Spring 8-6-1943

Re-Education of Handedness in the Rat Following Cerebral Injuries

David Roland McGiboney Jr.

Follow this and additional works at: https://digitalrepository.unm.edu/psy_etds

Part of the [Experimental Analysis of Behavior Commons](#)

Recommended Citation

McGiboney, David Roland Jr.. "Re-Education of Handedness in the Rat Following Cerebral Injuries." (1943).
https://digitalrepository.unm.edu/psy_etds/201

This Thesis is brought to you for free and open access by the Electronic Theses and Dissertations at UNM Digital Repository. It has been accepted for inclusion in Psychology ETDs by an authorized administrator of UNM Digital Repository. For more information, please contact disc@unm.edu.

UNIVERSITY OF NEW MEXICO-UNIVERSITY LIBRARIES

A14429 086220

378.789

Un 3 Om

1950

cop. 2

*McGilborey
Re-Education of Handicapped in the Real*

THE LIBRARY
UNIVERSITY OF NEW MEXICO

Call No.
378.789
Un30m
1950
cop.2

Accession
Number

1141013

UNIVERSITY OF NEW MEXICO LIBRARY

MANUSCRIPT THESES

Unpublished theses submitted for the Master's and Doctor's degrees and deposited in the University of New Mexico Library are open for inspection, but are to be used only with due regard to the rights of the authors. Bibliographical references may be noted, but passages may be copied only with the permission of the authors, and proper credit must be given in subsequent written or published work. Extensive copying or publication of the thesis in whole or in part requires also the consent of the Dean of the Graduate School of the University of New Mexico.

This thesis by David Rolland McGiboney, Jr.
has been used by the following persons, whose signatures attest their acceptance of the above restrictions.

A Library which borrows this thesis for use by its patrons is expected to secure the signature of each user.

NAME AND ADDRESS

DATE

MANUSCRIPT THESIS

Unpublished theses submitted for the Master's and Doctor's degrees and deposited in the University of New Mexico Library are open for inspection but are to be used only with due regard to the rights of the author. Bibliographical references may be noted, but passages may be copied only with the permission of the author and proper credit must be given in subsequent papers or published work. Extensive copying or publication of the thesis in whole or in part requires also the consent of the Dean of the Graduate School of the University of New Mexico.

This thesis by David E. and the University of New Mexico has been used by the following persons whose signatures attest their acceptance of the above restrictions:

A library which borrows this thesis for use in its library is expected to secure the signature of each user.

NAME AND ADDRESS DATE

RE-EDUCATION OF HANDINESS IN THE
RAT FOLLOWING CEREBRAL INJURIES

by

David Rolland McGiboney, Jr.

A Thesis

In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Psychology

The University of New Mexico
1949

ALL INFORMATION CONTAINED
HEREIN IS UNCLASSIFIED

BEKZHIEN
+ DAY
BOND *
+ COKEVZVRE
EVLOV2

ALL INFORMATION CONTAINED
HEREIN IS UNCLASSIFIED
DATE 10/10/01 BY 1045

ALL INFORMATION CONTAINED
HEREIN IS UNCLASSIFIED

This thesis, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

E. S. Castetter
DEAN

Aug. 6, 1949
DATE

RE-EDUCATION OF HANDEDNESS IN THE
RAT FOLLOWING CEREBRAL INJURIES

BY

David Rolland McGiboney, Jr.

Thesis committee

Geo. M. Peterson

CHAIRMAN

William S. Koster
Morton J. Keston

This thesis directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

John A. Johnston

Aug 24 1931

RECEIVED AT THE UNIVERSITY OF NEW MEXICO
THE 24th DAY OF AUGUST 1931

Book 1011 and 1012

1931-1932

John A. Johnston

John A. Johnston
John A. Johnston

1931

1931-1932

1931-1932

378.789
Un30m
1950
cop.2

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION	1
The importance of the study	2
Statement of the problem	4
Organization of the thesis	5
II. REVIEW OF THE LITERATURE	6
Literature on recovery of function as measured reflex responses	6
Literature on recovery of function as measured by the so-called "higher mental processes" . .	10
Theories regarding recovery	14
Interpretation of the literature	19
III. PROCEDURES	22
Sources of data	22
Observational methods	22
Operational techniques	27
Histological Methods	27
IV. INTERPRETATION AND ANALYSIS OF THE DATA	30
General precautions	30
Results	32
V. SUMMARY AND CONCLUSION	48
Summary	48
Conclusions	50

144013

I. INTRODUCTION	1
The importance of the study	1
Statement of the problem	2
Organization of the thesis	3
II. REVIEW OF THE LITERATURE	4
Literature on recovery of limestone	4
Related researches	5
Literature on recovery of limestone	6
by the so-called "recovery"	7
Theories regarding recovery	8
Investigation of the limestone	9
III. PROCEDURES	10
Sources of data	10
Observational methods	11
Experimental techniques	12
Statistical methods	13
IV. INTERPRETATION AND ANALYSIS OF DATA	14
General conclusions	14
Results	15
V. SUMMARY AND CONCLUSION	16
Summary	16
Conclusions	17

CHAPTER

PAGE

BIBLIOGRAPHY	54
APPENDIX	58

11

12

13

14

CHAPTER

RECEIVED

ATTEST

BECKHART
IN 3 V
+ BOND
COFFEE VENE
LAWSON
60

LIST OF TABLES

TABLES	PAGE
I. Influence of Forced Practice in Producing Transfers Among Normal Animals	34

I. Influence of forces exerted in the direction

of the line of action of the forces

DEKALB
GA

LIST OF FIGURES

FIGURE

PAGE

I. Composite Maps Comparing Common and Total Lesion

Areas 37

UNITED STATES

FIGURE

1. Composite map showing the location of the study area

Area

CHAPTER I

INTRODUCTION

This study is concerned with the re-education of handedness in the rat following cerebral injury. The general problem of the restitution of functions following cerebral destruction has had a long and varied history. In the case of man, knowledge regarding the problem is largely confined to the clinical literature. With lower animals, experimental study is more feasible and success of varying degrees has been reported. However, a review of the literature in this field leaves one in confusion, not only regarding the theories of how re-education occurs, but also in defining the functions which are studied in the determination of re-educability. At one extreme of such functions are the reflex responses such as grasping, standing, walking, postural adjustment, speed and strength of a peretic limb as compared with its opposing normal limb, relative freedom of an affected limb, knee jerk, and Babinsky and Rossolimo signs. At the other extreme the functions studied are intellectual performances such as re-education of aphasias and the acquired skills studied experimentally, especially by Lashley. The present confusion seems to result from inadequacies in the application of the theories derived from the functions studied.

BOND

LIBRARY

EX-100

This study is concerned with the relationship between
adhesion in the rat following unilateral section of the
problem of the relationship of the sectioned nerve to the
adhesion has had a long and varied history. In the case
of man, knowledge regarding the problem is largely confined
to the clinical literature. With lower animals, a systematic
study is more feasible and accurate. In the case of man
reported. However, a review of the literature in this field
leaves one in confusion, not only regarding the nature of
how re-adhesion occurs, but also in relation to the
which are studied in the laboratory of re-connection. At
one extreme of such functions and the other extreme
as rearing, walking, climbing, and other activities, and
and strength of a nerve fiber as compared with its
nerve fiber, relative to the degree of its re-connection
and adhesion and mechanical strength. The present study
functions studied are anatomical, physiological, and
education of animals and the study will be a systematic
mentally, especially by Walker. The present study is
to result from induction in the stimulation of the
derived from the formation of the

The Importance of the Study

There is a need of more information, and this study is an attempt to provide additional knowledge by using a well defined function of an "intermediate" nature.

The function of handedness seems to fall somewhere between the extremes cited above. In the Peterson¹ food situation, preferential handedness is determined by fastening a small "T" shaped canary dish to a central point on the cage wall in such a manner that only the leg of the "T" protrudes into the cage. The animal has equal opportunity to reach for food with either hand. It is necessary for the animal to reach for the food because the dish is too short and narrow to permit any great amount of mouth feeding. Mouth feeding occurs only when the level of food in the dish is very high. As the hand enters the dish it is brought into the position of pronation, food is grasped by flexion of the digits and the hand is withdrawn from the dish. The hand is carried to the position of supination, the digits are extended at a point near the mouth, and the food is then taken into the mouth from the hand. The complexity shown here is presum-

¹ G. M. Peterson, "A Preliminary Report on Right and Left Handedness in the Rat," Journal of Comparative Psychology, Vol. 12, (1931), pp. 243-250.

ably greater than that of a spinal reflex. Peterson² has outlined some suggestions for this presumption. In the first place, if a simple reflex center is removed the reflex is abolished. However, if the cortical area for handedness is ablated, there is a transfer in the preferential use of the hands, but there is not necessarily a restriction of use imposed upon the affected hand. The originally preferred hand will no longer be chosen for certain specific uses, although it may be forced into use under proper circumstances. The hand will be used in activities such as running, climbing, and holding objects in an apparently normal manner indicating intact reflex centers for such functioning. Another indication of greater complexity is seen in the function by the gradual transfers or recoveries frequently found following the cerebral injury. On the other hand, handedness is less complex than intellectual functions in the sense that ambidextrous animals favoring one hand do not fixate that hand after much practice. Furthermore, strongly right or left handed animals exhibit their preference before any appreciable practice may operate.³

2 G. M. Peterson, "Mechanisms of Handedness in the Rat," Comparative Psychology Monographs, Vol. 9, No. 6, (1934) p. 17.

3 Ibid., pp. 28-29.

THE PROBLEM

Peterson⁴ attempted re-education by binding with adhesive tape the nonaffected arms of four animals having unilateral destructions. Of the four cases, three animals reverted to the use of the transfer hand, and one "became quite ambidextrous" following the period of binding. It appears, then, that re-education is possible for the recovery of the handedness function in rats. This thesis is an extended, more systematic study of the re-education phase of his work.

Statement of the Problem

Answers to the following questions were sought in the study:

1. Although the loci of lesion will usually involve a single general area of the frontal lobe, will there be any noticeable differences between the amount of recovery or re-education with the variations in loci within the general area?
2. Is mass of destruction significant with regard to re-educability of handedness?
3. Is there a difference in re-educability between animals with lesions involving the cortex only and animals which have both cortical and subcortical destructions?

4 Ibid., loc. cit.

4. Are there significant differences in the recovery of young adult versus older adult rats?
5. Can an animal be effectively retrained more easily without the use of peripheral restraining techniques than with a combination of alternate forms of retraining, or do animals retrained in part with peripheral restraining techniques show greater recovery than animals not so restrained?
6. Is there a different potentiality for recovery in animals for which a retraining method is delayed after injury as compared with animals on which retraining is instituted soon after the operation?

Organization of the Thesis

The remaining chapters will follow in this sequence: a Review of the Literature on the subject of restitution of functions; Procedures, the sources of the data and methods; Interpretation and Analysis of the Data; Summary and Conclusions; and the Appendix.

REK21114
12.1.1942

BOND

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

REK21114
12.1.1942

CHAPTER II

REVIEW OF THE LITERATURE

The literature on the problem of recovery of function after central nervous system injury may be conveniently considered under two classifications.

1. Studies defining recovery as measured by reflex response functions. Under this classification will be considered some clinical studies of man and experimental studies of lower animals which have been based upon reflex responses and general behavior observation.
2. Studies defining recovery as measured by the "higher mental process" type of functions. These may be further divided into:
 - A. Motor Functions.
 - B. Sensory Functions.

Literature on Recovery of Function as Measured by Reflex Responses

Prior to the year 1874 some knowledge regarding the re-education of aphasics had been reported in clinical literature. However, these reports were so lacking in precision and supporting evidence that they provided little basis from which to continue research on the general problem of restitution of

The following are the results of the investigation after careful review of the records and after consultation with the appropriate authorities.

1. The following information was obtained from the records of the Department of the Interior, Bureau of Land Management, and the Bureau of Reclamation, and is being furnished to you for your information.
2. The following information was obtained from the records of the Department of the Interior, Bureau of Land Management, and the Bureau of Reclamation, and is being furnished to you for your information.

Information on the status of the land in the area of the

It is noted that the land in the area of the is being used for agricultural purposes, and it is suggested that the land be used for agricultural purposes.

function.¹ Franz, Sheets and Wilson² reported some success in cases of long standing hemiplegia in man. The possibilities found in the human hemiplegics were almost immediately tested experimentally in the monkey by Oden and Franz.³ They destroyed the motor cortex in seven animals to produce hemiplegia. The results of retraining in both the human and the monkey cases were found to be similar. They may be summarized by: 1) an hemiplegic man or monkey, left unguided in his activities, will show little recovery even after many months. 2) Forcing the use of a paralysed limb by restraining the opposing normal limb alone provides little improvement. 3) recovery may be rapid

...if treatment by muscle stimulation and nerve vibration be directed to the involved parts and if special stimulation exercises be given which will provoke the animal to the paralysed segments.³

There is, however, always some residual motor deficit.

1 S. I. Franz, "Studies of Re-education: The Aphasias," The Journal of Comparative Psychology, Vol. IV, No. 4, (August, 1924), p. 349.

2 S. I. Franz, M. E. Sheets, and A. A. Wilson, "The Possibility of Recovery of Motor Function in Long-standing Hemiplegia," The Journal of the American Medical Association, Vol. 65, (1915), pp. 2150-2154.

3 Robert Oden and S. I. Franz, "On Cerebral Motor Control. The Recovery from Experimentally Produced Hemiplegia," Psychobiology, Vol. 1, No. 1, (July, 1917), pp. 33-49.

Kennard⁴ reports recovery in monkeys following ablation of the Brodmann areas four and six. Her findings were: 1) older animals remained with a greater motor deficit after lesions than younger animals; 2) large lesions were followed by a slower recovery rate; 3) if only one of the two areas was invaded, the deficit was less than when both were invaded; 4) lesions forward of areas four and six did not increase motor deficit; 5) in very young animals loss of one complete hemisphere was followed ultimately by no greater deficit than in ablations of areas four and six; and, 6) bilateral motor and premotor lesions were followed by a greater rate of recovery; in fact, in a matter of days noticeable improvement occurred.

In 1911, Bechterew⁵ stated:

With unilateral destruction of the motor region in dogs, the associative reflex may be elicited in the homolateral fore-leg, but in the contralateral fore-leg the reflexes earlier learned are forever lost and cannot be re-established even after a number of conditioning associations.

4 Margaret Kennard, "Age and Other Factors in Motor Recovery from Precentral Lesions in Monkeys," The American Journal of Physiology, Vol. 115, (March 1936), pp. 38-146.

5 K. S. Lashley, "Studies of Cerebral Function in Learning: The Retention of Motor Habits After Destruction of the so-called Motor Areas in Primates," Archives of Neurology and Psychiatry. (September, 1924), Vol. 12, pp. 251-252. Quoting W. D. Bechterew, Die Funktionen der Nervencentra, Jena, 3, 1911, (p. 1511).

Recently the influence of certain drugs upon motor recovery in primates has been studied. Ward and Kennard⁶ report considerable increase over untreated animals in the rate of recovery from unilateral lesions of the Brodmann areas four and six by injection of Doryl and Atrophine. The latter drug was included to reduce the parasympathetic side effects of Doryl. A fair to good rate of recovery was noted using the drugs Doryl and thiamine. There was some increase in rate of recovery in animals medicated with strychnine and thiamine. Thiamine alone gave evidence of slight improvement over the entirely non-medicated control animals. A lapse of weeks between the incidence of lesion and the beginning of cholinergic medication indicated that the drug was effective even though not immediately instituted as a therapy. Lastly, the effect continued at least three months after medication ceased. Watson and Kennard⁷ found that medication by anticonvulsant drugs, specifically phenobarbital and dilantin, tend to decrease the rate of recovery. Phenobarbital actually

6 Arthur A. Ward, Jr., and M. L. Kennard, "Effect of Cholinergic Drugs on Recovery of Function Following Lesion to the Central Nervous System in Monkeys," Yale Journal of Biology and Medicine, Vol. 15, (December, 1942), pp. 189-223.

7 Charles W. Watson and M. L. Kennard, "The Effect of Anticonvulsant Drugs on Recovery of Function Following Cerebral Cortical Lesions," Neurophysiology, Vol. 8, No. 4, (July, 1945), pp. 221-231.

BEVERLY H. K. A.
1927
BOYD

caused retardation in motor performance, even in doses which had no observable sedative effect in the cage performance of the animals. Dilantin alone did not cause retardation, but it prevented the recovery rate obtained with Doryl.

Literature on Recovery of Function as Measured by the So-Called "Higher Mental Processes"

A. Motor Functions

Marie and Foix,⁸ upon studying motor aphasia due to war wounds, concluded that there is less speech disturbance if a lesion is in the anterior portion of the third frontal convolution of the cerebral hemisphere contralateral to the handedness of the individual. Conversely, disturbance to speech was greater if the lesion is posterior in the same convolution. Recovery was found to be greater in the first case and may seem complete. If the lesion is in the posterior portion of the convolution recovery is slower with a deficit evident which is signified by slowness and cautiousness of speech, slight aphasic symptoms and slow ideation.

⁸ Marion Hines, "On Cerebral Localization," Physiological Reviews, Vol. 9, No. 3, (July, 1929) pp. 524-526. Quoting P. Marie and C. Foix, "Les Aphasias des Guerre," Review Neurological, Vol. 31, No. 53, (1917).

 
and on the Growth of the Embryo

A. Retardation

 

That any recovery occurs at all is supported by Franz.⁹ Three aphasics were given retraining in such things as naming objects, color naming, naming of forms, writing, reading words, and associating printed names with pictures of objects. Learning was recorded quantitatively and was considered successful, when, for instance, the correct naming of an object occurred seven out of ten trials on each of six successive days. The conclusions reached by Franz were: 1) re-learning is slow at first but becomes more rapid as the training continues; 2) there are rather great fluctuations in ability from day to day or hour to hour; 3) in the learning of similar things, some things are easy to master, but with others mastery comes slowly and; 4) retraining procedures must be adapted to each individual case.

In experimental work with monkeys, Franz¹⁰ found that when the frontal lobes were removed, newly formed habits were lost but those habits could be relearned, and the animal could learn others. Also, he noted that when associations

9 S. I. Franz, op. cit., 1924, pp. 349-429.

10 S. I. Franz, "Observations on the Functions of the Association Areas (Cerebrum) in Monkeys," The Journal of the American Medical Association, Vol. 47, (November, 1906), pp. 1466-1467.

were firmly fixed, loss of association did not always follow the frontal destruction. He considered the possibility of long standing associations becoming more or less of a reflex which may operate through centers in the lower brain stem.¹¹ This supposition was experimentally tested by Lashley.¹² He trained rats in a simple habit of reacting to light. After all the animals could perform the habit some were given 1200 over-training trials. At this point the habit seemed automatic in the overtrained animals. The striate areas were then removed in all the animals. The overtrained group showed a recoverable loss of the habit comparable to the loss suffered by the animals not given overtraining. This seems to be the only direct evidence bearing on the question of automatized habits being reduced to subcortical levels, and it is opposed to the supposition.

