefore, the animals spent more time investigating the arm in which a change had been introduced. In 1950 Berlyne¹⁹ had reported similar results, as did Berlyne and Slater in 1957. The latter concluded

...(a) that rats will spend more time exploring a novel stimulus than stimuli which they have been previously able to explore; and (b) that they will spend less time exploring stimuli the second time they encounter them.²⁰

A response to change has also been observed using activity measures of exploration, eg. the number of maze units traversed by an animal in a given period of time. Corman²¹ found that changes in stimulus conditions led to changes in both total activity and in time spent in the area of the stimulus change. The animals avoided the familiar

19 D.E. Berlyne, "Novelty and Curiosity as Determinants of Exploratory Behavior", British Journal of Psychology, Vol. 41, 1950, p. 68-80.

20 D.E. Berlyne and J. Slater, "Perceptual Curiosity, Exploratory Behavior and Maze Learning" Journal of Comparative and Physiological Psychology, Vol. 50, 1957, p. 228-232.

21 C.D. Corman and J.N. Shafer, "Open Field Activity and Exploratory Behavior", Psychonomic Science, Vol. 13, 1968, p. 55-60.

section of the maze and spent more time, as well as more activity, exploring novel maze sections.

In addition to responding to novel stimuli, animals also show a preference for complex stimuli. Berlyne²², using a rectangular exploration box in which both novel and familiar stimulus objects were introduced, found that the animals spent more time investigating that part of the environment which provided complex stimuli as well as the novel rather than the familiar stimuli. Similar results were reported by Dember, Earl and Paradise²³, Hughes²⁴, Woods and Davidson²⁵, Chang and Yang²⁶, and Corman.²⁷

22 D.E. Berlyne, "The Arousal and Satiation of Perceptual Curiosity in the Rat", Journal of Comparative and Physiological Psychology, Vol. 48, 1955, p. 238-246.

23 W.N. Dember, R.W. Earl and N. Paradise, "Response by Rats to Differential Stimulus Complexities", Journal of Comparative and Physiological Psychology, Vol. 50, 1957, p. 514-518.

24 R.N. Hughes, "Behavior of Male and Female Rats With Free Choice of Two Environments Differing in Novelty", Animal Behavior, Vol. 16(1), 1964, p. 92-96.

25 P.J. Woods and E.H. Davidson, "The Behavioral Effects of Changes in Environmental Complexity", Canadian Journal of Psychology, Vol. 18(1), 1964, p. 23-37.

26 S.S. Chang and K.S. Yang, "The Exploratory Drive of the Rat", Acta Taiwanica, No. 3, 1961, p. 44-56.

27 Corman, Op. Cit., p. 55-56.

Other investigations of exploratory behavior attempted to determine the effects of the degree of novelty or complexity on exploratory behavior; the general hypothesis being that the strength of the exploratory drive as measured by the amount of exploratory behavior decreases with continuous exposure to a given stimulus situation. Montgomery²⁸ had thirty-two albino rats explore three enclosed mazes constructed in the form of an H. The mazes were identical except for brightness. One was painted flat black, one flat white, and one flat grey, their mean brightnesses being 0.18, 0.55, 3.30 ft.-l, respectively. The experimental results showed that exposure to the first situation produced a decrement in the amount of exploration of the second and also that this decrement was positively related to the degree of similarity between the two test situations. Therefore, the relevance of degree of novelty or complexity was indicated with (1) the general reduction or decrement in the amount of exploration of the second which was a basically similar situation and (2) with less of this reduction taking place in the second situation when it was more dissimilar in brightness to the first.

28 K.C. Montgomery, "Exploratory Behavior as a Function of Similarity and Stimulus Situations", Journal of Comparative and Physiological Psychology, Vol. 46, 1953, p. 129-133.

The relationship between strength of exploration and degree of novelty or complexity was also investigated by extending the animals' exposure to novel stimuli. In these cases, the animal's exploration declined over time of its exposure to the novel stimuli. This indicated that, as exploration continued, thereby decreasing the novelty, a decrease in exploratory response resulted. It was also noted that if the animal were to be removed from the test situation following extensive exposure to novel stimuli, and then returned sometime in the future, exploration recovered to its original strength. Such results are found in studies by Berlyne²⁹, Berlyne³⁰, Montgomery³¹, and Montgomery³².

It has, therefore, been well documented that exploration increases due to novelty as well as complexity of a stimulus situation. It has also been shown that as novelty decreases or time exposure to novel or complex stimuli

29 Berlyne, Op. Cit., p. 68-80.

30 Berlyne, Op. Cit., p. 238-246.

31 K.C. Montgomery, "Spontaneous Alternation as a Function of Time Between Trials and Amount of Work", Journal of Experimental Psychology, Vol. 42, 1951, p. 82-93.

32 K.C. Montgomery, "The Relationship Between Exploratory Behavior and Spontaneous Alternation in the White Rat", Journal of Comparative and Physiological Psychology, Vol. 44, 1951, p. 528-589.

increases, exploration diminishes. Similar results have been found by a number of investigators studying the effectiveness of changes in visual, auditory, and kinesthetic stimulation in eliciting exploration in Rhesus monkeys and chimpanzees. The most notable studies are Butler and Alexander³³, Butler³⁴, Butler and Harlow³⁵, Harlow³⁶, Harlow, Blazek and McClearn³⁷, Harlow, Harlow and Meyer³⁸

33 R.A. Butler and H.M. Alexander, "Daily Patterns of Visual Exploratory Behavior in Monkeys", Journal of Comparative and Physiological Psychology, Vol. 48, 1955, p. 247-249.

34 R.A. Butler, "Discrimination Learning by Rhesus Monkeys to Visual Exploration Motivation", Journal of Comparative and Physiological Psychology, Vol. 46, 1953, p. 95-98.

35 R.A. Butler and H.F. Harlow, "Persistence of Visual Exploration in Monkeys", Journal of Comparative and Physiological Psychology, Vol. 47, 1954, p. 258-263.

36 H.F. Harlow, "Learning and Satiation of Response in Intrinsically Motivated Complex Puzzle Performance by Monkeys", Journal of Comparative and Physiological Psychology, Vol. 43, 1950, p. 289-294.

37 H.F. Harlow, N.C. Blazek and G.E. McClearn, "Manipulatory Exploration in the Infant Rhesus Monkey", Journal of Comparative and Physiological Psychology, Vol. 49, 1956, p. 444-448.

38 H.F. Harlow, M.K. Harlow and D.R. Meyer, "Learning Motivated by a Manipulation Drive", Journal of Experimental Psychology, Vol. 40, 1950, p. 228-234.

Welker³⁹, Welker⁴⁰, and Welker.⁴¹

The studies aforementioned determined that animals will respond to novel stimuli or complex stimuli by exploration. A number of studies have indicated that the animal will not only respond to a change in stimulation but would also learn to respond for change. Whiting and Mowrer⁴² as well as, Berlyne⁴³ noted a relation between curiosity and fear. The animals exhibited a tendency to seek stimulation from fear provoking objects, although they remained at a safe distance. Myers and Miller⁴⁴ found that food and water satiated rats would learn to press a bar in a shuttle box in order to gain entry into a black compartment from a white

39 W.I. Welker, "Some Determinants of Play and Exploration in Chimpanzees", Journal of Comparative and Physiological Psychology, Vol. 49, 1956, p. 84-89.

40 W.I. Welker, "Effects of Age and Experience on Play and Exploration of Young Chimpanzees", Journal of Comparative and Physiological Psychology, Vol. 49, 1956, p. 223-226.

41 W.I. Welker, "Variability of Play and Exploratory Behavior in Chimpanzees", Journal of Comparative and Physiological Psychology, Vol. 49, 1956, p. 181-185.

42 J.W.M. Whiting and O.H. Mowrer, "Habit Progression and Regression - A Laboratory Study of Some Factors Relevant to Human Socialization", Journal of Comparative and Physiological Psychology, Vol. 36, 1943, p. 229-253.

43 Berlyne, Op. Cit., p. 68-80.

44 A.K. Myers and N.E. Miller, "Failure to Find a Learned Drive Based on Hunger; Evidence for Learning Motivated by Exploration", Journal of Comparative and Physiological Psychology, Vol. 47, 1954, p. 428-436.

one or vice versa. Chapman and Levy⁴⁵ have similarly found that visual changes in a goal box of a straight alley or runway results in an increase of a rat's running speed. Other investigations demonstrated that rats learn a bar press response when it was followed by weak light onset or weak light off-set. (See Girdner⁴⁶, Herwitz⁴⁷, Robinson⁴⁸, and Robinson⁴⁹).

Animals will learn to perform for exploratory rewards other than changes in visual stimulation. This was demonstrated in 1956 by Kish and Antonitis⁵⁰, who found that bar pressing responses of mice were able to be reinforced by

⁴⁵ R.M. Chapman and N. Levy, "Hunger Drive and Reinforcing Effect of Novel Stimuli", Journal of Comparative and Physiological Psychology, Vol. 50, 1957, p. 233-238.

⁴⁶ J.B. Girdner, "An Experimental Analysis of the Behavioral Effects of a Perceptual Consequence Unrelated to Organic Drive States", American Psychologist, Vol. 8, 1953, p. 354-355.

⁴⁷ H.M.B. Herwitz, "Conditioned Responses in Rats Reinforced by Light", British Journal of Animal Behavior, Vol. 4, 1956, p. 31-33.

⁴⁸ J.S. Robinson, "Light Onset and Termination as Reinforcers for Rats Under Normal Light Conditions", Psychological Reports, Vol. 5, 1959, p. 793-796.

⁴⁹ J.S. Robinson, "The Reinforcing Effects of Response-Contingent Light Increment and Decrement in Hooded Rats", Journal of Comparative and Physiological Psychology, Vol. 54, 1961, p. 470-473.

⁵⁰ G.B. Kish and J.J. Antonitis, "Unconditioned Operant Behavior in Two Homozygous Strains of Mice", Journal of Genetic Psychology, Vol. 88, 1956, p. 121-124.

microswitch clicks and other noises. The reinforcing effect of stimulation change was also demonstrated in selective learning tasks. In 1954, Montgomery⁵¹ showed that female rats would learn to enter the arm of a Y maze leading to a large Dashiell Maze that provided an opportunity for exploration. The results indicated that these animals would learn to reverse their choices when the incentive Dashiell Maze was switched to the other arm of the Y maze.

Investigations utilizing monkeys and chimpanzees led to similar results. Bar pressing by monkeys could be reinforced by a change of illumination as shown by Moon and Lodahl.⁵² Harlow and McClearn⁵³ showed that monkeys would improve in performance of discrimination problems on the basis of manipulatory incentives. In addition Harlow⁵⁴ indicated that monkeys would learn the solution to mechanical puzzles for no other incentives than those provided by the

⁵¹ K.C. Montgomery, "The Role of Exploratory Drive in Learning", Journal of Comparative and Physiological Psychology, Vol. 47, 1954, p. 60-64.

⁵² L.E. Moon and T.M. Lodahl, "The Reinforcing Effect of Changes in Illumination on Lever Pressing in Monkeys", American Journal of Psychology, Vol. 69, 1956, p. 288-290.

⁵³ H.F. Harlow and G.E. McClearn, "Object Discrimination Learned by Monkeys on the Basis of Manipulation Motives", Journal of Comparative and Physiological Psychology, Vol. 47, 1954, p. 73-76.

