VISUAL EXPLORATORY BEHAVIOR IN THE NORMAL AND BRAIN DAMAGED SQUIRREL MONKEY (SAIMIRI SCIUREA)

by

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CHAPTER I

INTRODUCTION

Although the idea of studying curiosity or exploratory behavior under laboratory conditions is a relatively new one, many facets of this particular behavior have come under scrutiny. A great deal of work has been done using rats and other lower mammals as the experimental animal. However, this review will emphasize those areas which are pertinent to the present study, namely those experiments involving visual exploration and activity in the primate. In a pioneering experiment, Butler (1953) tested what the author termed efficacy of externally elicited motivation. A two color discrimination task was presented to rhesus monkeys in an illuminated box with the opportunity for visual exploration as the reinforcement. The S opened a small window, through which a room frequented by students could be seen, by pressing the correct colored card. The results demonstrated learning with performance maintained over long periods of time.

Resistance to Satiation

In further studies more evidence has been produced which shows that visual exploratory behavior is very resistant to satiation. Butler and Alexander (1955), using an apparatus similar to the one previously described, a "Butler box," tested rhesus monkeys for ten continuous hours on six consecutive days on a simple task in which the Ss opened a door to view a room in which other monkeys were caged. The frequency and duration of responses were controlled by the Ss and were recorded automatically. The results clearly demonstrated the effectiveness of visual incentives in maintaining visual exploratory behavior. An average of 40 percent of the total time was spent in visual exploration. The authors suggest that the animals worked to obtain a relatively fixed amount of daily visual exploratory experience. Another good example of the tenacity of visual behavior is Moon's (1961) study in which rhesus monkeys were tested 2.5 hours a day for 10 consecutive days with a view of another monkey as the incentive. A motor-driven door opened and remained open as long as a bar was depressed. The data show the door was open 50.8 per cent of the time.

Rabedeau and Miles (1959) designed an experiment to determine if visual exploratory behavior would follow other types of emitted behavior and show a decrease in rate of response following environmental change. Each of five rhesus monkeys was placed in a modified Butler box for 24 minutes of testing daily. The apparatus allowed the S to push open a window once every 12 seconds to view a constant visual environment (an empty laboratory room). The results of this experiment showed an intrasessions decrement for all Ss. There was, however, no discernible decrease as a function of five test days. A replication in which the room was darkened yielded a marked decrease in total number of responses, indicating, as will be shown in further experiments, the relevance of the visual environment to over-all response frequency.

Manipulation

Harlow (1950) and Harlow and McLearn (1954) have shown that monkeys will engage for long periods of time in manipulative behavior with no other reward apparent. It would seem that this is an important point to be remembered in any experiment involving visual exploration. If the method involved in obtaining the external stimuli is at all complicated or manipulative, it can have a very real confounding effect on the results obtained from the study.

Visual Deprivation

It was thought that visual deprivation might increase exploratory behavior and so the effect of this was tested (Butler, 1957) on the rhesus monkey. The deprivation (total darkness) was of 0, 2, 4, and 8 hours duration. The animals were then tested to determine whether their responses to visual incentives would be increased as a result of this deprivation. Following the deprivation, a variable interval reinforcement schedule was used to test the motivational strength of the monkeys. Reinforcement consisted of a 12 second view of the monkey colony outside the test cage. The results showed that the number of responses to visual incentive approached a maximum after four hours of deprivation.

On the other hand, Haude and Oakly (1967) in two different experiments used rhesus monkeys and a modified "Butler box" with no overt manipulation and changing slides as the visual incentives. In the first experiment it was demonstrated that with an increase in rate of slide change the Ss showed a similar and related increase in rate of viewing. However, in the second study, the Ss when exposed to visual deprivation of 0, 2, 4, and 8 hours duration did not exhibit any related significant increase in viewing time.

In another approach to this visual deprivation problem, Wendt et al (1963) used two newborn rhesus monkeys, who were reared in darkness for 16 months except for daily one-hour periods of exposure to unpatterned light. The testing procedure allowed the Ss to press a lever to obtain unpatterned light. The experimental Ss responded at extremely high rates as compared to normally reared control Ss (3000 vs. 200 responses per hour). The experimental Ss continued at this high rate of lever pressing for 6 hours a day for 10 continuous weeks and showed no sign of decreasing. The authors stipulated, however, that the effects of sensory deprivation could not be isolated from the total sensory history of the animal and the cause of this apparently insatiable responding for light remains undetermined until further studies are undertaken.

Visual Incentives

A pioneering study was conducted by Butler (1954) who tested different incentive conditions of viewing and hearing, using viewing time as the criteria. The results of the experiment showed the following hierarchy of conditions in order of their decreasing incentive value; a caged monkey, a moving electric train, an array of food, and an empty room. Subsequently Symmes (1959a) reported two experiments dealing with visual exploration of a number of controlled stimuli by rhesus monkeys; namely, a picture of a restrained monkey, various colored slides, darkness, and a live monkey. These experiments were alike except for the nature of the instrumental response made by the monkey. In the first experiment, a swinging door had to be pushed open. In the second, the monkey, while remaining concealed himself, could view the outside by means of a small peephole. His response broke a light beam which controlled a relay and an inkwriter. The author thought that the second experiment measured visual exploration more accurately as the results were not contaminated by the manipulative factor. The data from the first study showed that all Ss increased door-pushing behavior throughout the experimental session. The increasing amount of exploratory behavior observed was due to an increase in the amount of time the door was kept open at each response rather than an increase in response rate. The live monkey was the most effective incentive, while darkness and the photograph were the least. Experiment II showed an increase in visual exploration after the first session and then the responses leveled off for the remainder of the sessions. In this case, the regularly changing slides, not the live monkey as in the first experiment, produced the greatest number of responses.

In a study by Butler (1961), it was determined that rhesus monkeys prefer movies and pictures that are in focus as opposed to those that are grossly out of focus. In a more elaborate study along this line (Butler, 1963), it was determined that viewing times were longest when motion pictures were (1) in focus, (2) brightly illuminated, (3) moving at a normal rather than a slower rate, (4) in color, and (5) spatially accented in the proper manner. It was also found that Ss watched automatically changing slides more than stationary slides. The author determined that the duration of individual viewing responses contributed more to the total viewing time than did the number of viewing responses.

Visual Exploration and Brain Lesions

The question as to whether visual exploratory behavior could be altered by discrete brain lesions has been raised. An early study (Butler and Harlow, 1954) showed that bilateral damage to the temporal lobes interfered with this behavior. In this case the one subject spent most of the time sleeping. Symmes (1959b) reported that normal and sham-operated rhesus monkeys showed an increase in looking through a peephole, as has been described (Symmes, 1959a), when colored slides replaced a blank screen. Bilateral ablation of the anterolateral temporal cortex virtually abolished this response to colored slides. No similar effect, however, was seen with anterolateral frontal removals. Unilateral temporal ablations produced a slight drop in exploration when compared with controls before and after operation. In a further study utilizing similar testing procedures, Symmes (1963) obtained preliminary data before subjecting S_s_ to four different cortical ablations: anterior temporal, inferior temporal, prefrontal and parietal. The results showed that the anterior temporal and inferior temporal bilateral lesions both significantly decreased exploratory activity.

Lindsley et al. (1964) using a modified Butler box tested the effect of frontal and inferotemporal lesions on the exploratory behavior of rhesus monkeys. The animals used a lever to obtain a view of either a moving electric train, an empty room, or a blank board. The results showed that the S_s_ with inferotemporal lesions had fewer stimulus viewings, but the ratio of number to duration of window openings was about that of normal animals. The animals with frontal lesions showed alterations primarily in the shortened duration of their responses without any substantial change in number of responses. The authors determined that the moving electric train had the greatest incentive value followed by the empty room and the blank board.

It is known that certain temporal lesions produce partial blindness (efferent retinal fibers loop forward in the temporal lobe to form the loop of Meyer; tumors or lesions in this area produce superior quadrant anopia). This fact would seem to complicate any results involving temporal lesions and exploratory behavior. As Butler has shown (1961, 1963) in his experiments dealing with movies, visual ability is a very important factor in exploratory behavior and unless it can be shown that no visual decrement has occurred from the temporal lesion, any result in this area must be viewed with reservation.

Activity and Brain Lesions

Very important in any study involving exploratory behavior and especially one involving brain lesions is the investigation of the basal activity of the animal. It has been shown (Kennard et al., 1941; French and Harlow, 1955; Isaac et al., 1958; Gross, 1963; and Somervill et al., 1964) that frontal and especially prefrontal lesions cause an increase in general activity of the animal. Other studies (Lynch and Campbell, 1969; Lynch et al, 1969; and Campbell and Lynch, 1967) have shown that removal of the frontal poles in rats but not posterior cortical lesions greatly potentiate spontaneous activity and also the increased activity responses to stimuli such as food deprivation and amphetamines. The reaction to water deprivation was not changed by these lesions. In lesions involving other areas of the brain this relationship is less clear. The hyperactivity consisted of constant, random pacing, with the animal seemingly capable of doing little else. Certainly this would have an effect on the visual exploratory behavior of the animal. However, these two factors have never been correlated in the primate.

Conclusion and Present Proposal

To summarize the above experiments, it may be said that a distinct type of behavior that has been termed exploratory has been observed and quantified. It has been shown that this behavior may be altered by external stimuli and by discrete brain lesions.

However, certain problems do exist in this area of study. One of these problems occurs in the choice of instrumental behavior, bar-pressing, door-pushing, or lever-pressing to obtain the visual reward. As has been mentioned, the effect of manipulation could interfere with experimental results. It would seem that the best solution may be to avoid the complication of a manipulative act (Symmes, 1959a) and utilize the relatively simple placement of the subject's head at a peephole.

As has been mentioned, experiments on visual exploration have neglected the investigation of general activity. Only infrequent and subjective observations of activity have been included. Activity would seem to be potentially related to exploration and to be of great importance when brain lesions are included as part of the visual exploratory study.

All of the studies mentioned involving primates have used the rhesus monkey as the experimental subject. The animal has proved to be quite suitable, however, there are drawbacks associated with the rhesus. Namely, they are often difficult to handle and very expensive to procure and maintain. It would be advantageous then if a primate could be found which could combine the advantages of the rhesus with ease of handling and maintenance. The squirrel monkey has been chosen for investigation in the hope that it would prove to be a satisfactory subject for visual exploratory studies.

The major purpose, then, of this study is to determine if the squirrel monkey will demonstrate visual exploratory behavior. Three questions will be examined relative to this: 1) Will this behavior be demonstrable in the absence of manipulation? 2) Can it be influenced by varying the visual stimulus? And 3) what is the relation between exploration and activity?

The second purpose of this study is to determine the effects, if any, that posterior association cortex lesions have on this behavior.

CHAPTER II

MATERIAL AND METHODS

Subjects

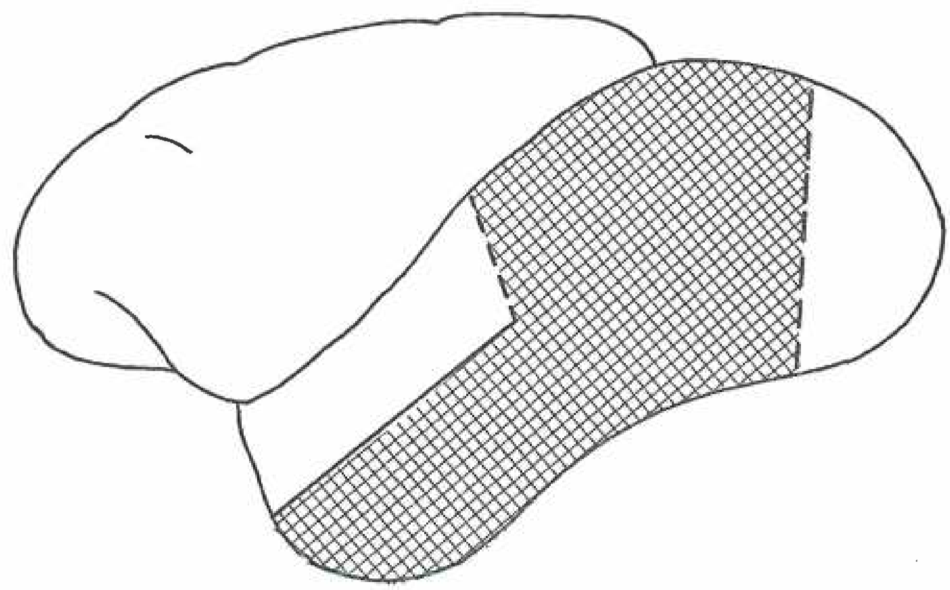
The experimental animals were 16 adult squirrel monkeys (Saimiri sciurea). Twelve were experimentally naive males obtained recently from a local dealer. The remainder had been tested for several years at the Psychology Department of the University of Oregon at Eugene, and consisted of two males and two females, each having extensive lesions of the posterior association cortex.