Franz and Lashley¹³ found retention of the maze habit

11 S. I. Franz, Ibid., p. 1467.

12 K. S. Lashley, "Integrative Function of the Cerebral Cortex," Physiological Review, Vol. 8, No. 1, 1-42, (January, 1933). Quoting K. S. Lashley, "Studies of Cerebral Functioning in Learning, II. The Effects of Long-continued Practice Upon Cerebral Localization," The Journal of Comparative Psychology, Vol. 1, (1921), p. 453.

13 S. I. Franz and K. S. Lashley, "The Retention of Habits by the Rat After Destruction of the Frontal Portion of the Cerebrum," Psychobiology, Vol. 1, No. 1, (July, 1917), pp. 3-18.

in rats after ablation of the frontal cerebrum. Peterson¹⁴ found that rats in the latch-box either did not forget, or could relearn, this intellectual function after destruction of a cortical handedness area. In this situation the intellectual process was not badly retarded but the hand preference was transferred.

B. Sensory Functions (Vision)

Although various sensory functions have been studied regarding re-education following sensory loss, most information has been gained through studies of visual functions. The literature here is confined to this particular sense. Lashley¹⁵ found that if any part of the geniculo-striate system remains intact, perfect retention of brightness discrimination is possible. In cases of total destruction of the visual cortex, and with the attending degeneration of the lateral geniculate nuclei, recovery of brightness discrimination could be re-learned at a normal rate. There seems to

14 G. M. Peterson, "The Influence of Cerebral Destruction Upon the Handedness of the Rat in the Latch-Box," The Journal of Comparative Psychology, Vol. 26, (December, 1938), pp. 445-459.

15 K. S. Lashley, "Mechanisms of Vision: XII. Nervous Structures Concerned in the Acquisition and Retention of Habits Based on Reactions to Light," The Comparative Psychology Monographs, Vol. 11, No. 52, (February, 1935), pp. 43-79.

be a sort of "lower order" mechanism which permits the re-learning. This is found in the superior colliculi.¹⁶ However, this relearning will not take place if the pretectile nuclei have been invaded. Lashley and Frank¹⁷ were unable to obtain any recovery of function with regard to detail vision if both striate areas of the rat brain were completely destroyed.

Theories Regarding Recovery

Since it is usually conceded that regrowth of functional central nervous tissue does not take place, other theories of how restitution of function occurs have been suggested. Chief among these are "diaschisis," "vicarious functioning," "learning to get along with what remains," and "equipotentiality."

Van Monakow's¹⁸ theory regards diaschisis as a re-

16 E. Ghiselli, "The Relation Between the Striate Area and the Superior Collicules in Brightness Discrimination," The Journal of Genetic Psychology, Vol. 52, (1938), pp. 151-157.

17 K. S. Lashley and Margaret Frank, "Mechanisms of Vision: X. Postoperative Disturbances of Habits Based on Detail Vision in the Rat After Lesions in the Cerebral Visual Area," The Journal of Genetic Psychology, Vol. 17, No. 3, (June, 1934), pp. 355-391.

18 K. S. Lashley, "Factors Limiting Recovery After Central Nervous Lesions," The Journal of Nervous and Mental Diseases, Vol. 88, No. 6, (December, 1938), p. 736. Quoting C. V. Monakow, "Neue Gesichtspunkte in der Frage Nach der Lokalisation im Grosshirn," (Wiesbaden, 1910).

facilitation of some region or area of the brain isolated from its usual facilitory centers by lesion. Sooner or later, the isolated area becomes again excitable. There is no account given of how this may come about. Lashley¹⁹ noted that in cases where known facilitative impulses are blocked there is no recovery. Also, in cases of recovery where diaschisis apparently occurs, a closer analysis may show that some retraining took place.²⁰ The present study will, nevertheless, attempt a test for diaschisis by delaying re-education.

Fritsch and Hitzig²¹ suggested the possibilities of vicarious functioning in their 1870 report. They noted that unilateral lesions of the motor cortex in dogs produced a paralysis which was not entirely permanent. They considered the possibility that the undamaged structures of the non-insulted hemisphere could assume control of the functions. This has not been demonstrated and is now generally discounted. The concept of vicarious functioning has some support,

19 K. S. Lashley, op. cit., 1938, p. 736.

20 K. S. Lashley, loc. cit., 1938.

21 G. Fritsch and E. Hitzig, "Über die elektrische Erregbarkeit des Grosshirns," Archive Für Anatomie, Physiologie und Wissenschaftliche Medizin, (1870), pp. 300-332. Quoted by K. S. Lashley, op. cit., (1938), p. 740.

however, as noted in the Lashley²² report and that of Ghiselli²³ as previously mentioned. Peterson and Chaplin²⁴ found "no evidence" of other brain mechanisms replacing a lost mechanism to express a function as adequately as did the original mechanism. To these experimenters, vicarious function may be such a vague term as to mean "that an animal uses the remaining nervous system to somehow carry on the function in the sense of reaching an end or goal..." If this is the meaning of vicarious functioning, it would be more accurate to express it as Lashley's²⁵ "getting along without the lost functions."

The better statement of the "lost functions" theory is, "learning to get along with what remains."²⁶ Lashley and McCarthy²⁷ made extensive cerebellar destruction in rats.

22 K. S. Lashley, op. cit., 1935, p. 73.

23 E. Ghiselli, op. cit., 1938.

24 G. M. Peterson and J. P. Chaplin, "Extrapyramidal Mechanisms in Handedness in the Rat," The Journal of Comparative Psychology, Vol. 33, No. 3, (June, 1942), pp. 358-359.

25 K. S. Lashley, "Integrative Functions of the Cerebral Cortex," Physiological Reviews, Vol. 8, No. 1, (January, 1933), p. 6.

26 G. M. Peterson and J. P. Chaplin, op. cit., 1942, p. 360.

27 K. S. Lashley and D. A. McCarthy, "The Survival of the Maze Habit After Cerebellar Injuries," The Journal of Comparative Psychology, Vol. 6, 1936, p. 423-434.

however, as noted in the preceding paragraph, the
Gibbs²² on previously mentioned. The first of these
found "the existence of a new phase in the system"
last mentioned as being a mixture of a solid and a
outgoing substance. The first of these phases is
that may be such a phase as to be in the solid state
the transition between solid and liquid is the
in the sense of the solid and the liquid. The first of
meaning of the solid and the liquid. The first of
to express it as a solid and the liquid. The first of
transitions."

The latter statement of the first of these phases
is, "transition to a new phase with a new
entropy" and the latter, "transition to a new phase with a new
entropy."

22. E. A. Gibbs, *Trans. Am. Math. Soc.*, 1902, p. 1.
23. E. A. Gibbs, *Trans. Am. Math. Soc.*, 1902, p. 1.
24. E. A. Gibbs, *Trans. Am. Math. Soc.*, 1902, p. 1.
25. E. A. Gibbs, *Trans. Am. Math. Soc.*, 1902, p. 1.
26. E. A. Gibbs, *Trans. Am. Math. Soc.*, 1902, p. 1.
27. E. A. Gibbs, *Trans. Am. Math. Soc.*, 1902, p. 1.
28. E. A. Gibbs, *Trans. Am. Math. Soc.*, 1902, p. 1.
29. E. A. Gibbs, *Trans. Am. Math. Soc.*, 1902, p. 1.
30. E. A. Gibbs, *Trans. Am. Math. Soc.*, 1902, p. 1.

RECEIVED
JAN 10 1903

Maze running was not abolished but "the animals practically rolled through the maze." In the Peterson and Chaplin²⁸ experiment a similar occurrence was seen. Animals which had extensive bilateral cerebellar destructions clearly gave evidence that their handedness was affected because of postural interference. This caused the animals to alternate hands when reaching for food while attempting to remain upright. The impression given is that there is not a recovery or restitution of function per se after brain lesions, but there may be a sort of substitution or reorganization of the remaining system. Goldstein²⁹ states this as "...a newly achieved state of ordered functioning..." This new state requires a "...shrinkage or diminution of performance potentialities (essential nature) and of milieu."

The theory of equipotentiality as developed from studies on the sensory function of vision may be shown in the following manner. The striate area in rats normally functions in the mediation of responses to differences in brightness. When this area is entirely removed, habits of brightness discrimination are lost. However, ninety percent of the area may be removed with perfect retention of the habit being the

28 G. M. Peterson and J. P. Chaplin, op. cit., 1942, p. 360.

29 Kurt Goldstein, The Organism, English Edition (New York Book Company, 1939), p. 439.

rule. If less than one-twelfth remains, however, there is an amnesia for the habit, but the habit can easily be recovered by retraining. In such instances, a small part seems equivalent to the whole.³⁰

In a sense, the superior colliculi might be regarded as equipotential to the striate area because they serve in the brightness discrimination in an apparently normal manner when the striate areas are completely non-functional. However, the colliculi do not appear to function if the striate areas are intact, for they can be removed, in this instance, with no demonstratable effect upon the discrimination.^{31 & 32}

According to Morgan,³³ equipotentiality varies with regard to the neural mechanisms and psychological functions involved. The brightness discrimination "unit"³⁴ for equi-

30 K. S. Lashley and M. Frank, op. cit., 1934, pp. 355-380.

31 K. S. Lashley and M. Frank, op. cit., 1934.

32 E. Ghiselli, op. cit., 1938.

33 Clifford T. Morgan, Physiological Psychology, McGraw-Hill Book Company, Inc. (New York and London, 1943), p. 517.

34 Unit as used here means that proportion of a system which normally operates in the mediation of a function and which is necessary for the continuance of that function without impairment.

potentiality is about ten percent of the visual cortex. In more complex situations, such as form discrimination, the unit is larger. In complex problem-solving situations involving the frontal areas of the cortex one side may be removed without an attendant deficit. However, any invasion of the other side is followed by a definite deficiency in performance. These observations led Morgan to consider equipotentiality as: the simpler the problem the more equipotential the parts of the cortex, and as the problem's complexity increases the parts of the cortex become less equipotential.³⁵

Interpretation of the Literature

In general, reports intimate considerable possibilities for some sort of recovery. However, the theories, such as diaschisis and vicarious functioning, developed from these experiments are altogether dependent on the functions studied and are wholly independent of each other. Diaschisis may be operating in the restitution of functions for reflex actions, including conditioned reflexes. Vicarious functioning may operate to permit re-learning in such a function as brightness discrimination. An example applicable in these connec-

³⁵ Clifford T. Morgan, op. cit., p. 518.

potentially to have the same effect as the
more complex system of the other side of the
the system. It is not clear if the system is
the system, and if the system is the same as
out as a system, it is not clear if the system
also is related to the system. It is not clear
these observations are correct. It is not clear
the system, and if the system is the same as
the system, and if the system is the same as
of the system, and if the system is the same as

Interpretation of the Results

In general, the results indicate that the
the for some of the results. It is not clear
as distinct and also for the results. It is not clear
experiments are also correct. It is not clear
and are really independent of the results. It is not clear
of the results. It is not clear if the results are
including conditions and results. It is not clear
operate to correct the results. It is not clear
mean direct results. It is not clear if the results are

tions is a report by Marquis.³⁶ In several dogs a conditioned eye-lid response to a light was established. Then the animals were trained to discriminate between bright and dim lights in order to secure food. An operation was then performed, and the entire visual cortex was removed. Soon after the operation neither the lid response nor the discrimination could be performed. By the fifth postoperative day, however, the lid response had returned to "about its normal strength." This occurred without re-enforcement. There was no spontaneous recovery of the discrimination habit, although the animals could be retrained to perform it in about as many trials as were required in the pre-operation learning. There was no recovery of the more complex visual function, form discrimination, with or without attempted re-education.

Thus the literature now presents studies analysed on two quite different bases. What would be the situation developed from a study using an intermediate process, that is, using a process not dependent upon reflexology, nor, upon processes involving learning?

The Peterson^{37 & 38} food situation for transferring

37 G. M. Peterson, op. cit., 1931, pp. 242-250.

38 G. M. Peterson, op. cit., 1934, p. 41.

There is a report of a person who was
 

handedness is well adapted for investigating this problem. The handedness function is well defined anatomically, and it can be dealt with quantitatively. Hand preference among untrained rats is not the result of learning, and, as analyzed by Peterson, is not a reflex or an intellectual performance in itself.³⁹

³⁹ G. M. Peterson, op. cit., 1934, pp. 40-41.

CHAPTER III

PROCEDURES

Sources of Data

All data were obtained from albino rats selected from the University of New Mexico colony. Twenty-six strongly right or left handed animals formed the operated group. No animal which deviated more than two percent from its preferential hand was used.

A control group of ninety-seven animals was obtained by using animals from an unpublished study performed by others in this laboratory.

Observational Methods

Handedness was determined by the use of Peterson's food situation.^{1 & 2} This test consisted of three consecutive days of one observation period per day. An observation period was complete when the animal had reached for food fifty times. However, at times during the retraining period it was not possible to obtain fifty reaches, and in such cases more than fifty were obtained at a later period to make up the differ-

1 G. M. Peterson, op. cit., 1931.

2 G. M. Peterson, op. cit., 1934.

ence. A careful record was kept of the number of times a hand was used during these periods. Seven of the animals had been previously tested by other students for four to seven days. Six of the seven were one hundred percent right or left handed and one had a record of one right hand reach to 249 left hand reaches. Regardless of previous records, these and all other animals of the operated group, were given the three day preliminary test by the writer. Thus a single experimenter made all these observations, in that way minimizing observational variation. Contralateral, frontal operations were then performed.

A week's recovery period was permitted following the operation, after which the animals were tested for transfer in handedness for four consecutive days, again allowing no variation greater than two percent.

When hand preference had changed to the required degree, retraining was instituted in an off-set dish. This method was originally used by Wentworth³ and has since been systematically investigated in normal animals in this laboratory. The off-set dish was so arranged that one side of the

3 K. L. Wentworth, "Some Factors Determining Handedness in the White Rat," Genetic Psychology Monographs, Vol. 26, (August, 1942), pp. 55-117.

... A ... hand ... had been ... seven days ... or left ... the ... the third ... experiment ... ing observational ... were then ...

A ... operation ... in ... vegetation ... then ... tree, ... method ... systematically ... story. The ...

... mean in the ... 20, (August, 1921), pp. ...

dish was against the cage wall and the other side of the dish was extended by a vertical flange which prevented, or made inconvenient, the use of the unaffected arm for food reaching. Thus, if the dish were off-set to the right of the animal, the right hand would be forced into use, and if off-set to the left, the left hand was in the better position for reaching the food. Animals with left cerebral hemisphere destructions were, of course, retrained in the situation off-set to the right and reverse procedure was followed for animals with right hand destruction.

In nine cases the animals would not reach or attempt to reach in the off-set dish situation. In these cases binding of the non-affected arm was resorted to (number 7♀, 8♂, 9♀, 10♀, 11♂, 12♀, 13♀, 14♀, and 15♀). Binding was effected by the use of inch wide adhesive tape. A loop of tape was snugly placed around the wrist and forearm of the limb unaffected by the injury. The tape was then brought upward and across the animal's back. This pulled the arm into a position more or less parallel with the median plane of the body. The adhesive was carried around the body, care being taken to keep it as far forward as possible without immobilizing the affected arm. The tape was finally carried under the animal's body, over the bound arm and beyond. Care was taken to avoid peripheral arm injury. During the binding period the tape

was removed very often for hours between observations, and most animals were able to remove the binding at various times by themselves. Of the nine animals that were bound, six learned to reach into the off-set dish during 500 to 550 reaches. Three would not reach in the original canary dish of Peterson's⁴ food situation when the unaffected arm was bound; or in the off-set dish, bound arm situation; or in the off-set dish, unbound situation, even after twenty-eight days of binding. These animals were number 7♀, 11♂, and 14♀. The remaining animals were able to reach in the off-set situation.

After the retraining period, consisting of 1500 forced reaches, the animals were immediately placed in the canary, "T"-shaped dish situation in which there was again equal opportunity for use of either arm, in order to test for any residual effect due to retraining. Again, the observation period was fifty reaches per day, and the animals were tested at approximately weekly intervals for one month. Finally, the last test for residual effect was given one month after the weekly series, or two months after the end of the retraining period. It was soon found that if no residual effect was evident at the first observation after retraining, there would

⁴ Peterson, op. cit., 1931, p. 1.

was received very early in the morning, and the
most animals were seen to move about the place
by themselves. Of the many animals that were seen,
learned to swim into the water, and the only one
reached. These would not be the only ones that
of Peterson's last statement, when he mentioned animals
found; or in the 15th day, found the animals in the
off-rod that, without exception, were at the same place
of finding. These animals were seen on 15th, 16th, 17th, 18th,
reaching animals were able to swim in the water, and
After the following period, continuing on 19th day,
reaches, the animals were found in the water, and
"T-shaped fish" appeared in the water, and the animals
early for use of other fish, in order to keep the water
and other fish as well as the animals. The animals were
was 15th, 16th, 17th, 18th, and 19th day, and the animals
significantly and is known to the animals. The animals
last cost for the animals, and the animals were seen
weekly series, at the same place, and the animals
period. It was also found that the animals were seen
dent at the first observation of the animals, and the

A. Peterson, M.D., 1911, p. 1.

RECEIVED
JAN 20 1911

be no need for continuing the procedure. Nevertheless, the final test series was continued for at least two, and generally more, observation periods.

Prior to the beginning of the actual procedures noted above, two animals, one right handed, and the other left handed, were operated upon and used to test the possibilities of the off-set dish situation. Both reacted favorably by reaching with the originally preferred hand. One of these, No. 1♀, is included in the data because of a peculiar occurrence. When placed in the off-set dish for forcing the left hand there were but four reaches in nine days. The animal was then transferred to the opposite off-set dish for reaching with the non-affected hand for fifty reaches with immediate replacement in the off-set dish for the left hand. At once, the animal reached accurately and rapidly with that hand, which was the one affected by the operation. A similar occurrence was noted in another animal which died about mid-way in the retraining period. The effect just noted became incorporated in the general procedure for any animal which failed to reach in the off-set dish with the affected hand after six days of observation (No. 7♀, 8♂, 9♀, 10♀, 11♂, 12♀, 13♀, 14♀, and 15♀). This Gestalt-like effect of "learning about the problem" did not occur in any case but the two cited.

 

Operational Techniques

All operations were unilateral involving the cortical hemisphere contralateral to the originally preferred hand. All were done under deep ether anesthesia. A 3/32 inch trephine was used to open the skull, as it was desired in several cases to stimulate the cortex electrically to find an area in which arm movement took place (Nos. 17♀, 18♀, 19♀, 21♀, 22♀, 23♀, 24♀, 25♀, and 26♀). In two cases, Nos. 16♀ and 20♀, circumsection was tried, and in others rather extensive destructions attempted. A dental thermocautery was used to produce all lesions except the two circumsections. Wounds were closed with aseptic, metallic, wound clips.