⁵⁴ Harlow, Op. Cit., p. 289-294.

manipulation of the puzzles themselves. Hebb and Mahut⁵⁵ have shown that rats would learn to choose a route to food that would lead it through a barrier situation which meant an increase in novelty.

The above studies therefore support Hebb's⁵⁶ general conclusion that mammals seek excitement, that is, they not only respond to change but also for external environmental change.

This section reviewed the important studies dealing with exploratory behavior. One of the aims was to acquaint the reader with the major investigations that have attempted to understand the nature of exploration. In this way the distinctness between exploratory and PS behavior may be more easily discerned. Finally this section yields important background information regarding exploratory behavior necessary for the comprehension of the following section of this study.

3. Perceptual Deprivation Effects On Behavior

In this section the writer wishes to review relevant studies of the effects of perceptual deprivation upon

55 Hebb and Mahut, Op. Cit., p. 209-221.

56 D.O. Hebb and W.R. Thompson, "The Social Significance of Animal Studies", G. Lindzley (Ed.), Handbook of Social Psychology, Cambridge, Mass., Addison-Wesley, 1954, p. 551.

exploratory behavior.

Hebb⁵⁷ has suggested that learning utilizes and builds on earlier learning, and has stated "...that early learning tends to be permanent, that it has generalized transfer affects, and that it is not specific to particular situations."⁵⁸ Numerous experimental studies dealing with the effects of early experience upon later behavior have been stimulated by Hebb's theory and early investigations. In 1947, in an experiment studying early experiential effects on problem solving at maturity, Hebb⁵⁹ concluded that animals given much perceptual experience early in life will prove to be better learners than animals deprived of such experiences. The following investigators have supported Hebb's view in showing that deprived rats are inferior learners: Bingham and Griffiths⁶⁰, Hymovitch⁶¹, Forgays

57 D.O. Hebb, 1949, Op. Cit., p. 109.

58 D.O. Hebb, 1949, Op. Cit., p. 296.

59 D.O. Hebb, "The Effects of Early Experience on Problem-Solving at Maturity", American Psychologist, Vol. 2, 1957, p. 306-307.

60 W.E. Bingham and W.J. Griffiths Jr., "The Effect of Different Environments During Infancy on Adult Behavior in the Rat", Journal of Comparative and Physiological Psychology, Vol. 45, 1952, p. 307-312.

61 B. Hymovitch, "The Effects of Experimental Variations on Problem Solving in the Rat", Journal of Comparative and Physiological Psychology, Vol. 45, 1952, p. 313-320.

and Forgays⁶², Forgus⁶³, Schweikert and Collins⁶⁴, and Sturgeon and Reid.⁶⁵

Hebb's writings have also given impetus to experimental work attempting to determine the effects of perceptual deprivation on exploratory behavior. Specifically, investigators have compared the exploration of animals previously reared in either enriched or deprived environments. The enriched environments usually are more spacious and contain a variety of stimulus objects; the deprived environments, in contrast, are usually smaller isolation cages containing one or sometimes two animals. Reports on the effects of later exploratory behavior due to these different rearing conditions have been inconsistent. Some studies find that deprivation results in a decrease of

62 D.G. Forgays and J.W. Forgays, "The Nature of the Effect of Free-Environment Experience in the Rat", Journal of Comparative and Physiological Psychology, Vol. 45, 1952, p. 322-328.

63 R.H. Forgus, "The effect of Early Perceptual Learning on the Behavioral Organization of Adult Rats", Journal of Comparative and Physiological Psychology, Vol. 47, 1954, p. 331-336.

64 G.E. Schweikert and G. Collins, "The Effects of Differential Post Weaning Environments on Later Behavior in the Rat", Journal of Genetic Psychology, Vol. 109, 1966, p. 225-263.

65 R.D. Sturgeon and L.D. Reid, "Rearing Variations and Hebb-Williams Maze Performance", Psychological Reports, Vol. 29, 1971, p. 571-580.

exploratory behavior, others report an increase in exploratory behavior, whereas a third group are unable to differentiate the exploratory behavior of the enriched versus the deprived animals and, therefore, find no differences as a result of rearing conditions.

Patrick and Laughlin⁶⁶, in studying the wall-seeking tendency of the white rat, reared rats in either an open growing cage or in smaller ordinary nesting conditions. When their subjects were tested on an activity maze as well as on an open alley maze for exploration differences, the results clearly showed that the exploratory drive on the part of rats grown up in ordinary nesting conditions is lower than that of animals grown up in the relatively larger open cage. In this case a more deprived environment resulted in a decreased amount of exploration.

Luchins and Forgas⁶⁷ found similar results in studying rats that had been subjected to different post-weaning environments. They were concerned with the effects of variations in experiential background that animals bring to an experimental situation.

66 J.R. Patrick and R.M. Laughlin, "Is the Wall-Seeking Tendency in the White Rat an Instinct", Journal of Genetic Psychology, Vol. 44, 1934, p. 378-389.

67 A.S. Luchins and R.H. Forgas, "The Effect of Differential Post-Weaning Environments on the Rigidity of an Animals Behavior", Journal of Genetic Psychology, Vol. 8, 1955, p. 51-58.

They designed a study in which eighteen female rats were divided into a control and an experimental group. The former were reared from weaning until fifty-two days of age in a limited environment, poor in the variety of experiences it offered. The experimental group was reared in an environment offering a greater variety of experiences and was also handled and fondled to a greater extent during the rearing period. After fifty-two days the animals were observed in three test situations, two of which were an activity test and a variability test. In the activity test each animal was placed on an elevated maze for five minutes, while activity and emotionality scores were taken. The former was based on the number of sixteen-inch units traversed during five minutes, the latter on the number of pellets defecated. The variability test consisted of a four unit Y shaped maze. Branching off the two arms were two paths, each eighteen inches long and leading to a food receptacle. The variability index was based on the variety of routes traversed by the rat in ten trials.

The results showed that the control group appeared more frightened and hesitant, took a longer time to start running, and thereafter ran more slowly than the experimental group. Those rats, therefore, which were afforded a less stimulating environment showed less activity in terms of the number of maze units traversed, were more emotional

as determined by the number of pellets defecated, and less variable in terms of taking a lesser variety of equidistant paths to food, than those animals that lived in a more stimulating environment. In this case deprivation also led to a decreased amount of exploration.

A study comparing the exploratory activity of differentially reared animals in two alternate exploratory settings that either afforded subjects the opportunity to seek novel stimulation from a familiar environment or forced subjects to adjust to a radical novel environment was designed by Lore and Levowitz.⁶⁸

Thirty-six male Wistar rats were weaned and placed in one of three rearing conditions when twenty-five days of age. Free environment animals were reared in a large cage containing various manipulanda. Restricted animals were placed in individual confinement cages which allowed only reduced visual stimulation. The third group was placed in standard Wahmann cages.

Forced exploration was measured in a rectangular cage 36 inches long x 12 inches wide x 10 inches high, constructed of hard-ware cloth supported by a metal frame. The cage contained five wooden objects and ten metal objects

⁶⁸ R.K. Lore and A. Levowitz, "Differential Rearing and Free Versus Forced Exploration", Psychonomic Science, Vol. 5, 1966, p. 421-422.

of various shapes. After 40-41 days of differential rearing all animals were housed in Wahmann cages. Free exploration was observed by allowing animals the opportunity to peer out or emerge from the top of their own cages when 86-88 days old. Three measures were taken: the latency of the first appearance of any portion of the rat's body above the cage top; the total time during the five minute open cage period when any portion of the rat's body was above the cage and the number of animals in each group who left the home cage entirely. The forced exploration task was administered when the animals were 121 days old. In this case each animal was placed in the cage and its exploratory activity continuously recorded for fifteen minutes. Forced differs from free exploration in that in the former the animal is unable to freely return to its home cage, its behavior being continuously monitored in the forced exploration apparatus.

According to the authors, the results did not justify the conclusion that restriction leads to an increased exploratory drive, because when the animals were presented with an opportunity to seek novelty from a familiar environment, they exhibited less exploratory activity.

In contrast to the above studies are those that showed that deprivation leads to increased exploration.

Woods⁶⁹, investigating subsequent free-environmental experience on animals that had been shown to be inferior maze solvers due to early restricted environmental experience found that isolated animals exhibited more exploratory behavior in his testing apparatus.

He placed twelve Sprague Dawley rats in a free environment apparatus and nineteen in isolation cages from weaning until two months of age. They were then tested on a Hebb-Williams Maze. After this first testing, half of the restricted animals were placed in the free environment, and all animals were again tested after thirty days and a third time after ninety days. Results showed that the restricted animals were poorer maze solvers apparently due to a heightened exploratory drive.

Woods, Ruckelshaus and Bowling⁷⁰ compared rats reared under restricted versus free-environmental conditions and also concluded that the restricted animals explore more. Their results were in agreement with those obtained by

⁶⁹ P.J. Woods, "The Effects of Free and Restricted Experience on Problem-Solving Behavior in the Rat", Journal of Comparative and Physiological Psychology, Vol. 52, 1959, p. 399-402.

⁷⁰ P.J. Woods, S.I. Ruckelshaus and D. Bowling, "Some Effects of "Free" and "Restricted" Environmental Rearing Conditions Upon Adult Behavior in the Rat", Psychological Reports, Vol. 6, 1960, p. 191-200.

Zimbardo and Montgomery⁷¹, who found that rats reared in normal lab cages explored a simple Y maze significantly more than rats reared in an environment offering complex sensory and proprioceptive stimulation.

Ehrlich⁷², also attempted to evaluate the effects on exploration of early environment and immediate past experience. Specifically, the effects of exploration of free versus restricted environments were investigated. In addition, handling versus non-handling as well as repeated exposures to the same testing situation were also studied. Although no significant results were found regarding exploratory behavior, the author did report a tendency for rats reared in a restricted environment to explore more than those reared in a free environment.

71 P.G. Zimbardo and K.C. Montgomery, "Effects of "Free Environment" Rearing Upon Exploratory Behavior", Psychological Reports, Vol. 3, 1957, p. 589-594.

72 A. Ehrlich, "Effects of Past Experience on Exploratory Behavior in Rats", Canadian Journal of Psychology, Vol. 13, 1959, p. 248-254.

Finally, in studying rats reared under different conditions of stimulus deprivation, Sackett concluded that,

In general the amount of sensory deprivation on days 15-60 of life related directly to the gross amount of movement in a novel environment. This effect appears to persist through the young adult stages of development, even though the animal has lived under normal colony conditions since day 60, and thus seems to be irreversible up to the age tested in this study.

With respect to exploratory behavior, modest degrees of sensory deprivation appear to produce maximum interest in novel and in complex visual input...⁷³

Other investigators were unable to differentiate animals' exploratory behavior as a result of differential rearing. In 1957, Montgomery and Zimbardo⁷⁴ studied the effect upon exploratory behavior of varying durations of early behavioral and early sensory deprivation. After weaning, they placed seventy-two rats in one of three living conditions. One group was placed in normal size cages, another in small behavioral deprivation cages and the third group was reared in small behavioral and sensory deprived cages. The normally reared animals were able to move about freely and were exposed to stimulation occurring

⁷³ G.P. Sackett, "Response to Stimulus Novelty and Complexity as a Function of Rats' Early Rearing Experiences", Journal of Comparative and Physiological Psychology, Vol. 63, 1967, p. 369-375.

