Interocular interaction of conflicting discrimination habits in the albino rat: A preliminary report¹

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Abstract

Shock-motivated albino rats promptly learned a reversal habit via one eye while retaining the original habit via the opposite eye, even though they previously had shown veridical interocular transfer in the same situation. Binocular tests revealed marked individual variations in conflicting-habit dominance.

Problem

Pigeons retain conflicting discrimination habits mediated by opposite eyes without special conditional discrimination training (Levine, 1945), but mammals apparently do so only when the cerebral hemispheres have been isolated from each other (Trevvarthen, 1962; Bures & Buresova, 1960). Since shock motivation gives rise to interocular transfer in "split-brain" cats (Sechzer, 1964), it would be reasonable to suppose that such conflicting habit retention does not occur in shock-motivated mammals, even when "split-brained." But interocular transfer in shock-motivated rats is incomplete (Sheridan, 1965; Sheridan & Shrout, 1965), so it is possible that the rat is one mammal which can retain conflicting habits mediated by opposite eyes. The experiments reported here were done in order to examine this possibility empirically, and to observe conflicting-habit interaction under binocular viewing conditions, as has been done with "split-brain" monkeys (Trevvarthen, 1962).

Experiment I

Subjects. Ss were four corpus callosotomized and four sham operated Sprague-Dawley albino rats.

Apparatus and Procedure. A detailed account of the apparatus and training procedures has been published elsewhere (Sheridan, 1965). Binocular Ss were required, in order to avoid shock, to run through a door covered with horizontal stripes in preference to one covered with vertical stripes until they reached a criterion of 18 correct Rs in 20 consecutive trials, then overtraining was given until Ss had made an additional 10 consecutive correct Rs. Five-trial tests (all Rs reinforced) were then given with alternate eyes covered by an opaque contact occluder. This was done in order to detect any normal or surgically induced dominance of one eye (See Levine 1945; and Meyer & Meyer, 1963). Next, Ss with one eye covered were reversal trained to the same criterion used during original training. After reaching the reversal criterion, Ss were returned to the original problem, the occluder having been shifted to cover the reversal-trained eye. After this, Ss were trained with H+, V- on one eye and V+, H- on the other until the conflicting habits were well established, at which time they were binocularly tested with all Rs reinforced.

Results. Three Ss will not be considered, since they failed to reach criterion, one on the first and two on the second eye. Operated and unoperated Ss did not differ, and are treated together. The median percent correct for the first 10 trials on which the eye covered during reversal training was re-presented with the original problem was 70. Further training with conflicting problems on opposite eyes resulted in median 10-trial performances of 100% correct on the reversal-problem eye immediately followed by 90% correct on the original-problem eye. The latter performances were reached after a median of three occluder shifts. On the final binocular test, three Ss responded at chance levels and two chose the reversal S+ on 9 of the 10 trials.

Experiment II

Since conflicting-habit retention was immediate, it is unlikely that a conditional discrimination based on a "which eye" S^D had been formed. It would seem more probable that the ocular projections are isolated from each other centrally. However, it might be that albino rats retain conflicting habits under conditions which result in veridical interocular transfer in "split-brain" cats because of an interocular reversal effect like that exhibited by pigeons (Mello, 1965). Pigeons monocularly trained to respond to stripes tilted 45° vs. stripes tilted 135° respond maximally to S- during a naive-eye retention test. Moreover, on a triangle vs. circle problem, 10 out of 12 of Levine's (1945, Table 2) pigeons showed positive savings when presented with a reversal problem on the naive eye. Thus, an interocular reversal effect might be general to a variety of stimulus types, and might also occur in a simple mammal. In effect, this would mean that information transfers from one hemisphere to the other, but that its positive-negative valence is reversed. Experiment 2 was done in order to find whether interocular reversal occurs in albino rats.

Subjects. Five callosum-sectioned and two sham-operated Sprague-Dawley albino rats were used.

Apparatus and Procedure. The apparatus was unchanged in Experiment 2. Ss were originally trained monocularly, two of them with H+ and six with V+. After reaching an 18/20 criterion and then being overtrained to a 10/10 criterion, the occluder was shifted to the opposite eye, and Ss were given 10 test trials with all Rs reinforced, then they were reversal trained on the naive eye. Having reached the 18/20 + 10/10 criterion on the naive-eye reversal, Ss were shifted back to the original eye and given 10 trials on the original problem. Finally, with conflicting habits well established in opposite eyes, Ss were binocularly tested,

10 trials being given with all Rs reinforced.