The lesions were planned to remove virtually all posterior association cortex bilaterally in the squirrel monkey. The lesion was bordered anteriorly by the intraparietal sulcus dorsally and the superior temporal sulcus on the temporal lobe. Ventrally the lesion extended to the rhinal sulcus. Dorsomedially it extended into the medial wall. Posteriorly it was bounded dorsally by the "lunate" sulcus and an imaginary line extending lateroventral on a coronal plane. The approximate extent of the lesion is indicated by cross-hatching in Figure 1.

The animals were kept in standard squirrel monkey cages in a room in the animal quarters of the University of Oregon Medical School. Ten of the experimentally naive animals were housed in pairs as were the four lesioned S*s*. The other three animals were housed separately. The room which was painted light green and measured approximately 14 1/2 feet by 14 1/2 feet was illuminated from 8 a.m. to 5 p.m. by flourescent lights. From the time of their arrival (four months previous to the start of the experiment), through the experiment,

Figure 1

Diagram of operated monkey brain
with area of lesion crosshatched.



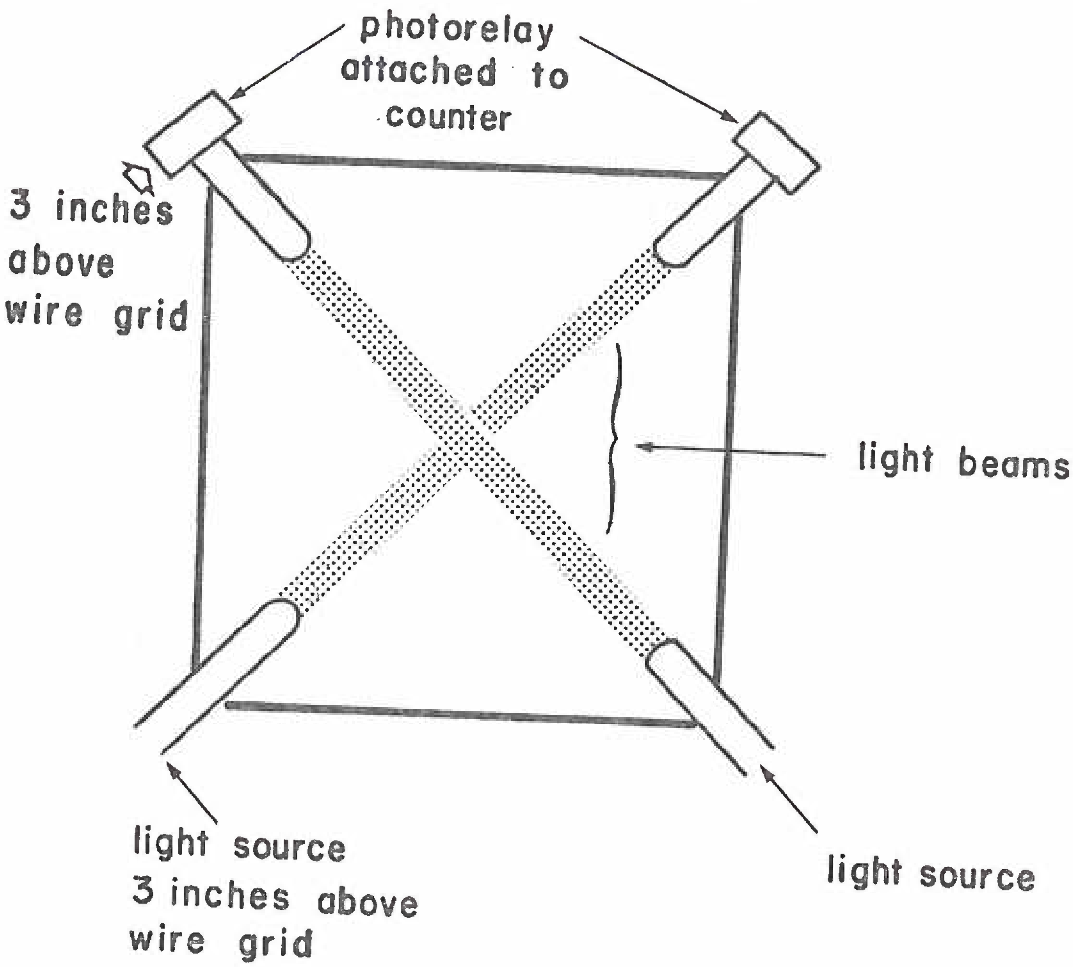
the animals never left the room. They were fed and their cages cleaned every day at 8 a.m. before testing began at 9 a.m., six days a week. Testing concluded at approximately 5 p.m. On the seventh day the animals were placed in transport cages while their home cages were steam cleaned and no testing was done on that day. One S, a pilot animal, was not utilized in the experiment and the remaining animals were numbered 1 to 16, with the brain damaged animals assigned to numbers 12, 14, 15, and 16.

Apparatus

A modified Butler box was constructed of 3/4 inch plywood with finished inside dimensions of 24 x 24 x 24 inches. Two of the opposite walls of the box were double thicknesses of plywood with a one-inch space between them. In order to provide ventilation without admitting light, out-of-phase holes were drilled in the inner and outer boards of each wall and the sides which faced one another were painted black. The box was essentially light tight as the door at the back and the fittings were flanged to eliminate exterior light. The floor consisted of a round wire grid permitting excreta to fall into a pan of sawdust below, which was incorporated onto the box. Beneath the wooden top of the box a 25W light bulb was placed above a ceiling of clouded plexiglas and a bright diffuse illumination was provided throughout the testing. The inside walls were painted light gray. As shown in Figure 2, light sources were mounted in two corners, three inches above the wire grid, so that their light beams diagonally crossed each other. The light source consisted of a 2.8W bulb housed in an aluminum cylinder which concentrated the light beam through a 0.5 mm aperture that was

Figure 2

A diagram of the activity apparatus showing the relationship of photo-relays and light sources.


photorelay attached to counter
3 inches above wire grid
light beams
light source 3 inches above wire grid
light source

flush with the inside wall. These beams impinged on photorelays in the opposite corners (adapted from French and Harlow, 1955). The beams were not visible when the overhead light was on. Every time a light beam was broken one unit of activity was recorded on a counter connected to the photorelay, separate counters being used for each beam.

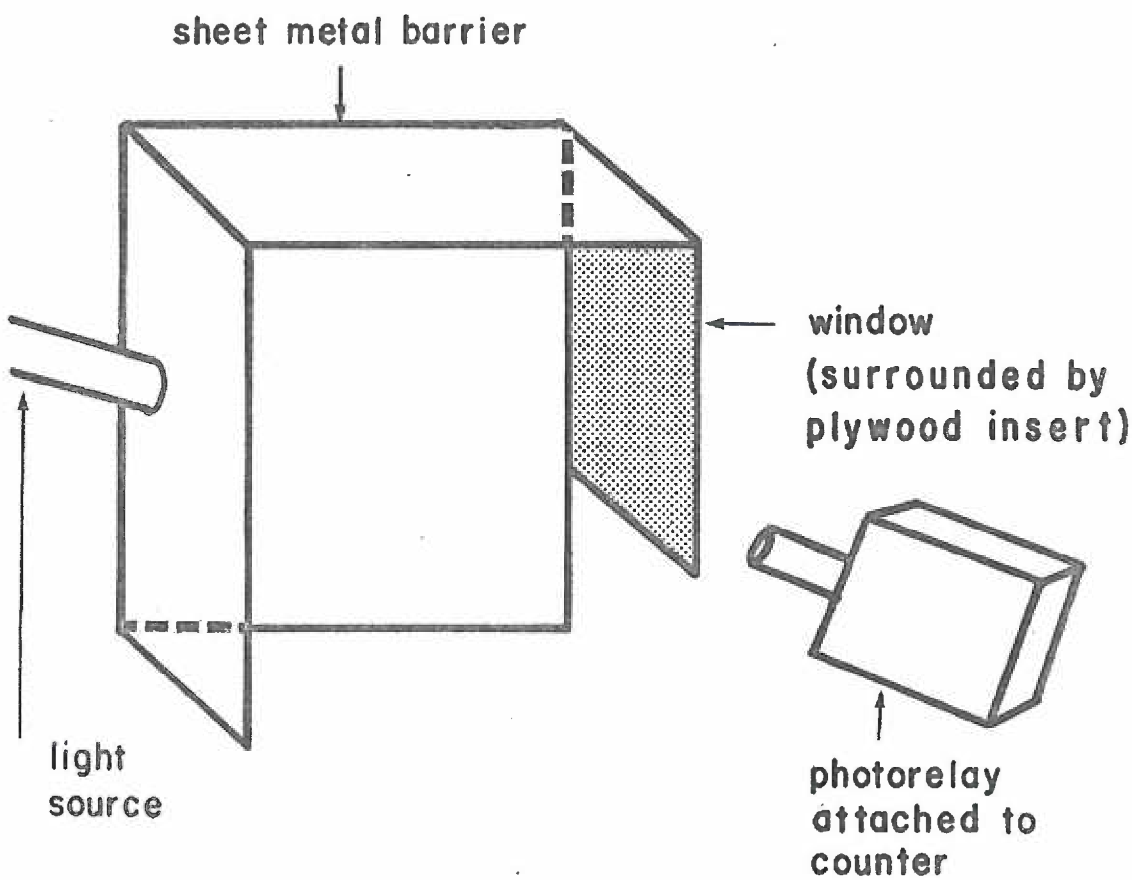
During curiosity (or exploratory) testing a 12 x 12 inch plywood insert was secured in an opening in one of the single thickness walls of the box (the one opposite the door). The insert contained a 3 x 3 inch plexiglas window three inches above the grid floor of the box. A barrier of sheet metal which ran to the grid, shielded the window and three sides - top, left, and back. On the back corner of the barrier, a light source was mounted and diagonally opposite it on the outside of the box, a photorelay was attached (Figure 3). In order to look out of the window, a monkey had to enter the barrier from the right. The S was unable to see out the window without breaking the beam. Both a counter which scored one unit for each head entry and a clock that ran as long as the beam was broken were attached to the photorelay (adapted from Symmes, 1959). When activity was being tested, the insert described above was replaced by a piece of plywood which was painted gray and harmonized with the color of the rest of the interior.

Testing Procedure

Half of the 16 Ss were run on the first day, the other half on the second day and so on. Each S was tested for 50 minutes every other day (skipping 7th days) for a total of eleven days. Days 1, 2 and 11 were for activity measurement (curiosity panel absent), while days 3 through 10 were both curiosity testing and activity measurement.

Figure 3

An illustration of the curiosity apparatus attached to the plywood insert.


sheet metal barrier
window
(surrounded by
plywood insert)
light
source
photorelay
attached to
counter

The order in which the animals were tested varied in a semirandom fashion from day to day.[1]

At the beginning of a curiosity test, E entered the room and reset the two activity counters and the curiosity counter to zero. She noted the time on the cumulative curiosity clock and turned the Butler box so that the window faced either the wall (Condition W) or the center of the room where the other Ss in their cages were visible (Condition R). Condition R and Condition W were alternated with half the Ss assigned initially to Condition R and the other half to Condition W. The S was then placed in the box by E who started the recording equipment and left the room, returning in 50 minutes to obtain the scores. The scores from each of the activity counters were entered separately into the experimental log as were the number of counts on the curiosity counter and the amount of time on the clock. The animal was then returned to its home cage and the counters and position of the box made ready for the next S. Activity sessions on Days 1, 2, and 11 were conducted similarly except that the solid plywood was present instead of the curiosity insert.

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[1]See Appendix for testing pattern.

CHAPTER III

RESULTS

A total of 12 out of 16 Ss spontaneously used the viewing apparatus through the duration of the experiment. Of the four Ss who did not use the apparatus, three were normal and one was brain damaged. Food reinforcement was never used to induce an animal to use the apparatus. The data from the four animals that did not use the viewing apparatus were also included in the analyses. The raw data were categorized in four ways: (1) the total number of counts recorded per session from the curiosity counter; (2) the total number of seconds spent at the window per session (as determined from the clock); (3) the average duration of peeks per session (This was obtained by dividing the total number of seconds at the window per session by the number recorded per session from the curiosity counter.); and (4) the total amount of activity per session as determined by adding the counts on both activity counters.

Because the data were positively skewed, nonparametric tests[2] were used in analyzing the data. These data are shown in Tables I through VII together with the analyses.

Table I shows the median total number of peeks per session for each animal. Normal animals consistently showed higher medians when viewing the room than when viewing the wall. This tendency was significant at the $p < .01$ level (Wilcoxson matched pairs signed ranks test).

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[2]Parametric analyses of the data will be found in the appendix, along with corresponding graphs using means instead of medians (Tables IX through XIV and Figures 8 through 15).