Histological Methods

After all observations were completed, each animal was killed. The brains were removed, fixed in alcohol and imbedded in celloidin. Serial sections of fifty microns thickness at 1/4 millimeter intervals were saved, stained with thionin and mounted on slides. Reconstructions of lesions were made following Lashley's technique,⁶ and aided

⁶ K. S. Lashley, Brain Mechanisms and Intelligence, (University of Chicago Press, Chicago, 1929) pp. 16-17.

by referring to plates given by Craigie.⁷ The area of destruction was computed for each case with a planimeter. Percent of lesion area is based on one hundred percent of the area of one hemisphere.⁸

A map or reconstruction of each of the twenty-six lesions was constructed. From these individual maps, composite maps were drawn. An example of the method follows. Several individual maps of left hemisphere destructions were traced, one by one, upon a single map card. Then, tracing the outermost lines with heavy ink established the total composite lesion area. The inner limits were also overlayed with heavy ink and the area within them shaded. This demarked the area of destruction common to all animals considered in a particular group. In most cases all destructions were not in the same hemisphere. Where this was the case, direct tracings could be drawn as mentioned above, but a right hemisphere case required the drawing of its mirror image. The mirror image could then properly be traced directly upon the left hemisphere. Results of this method are found in the not re-

7 E. Horne Craigie, An Introduction to the Finer Anatomy of the Central Nervous System Based Upon That of the Albino Rat, (Philadelphia: P. Blakiston's Sons & Co., 1925) p. 194.

8 Peterson, op. cit., 1934, p. 19.

by referring to plates of the same
fracture was compared with each of the plates
sent of fracture and in each of the plates of the
area of the fracture.

A map of the fracture of each of the plates was
fracture was compared. The plates of the same
positive maps were made. The area of the fracture
several individual maps of the fracture were
fracture, one of one, upon which the map was
the fracture lines with heavy ink. The fracture
composite fracture lines. The fracture lines were also
with heavy ink and the area of the fracture was
the area of fracture was marked by a number of lines
particular group. In each group the fracture was
the same fracture. The area of the fracture
could be drawn as a line of fracture. The area of the
required the drawing of the fracture lines. The area of the
could then properly be traced with a pencil.
sphere. Results of this section are given in the

7. E. Home, London, 1914.
J. E. Home, London, 1914.
J. E. Home, London, 1914.
J. E. Home, London, 1914.

6. Home, London, 1914.

educated groups of Figure 1, left hemispheres. The reverse of the method was to trace, directly, right hemisphere maps and to draw mirror images of the left hemisphere destruction which might be involved. The final maps were then drawn showing only the lines comprising the total, and the common composite areas. These results are found in the re-education cases of Figure 1, right hemisphere.

estimated gross of \$1,000,000, and the
of the nation has been, however, the
and to give a full report of the
which might be made. It is also
showing only the income statement and
composite view. These reports are
cases of \$1,000,000, and the

CHAPTER IV

INTERPRETATION AND ANALYSIS OF THE DATA

General Precautions

Constant factors which will add reliability to the experiment should be mentioned.

A) The nature of a "reach" as required during the retaining period is based on the following criterion: the animal must first insert its hand into the food dish and obtain food, bring the hand and food to any point beyond the lip of the dish and then eat from the hand. This requirement is not unduly severe, for all animals which attempted any sort of reaching soon used this method exclusively. During the earliest periods of retraining a reach of another sort usually occurred. Here, the reach was one of scooping food in the dish to a level where tongue feeding was possible. The hand in these reaches remained in the dish while eating was carried on. Generally, however, during these periods some reaches of the more normal type did occur. Only reaches of the more normal type were included in the 1500 required during retraining. Furthermore, every animal which reached at all eventually became so proficient in reaching that no differences between the forced reaches and reaches by entirely normal animals could be seen.

RECEIVED
JAN 10 1941
U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PLANT INDUSTRY
WASHINGTON, D.C.

General Experiment
Conducted by: J. H. ...

Experiment should be made in ...

(A) The nature of the ...

retaining period is based on ...

animal must first ...

obtain food, which the ...

tip of the stick and ...

ment is not usually ...

any sort of ...

During the earliest ...

sort usually ...

food in the glass ...

The band in ...

not ...

some ...

of the ...

B) Motivation was maintained at the highest possible level by depriving the animals of food for at least twenty-four hours prior to an observation period. Much is made of motivation as a factor in re-education in the clinical literature. Franz¹ considered incentive, drive, or interest in the problem as a most important aid in re-education. In this experiment the operated animals were maintained, at all times, in a state of vigorous health. They contorted their bodies, scratched and bit at the dish and cage wall for long periods of time in their attempts to get food. In many cases they struggled without rest for periods exceeding two hours in length. Such struggling was especially true in the three cases (Nos. 7♀, 11♂, and 14♀) which never attempted a reach.

C) The amount of retraining was constant for all animals, consisting of 1500 forced reaches. Animals which could not be retrained in the off-set dish situations had their unaffected arms bound for a period of approximately one-third of the complete retraining course. During retraining, while the arms were bound, all but the last fifty reaches were performed in the central, canary-type dish. Then the binding

1 S. I. Franz, Motor Education, a four page paper published at the University of California, Los Angeles, California, (1928).

 

was removed and 950 additional re-education reaches were given in the off-set dish situation.

Results

The quantitative results for individual animals are given in the appendix. It can be seen that very few animals show any residual effects of retraining when finally given a preferential opportunity in the center, "T"-shaped dish. The animals which did show such effects include numbers 8♂, 9♀, 10♀, 12♀, 13♀, and 15♀. In one of these (No. 8♂) the effect amounts to but one reach, the very first one of the first test observation. This test occurred in a matter of seconds following the 1500th forced reach. Thereafter, this animal used his transferred hand exclusively; it should be classed with those which reached but showed no residual effect. In only two cases was the effect at all permanent (Nos. 24♀ and 26♀). In only one of these (No. 26♀) was there a greater use of the originally preferred hand. With animal (No. 24♀) the retrained hand was used less often than the transfer hand. There was a peculiarity in the reaches noted during the final test series of this animal. Handedness could be varied by varying the food level in the dish.² All animals were observed

² This peculiarity has been noted among ambidextrous animals and is now being systematically studied in the University of New Mexico Laboratory.

was removed and 500 additional...
in the old... and...

Results

The quantitative results for the...
given in the...
show any...
presented...
analysis...
100, 120, 140, and 160...
amount to...
test...
following the...
used his...
with those...
only two...
25%). In only one of these...
of the...
retained...
There was a...
very early...
varying the... in the...

2 This...
animals...
variety of...

regarding the peculiar trait but only No. 24♀ gave evidence of having it. In the majority of animals, (Nos. 8♂, 9♀, 10♀, 12♀, 13♀, and 15♀) which showed any residual effect of re-training, those effects were lost between the third and fourth test observation periods. The unaffected hand alone was used thereafter. Fifteen of the rats (Nos. 1♀, 2♀, 3♀, 4♀, 5♀, 6♀, 16♀, 17♀, 18♀, 19♀, 20♀, 21♀, 22♀, 23♀, and 25♀) which carried through the retraining course returned immediately to use of the unaffected or transferred hand without once taking a reach with the retrained hand. Lastly, three rats (Nos. 7♀, 11♂, and 14♀) could not be retrained. They would not reach with the affected hand in the offset dish or bound arm situations. It should be emphasized again that these animals were highly motivated. They struggled for long periods of time, were left overnight in the food situations, but the food level was never lower than what could be reached by tongue feeding. It may be restated that these animals were given an opportunity to "learn about the problem" by being put in the off-set dish for reaching by the unaffected hand for fifty reaches. They reached here, but never with the forced affected hand.

These operated animals can be compared with normal animals given training in the off-set dish. Table I, which is

regarding the possibility of only 10-15% of the population
of having 10-15% in the majority of cases, (see also 10-15%)
12, 13, and 14) which showed the following results:
training, these effects were found between the first and
fourth test observations. The results of the first test
was used throughout. The results of the first test 10-15%
42, 52, 62, 72, 82, 92, 102, 112, 122, 132, 142, 152, 162, 172, 182, 192, 202
which occurred through the training of the subjects. The results
to use of the first test in the first test and second test
taking a year, with the following results: 10-15%, 10-15%, 10-15%,
(10-15%, 10-15%, 10-15%) which was not a mistake. The results
not shown with the following results in the first test and second test
and a mistake. The results of the first test 10-15%
animals were in the first test. The results of the first test
of the first test, which was not a mistake. The results of the first test
food level was found to be 10-15% in the first test and second test
tongue feeding. The results of the first test 10-15%
given an opportunity to 10-15% in the first test and second test
put in the off-off test. The results of the first test 10-15%
for fifty percent. The results of the first test 10-15%
found affected animals.

Those animals which were not trained in the first test
animals given training in the first test. The results of the first test

summarized from an unpublished study,³ indicates the extent of influence to be expected in normal animals. It will be seen that forced practice is effective in the majority of animals, with even as few as one hundred reaches, and that all animals are influenced when given 1000 forced reaches.

TABLE I
INFLUENCE OF FORCED PRACTICE IN PRODUCING TRANSFERS
AMONG NORMAL ANIMALS

	AMOUNT OF FORCING					
	100 Reaches N=10	200 Reaches N=10	400 Reaches N=20	600 Reaches N=38	800 Reaches N=10	1000 Reaches N=9
1. Percentage of transfer	30	30	55	63	60	67
2. Percentage made ambidextrous	<u>40</u>	<u>50</u>	<u>15</u>	<u>13</u>	<u>20</u>	<u>33</u>
3. Percentage influenced	70	80	70	76	80	100
4. Percentage using originally preferred hand	<u>30</u>	<u>20</u>	<u>30</u>	<u>24</u>	<u>20</u>	<u>0</u>
Total (N=97)	100	100	100	100	100	100

Yet the operated animals of this experiment with 1500 forced reaches returned with two exceptions, to the exclusive use of the hand unaffected by brain injury.

³ G. M. Peterson, "Acetylcholine as a Neurochemical Equivalent of Practice," Unpublished Study, (1940), The University of New Mexico.

The operated group of animals can be divided into four classes:

1. Those which could be retrained with some slight residual effects.
2. Those which could be retrained but with no residual effects.
3. Those which could not be retrained.
4. Two cases which showed some permanent effects

It is informative to analyze the cases comparing these different groups as to:

- A. locus, size and nature of lesion;
- B. age of animal at time of operation;
- C. time lapse between time of operation and the time retraining was begun;
- D. types of retraining.

WEEKLY
BOND
COBBLESTONE
FLOOR

Four classes:

1. Those who are...
2. Those who are...
3. Those who are...
4. Those who are...

It is important to know...

Attention should be paid:

- A. Power, also and...
- B. and the...
- C. and the...
- D. and the...

OUTLINE OF COMPARISONS AFTER RETRAINING PERIOD*

LEFT HEMISPHERE IN FIGURE	RIGHT HEMISPHERE IN FIGURE
<p>No Re-education No subcortical destruction. Lesion ranging from 8 to 17%. Mean lesion 12%.</p> <p>Eight animals: Nos. 2♀, 5♀, 6♀, 8♂, 16♀, 19♀, 22♀, and 25♀.</p>	<p>A Re-education No subcortical destruction. Lesion area 13%.</p> <p>One animal: No. 12♀.</p>
<p>No Re-education Cortical and subcortical destruction. Lesion ranging from 13 to 27%. Mean lesion 21%.</p> <p>Eight animals: Nos. 1♀, 3♀, 4♀, 17♀, 18♀, 20♀, 21♀, and 23♀.</p>	<p>B Re-education Cortical and subcortical destruction. Lesion ranging from 15 to 30%. Mean lesion 22%.</p>
<p>Non-Reachers Cortical and subcortical destruction. Lesion ranging from 10 to 24%. Mean lesion 18%.</p> <p>Three animals: Nos. 7♀, 11♂, and 14♀.</p>	<p>C Reachers Cortical and subcortical destruction. Lesion ranging from 13 to 30%. Mean lesion 21%.</p> <p>Twelve animals: Nos. 1♀, 3♀, 4♀, 9♀, 10♀, 13♀, 15♀, 17♀, 18♀, 20♀, 21♀, and 23♀.</p>
<p>D Lasting re-education, cortical involvement only.</p> <p>No. 24♀ Lesion area 9%.</p>	<p>No. 26♀ Lesion area 3%.</p>

* See Figure 1.

FIGURE 1. COMMON AREAS IN SOLID BLACK. TOTAL AREAS OUTLINED.

Regarding animals with lesions involving no subcortical destruction (Nos. 2♀, 5♀, 6♀, 8♂, 12♀, 16♀, 19♀, 22♀, and 25♀) comparison must be made on the basis of No. 12♀ which showed some residual effect (No. 8♂ being classed as a no-re-education case). In the case of No. 12♀, the lesion site extended from the frontal pole, and almost entirely covered the critical area for handedness found by Peterson and Pracarol,⁴ which lies about 250 microns behind the genu of the corpus callosum. The lesion covered thirteen percent of the cerebral hemisphere, and a residual effect was evident through three of the final test series. In animal No. 8♂ the lesion was almost exactly comparable, being only slightly more extensive laterally, and also covering an area of thirteen percent of the hemisphere. This animal was, for practical purposes, a no residual effect animal. Both of these animals were among the group which had one arm bound during the first third of their retraining. This may indicate that the locus of lesion within the frontal lobe is not a determining factor for re-educability.

A further comparison can be made with animals No. 12♀ and No. 5♀. The lesion of No. 5♀ is but eight percent in area

4 G. M. Peterson and La Charles Pracarol, "The Relative Influence of the Locus and Mass of Destruction Upon the Control of Handedness by the Cerebral Cortex," The Journal of Comparative Neurology, 68 , No. 2, (February, 1958), pp. 173-190.

and almost identical with that of No. 12♀, except that it does not extend backward into the critical area. At the other extreme, the lesion of animal No. 2♀ includes all the area of No. 12♀ except the lateral portion. It approaches more the mid-line, and both the pole and critical area are definitely invaded. The lesion area here is seventeen percent of the hemisphere. Furthermore, the destruction of No 19♀ does not include the pole but covers the critical area and extends well to the rear of the cerebrum. Its area is also seventeen percent. A comparison of No. 12♀'s lesion with the area common (See Figure 1, page 37, A.) to Nos. 2♀, 5♀, 6♀, 8♂, 16♀, 19♀, 22♀, and 25♀ shows that the re-educated rat was similarly injured to those which would not re-educate.

It is evident, then, that re-educability does not depend upon the presence of an intact pole or an intact critical area for handedness. Nor does it depend upon the smallness of the lesion, at least when the lesion area is not less than eight percent of one hemisphere of the brain.

Other cases in which subcortical structures were invaded show results similar to the foregoing with regard to re-educability. Among these cases is the one with the greatest destruction in any animal (No. 9♀). Thirty percent of the cortex of one hemisphere was destroyed together with

invasion of the dorsal head of the caudate nucleus. There was also loss of some of the corpus striatum, septum, lentiform body, interior portion of the thalamus, and interruption of the dorsal hippocampus. This animal showed residual effects during three test observations. The lesion completely covers the frontal pole, extends to the mid-line and continues over the critical area to involve the parietal lobe. The major comparison here is with No. 20♀ where the lesion area was but thirteen percent. The caudate nucleus was very slightly invaded at the forward tip. There were no effects with this animal, having relatively slight destruction.

The reverse of this extreme is found between animal No. 15♀ and No. 3♀. Re-education animal No. 15♀ had a lesion area of fifteen percent. The pole was removed and the critical area was slightly invaded. The head of the caudate nucleus was entirely removed. This animal showed residual effects for two test observations after retraining. The area of lesion in No. 3♀ was twenty-seven percent. The pole and critical areas were removed and the injury went to the longitudinal fissure. The subcortical injury was only a slight invasion of the dorsal convexity of the caudate nucleus. Number 3♀ reverted to its transfer hand immediately after 1500 forced reaches in the off-set dish situation.

injection of the liquid into the ...
also loss of ...
body, internal ...
the dorsal ...
during three ...
the ...
the ...
compensation ...
thirteen ...
at the ...
having relatively ...

The ...
152 and No. 32. ...
of ...
was ...
two ...
No. 32 ...
were ...
the ...
convexity of ...
transfer ...
set ...

Composite comparison of the cortical and subcortical destruction cases show that the re-education animals have a slightly less total composite area of destruction as compared with animals in the same class which did not show residual effects. The common area is much greater for the re-education cases than it is with the animals showing no effects. The common area of the re-education animals would include almost the entire common area found in the opposing group. Only a slight medial notch of the "no residual effect" group's common area may not be within that of the re-education group (see Figure 1, B, page 37).

There is no evidence from these results to support a theory of mass, locus, or subcortical involvement as being significant for the re-education of handedness.

Any attempt to compare cortical only with cortical and subcortical injuries ends in bafflement, for there is no explanation of the comparison of No. 5♀, with a lesion of eight percent, cortical only, with No. 9♀, with a lesion almost four times as great with extensive subcortical damage. Possibly a better comparison, one in which animals were given exactly the same kind of retraining, is between No. 8♂ and No. 9♀. The residual effect obtained from No. 8♂ was, for any practical purpose, not present, yet it was noticeable in

BOYD
CORVETTE

the case of No. 9♀.

The non-reach animals with subcortical destruction (Nos. 7♀, 11♂, and 14♀) are compared with reaching animals with subcortical lesions (Nos. 1♀, 3♀, 4♀, 9♀, 10♀, 13♀, 15♀, 17♀, 18♀, 20♀, 21♀, and 23♀, (see Figure 1, C). The total composite area is less in the case of the non-reachers. The common area of the non-reachers would be almost entirely included in the common area of the reachers, the exception being due to a slight medial strip. This slight strip cannot be assumed to contain the region necessary for the activity or non-activity of food reaching, for several animals of the reaching group have lesions inclosing that small area completely.

In any event, no evidence is produced to support the concepts of size, locus, or nature of lesion as being, one or all, requisites for success in re-education. The theory of vicarious functioning is given very little support, for in most cases where no subcortical damage was indicated there was no recovery. In addition, small destructions may produce no effect while larger ones sometimes do permit residual effects.

Although most animals of the operated group were in the age range of 90 to 120 days at the time of their operation

an older group with ages ranging from 270 to 300 days was included (Nos. 21♀, 22♀, 23♀, 24♀, 25♀, and 26♀). The lesion areas ranged from three percent to twenty-five percent. Two of these animals had destructions quite atypical with regard to the general and should be considered separately (Nos. 24♀ and 26♀). The remaining four (Nos. 21♀, 22♀, 23♀, and 25♀) were retrained entirely in the off-set dish situation. The areas of destruction range from nine percent to twenty-five percent. In Nos. 22♀ and 25♀ there was no subcortical damage, while there was some slight damage to the caudate nucleus in Nos. 21♀ and 23♀. None of the four re-educated in any degree. These results lead to the belief that age differences between adolescent, or young adult, and older animals are not significant factors in re-educability.

In the case of five animals (Nos. 16♀, 17♀, 18♀, 19♀, and 20♀) a delay in the institution of retraining, lasting eight months and twelve days gave these results:

1. No diaschisis effect occurred;
2. No spontaneous recovery was shown.

The lesions areas ranged from nine percent to twenty-three percent. The age of the animals at the time they were operated ranged from 90 to 120 days. These cases were trained in the off-set dish situation only, and they gave absolutely no evidence of a residual effect. Comparing these with other

animals operated at the same age, and retrained in the off-set dish soon after the injury, indicates there is no significant value for early retraining as opposed to delayed retraining.