Results. Only one S (an operate) showed a tendency to pick the original S- when the naive-eye was open. He chose it on 60% of the naive-eye test trials and on 80% of the first 10 reversal-training trials. In general, there were no consistent differences between operated and unoperated Ss, so their data were combined. Three measures indicated that most Ss retained the original habit on the naive eye. A median of 60% original S+ selections was made during the naive-eye test, the median performance on the first 10 naive-eye reversal training trials was only 35% correct, and, most convincing of all, the median S made eight incorrect Rs (original S+ choices) in at least one 10-trial block during reversal training. This evidence of interocular retention is in accord with the recent observation that a horizontal-vertical discrimination transfers more readily than the more difficult one used in previous studies of interocular transfer in the rat (Creel & Sheridan, 1965).

Despite the presence of veridical interocular transfer, most Ss showed no retardation in learning the reversal problem on the naive eye, the median number of trials to criterion being 89.5 on the original problem and only 58.5 on the reversal. However, two Ss failed to reach criterion on the second eye, the median number of trials being low because of very rapid learning by most Ss. After reversal learning, Ss (N=6) were shifted back to the originally trained eye and given 10 training trials on the original problem. Performances were 100% correct during the last 10 reversal trials (10/10 criterion), and the median was 90% correct on the first 10 original problem trials. On the final binocular test, the original habit dominated in two Ss, the reversal habit dominated in two, and neither habit dominated in the remaining two.

Discussion

Shock-motivated albino rats, whether callosum-sectioned or not, retained a monocularly acquired discrimination habit while learning a reversal habit via the opposite eye, and, in general, they retained conflicting habits with what seems to be insufficient opportunity to form a conditional discrimination. Furthermore, this occurred with a discrimination which transferred veridically from one eye to the other.

Catania (1965), using a free-operant procedure, reported retention of conflicting habits via opposite eyes in pigeons after they had exhibited veridical interocular transfer. However, special conditional discrimination training was required before conflicting habits were retained. The present findings (and the present apparatus) are more like those of Levine (1945), who observed retention of conflicting habits in pigeons without specific conditional discrimination training. This suggests that Catania's attribution of the differences between his findings and those of Levine to the use of free vs controlled operant procedures may well be correct.

Although only one S preferred the original S- on the

naive eye after learning the original problem, it would be wrong to discount entirely the possibility that an interocular reversal effect like that shown by pigeons (Mello, 1965) exists in some rudimentary form in albino rats. Whereas pigeons predominantly transfer reversal information and higher mammals transfer veridical information, perhaps the rat, whose brain has many intermediate structural features (optic chiasm, corpus callosum, anterior commissure, etc.) transfers both kinds. Though a proper evaluation of this conjecture must wait for future research, such an account has the advantage of not only helping us to understand the findings reported here, but also of helping to account for the striking disparity between interocular transfer in the rat (Sheridan, 1965; Sheridan & ShROUT, 1965) and in higher mammals, (e.g. Sechzer, 1964).

Dominance of one of the conflicting habits occurred in some rats, and this cannot generally be attributed to unilateral surgical impairment. However, it is not possible to say whether such dominance is an enduring trait of one hemisphere or whether perhaps it is a temporary characteristic induced by circumstances of training. The dominance observed in this experiment was certainly independent of strength of the habit as measured both by percentage correct and by crudely observed latencies. Neither was it possible to relate dominance to such factors as recency, ocular orientation during binocular testing, or original vs. reversal habit.

References

- Bures, J., & Buresova, O. The use of Leao's spreading depression in the study of interhemispheric transfer of memory traces. *J. comp. physiol. Psychol.*, 1960, 53, 558-563.
- Catania, A. C. Interocular transfer of discriminations in the pigeon. *J. exp. Anal. Behav.*, 1965, 8, 147-155.
- Creel, D., & Sheridan, C. L. Monocular acquisition and interocular transfer of a pattern discrimination in albino rats with unilateral striate lesions. Paper read at Midwestern Psychological Association Meeting held in Chicago, 1965.
- Levine, J. Studies in the interrelationship of central nervous structures in binocular vision: I. *J. genet. Psychol.*, 1945, 67, 105-129.
- Mello, N. K. Interhemispheric reversal of mirror-image oblique lines after monocular training in pigeons. *Science*, 1965, 148, 252-254.
- Meyer, D. R., & Meyer, P. M. Brain functions. *Ann. Rev. Psychol.*, 1963, 14, 155-174.
- Sechzer, J. A. Successful interocular transfer of pattern discrimination in "split-brain" cats with shock-avoidance motivation. *J. comp. physiol. Psychol.*, 1964, 58, 76-83.
- Sheridan, C. L. Interocular transfer of brightness and pattern discriminations in normal and corpus callosum-sectioned rats. *J. comp. physiol. Psychol.*, 1965, 59, 292-294.
- Sheridan, C. L., & ShROUT, L. L. Interocular transfer in the rat: The role of the occlusion process. *Psychon. Sci.*, 1965, 2, 173-174.
- Trevarthen, C. B. Double vision learning in split-brain monkeys. *Science*, 1962, 136, 258-259.

Notes

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