TABLE I

Median total number of peeks per session for each S for each of the two viewing conditions computed over sessions 3 - 10°

Non-Lesioned Ss	Total number of peeks per session		
	Medians		
S#	R	W	T
			0***
1	112(86-170)	59(52-72)	
2	126(54-241)	43(21-62)	
3	0(0-0)	0(0-1)	
4	59(23-66)	32(25-44)	
5	0(0-0)	0(0-0)	
6	22(6-43)	8(2-21)	
7	0(0-0)	0(0-0)	
8	1(0-4)	0(0-0)	
9	89(63-225)	61(46-126)	
10	286(218-358)	120(93-139)	
11	65(57-158)	14(5-25)	
Lesioned Ss			6*
12	0(0-0)	0(0-0)	
14	277(176-327)	53(30-91)	
15	12(6-25)	7(2-17)	
16	148(98-227)	70(29-110)	

°A Wilcoxson matched pairs signed ranks test was used to analyze the data.
*Significant at = 0.125 (one-tailed test)
**Significant at = 0.05 (two-tailed test)
***Significant at = 0.01 (two-tailed test)

Ranges are in parentheses.

The operated animals showed greater median total peeks per session when viewing the room ($p < .125$, one-tailed Wilcoxson test). Although this difference is not significant, it is the maximum probability that could be achieved with the small N in this group.

The median total number of seconds at the window per session is shown in Table II for each S. The non-lesioned animals consistently spent a greater number of seconds at the window when the room was in view than when the wall was present. The resulting medians were significantly different when analyzed by the Wilcoxson matched pairs signed ranks test. ($p < .01$ level, two-tailed test.)

The lesioned animals exhibited a similar tendency to spend a greater amount of time at the window when the room was in view as compared to the wall situation. This tendency reached the $p < .125$ level using the same Wilcoxson test (one-tailed test).

Table III presents the median average duration of peeks per session for each S. The normal animals in all cases exhibited higher median averages under the room condition than when under the wall condition. These medians were significantly different at the $p < .01$ level. (Wilcoxson matched pairs, signed ranks test, two-tailed.) The operated animals showed this same preference. And the median average duration of peeks was higher for them when the room was in view as opposed to when the wall was in view ($p = .125$ for the same Wilcoxson test, one-tailed).

Median total activity counts per session for each S are presented in Table IV. The non-lesioned animals' activity medians did not reflect any difference between condition R and W. Their activity did not

TABLE II

Median total number of seconds at the window per session for each S for each of the two viewing conditions computed over sessions 3 - 10°

S#	Total number of seconds at window per session: Median R	W	T
Non-Lesioned Ss			1***
1	404(245-600)	75(50-100)	
2	307(80-600)	65(45-78)	
3	0(0-0)	0(0-2)	
4	194(68-280)	66(25-101)	
5	0(0-0)	0(0-0)	
6	150(12-390)	56(20-168)	
7	0(0-0)	0(0-0)	
8	3(0-10)	0(0-2)	
9	152(120-400)	68(46-100)	
10	1445(1380-1510)	223(153-278)	
11	166(120-398)	17(11-38)	
Lesioned Ss			6*
12	0(0-0)	0(0-0)	
14	680(465-915)	80(50-177)	
15	63(32-106)	44(3-100)	
16	374(295-455)	165(47-365)	

°A Wilcoxson matched pairs signed ranks test was used to analyze the data.
*Significant at = 0.125 (one-tailed test)
**Significant at = 0.05 (two-tailed test)
***Significant at = 0.01 (two-tailed test)

Ranges are in parentheses.

TABLE III

Median average duration of peeks per session for each S for each of the two viewing conditions computed over sessions 3-10°

S#	Average duration of peeks per session — Medians: R	W	T
Non-Lesioned Ss			0***
1	3.3(2.4-5.0)	1.4(0.7-1.7)	
2	2.5(1.1-3.2)	1.5(1.3-2.1)	
3	0(0-0)	0(0-1.0)	
4	3.1(2.8-5.1)	2.1(0.6-4.0)	
5	0(0-6.0)	0(0-0)	
6	8.2(1.0-10)	7.6(6.3-10)	
7	0(0-0)	0(0-0)	
8	1.2(0-2.5)	0(0-1.0)	
9	1.8(1.7-2.0)	1.2(0.4-1.8)	
10	5.2(3.9-6.9)	2.0(1.3-2.1)	
11	2.3(2.1-2.9)	1.6(1-2.8)	
Lesioned Ss			6*
12	0(0-0)	0(0-0)	
14	2.7(1.2-3.0)	1.7(1.2-2.0)	
15	6.1(1.3-13.3)	3.7(1.5-10.9)	
16	2.5(2.0-3.0)	2.4(1.6-3.8)	

°A Wilcoxson matched pairs signed ranks test was used to analyze the data.
*significant at = 0.125 (one-tailed test)
**significant at = 0.05 (two-tailed test)
***significant at = 0.01 (two-tailed test)

Ranges are in parentheses

TABLE IV

Median total number of activity counts per session for each S for each of the two viewing conditions computed for sessions 3 - 10°

Non-Lesioned Ss	Total number of activity counts per session		
	Median		
S#	R	W	T
			32
1	712(492-826)	745(369-805)	
2	439(294-460)	346(256-422)	
3	34(3-66)	57(39-206)	
4	736(295-879)	744(284-986)	
5	22(0-67)	63(3-182)	
6	105(38-162)	432(82-759)	
7	57(3-120)	86(52-128)	
8	384(310-465)	364(46-406)	
9	1324(796-1563)	1148(1043-1223)	
10	1476(932-2194)	1693(773-3955)	
11	369(200-415)	198(176-260)	
Lesioned Ss			
			4
12	27(5-56)	40(30-100)	
14	3463(3103-2934)	4009(3698-4907)	
15	171(110-303)	170(71-322)	
16	1464(1233-2203)	898(518-1107)	

°A Wilcoxson matched pairs signed ranks test was used to analyze the data.
*significant at = 0.125 (one-tailed test)
**significant at = 0.05 (two-tailed test)
***significant at = 0.01 (two-tailed test)

Ranges are in parentheses

change significantly under either condition and when these medians were analyzed (Wilcoxson matched pairs, signed ranks test), the results were not at all significant (T = 32). The same can be said for the lesioned animals' data. Their activity was not at all affected by the change in R or W conditions. The same Wilcoxson test when applied to the lesioned Ss median averages showed no significance (T = 4). However, for the lesioned data due to the smallness of the N, significance is only possible at p = 0.125. This level was reached for the lesioned data for all three exploratory measurements. Though the p level is not the best, it is at the limit at which such a small N can reach. It would seem important that the lesioned Ss match the non-lesioned Ss four out of four times. For both lesioned and non-lesioned groups, the activity measurement did not reflect any differences in the two conditions.

To summarize the above results: the Wilcoxson matched pairs, signed ranks test revealed significance in variation of the medians of the data obtained under Condition R versus those obtained under Condition W for all three of the exploratory measures. This was true for the non-lesioned Ss, but the lesion group although the N is too small to reach significance, gave as small a p value as can be obtained. The statistical results for all three curiosity measures for the non-lesioned Ss were highly significant, in this case p = 0.01 on a two tailed test.

A Friedman Two-Way Analysis of Variance (Tables V and VI) was done to test for a significant temporal variable effect over the four test days within each condition. The results show no significant time effect for any of the curiosity measures under R or W conditions in the

TABLE V

Median performance over sessions 3 through 10 for non-lesioned Ss for each of the viewing conditions and each of the experimental measures° of day to day variation for the exploratory and activity data obtained under R and W conditions.

Non-Lesioned Ss	Condition R Medians				x_r^2	Condition W Medians				x_r^2
Session #	3	5	7	9		4	6	8	10	
Total number of peeks per session	23 (0-243)	63 (0-241)	68 (0-328)	66 (0-358)	1.4	21 (0-139)	7 (0-122)	25 (0-117)	21 (0-93)	3.5
Total number of seconds at window per session	68 (0-1450)	120 (0-1510)	120 (0-1440)	180 (0-1380)	0.4	46 (0-278)	20 (0-256)	38 (0-153)	63 (0-190)	4.0
Average duration of peeks per session	2.2 (0-6.0)	2.1 (0-10.0)	2.6 (0-7.3)	2.5 (0-9.1)	0.2	1.4 (0-8.0)	1.0 (0-10.0)	1.3 (0-7.1)	1.3 (0-6.3)	1.4
Total number of activity counts per session	310 (3-1289)	445 (0-1563)	415 (25-1662)	392 (66-2194)	15.5**	260 (15-1216)	304 (3-1079)	406 (39-2569)	422 (93-3955)	8.1*

°A Friedman two-way analysis of variance test was used to analyze day to day variation.
*significant at $p = 0.05$
**significant at $p = 0.01$

Ranges in parentheses
Degrees of freedom for all of above tests = 3

TABLE VI

Median performance over sessions 3 through 10 for lesioned Ss for each of the viewing conditions and each of the experimental measures°

Lesioned Ss	Condition R					Condition W				
	Medians				x_r^2	Medians				x_r^2
Session #	3	5	7	9		4	6	8	10	
Total number of peeks per session	65 (0-246)	53 (0-327)	94 (0-297)	100 (0-227)	0.5	49 (0-95)	24 (0-30)	18 (0-64)	22 (0-110)	1.4
Total number of seconds at window per session	204 (0-480)	170 (0-915)	268 (0-880)	238 (0-880)	2.0	127 (0-365)	75 (0-130)	29 (0-108)	27 (0-200)	2.4
Average duration of peeks per session	2.3 (0-6.6)	2.9 (0-5.6)	2.8 (0-13.3)	1.7 0-2.6)	3.1	2.9 (0-10.9)	2.4 (0-5.9)	1.7 (0-1.8)	1.3 (0-1.8)	24.9**
Total number of activity counts per session	730 (5-3934)	739 (15-3284)	847 (56-3103)	1253 (38-3641)	3.3	609 (48-3897)	558 (32-3698)	320 (30-4121)	600 (71-4907)	3.0

°A Friedman two-way analysis of variance test was used to analyze day to day variation
*significant at = 0.05
**significant at = 0.01

Ranges in parentheses
Degrees of freedom for all of above tests = 3

non-lesioned group of Ss. The same was true for the lesioned group except that one measure (average duration of peeks per session) under Condition W did show a highly significant decrease as the experiment progressed. No explanation can be offered as to why this was found only in the lesioned animals. The activity measure showed a significant increase for the non-lesioned group under both R and W conditions; this increase did not appear in the lesioned Ss.

The medians for each Ss were grouped into lesioned and non-lesioned headings for each viewing condition and each experimental measure (Table VII). These group medians displayed no significant difference in performance of the lesioned animals versus the performance of the non-lesioned animals in the various experimental conditions tested. When the individual medians for each S were compared for each viewing condition and each experimental measure, the results were the same (Mann-Whitney U test[3]). That is, no statistically significant difference in the performance was exhibited between the lesioned and non-lesioned Ss. This result will be discussed more fully in Chapter IV.

Figures 4 through 7 show daily median scores for the lesioned and non-lesioned Ss under Conditions R and W. Figure 4 depicts the

---

[3]Mann Whitney U* Lesioned vs. non-lesioned for the four experimental conditions.

Experimental Condition	R	W
1	17	18
2	16	17
3	18	13
4	18	21

* All U's not significant

TABLE VII

Medians of group totals for non-lesioned and lesioned Ss for each viewing condition for each experimental measure°

	Condition R			Condition W		
	Medians		x_r^2	Medians		x_r^2
	Non-lesioned Ss	Lesioned Ss		Non-lesioned Ss	Lesioned Ss	
Total number of peeks per session	59(0-286)	80(0-272)	4.8	32(0-120)	30(0-70)	0.6
Total number of seconds at window per session	152(0-1445)	219(0-680)	4.8	56(0-223)	62(0-162)	1.8
Average duration of peeks per session	2.3(0-8.2)	2.6(0-6.1)	1.8	1.4(0-7.6)	2.1(0-3.7)	3.6
Total activity per session	384(22-1476)	818(27-3463)	1.8	364(57-1693)	534(40-4009)	1.8