Disregarding the two animals, the unusual, Nos. 24♀ and 26♀, evidence of retraining occurred only in cases where binding down the unaffected arm was resorted to. In these cases (Nos. 8♂, 9♀, 10♀, 12♀, 13♀, and 15♀) no effects of lasting nature were obtained. Nevertheless, the only significant method in producing re-education in any degree is that involving the restriction of the unaffected arm, and this is by no means an assured means of effecting re-education in preferential handedness.

Turning to consideration of the two cases showing some permanent recovery (Nos. 24♀ and 26♀), (see Figure 1, D), it will be seen that the lesions are small; nine percent in the case of No. 24♀, and three percent for No. 26. Both of these animals were operated at the point on the cortex which gave arm movement upon electrical stimulation. Furthermore, the destructions did not involve subcortical structures. An interesting point is that both of these animals were among the older group, yet former reports have considered the possibilities of re-education to be less with the increase in age.

In the case of No. 24♀ the lesion is far removed from the general critical area for handedness. In fact, from the site of lesion it would not have been expected to transfer at all. Although anatomical variations between animals have been reported none seem to have been so extreme as this one.^{6 & 7} The injury in No. 24♀ is almost entirely lateral with a very slight invasion of the pole. Normally, the area for the cortical control of the handedness function is found on the dorsal aspect of the cortex. This would suggest that variations between animals is sometimes very great, and could suggest that variation might occur in the same animal with functional loci sometimes at one place, and at other times in another region of the same frontal area of the cortical hemisphere.

In animal No. 26♀ the lesion was more usual with regard to locus. It may have invaded the critical area but definitely did not approach the pole.

From these two cases it is not possible to state definitely that re-education was a necessary factor in their re-

6 K. S. Lashley, op. cit., 1929, p. 24.

7 G. M. Peterson and La Charles Fracarol, op. cit., pp. 180-182.

In the case of No. 261 the lesion is less removed from the general critical area for handness. In fact, from the site of lesion it would not have been expected to approach at all. Although anatomical variations between animals have been reported none seem to have been as extreme as this one. The injury in No. 242 is almost entirely lateral with a very slight invasion of the pole. Normally, the area for the cortical control of the handness function is found on the dorsal aspect of the cortex. This would suggest that variations between animals is sometimes very great, and would suggest that variation might occur in the same animal with functional foot sometimes at one place, and at other times in another region of the same frontal area of the cerebral hemisphere.

In animal No. 262 the lesion was more usual with regard to focus. It may have invaded the critical area but definitely did not approach the pole. From these two cases it is not possible to state definitely that re-association was a necessary factor in their recovery.

G. K. S. Bashley, *op. cit.*, 1939, p. 24.

V. G. M. Peterson and J. A. G. B. Peterson, *op. cit.*, 1939, pp. 180-182.

covery, for, as already mentioned, Peterson⁸ found gradual recoveries in cases in which the critical area was not completely removed.

The real value of these animals is found with consideration of the theory of equipotentiality. If the "unit" of equipotentiality requires there be no impairment of a function, the "unit," with regard to strongly right or left handed animals, is more than ninety-seven percent of the injured hemisphere. Peterson and Fracarol⁹ have already found that a loss of one percent or less among ambidexters will cause transfers and in those cases the "unit" must be between ninety-nine percent and one hundred percent of the operated hemisphere.

The results of this experiment follow closely the pattern found by Peterson¹⁰ in a study using twelve animals. In his cases all animals were retrained by binding the transferred hand. There were several different periods of retraining used. Some animals did not show any residual effects even after 1400

8 G. M. Peterson, op. cit., 1934.

9 G. M. Peterson and La Charles Fracarol, op. cit., p. 180 (Table).

10 G. M. Peterson, Unpublished Study, University of New Mexico.

covery, for, as already mentioned, Peterson found that
 recovered in cases in which the original ones were not
 clearly removed.

The real value of these animals is found in the number
 of the theory of equilibrium. It is the only
 experimentally verifiable there be no displacement of a function,
 the "unit," with regard to strongly light or darkened and
 male, is more than thirty-seven percent of the original number.
 Peterson and Peterson have already found that a loss of one
 percent or less among embryos will cause sterility and in
 those cases the "unit" must be determined by the percent and
 one hundred percent of the original number.

The results of this experiment follow closely the pattern
 found by Peterson¹⁰ in a study using twelve animals. In his
 cases all animals were retained by blinding the transverse
 hand. There were several different periods of retaining used.
 Some animals did not show any residual effects even after 1400

10 G. H. Peterson, op. cit., 1934.
 9 G. H. Peterson and J. G. Peterson, op. cit.,
 p. 180 (Table).
 10 G. H. Peterson, unpublished study, University of
 New Mexico.

forced reaches. Others showed such effects with much less retraining. One animal remained ambidextrous for a period of several months after only 500 forcings. Another began retraining but suddenly stopped and could not be forced to reach again. This peculiar case involved a lesion which did not include subcortical damage.

CHAPTER V

SUMMARY AND CONCLUSION

Summary

Twenty-six right or left handed rats were subjected to unilateral frontal lesions of the cerebrum for the purpose of studying the possibilities and limitations of re-establishing the functional recovery of hand preference. The method used in attempting re-education was the forcing of practice with the hand affected by the cerebral operation. Primarily, forcing was caused by using a dish off-set to the right or left which made it impractical for the animal to reach for food with the normal hand. In nine cases animals would not practice in this situation and binding down of the normal arm with adhesive tape was resorted to. Three of these nine would not force practice in any situation, however. Their motivation, as well as all others, was extremely high as shown by the great struggles they made in attempting to get food. Six animals, those whose arms were bound, did show some residual effect, but these effects were soon lost in all cases. Two animals of the older operated group did have residual effects of a more or less permanent nature following the retraining period. It is questionable to say that the retraining was responsible for these effects. They may have shown the recovery without retraining.

Summary

Twenty-five miles or more beyond the first station to
unilateral control. Instead of the station, the station
stationing the vessel, the stationing of the vessel, the
the functional stationing of the vessel, the stationing
in stationing the stationing of the vessel, the stationing
the hand stationing of the vessel, the stationing
stationing was stationing of the vessel, the stationing
left which stationing of the vessel, the stationing
food with the stationing of the vessel, the stationing
question of the stationing of the vessel, the stationing
with stationing of the vessel, the stationing
not force stationing of the vessel, the stationing
as well as stationing of the vessel, the stationing
stationing of the vessel, the stationing
those whose stationing of the vessel, the stationing
but these stationing of the vessel, the stationing
of the stationing of the vessel, the stationing
more or less stationing of the vessel, the stationing
it is stationing of the vessel, the stationing
for those stationing of the vessel, the stationing
stationing.

A control group of ninety-seven animals, forced to reach for food with their non-preferred hand, gave clear evidence that forced practice can influence the large majority of normal animals by causing transfers or ambidexterity and that this influence is a relatively lasting one.

From the results obtained re-education for regaining a lost function following cerebral injury is given very slight support. Where an animal must use a function to accomplish an end, many reports in the literature state that re-education is possible at the reflex level; such re-education is sometimes exceptional in cases of intellectual functions such as brightness discrimination. However, where the animal has a choice of two ways of accomplishing an end, re-education of the old preferred way after cerebral injury is almost a dismal failure over a newly adopted way. In the handedness function used in this study an intact mechanism remains to regulate the originally non-preferred hand and that hand will almost invariably be chosen for food-reaching. Yet the affected hand in most instances can, if forced, be used for food-reaching. This indicates the presence of a residual mechanism which can govern the function. Possibly this operates as a reflex. If so, an intact or restituted reflex of the affected arm will not take over the entire function of the complete mechanism part of which is found in the contralateral cerebral hemisphere.

A control group of thirty-seven subjects, known to reach for food with their non-preferred hand, gave almost invariably the same response. This large majority of normal animals by causing tremors of ambidexterity and that this influence is a reflexively learning one.

From the results obtained re-adjustment for reaching a lost function following cerebral injury is given very slight support. Where an animal must use a function to accomplish an end, many reports in the literature state that re-adjustment is possible at the reflex level; such re-adjustment is sometimes exceptional in cases of intellectual functions such as bright maze discrimination. However, where the animal has a choice of two ways of accomplishing an end, re-adjustment of the old preferred way after cerebral injury is almost a dismal failure over a newly adopted way. In the hemisphere function used in this study an intact mechanism remains to regulate the ordinarily non-preferred hand and that hand will almost invariably be chosen for food-reaching. Yet the affected hand in most instances can, if forced, be used for food-reaching. This indicates the presence of a residual mechanism which can govern the function. Presumably this operates as a reflex. It is intact or restricted reflex of the affected arm will not take over the entire function of the complete mechanism part of which is found in the contralateral cerebral hemisphere.

Where binding the unaffected arm was resorted to and there was a temporary residual effect, there is the suggestion of vicarious functioning. Nevertheless, when this forced practice was followed by a re-enforcement through re-training in the off-set dish, the recovery soon disappeared. Recovery, temporary or permanent, cannot be predicated upon variations in the size of lesions, the variations of léci within the same general area, due to either intact or severely damaged subcortical structures. Total recovery of the food reaching function following brain injury is not to be expected. In this respect doubt is cast upon the theory of equipotentiality. Likewise, diaschisis was not shown, although several animals were permitted to exist after operation for approximately one-third of the usual life span for rats. They remained as strongly transferred at the end of that period as they were when tested one week after the operation.

Conclusions

The following conclusions may be drawn from the results of this study:

1. High motivation gives no assurance that the recovery of preferential handedness in rats can be effected.
2. Residual mass is, in itself, not a determining factor for the recovery of hand preference.

3. Different loci of lesion within the frontal areas of the cerebrum do not prove to be significant factors for recovery through re-education.
4. Loss or impairment of subcortical structures indicates no greater or lesser limitations than injuries within the cortex alone.
5. Age, at least among older adolescent, young adult, and old adult animals does not have significance regarding re-educability.
6. The institution of a retraining procedure soon after cerebral injury does not seem to produce any greater recovery than that found among animals similarly injured but where a long delay occurred before retraining was begun.
7. If a retraining technique which imposes restraint upon an opposing "normal" limb in an effort to produce forced practice in the affected limb is resorted to, there is no assurance that:
 - a) any practice of any sort will occur
 - b) any success in re-education will be of a lasting nature or stable character.

However, restraint of the unaffected limb provided the only positive results obtained in this experiment.

 

of the system is not to be used in the

8. The limitations of re-educability are far greater than the possibilities.

8. The limitations of responsibility are the greater

than the possibilities.

BIBLIOGRAPHY

BEK 2140

YPCASGOTLSTH

BOLD

COEY 2140

EVLOP 2

BIBLIOGRAPHY

A. BOOKS

- Craigie, E. Horne, An Introduction to the Finer Anatomy of the Central Nervous System Based Upon That of the Albino Rat, (Philadelphia: P. Blakiston's Sons and Company, 1925). 194 pp.
- Goldstein, Kurt, The Organism, (New York: American Book Company, 1939). 533 pp.
- Lashley, Karl Spenser, Brain Mechanisms and Intelligence, (Chicago: University of Chicago Press, 1929). 186 pp.
- Morgan, Clifford T., Physiological Psychology, (New York-London: McGraw-Hill Book Company, Inc., 1943). 623 pp.
- Moss, F. A., editor, Comparative Psychology, (New York: Prentice Hall, Inc., 1942). 404 pp. Chapter 7, pp. 153-177, "The Neurology of Learning," by Donald G. Marquis.

B. PERIODICAL ARTICLES

- Franz, Shephard Ivory, "Observations on Functions of the Functions of the Association Areas (Cerebrum) in Monkeys," The Journal of the American Medical Association, 47: 1464-1467, November 3, 1906.
- _____, M. E. Sheets and A. A. Wilson, "The Possibilities of Recovery of Motor Function in Long-standing Hemiplegia," The Journal of the American Medical Association, 65:2150-2154, 1915.
- _____, and K. S. Lashley, "The Retention of Habits by the Rat After Destruction to the Frontal Portion of the Cerebrum," Psychobiology, 1, No. 1: 3-18, July, 1917.
- _____, "Studies in Re-education: The Aphasias," The Journal of Comparative Psychology, 4, No. 4: 349-429, August, 1924.
- Ghiselli, E., "The Relation Between the Striate Area and the Superior Colliculus in Brightness Discrimination," The Journal of Genetic Psychology, 52: 151-157, 1938.

REFERENCES

A. BOOKS

- Dravida, H. H., An Introduction to the History of the Central Nervous System from the Standpoint of the Physiological Basis of the Mind, 1923, 194 pp.
- Goldstein, Kurt, The Organism, (New York: American Book Company, 1932), 275 pp.
- Leslie, Mary Spenser, Brain Mechanisms and Intelligence, (Chicago: University of Chicago Press, 1932), 125 pp.
- Morgan, Clifford E., Physiological Psychology, (New York: McGraw-Hill Book Company, Inc., 1923), 623 pp.
- Ross, P. A., editor, Comparative Psychology, (New York: Prentice Hall, Inc., 1924), 404 pp. Chapter V, pp. 177-179, "The Neurology of Learning," by Donald S. Hebb.

B. PERIODICAL ARTICLES

- Pratt, Shepard Ivory, "Observations on Functions of the Functions of the Association Areas (Cerebrum) in Man," The Journal of the American Medical Association, 47: 124-127, November 3, 1906.
- M. H. Green and A. A. Elson, "The Possibilities of Recovery of Motor Function in Long-standing Hemiplegia," The Journal of the American Medical Association, 63: 1230-1234, 1915.
- and K. S. Leslie, "The Retention of Habits by the Rat After Destruction of the Frontal Portion of the Cerebrum," Psychology, 1, No. 1, 2-18, July, 1917.
- "Studies in Re-education: The Aphasia," The Journal of Comparative Psychology, 4, No. 4: 243-252, August, 1924.
- Whitell, E., "The Relation Between the Spinal Area and the Superior Colliculus in Rats," Journal of Genetic Psychology, 52: 127-129, 1928.

- Hines, Marion, "On Cerebral Localization," Physiological Reviews, 9, No. 3: 462-574, July, 1929.
- Kennard, Margaret A., "Age and Other Factors in Motor Recovery From Precentral Lesions in the Monkey," The American Journal of Physiology, 115: 138-146, March, 1936.
- Lashley, Karl S., "Studies of Cerebral Function in Learning: V. The Retention of Motor Habits After Destruction of the So-called Motor Areas in Primates," The Archives of Neurology and Psychiatry, 12: 249-276, September, 1924.
- _____, and D. A. McCarty, "The Survival of the Maze Habit After Cerebellar Injuries," The Journal of Comparative Psychology, 6: 443-434, 1926.
- _____, "Integrative Functions of the Cerebral Cortex," Physiological Reviews, 8, No. 1: 1-42, January, 1933.
- _____, and M. Frank, "The Mechanism of Vision: I. Post-operative Disturbances of Habits Based on Detail Vision in the Rat After Lesions in the Cerebral Visual Areas," The Journal of Comparative Psychology, 17: 355-380, June, 1934.
- _____, "Factors Limiting Recovery After Central Nervous Lesions," The Journal of Nervous and Mental Diseases, 88: 733-755, December, 1938.
- Oden, Robert, and S. I. Franz, "On Cerebral Motor Control: The Recovery From Experimentally Produced Hemiplegia," Psychobiology, 1, No. 1: 33-49, July, 1917.
- Peterson, George M., "A Preliminary Report on Right and Left Handedness in the Rat," The Journal of Comparative Psychology, 12: 243-250, August, 1931.
- _____, "Mechanisms of Handedness in the Rat," Comparative Psychology Monographs, 9, No. 6: 1-41, 1934.
- _____, and La Charles Fracarol, "The Relative Influence of the Locus and Mass of Destruction Upon the Control of Handedness by the Cerebral Cortex," The Journal of Comparative Neurology, 68, No. 2: 173-190, February, 1938.

- Huber, Marion, "On Cerebral Localization," Psychological Review, 9, No. 3: 455-574, July, 1902.
- Kennedy, Margaret A., "Age and Other Factors in Motor Recovery from Unilateral Lesions in the Monkey," The American Journal of Psychology, 193: 145-146, March, 1936.
- Lashey, Karl S., "Studies of Cerebral Function in Monkeys. V. The Retention of Motor Habits After Destruction of the So-called Motor Areas in Monkeys," The American Journal of Psychology, 193: 145-146, March, 1936.
- _____, and D. A. McGarr, "The Recovery of the Motor Habits After Cerebral Injury," The Journal of Experimental Psychology, 61: 443-474, 1936.
- _____, "Integrative Functions of the Cerebral Cortex," Psychological Review, 9, No. 1: 1-47, January, 1902.
- _____, and M. Frank, "The Mechanism of Vision: A Study of Operative Mechanisms of Habit Based on Visual Stimuli in the Rat After Lesions in the Cerebral Visual Areas," The Journal of Comparative Neurology, 17: 255-280, June, 1934.
- _____, "Motor Habits Based on Motor Habits," Psychological Review, 9, No. 1: 1-47, January, 1902.
- Olsen, Robert, and S. I. Franz, "On Cerebral Motor Control: The Recovery from Experimentally Produced Lesions," Psychological Review, 9, No. 1: 1-47, January, 1902.
- Peterson, George W., "A Preliminary Report on Habit and Habit Handness in the Rat," The Journal of Experimental Psychology, 12: 245-250, March, 1931.
- _____, "Mechanism of Handness in the Rat," Psychological Monographs, 9, No. 1: 1-47, 1934.
- _____, and L. Charles Swanson, "The Relative Influence of the Loss and Gain of Lesions upon the Control of Handness by the Cerebral Cortex," The Journal of Experimental Psychology, 60, No. 2: 171-180, February, 1935.

- _____, "The Influence of Cerebral Destruction Upon the Handedness of the Rat in the Latch-box," The Journal of Comparative Psychology, 26: 445-459, December 1938.
- _____, and James P. Chaplin, "Extrapyramidal Mechanisms in Handedness in the Rat," The Journal of Comparative Psychology, 33, No. 3: 343-361, June, 1942.
- Ward, Arthur, and Margaret A. Kennard, "Effect of Cholinergic Drugs on Recovery of Functioning Lesions to the Central Nervous System in Monkeys," The Yale Journal of Biology and Medicine, 15: 189-223, December, 1942.
- Watson, Charles W. and Margaret A. Kennard, "The Effect of Anticonvulsant Drugs on Recovery of Function Following Cerebral Cortical Lesions," Journal of Neurophysiology, 8: 221-231, July, 1945.
- Wentworth, K. L., "Some Factors Determining Handedness in the White Rat," Genetic Psychology Monographs, 26: 55-117, August, 1942.

C. ESSAY

- Franz, S. I., Motor Education, A four page paper published at the University of California at Los Angeles, California, 1928.

D. UNPUBLISHED MATERIALS

- Peterson, G. M., An untitled study on re-education. No date.
- _____, "Acetylcholine as a Neurochemical Equivalent of Practice," Unpublished Study, The University of New Mexico, 1940 to date.