⁷⁴ K.C. Montgomery and P.J. Zimbardo, "Effect of Sensory and Behavioral Deprivation Upon Exploratory Behavior in the Rat", Perceptual and Motor Skills, Vol. 7, 1957, p. 223-229.

in the laboratory. The behaviorally deprived rats were severely restricted behaviorally but were exposed to normal laboratory stimulation. The severely behaviorally deprived animals of the third group were reared in small sheet metal cages placed in a light-proof, sound screened cabinet and were, therefore, restricted both behaviorally and sensorially. Nine groups of animals were formed by subdividing the three groups into three equal subgroups, a twenty-five day, a fifty day and a one hundred day group, each remaining in its respective living conditions for the designated number of days prior to testing. On the 26th, 51st and 101st day, four exploratory behavior tests were given each animal in a standard Y maze. A trial consisted of removing the rat from its living cage and placing it at the choice point of the Y maze, thus allowing it to explore freely for ten minutes before replacing it in its living cage. On each trial, records were taken of the number of twelve-inch maze sections traversed per minute, the sequence of arm entries, grooming activities, and the amount of defecation. For each rearing condition, the results did not indicate any systematic effect of length of deprivation upon amount of exploratory behavior. No differences were found among the groups despite radical differences in living conditions and gross differences in duration of exposure to those conditions. The authors conclude that these findings lend support to the position that exploratory

behavior is dependent upon exteroceptive stimulation. The findings yield negative evidence for the hypothesis that exploratory behavior is motivated by an exercise or boredom drive or by acquired drives based upon primary drives such as hunger or thirst.

Charlesworth and Thompson's⁷⁵ study lends support to Montgomery and Zimbardo's⁷⁶ position. They divided thirty-two albino rats of the Sherman strain into a control and three experimental groups, each containing four males and four females. Eight individual living cages with hinged doors were provided for the control group animals. The three experimental groups of eight rats each were housed individually in white pine boxes with grey interiors divided into two equal sections by a vertical sliding door. This created a free exploration field adjacent to the animals' living section. Four boxes in each group had a 12 volt, 2 amp. lighting unit attached above a circular smoked glass window which was placed in the roof of the box. The remaining four boxes were placed in a darkened area of the laboratory. Each group, therefore, contained four animals

⁷⁵ W.R. Charlesworth and W.R. Thompson, "Effect of Lack of Visual Stimulus Variation on Exploratory Behavior in the Adult White Rat", Psychological Reports, Vol. 3, 1957, p. 509-512.

⁷⁶ Montgomery and Zimbardo, Op. Cit., p. 223-229.

in a light monotonous environment and four animals in a completely dark monotonous environment. The exploratory part of each box had a wire roof and contained a triangular piece of wood, one side painted black, one white and one black and white striped.

All animals were sated for food and water. The controls were taken from their normal living cages approximately ten days prior to the experiment and placed in individual cages allowing a full view of the laboratory. The animals were observed for two sessions of ten minutes each in the exploratory half of the cages and records were taken of autonomic activity and amount of exploration. One of the three experimental groups lived in its box for a period of three days, another for six and the third for nine days prior to exposure to the exploratory field.

For each five second interval during two ten-minute sessions the following measures were taken: exploration of the object, roof and corners of the field; latency of entrance into the field; autonomic activity determined by scratching, licking and grooming; total time spent in the exploration field.

The results indicated that confinement limiting the variety of visual stimulation had no observable effects on the amount of autonomic activity. In addition, the rats that were completely deprived of all visual stimulation,

did not explore more than the other groups. The different groups of animals, therefore, could not be differentiated in either amount or latency of exploratory behavior.

Hoffman⁷⁷ assigned thirty experimentally naive albino rats to three different environments, thus constituting an unrestricted group living in a free environment, a community cage group, and an isolation group. The animals remained in these environments from weaning until seventy days of age when testing began. These results showed that these animals could not be differentiated in terms of exploratory behavior.

McCall, Lester and Dolan⁷⁸, as well as Brown⁷⁹, also found that they could not differentiate animals in terms of exploratory behavior as a result of differential rearing. These authors did, however, determine that although the animals could not be differentiated in terms of quantitative measures of exploratory behavior, different

77 C.S. Hoffman, "Effect of Early Environmental Restriction on Subsequent Behavior in the Rat", Psychological Record, Vol. 9, 1959, p. 171-177.

78 R.B. McCall, M.L. Lester and C.G. Dolan, "Differential Rearing and The Exploration of Stimuli in the Open Field", Developmental Psychology, Vol. 1, 1969, p. 750-762.

79. R.T. Brown, "Early Experience and Problem-Solving Ability", Journal of Comparative and Physiological Psychology, Vol. 65, 1968, p. 433-440.

rearing did determine the style of exploration. The data of former authors, for example, suggested that the deprived subjects responded with less discrimination to novel versus familiar objects in an exploratory field, that they spent less time in extra field exploration as well as in sniffing and looking behavior.

Experimental results utilizing animals other than rats seem to be more consistent than the above studies. Experiments using dogs have shown that deprivation results in an increase of exploratory behavior.

Thompson and Heron's⁸⁰ investigation of the effects of early restriction on the activity in dogs led to the conclusion that the term activity might be aptly replaced by the term exploratory behavior. In this study, twelve Scottish Terriers were reared under three degrees of restriction for the first seven to ten months of life. Upon testing at various ages in two experiments involving situations of varying complexity, the results seemed to justify the conclusion that the restricted dogs explored significantly more than the normal animals.

Hebb's discussion regarding the functioning of phase sequences seems particularly relevant to the above

80 W.R. Thompson and W. Heron, "The Effect of Early Restriction on Activity in Dogs", Journal of Comparative and Physiological Psychology, Vol. 47, 1954, p. 77-82.

studies. According to Hebb⁸¹, phase sequences are central determinants of behavior that consist of persistent, organized and directed cerebral activities. In accounting for an organism's tendency to seek a certain amount of variety and stimulation, he has proposed that, "...the phase sequence continually needs new input in order to maintain its organization and persistence."⁸²

New cell assembly combinations are continually necessary in order that the phase sequence and a normal level of excitability are maintained. As Solomon et al.⁸³ explained, the nature and patterning of stimulation is important. In the absence of varied stimulation, brain function becomes less efficient. In *Drives and the C.N.S. (Conceptual Nervous System)* Hebb states, "There is a great deal of behavior, in the higher animal especially, that is at the very best difficult to reduce to hunger, pain, sex, and the maternal drives plus learning."⁸⁴ In explaining

81 Hebb, 1949, Op. Cit., p. 222.

82 Hebb, 1949, Op. Cit., p. 227.

83 P. Solomon, P.E. Kubzansky, P.E. Leiderman, P.H. Mendelson, and D. Wexler (Eds.), Sensory Deprivation: A Symposium Held at Harvard Medical School, Cambridge, Mass., Harvard University Press, 1961, xviii-262 p.

84 D.O. Hebb, "Drives and the C.N.S. (Conceptual Nervous System)", Psychological Review, Vol. 62, 1955, p. 243-254.

the elicitation of behavior resulting from exteroceptive sources, Hebb and Thompson's⁸⁵ statement that an animal will always behave in such a way as to produce an optimal level of excitation seems especially pertinent. This has been supported by Leuba⁸⁶, who suggested that when organisms are over-stimulated they learn reactions which reduce stimulation to more moderate levels. In effect, organisms tend to learn those reactions which will produce an optimal level of total stimulation.

Perceptual deprivation is certainly a condition of decreased sensory input. The effects of such a decrease should lead to an attempt by the animals to increase the total amount of sensory stimulation. In terms of exploratory behavior the lack of consistency characterizing the results of previous investigations have been noted. As McCall et al. have stated,

An attempt to synthesize these diverse results is obviated by the total lack of uniformity in procedures, and thus a critical experiment awaits the refinement of the factors involved.⁸⁷

85 D.O. Hebb and W.R. Thompson, The Social Significance of Animal Studies, G. Lindzley (Ed.), Handbook of Social Psychology, Cambridge, Mass., Addison-Wesley, 1954, p. 532-561.

86 C. Leuba, "Toward Some Integration of Learning Theories: The Concept of Optimal Stimulation", Psychological Reports, Vol. 1, 1955, p. 27-33.

87 McCall et al., Op. Cit., p. 750.

The effect of perceptual deprivation on exploratory behavior should be an increase of exploratory behavior. If the notion of perceptual elaboration is used in explaining the nature of PS behavior, PS being aroused by a continually varying relationship between barriers and a food goal then the effects of perceptual deprivation on PS behavior should be an increase in PS behavior. Thus, the writer predicts that perceptual deprivation will increase both exploration and PS behavior, although the correlation between the two variables should be low.

4. Summary and Hypothesis.

This chapter has reviewed major studies designed to investigate PS behavior, exploratory behavior and the effects of perceptual deprivation on exploratory behavior. The writer's purpose in covering these topics has been to show the reasons for the present study, and to develop experimental hypotheses in terms of the literature reviewed.

The first section reviewed the major investigations into the area of PS behavior. The major studies delving into the nature of PS behavior as well as its quantitative measurement were discussed. A series of studies dealing with the area of exploratory behavior were reviewed in the second section of this chapter with the aim of acquainting the reader with the major studies that have attempted to

understand the nature of exploration.

The last section reviewed studies dealing with the effects of perceptual deprivation upon exploratory behavior. This last section has brought to light the general lack of consistency found in the literature with regard to the effects of perceptual deprivation on exploration.

No attempt has been made thus far to determine the effects of perceptual deprivation on PS behavior. The possible effects of perceptual deprivation on PS behavior is considered a topic worthy of investigation, in view of the wide spread agreement of the importance of early environment on later behavior. Similarly, the effects of perceptual deprivation on exploratory behavior requires a re-examination in an attempt at clarification.

In view of these studies, the major hypothesis of the present thesis is that the placement of animals in a perceptually deprived environment for a thirty day period will result in significant changes in both their PS behavior and exploratory behavior. Stated in the null form the hypotheses are as follows:

1. There will be no significant increase in PS behavior of rats after being placed in a perceptually deprived environment for a period of thirty days.
2. There will be no significant increase in exploratory behavior of rats after being placed in a perceptually deprived environment for a period of thirty days.

3. There will be no significant increase in PS behavior of rats after being maintained in their normal cages for a period of thirty days.
4. There will be no significant increase in exploratory behavior of rats after being maintained in their normal cages for a period of thirty days.
5. When the average change in PS behavior of rats kept in a perceptually deprived environment for thirty days is compared to the average change in PS behavior of rats kept in a normal environment for thirty days, there will be no significant difference between the two mean changes.
6. When the average change in exploratory behavior of rats kept in a perceptually deprived environment for thirty days is compared to the average change in exploratory behavior of rats kept in a normal environment for thirty days, there will be no significant difference between the two mean changes.
7. There will be no significant relationship between the pre-differential rearing scores of rats tested on PS and exploratory behavior.

Eight additional minor hypotheses may be tested by a further analysis of the data. Stated in the null form they are as follows:

8. When rats are divided into high and low groups according to their exploratory behavior and subsequently reared in a perceptually deprived environment for thirty days, the changes in exploratory scores of the two groups will not be significantly different.
9. When rats are divided into high and low groups according to their exploratory behavior and subsequently reared in a perceptually deprived environment for thirty days, the changes in PS scores of the two groups will not be significantly different.