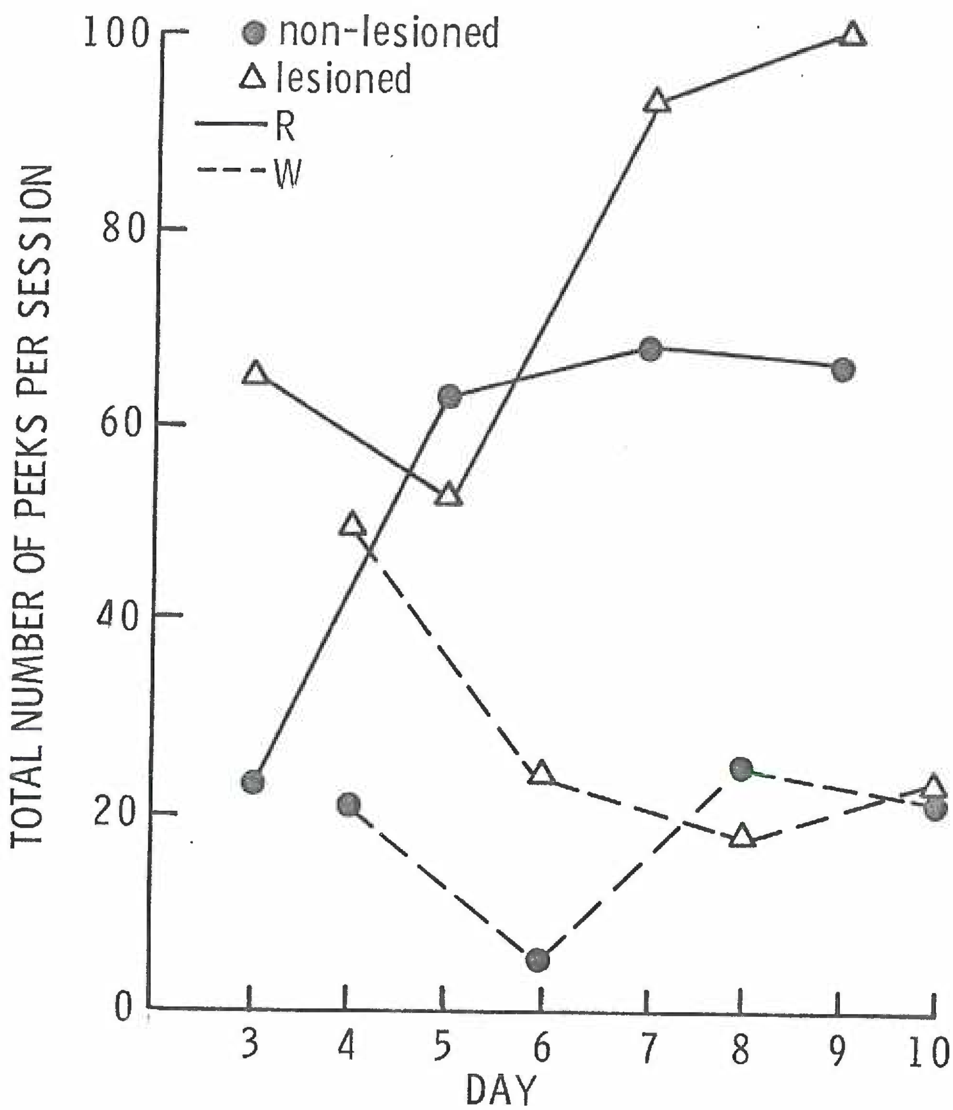
°A Friedman two-way analysis of variance was used to analyze the group medians.
*significant at = 0.05
**significant at = 0.01

Ranges in parentheses
Degrees of freedom for all of above tests = 3

Figure 4

A graph showing the total number of peeks per session under Room and Wall Conditions for lesioned and non-lesioned S*s*.

(Medians for 11 non-lesioned S*s* and for 4 lesioned S*s*)



non-lesioned
lesioned
R
W
TOTAL NUMBER OF PEEKS PER SESSION
100
80
60
40
20
0
3
4
5
6
7
8
9
10
DAY

Figure 5

A graph illustrating the total number of seconds spent at the window per session under Room and Wall Conditions for lesioned and non-lesioned S_s_.

(Medians for 11 non-lesioned S_s_ and 4 lesioned S_s_)

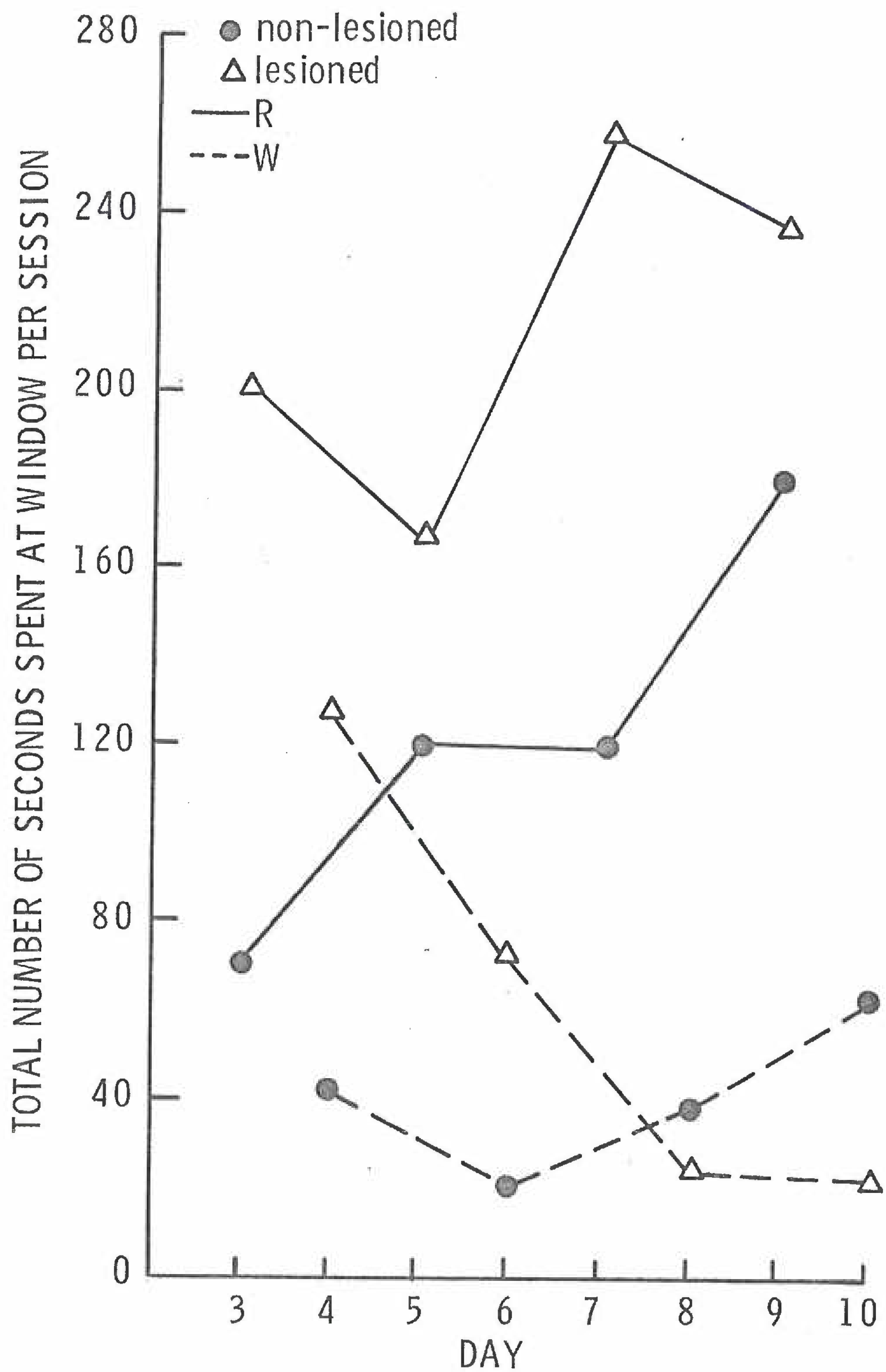

non-lesioned
lesioned
R
W
TOTAL NUMBER OF SECONDS SPENT AT WINDOW PER SESSION
280
240
200
160
120
80
40
0
3
4
5
6
7
8
9
10
DAY

Figure 6

A comparison of the average duration of peeks per session under Room and Wall Conditions for lesioned and non-lesioned Ss.

(Medians for 11 non-lesioned Ss and 4 lesioned Ss)

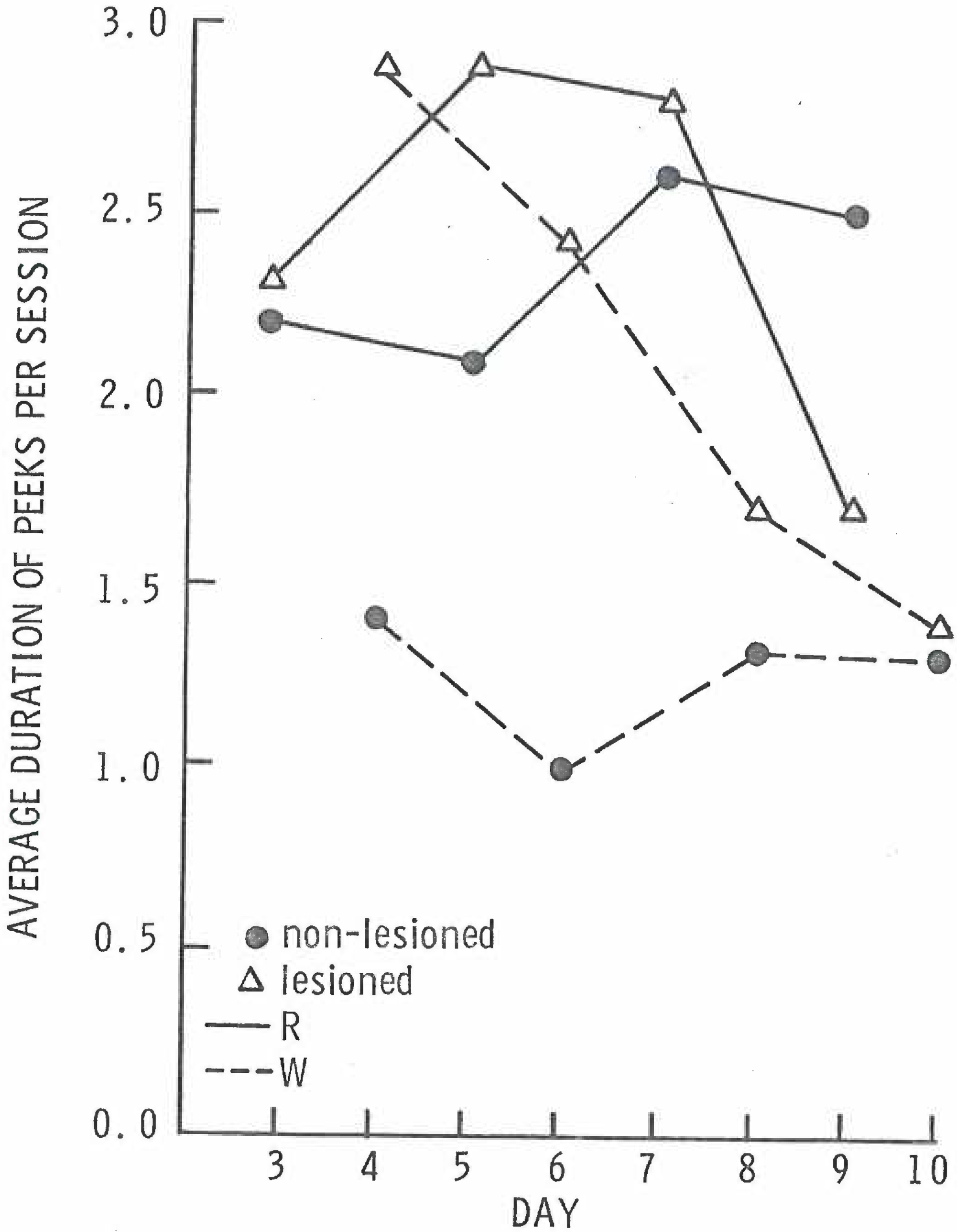

AVERAGE DURATION OF PEEKS PER SESSION
3.0
2.5
2.0
1.5
1.0
0.5
0.0
non-lesioned
lesioned
R
W
3
4
5
6
7
8
9
10
DAY

Figure 7

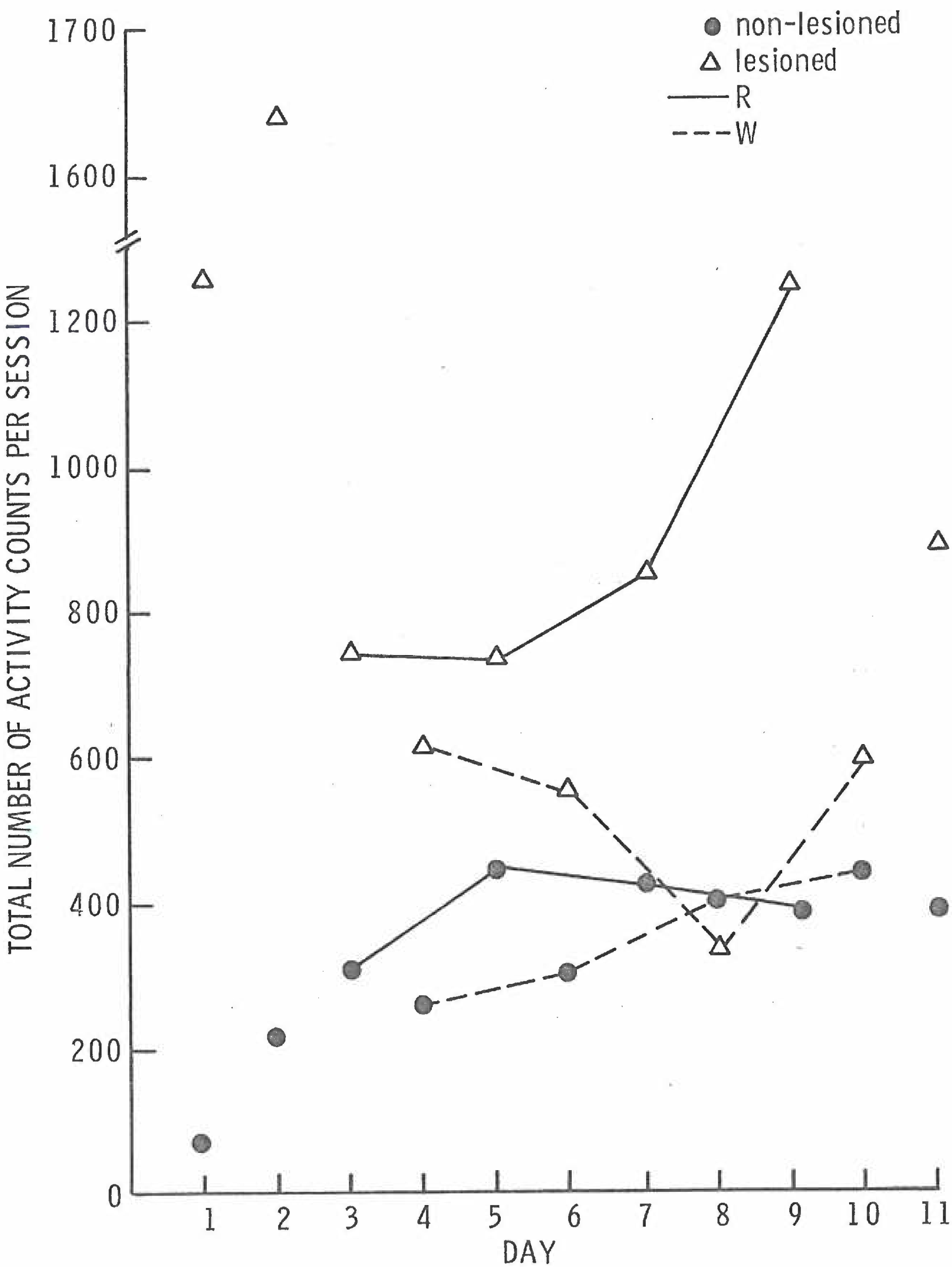
A graph depicting the total number of activity counts