"The Influence of Cortical Lesions upon the
Handicaps of the Rat in the Maze," The Journal of
Comparative Psychology, 35: 445-452, December 1942.

and Joseph F. Gagliardi, "Experimental Lesions in
Handicaps in the Rat," The Journal of Comparative
Psychology, 35, No. 3: 325-331, June, 1943.

Word, Arthur, and Margaret A. Leonard, "Effect of Unilateral
Tracts on Recovery of Rats after Lesions to the Cerebral
Nerve System in Monkeys," The Yale Journal of Biology
and Medicine, 37: 189-202, December, 1942.

Watson, Charles F. and Margaret A. Leonard, "The Effect of
Anticerebral Tracts on Recovery of Rats after Following
Cerebral Cortical Lesions," Journal of Neurophysiology, 8:
221-231, July, 1945.

Wentworth, E. L., "Some Factors Affecting Handicaps in the
White Rat," Genetic Psychology Monographs, 36: 55-117,
August, 1943.

C. REFERENCES

Pratt, E. L., Motor Education, A four page paper published
at the University of California at Los Angeles, California,
1938.

D. UNPUBLISHED MATERIALS

Peterson, G. M., An entitled study on education. No date.

"Acetylcholine as a Neurochemical Indicator of Pro-
cess," Unpublished Study, The University of New Mexico,
1940 to date.

APPENDIX

ИЗДАТЕЛЬСТВО

ВРЕМЕНИ

ОБЩЕСТВО

ИЗДАТЕЛЬСТВО

ОБЩЕСТВО

ИЗДАТЕЛЬСТВО

In this appendix the records of individual animals have been divided into four classes. Classification is based upon the following factors:

1. The age of the animal at the time the operation was performed.
2. The modes of retraining.
3. The time when retraining was begun following the injury.

In this appendix the records of individual animals
have been divided into four classes. Classification is
based upon the following tests:

1. The age of the animal at the time the operation
was performed.
2. The modes of restraining.
3. The time when restraining was begun following the
injury.

CLASS I (N-6)

ANIMAL NUMBERS

	Originally Preferred Hand
#1♀	Left
#2♀	Left
#3♀	Left
#4♀	Right
#5♀	Left
#6♀	Left

1. Age at time of operation: 90-120 days.
2. Retraining begun after the one week recovery period.
3. All retraining, forced reaches in the flanged, off-set dishes.

CLASS E (M-2)

UNITED STATES

Originally Reported

and

Left
Left
Left
Right
Left
Left
Left

812
827
837
844
857
867
867

1. Age at time of operation: 50-120 days.
2. Retaining beam after the one week recovery period.
3. All retaining, forced removed in the 12-week old-age.

disco.

DATE	R	L
11/4/47	0	50
5	0	50
6	0	50
Total	0	150
11/6/47	Operation R-Hemisphere	
11/11/47	50	0
12	50	0
13	50	0
Total	150	0

Complete
Transfer

DATE	FORCED REACHES L-HAND
11/13/47	none
14	none
15	none
16	none
17	none
18	none
19	3
20	1
21	none
	50 ²
22	46
23	50
24	50
25	50

DATE	REACHES
11/26/47	50
27	50
28	50
29	50
30	50
Total	500

DATE	R	L
Test A		
11/30/47	50	0

DATE	REACHES
12/1/47	50
2	50
3	50
4	50
5	50
6	50
7	50
11	50
12	50
13	50
Total	1000

DATE	R	L
Test B		
12/13/47	50	0

DATE	REACHES
12/14/47	50
15	50
16	50
17	50

1 This animal was one of two preliminary animals used to test possibilities for use of the off-set dish. After each 500 forced reaches they were tested for residual effects. None were shown in either case.

2 Placed in off-set dish for R-hand for fifty reaches, then transferred into L-dish.

412—STANDARD 2 1/2

DATE	REMARKS
11/1/47	20
11/2/47	20
11/3/47	20
11/4/47	20
11/5/47	20
11/6/47	20
11/7/47	20
11/8/47	20
11/9/47	20
11/10/47	20
11/11/47	20
11/12/47	20
11/13/47	20
11/14/47	20
11/15/47	20
11/16/47	20
11/17/47	20
11/18/47	20
11/19/47	20
11/20/47	20
11/21/47	20
11/22/47	20
11/23/47	20
11/24/47	20
11/25/47	20
11/26/47	20
11/27/47	20
11/28/47	20
11/29/47	20
11/30/47	20

DATE	REMARKS
11/1/47	20
11/2/47	20
11/3/47	20
11/4/47	20
11/5/47	20
11/6/47	20
11/7/47	20
11/8/47	20
11/9/47	20
11/10/47	20
11/11/47	20
11/12/47	20
11/13/47	20
11/14/47	20
11/15/47	20
11/16/47	20
11/17/47	20
11/18/47	20
11/19/47	20
11/20/47	20
11/21/47	20
11/22/47	20
11/23/47	20
11/24/47	20
11/25/47	20
11/26/47	20
11/27/47	20
11/28/47	20
11/29/47	20
11/30/47	20

DATE	REMARKS
11/1/47	20
11/2/47	20
11/3/47	20
11/4/47	20
11/5/47	20
11/6/47	20
11/7/47	20
11/8/47	20
11/9/47	20
11/10/47	20
11/11/47	20
11/12/47	20
11/13/47	20
11/14/47	20
11/15/47	20
11/16/47	20
11/17/47	20
11/18/47	20
11/19/47	20
11/20/47	20
11/21/47	20
11/22/47	20
11/23/47	20
11/24/47	20
11/25/47	20
11/26/47	20
11/27/47	20
11/28/47	20
11/29/47	20
11/30/47	20

DATE	REMARKS
11/1/47	20
11/2/47	20
11/3/47	20
11/4/47	20
11/5/47	20
11/6/47	20
11/7/47	20
11/8/47	20
11/9/47	20
11/10/47	20
11/11/47	20
11/12/47	20
11/13/47	20
11/14/47	20
11/15/47	20
11/16/47	20
11/17/47	20
11/18/47	20
11/19/47	20
11/20/47	20
11/21/47	20
11/22/47	20
11/23/47	20
11/24/47	20
11/25/47	20
11/26/47	20
11/27/47	20
11/28/47	20
11/29/47	20
11/30/47	20

DATE	REMARKS
11/1/47	20
11/2/47	20
11/3/47	20
11/4/47	20
11/5/47	20
11/6/47	20
11/7/47	20
11/8/47	20
11/9/47	20
11/10/47	20
11/11/47	20
11/12/47	20
11/13/47	20
11/14/47	20
11/15/47	20
11/16/47	20
11/17/47	20
11/18/47	20
11/19/47	20
11/20/47	20
11/21/47	20
11/22/47	20
11/23/47	20
11/24/47	20
11/25/47	20
11/26/47	20
11/27/47	20
11/28/47	20
11/29/47	20
11/30/47	20

DATE	REMARKS
11/1/47	20
11/2/47	20
11/3/47	20
11/4/47	20
11/5/47	20
11/6/47	20
11/7/47	20
11/8/47	20
11/9/47	20
11/10/47	20
11/11/47	20
11/12/47	20
11/13/47	20
11/14/47	20
11/15/47	20
11/16/47	20
11/17/47	20
11/18/47	20
11/19/47	20
11/20/47	20
11/21/47	20
11/22/47	20
11/23/47	20
11/24/47	20
11/25/47	20
11/26/47	20
11/27/47	20
11/28/47	20
11/29/47	20
11/30/47	20

Complete
Inventory

DATE	REMARKS
11/1/47	20
11/2/47	20
11/3/47	20
11/4/47	20
11/5/47	20
11/6/47	20
11/7/47	20
11/8/47	20
11/9/47	20
11/10/47	20
11/11/47	20
11/12/47	20
11/13/47	20
11/14/47	20
11/15/47	20
11/16/47	20
11/17/47	20
11/18/47	20
11/19/47	20
11/20/47	20
11/21/47	20
11/22/47	20
11/23/47	20
11/24/47	20
11/25/47	20
11/26/47	20
11/27/47	20
11/28/47	20
11/29/47	20
11/30/47	20

1 This animal was one of two preliminary animals used to test possibilities for use of the off-set dish. After about 500 forced responses they were tested for residual effects. None were shown in alpha case.

2 Placed in off-set dish for R-hand for first response. Then transferred into L-dish.

#12 -- SPECIAL CASE

DATE	REACHES
12/18/47	50
19	50
20	50
21	50
22	50
23	50
Total	1500

DATE	R	L
<u>Test I</u> 12/23/47	50	0
<u>Test II</u> 12/30/47	50	0
<u>Test III</u> 1/8/48	50	0
<u>Test IV</u> 1/11/48	50	0
<u>Test V</u> 1/21/48	50	0
<u>Test VI</u> 3/10/48	50	0

Area of lesion: 23%.

Subcortical involvement: tip caudate nucleus slightly invaded.

TABLE 1--RESEARCH DATA

DATE	RESEARCH
12/21/47	30
12/22/47	30
12/23/47	30
12/24/47	30
12/25/47	30
12/26/47	30
12/27/47	30
12/28/47	30
12/29/47	30
12/30/47	30
12/31/47	30
Total	300

DATE	RESEARCH	TEST
12/21/47	30	Test I
12/22/47	30	Test II
12/23/47	30	Test III
12/24/47	30	Test IV
12/25/47	30	Test V
12/26/47	30	Test VI
12/27/47	30	Test VII
12/28/47	30	Test VIII
12/29/47	30	Test IX
12/30/47	30	Test X
12/31/47	30	Test XI
Total	300	

Area of Interest: 100

Experimental Involvement: 100 (Slightly involved)

#2 ♀

DATE	R	L
12/17/47	1	49
18	2	48
19	0	50
Total	3	147
12/22/47	Operation R-Hemis- phere	
12/29/47	49	1
30	50	0
31	50	0
1/1/48	50	0
Total	199	1

Transferred

DATE	FORCED REACHES L-HAND
1/2/48	none
3	20
4	30
5	30
6	58
8	26
9	26
11	8
12	25
13	70
14	50
16	57
18	50
19	50

DATE	REACHES
1/20/48	28
21	45
23	37
24	12
25	128
26	50
27	50
28	50
29	50
31	50
2/1/48	50
2	50
3	50
4	50
10	50
12	50
13	50
17	50
18	50
20	50
Total	1500

DATE	R	L
Test I		
2/20/48	50	0
Test II		
2/27/48	50	0
Test III		
2/10/48	50	0
Test IV		
4/19/48	50	0

Area of lesion: 17%.

Subcortical involvement: none.

DATE	REMARKS
12/10/47	30
12/11/47	30
12/12/47	30
12/13/47	30
12/14/47	30
12/15/47	30
12/16/47	30
12/17/47	30
12/18/47	30
12/19/47	30
12/20/47	30
12/21/47	30
12/22/47	30
12/23/47	30
12/24/47	30
12/25/47	30
12/26/47	30
12/27/47	30
12/28/47	30
12/29/47	30
12/30/47	30
12/31/47	30
Total	1200

DATE	REMARKS	AMOUNT
12/10/47	Year I	30
12/11/47	Year II	30
12/12/47	Year III	30
12/13/47	Year IV	30
12/14/47	Year V	30
12/15/47	Year VI	30
12/16/47	Year VII	30
12/17/47	Year VIII	30
12/18/47	Year IX	30
12/19/47	Year X	30
12/20/47	Year XI	30
12/21/47	Year XII	30
12/22/47	Year XIII	30
12/23/47	Year XIV	30
12/24/47	Year XV	30
12/25/47	Year XVI	30
12/26/47	Year XVII	30
12/27/47	Year XVIII	30
12/28/47	Year XIX	30
12/29/47	Year XX	30
12/30/47	Year XXI	30
12/31/47	Year XXII	30
Total		1200

DATE	REMARKS	AMOUNT
12/10/47	Year I	30
12/11/47	Year II	30
12/12/47	Year III	30
12/13/47	Year IV	30
12/14/47	Year V	30
12/15/47	Year VI	30
12/16/47	Year VII	30
12/17/47	Year VIII	30
12/18/47	Year IX	30
12/19/47	Year X	30
12/20/47	Year XI	30
12/21/47	Year XII	30
12/22/47	Year XIII	30
12/23/47	Year XIV	30
12/24/47	Year XV	30
12/25/47	Year XVI	30
12/26/47	Year XVII	30
12/27/47	Year XVIII	30
12/28/47	Year XIX	30
12/29/47	Year XX	30
12/30/47	Year XXI	30
12/31/47	Year XXII	30
Total		1200

Transferred

DATE	REMARKS	AMOUNT
12/10/47	Year I	30
12/11/47	Year II	30
12/12/47	Year III	30
12/13/47	Year IV	30
12/14/47	Year V	30
12/15/47	Year VI	30
12/16/47	Year VII	30
12/17/47	Year VIII	30
12/18/47	Year IX	30
12/19/47	Year X	30
12/20/47	Year XI	30
12/21/47	Year XII	30
12/22/47	Year XIII	30
12/23/47	Year XIV	30
12/24/47	Year XV	30
12/25/47	Year XVI	30
12/26/47	Year XVII	30
12/27/47	Year XVIII	30
12/28/47	Year XIX	30
12/29/47	Year XX	30
12/30/47	Year XXI	30
12/31/47	Year XXII	30
Total		1200

Area of lesion: 174.

Subtotal investment: none.

DATE	R	L
11/4/47	1	4
5	0	0
6	0	0
7	0	0
10	Overnight cleaned dish	
11		
11		
11	0	50
12	0	50
13	0	50
Total	1	154
12/7/47	Operation R-Hemis- phere	
12/15/47		
16		
16	50	0
17	50	0
18	50	0
Total	200	0

Transferred

DATE	FORCED REACHES L-HAND
12/19/47	none
20	5
21	7
22	38
23	50
24	50
25	50
26	50
27	50
28	50
29	50
30	50

DATE	REACHES
12/31/47	50
1/1/48	50
2	50
3	15
4	15
5	20
6	25
8	50
9	50
11	25
12	25
13	50
14	50
16	25
18	50
19	50
20	50
21	50
23	50
24	50
25	50
26	50
27	50
28	50
29	50
Total	1500

DATE	R	L
Test I		
1/29/48	50	0
Test II		
2/5/48	50	0
Test III		
2/12/48	50	0
12/19/48	Died	

Area of lesion: 27%.

Subcortical involvement: Dorsal convexity of caudate nucleus slightly invaded.

DATE	R	L
12/17/47	50	0
18	49	1
19	50	0
Total	149	1
12/22/47	Operation L-Hemis- phere	
12/29/47	0	50
30	0	50
31	0	50
1/1/48	0	50
Total	0	200

Transferred

DATE	FORCED REACHES R-HAND
1/2/48	3
3	10
4	15
5	2
6	12
8	36
9	25
11	4
12	7
13	75
14	67
16	44
18	50
19	50
20	50
21	50

DATE	REACHES
1/23/48	50
24	50
25	50
26	50
27	50
28	50
29	50
31	50
2/1/48	50
2	50
3	50
4	50
10	50
12	50
13	50
17	50
18	50
19	50
20	50
21	50
Total	1500

DATE	R	L
Test I		
2/21/48	0	50
Test II		
2/28/48	No obser- vation	
Test III		
3/10/48	0	50
Test IV		
3/18/48	0	50
Test V		
4/17/48	0	50

Area of lesion: 24%.

Subcortical involvement: tip caudate nucleus removed, deep dorsal caudate invasion.

#5 ♀

65

DATE	R	L
12/17/47	1	49
18	0	50
19	0	50
Total	1	149
12/22/47	Operation R-Hemis- phere	
12/29/47	49	1
30	50	0
31	50	0
1/1/48	50	0
Total	199	1

Transferred

DATE	FORCED REACHES L-HAND
1/2/48	none
3	25
4	50
5	75
6	50
8	100
9	50
11	25
12	50
13	50
14	50
16	25
18	50
19	50
20	50
21	50

DATE	REACHES
1/23/48	50
24	50
25	50
26	50
27	50
28	50
29	50
31	50
2/1/48	50
2	50
3	50
4	50
10	50
12	50
13	50
Total	1500

DATE	R	L
<u>Test I</u>		
2/13/48	50	0
<u>Test II</u>		
2/21/48	50	0
<u>Test III</u>		
2/28/48	50	0
<u>Test IV</u>		
3/10/48	50	0
<u>Test V</u>		
3/18/48	50	0
<u>Test VI</u>		
4/13/48	50	0

Area of lesion: 8%.

Subcortical involvement: none.

DATE		
12/17/47	2	49
12/18/47	0	50
12/19/47	0	50
Total	2	149
12/23/47	Operation	
	H-Hand-a-	
	Phone	
12/29/47	49	1
30	50	0
31	50	0
1/1/48	50	0
Total	159	1

Transferred

DATE	WORKED BRACKET I-BAND
1/2/48	50
3	50
4	50
5	50
6	50
7	100
8	50
9	50
10	50
11	50
12	50
13	50
14	50
15	50
16	50
17	50
18	50
19	50
20	50
21	50

Area of Interest: BK.

Spectral Investigation: none.

DATE	REMARKS
1/28/48	50
29	50
30	50
31	50
2/1/48	50
2	50
3	50
4	50
5	50
6	50
7	50
8	50
9	50
10	50
11	50
12	50
13	50
Total	159

DATE	R	L
Test I	50	0
Test II	50	0
Test III	50	0
Test IV	50	0
Test V	50	0
Test VI	50	0

DATE	R	L
12/17/47	2	48
18	1	49
19	0	50
Total	3	147
12/22/47	Operation R-Hemis- phere	
12/29/47	50	0
30	50	0
31	50	0
1/1/48	50	0
Total	200	0

Transferred

DATE	FORCED REACHES L-HAND
1/2/48	50
3	100
4	50
5	50
6	50
8	75
9	75
11	50
12	50
13	50
14	50
16	50
18	50
19	50
20	50
21	50
23	50
24	50

DATE	R	L
Test A		
1/25/48	10	0
DATE	REACHES	
1/25/48	50	
26	50	
27	50	
28	50	
29	50	
31	50	
2/1/48	50	
2	50	
3	50	
4	50	
Total	1500	

DATE	R	L
Test I		
2/4/48	50	0
Test II		
2/12/48	50	0
Test III		
2/18/48	50	0
Test IV		
2/25/48	50	0
Test V		
3/10/48	50	0
Test VI		
4/10/48	50	0

Area of lesion: 11%.

Subcortical involvement: none.

1 This animal was so quick and precise in its forced reaching that a short test of ten reaches in the center dish was accomplished with no positive results.

