Interocular transfer in the rat: The role of the occlusion process¹

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Abstract

Interocular transfer of a pattern and of a black-white discrimination was measured in albino rats under shock motivation. Ss exhibited a reliable interocular decrement for either problem. The effectiveness of the black vinyl-acrylic contact occluders used to blind Ss was evaluated by presenting 20 test trials with both eyes occluded after training and interocular testing. Despite the complete superficial coverage of the eye, performance was somewhat above chance on the black-white problem, suggesting that the interocular transfer deficit is not only reliable, but also sizeable for both problems. An error analysis showed that the interocular decrement was not due to the introduction of a tendency which had been reported by previous experimenters, for monocular rats to go in the direction of the uncovered eye.

Problem

Only low-level interocular transfer occurs in the albino rat, and transfer is almost entirely absent in such animals following section of the corpus callosum (Sheridan, 1965). This is in spite of the use of shock motivation, which results in excellent interocular transfer in cats, even after midline section of the corpus callosum and optic chiasm (Sechzer, 1964). A possible source of the relative lack of interocular equivalence in albino rats is suggested by the report of Muntz & Sutherland (1964) that, following binocular training on a pattern discrimination, unilateral introduction of a blinder results in a strong tendency for rats to approach the stimulus ipsilateral to the open eye. A similar phenomenon could occur when a blinder is switched to the opposite eye after monocular training, and this might suggest that the abovementioned lack of interocular equivalence is due not to a relatively undeveloped system of interhemispheric communication, but rather to the introduction of a strong response tendency which competes with the correct pattern of responding.

The primary purpose of the present experiment was to examine the pattern of errors occurring during interocular testing in order to determine whether such competing response tendencies are in fact related to transfer deficits. A secondary purpose was to determine whether low-level transfer is general to albino strains, or whether it might perhaps be characteristic of the inbred Wistar strain used in the previous study (Sheridan, 1965). In that experiment, hooded rats showed excellent transfer when albinos were exhibiting interocular decrement, and these variations were attributed to differences between pigmented and unpigmented strains. However, the possibility remains that strain differences unrelated to pigmentation were responsible.

Subjects

The Ss were 15 Sprague-Dawley albino rats from the colony maintained by the University of Missouri at Kansas City.

Apparatus

A two-choice discrimination box utilizing escape from shock as reinforcement was used. This apparatus, which has been described in detail elsewhere (Thompson & Bryant, 1955), consists essentially of four portions: a start box, a runway, a choice-point, and a goal box. The first three sections have grid floors, the shock to which can be separately controlled.

Procedure

Ss were pretrained to run to the goal box in order to avoid shock and to knock over grey stimulus cards which blocked the goal-box entryways. One eye was then covered with an opaque contact occluder (Schuck & Copolla, 1963) made of black vinyl acrylic and fitted so that no portion of the eye was visible, then Ss were given discrimination training. On the pattern problem, Ss discriminated between 1/2 in black and white stripes slanting 45° to the right or to the left, and for the black-white problem they discriminated between a stimulus card painted flat white and one painted flat black. 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. After an S reached criterion, the occluder was removed and reattached to the same eye, and S was run to the 18/20 criterion again, providing what we term a "homolateral control." Next, the occluder was removed and attached to the opposite eye, and S was run to the 18/20 criterion a third time. Finally, Ss were given 20 test trials with both eyes occluded, in order to evaluate the effectiveness of the occluders. All 15 Ss were run on the black-white problem, and 11 of them were run on pattern, the order of problem presentation being counterbalanced.

