

# The lateral pedunculo-nigral area and visual discrimination performance in the white rat\*

ROBERT THOMPSON, MARSHA A. HOWZE

and

JOHN H. PUCHEU

*Louisiana State University, Baton Rouge, La. 70803*

Discrete bilateral electrolytic lesions destroying the lateral half of the cerebral peduncle and overlying substantia nigra at prerubral levels (which disjoin a pathway from the occipital cortex to the brainstem reticular formation) in the rat produced profound losses in retention of a brightness and a pattern discrimination habit. Lesions damaging the substantia nigra alone had significantly smaller effects on retention. These results, in conjunction with others, support the notion that a direct occipitoreticular pathway may be involved in the performance of visual discrimination habits, possibly serving in attention to visual cues, visuomotor integration, and/or formation of visual engrams.

It has recently been reported that electrolytic lesions destroying the lateral pedunculo-nigral area (LPNA) in rats seriously impair retention of a visual pattern discrimination habit, while only slightly impairing retention of a nonvisual kinesthetic discrimination habit (Thompson & Craddock, 1972). Since the LPNA is traversed by corticoreticular fibers originating within the posterior regions of the cerebrum (Knook, 1966; Valverde, 1962), the possibility exists that a direct pathway between the occipital cortex and the brainstem reticular formation functions in the maintenance of discriminative responses to visual stimuli. Further support for this notion comes from the findings that visual pattern discrimination habits are susceptible to interference either by longitudinal knife cuts situated between the LPNA and the mesencephalic reticular formation (Howze & Thompson, 1972) or by electrolytic lesions of the mesencephalic reticular formation (Thompson & Thorne, 1973).

In the current study, a more intensive investigation of the effects of LPNA lesions on visual discrimination performance was made. Specifically, we attempted to determine if a brightness discrimination habit is likewise abolished following lesions of the LPNA, and if the deficits in brightness and pattern discrimination performance are more related to nigral damage than to peduncular damage. In addition, data are provided on the effects of lesions to the region of the lateral and dorsal terminal nuclei of the accessory optic system. This was deemed necessary in view of the fact that LPNA damage interrupts a portion of the accessory optic fibers which traverse the ventral surface of the cerebral peduncle at nigral levels (see Hayhow, Webb, & Jervie, 1960).

## METHOD

Adult male albino rats of the Wistar strain were initially

\*This research was supported in part by a grant from the Graduate Council on Research, Louisiana State University.

trained in a Thompson-Bryant (1955) discrimination box to approach a white stimulus card and to avoid an adjacent black stimulus card (Problem WB). Under the motive of escape from footshock, a response to the unlocked white card admitted S to the goalbox, whereas a response to the locked black card was automatically punished by mild footshock. Eight trials were given daily with an intertrial interval of 60 sec. The criterion of learning consisted of no more than one error in 2 consecutive days. Upon reaching the criterion on Problem WB, the Ss were then required to approach a horizontal black and white striped card and to avoid an adjacent vertical black and white striped card (Problem HV)—the striations were  $\frac{1}{2}$  in. thick. The training procedure on Problem HV was the same as that described for Problem WB.

Following learning of Problem HV, the Ss were divided into four groups, the groups being roughly matched in terms of the number of errors made in original learning. One group (Group LPNA) sustained lesions destroying portions of the lateral half of the cerebral peduncle and overlying substantia nigra at prerubral levels. A second group (Group LSN) received lesions of the lateral half of the substantia nigra at prerubral levels with minimal involvement of the subjacent cerebral peduncle. A third group (Group MGN) suffered lesions in the region of the medial geniculate nucleus which were intended to destroy the lateral and/or dorsal terminal nuclei of the accessory optic system. The fourth group (Group NC) served as normal controls.

A 2-week recovery period (or rest period in the case of Group NC) was allowed prior to the retention test. The retention test consisted of relearning the discrimination problems in the same order in which they were originally mastered. Retention was measured in terms of percentage error savings scores using the conventional formula.

Following the retention test, each operated S was anesthetized and its vascular system perfused with 10% Formalin. The brain was then removed, fixed, and subsequently sectioned frontally at 90 microns. Every third section through the lesion was photographed at 14X. For the purpose of ranking the Ss in terms of the amount of damage to the cerebral peduncle and substantia nigra, the lesions of each S composing Groups LPNA and LSN were reconstructed on work sheets containing a series of frontal sections through prerubral and rubral levels. A transparent grid was then used to obtain an index of the overall size of the lesions as well as of the extent of central necrotic damage to the cerebral peduncle and substantia nigra.

## RESULTS

In spite of the moderate size of the lesions (see Fig. 1), the majority of Ss showed no obvious evidence of brain damage by the end of the second postsurgical day, nor did they show any belated symptomatology. The only notable behavioral change was a heightening of startle reflexes to auditory and tactile stimuli. This hyperexcitability (which lasted from 2 to 7 days) was observed in five of the six Ss in Group LPNA, three of the five Ss in Group LSN, and two of the eight Ss in Group MGN. All Ss were subsequently found to be excellent runners in the apparatus during the retention test; they were highly motivated to gain entrance into the goalbox, oriented well to the stimulus cards, showed frequent VTE behavior, and exhibited normal correction responses following the commission of an error.