DATE	TIME	TEST
12/17/47	10:00	Test I
12/18/47	10:00	Test II
12/19/47	10:00	Test III
12/20/47	10:00	Test IV
12/21/47	10:00	Test V
12/22/47	10:00	Test VI
12/23/47	10:00	Test VII
12/24/47	10:00	Test VIII
12/25/47	10:00	Test IX
12/26/47	10:00	Test X
12/27/47	10:00	Test XI
12/28/47	10:00	Test XII
12/29/47	10:00	Test XIII
12/30/47	10:00	Test XIV
12/31/47	10:00	Test XV

DATE	TIME	TEST
12/17/47	10:00	Test I
12/18/47	10:00	Test II
12/19/47	10:00	Test III
12/20/47	10:00	Test IV
12/21/47	10:00	Test V
12/22/47	10:00	Test VI
12/23/47	10:00	Test VII
12/24/47	10:00	Test VIII
12/25/47	10:00	Test IX
12/26/47	10:00	Test X
12/27/47	10:00	Test XI
12/28/47	10:00	Test XII
12/29/47	10:00	Test XIII
12/30/47	10:00	Test XIV
12/31/47	10:00	Test XV

DATE	TIME	TEST
12/17/47	10:00	Test I
12/18/47	10:00	Test II
12/19/47	10:00	Test III
12/20/47	10:00	Test IV
12/21/47	10:00	Test V
12/22/47	10:00	Test VI
12/23/47	10:00	Test VII
12/24/47	10:00	Test VIII
12/25/47	10:00	Test IX
12/26/47	10:00	Test X
12/27/47	10:00	Test XI
12/28/47	10:00	Test XII
12/29/47	10:00	Test XIII
12/30/47	10:00	Test XIV
12/31/47	10:00	Test XV

Transferred

DATE	TIME	TEST
12/17/47	10:00	Test I
12/18/47	10:00	Test II
12/19/47	10:00	Test III
12/20/47	10:00	Test IV
12/21/47	10:00	Test V
12/22/47	10:00	Test VI
12/23/47	10:00	Test VII
12/24/47	10:00	Test VIII
12/25/47	10:00	Test IX
12/26/47	10:00	Test X
12/27/47	10:00	Test XI
12/28/47	10:00	Test XII
12/29/47	10:00	Test XIII
12/30/47	10:00	Test XIV
12/31/47	10:00	Test XV

Area of lesion: 1/4

Subcutaneous involvement: none

This animal was so quiet and passive in its behavior that a short test of ten minutes in the water dish was accomplished with no positive results.

CLASS II (N=9)

ANIMAL NUMBERS

	Originally Preferred Hand
#7 ♀	Left
#8 ♂	Right
#9 ♀	Right
#10 ♀	Left
#11 ♂	Right
#12 ♀	Right
#13 ♀	Right
#14 ♀	Left
#15 ♀	Right

1. Age at time of operation: 90-120 days.
2. Retraining begun after the one week recovery period.
3. Attempted retraining in off-set dishes for six to seven days after which time the originally preferred arm was bound with tape and forced reaching occurred in the "T"-shaped canary dishes for 500 reaches.
4. After 500 to 550 reaches with binding, the animals were placed in the offset dish, still bound, for fifty reaches. From then on all forced reaching was accomplished in the off-set dish situation thru the 1500th forced reach. Animals 7♀, 11♂, and 14♀ would not force reach after the brain injury.

#79

DATE	R	L
1/1/48	1	49
2	0	50
3	0	50
Total	1	149
1/4/48	Operation R-Hemis- phere	
1/11/48	50	0
12	50	0
13	50	0
14	50	0
Total	200	0

Transferred

DATE	FORCED REACHES L-Hand
1/15/48	none
16	none
18	none
19	none
20	none
21	none
23	none ¹

DATE	REACHES
1/24/48	none
25	none
26	none
27	none
28	none
29	none
30	none
31	none
2/1/48	none
2	none
3	none
4	none
10	none
12	none
13	none
14	none
15	none
16	none
17	none
18	none
19	none
20	none
21	none
22	none
23	none
24	none
25	none
26	none
	unbound

Would never force reach, tongue feeding only.

Area of lesion: 24%.

Subcortical involvement: slight invasion tip of caudate nucleus.

¹ Transferred to R-dish for fifty reaches. No reaches. Right arm bound.

472

DATE	REMARKS
1/24/48	none
25	none
26	none
27	none
28	none
29	none
30	none
31	none
2/1/48	none
2	none
3	none
4	none
10	none
12	none
13	none
14	none
15	none
16	none
17	none
18	none
19	none
20	none
21	none
22	none
23	none
24	none
25	none
26	none
27	none
28	none
29	none
30	none
31	none

DATE	A	B
1/1/48	1	42
2	0	50
3	0	50
Total	1	142
1/4/48	Operation	
	5-Hours-	
	phone	
1/11/48	50	0
12	50	0
13	50	0
14	50	0
Total	200	0

Transferred

DATE	REMARKS
1/15/48	none
16	none
18	none
19	none
20	none
21	none
22	none

Would never force reach, target looking only.

Area of focus: 242.

Substantial investments: slight invasion tip of evidence
inclusion.I transferred to 5-414 for fifty weeks. He reached.
Right and bound.

#8♂

DATE	R	L
11/19/47	50	0
20	50	0
21	50	0
Total	150	0
11/22/47	Operation L-Hemis- phere	
11/29/47	0	50
30	0	50
12/1/47	0	50
2	0	50
Total	0	200

Complete Transfer

DATE	FORCED REACHES R-HAND
12/3/47	none
4	none
5	none
6	none
7	none
8	*
9	none ¹
10	none
11	none
12	17
13	50
14	33
15	50
16	none

DATE	REACHES
12/17/47	none
18	none
19	none
20	none
21	150
22	50
23	50
24	none
25	50
26	50
27	none ²
28	12
29	14
30	24
	unbound
31	50
1/1/48	50
3	50
4	50
5	50
6	50
7	3
8	50
9	47
10	50
11	50
12	50
13	50
14	50
15	50
16	50
17	50
18	50
19	50
20	50
Total	1500

* Transferred to L-hand dish for fifty reaches, immediately back to R-hand dish. No reaches.

1 Bound left arm.

2 No reaches while in R-hand dish.

DATE	R	L
<u>Test I</u> 1/20/48	1*	49
<u>Test II</u> 1/27/48	0	50
<u>Test III</u> 2/3/48	0	50
<u>Test IV</u> 2/12/48	0	50
<u>Test V</u> 2/18/48	0	50
<u>Test VI</u> 3/18/48	0	50

Area of lesion: 13%.

Subcortical involvement: very slight dorsal injury to head of caudate nucleus.

* First reach right hand.

DATE	R	I
Test I 1/10/48	1.5	40
Test II 1/10/48	0	20
Test III 1/10/48	0	20
Test IV 1/10/48	0	20
Test V 1/10/48	0	20
Test VI 1/10/48	0	20

Area of lesion: 15%.

Gastrointestinal involvement: very slight, focal in mid. to head of caudate nucleus.

* First week right hand.

DATE	R	L
11/17/47	50	0
18	50	0
19	50	0
Total	150	0
11/22/47	Operation L-Hemis- phere	
11/29/47	50	0
30	50	0
12/1/47	50	0
2	50	0
Total	200	0

No Transfer

12/2/47	Re-oper- ate L-Hem- isphere	
12/3/47	49	1
12/4/47	Re-oper- ate L-Hem- isphere	
12/5/47	0	50
6	0	50
7	0	50
8	0	50
Total	0	200

Transferred

DATE	REACHES
12/9/47	none
10	none
11	none
12	none
13	none
14	none ¹
12/31/47	Bound L- arm.
1/1/48	none
2	none
3	none
4	12
5	50
6	38
7	50
8	none
9	50
10	50
11	8
12	42
13	50
14	50
15	50
16	23
17	27
18	none ²
19	none
20	none
21	none
22	none
23	none ³
24	none
25	4
26	10
	(unbound)

1 Transferred to L-dish for fifty reaches, immediately back to R-dish.

2 Unbound arm in off-set dish situation.

3 Left arm rebound.

#9 ♀

DATE	REACHES
1/27/48	16
28	20
29	50
30	50
31	50
2/1/48	50
2	50
12	50
17	50
18	50
19	50
20	50
21	50
22	50
23	50
24	50
25	50
26	50
27	50
28	50
3/1/48	50
Total	1500

DATE	R	L
Test I ¹		
3/1/48	17	33
Test II ²		
3/9/48	1	49
Test III		
3/19/48	1	49
Test IV		
3/26/48	0	50
Test V		
4/1/48	0	50
Test VI		
5/1/48	0	50

Area of lesion: 30%.

Subcortical involvement: some loss of head (dorsal) of caudate nucleus. Slight loss of corpus striatum, septum, lentiform body. Some loss of Hippocampus, slight loss of anterior thalamus.

1 First fifteen reaches right hand, two right hand reaches mixed among thirty-three left hand.

2 One right hand reach not the first one.

BOND CORRECTION

103

Test I	Value	Test II	Value	Test III	Value	Test IV	Value	Test V	Value	Test VI	Value
1	10	1	10	1	10	1	10	1	10	1	10
2	20	2	20	2	20	2	20	2	20	2	20
3	30	3	30	3	30	3	30	3	30	3	30
4	40	4	40	4	40	4	40	4	40	4	40
5	50	5	50	5	50	5	50	5	50	5	50
6	60	6	60	6	60	6	60	6	60	6	60
7	70	7	70	7	70	7	70	7	70	7	70
8	80	8	80	8	80	8	80	8	80	8	80
9	90	9	90	9	90	9	90	9	90	9	90
10	100	10	100	10	100	10	100	10	100	10	100

Test I	Value	Test II	Value	Test III	Value	Test IV	Value	Test V	Value	Test VI	Value
1	10	1	10	1	10	1	10	1	10	1	10
2	20	2	20	2	20	2	20	2	20	2	20
3	30	3	30	3	30	3	30	3	30	3	30
4	40	4	40	4	40	4	40	4	40	4	40
5	50	5	50	5	50	5	50	5	50	5	50
6	60	6	60	6	60	6	60	6	60	6	60
7	70	7	70	7	70	7	70	7	70	7	70
8	80	8	80	8	80	8	80	8	80	8	80
9	90	9	90	9	90	9	90	9	90	9	90
10	100	10	100	10	100	10	100	10	100	10	100

Area of Section: 100.
 Suboptical investigation: Some loss of mass (normal) of
 condyle region. Right loss of condyle region, normal.
 Anterior body. Some loss of hyomandibula, slight loss of
 anterior pharynx.

- 1 First fifteen sections right hand, two right hand
 sections mixed being thirty-three left hand.
- 2 One right hand head and one right eye.

DATE	R	L
12/1/47	0	50
2	0	50
3	1	49
Total	1	149
12/4/47	Operation R-Hemis- phere	
12/11/47	50	0
12	50	0
13	50	0
14	50	0
Total	200	0

Transferred

DATE	FORCED REACHES L-HAND
12/15/47	none
16	none
17	none
18	none
19	none
20	none ¹
21	none
31	Bound R- arm.
1/1/48	none
2	none
3	50
4	50

DATE	REACHES
1/5/48	50
6	50
7	50
8	50
9	50
10	50
11	29
12	71*
13	5
14	10
15	8
16	14
17	13
	(unbound)
18	50
19	50
20	50
21	50
22	50
23	50
24	50
25	50
26	50
27	50
28	50
29	50
30	50
31	50
2/1/48	50
2	50
12	50
17	50
18	50
Total	1500

1 To R-hand dish for fifty reaches immediately back to L-dish.

* To off-set dish still bound.

#10 ♀

DATE	R	L
<u>Test I¹</u> <u>2/18/48</u>	29	21
<u>Test II²</u> <u>2/26/48</u>	49	1
<u>Test III</u> <u>3/18/48</u>	50	0
<u>Test IV</u> <u>3/18/48</u>	50	0
<u>Test V</u> <u>4/18/48</u>	50	0

Area of lesion: 25%.

Subcortical involvement: slight loss dorsally of caudate nucleus.

1 First twenty-one reaches left hand.

2 First reach left hand.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----

BEKZHT
 125
 + BOLD
 COBZVTE
 EVLOV2
 Q

Area of Section: 2.5
 Geological Survey: 1.5
 Surface: 1.0

1 First twenty-one sections only
 2 First twenty-one sections only

#11 ♂

DATE	R	L
11/19/47	50	0
20	50	0
21	50	0
Total	150	0
11/22/47	Operation L-Hemis- phere	
11/29/47	0	50
30	0	50
12/1/47	0	50
2	0	50
Total	0	200

Complete Transfer

DATE	FORCED REACHES R-HAND
12/9/47	none
10	none
11	none
12	none
13	none
14	none
15	none ¹

DATE	REACHES
12/16/47	none
17	none
18	none
19	none
20	none
21	none
22	none
23	none
24	none
25	none
26	none
27	none
28	none
29	none
30	none
31	none
1/1/48	none
2	none
3	none
4	none
5	none
6	none
7	none
8	none
9	none
10	none
11	none
12	none
	(unbound)

Left arm bound 28 days.

Area of lesion: 10%.

Subcortical involvement: like #9 except caudate nucleus intact, no involvement of thalamus or hippocampus.

¹ Transferred to L-dish for fifty reaches, then bound left arm.

1000

DATE	REMARKS
12/15/47	None
17	None
18	None
19	None
20	None
21	None
22	None
23	None
24	None
25	None
26	None
27	None
28	None
29	None
30	None
31	None
1/1/48	None
2	None
3	None
4	None
5	None
6	None
7	None
8	None
9	None
10	None
11	None
12	None

DATE	REMARKS
12/15/47	None
17	None
18	None
19	None
20	None
21	None
22	None
23	None
24	None
25	None
26	None
27	None
28	None
29	None
30	None
31	None
1/1/48	None
2	None
3	None
4	None
5	None
6	None
7	None
8	None
9	None
10	None
11	None
12	None

Complete transfer

DATE	REMARKS
12/15/47	None
17	None
18	None
19	None
20	None
21	None
22	None
23	None
24	None
25	None
26	None
27	None
28	None
29	None
30	None
31	None
1/1/48	None
2	None
3	None
4	None
5	None
6	None
7	None
8	None
9	None
10	None
11	None
12	None

Left and bound 28 days.

Area of lesion: 100.

Specialist involvement: The following results indicate that no involvement of the brain or spinal cord is present.

I transferred to L-10 for fifty weeks, then bound left arm.

DATE	R	L
12/17/47	50	0
18	50	0
19	50	0
Total	150	0
11/22/47	Operation L-Hemis- phere.	
11/29/47	0	50
30	0	50
12/1/47	0	50
2	0	50
Total	0	200

Complete Transfer

DATE	FORCED REACHES R-HAND
12/9/47	none
10	none
11	none
12	none
13	none
14	none ¹
15	none
16	Bound L- arm.
17	none
18	none
19	50
20	50
21	50
22	50

DATE	REACHES
12/23/47	50
24	50
25	50
26	50
27	50
28	15
29	35
30	50*
31	none
1/1/48	none
2	15
3	15
4	20
	(unbound)
5	50
6	50
7	50
8	50
9	50
10	50
11	50
12	50
13	50
14	50
16	50
17	100
18	50
19	50
20	50
21	50
22	50
Total	1500

DATE	R	L
Test I		
1/22/48	46	4

1 Transferred to left hand dish for fifty reaches, immediately back to right hand dish. No reaches.

* To off-set dish still bound.

#12 ♀

DATE	R	L
<u>Test II</u> <u>1/29/48</u>	10	40
<u>Test III</u> <u>2/6/48</u>	5	45
<u>Test IV</u> <u>2/13/48</u>	0	50
<u>Test V</u> <u>3/13/48</u>	0	50

Area of lesion: 13%.

Subcortical involvement: none.

#13♀

DATE	R	L
11/17/47	50	0
18	50	0
19	50	0
Total	150	0
11/22/47	Operation L-Hemis- phere	
11/29/47	0	50
30	0	50
12/1/47	0	50
2	0	50
Total	0	200

Complete Transfer

DATE	FORCED REACHES R-HAND
12/9/47	none
10	none
11	none
12	none
13	none ¹
14	none
15	bound L- arm.
16	none
17	none
18	50
19	50
20	50

DATE	REACHES
12/21/47	50
22	50
23	50
24	50
25	50
26	50
27	50
28	none ²
29	10
30	12
31	11
1/1/48	5
2	12
	(unbound)
3	8
4	42
5	50
6	50
7	50
8	50
9	50
10	50
11	50
12	50
13	50
14	50
15	50
16	50
17	50
18	100
19	50
20	50
21	50
Total	1500

1 Transferred to L-hand dish for fifty reaches, immediately back to R-hand dish. No reaches.

2 In off-set dish still bound.

#137

DATE	R	L
Test I 1/21/48	8	42
Test II 1/28/48	1	49
Test III 2/2/48	3	47
Test IV 2/12/48	0	50
Test V 3/12/48	0	50

Area of lesion: 18%.

Subcortical involvement: tip caudate nucleus very slightly invaded.

100%
 BOND
 COBALT
 100%
 100%

2012

DATE	NO.	NAME
12/12	1	JOHN J. SMITH
12/12	2	JOHN J. SMITH
12/12	3	JOHN J. SMITH
12/12	4	JOHN J. SMITH
12/12	5	JOHN J. SMITH
12/12	6	JOHN J. SMITH
12/12	7	JOHN J. SMITH
12/12	8	JOHN J. SMITH
12/12	9	JOHN J. SMITH
12/12	10	JOHN J. SMITH

Area of London: 1234

Substantial involvement: 1234

Involved: 1234

#142

DATE	R	L
1/1/48	0	50
2	0	50
3	0	50
Total	0	150
1/4/48	Operation R-Hemis- phere	
1/11/48	50	0
12	50	0
13	50	0
14	50	0
Total	200	0

Complete Transfer

For forced reaching data see #72 page 68. This animal would not force reach in any situation. The right arm was bound for twenty-eight days.

Area of lesion: 20%.

Subcortical involvement: head of caudate nucleus barely invaded.

1944

Year	1	2
1/1/48	0	50
2/1/48	0	50
3/1/48	0	50
Total	0	150
1/1/48	Operation H-Horn phase	
1/1/48	50	0
2/1/48	50	0
3/1/48	50	0
4/1/48	50	0
Total	200	0

Complete Transfer

For forced ranching data see 71 page 88. This animal would not force ranch in any situation. The right arm was found for twenty-eight days.

Area of lesion: 20%.

Subcortical involvement: head of caudate nucleus partly involved.