10. When rats are divided into high and low groups according to their PS behavior and subsequently reared in a perceptually deprived environment for thirty days, the changes in PS scores of the two groups will not be significantly different.
11. When rats are divided into high and low groups according to their PS behavior and subsequently reared in a perceptually deprived environment for thirty days, the changes in exploratory scores of the groups will not be significantly different.
12. When rats are divided into high and low groups according to their exploratory behavior and subsequently maintained in a normal environment for thirty days, the changes in exploratory scores of the two groups will not be significantly different.
13. When rats are divided into high and low groups according to their exploratory behavior and subsequently maintained in a normal environment for thirty days, the changes in PS scores of the two groups will not be significantly different.
14. When rats are divided into high and low groups according to their PS behavior and subsequently maintained in a normal environment for thirty days, the changes in PS scores of the two groups will not be significantly different.
15. When rats are divided into high and low groups according to their PS behavior and subsequently maintained in a normal environment for thirty days, the changes in exploratory scores of the two groups will not be significantly different.

The chapters that follow present a discussion of the apparatus, methods, and results of the present study.

CHAPTER II

EXPERIMENTAL DESIGN

This chapter describes the experimental method used to test the hypotheses presented in the first chapter. The first and second sections describe the subjects and apparatus used. The third and fourth sections present the experimental procedure and the statistics employed in the analysis of the data.

1. The Sample.

The sample consisted of sixty naive male albino rats¹, of the Sprague-Dawley strain. They were obtained after weaning and were thirty days of age at the beginning of the experiment. Sprague-Dawley males were specifically chosen because of their ease of maintenance under laboratory conditions and low disease susceptibility. The fact that this species has been extensively used in other studies was also a consideration.

2. The Apparatus

In this section the apparatus employed in obtaining measures of exploratory behavior and PS behavior is

¹ The animals were obtained from Bio-Breeding Laboratories of Canada Limited, Ottawa, Ontario.

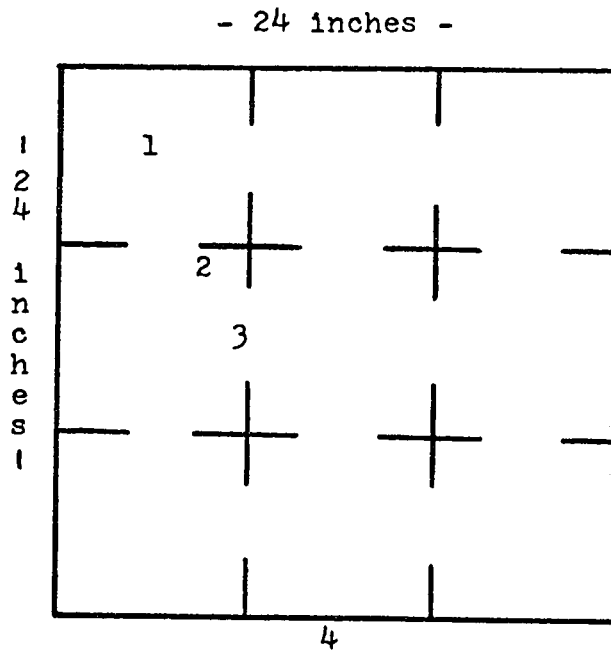
described. Following this, a description of the perceptually deprived and normal environments will be presented along with a description of the gentling stand which was used during the initial handling of the rats.

a) Exploration Maze - Exploratory behavior was measured using a maze described by Zimbardo and Montgomery², as shown in Figure 1. It consisted of a twenty-four inch square plywood base enclosed by twelve inch high walls, divided into nine equal compartments by twelve inch high partitions. All sections were interconnected by four inch openings between adjacent compartments. The top of the maze was open and the apparatus was painted flat grey.

b) Problem-Seeking Maze - A second maze was used to measure PS behavior, as previously described by Havelka.³ It is shown in Figure 2. It consisted of a six inch long by four inch wide start box which opened on to a forty inch long by twenty-three inch wide base all constructed out of plywood. It was open at the top and enclosed by twelve inch high walls. A cross-shaped barrier was made by attaching four, three and a half inch wide by twelve inch high plywood

2 P.G. Zimbardo and K.C. Montgomery, "The Relative Strengths of Consumatory Responses in Hunger, Thirst, and Exploratory Drive", Journal of Comparative and Physiological Psychology, Vol. 50, 1957, p. 505.

3 J. Havelka, "Problem-Seeking Behavior in Rats", Canadian Journal of Psychology, Vol. 10, 1956, p. 92.



Legend:

- 1. Eight inch square compartment.
- 2. Partitions.
- 3. Intercompartmental opening.
- 4. Outer wall.

Figure 1. - Exploration Maze.

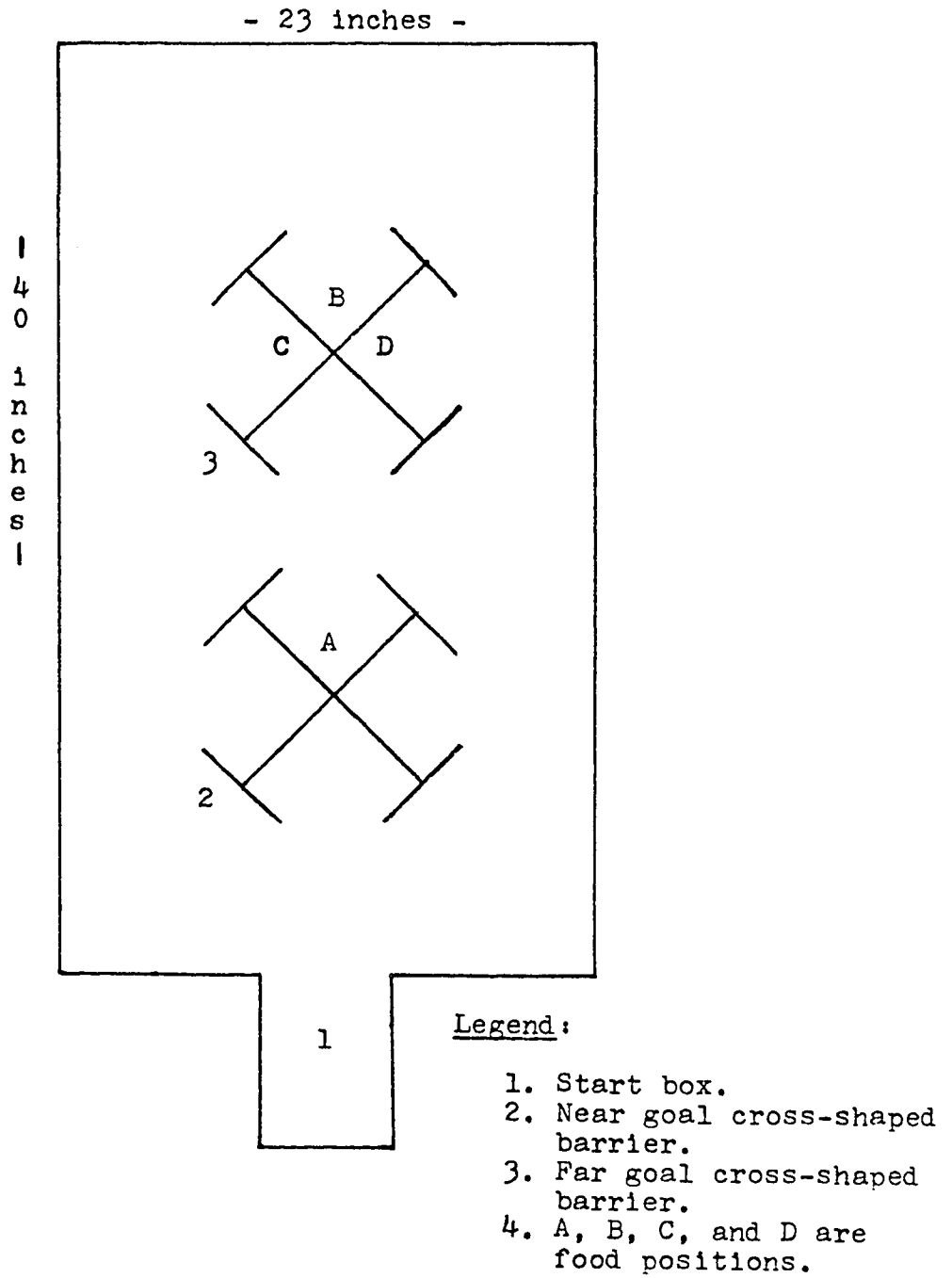


Figure 2. - Problem-Seeking Maze.

pieces together at right angles. Two of these barriers were placed in the maze, one located nine inches directly in front of the opening of the start box, the other, nine inches from the wall directly opposite the opening of the start box. These two barriers, one near and one further from the start box created eight potential sections in which food could be placed. The dimensions of an individual section was three and a half inches deep by three and a half inches wide. This maze, as well, was painted flat grey.

c) Gentling Stand - The PS maze positioned vertically with the start box up was the gentling stand. It was forty inches high. A rat was placed on a section located adjacent to the start box measuring nine and a half by twelve inches. This too was painted flat grey.

d) Differential Environments - As mentioned in the first chapter, two different environments were used in the present study; a perceptually deprived and a normal environment.

The perceptually deprived environment consisted of thirty individual cages, nine inches long, six inches wide, and six inches high. Each cage was made up of three galvanized steel sides with a wire mesh front and bottom. All cages were mounted on a five-tiered portable rack which was

placed two feet from one of the walls in the fifteen by fourteen foot room. Top vision was obstructed due to the tiered arrangement of the cages and the view from the front was made patternless by stapling a plain white sheet to the wall in front of the cages. This arrangement did not interfere with the passage of adequate ventilation or light. The room was illuminated by a sixty watt bulb and extraneous noise was masked by the constant hum of an electric fan. The animals were fed water and food in dry mash form. This environment fulfills the requirement for perceptual deprivation of most authors including Krech et al.⁴

e) Normal Environment - The normal environment was the environment in which all the animals were housed prior to the period of differential environment. Those animals which were not placed in a perceptually deprived situation remained in the normal environment, which consisted of thirty individual cages, ten inches long by eight inches wide by eight inches high. The cages were constructed using three galvanized steel sides with a wire mesh front and bottom and were mounted on a five-tiered portable rack. The animals were allowed to experience the usual visual and auditory stimuli ongoing in the laboratory. Water and food

⁴ D. Krech, M.R. Rosenzweig and E.L. Bennett, "Effects of Environmental Complexity and Training on Brain Chemistry", Journal of Comparative and Physiological Psychology, Vol. 53, 1960, p. 509-519.

in cube form was available on an ad libitum basis. The animals were housed in a fifteen foot by twenty-five foot room lit by nine fluorescent fixtures giving off an average illumination of thirty-five foot candles.

During the period of perceptual deprivation, the animals in both environments were not handled or removed from their cages, even during the once weekly cleaning of the dropping pans. Both environments were kept between seventy-five and eighty degrees Fahrenheit, and all animals were maintained on a twelve hour light-dark schedule by electric timers.