Table 1 presents the retention scores for each group

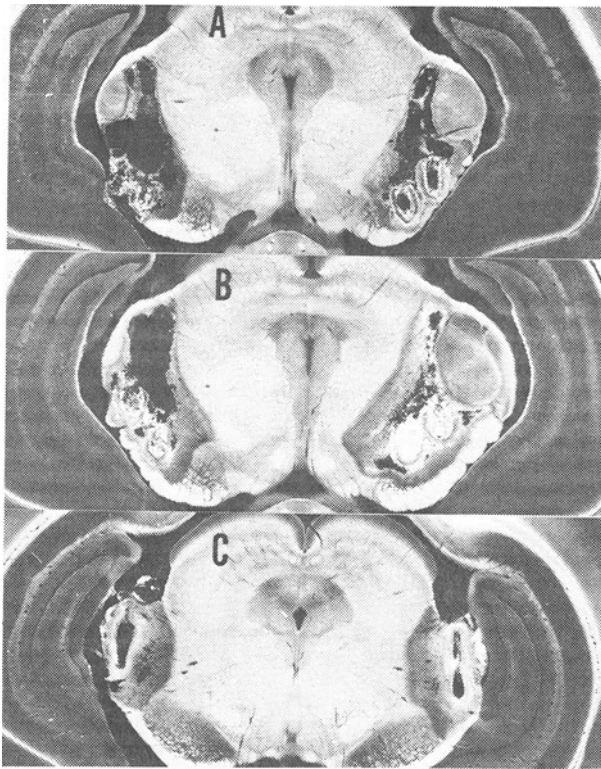


Fig. 1. Photographs of unstained sections showing lesions of the lateral pedunculo-nigral area (A) in one rat (Problem WB = -88%, Problem HV = 21%), lateral substantia nigra (B) in one rat (Problem WB = 0%, Problem HV = 54%), and medial geniculate nucleus (C) in one rat (Problem WB = 100%, Problem HV = 100%).

on Problems WB and HV. The Mann-Whitney test disclosed that Groups LPNA and LSN were significantly inferior to Group NC in retention of both problems ( $ps < .05$ ). On the other hand, Group MGN did not differ significantly from Group NC in retention of either problem ( $ps > .30$ ). Of particular interest was the finding that Group LPNA was significantly inferior to Groups LSN and MGN ( $ps < .05$ ) in retention of both problems. The differences between the latter two groups were also significant beyond the .05 level.

It must be emphasized that the extent of the retention deficits in Groups LPNA and LSN was not related to the overall size of the lesions; the rank-order correlations were found to be negative (-.10 for

Problem WB and -.30 for Problem HV) and insignificant. Correlations between retention deficits and extent of damage to the cerebral peduncle were positive (.52 for Problem WB and .69 for Problem HV), but only the latter reached statistical significance. With respect to retention deficits and extent of damage to the substantia nigra, the correlations were again positive (.69 for Problem WB and .37 for Problem HV), but only the former was significant. Finally, correlations between retention deficits and extent of combined damage to the cerebral peduncle and substantia nigra were positive and significant (.80 for Problem WB and .59 for Problem HV).

## DISCUSSION

These results confirm earlier findings (Thompson & Craddock, 1972) in showing that LPNA lesions drastically impair retention of a horizontal-vertical discrimination habit in the rat. The finding that a brightness discrimination habit was likewise abolished following LPNA damage provides additional evidence for the importance of the lateral portions of the cerebral peduncle and substantia nigra in the maintenance of discriminative responses to visual stimuli.

It would appear that the dramatic retention losses observed in Group LPNA are attributable to damage to both the cerebral peduncle and substantia nigra, and not to damage to any one structure alone. This conclusion is based upon the finding that Group LSN showed significantly poorer retention scores than Group NC, but significantly better retention scores than Group LPNA, and upon the observation that the amount of damage to the LPNA (rather than the amount of damage to either the cerebral peduncle or substantia nigra) is the best index for predicting the extent of retention losses on both visual discrimination problems. On the other hand, inadvertent injury to the accessory optic fibers underlying the cerebral peduncle does not appear to contribute to the retention losses observed in Group LPNA. This was clearly demonstrated by the excellent performance of those Ss composing Group MGN which sustained damage to the dorsal and/or lateral terminal nuclei of the accessory optic system.

Thus, the overall results of this study, coupled with those of related studies (Howze & Thompson, 1972; Thompson & Craddock, 1972; Thompson & Thorne, 1973), strongly favor the notion that the disruptive effects of LPNA lesions on visual discrimination performance are due to interruption of an occipitoreticular pathway. The functional significance of this pathway may lie in attention to visual cues, visuomotor integration, and/or formation of visual engrams.

## REFERENCES

- Hayhow, W. R., Webb, C., & Jervie, A. The accessory optic fiber system in the rat. *Journal of Comparative Neurology*, 1960, 115, 187-215.
- Howze, M. A., & Thompson, R. Disconnecting occipitoreticular projections: Amnesic effects on a visual habit in the rat. *Psychonomic Science*, 1972, 27, 143-145.
- Knook, H. L. *The fibre-connections of the forebrain*. Philadelphia: Davis, 1966.
- Thompson, R., & Bryant, J. H. Memory as affected by activity of the relevant receptor. *Psychological Reports*, 1955, 1, 393-400.
- Thompson, R., & Craddock, S. N. Lateral cerebral peduncle lesions: Amnesic effects on a visual habit in the rat. *Psychonomic Science*, 1972, 27, 140-142.
- Thompson, R., & Thorne, B. M. Brainstem reticular formation lesions: Amnesic effects on learned habits in the rat. *Physiological Psychology*, 1973, 1, 61-70.
- Valverde, F. Reticular formation of the albino rat's brainstem cytoarchitecture and corticofugal connections. *Journal of Comparative Neurology*, 1962, 119, 25-53.

(Received for publication May 21, 1973.)

Table 1  
Retention Scores for All Groups

Group	N	Problem WB		Problem HV	
		Mean	Range	Mean	Range
NC	6	100		99.0	94-100
LPNA	6	-46.3	-167- 68	6.7	-25- 35
LSN	5	57.2	0-100	67.6	50-100
MGN	8	94.3	80-100	95.0	83-100