Results

The results for both discriminations are summarized in Table 1. Three Ss failed to meet criterion on the pattern problem before the 300 trial cut-off point and these data are not included. The reliability of performance decrements on interocular testing was determined by comparing both percentage of savings to criterion and the percentage correct for the first 20 test trials on the homolateral vs the interocular test. Since more learning trials had been given prior to the interocular test than to the homolateral test, the estimated statistical reliability should err in a conservative direction. A Sign Test comparing trials to criterion on homolateral vs interocular test revealed

Table 1. Median Percentage of Savings to Criterion and Percentage Correct in the First 20 Trials for Homolateral and Interocular Testing

	Median % Savings To Criterion		Median % Correct First 20 Trials	
	Homolateral Test	Interocular Test	Homolateral Test	Interocular Test
Pattern Problem (N = 8)	100.0	44.7	90.0	55.0
Black-White Problem (N = 15)	100.0	75.9	90.0	80.0

that switching to the naive eye resulted in a reliable decrement for either discrimination problem (pattern $p < .02$; black-white $p < .03$). A similar comparison using the 20-trial block percentage correct score yielded $p < .03$ for pattern and $p < .01$ for black-white.

When Ss were tested with both eyes occluded it was found that performance fell to 50.0% correct on the pattern discrimination, but remained somewhat above chance (60.0% correct) for black-white. Of the 15 Ss tested on black-white, 11 performed at a level above chance and only two were below chance, indicating that some visual discrimination took place in spite of the superficially complete coverage of the eye.

Analysis of position errors with relation to which eye was open during training showed no indication that interocular transfer decrements were due to a tendency to approach either the open or the covered eye. Ss typically showed position preferences, but, with the exception of one S on the pattern discrimination, the preference did not change when the occluder was shifted to the opposite eye. Errors were examined for each successive 20-trial block, and the outcome was substantially the same whether all errors were taken into account or only errors from a fixed number of early trials. Taking total second-eye errors up to the criterional trials, 50.7% were made on the side of the open eye and 49.3% on the side of the occluded eye when Ss were discriminating pattern. For the black-white problem, 45.3% of the errors were to the side of the open eye and 54.7% to the occluded side.

Discussion and Conclusions

The tendency, reported by Muntz & Sutherland (1964), of monocular rats to approach the side of the exposed eye did not occur under the present conditions, showing that it does not underly the breakdown of discrimination on interocular testing. There were a number of procedural differences between the two experiments any one of which might account for the present failure to observe

the ocular dominance effect. An obvious possibility is the relatively cumbersome bandage-type blinder used by Muntz & Sutherland. The weight of the blinder itself might give rise to a tendency to approach the contralateral side.

It seems probable, on the basis of the present data, that low-level interocular equivalence is a general characteristic of unpigmented rat strains. The amount of transfer observed here was remarkably close to that previously observed in Wistar stock (Sheridan, 1965), though, in the previous experiment, interocular decrement on the black-white habit approached, but did not reach an acceptable level of statistical reliability. Judging from the level of performance maintained on the black-white discrimination when both eyes were covered, the present estimate of savings on that problem is probably exaggerated. It is likely that the interocular loss is not only reliable, but also sizeable. This lack of interocular equivalence in the albino rat is in contrast to that exhibited by cats (Meikle & Sechzer, 1960) since these animals transfer "brightness" discriminations at high levels, even after midline section of the optic chiasm and corpus callosum. The contrast is even more striking when we consider that, under shock motivation, even pattern discriminations transfer in the split-brain cat (Sechzer, 1964).

Observations on the excised eye suggest that the failure of the opaque contact occluders to obliterate all vision was probably due to leakage of light around the edges of the occluder. In any case, it is clear that with unpigmented animals the use of occluders of the present type, and a fortiori of the small floating type described by Schuck & Copolla (1963) can entail considerable risk, and should be accompanied by careful controls to assure completeness of the occlusion.

References

- MEIKLE, T., & SECHZER, J. A. Interocular transfer of brightness discrimination in "split-brain" cats. *Science*, 1960, 132, 734.
- MUNTZ, W. R. A., & SUTHERLAND, N. S. The role of crossed and uncrossed optic nerve fibers in the visual discrimination of shape by rats. *J. comp. Neurol.*, 1964, 122, 69-77.
- SCHUCK, J. R., & COPOLLA, L. A. Contact occluders for restricting vision in the rat. *Amer. J. Psychol.*, 1963, 76, 135-137.
- 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, in press.
- THOMPSON, R., & BRYANT, H. Memory as affected by activity of the relevant receptor. *Psychol. Rep.*, 1955, 1, 393-400.

Notes

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