3. Experimental Procedure.

The object of the present thesis was to determine the effects of perceptual deprivation on PS and exploratory behavior of albino rats. A three-phase experimental procedure was used to accomplish this aim. In phase one, pre-experimental measures were obtained from all subjects of their exploratory and PS behavior. During the experimental phase, (phase two), the animals were divided and housed as two separate groups, one in a perceptually deprived environment, the other, in a normal environment. Phase three consisted of post-testing of all animals from both groups on both the exploratory and PS measures.

The rats were twenty-seven days old upon receipt. They were immediately individually caged in the normal environment and allowed water and food cubes ad libitum. The experiment proper began when the rats reached thirty days of age.

a) Gentling - The first step was a gentling procedure the purpose of which was to tame the animals. This was necessary as the rats were subsequently going to be picked up often during phases one and three of the experiment. Gentling tends to reduce the anxiety level of the animals and, therefore, allows for ease of handling.

The gentling procedure involved taking a rat from its cage and holding it in the left hand which was placed against the writer's chest. With the index and middle fingers of the right hand, the animal was gently stroked from head to tail for four minutes. It was then set on the gentling stand and continued to be stroked for a further minute before being returned to its cage. This method of gentling is similar to that of Weininger⁵ and of Morgenson.⁶

⁵ O. Weininger, "Mortality of Albino Rats Under Stress as a Function of Early Handling", Canadian Journal of Psychology, Vol. 7, 1953, p. 111-114.

⁶ G.J. Morgenson, G.A. McMurray and L.B. Jaques, "Effects of Stress and Administration of Cortisone on Weight Gain in Gentled Rats", Canadian Journal of Psychology, Vol. 11, 1957, p. 123-127.

One hour after gentling on the third day of the experiment, a twenty-three hour food deprivation schedule was substituted for the ad libitum feeding. In this schedule, access to food was permitted for one hour immediately following each day's trials, and this remained in effect throughout both the pre and post-testing sessions. Water was always available to all the animals.

b) Measurement of Exploratory Behavior - The measurement of exploratory behavior took place on days seven and eight. Zimbardo and Montgomery's⁷ procedure was followed which entailed putting a rat in the centre unit of the exploratory maze and allowing it to move about freely for exactly five minutes. The animal, therefore, had free access to all nine compartments of the maze. The number of full-bodied maze units entered (the entire body excluding the tail), was counted and the exploratory score was, thus, the total number of units entered in a period of ten minutes.

c) Problem-Seeking Maze Adaptation Procedure - Days nine to eighteen constituted a pre-test adaptation period in the PS maze. During this time the rats were placed individually either in the start box, or in one of the four corners of the maze, at random, and allowed five minutes of free exploration. A tray containing food cubes in wet mash

⁷ Zimbardo and Montgomery, Op. Cit., p. 504-508.

form could be found in one of the four sections of each cross barrier. In the near goal the food was always placed in position A. In the far goal it was randomly located in one of positions B, C, or D. (see Figure 2).

When a rat found the food in a fixed location it was allowed to eat for three seconds, sub-verbally timed by the experimenter, after which it was picked up with the writer's right hand and replaced in one of the positions aforementioned. After locating the food and eating for three seconds in the far, variable goal, the animal was also picked up and replaced in one of the positions aforementioned with the writer's right hand. In the latter situation, however, the food location was simultaneously being changed by the writer's left hand. At the end of five minutes, the rat was returned to its cage where it was allowed one hour of feeding time.

d) Measurement of Problem-Seeking Behavior - The measurement of PS behavior began on the nineteenth day and continued daily up to and including the twenty-eighth day of the experiment. Each animal was taken from its cage and placed in the start box of the PS maze. Its movement from the start box to one of the food locations constituted a trial, and ten consecutive choice trials were given daily. As in the adaptation procedure, the food locations consisted of the near goal being fixed, the far one varied at

random from trial to trial. Three seconds of eating time was allowed between trials.

PS behavior, therefore, is that behavior a rat exhibits, such that, when on a twenty-three hour food deprivation schedule and offered two routes to food, one variable and longer, the other fixed and shorter, it chooses the former. A PS score is, thus, the number of times the rat chooses the longer variable goal out of a total of one hundred trials. This procedure is a modification of Havelka's⁸ original method of quantifying PS behavior.

e) Differential Environments - On the morning of the twenty-ninth day the rats were divided into two equal groups. One group was placed in the perceptually deprived environment, the other remained in the normal environment. The nature of the perceptually deprived environment necessitated that these animals be moved to a separate room. An attempt was made to counterbalance the effects of this change by moving the other rats, that is, those that remained in the normal environment, into different cages and situating them in another position in the testing laboratory.

Animals were paired on the basis of having similar PS scores. Following the initial pairing, a coin was tossed to determine the environment in which the rat would be

⁸ Havelka, Op. Cit., p. 91-97.

placed.

f) Post-Testing - After thirty days in differential environments all the rats were returned to their original cages. Beginning on day fifty-nine the procedures for measuring exploratory behavior and PS behavior were repeated.

4. Statistical Analysis

To determine the degree of the relationship between PS behavior and exploratory behavior, the Pearson Product Moment Correlation Coefficient was used as suggested by Dayhaw.⁹ The formula is:

$$r_{xy} = \frac{N\sum XY - \sum X \sum Y}{\sqrt{N\sum X^2 - (\sum X)^2} \sqrt{N\sum Y^2 - (\sum Y)^2}}$$

The correlation coefficient obtained was tested for linearity as suggested by Dayhaw.¹⁰

In regard to hypotheses one to four inclusive, since both measures are taken from the same animals, a t-test for the significance of the difference between two means from

⁹ L.T. Dayhaw, Manuel de Statistique, L'Éditions de l'Université D'Ottawa, 1966, p. 126.

¹⁰ Dayhaw, Op. Cit., p. 173

non-independent small samples was used as the test of significance, as suggested by Dayhaw.¹¹ The formula is:

$$t = \frac{Md}{\sqrt{\frac{\sum(D - Md)^2}{N(N - 1)}}$$

This same formula was used to test hypotheses eight through fifteen.

For hypotheses five and six, the data was drawn from two different groups of rats and, hence, a t-test for the difference between independent means was used as the test of significance, as suggested by Dayhaw.¹² The formula is:

$$t = \frac{M_1 - M_2}{\sqrt{\left(\frac{\sum x_1^2 + \sum x_2^2}{N_1 + N_2 - 2}\right) \left(\frac{N_1 + N_2}{N_1 N_2}\right)}}$$

11 Dayhaw, Op. Cit., p. 364.

12 Dayhaw, Op. Cit., p. 361.

It was the purpose of this chapter to describe the subjects and apparatus used in the present study and to present a detailed description of the experimental procedure as well as the method by which the data was analyzed. The results of the study will be presented and discussed in the third and final chapter.

CHAPTER III

PRESENTATION AND DISCUSSION OF RESULTS

This is the final chapter, devoted to the presentation and discussion of the results of this experiment. During the discussion, an effort will be made to point out the implications of the present study in terms of further research in this area.

1. Results of the Tests of Significance.

In this section, the results obtained will be presented with reference to the hypotheses stated in Chapter I.

Hypotheses one through four inclusive state that there will be no significant increase in exploratory or PS behavior of rats after being placed in a perceptually deprived environment or maintained in a normal environment for a period of thirty days. These results are presented in Table I, from which it can be observed that in the perceptually deprived group, both PS and exploratory behavior significantly increased. Hypotheses one and two are therefore rejected. In the normal environment the rats' exploratory behavior significantly increased, although their PS behavior did not. Based on these findings the writer rejects hypothesis three but is unable to reject the fourth

Table I.-

Comparison of Pre-Test and Post-Test Exploration and PS Scores Obtained from Rats Reared in Perceptually Deprived and Normal Environments for Thirty Days.

| Group | Behavior | Pre-Test Mean ^a | Post-Test Mean ^b | Diff. | t | Significance |
|------------|-----------|----------------------------|-----------------------------|-------|-------|--------------|
| Perc. Dep. | Explor. | 124.40 | 154.67 | 30.27 | 3.91 | .001 |
| | <u>PS</u> | 38.97 | 44.00 | 5.03 | 2.26 | .05 |
| Normal | Explor. | 112.27 | 133.93 | 21.66 | 2.46 | .05 |
| | <u>PS</u> | 40.20 | 32.00 | -8.20 | -2.94 | n.s. |

a The means represent the average number of full bodied maze units entered in ten minutes prior to differential rearing in the case of exploration. For PS they represent the average number of times the variable food goal was chosen out of one hundred trials prior to differential rearing.

b The means represent similar measurements (as in a), however, they were calculated post differential rearing.

hypothesis.

Hypothesis five and six compared the perceptually deprived and normally reared animals with respect to the groups relative change in PS and exploratory behaviors during the thirty day period of differential rearing.

Hypothesis five compared the average change in PS behavior of rats kept in a perceptually deprived environment for thirty days with the average change in PS behavior maintained in a normal environment for thirty days. The t-test for the difference between independent means was used as the test for significance and as can be seen in Table II, the t-test yielded a value which is significant beyond the .001 level of probability and permits rejection of the null hypothesis.

Hypothesis six compared the average change in exploratory behavior of rats kept in a perceptually deprived environment for thirty days with the average change in exploratory behavior of rats kept in a normal environment for thirty days. These results are also presented in Table II. The t-test, similar to that used in testing hypothesis five failed to reach a statistically significant value.

Hypothesis seven states that there will be no significant relationship between the pre-differential rearing scores of rats tested on PS and exploratory behavior. A positive Pearson Product Moment Correlation Co-efficient

Table II.-

Comparison of Mean Change Scores of Exploratory and PS Behavior of Rats Reared in Perceptually Deprived and Normal Environments for Thirty Days.

| Behavior | Perc. Dep. Environment Mean Change | Normal Environment Mean Change | Diff. | t | Significance |
|-----------|---------------------------------------|-----------------------------------|-------|------|--------------|
| <u>PS</u> | 5.03 | -8.20 | 13.23 | 7.47 | .001 |
| Explor. | 30.27 | 21.66 | 8.61 | 1.49 | n.s. |

of .405 was obtained, significant at the 0.01 level of probability ($F=11.389 < 0.01$). Because of the possibility of a non-linear relationship, it was decided to do a test of linearity. Using exploration as criterion, a non-significant η value of 0.552 was obtained. The test of linearity ($F_{lin.}=0.20$) was not statistically significant, thereby indicating that the relationship between PS and exploratory behavior is not significantly non-linear. The Pearson r value is thereby accepted as a meaningful statistic.

Hypotheses eight through eleven inclusive compared changes in the PS and exploratory scores of animals that had previously been divided into high and low groups according to their pre-test PS or exploratory scores respectively, and then reared in a perceptually deprived environment for thirty days. The results are shown in Table III, and show no significant differences. Thus, the four hypotheses as stated cannot be rejected.

Finally, hypotheses twelve through fifteen compare changes in PS and exploratory behavior of rats maintained in a normal environment for thirty days, when the animals had been divided into high and low groups according to either their PS or exploratory scores.

