Interocular Transfer of Pattern Discrimination without Prior Binocular Experience

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The behavioral apparatus consisted of a clear plastic starting box and goal box of identical construction, suspended from two rails in a test aquarium. Suitable electric connections allow shock to be introduced into the water inside either box. When the positive stimulus is presented monocularly, the fish has 10 seconds to swim forward from the starting box to the goal box, thus avoiding shock. When the neutral stimulus is presented, the fish must learn to remain stationary in the starting box, or else shock is administered in the anterior goal box. After the fish moves to the goal box, either correctly or incorrectly, the starting box is lifted from the water and the goal box (with the fish inside) is slid back into the starting position. The original starting box is then placed in front of the fish where it then becomes the goal box for the next trial. The fish were trained through one eye to a criterion of nine correct out of ten trials and then immediately tested for the differential response through the opposite "naive" eye. Further details of the training and testing, as well as an illustration of the apparatus used in a series of experiments that involved the same procedure, have already been reported *(2)*. Also included in this previous report is a description of a control procedure demonstrating that there are no reflections within the test aquarium that permit the contralateral eye to view the stimuli.

The two stimuli (Fig. 1) were attached to the end of separate, thin, transparent rods so that they could be presented to the fish by being gently bobbed in front of one or the other eye. Whether the stimuli were being presented to the one eye during training or the contralateral eye during the test for transfer, the patterns were always presented either in the lateral or caudolateral part of the monocular visual field. (It should be mentioned that the goldfish is not capable of making sufficiently large eye movements to

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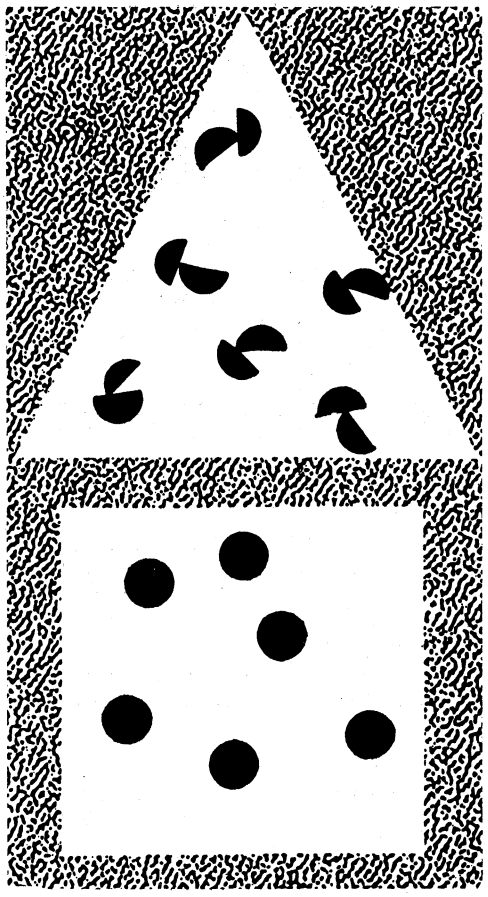

Fig. 1. Two stimuli used in avoidance training and test for interocular transfer. The square stimulus was 1.5 in. high.

enable binocular retina to be directed laterally.) In other words, the stimuli were consistently presented in a way that involved only that portion of either retina that could never have participated in binocular vision. *In order to preclude the possibility of a brightness discrimination, the two stimuli were constructed so that both contained the same amounts of black and white.* Three of the five fish were trained with the triangular pattern as positive; the square stimulus was positive for the remaining two. Previous experience with pattern discrimination in fish suggests that the small, black dots and half-dots contributed the important differential characteristic to the stimuli.

The results are shown in Fig. 2. Quite clearly, interocular transfer of a pattern discrimination is immediately present when the naive eye is tested. Considering all five fish together, there were 25 positive trials and 25 neutral trials. In these 50 trials, there were only four occasions when a fish responded incorrectly, always by responding inappropriately to the neutral stimulus.

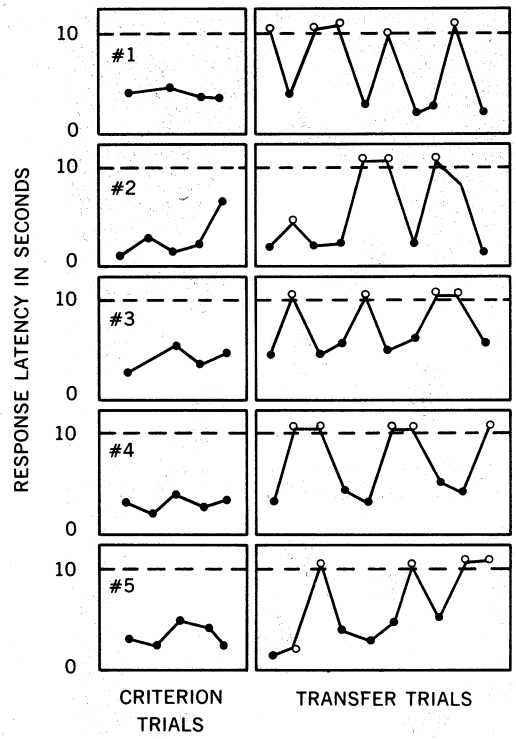

Fig. 2. Avoidance response latencies of five fish during criterion trials for "trained" eye (shown for positive stimulus only) and during test of the contralateral "naïve" eye for interocular transfer. Solid circles, responses to positive stimulus; open circles, responses to neutral stimulus. With a 10-second limit on each trial, points above the dashed line represent the absence of a response.

As far as this simple vertebrate animal is concerned, the results clearly demonstrate that prior binocular experience is not a necessary prerequisite for successful interocular transfer. However, Hebb's concern was with the proposed importance of past perceptual experience for the development of neocortical neural circuits (that is, cell assemblies). The fish has no neocortex. It could still be, for animals with neocortex, that prior perceptual experience does indeed play either a crucial or ancillary role in shaping adult perceptual abilities. There are a number of quite convincing experiments *(4)* to suggest that this is the case. On the other hand, an alternative interpretation of the results of these experiments is possible *(2)*.

There are already numerous ethological studies showing that the vertebrate nervous system is innately capable of responding appropriately to the relative configuration of a stimulus. Further, recent electrophysiological findings also indicate that the adult nervous system, as far peripheral as the retina, is able to respond differentially to the configurational aspects of a stimulus *(5)*. The present results demonstrate that this innate characteristic of the nervous system is also at work when an organism has learned a new response to a new stimulus *(6)*.

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