per session under Room and Wall Conditions

for lesioned and non-lesioned Ss.

Also includes three sessions when activity alone was tested.

(Medians for 11 non-lesioned Ss and 4 lesioned Ss)



non-lesioned
lesioned
R
W
1700
1600
1200
1000
800
600
400
200
0
TOTAL NUMBER OF ACTIVITY COUNTS PER SESSION
1
2
3
4
5
6
7
8
9
10
11
DAY

median number of peeks per session. It may be seen that for the R condition there were roughly three times as many peeks as for Condition W. When the total number of seconds spent at the window per session (Figure 5) was plotted, the R condition surpassed the W condition by a factor ranging from 2 to 6. A large difference in time per peek is indicated in Figure 6 for the two conditions with, as has been mentioned, the lesioned Ss under W condition having a significant decrease in time per peek. Overlapping activity scores are indicated in Figure 6, for conditions R and W; however, the curves show a consistent increase over time. The results of activity measures on days 1, 2, and 11 are also presented as medians on Figure 7. Separate testing indicated that there was no significant differences in the scores for these three days (x_r^2 = 6) for the non-lesioned Ss and 3.5 for the lesioned Ss, with two degrees of freedom for each). In all of these figures, it may be seen that the lesioned Ss tended to obtain higher scores than did the non-lesioned Ss, this was true for every measure under both incentive conditions. These differences were not significant, as has been previously mentioned, this is perhaps due to the small N's of the two groups.

To summarize the graphs, it may be said that both the lesioned and non-lesioned animals, when able to view the home room, went to the window more often and spent more time there than when only a blank wall was visible. The average activity of the non-lesioned Ss during curiosity testing increased as the experiment progressed while their curiosity behavior did not exhibit this time effect.

A product-moment correlation coefficient was calculated for the activity measurement versus each of the curiosity measurements (see Table VIII). This was done to determine if a relation existed between the amount of activity and the amount of curiosity of each individual animal. That is, for a positive correlation an animal with a high activity count would also have high exploratory scores, or perhaps vice versa for a negative relationship. It was calculated on a day by day basis because of the highly significant time factor in the activity measurement. When activity was compared with the first two measures (number of peeks per session and total number of seconds at the window), a significant positive relationship emerged for activity and curiosity behavior. This was particularly evident on days when the S could view his peers since all eight of the correlations for Condition R were significant. For Condition W only four of the correlations were significant. This effect of the visual incentive on the activity measure did not appear under the various non-parametric tests comparing Condition R versus Condition W. The correlation coefficient does reveal a relationship between the amount of activity and the amount of viewing behavior (measured in terms of number of peeks or total time at the window).

The third curiosity measurement (average duration of peeks per session) revealed a slightly negative relationship. That is, the more active the animal, the less time spent at each viewing count. However, none of these correlations were significant.

TABLE VIII

Product moment correlation coefficients for activity versus the various curiosity measures (correlations for all 16 Ss)

	Day	R 3	W 4	R 5	W 6	R 7	W 8	R 9	W 10
Activity vs. Number of Peeks Per Session	r	.79**	.59*	.82**	.26	.90**	.67**	.74**	.50*
Activity vs. Total Time Spent at Window	r	.48*	.42	.61*	.22	.74**	.72**	.49*	.46
Activity vs. Average Duration of Peeks per Session	r	.04	-.01	-.10	-.03	-.13	.16	-.03	.11

* Significant at .05 level
**Significant at .01 level

CHAPTER IV

DISCUSSION

The major purpose of this study was to assess the extent to which squirrel monkeys exhibit visual exploration behavior, particularly in the absence of overt manipulation tasks. The results indicate clearly that this is in fact the case; the majority of the animals exhibited visual exploration behavior and it was independent of overt manipulation.

To be able to maintain the existence of exploratory behavior, the external environment must be shown to exert some influence on the Ss. The results indicate a significant increase in viewing behavior when the room with the colony of monkeys was in view as opposed to when only the blank wall was visible. On the basis of this evidence, it is proposed that exploratory behavior was exhibited by the squirrel monkey.

Since the squirrel monkey had never been used in this type of experiment, the visual incentive ranked highest for the rhesus monkey by other experimentors was used; namely, a view of the monkey colony. It is not surprising then, that it proved more potent than a blank wall for the squirrel monkey too. Further studies would seem in order to determine exactly where this incentive fits into a hierarchy of values for the squirrel monkey.

In all of the experiments that have been reviewed, the monkey performed some task or response in order to obtain a view of the environment outside of the box. In the present study, the response required was simplified to a point where the problems of "manipulative drive" (Harlow, 1950) and secondary reinforcement were greatly reduced. The response involved nothing other than the actual viewing behavior and was never associated with any reward other than the view of the external environment. The S might, indeed, accidently enter the viewing apparatus but certainly not at the rate reported. Secondary reinforcement might of course exist to some degree but the different response rates obtained for the two conditions indicate that it was present in negligible quantities or absent. If the animals' responses were accidental or if the animals were performing for a click (if this could be heard), these motives were overshadowed by the effect of the external environment. It is interesting to note that in Butler and Alexander's (1955) study in which the S had to push open a door to view the external stimuli, the S spent 40% of the available time with the door held open. In the present study with the door eliminated, the Ss spent 9% for Condition R and 7% for Condition W of the time allowed peeking. Of course these studies differed on many counts, including the type of research animal used; however, it would seem that the response of door pushing affects the results of exploratory experiments, and that when the Ss had to work less to obtain a view of the stimulus, in this case they looked less. Symmes (1959a) reported this same phenomena when he eliminated the door. Symmes also reported in this same paper that when the door was present the increase in door pushing was due to an increase in the amount of time the door was left open. In this present study, the average duration of peeks showed no such significant time variable effect. In fact the lesioned

Ss decreased the amount of time at the window as the experiment progressed. This increase in peeking duration could also be an effect of the door pushing itself as this effect was not noted when Symmes eliminated the door. All of this would seem to be connected with the "manipulative drive" theory of Harlow (1950) and would best be eliminated as much as possible in future exploratory experiments.

The animals when tested in this study, were certainly not in a "normal" environment; however, it was one that prompted responses and behavior that would otherwise be hard to observe. This new environment may, however, have increased the "emotionality" of the Ss. Ordinarily, this effect could be expected to attenuate in time and the fact that activity increased may possibly be attributed to this decreasing "emotionality". This inverse relationship between these two factors has been postulated for the rat (Miller, 1951) and may hold true for the monkey; although there is no evidence to support this supposition at this time. Curiosity behavior, however, appeared to be independent of any time-related factor.

The positive relationship between exploratory behavior and activity that emerged from this experiment has been overlooked in previous curiosity studies. It seems, however, to be a logical one; as the more active the monkey, the greater one would expect his exploratory behavior to be. This would be self-limiting, of course, for the very active or hyperactive animal would not be able to focus its attention for any period of time, and his exploratory behavior would decrease accordingly.

With regard to lesions, Lindsley's (1964) results showed that the inferotemporal lesions yielded fewer peeks but the ratio of number to duration was about the same. That is, the Ss looked for the same length of time as the normals though they looked less. The frontal animals yielded a decrease in duration without any change in number of responses. Symmes (1959a, 1963) demonstrated that anterior temporal and inferior temporal lesions significantly decreased exploratory behavior. The Ss in the present study with their posterior association cortex lesions tended to look more often and spend more time at the window than did the non-lesioned Ss (see Figures 3, 4, and 5). They also had higher scores on all of the activity measures. So as where the other experimentors demonstrated a decrease in exploratory behavior, these lesions in the present study seemed to have increased it. As has been previously stated, none of these differences were statistically significant. This lack of significance may be due to a number of statistical reasons, not related to the effect of the lesion itself (small n's, extreme variation within groups). Further inquiry in this area is certainly indicated.

Two of the brain damaged monkeys exhibited very high activity levels which may have been due to the lesion. The literature does not reveal any relation between this type of lesion and activity, but this seems to be the most probable cause. The only type of lesion known to yield an increase in activity is the prefrontal lesion but because it has been shown that activity and exploratory behavior are related, any further lesions involving exploratory behavior should be made with a specific effort to avoid affecting the basal activity level of the animal.

The variety of behavior observed in this study exhibited a wide range in both the normal and brain damaged groups. This ranged from animals that had no score whatever and must have spent the session sitting in a corner of the box to the extremely active animals whose scores ranged in the thousands. It can only be assumed that this was a representative group of squirrel monkeys. Because of this wide fluctuation of observed behavior, it would seem better for future studies to have larger samples. This sample was large, however, in comparison to those in most of the studies using rhesus monkeys in which four or five S_s_ are common. This problem of sample size is found in every study and must, of course, be dealt with as well as circumstances permit.

The question as to what prompted the exploratory response has certainly been asked and various answers have been proposed. They include such mechanisms as a "boredom drive" (Myers and Miller, 1954), anxiety reduction (Brown, 1953) and a specific "curiosity drive" (Butler, 1953). None of these ideas have been backed by any substantial experimental evidence and are simply tentative answers to the question of why the animal is "curious". Certainly our level of knowledge is superficial and a great deal of work remains to be done before any answer can be given with assurance. In this present study, no answers to the whys of exploratory behavior have been included because it is felt that none are warranted from the results obtained. It is simply a brick in the foundation that has to be laid in the area of visual exploratory behavior before this aspect of behavior may be understood in its entirety.

CHAPTER V

SUMMARY AND CONCLUSION

From the results presented, it would seem that a behavior which may be termed exploratory or "curiosity" has been observed and quantified in the squirrel monkey. This behavior has shown some significant correlation with the amount of activity of the animal. The behavior of the previously lesioned animals in this case was not significantly different from that of the non-lesioned animals and it may be said that this particular lesion had no effect on the behavior being tested.

This animal, the squirrel monkey, has proved to be a suitable S for these experiments and because of its ease of handling and maintenance is highly recommended for further exploratory experiments.