These results are presented in Table IV, from which it can be observed that, when the animals were divided according to their exploratory behavior, comparison of mean

Table III.-

Comparison of Mean Changes in Exploratory and PS Scores of Rats Reared in a Perceptually Deprived Environment for Thirty Days when the animals have been Divided into High and Low Groups According to their Pre-Test Exploratory or PS Scores.

| Pre-Test Behaviors | Change Behaviors | Low Group Mean Change | High Group Mean Change | Diff. | t | Significance |
|--------------------|------------------|-----------------------|------------------------|-------|------|--------------|
| Explor. | Explor. | 33.33 | 30.00 | 3.33 | 0.22 | n.s. |
| Explor. | <u>PS</u> | 7.13 | 2.93 | 4.20 | 0.94 | n.s. |
| <u>PS</u> | <u>PS</u> | 5.13 | 4.93 | 0.20 | 0.04 | n.s. |
| <u>PS</u> | Explor. | 26.93 | 36.40 | 9.47 | 0.63 | n.s. |

Table IV.-

Comparison of Mean Changes in Exploratory and PS Scores of Rats Maintained in a Normal Environment for Thirty Days when the Animals have been Divided into High and Low Groups According to their Pre-Test Exploratory or PS Scores.

| Pre-Test Behaviors | Change Behaviors | Low Group Mean Change | High Group Mean Change | Diff. | t | Significance |
|--------------------|------------------|-----------------------|------------------------|-------|------|--------------|
| Explor. | Explor. | 53.33 | -9.73 | 63.06 | 4.73 | .001 |
| Explor. | <u>PS</u> | -7.00 | -9.40 | 2.40 | 0.42 | n.s. |
| <u>PS</u> | <u>PS</u> | -2.00 | -14.40 | 12.40 | 2.39 | .05 |
| <u>PS</u> | Explor. | 31.66 | 12.00 | 19.66 | 1.12 | n.s. |

scores of post-differential rearing exploratory behavior obtained by the low and high groups yielded a t value which is significant beyond the .001 level of probability. Similarly when the animals were divided into high and low groups according to their PS behavior and subsequently tested on their post-differential rearing PS scores the means of the high and low groups differed significantly, beyond the .05 level of probability.

Dividing the animals according to their exploratory scores and comparing their corresponding post-differential rearing PS behavior and vice versa, dividing the animals according to their PS scores into high and low groups and testing their corresponding post-differential rearing exploratory behavior led in both cases to non-significant results.

2. Discussion of Results

The results obtained from the analysis of the data indicate that perceptual deprivation has measurable effects on both PS and exploratory behavior. Following thirty days in a perceptually deprived environment, the animals exhibited a significant increase in both exploratory and PS behavior.

The concept of optimal stimulation seems relevant in explaining the animals' increase in PS and exploratory

behavior as a result of perceptual deprivation. Hebb¹, Cooper and Zubek², Leuba³, Fiske and Maddi⁴ as well as Fowler⁵ have elaborated on this concept. The concept of optimal stimulation proposes that an organism tends to learn reactions which produce an optimal level of total stimulation. The organism acquires those reactions which, when overall stimulation is low, are accompanied by increasing stimulation. On the other hand, when the overall stimulation is high, the animal acquires those reactions which are accompanied by decreasing stimulation.

1 D.O. Hebb, "Drives and the C.N.S. (Conceptual Nervous System)", Psychological Review, Vol. 62, 1955, p. 243-254.

2 R.M. Cooper and J.P. Zubek, "Effects of Enriched and Restricted Early Environment on the Learning Ability of Bright and Dull Rats", Canadian Journal of Psychology, Vol. 12, 1958, p. 159-164.

3 C. Leuba, "Towards Some Integration of Learning Theories: The Concept of Optimal Stimulation", Psychological Reports, Vol. 1, 1955, p. 27-33.

4 D.W. Fiske and S.R. Maddi, Functions of Varied Experience, 1961, The Dorsey Press Inc., Homewood, Illinois, v-501 p.

5 H. Fowler, "Satiation and Curiosity: Constructs for a Drive and Incentive-Motivational Theory of Exploration", The Psychology of Learning and Motivation, Advances in Research and Theory, K.W. Spence and Janet Taylor Spence (Eds.) Vol. 1, 1967, Academic Press, New York, v-381 p.

Sackett et al.⁶ have recently postulated that an organism's need for perceptual experience may involve biological processes as basic as the classical primary biological needs. Early perceptual deprivation may have persistent effects on later behavior in the form of a strong motive to respond to complex stimulation throughout the organism's life. The authors further proposed that the need to maintain an optimal stimulus input may be as basic a requirement as that of primary drive satisfaction.

The writer has interpreted his findings of an increase in the PS and exploratory behavior of his subjects due to perceptual deprivation in the context of optimal level of stimulation as proposed by Hebb⁷ and others. From the more basic neurophysiological viewpoint, the writer's findings are compatible with those of Lindsley⁸ and Moruzzi

6 G.P. Sackett, P. Keith-Lee, and R. Treat, "Food Versus Perceptual Complexity as Rewards for Rats Previously Subjects to Sensory Deprivation", Science, Vol. 141, 1963, p. 518-520.

7 Hebb, Op. Cit., p. 243-254.

8 D.E. Lindsley, "Common Factors in Sensory Deprivation, Sensory Distortion and Sensory Overload", Sensory Deprivation: A Symposium Held at Harvard Medical School, Cambridge, Harvard University Press, 1961, Solomon et al. (Eds.), p.174-194.

and Magoun.⁹ Lindsley¹⁰ has explained this concept with regard to the diffuse projection system of the brain stem, specifically the ascending reticular activating system (ARAS). This was shown by Moruzzi and Magoun¹¹ to be an arousal system, the activity of which makes organized cortical activity possible. Lindsley¹² stated that the reticular activating system along with the diffuse thalamo-cortical projection system provides a mechanism capable of general arousal as well as an alerting and specific attentional mechanism. Linked with this system is also a cortico-thalamic mechanism, the two systems permitting continual monitoring and regulation of all sensory input. He continues to state that the reticular formation may be a barometer like system for both input and output level of stimuli, the structure serving as a sort of homeostat regulating or adjusting input-output relations. It seems likely that these systems have an adaptation level, such that if basal input level is low, the organism will compensate by seeking increased input and conversely, if basal input level

9 G. Moruzzi and H.W. Magoun, "Brain Stem Reticular Formation and Activation of the EEG", EEG and Clinical Neurophysiology, Vol. 1, 1949, p. 455-473.

10 Lindsley, Op. Cit., p. 174-194.

11 Moruzzi and Magoun, Op. Cit., p. 455-473.

12 Lindsley, Op. Cit., p. 174-194.

is high the organism will compensate by seeking diminished input.

Continuing at the neurophysiological level, Hebb¹³ assumed that cortical synaptic function is facilitated by diffuse bombardment of this arousal system. When this is low, an increase will tend to strengthen or maintain the concurrent cortical activity. When arousal is low, responses producing increased stimulation and hence, greater arousal will tend to be repeated. If incoming stimulation is excessive, the opposite would prevail and the animal would so act as to cut down the level of incoming stimuli. Thus, there will be an optimal level for all effective behavior.

Havelka's¹⁴ notion of perceptual elaboration was based on Hebb's¹⁵ early work. Perceptual elaboration, as mentioned previously, refers to the capacity and tendency to develop organized systems of cerebral activity in the course of repeated commerce with the environment. This cerebral activity in turn constitutes determinants of behavior. It seems reasonable to propose that different rats

13 Hebb, Op. Cit., p. 243-254.

14 J. Havelka, "On the Motivation of the Rat in Problem Solving", unpublished masters thesis presented to the Graduate Faculty of McGill University, Montreal, 1954, 1-28 p.

15 D.O. Hebb, The Organization of Behavior, John Wiley and Sons Inc., New York, 1949, xix-335 p.

come to the environmental situation with different dispositions to seek perceptual elaboration. The differing dispositions to seek perceptual elaboration may be explainable in terms of adaptation level which is dependent on the individual animals need for a certain degree of incoming stimuli. Each animal attempts to maintain its own idiosyncratic level of arousal.

The functioning of the reticular activating system, together with the diffuse thalamo-cortical projection system and cortico-thalamic downward tracts in addition to the concept of optimal stimulation requirements at the individual level may be an adequate explanation for both PS and exploratory behavior. The widespread acceptability of the fact that animals respond to novelty by exploration and seek a certain degree of variability in their behavioral functioning may be answerable by the above concept. However, although both behaviors are affected in a similar manner by perceptual deprivation, it does not necessarily mean that they are identical as the writer tends to agree with Havelka's explanation for the differences between the two behaviors. Both seem to be dependent on perceptual elaboration and are affected in similar ways by perceptual deprivation. Exploration is dependent on novelty in the external environment and when this is unchanging the animal will eventually adapt and the behavior diminishes finally

ceasing altogether. PS behavior on the other hand seems to result from a continually varying relationship, in this case between barriers and a food goal. The rat does not adapt to this kind of changing pattern.

The difference between PS and exploratory behavior is substantiated by the fact that the correlation between the two behaviors although significant was found to be rather low. This also is compatible with Havelka's findings, and the explanation that exploration seems to be a reaction to fixed sets of novel stimuli in the absence of specific goals, while PS behavior involves a reaction to a variable means as related to a specific goal seems to be meaningful. The variable goal seems to constitute a continuing problem for the rat because the means to the food remains unpredictable between trials.

The rejection of hypothesis four which stated that no significant increase in exploratory behavior would result after maintenance in normal cages for a period of thirty days is an interesting finding. It might be that maintenance in normal cages is in itself somewhat restrictive in terms of exploration, but not so in terms of PS behavior. It is true that during the thirty days of differential rearing there was little activity in the normal environment. Only the writer had access to the laboratory, animals were not handled, and no other experiments were ongoing. Still,

why exploratory behavior increased significantly remains rather obscure, requiring further research.

The comparison between perceptually deprived environment and normal environment in regard to mean changes in both PS and exploratory behavior led to a significant result beyond the .001 level of probability in PS but not in exploratory behavior. The trend in exploration, however, was in the same direction and this as well as the fact that exploration significantly increased in the normal environment may indicate that perceptual deprivation has differential effects on the two behaviors although perhaps in the same direction in both. A longer period of perceptual deprivation may be required to obtain unequivocal results in regard to exploration.

High and low scoring animals in both exploratory and PS behavior do not seem to be differentially affected by perceptual deprivation. Maintenance in the normal environment seems to lead to different conclusions. When animals were divided into high and low groups according to their exploratory behavior and also according to their PS behavior and subsequently tested on their post-differential exploratory and PS behaviors respectively, significant results were obtained. The perceptually deprived environment may have a homogenizing effect in these cases, an effect that does not occur when the animals are maintained

in their normal environment. This might tend to eliminate differential changes when the animals are reared in the perceptually deprived situation, however, further research is required to determine specific causation.

Jones¹⁶, in summarizing human and animal studies in the area of sensory deprivation relate that they both seem to share a similar basic motivational assumption; that is, that a lack of variability in the external environment motivates both humans and animals to respond in order to increase variability. The literature is replete with substantiations of this hypothesis at the human level.

Smith et al.¹⁷ experimentally assessed differences in stimulation seeking in sensory deprived versus control subjects at the human level and concluded that one of the profound aspects of boredom and monotony seems to lead to an effort by the subjects to seek a return to a homeostatic like balance of stimulus variability. Leckart et al.¹⁸ and

16 A. Jones, "Stimulus Seeking Behavior", Sensory Deprivation: Fifteen Years of Research, J.P. Zubek (Ed.), Appleton-Century Crofts, New York, 1969, ix-522 p.

