Differences in the effectiveness of optic uncrossed fiber systems in albino and hooded rats¹

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Pattern discrimination performances were evaluated in albino and hooded rats surgically limited to uncrossed optic fiber systems. These pathways proved far less effective in albino than in hooded rats, thus providing a partial explanation of the marked differences in interocular transfer exhibited by the two strains.

Hooded rats exhibit high level interocular transfer of either black-white or pattern discriminations (Sheridan, 1965), and in this regard they resemble more advanced mammals such as cats (Myers, 1962), monkeys (Downer, 1962) and chimpanzees (Black & Myers, 1965). Albino rats, in sharp contrast to hooded rats trained under identical circumstances, display only very low level interocular transfer (Sheridan, 1965; Sheridan & ShROUT, 1965), their performances being similar to those of submammalian forms such as pigeons (Levine, 1945) and goldfish (McCleary, 1960). Sheridan (1965) suggested that these strain differences in interocular transfer might be due to a further reduction in albino rats of the sparse uncrossed fiber bundles which characterize rodents in general, and this suggestion has since been confirmed at the anatomical level (Lund, 1965). But the quantity of fibers necessary to mediate visual pattern discriminations is very small (Lashley, 1939), and it, therefore, remains to be demonstrated that the structural differences in uncrossed fiber density have a parallel in the relative ability of albino and hooded rats to acquire visual discrimination habits via the uncrossed fiber bundles. It was to this end that the present experiment was undertaken.

METHOD

Subjects

The Ss were 11 albino and 9 hooded rats which had survived stereotaxic sectioning of the corpus callosum and severance of some part of the optic pathway.

Apparatus

The apparatus, which has been described in detail elsewhere (e.g., Sheridan, 1965), utilized escape from shock as reinforcement, and consisted of a start box, runway, choice point with two alternative entryways, and a goalbox.

Procedure

Surgery: A modification of a previously described (Sheridan, 1965) surgical technique was used in making the lesions. Lesions (e.g. optic tract section, midline section of chiasm) were made in the area of the optic chiasm by stereotaxically lowering a sharp needle in a dorso-ventral direction until it reached the floor of the skull. In the same operation, the

corpus callosum was sectioned by passing the needle at a depth just below that of the corpus callosum from the splenium through the rostrum.

Training

Ss were pretrained to run to the goalbox, and to knock over grey stimulus cards which blocked the goalbox entryways. One eye was then covered with an opaque contact occluder, and the Ss were trained to discriminate between half-inch black and white stripes slanting 45° to the right or left. Twenty-five trials per day were given until a criterion of 18 correct responses in 20 consecutive trials had been reached, or until 300 trials had elapsed, then the occluder was shifted to the opposite eye and the Ss were trained again to criterion. After completion of training most Ss were given 20 trials with both eyes covered, affirming the reliability of the occluder.

RESULTS

Table I presents the 1st and 2nd-eye trials to criterion for each S categorized according to whether an uncrossed, a crossed system or both systems mediated the discrimination. In addition, the peak percentage correct in any block of 20 trials is given for Ss which failed to reach criterion before the 300-trial cut-off point.

There were 8 instances among the albino Ss and 6 among the hooded Ss in which vision was restricted to an uncrossed fiber system. Using the trials to criterion measure, there was no overlap between

Table I. Trials to Criterion for Albino and Hooded Subjects According to the Fiber System Employed During Training. (Percentage Correct for the Best 20-trial Block is given in Parentheses for Ss Failing to Meet Criterion)

	S	First Eye	Second Eye	S	First Eye	Second Eye
Uncrossed Fibers	A1	300*(55%)		H5	141	157
	A2	214	300*(85%)	H6	109	
	A4		300*(75%)	H7		1
	A5	300*(80%)	300*(75%)	H8		2
	A8	300*(75%)		H9	111	
	A9	300*(80%)				
Crossed Fibers	A1		165	H7	252	
	A6	199		H8	148	
	A9		45	H9		26
	A11	195				
Both Systems	A3	254	187	H1	78	3
	A6		22	H2	75	0
	A7		194	H3	105	35
	A8		127	H4	125	75
	A10	161				

* Failed to meet 18/20 criterion within 300 trials

albino and hooded rat uncrossed fiber performances, and the strains differed significantly with a $p = .002$ (Mann-Whitney U). Since both first and second eye performances are included here, it might be supposed that the difference was at least partially due to differences in the proportion of second eye performances, but even if we ignore second eye data altogether the two strains differed with a $p < .04$ (Mann-Whitney U = 0). Furthermore, a measure which ignores rate of acquisition and simply takes into account peak percentage correct in any block of 20 trials leads to the same conclusion. Using this measure, albinos differ from hooded Ss with a $p = .004$ (U = 3).

Examination of the peak percentage correct scores reveals that, in spite of the failure of albinos to discriminate at the criterion level, some learning occurred via uncrossed fibers. In fact, only one animal failed to reach the .05 level (15/20 correct) or better. Six of the 8 animals met the commonly used 9/10 criterion, the median trials to this criterion for all 8 cases being 168. However, these performances were not sustained. All Ss, regardless of strain, discriminated at criterional levels when using either a crossed fiber system or both systems.

DISCUSSION

There are variations in the acquisition of pattern discriminations corresponding to the differences in density of uncrossed fiber bundles in albino vs hooded rats. It is, therefore, likely that the contrasting interocular transfer performances of these two varieties of rat are founded largely on this simple structural variation. The direct visual pathways from a given eye in the albino rat terminate almost entirely in a single cerebral hemisphere, and monocular visual inputs are, therefore, isolated in a manner which, *mutatis mutandis*, makes the albino rat almost identical to the higher mammal whose optic chiasm has undergone midline sectioning. The failure of the corpus callosum to transmit veridical unilateral input to the opposite hemisphere remains an enigma.

It is probable that the differing evaluations of uncrossed fiber effectiveness previously reported by Chang (1936a,b) and by Muntz & Sutherland (1963) stem from the use of albino rats in the former experiment and hooded rats in the latter. As we might expect, (Chang, 1936a,b) found the uncrossed fibers "useless" in pattern discrimination, whereas Muntz & Sutherland (1963) found them quite capable of mediating

such discrimination.

Finally, it is suggested that further efforts invested in the examination of strain differences in brain-behavior relations would be well spent. Within a single species the transition from completely (in a functional sense) to partially decussated optic chiasm can be observed, and its significance evaluated. (It is by no means certain that this significance lies solely in the relative isolation of input.) Furthermore, it is clear that slight inter-strain structural variations can give rise to major behavioral divergences, and since several variations of this sort have already been described (see Lund, 1965), with perhaps still more waiting to be delineated, careful consideration should be given to the task of evaluating the generality of neuro-psychological findings obtained within a given strain.

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Note

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