#15♀

DATE	R	L
12/1/47	50	0
2	50	0
3	50	0
Total	150	0
12/4/47	Operation L-Hemis- phere	
12/11/47	0	50
12	0	50
13	0	50
14	0	50
Total	0	200

Complete Transfer

DATE	FORCED REACHES R-HAND
12/21/47	none
22	none
23	none
24	none
25	none
26	none ¹
27	none
28	bound arm
29	none
30	none
31	none
1/1/48	50
2	50
3	50
4	50

DATE	REACHES
1/5/48	11
6	39
7	50
8	none
9	50
10	50
11	50
12	50
13	20 ²
14	30
	(unbound)
15	50
16	50
17	50
18	50
19	50
20	50
21	50
22	50
23	50
24	50
25	50
26	50
27	50
28	100
29	50
30	50
31	50
2/1/48	50
Total	1500

DATE	R	L
Test I		
2/1/48	9	41

1 Transferred to L-hand dish for fifty reaches, immediately back to R-dish. No reaches.

2 To off-set dish still bound.

DATE	REMARKS
12/1/47	11
2	30
3	30
4	30
5	30
6	30
7	30
8	30
9	30
10	30
11	30
12	30
13	30
14	30
15	30
16	30
17	30
18	30
19	30
20	30
21	30
22	30
23	30
24	30
25	30
26	30
27	30
28	30
29	30
30	30
31	30
1/1/48	30
Total	1200

DATE	REMARKS
12/1/47	11
2	30
3	30
4	30
5	30
6	30
7	30
8	30
9	30
10	30
11	30
12	30
13	30
14	30
15	30
16	30
17	30
18	30
19	30
20	30
21	30
22	30
23	30
24	30
25	30
26	30
27	30
28	30
29	30
30	30
31	30
1/1/48	30
Total	1200

DATE	R	L
12/1/47	50	0
2	50	0
3	50	0
Total	150	0
12/4/47	Operation	
12/11/47	1-Ham-	
12	0	50
13	0	50
14	0	50
15	0	50
Total	0	200

Complete Transaction

DATE	REMARKS
12/1/47	11
2	30
3	30
4	30
5	30
6	30
7	30
8	30
9	30
10	30
11	30
12	30
13	30
14	30
15	30
16	30
17	30
18	30
19	30
20	30
21	30
22	30
23	30
24	30
25	30
26	30
27	30
28	30
29	30
30	30
31	30
1/1/48	30
2	30
3	30
4	30

1 Transferred to L-hand side for 12/1/47 transaction, the
 immediately back to R-hand. No received.
 2 No off-set side still found.

#15♀

DATE	R	L
<u>Test II</u> <u>2/13/48</u>	0	50
<u>Test III</u> <u>2/17/48</u>	0	50
<u>Test IV</u> <u>2/24/48</u>	0	50
<u>Test V</u> <u>3/24/48</u>	0	50

Area of lesion: 15%.

Subcortical involvement: head caudate nucleus entirely removed.

1952

DATE	AMOUNT	REMARKS
1952 II	0 50	1952 II
1952 III	0 50	1952 III
1952 IV	0 50	1952 IV
1952 V	0 50	1952 V

Area of land: 152.

Subsidiary investments: land and/or mineral rights removed.

CLASS III (N=5)

ANIMAL NUMBERS

	Originally Preferred Hand
#16 ♀	Right
#17 ♀	Left
#18 ♀	Right
#19 ♀	Left
#20 ♀	Left

1. Age at time of operation: 90-120 days.
2. Retraining began eight months and twelve days after date of operation.
3. All retraining in off-set dish.
4. Two animals of this group were operated by circumsection, however, microscopic examination of the brains finds little, if any, qualitative difference between these and brains operated on by thermocautery.

1901-1902

1901-1902

1901-1902

1901-1902

1901-1902

1. Age at time of operation. (See table)
2. Retaining organ after operation. (See table)
3. All operations in one year.
4. Two animals of same breed were used in the operation. However, the operation was performed in the same manner.
5. The operation was performed in the same manner.

BRITISH
BOND
CONVICTS
1901-1902

DATE	R	L
1/18/48	50	0
19	50	0
20	50	0
Total	150	0
1/22/48	Operation L-Hemis- phere	
1/31/48	2	48
2/1/48	0	50
2	0	50
3	0	50
Total	2	198

Transferred

Period of no retraining

DATE	R	L
10/15/48	4	46
16	0	50
17	0	50
18	0	50
Total	4	196

DATE	FORCED REACHES R-HAND
10/19/48	50
20	28
21	72
22	50
23	50
24	50
25	50
27	50

DATE	REACHES
11/3/48	50
4	50
5	50
6	50
7	50
9	50
10	50
11	50
12	50
16	50
17	50
18	50
19	50
20	50
21	50
22	50
23	50
24	50
25	50
26	50
27	50
30	50
Total	1500

DATE	R	L
Test I 11/30/48	0	50
Test II 12/6/48	0	50
Test III 12/12/48	0	50
Test IV 12/20/48	0	50
Test V 12/30/48	0	50

Area of lesion: 9%.

Subcortical involvement: none.

DATE	R	L
1/18/48	0	50
19	0	50
20	0	50
Total	0	150
1/22/48	Operation R-Hemis- phere	
1/31/48	0	0
	Overnight	
2/1/48	50	0
2	50	0
3	50	0
4	50	0
Total	200	0

Complete Transfer

Period of no retraining

DATE	R	L
10/15/48	50	0
16	50	0
17	50	0
18	50	0
Total	200	0

DATE	FORCED REACHES L-HAND
10/19/48	none
20	none
21	none
22	none
23	50
24	50
25	50
27	50

DATE	REACHES
11/3/48	50
4	50
5	50
6	50
7	50
9	50
10	50
11	50
12	50
16	50
17	50
18	50
19	50
20	50
21	50
22	50
23	50
24	50
25	50
26	50
27	50
30	50
12/1/48	50
2	50
4	50
Total	1500

DATE	R	L
Test I		
12/4/48	50	0
Test II		
12/12/48	50	0
Test III		
12/20/48	50	0
Test IV		
12/30/48	50	0
Test V		
1/6/49	50	0

Area of lesion: 14%.

Subcortical involvement: dorsal caudate nucleus slightly invaded.

DATE	AMOUNT	REMARKS
11/1/48	50	11/1/48
11/2/48	50	11/2/48
11/3/48	50	11/3/48
11/4/48	50	11/4/48
11/5/48	50	11/5/48
11/6/48	50	11/6/48
11/7/48	50	11/7/48
11/8/48	50	11/8/48
11/9/48	50	11/9/48
11/10/48	50	11/10/48
11/11/48	50	11/11/48
11/12/48	50	11/12/48
11/13/48	50	11/13/48
11/14/48	50	11/14/48
11/15/48	50	11/15/48
11/16/48	50	11/16/48
11/17/48	50	11/17/48
11/18/48	50	11/18/48
11/19/48	50	11/19/48
11/20/48	50	11/20/48
11/21/48	50	11/21/48
11/22/48	50	11/22/48
11/23/48	50	11/23/48
11/24/48	50	11/24/48
11/25/48	50	11/25/48
11/26/48	50	11/26/48
11/27/48	50	11/27/48
11/28/48	50	11/28/48
11/29/48	50	11/29/48
11/30/48	50	11/30/48
Total	1500	

DATE	AMOUNT	REMARKS
12/1/48	50	12/1/48
12/2/48	50	12/2/48
12/3/48	50	12/3/48
12/4/48	50	12/4/48
12/5/48	50	12/5/48
12/6/48	50	12/6/48
12/7/48	50	12/7/48
12/8/48	50	12/8/48
12/9/48	50	12/9/48
12/10/48	50	12/10/48
12/11/48	50	12/11/48
12/12/48	50	12/12/48
12/13/48	50	12/13/48
12/14/48	50	12/14/48
12/15/48	50	12/15/48
12/16/48	50	12/16/48
12/17/48	50	12/17/48
12/18/48	50	12/18/48
12/19/48	50	12/19/48
12/20/48	50	12/20/48
12/21/48	50	12/21/48
12/22/48	50	12/22/48
12/23/48	50	12/23/48
12/24/48	50	12/24/48
12/25/48	50	12/25/48
12/26/48	50	12/26/48
12/27/48	50	12/27/48
12/28/48	50	12/28/48
12/29/48	50	12/29/48
12/30/48	50	12/30/48
Total	1500	

DATE	AMOUNT	REMARKS
1/1/49	50	1/1/49
1/2/49	50	1/2/49
1/3/49	50	1/3/49
1/4/49	50	1/4/49
1/5/49	50	1/5/49
1/6/49	50	1/6/49
1/7/49	50	1/7/49
1/8/49	50	1/8/49
1/9/49	50	1/9/49
1/10/49	50	1/10/49
1/11/49	50	1/11/49
1/12/49	50	1/12/49
1/13/49	50	1/13/49
1/14/49	50	1/14/49
1/15/49	50	1/15/49
1/16/49	50	1/16/49
1/17/49	50	1/17/49
1/18/49	50	1/18/49
1/19/49	50	1/19/49
1/20/49	50	1/20/49
1/21/49	50	1/21/49
1/22/49	50	1/22/49
1/23/49	50	1/23/49
1/24/49	50	1/24/49
1/25/49	50	1/25/49
1/26/49	50	1/26/49
1/27/49	50	1/27/49
1/28/49	50	1/28/49
1/29/49	50	1/29/49
1/30/49	50	1/30/49
Total	1500	

Complete Transfer

Period of no reporting

DATE	AMOUNT	REMARKS
10/1/48	50	10/1/48
10/2/48	50	10/2/48
10/3/48	50	10/3/48
10/4/48	50	10/4/48
10/5/48	50	10/5/48
10/6/48	50	10/6/48
10/7/48	50	10/7/48
10/8/48	50	10/8/48
10/9/48	50	10/9/48
10/10/48	50	10/10/48
10/11/48	50	10/11/48
10/12/48	50	10/12/48
10/13/48	50	10/13/48
10/14/48	50	10/14/48
10/15/48	50	10/15/48
10/16/48	50	10/16/48
10/17/48	50	10/17/48
10/18/48	50	10/18/48
10/19/48	50	10/19/48
10/20/48	50	10/20/48
10/21/48	50	10/21/48
10/22/48	50	10/22/48
10/23/48	50	10/23/48
10/24/48	50	10/24/48
10/25/48	50	10/25/48
10/26/48	50	10/26/48
10/27/48	50	10/27/48
10/28/48	50	10/28/48
10/29/48	50	10/29/48
10/30/48	50	10/30/48
Total	1500	

DATE	AMOUNT	REMARKS
10/1/48	50	10/1/48
10/2/48	50	10/2/48
10/3/48	50	10/3/48
10/4/48	50	10/4/48
10/5/48	50	10/5/48
10/6/48	50	10/6/48
10/7/48	50	10/7/48
10/8/48	50	10/8/48
10/9/48	50	10/9/48
10/10/48	50	10/10/48
10/11/48	50	10/11/48
10/12/48	50	10/12/48
10/13/48	50	10/13/48
10/14/48	50	10/14/48
10/15/48	50	10/15/48
10/16/48	50	10/16/48
10/17/48	50	10/17/48
10/18/48	50	10/18/48
10/19/48	50	10/19/48
10/20/48	50	10/20/48
10/21/48	50	10/21/48
10/22/48	50	10/22/48
10/23/48	50	10/23/48
10/24/48	50	10/24/48
10/25/48	50	10/25/48
10/26/48	50	10/26/48
10/27/48	50	10/27/48
10/28/48	50	10/28/48
10/29/48	50	10/29/48
10/30/48	50	10/30/48
Total	1500	

Area of London: 144

Subsidiary investments: 144
Invested.

#18?

DATE	R	L
1/18/48	50	0
19	50	0
20	50	0
Total	150	0
1/22/48	Operation L-Hemis- phere	
1/31/48	0	50
2/1/48	0	50
2	0	50
3	0	50
Total	0	200

Complete Transfer

Period of no retraining

DATE	R	L
10/15/48	0	50
16	0	50
17	0	50
18	0	50
Total	0	200

DATE	FORCED REACHES R-HAND
10/19/48	none
20	13
21	62
22	75
23	50
24	50
25	50
27	50
11/3/48	50

DATE	REACHES
11/4/48	50
5	50
6	25
8	25
9	50
10	50
11	50
12	50
16	50
17	50
18	50
19	25
20	75
21	50
22	50
23	50
24	50
25	50
26	50
27	50
30	50
12/1/48	50
4	50
Total	1500

DATE	R	L
Test I		
12/4/48	0	50
Test II		
12/12/48	0	50
Test III		
12/20/48	0	50
Test IV		
12/30/48	0	50
Test V		
1/6/49	0	50

Area of lesion: 23%.

Subcortical involvement:: very slight dorsal caudate invasion, fimbria touched.

DATE	H	I
1/18/48	50	0
19	50	0
20	50	0
Total	150	0
1/22/48	Operation I-Kent- Phase	
1/21/48	0	50
2/1/48	0	50
2	0	50
2	0	50
Total	0	200

Complete Transfer

Period of no recording

DATE	H	I
10/13/48	0	50
18	0	50
17	0	50
18	0	50
Total	0	200

DATE	RECORDS H-HAND	RECORDS I-HAND
10/13/48	none	50
20		50
21		50
22		50
23		50
24		50
25		50
27		50
11/2/48		50

Area of action: 25%

Substantial involvement: very slight coral damage observed.
flaple touched.

DATE	H	I
1/17/48	0	50
18	0	50
19	0	50
20	0	50
21	10	50
22	11	50
23	12	50
24	13	50
25	14	50
26	15	50
27	16	50
28	17	50
29	18	50
30	19	50
31	20	50
1/2/48	21	50
3	22	50
4	23	50
5	24	50
6	25	50
7	26	50
8	27	50
9	28	50
10	29	50
11	30	50
12/1/48	31	50
2	32	50
Total	12/1/48	1200

I	II	III
02	0	11 1

DATE	R	L
1/18/48	0	50
19	0	50
20	0	50
Total	0	150
1/22/48	Operation R-Hemis- phere	
1/31/48	50	0
2/1/48	50	0
2	50	0
3	50	0
Total	200	0

Complete Transfer

Period of no retraining

DATE	R	L
10/15/48	49	1
16	50	0
17	50	0
18	50	0
Total	199	1

DATE	FORCED REACHES L-HAND
10/19/48	none
20	none
21	none
22	50
23	50
24	50
25	50
27	50
11/3/48	50
4	50

DATE	REACHES
11/5/48	50
6	50
7	50
9	50
10	50
11	50
12	50
16	50
17	50
18	50
19	50
20	50
21	50
22	50
23	50
24	50
25	50
26	50
27	50
30	50
12/1/48	50
3	50
4	50
Total	1500

DATE	R	L
Test I 12/4/48	50	0
Test II 12/12/48	50	0
Test III 12/20/48	50	0
Test IV 12/30/48	50	0
Test V 1/6/49	50	0

Area of lesion: 17%.

Subcortical involvement: none.

DATE	R	L
1/18/48	0	50
19	0	50
20	1	49
Total	1	149
1/22/48	Operation R-Hemis- phere	
1/31/48	50	0
2/1/48	50	0
2	50	0
3	50	0
Total	200	0

Transferred

Period of no retraining

DATE	R	L
10/15/48	50	0
16	50	0
17	50	0
18	50	0
Total	200	0

DATE	FORCED REACHES L-HAND
10/19/48	none
20	29
21	8
22	50
23	50
24	50
25	50
27	50
11/3/48	50

DATE	REACHES
11/4/48	50
5	50
6	50
7	50
9	63
10	50
11	50
12	50
16	50
17	50
18	50
19	50
20	50
21	50
22	50
23	50
24	50
25	50
26	50
27	50
30	50
12/1/48	50
4	50
Total	1500

DATE	R	L
Test I 12/4/48	50	0
Test II 12/12/48	50	0
Test III 12/20/48	50	0
Test IV 12/30/48	50	0
Test V 1/6/49	50	0

Area of lesion: 13%.

Subcortical involvement: tip caudate slightly invaded.

(Continued)

DATE	REACHES
12/1/48	20
12/2/48	20
12/3/48	20
12/4/48	20
12/5/48	20
12/6/48	20
12/7/48	20
12/8/48	20
12/9/48	20
12/10/48	20
12/11/48	20
12/12/48	20
12/13/48	20
12/14/48	20
12/15/48	20
12/16/48	20
12/17/48	20
12/18/48	20
12/19/48	20
12/20/48	20
12/21/48	20
12/22/48	20
12/23/48	20
12/24/48	20
12/25/48	20
12/26/48	20
12/27/48	20
12/28/48	20
12/29/48	20
12/30/48	20
Total	1200

DATE	REACHES
12/1/48	20
12/2/48	20
12/3/48	20
12/4/48	20
12/5/48	20
12/6/48	20
12/7/48	20
12/8/48	20
12/9/48	20
12/10/48	20
12/11/48	20
12/12/48	20
12/13/48	20
12/14/48	20
12/15/48	20
12/16/48	20
12/17/48	20
12/18/48	20
12/19/48	20
12/20/48	20
12/21/48	20
12/22/48	20
12/23/48	20
12/24/48	20
12/25/48	20
12/26/48	20
12/27/48	20
12/28/48	20
12/29/48	20
12/30/48	20

DATE	REACHES
12/1/48	20
12/2/48	20
12/3/48	20
12/4/48	20
12/5/48	20
12/6/48	20
12/7/48	20
12/8/48	20
12/9/48	20
12/10/48	20
12/11/48	20
12/12/48	20
12/13/48	20
12/14/48	20
12/15/48	20
12/16/48	20
12/17/48	20
12/18/48	20
12/19/48	20
12/20/48	20
12/21/48	20
12/22/48	20
12/23/48	20
12/24/48	20
12/25/48	20
12/26/48	20
12/27/48	20
12/28/48	20
12/29/48	20
12/30/48	20
Total	1200

Period of no reaching

DATE	REACHES
12/1/48	20
12/2/48	20
12/3/48	20
12/4/48	20
12/5/48	20
12/6/48	20
12/7/48	20
12/8/48	20
12/9/48	20
12/10/48	20
12/11/48	20
12/12/48	20
12/13/48	20
12/14/48	20
12/15/48	20
12/16/48	20
12/17/48	20
12/18/48	20
12/19/48	20
12/20/48	20
12/21/48	20
12/22/48	20
12/23/48	20
12/24/48	20
12/25/48	20
12/26/48	20
12/27/48	20
12/28/48	20
12/29/48	20
12/30/48	20

DATE	REACHES
12/1/48	20
12/2/48	20
12/3/48	20
12/4/48	20
12/5/48	20
12/6/48	20
12/7/48	20
12/8/48	20
12/9/48	20
12/10/48	20
12/11/48	20
12/12/48	20
12/13/48	20
12/14/48	20
12/15/48	20
12/16/48	20
12/17/48	20
12/18/48	20
12/19/48	20
12/20/48	20
12/21/48	20
12/22/48	20
12/23/48	20
12/24/48	20
12/25/48	20
12/26/48	20
12/27/48	20
12/28/48	20
12/29/48	20
12/30/48	20

Area of land: 1200

Statistical investigation: 1200

CLASS IV (N=6)

ANIMAL NUMBERS

Originally Preferred
Hand

#21 ♀	Right
#22 ♀	Left
#23 ♀	Right
#24 ♀	Right
#25 ♀	Right
#26 ♀	Left

1. Age at time of operation: 270-300 days.
2. Retraining begun immediately after one week recovery period.
3. All retraining in off-set dish situation.

CLASS IV (M-6)

ARMED SERVICES

Officially Released

Left
Left
Left
Left
Left
Left
Left

Left
Left
Left
Left
Left
Left
Left

1. Age at time of operation: 270-500 days.
2. Retention time: Immediately after one week in custody.
3. All retention in off-set disk operation.

DATE	R	L
10/6/48	50	0
7	50	0
8	50	0
Total	150	0
10/13/48	Operation L-Hemis- phere.	
10/22/48	0	50
23	0	50
24	0	50
27	0	50
Total	0	200

Complete Transfer

DATE	FORCED REACHES R-HAND
11/4/48	none
5	50
6	50
7	none
9	50
10	50
11	50
12	50
16	50
17	50
18	50

DATE	REACHES
11/19/48	50
20	50
21	50
22	50
23	50
24	50
25	50
26	50
27	50
30	50
12/1/48	50
2	50
3	50
4	50
5	50
6	50
11	50
12	50
13	50
15	50
16	50
Total	1500

DATE	R	L
Test I		
12/16/48	0	50
Test II		
12/22/48	0	50
12/27/48	Died	

Area of lesion: 15%.