17 S. Smith, T.A. Myers and E. Johnson III, "Stimulation Seeking as a Function of Duration and Extent of Sensory Deprivation", Proceedings, 1968, 76th Annual Convention, A.P.A.

18 B.T. Leckart, J.R. Levine, C. Goscinski and W. Brayman, "Duration of Attention: The Perceptual Deprivation Effect", Perception and Psychophysics, 1970, Vol. 7, p. 163-164.

Garlington and Shimota¹⁹ further support this hypothesis at the human level. Supportive evidence has also been found at the level of the primate by Isaac²⁰ and Fox.²¹

It appears likely that the concept of optimal stimulation will provide a meaningful conceptual basis for further research. This may be basic to the explanation of all the various hypothesized drives that have been so heavily researched over the past three decades. Exploration, the complexity drive, curiosity and boredom drives, manipulation drives, stimulation seeking, activity seeking, and PS may all be explainable via the concept of the organisms attempt at maintenance of an idiosyncratic optimal level of stimulation.

Optimal level requirements are probably constitutionally based, although capable of influence by physiological factors, age and experience. In addition, they fluctuate widely and continually over time. Much further research is required to determine arousal requirements in any one animal.

19 W.G. Garlington and H.E. Shimota, "The Change Seeker Index: A Measure of the Need for Variable Stimulus Input", Psychological Reports, Vol. 14, 1964, p. 919-924.

20 W. Isaac, "Evidence For a Sensory Drive in Monkeys", Psychological Reports, Vol. 11, 1962, p. 175-181.

21 S.S. Fox, "Self-Maintained Sensory Input and Sensory Deprivation in Monkeys: A Behavioral and Neuropharmacological Study", Journal of Comparative and Physiological Psychology, Vol. 55, 1962, p. 438-441.

Perhaps longitudinal neurophysiological studies utilizing young animals may more firmly establish the nature of the concept of optimal stimulation. Certainly it is an interesting area worthy of much further research.

SUMMARY AND CONCLUSIONS

This investigation was designed to assess the effects of perceptually deprived environmental experience on problem-seeking behavior of albino rats. In addition, the validity of the differentiation made between problem-seeking and exploratory behavior as well as the relationship between perceptual deprivation and exploratory behavior was studied.

Seven main hypotheses and eight secondary hypotheses were tested. The first four hypotheses stated that there will be no significant increase in problem-seeking or exploratory behavior of rats after being placed in a perceptually deprived environment or maintained in a normal environment for a period of thirty days. The t-test for non-independent small samples was used as the statistical test of significance. The results indicated that perceptual deprivation leads to a significant increase in both problem-seeking and exploratory behavior. In the normal environment, however, exploration significantly increased while problem-seeking behavior did not.

Hypotheses five and six compared the perceptually deprived and normally reared animals with respect to their relative change in problem-seeking and exploratory behaviors during the thirty day period of differential rearing, that is, rearing in perceptually deprived versus normal

environments. The t-test for the difference between independent means was used as the statistical test in both hypotheses, and significant results were obtained for problem-seeking but not in the case of exploration.

The relationship between problem-seeking and exploratory behavior was investigated in hypothesis seven, using the Pearson Product Moment Correlation Co-efficient. A significant but low correlation was found indicating that the two behaviors do share common elements. The writer concluded, however, that the size of the correlation warrants the study of problem-seeking and exploration as distinct behaviors.

Hypotheses eight through fifteen compared problem-seeking and exploratory scores of animals that had previously been divided into high and low groups according to either their problem-seeking or exploratory scores and then reared in a perceptually deprived or normal environment. The statistical tests used were t-tests for non-independent small samples and non-significant results were obtained in all but two cases. When the animals were divided into high and low groups according to their exploratory behavior, a comparison of subsequent post-differential rearing exploratory mean scores yielded a significant result. A similar conclusion was obtained by dividing the scores according to problem-seeking behavior and comparing post-differential

rearing problem-seeking mean scores. In both of the latter cases the comparison of change took place from scores of animals that were maintained in the normal environment.

The results were explained in terms of the concept of optimal level of stimulation and a neurophysiological explanation was put forth. Implications for further research were suggested.

BIBLIOGRAPHY

Berlyne, D.E., "The Arousal and Satiation of Perceptual Curiosity in the Rat", Journal of Comparative and Physiological Psychology, Vol. 48, 1955, p. 238-246.

In this article animals are shown to prefer complex rather than more simple environments. The author found that rats spend more time investigating that part of a maze which provided complex stimuli as well as the novel rather than the familiar stimuli. It is concluded that curiosity is aroused primarily by short term novelty.

Bingham, W.E. and W.J. Griffiths Jr., "The Effect of Different Environments During Infancy on Adult Behavior in the Rat", Journal of Comparative and Physiological Psychology, Vol. 45, 1952, p. 307-312.

This study was based on Hebb's original findings. It investigates the behavior of enriched and deprived rats and concludes that the former are superior in maze performance, but the two groups do not differ in terms of emotionality or ability to solve brightness discrimination tasks.

Brown, R.T., "Early Experience and Problem-Solving Ability", Journal of Comparative and Physiological Psychology, Vol. 65, 1968, p. 433-440.

Four differentially reared groups of rats were given three exploration tests and on the basis of results obtained the author concludes that rearing condition does not affect amount of exploration. The superior performance of the three enriched groups on the Hebb-Williams Maze is considered due to their greater use of extrafield cues.

Butler, R.A., "Discrimination Learning by Rhesus Monkeys to Visual Exploration Motivation", Journal of Comparative and Physiological Psychology, Vol. 46, 1953, p. 95-98.

An important early study using Rhesus monkeys given a discrimination task with no incentive for performance other than exploration. On the basis of results the author hypothesized an independent exploration drive not derived from or conditioned upon other motives or drives. This supports other studies determining that exploration results from novelty or changes in the external environment.

Chapman, R.M. and N. Levy, "Hunger Drive and Reinforcing Effect of Novel Stimuli", Journal of Comparative and Physiological Psychology, Vol. 50, 1957, p. 233-238.

This article presents supporting evidence that animals will learn to respond for change of stimulation. The authors found that visual changes in a goal box of a straight alley or runway results in an increase of a rats running speed.

Dashiell, J.P., "A Quantitative Demonstration of Animal Drive", Journal of Comparative Psychology, Vol. 5, 1925, p. 205-208.

An important forerunner of exploration research, the author, while studying the principles of drive, noted that hungry rats explore strange surroundings prior to eating.

Forgays, D.G. and J.W. Forgays, "The Nature of the Effect of Free-Environment Experience in the Rat", Journal of Comparative and Physiological Psychology, Vol. 45, 1952, p. 322-328.

In this extension of an earlier experiment by Hymovitch, the authors find that free environmentally raised rats are superior problem-solvers to rats raised in an impoverished environment.

Harlow, H.F., "Learning and Satiation of Response in Intrinsically Motivated Complex Puzzle Performance by Monkeys", Journal of Comparative and Physiological Psychology, Vol. 43, 1950, p. 289-294.

This investigation using two Rhesus monkeys each given sixty, two hour sessions with a mechanical puzzle leads to the conclusion that the animals respond to kinesthetic stimulation with exploration. The manipulation of the puzzles decreased over time supporting the contention that as novelty decreases, exploration decreases not only in rats but in other species as well.

Havelka, J., "Problem Seeking Behavior in Rats", Canadian Journal of Psychology, Vol. 10, 1956, p. 91-97.

This study and the thesis by the same author gave impetus to the present investigation and are, therefore, the two most important references. The author designed an experiment to study the rats tendency to seek novel stimuli. Using fifty naive Hooded rats tested in three mazes, two for problem-seeking and one for exploration, the author concluded that the rats could be divided into groups of problem-seeking, non-problem-seeking and those showing neither tendency. In addition problem-seeking and exploration are found to be different and distinct behaviors. The results are explained mainly in terms of Hebb's theory.

Other possible explanations are also put forth.

Hebb, D.O., The Organization of Behavior, John Wiley and Sons Inc., New York, 1949, xix-335 p.

The relevant sections of this book contains Hebb's stimulus deprivation theory proposing that differential early perceptual experience is an important determinant in later problem-solving ability. In addition the author sets forth his neurophysiological explanations for organized behavior.

-----, "The Effects of Early Experience on Problem-Solving at Maturity", American Psychologist, Vol. 2, 1957, p. 306-307.

In this early study, Hebb compares laboratory rats with pet rats and also investigates the effects on subsequent behavior of blinding the animals at different ages. He finds that pet animals and those blinded later in their development, therefore receiving more perceptual experience in early life are superior learners as tested on the Hebb-Williams Maze.

-----, "Drives and the C.N.S. (Conceptual Nervous System)", Psychological Review, Vol. 62, 1955, p. 243-254.

In this important early article Hebb examines the concept of motivation as it relates to the conceptual nervous system pre-1930, in the 1940's and more recently. The different conceptions are related neurophysiologically and the concept of optimal stimulation is presented.

Hebb, D.O. and H. Mahut, "Motivation et Recherche du Changement Perceptif Chez Le Rat et Chez l'Homme", Journal de Psychologie Normale et Pathologique, Vol. 52, 1955, p. 209-221.

In this experiment the authors are concerned with the rats' motivation in problem-solving. The findings indicate that problem-solving by rats is not only tied to motivation by food need but problem-seeking for its own sake is also a factor. The results are discussed with reference to the importance of perceptual factors for optimal reticular formation functioning.

Kish, G.B. and J.J. Antonitis, "Unconditioned Operant Behavior in Two Homozygous Strains of Mice", Journal of Genetic Psychology, Vol. 88, 1956, p. 121-124.

Using mice, these authors demonstrate that animals will learn to perform for exploratory rewards other than changes in visual stimulation. In this case, bar-pressing

responses were able to be reinforced by microswitch clicks and other noises.

Kivy, P.N., R.W. Earl and E.L. Walker, "Stimulus Context and Satiation", Journal of Comparative and Physiological Psychology, Vol. 49, 1956, p. 90-93.

The authors in this study show that animals respond to novel stimuli. Twelve albino rats reliably chose to enter the changed or novel part of a T maze and avoid the section previously explored.

Krechevsky, T., "Brain Mechanism and Variability", Journal of Comparative Psychology, Vol. 23, 1937, p. 139-163.

The author studied eighty-one rats both operated and normal, attempting to determine the effects of cortical lesions upon variability of behavior where no learning was required. One of the conclusions arrived at is that variability of behavior is a basic characteristic of a normal animal.

Leckart, B.T., J.R. Levine, C. Goscinski and W. Brayman, "Duration of Attention: The Perceptual Deprivation Effect", Perception and Psychophysics, Vol. 7, 1970, p. 163-164.

In this important article the authors investigated the relationship between perceptual deprivation and duration of attention. Using thirty-one college students, the results are interpreted in terms of perceptual deprivation leading to a need for stimulation.

Leuba, C., "Towards Some Integration of Learning Theories: The Concept of Optimal Stimulation", Psychological Reports, Vol. 1, 1955, p. 27-33.

The author presents an outline of the concept of optimal stimulation. Observational and experimental evidence are presented to support the concept.