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A P P E N D I X

TABLE IX

RESULTS OF A THREE-WAY ANALYSIS OF VARIANCE
FOR THE NUMBER OF PEEKS PER SESSION

Number of Peeks per Session	F
A/AC	0.518
B/BC	7.82*
AB/ABC	1.418

A = Days of experiment (3 through 10)

B = R or W condition

C = S*s*

*significant at .05
**significant at .01

TABLE X

RESULTS OF A THREE-WAY ANALYSIS OF VARIANCE
FOR THE TOTAL NUMBER OF SECONDS AT WINDOW PER SESSION

Total number of seconds at window per session	F
A/AC	0.474
B/BC	7.18*
AB/ABC	2.23

A = Days of experiment (3 through 10)

B = R or W Condition

C = S_s_

*significant at .05
**significant at .01

TABLE XI

RESULTS OF A THREE-WAY ANALYSIS OF VARIANCE
FOR THE AVERAGE NUMBER OF SECONDS PER PEEK PER SESSION

Average number of seconds per peek per session	F
A/AC	1.07
B/BC	3.53
AB/ABC	0.212

A = Days of experiment (3 through 10)

B = R or W condition

C = S_s_

*significant at .05
**significant at .01

TABLE XII

RESULTS OF A THREE-WAY ANALYSIS OF VARIANCE
FOR THE TOTAL NUMBER OF ACTIVITY COUNTS PER SESSION

Total number of activity counts per session	F
A/AC	4.434**
B/BC	0.212
AB/ABC	1.04

A = Days of experiment (3 through 10)

B = R or W condition

C = S*s*

*significant at .05
**significant at .01

TABLE XIII

AN ANALYSIS OF VARIANCE FOR THE FOUR MEASURES WHEN SUBDIVIDED INTO LESIONED AND NON-LESIONED GROUPS

	F		
		Within *Ss*	
Measure	Between *Ss*	Treatments	Interaction
Number of peeks per session	0.088	7.341*	0.081
Total number of seconds at window per session	0.042	6.706*	0.010
Average number of seconds per peek per session	1.771	3.717	1.777
Total° number of activity counts per session	1.292	4.350**	0.745

Between *Ss* = lesioned vs. non-lesioned

Treatments = R or W condition

°R and W combined so as to have four variables.
*significant at .05
**significant at .01

TABLE XIV

POINT BISERIAL CORRELATION COEFFICIENTS FOR ACTIVITY VERSUS THE VARIOUS CURIOSITY MEASURES

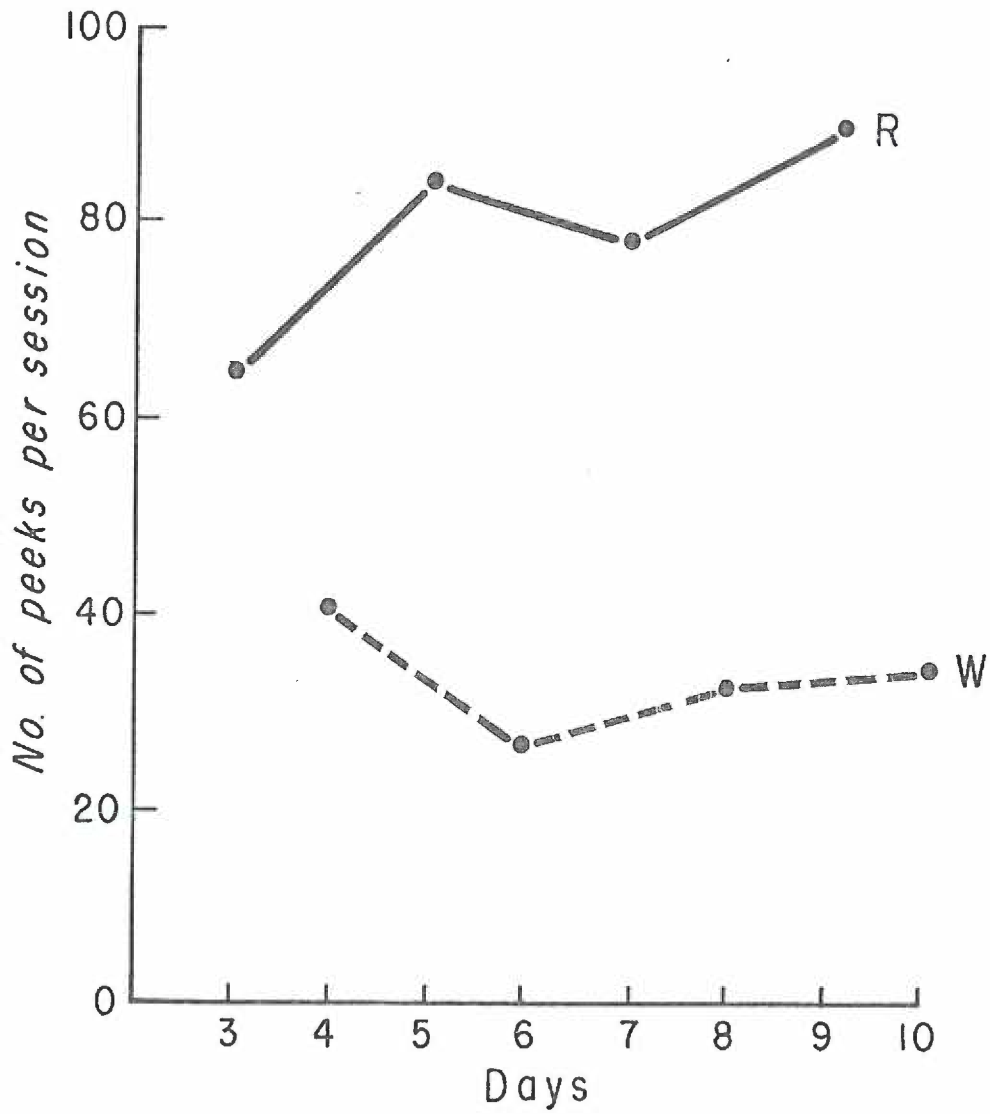
(CORRELATIONS FOR ALL 16 Ss)

	Day	R 3	W 4	R 5	W 6	R 7	W 8	R 9	W 10
Activity vs. number of peeks per session	r_{pb}	.79**	.59*	.82**	.26	.90**	.67**	.74**	.50*
Activity vs. Total time spent at window	r_{pb}	.48*	.42	.61*	.22	.74**	.72**	.49*	.46
Activity vs. average duration of peeks per session	r_{pb}	.04	-.01	-.10	-.03	-.13	.16	-.03	.11

*significant at .05 level
**significant at .01 level

FIGURE 8

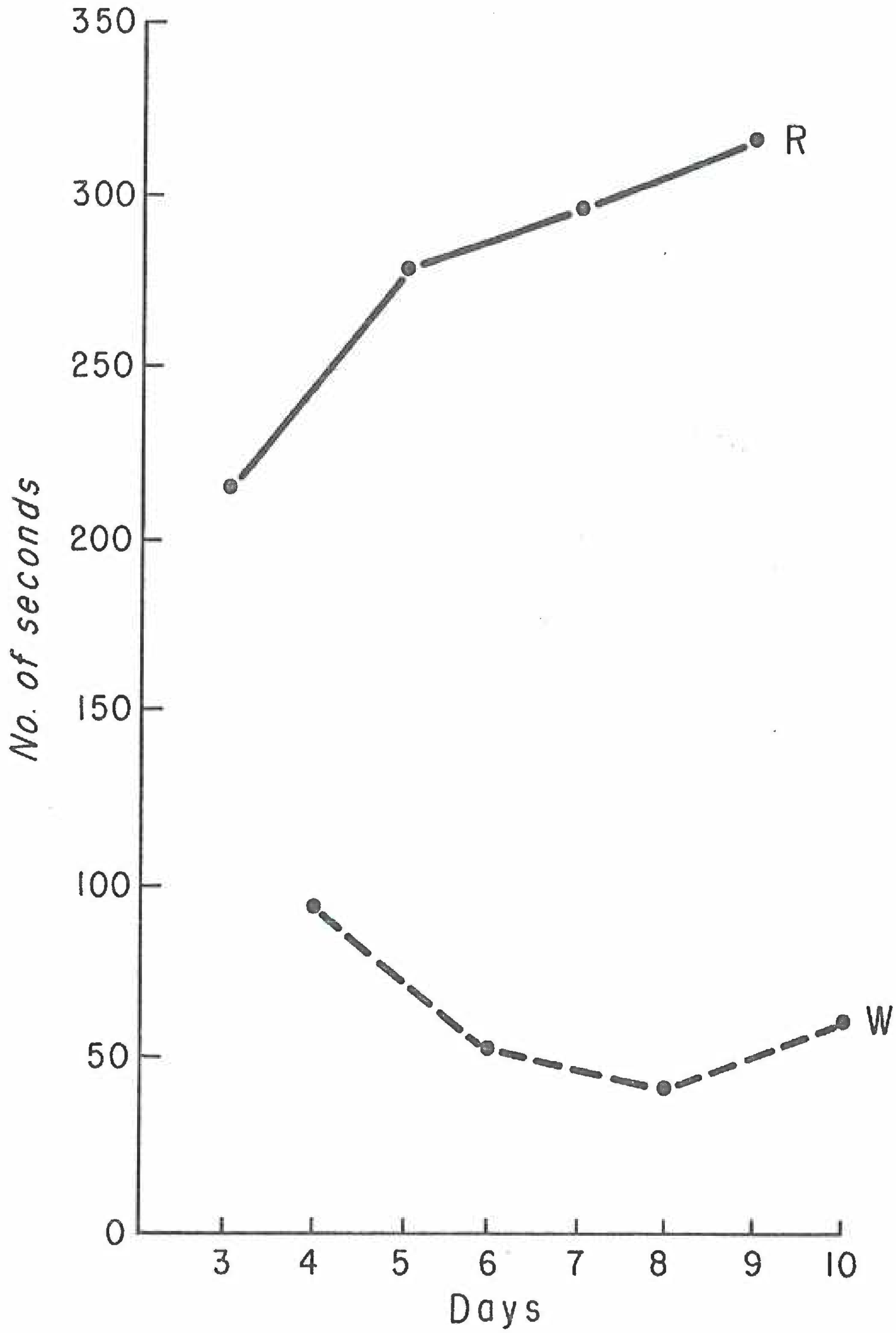
A comparison of the average total number of peeks per session under Room and Wall Conditions. (means for all 16 Ss)



100
80
60
40
20
0
No. of peeks per session
R
W
3
4
5
6
7
8
9
10
Days

FIGURE 9

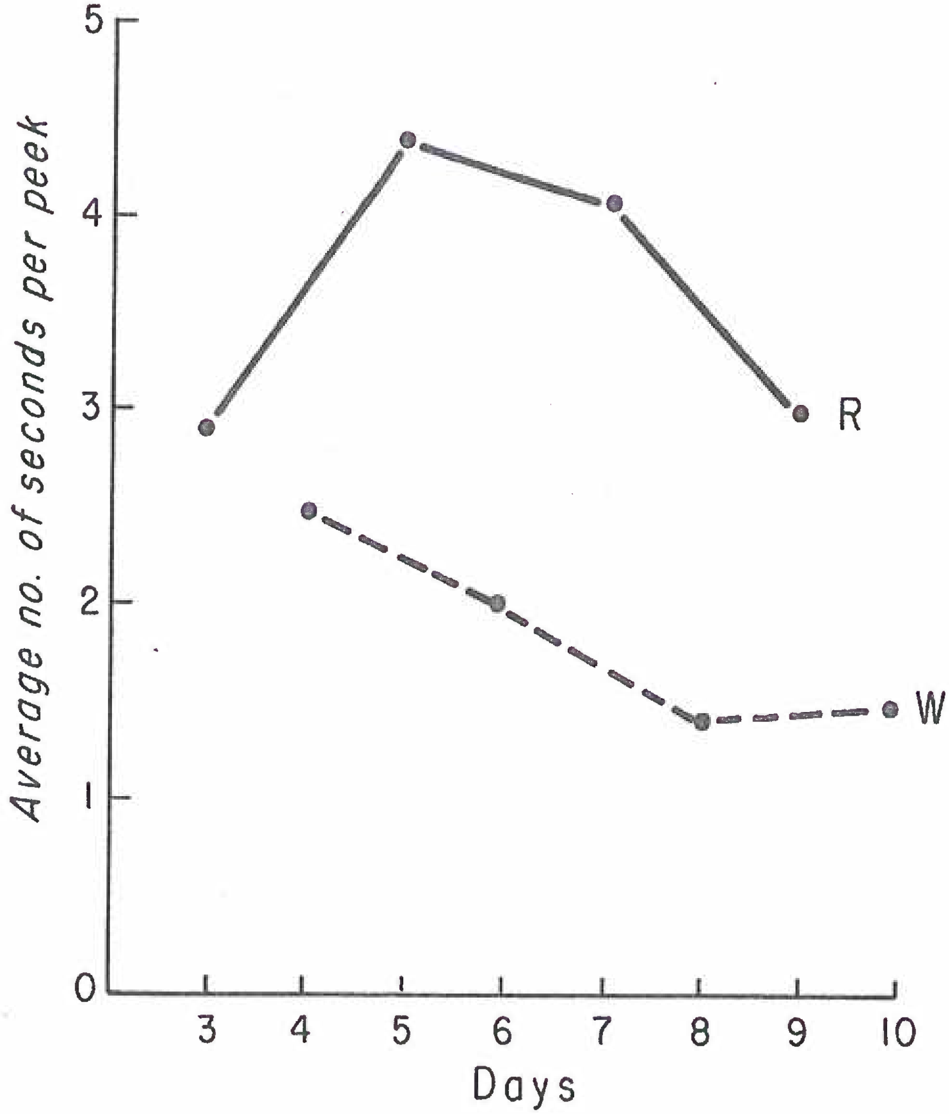
A graph illustrating the total number of seconds spent at the window per session under Room and Wall Conditions. (means for all 16 Ss)



350
300
250
200
150
100
50
0
No. of seconds
R
W
3
4
5
6
7
8
9
10
Days

FIGURE 10

A graph showing the average duration of peeks per session under Room and Wall Conditions. (means for all 16 Ss in seconds)