Subcortical involvement: tip caudate slightly invaded.

DATE	1	2
10/6/48	70	0
7	20	0
8	20	0
Total	110	0
10/13/48	Operation	
	1-Henry	
	charge	
10/20/48	0	20
21	0	20
22	0	20
23	0	20
24	0	20
Total	0	100

Complete Transfer

DATE	1	2
11/4/48	none	20
5	20	0
6	20	0
7	none	20
8	20	0
10	20	0
11	20	0
12	20	0
13	20	0
14	20	0
15	20	0
16	20	0

Area of Interest: 12%

DATE	1	2
11/1/48	20	0
2	20	0
3	20	0
4	20	0
5	20	0
6	20	0
7	20	0
8	20	0
9	20	0
10	20	0
11	20	0
12	20	0
13	20	0
14	20	0
15	20	0
16	20	0
17	20	0
18	20	0
19	20	0
20	20	0
Total	400	0

DATE	1	2
11/17/48	0	20
Total II	0	20
12/21/48	20	0

Exponential Investment: 20% and slightly increased.

#22 ♀

DATE	R	L
10/5/48	2	48
6	0	50
7	0	50
Total	2	148
10/13/48	Operation R-Hemis- phere	
10/22/48	25	0
23	75	0
24	50	0
27	50	0
Total	200	0
Transferred		
DATE	FORCED REACHES L-HAND	
11/4/48	none	
5	50	
6	50	
7	none	
9	50	
10	50	
11	50	
12	50	
16	40	
17	60	
18	50	
19	50	
20	22	
21	78	
22	50	

DATE	REACHES
11/23/48	50
24	50
25	50
26	50
27	50
30	50
12/1/48	50
2	50
3	50
4	50
5	50
6	50
11	50
12	50
13	50
15	50
16	50
Total	1500

DATE	R	L
Test I		
12/16/48	50	0
Test II		
12/22/48	50	0
Test III		
12/30/48	50	0
Test IV		
1/6/49	50	0
Test V		
1/13/49	50	0

Area of lesion: 13%.

Subcortical involvement: none.

#23 ♀

DATE	R	L
10/2/48	48	2
3	50	0
4	50	0
Total	148	2
10/13/48	Operation L-Hemis- phere	
10/22/48	0	50
23	0	50
24	0	50
27	0	50
Total	0	200

Transferred

DATE	FORCED REACHES R-HAND
11/4/48	none
5	none
6	none
7	none
	Overnight
8	50
9	50
10	50
11	50
12	50
16	50
17	50
18	50
19	50
20	50

DATE	REACHES
11/21/48	50
22	50
23	50
24	50
25	50
26	50
27	50
30	50
12/1/48	50
2	50
3	50
4	50
5	50
6	50
11	50
12	50
13	50
14	50
15	50
16	50
Total	1500

DATE	R	L
Test I		
12/16/48	0	50
Test II		
12/23/48	0	0 ¹
Test III		
12/30/48	0	50
Test IV		
1/6/49	0	4

Area of lesion: 25%.

Subcortical involvement: tip caudate nucleus removed.

1 Would not reach.

#24 ♀

DATE	R	L
10/5/48	48	2
6	50	0
7	50	0
Total	148	2
10/13/48	Operation L-Hemis- phere	
10/22/48	0	50
23	0	50
24	0	50
27	0	50
Total	0	200

Transferred

DATE	FORCED REACHES R-HAND
11/4/48	25
5	50
6	50
7	19
9	31
10	50
11	50
12	50
16	50
17	50
18	50
19	50
20	50
21	50
22	50
23	75

DATE	REACHES
11/24/48	50
25	50
26	50
27	50
30	50
12/1/48	50
2	50
3	50
4	50
5	50
6	50
11	50
12	50
15	50
16	50
Total	1500

DATE	R	L
Test I 12/16/48	8	42
Test II 12/22/48	17	33
Test III 12/30/48	14	36
Test IV 1/6/49	6	44
Test V 1/13/49	3	47
Test VI 2/13/49	12	38

Area of lesion: 9%.

Subcortical involvement: none.

DATE	DESCRIPTION
10/1/48	100.00
10/2/48	100.00
10/3/48	100.00
10/4/48	100.00
10/5/48	100.00
10/6/48	100.00
10/7/48	100.00
10/8/48	100.00
10/9/48	100.00
10/10/48	100.00
10/11/48	100.00
10/12/48	100.00
10/13/48	100.00
10/14/48	100.00
10/15/48	100.00
10/16/48	100.00
10/17/48	100.00
10/18/48	100.00
10/19/48	100.00
10/20/48	100.00
10/21/48	100.00
10/22/48	100.00
10/23/48	100.00
10/24/48	100.00
10/25/48	100.00
10/26/48	100.00
10/27/48	100.00
10/28/48	100.00
10/29/48	100.00
10/30/48	100.00
10/31/48	100.00
TOTAL	3000.00

DATE	DESCRIPTION
10/1/48	100.00
10/2/48	100.00
10/3/48	100.00
10/4/48	100.00
10/5/48	100.00
10/6/48	100.00
10/7/48	100.00
10/8/48	100.00
10/9/48	100.00
10/10/48	100.00
10/11/48	100.00
10/12/48	100.00
10/13/48	100.00
10/14/48	100.00
10/15/48	100.00
10/16/48	100.00
10/17/48	100.00
10/18/48	100.00
10/19/48	100.00
10/20/48	100.00
10/21/48	100.00
10/22/48	100.00
10/23/48	100.00
10/24/48	100.00
10/25/48	100.00
10/26/48	100.00
10/27/48	100.00
10/28/48	100.00
10/29/48	100.00
10/30/48	100.00
10/31/48	100.00
TOTAL	3000.00

Continued

DATE	DESCRIPTION
10/1/48	100.00
10/2/48	100.00
10/3/48	100.00
10/4/48	100.00
10/5/48	100.00
10/6/48	100.00
10/7/48	100.00
10/8/48	100.00
10/9/48	100.00
10/10/48	100.00
10/11/48	100.00
10/12/48	100.00
10/13/48	100.00
10/14/48	100.00
10/15/48	100.00
10/16/48	100.00
10/17/48	100.00
10/18/48	100.00
10/19/48	100.00
10/20/48	100.00
10/21/48	100.00
10/22/48	100.00
10/23/48	100.00
10/24/48	100.00
10/25/48	100.00
10/26/48	100.00
10/27/48	100.00
10/28/48	100.00
10/29/48	100.00
10/30/48	100.00
10/31/48	100.00
TOTAL	3000.00

DATE	DESCRIPTION
10/1/48	100.00
10/2/48	100.00
10/3/48	100.00
10/4/48	100.00
10/5/48	100.00
10/6/48	100.00
10/7/48	100.00
10/8/48	100.00
10/9/48	100.00
10/10/48	100.00
10/11/48	100.00
10/12/48	100.00
10/13/48	100.00
10/14/48	100.00
10/15/48	100.00
10/16/48	100.00
10/17/48	100.00
10/18/48	100.00
10/19/48	100.00
10/20/48	100.00
10/21/48	100.00
10/22/48	100.00
10/23/48	100.00
10/24/48	100.00
10/25/48	100.00
10/26/48	100.00
10/27/48	100.00
10/28/48	100.00
10/29/48	100.00
10/30/48	100.00
10/31/48	100.00
TOTAL	3000.00

BOLD
 ACCOUNTS
 10/1/48

Lines of text: 10/1/48
 Subsequent lines: 10/2/48, 10/3/48, etc.

#25 ♀

DATE	R	L
10/2/48	50	0
3	50	0
4	50	0
Total	150	0
10/13/48	Operation L-Hemis- phere	
10/22/48	0	50
23	0	50
24	0	50
27	0	50
Total	0	200
Complete Transfer		
DATE	FORCED REACHES R-HAND	
11/4/48	none	
5	none	
6	none	
7	none	
8	none	
	Overnight	
9	50	
10	50	
11	50	
12	50	
16	50	
17	50	
18	50	
19	50	
20	50	
21	50	

DATE	REACHES
11/22/48	50
23	50
24	50
25	50
26	50
27	50
30	50
12/1/48	50
2	50
3	50
4	50
5	50
6	50
11	50
12	100
13	50
14	50
15	50
16	50
Total	1500

DATE	R	L
Test I		
12/16/48	0	50
Test II		
12/22/48	0	50
Test III		
12/30/48	0	50
Test IV		
1/6/49	0	50
Test V		
1/13/49	0	50

Area of lesion: 9%.

Subcortical involvement: none.

DATE	TIME	REMARKS
11/13/48	11:15	20
	11:20	20
	11:25	20
	11:30	20
	11:35	20
	11:40	20
	11:45	20
	11:50	20
	11:55	20
	12:00	20
	12:05	20
	12:10	20
	12:15	20
	12:20	20
	12:25	20
	12:30	20
	12:35	20
	12:40	20
	12:45	20
	12:50	20
	12:55	20
	13:00	20
	13:05	20
	13:10	20
	13:15	20
	13:20	20
	13:25	20
	13:30	20
	13:35	20
	13:40	20
	13:45	20
	13:50	20
	13:55	20
	14:00	20
	14:05	20
	14:10	20
	14:15	20
	14:20	20
	14:25	20
	14:30	20
	14:35	20
	14:40	20
	14:45	20
	14:50	20
	14:55	20
	15:00	20
	15:05	20
	15:10	20
	15:15	20
	15:20	20
	15:25	20
	15:30	20
	15:35	20
	15:40	20
	15:45	20
	15:50	20
	15:55	20
	16:00	20
	16:05	20
	16:10	20
	16:15	20
	16:20	20
	16:25	20
	16:30	20
	16:35	20
	16:40	20
	16:45	20
	16:50	20
	16:55	20
	17:00	20
	17:05	20
	17:10	20
	17:15	20
	17:20	20
	17:25	20
	17:30	20
	17:35	20
	17:40	20
	17:45	20
	17:50	20
	17:55	20
	18:00	20
	18:05	20
	18:10	20
	18:15	20
	18:20	20
	18:25	20
	18:30	20
	18:35	20
	18:40	20
	18:45	20
	18:50	20
	18:55	20
	19:00	20
	19:05	20
	19:10	20
	19:15	20
	19:20	20
	19:25	20
	19:30	20
	19:35	20
	19:40	20
	19:45	20
	19:50	20
	19:55	20
	20:00	20
	20:05	20
	20:10	20
	20:15	20
	20:20	20
	20:25	20
	20:30	20
	20:35	20
	20:40	20
	20:45	20
	20:50	20
	20:55	20
	21:00	20
	21:05	20
	21:10	20
	21:15	20
	21:20	20
	21:25	20
	21:30	20
	21:35	20
	21:40	20
	21:45	20
	21:50	20
	21:55	20
	22:00	20
	22:05	20
	22:10	20
	22:15	20
	22:20	20
	22:25	20
	22:30	20
	22:35	20
	22:40	20
	22:45	20
	22:50	20
	22:55	20
	23:00	20
	23:05	20
	23:10	20
	23:15	20
	23:20	20
	23:25	20
	23:30	20
	23:35	20
	23:40	20
	23:45	20
	23:50	20
	23:55	20
	24:00	20
	24:05	20
	24:10	20
	24:15	20
	24:20	20
	24:25	20
	24:30	20
	24:35	20
	24:40	20
	24:45	20
	24:50	20
	24:55	20
	25:00	20
	25:05	20
	25:10	20
	25:15	20
	25:20	20
	25:25	20
	25:30	20
	25:35	20
	25:40	20
	25:45	20
	25:50	20
	25:55	20
	26:00	20
	26:05	20
	26:10	20
	26:15	20
	26:20	20
	26:25	20
	26:30	20
	26:35	20
	26:40	20
	26:45	20
	26:50	20
	26:55	20
	27:00	20
	27:05	20
	27:10	20
	27:15	20
	27:20	20
	27:25	20
	27:30	20
	27:35	20
	27:40	20
	27:45	20
	27:50	20
	27:55	20
	28:00	20
	28:05	20
	28:10	20
	28:15	20
	28:20	20
	28:25	20
	28:30	20
	28:35	20
	28:40	20
	28:45	20
	28:50	20
	28:55	20
	29:00	20
	29:05	20
	29:10	20
	29:15	20
	29:20	20
	29:25	20
	29:30	20
	29:35	20
	29:40	20
	29:45	20
	29:50	20
	29:55	20
	30:00	20
	30:05	20
	30:10	20
	30:15	20
	30:20	20
	30:25	20
	30:30	20
	30:35	20
	30:40	20
	30:45	20
	30:50	20
	30:55	20
	31:00	20
	31:05	20
	31:10	20
	31:15	20
	31:20	20
	31:25	20
	31:30	20
	31:35	20
	31:40	20
	31:45	20
	31:50	20
	31:55	20
	32:00	20
	32:05	20
	32:10	20
	32:15	20
	32:20	20
	32:25	20
	32:30	20
	32:35	20
	32:40	20
	32:45	20
	32:50	20
	32:55	20
	33:00	20
	33:05	20
	33:10	20
	33:15	20
	33:20	20
	33:25	20
	33:30	20
	33:35	20
	33:40	20
	33:45	20
	33:50	20
	33:55	20
	34:00	20
	34:05	20
	34:10	20
	34:15	20
	34:20	20
	34:25	20
	34:30	20
	34:35	20
	34:40	20
	34:45	20
	34:50	20
	34:55	20
	35:00	20
	35:05	20
	35:10	20
	35:15	20
	35:20	20
	35:25	20
	35:30	20
	35:35	20
	35:40	20
	35:45	20
	35:50	20
	35:55	20
	36:00	20
	36:05	20
	36:10	20
	36:15	20
	36:20	20
	36:25	20
	36:30	20
	36:35	20
	36:40	20
	36:45	20
	36:50	20
	36:55	20
	37:00	20
	37:05	20
	37:10	20
	37:15	20
	37:20	20
	37:25	20
	37:30	20
	37:35	20
	37:40	20
	37:45	20
	37:50	20
	37:55	20
	38:00	20
	38:05	20
	38:10	20
	38:15	20
	38:20	20
	38:25	20
	38:30	20
	38:35	20
	38:40	20
	38:45	20
	38:50	20
	38:55	20
	39:00	20
	39:05	20
	39:10	20
	39:15	20
	39:20	20
	39:25	20
	39:30	20
	39:35	20
	39:40	20
	39:45	20
	39:50	20
	39:55	20
	40:00	20
	40:05	20
	40:10	20
	40:15	20
	40:20	20
	40:25	20
	40:30	20
	40:35	20
	40:40	20
	40:45	20
	40:50	20
	40:55	20
	41:00	20
	41:05	20
	41:10	20
	41:15	20
	41:20	20
	41:25	20
	41:30	20
	41:35	20
	41:40	20
	41:45	20
	41:50	20
	41:55	20
	42:00	20
	42:05	20
	42:10	20
	42:15	20
	42:20	20
	42:25	20
	42:30	20
	42:35	20
	42:40	20
	42:45	20
	42:50	20
	42:55	20
	43:00	20
	43:05	20
	43:10	20
	43:15	20
	43:20	20
	43:25	20
	43:30	20
	43:35	20
	43:40	20
	43:45	20
	43:50	20
	43:55	20
	44:00	20
	44:05	20
	44:10	20
	44:15	20
	44:20	20
	44:25	20
	44:30	20
	44:35	20
	44:40	20
	44:45	20
	44:50	20
	44:55	20
	45:00	20
	45:05	20
	45:10	20
	45:15	20
	45:20	20
	45:25	20
	45:30	20
	45:35	20
	45:40	20
	45:45	20
	45:50	20
	45:55	20
	46:00	20
	46:05	20
	46:10	20
	46:15	20
	46:20	20
	46:25	20
	46:30	20
	46:35	20
	46:40	20
	46:45	20
	46:50	20
	46:55	20
	47:00	20
	47:05	20
	47:10	20
	47:15	20
	47:20	20
	47:25	20
	47:30	20
	47:35	20
	47:40	20
	47:45	20
	47:50	20
	47:55	20
	48:00	20
	48:05	20
	48:10	20
	48:15	20
	48:20	20
	48:25	20
	48:30	20
	48:35	20
	48:40	20
	48:45	20
	48:50	20
	48:55	20
	49:00	

DATE	R	L
10/2/48	1	49
3	0	50
4	0	50
Total	1	149
10/13/48	Operation R-Hemis- phere	
10/22/48	49	1
23	50	0
24	0	0
	Overnight	
25	0	0
27	50	0
28	50	0
Total	199	1

Transferred

DATE	FORCED REACHES L-HAND
11/4/48	50
5	50
6	50
7	none
9	50
10	50
11	50
12	50
16	32
17	18
18	50
19	50
20	1
21	99
22	50

DATE	REACHES
11/23/48	50
24	50
25	50
26	50
27	50
30	50
12/1/48	50
2	50
3	50
4	50
5	50
6	50
11	50
12	50
13	50
15	50
16	50
Total	1500

DATE	R	L
Test I		
12/16/48	25	25
Test II		
12/23/48	0	0 ¹
Test III		
12/30/48	31	19
Test IV		
1/6/49	16	34
Test V		
1/13/49	13	37
Test VI		
2/13/49	5	45

Area of lesion: 3%.

Subcortical involvement: none.

1 Would not reach.

DATE	I	A
10/2/48	1	20
3	0	20
4	0	20
Total	1	60
10/12/48	2	20
3	0	20
4	0	20
Total	2	60
10/22/48	3	20
3	0	20
4	0	20
Total	3	60
10/32/48	4	20
3	0	20
4	0	20
Total	4	60

Investment

DATE	AMOUNT
11/1/48	20
2	20
3	20
4	20
5	20
6	20
7	20
8	20
9	20
10	20
11	20
12	20
13	20
14	20
15	20
16	20
17	20
18	20
19	20
20	20
21	20
22	20
23	20
24	20
25	20
26	20
27	20
28	20
29	20
30	20
31	20
32	20

Area of location: 32.

Subsidiary investment: none.

I would not return.

DATE	I	A
10/2/48	1	20
3	0	20
4	0	20
Total	1	60
10/12/48	2	20
3	0	20
4	0	20
Total	2	60
10/22/48	3	20
3	0	20
4	0	20
Total	3	60
10/32/48	4	20
3	0	20
4	0	20
Total	4	60

DATE	AMOUNT
11/1/48	20
2	20
3	20
4	20
5	20
6	20
7	20
8	20
9	20
10	20
11	20
12	20
13	20
14	20
15	20
16	20
17	20
18	20
19	20
20	20
21	20
22	20
23	20
24	20
25	20
26	20
27	20
28	20
29	20
30	20
31	20
32	20

BERKSHIRE

BOND

CORPUS

LEAFON

BEKZHN

BOND

CORVETTE

EVANS

[illegible]

Special care should be taken to prevent loss or damage of this volume. If lost or damaged, it must be paid for at the current rate of typing.