Lindsley, D.E., "Common Factors in Sensory Deprivation, Sensory Distortion and Sensory Overload", Sensory Deprivation: A Symposium Held at Harvard Medical School, Cambridge, Harvard University Press, 1961, Solomon et al. (Eds.), p. 174-194.

The author presents a good neurophysiological explanation of the concept of optimal stimulation in regard to the diffuse projection system of the brain stem. Specifically, the reticular activating system with upward and downward tracts is discussed as a homeostat like system regulating input-output stimulation level.

Montgomery, K.C., "Exploratory Behavior as a Function of Similarity and Stimulus Situations", Journal of Comparative and Physiological Psychology, Vol. 46, 1953, p. 129-133.

This article investigates the affects of degree of novelty or complexity on exploratory behavior. Thirty-two albino rats explored three mazes that were identical except for brightness. The results showed that exposure to the first situation produces a decrement in the amount of exploration of the others, therefore, exploration diminishes with continuous exposure to a given stimulus situation.

-----, "The Role of Exploratory Drive in Learning", Journal of Comparative and Physiological Psychology, Vol. 47, 1954, p. 60-64.

Using a Y maze, one arm of which was connected with a Dashiell Maze, the author showed that rats would learn to enter the arm containing the Dashiell Maze. These results indicate that rats would learn a response that allows an opportunity for exploration. Novel stimulation therefore leads to an increase of exploratory behavior.

Montgomery, K.C. and P.J. Zimbaro, "Effect of Sensory and Behavioral Deprivation Upon Exploratory Behavior in the Rat", Perceptual and Motor Skills, Vol. 7, 1957, p. 223-229.

In this article seventy-two rats were divided into three groups, one group reared in normal cages, a second group in behavioral deprivation cages and the third in small behavioral and sensory deprivation cages. Nine groups of animals were formed by dividing the three groups into sub-groups remaining in the rearing condition for 25, 50 and 100 days. Exploratory tests were administered using a Y maze. The results did not indicate any systematic effect of length of deprivation upon amount of exploratory behavior. The findings support the position that exploration is dependent upon exteroceptive stimulation.

Patrick, J.R. and R.M. Laughlin, "Is the Wall-Seeking Tendency in the White Rat an Instinct", Journal of Genetic Psychology, Vol. 44, 1934, p. 378-389.

In this early study the authors reared rats in an open growing cage or smaller nesting conditions. When tested for activity and exploratory behavior differences, the results indicated that exploration of animals reared in the smaller, hence, more deprived conditions was lower than those reared in the larger area.

Sackett, G.P., "Response to Stimulus Novelty and Complexity as a Function of Rats' Early Rearing Experiences", Journal of Comparative and Physiological Psychology, Vol. 63, 1967, p. 369-375.

This article is supportive of the contention that deprivation leads to increased exploration. The author studied rats reared under different conditions of stimulus deprivation and concluded that the amount of sensory deprivation on days 15-60 of life is directly related to the gross amount of movement in a novel environment. Modest degrees of sensory deprivation seems to produce exploration.

Sackett, G.P., P. Keith-Lee and R. Treat, "Food Versus Perceptual Complexity as Rewards for Rats Previously Subjected to Sensory Deprivation", Science, Vol. 141, 1963, p. 518-520.

In this important study the authors found that rats reared in darkness or in constantly lighted white cages go to food in a T maze if its located in a checkerboard goal but not if the food is located in a less visually complex goal. Normally reared animals go to the food regardless of the goal complexity. The authors suggest that the need for perceptual experience may be as basic a biological process as the classical biological needs. They propose that the need to maintain an optimal stimulus input may be as basic a requirement as primary drive satisfaction.

Williams, K.D. and J.C. Kuchta, "Exploratory Behavior in Two Mazes with Dissimilar Alternatives", Journal of Comparative and Physiological Psychology, Vol. 50, 1957, p. 509-513.

This investigation gives supporting evidence that rats respond to novel stimuli by exploration. Using Y mazes with dissimilar alternatives in two experiments, the authors determined that animals spent more time exploring the arm in which a change had been introduced.

Woods, P.J., S.I. Ruckelshaus and D. Bowling, "Some Effects of "Free" and "Restricted" Environmental Rearing Conditions Upon Adult Behavior in the Rat", Psychological Reports, Vol. 6, 1960, p. 191-200.

In this investigation the author verifies previous findings on the effects of differential environments on problem-solving. The author concludes that restricted animals were poorer maze solvers apparently due to a heightened exploratory drive resulting from their restricted early rearing.

BIBLIOGRAPHY

84

Zimbardo, P.G. and K.C. Montgomery, "Effects of
"Free Environment" Rearing Upon Exploratory Behavior",
Psychological Reports, Vol. 3, 1957, p. 589-594.

This study supports the contention that deprivation leads to increased exploration and agrees with Woods. The authors found that rats reared in normal laboratory cages explored a Y maze significantly more than those reared in an environment offering more complex experiences.

APPENDIX 1

PRE AND POST-DIFFERENTIAL REARING PROBLEM-SEEKING AND
EXPLORATORY BEHAVIOR SCORES OF RATS MAINTAINED IN THE
NORMAL ENVIRONMENT

APPENDIX 1

PRE AND POST-DIFFERENTIAL REARING PROBLEM-SEEKING AND
EXPLORATORY BEHAVIOR SCORES OF RATS MAINTAINED IN THE
NORMAL ENVIRONMENT

| Subject ¹ | Problem-Seeking Score | | Exploratory Score | |
|----------------------|--------------------------|------|----------------------|------|
| | Pre | Post | Pre | Post |
| 1 | 56 | 39 | 81 | 105 |
| 2 | 9 | 5 | 40 | 109 |
| 3 | 75 | 70 | 89 | 119 |
| 6 | 24 | 42 | 106 | 215 |
| 7 | 36 | 30 | 124 | 91 |
| 10 | 9 | 16 | 92 | 131 |
| 12 | 20 | 7 | 125 | 205 |
| 18 | 0 | 1 | 73 | 140 |
| 20 | 66 | 57 | 154 | 142 |
| 25 | 13 | 9 | 105 | 102 |
| 26 | 68 | 70 | 186 | 162 |
| 28 | 34 | 66 | 99 | 104 |
| 34 | 56 | 36 | 167 | 165 |
| 38 | 45 | 28 | 103 | 141 |
| 39 | 0 | 9 | 129 | 146 |
| 41 | 48 | 19 | 110 | 159 |
| 43 | 58 | 63 | 135 | 120 |
| 44 | 53 | 43 | 118 | 133 |
| 45 | 47 | 27 | 62 | 146 |
| 47 | 15 | 21 | 174 | 156 |
| 48 | 44 | 23 | 174 | 174 |
| 49 | 39 | 20 | 31 | 106 |
| 50 | 10 | 6 | 65 | 168 |
| 51 | 60 | 54 | 111 | 76 |
| 52 | 96 | 88 | 100 | 157 |
| 54 | 41 | 44 | 146 | 91 |
| 55 | 45 | 8 | 101 | 126 |
| 57 | 29 | 10 | 48 | 126 |
| 58 | 73 | 49 | 137 | 79 |
| 60 | 37 | 0 | 183 | 124 |

¹ During the experiment, each subject had an identifying number.

APPENDIX 2

PRE AND POST-DIFFERENTIAL REARING PROBLEM-SEEKING AND
EXPLORATORY BEHAVIOR SCORES OF RATS REARED IN THE
PERCEPTUALLY DEPRIVED ENVIRONMENT

APPENDIX 2

PRE AND POST-DIFFERENTIAL REARING PROBLEM-SEEKING AND
EXPLORATORY BEHAVIOR SCORES OF RATS REARED IN THE
PERCEPTUALLY DEPRIVED ENVIRONMENT

| Subject | Problem-Seeking Score | | Exploratory Score | |
|---------|--------------------------|------|----------------------|------|
| | Pre | Post | Pre | Post |
| 4 | 65 | 89 | 109 | 125 |
| 5 | 12 | 20 | 80 | 145 |
| 8 | 39 | 50 | 59 | 133 |
| 9 | 48 | 67 | 124 | 133 |
| 11 | 55 | 66 | 160 | 258 |
| 13 | 4 | 3 | 128 | 172 |
| 14 | 34 | 39 | 113 | 113 |
| 15 | 45 | 37 | 124 | 160 |
| 16 | 82 | 76 | 186 | 218 |
| 17 | 53 | 47 | 141 | 216 |
| 19 | 0 | 5 | 54 | 82 |
| 21 | 28 | 19 | 107 | 141 |
| 22 | 70 | 82 | 140 | 137 |
| 23 | 28 | 22 | 109 | 258 |
| 24 | 68 | 62 | 120 | 168 |
| 27 | 13 | 35 | 102 | 93 |
| 29 | 51 | 41 | 106 | 161 |
| 30 | 58 | 75 | 192 | 225 |
| 31 | 32 | 43 | 129 | 144 |
| 32 | 0 | 5 | 89 | 71 |
| 33 | 54 | 72 | 105 | 144 |
| 35 | 0 | 0 | 110 | 109 |
| 36 | 52 | 25 | 192 | 285 |
| 37 | 37 | 29 | 113 | 183 |
| 40 | 77 | 89 | 148 | 159 |
| 42 | 23 | 47 | 116 | 109 |
| 46 | 45 | 62 | 136 | 148 |
| 53 | 37 | 35 | 180 | 135 |
| 56 | 43 | 50 | 144 | 106 |
| 59 | 16 | 28 | 116 | 109 |

APPENDIX 3

ABSTRACT OF

The Effects of Perceptual Deprivation on Exploratory
and Problem-Seeking Behavior of the Albino Rat

APPENDIX 3

ABSTRACT OF

The Effects of Perceptual Deprivation on Exploratory and Problem-Seeking Behavior of the Albino Rat¹

This is a longitudinal study, having as its main purpose to determine the influence of environmental experience, specifically that of perceptual deprivation on problem-seeking behavior of rats. The effects of perceptual deprivation on exploratory behavior, and the distinctness of exploratory and problem-seeking behavior are also investigated.

The subjects for the present study were sixty Sprague-Dawley albino rats. A three phase experimental procedure was utilized. In phase one pre-experimental measures were obtained from all subjects of their problem-seeking and exploratory behavior. Phase two, the experimental phase, consisted of dividing the animals into two groups and rearing them for thirty days in either a perceptually deprived or normal environment. During the third phase, all rats were post-tested on both the problem-seeking and exploratory measures.

¹ A.M. Blank, doctoral thesis presented to the School of Graduate Studies of the University of Ottawa, Ontario, 1973, viii-88 p.

The major hypothesis tested states that the placement of animals in a perceptually deprived environment for a thirty day period will result in significant increases in both their problem-seeking and exploratory behaviors. Significant results were found and the hypothesis, therefore, was substantiated.

A low but significant relationship was found to exist between problem-seeking and exploratory behavior indicating that the two behaviors do contain common elements.

Eight minor hypotheses were also tested, attempting to determine the changes in exploratory or problem-seeking behavior of animals that have previously been divided into high or low groups according to either their problem-seeking or exploratory behavior and then reared in perceptually deprived or normal environments. Non-significant results were found in all but two cases.

The results of the present investigation were interpreted in the light of the concept of optimal stimulation. Neurophysiological explanations were put forth indicating that the behavior changes due to the deprived rearing are dependent on neural changes, particularly in the reticular activating system.