Average no. of seconds per peek
5
4
3
2
1
0
R
W
3
4
5
6
7
8
9
10
Days

FIGURE 11

A graph depicting the total number of
activity counts per session under
Room and Wall Conditions.
Also includes three sessions when activity
alone was tested.
(means of all 16 S_s_)

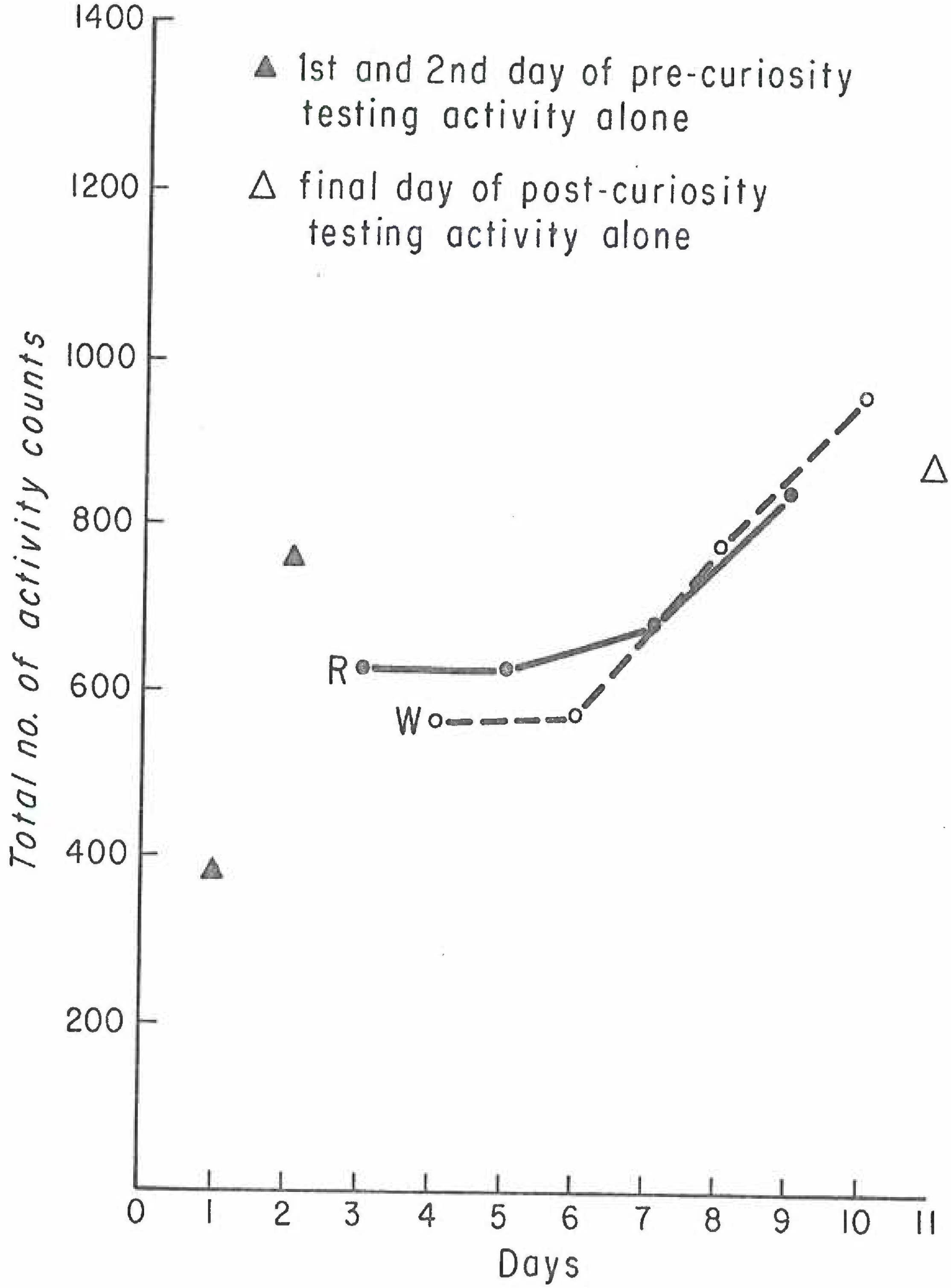
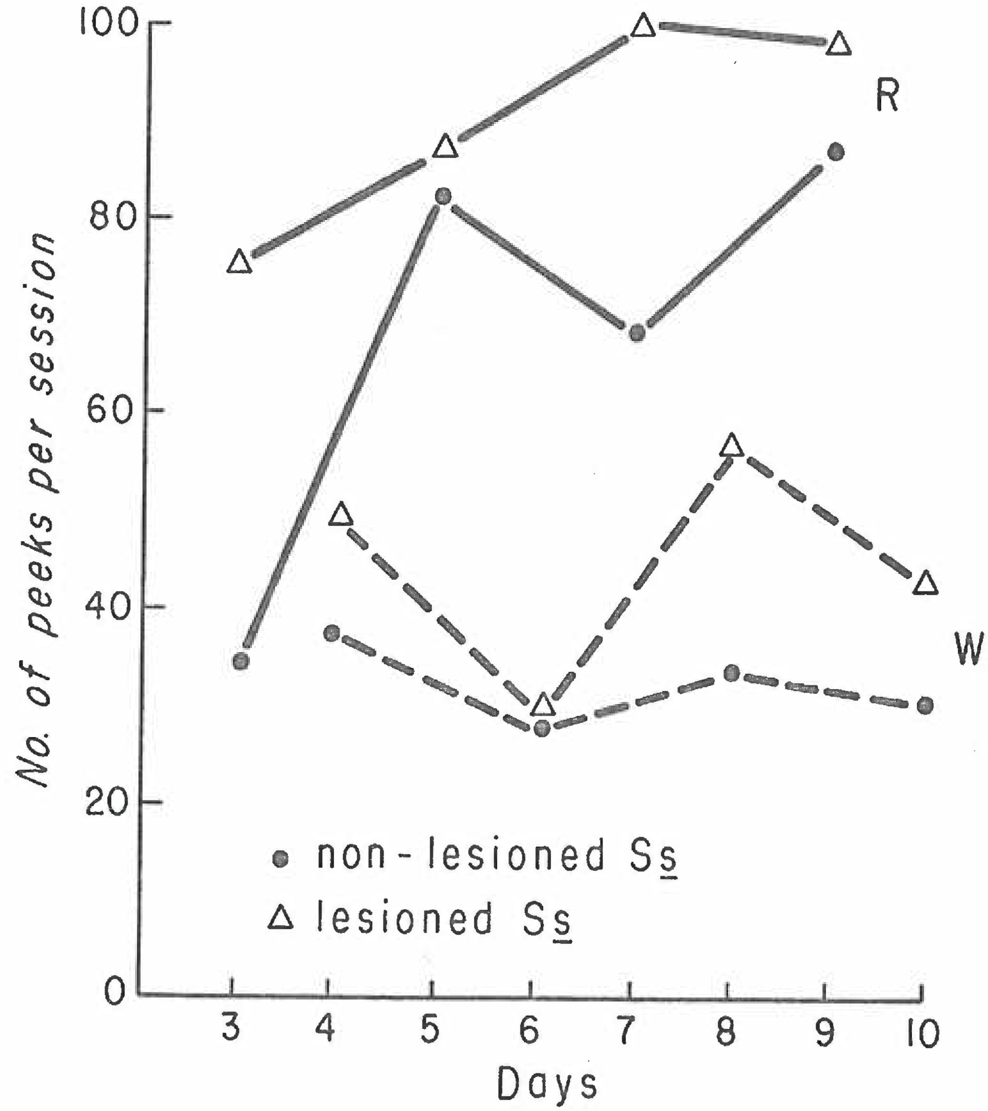

1st and 2nd day of pre-curiosity testing activity alone
final day of post-curiosity testing activity alone
Total no. of activity counts
1400
1200
1000
800
600
400
200
R
W
0
1
2
3
4
5
6
7
8
9
10
11
Days

FIGURE 12

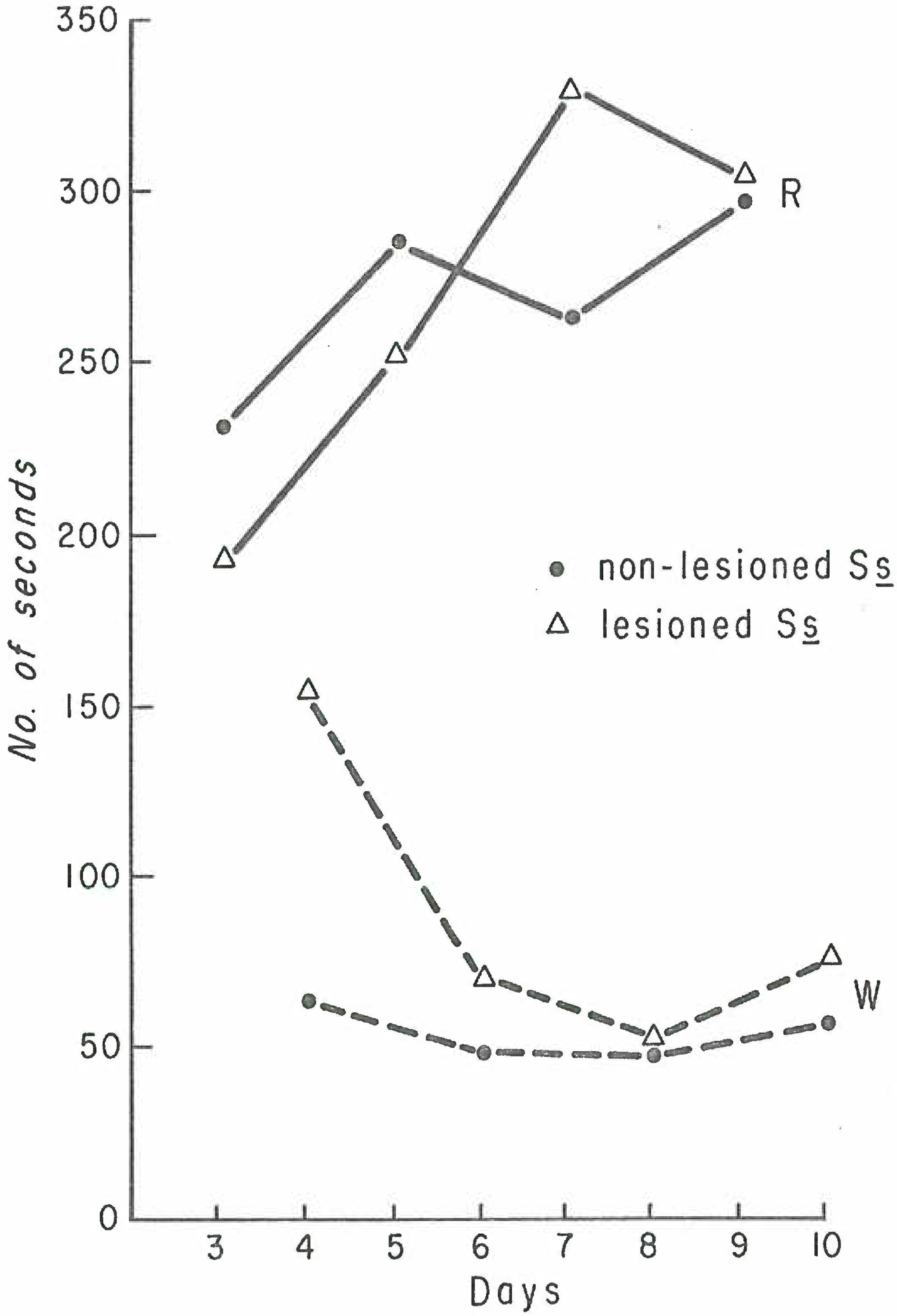
A graph showing the total number of peeks per session under Room and Wall Conditions for lesioned and non-lesioned Ss.
(means for 11 non-lesions Ss and for 5 lesioned Ss)



100
80
60
40
20
0
No. of peeks per session
3
4
5
6
7
8
9
10
Days
R
W
non-lesioned Ss
lesioned Ss

FIGURE 13

A graph illustrating the total number of seconds spent at the window per session under Room and Wall Conditions for lesioned and non-lesioned Ss. (means for 11 non-lesioned Ss and 5 lesioned Ss)



350
300
250
200
150
100
50
0
No. of seconds
R
W
non-lesioned Ss
lesioned Ss
3
4
5
6
7
8
9
10
Days

FIGURE 14

A comparison of the average duration of peeks per session under Room and Wall Conditions for lesioned and non-lesioned Ss.

