Cues utilized by normal and posterior-neodecorticate rats in the Yerkes brightness discrimination task¹

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Abstract

Single-eyed rats that had undergone sham, bilateral and unilateral striate removals were tested to determine whether they use luminous flux cues in performing a Yerkes brightness habit. In contrast to sham-operated rats, bilateral striate animals were found to use flux cues. Unilateral rats tended to use flux cues if the cortex contralateral to the remaining eye had been ablated and did not if the cortex ipsilateral to the remaining eye had been removed.

Introduction

Lashley rejected the possibility that loss of the brightness habit following visual cortical removals could be interpreted in terms of a loss of pattern vision. One reason for his belief was that rats initially trained on the task with the lenses of their eyes removed—to impair pattern vision—showed the usual postoperative loss (Lashley, 1937). In a similar experiment, however, Bauer & Cooper (1964) demonstrated that rats trained with white translucent cups sewn over their eyes showed good postoperative savings. Lashley (1935) felt his belief was also supported by his difficulty in training rats to discriminate on the basis of pattern in the Yerkes box; thus, the lack of pattern vision would not affect postoperative performance on the task. Lashley's position on the way in which the normal rat solves the "brightness" discrimination problem parallels Klüver's (1942) findings for the striate monkey. Klüver has shown that such animals do not in fact respond to brightness but to luminous flux.

In contrast to Lashley, Bauer & Cooper (1964) argue that normal rats use pattern vision and striate rats luminous flux and that this change in the nature of the cues utilized can account for postoperative loss. As a test of their position the present experiment was carried out to determine whether bilateral striate and intact rats use flux cues in the Yerkes situation. In addition, unilateral striate rats were also utilized to examine how partial removals might affect postoperative performance in the Yerkes task.

Procedure and Results

Twenty single-eyed black-hooded rats subjected to either bilateral, unilateral (Fig. 1) or sham striate ablations were used. The unilateral Ss were split into two groups with an eye removed either contralateral or ipsilateral to the side of the lesion.

A modified Yerkes box similar in dimensions to that described by Thompson (1960) was used. The stimulus panels, illuminated at the back by a 32 ft c intensity, consisted typically of 4 by 4 in neutral density filters

sandwiched between 1/8 in thick sheets of clear Perspex and white paper. A 580 volt AC source in series with about one megohm resistance was used to electrify the start box, choice chamber and two 4 in long alley grids.

Ss were trained in 10 trial daily sessions to avoid an unlighted panel and to approach a lighted panel and over a series of steps to choose the brighter of two 4 by 4 in panels differing at an 8:1 intensity ratio. After S reached a criterion of at least 10 correct consecutive responses at this ratio 14 more trials were given with six test trials interspersed. On the free choice (shockless) test trials the area of the brighter patch was reduced to one-eighth its size making the two patches equal in luminous flux but leaving the brightness ratio unchanged. On all test trials all Ss chose the larger dimmer patch which was presented equally often in the left and right alleys. Since the difference in area between the two stimuli was so great in this test we assumed that the larger, although dimmer, patch was more easily sampled by all Ss and substituted another test. (We had hoped to train all Ss to at least a 4:1 intensity ratio to circumvent this problem but as Lashley had found earlier (1930) some of the operated

Fig. 1. Photograph of bilateral and unilateral lesions.

TABLE I
Responses to negative stimulus on
56 training and 24 test trials.

Group	rat no.	training	test
Sham-operate	7	0	24
	8	0	19
	15	0	24
	16	3	23
	17	1	24
Bilateral striate	1	5	14
	2	5	12
	9	5	11
	10	4	15
	20	2	14
Eye contralateral to intact hemisphere	4	9	17
	13	0	23
	14	11	22
	19	4	24
Eye ipsilateral to intact hemisphere	6	4	15
	11	4	15
	12	0	15
	18	2	23

Ss had difficulty in reaching even the 8:1 level. Two unilateral Ss which did not reach criterion in 150 trials at the 8:1 level were dropped from the experiment.)

In the second test 16 tiny bright patches (about .35 by .35 in) were substituted for the small bright patch (about 1.4 by 1.4 in) used in the first test. They were evenly spread out to form a 4 by 4 in squarelike pattern. Again six test trials were interspersed among 14 training trials per daily training session. This procedure was repeated for four consecutive days. From Table 1 it can be seen that all Ss approached the negative stimulus infrequently enough on training trials to validate the significance of the responses made on test trials. It can also be seen that only one sham-operate S was not highly consistent in choosing the negative stimulus on test trials. In contrast, bilaterally striate Ss chose the same stimulus at a chance rate. Ss using an eye ipsilateral to the side of the lesion, i.e. with 90-95% (Polyak, 1957) of the fibers crossed to the intact hemisphere, tend to behave like the sham operates, while those with the majority of fibers crossing to the impaired hemisphere tend to behave like bilaterally lesioned Ss.

Discussion

The work of several investigators seems to point to a primitive pattern vision after striate removal (Morgan, 1965). In the first test of the present experiment striate rats were found to consistently approach the larger of two patches equivalent in luminous flux. This should not be construed as evidence for pattern vision. The performance of the rat under the final test condition does not support this possibility. The reader should

consult Klüver (1942) for some of the factors requiring control before presupposing pattern vision exists in striate animals.

The difference in performance of the striate and normal rats in the second test indicates that the nature of the cues utilized by the two groups is different. In conflict with Lashley's belief the normal rats do not seem to respond on the basis of flux in the Yerkes box, while the bilateral striate rats do. These results support Bauer & Cooper's argument (1964) that post-operative losses of the brightness habit can be interpreted in terms of a loss of pattern vision.

On the basis of Lashley's (1935) paper most workers have been left with the impression that if a postoperative deficit in the brightness habit is to be demonstrated the entire striate area must be removed. As Lashley pointed out, all his data were not consistent on this point. The tendency of rats with a small part of their visual field intact (eye contralateral to lesion) to behave like striate animals makes it seem likely that loss of the brightness habit could vary with lesion size. The performances of the unilateral striate rats may also bear on investigations of two stage removals of striate cortex (e.g., Thompson, 1960). These studies indicate that during the inter-operative interval the animals may learn something that can later bring about savings in retention of habits based on light. Possibly this something is learning to respond on the basis of flux cues, making the final transition to patternless vision easier.

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Note

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