(means for 11 non-lesioned Ss and 5 lesioned Ss)

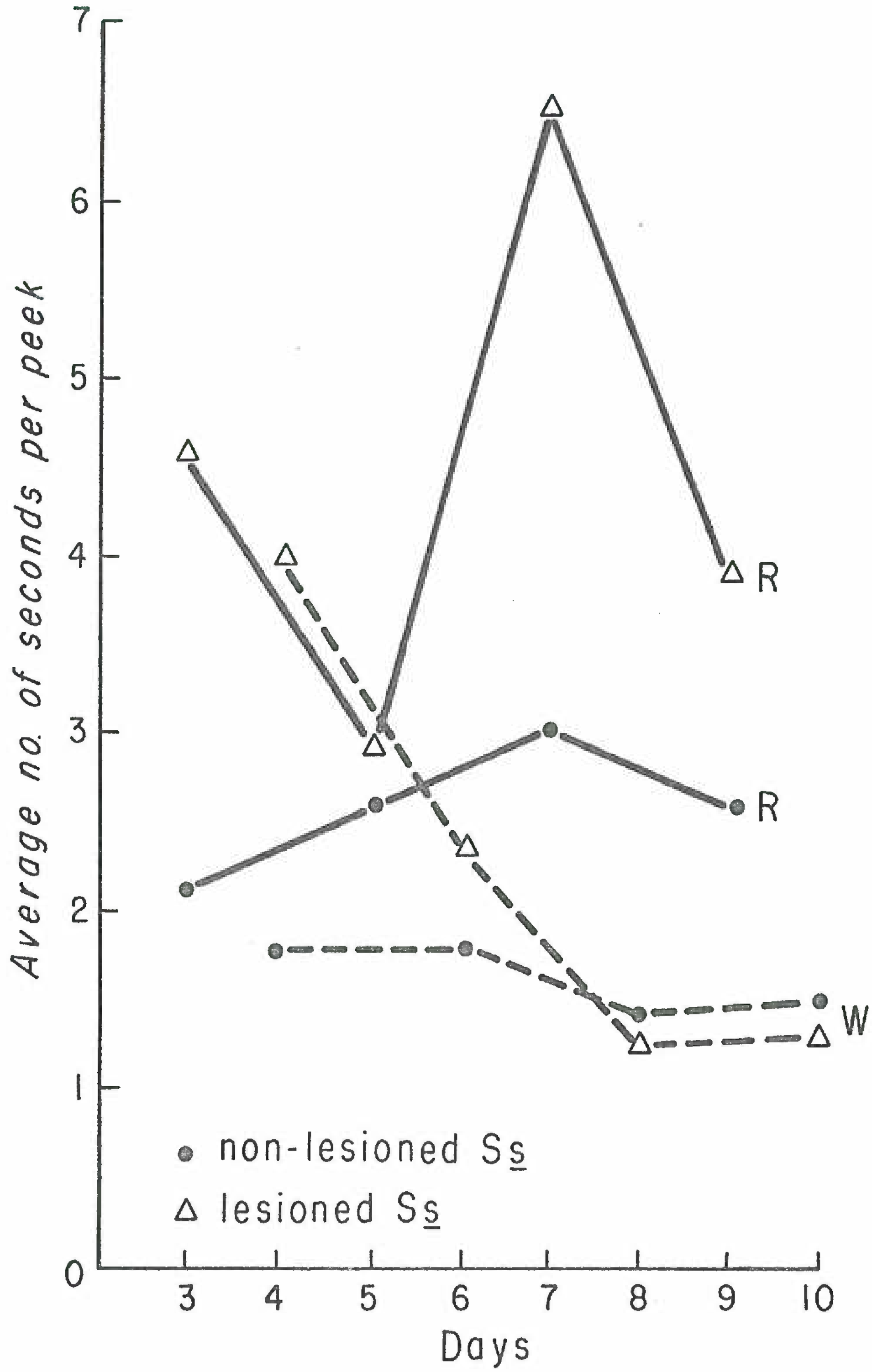
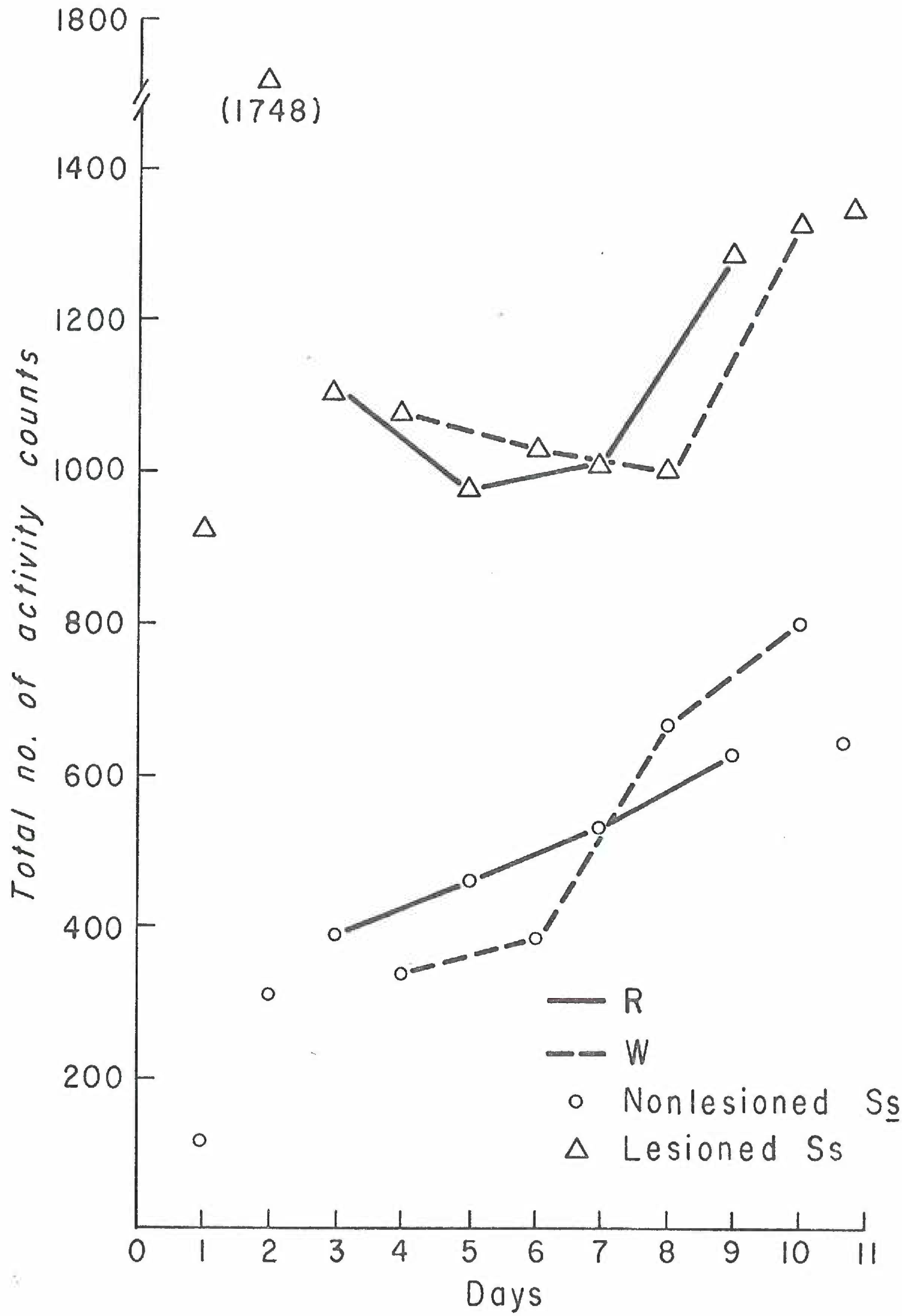

Average no. of seconds per peek
0
1
2
3
4
5
6
7
R
R
W
non-lesioned Ss
lesioned Ss
3
4
5
6
7
8
9
10
Days

FIGURE 15

A graph depicting the total number of activity counts per session under Room and Wall Conditions for lesioned and non-lesioned Ss.

Also includes three sessions when activity alone was tested.

(means for 11 non-lesioned Ss and 5 lesioned Ss)



Total no. of activity counts
1800
1400
1200
1000
800
600
400
200
(1748)
R
W
Nonlesioned Ss
Lesioned Ss
0
1
2
3
4
5
6
7
8
9
10
11
Days

TABLE XV

TESTING PATTERN

	DAY										
	1	2	3	4	5	6	7	8	9	10	11
Group I, Pattern #	I	II	III	IV	VIII	X	VII	V	IX	VI	VIII
Group II, Pattern #	I	II	III	VII	X	V	VI	IV	VIII	IX	VI
	PATTERN (TESTING ORDER)										
Animal #	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1,9	1	8	7	6	5	4	3	2	1	8	7
2,10	2	1	8	7	6	5	4	3	2	1	8
3,11	3	2	1	8	7	6	5	4	3	2	1
4,12	4	3	2	1	8	7	6	5	4	3	2
5	5	4	3	2	1	8	7	6	5	4	3
6,14	6	5	4	3	2	1	8	7	6	5	4
7,15	7	6	5	4	3	2	1	8	7	6	5
8,16	8	7	6	5	4	3	2	1	8	7	6

Group I = first 8 _Ss_ used
Group II = second 8 _Ss_ used

TABLE XVI

RAW DATA

Total # of Peeks per Session								
	DAYS*							
Subject #	3 R	4 W	5 R	6 W	7 R	8 W	9 R	10 W
1	86	52	103	72	120	59	170	60
2	180	39	241	21	73	62	54	47
3	0	0	0	0	0	0	0	1
4	23	25	63	31	55	44	66	33
5	0	0	0	0	0	0	0	0
6	11	21	6	2	33	7	43	10
7	0	0	0	0	0	0	0	0
8	4	0	0	0	0	1	2	0
9	63	126	225	46	72	57	105	65
10	243	139	218	122	328	117	358	93
11	62	5	57	7	68	25	158	21
12	0	0	0	0	0	0	0	0
14	246	91	327	30	297	64	176	41
15	16	7	8	17	6	6	25	2
16	114	95	98	44	181	29	227	110

*The data are presented so that the first R day, first W day, etc. for each animal is in the same column. This is done for convenience in reading the chart.

TABLE XVII

RAW DATA

Total # of Seconds Spent at Window per Session								
	DAYS							
Subject #	3 R	4 W	5 R	6 W	7 R	8 W	9 R	10 W
1	300	75	245	50	600	75	508	100
2	441	60	600	45	80	78	172	70
3	0	0	0	0	0	0	0	2
4	68	101	200	64	280	25	188	67
5	0	0	0	0	0	0	0	0
6	12	168	60	20	240	50	390	63
7	0	0	0	0	0	0	0	0
8	10	0	0	0	0	2	5	0
9	124	46	400	50	120	100	180	85
10	1450	278	1510	256	1440	153	1380	190
11	135	14	120	11	196	38	398	20
12	0	0	0	0	0	0	0	0
14	480	177	915	50	880	108	465	51
15	106	76	45	100	80	11	32	3
16	302	365	295	130	455	47	445	200

TABLE XVIII

RAW DATE

Average Duration of Peeks per Session

	DAYS							
Subject #	3 R	4 W	5 R	6 W	7 R	8 W	9 R	10 W
1	3.5	1.4	2.4	0.7	5	1.3	3.0	1.7
2	2.5	1.5	2.5	2.1	1.1	1.3	3.2	1.5
3	0	0	0	0	0	0	0	1.0
4	3.0	4.0	3.2	2.1	5.1	0.6	2.8	2.0
5	0	0	0	0	6.0	0	0	0
6	1.0	8.0	10	10	7.3	7.1	9.1	6.3
7	0	0	0	0	0	0	0	0
8	2.5	0	0	0	0	1.0	2.5	0
9	2.0	0.4	1.8	1	1.7	1.8	1.7	1.3
10	6.0	2.0	6.9	2.1	4.4	1.3	3.9	2.0
11	2.2	2.8	2.1	1.6	2.9	1.5	2.5	1
12	0	0	0	0	0	0	0	0
14	2.0	2.0	2.8	1.7	3	1.7	2.6	1.2
15	6.6	10.9	5.6	5.9	13.3	1.8	1.3	1.5
16	2.6	3.8	3	3	2.5	1.6	2.0	1.8

TABLE XIX

RAW DATA

Total # of Activity Counts per Session								
	DAYS							
Subject #	3 R	4 W	5 R	6 W	7 R	8 W	9 R	10 W
1	639	469	492	369	785	805	826	720
2	429	256	448	304	460	388	294	422
3	3	44	30	69	38	39	66	206
4	295	284	729	652	742	835	879	986
5	18	15	0	3	25	182	67	110
6	111	332	38	82	99	759	162	531
7	3	52	55	128	59	98	120	93
8	310	46	445	370	323	406	465	357
9	796	1216	1563	1079	1248	1043	1399	1223
10	1289	773	932	817	1662	2569	2194	3955
11	334	260	200	185	415	211	392	176
12	5	48	15	32	56	30	38	100
14	3934	3897	3284	3698	3103	4121	3641	4907
15	227	218	115	322	110	123	303	71
16	1233	1001	1343	795	1584	518	2203	1107

TABLE XX

RAW DATA

Total # of Activity Counts per Session (Activity Alone)			
	DAYS		
Subject #	1	2	11
1	211	217	420
2	69	120	120
3	45	13	101
4	5	89	251
5	77	235	65
6	60	733	347
7	72	80	36
8	324	26	428
9	59	787	1468
10	138	928	3441
11	284	136	385
12	11	18	16
14	1632	4634	4490
15	892	742	184
16	1663	2645	1607