that the Northern Arizona pattern exists. Second, the fluctuations of the tension zone depend upon a change in the distribution and quantity of rainfall as transmitted through soil moisture. Upward penetration of the West Texas type and downward migration of the Central California type produce the alternation of conditions yielding the Northern Arizona pattern.

The last major intrusion upward of the West Texas type and pattern ended in 1904–1905. It was realized in 1946 that the tension zone had been dominated for 40 years by the Central California pattern and that this period was one of the longest, if not the longest, during the last few centuries. A long-range program was begun: 12 permanent stations were established in the vicinity of Flagstaff and, except for 1948, increment cores were taken annually from some 70 to 90 trees. We hoped to observe actual migration of the tension zone. Later study proved that our collections span such a period of migration.

A major change in pattern apparently began in 1947–1948 among the trees in the heart of the tension zone. During the past year a thorough study of all cores has emphasized the intensity of the upward intrusion of the West Texas type. Figure 1 shows the alternation of growth patterns: West Texas, 1899–1904; Central California, 1905–1946; and West Texas, 1947–1956. In addition to variability the figure shows lenticularity, which is characteristic of the growth layers for 1899, 1900, 1902, 1904, 1947, 1951, and 1956.

The upward intrusion since 1947 of the West Texas pattern, caused by a shifting rainfall regime, appears to be a major migration and, in conjunction with glacier advances (*1*), may reveal evidence of a widespread climatic fluctuation.

Future collections will reveal whether the intrusion has ended or will continue over a span of years approaching the length and intensity of intrusions recorded during recent centuries (*4*).

WALDO S. GLOCK
SHARLENE R. AGERTER
DAVID G. SMITH*
Tree-Ring Research Laboratory,
Macalester College, St. Paul, Minnesota

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4. Deep appreciation is due the Smithsonian Institution for its support during the early phases of the work from 1946 to 1953, and the National Science Foundation for its support from 1954 to the present through grants G610, 4398, and 14262. One of us (D.G.S.), as undergraduate research participant, studied the tension zone migration under NSF grant G7847. For a majority of the years, Mr. and Mrs. John Bieber of Los Angeles gave invaluable assistance throughout the field season. The cooperation of the personnel of the Rocky Mountain Forest and Range Experiment Station (Fort Valley Research Center), the Walnut Canyon National Monument, and the Coconino National Forest is most gratefully acknowledged. We are grateful to Macalester College for providing time and facilities and to the College Research Committee for funds to carry on supplementary studies.
* Present address: University of Arizona, Tucson.

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Interocular Transfer of Pattern Discrimination without Prior Binocular Experience

Abstract. Interocular transfer of a learned, differential pattern discrimination, as measured by an avoidance response, occurs in the goldfish. Since the stimuli, both during training and testing, were always presented in the lateral or caudal visual field, the parts of a retina involved could not have participated in prior, binocular experience.

There is as yet no sure answer to the perplexing problem of how the central nervous system is capable of responding appropriately to the relative configuration of a stimulus without regard to variations in its detailed, sensory characteristics. Interest in this problem continues to prompt numerous studies of interocular transfer in a wide range of species, including mammals, fish, and invertebrates (for example, see *1* and *2*). The relevance of interocular transfer for this problem area lies in the fact that when an organism learns a visual problem exclusively with one eye and then performs it, *de novo*, with the sole guidance of the other eye, the nervous system is clearly demonstrating its ability to respond correctly to a given stimulus even though the specific afferent characteristics of the related sensory input have been dramatically altered (namely, during the transfer test, the sensory input is arriving centrally by way of a different afferent pathway).

Hebb, in his scholarly effort to explain this phenomenon and related problems (*3*), suggested that early, binocular, perceptual experience is responsible for developing such binocular equivalence in the related neural centers.

The present study affords a test of Hebb's suggestion, since training and test stimuli can be presented to the fish in such a way that only monocular retina is involved in either eye.

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 out of ten correct 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 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

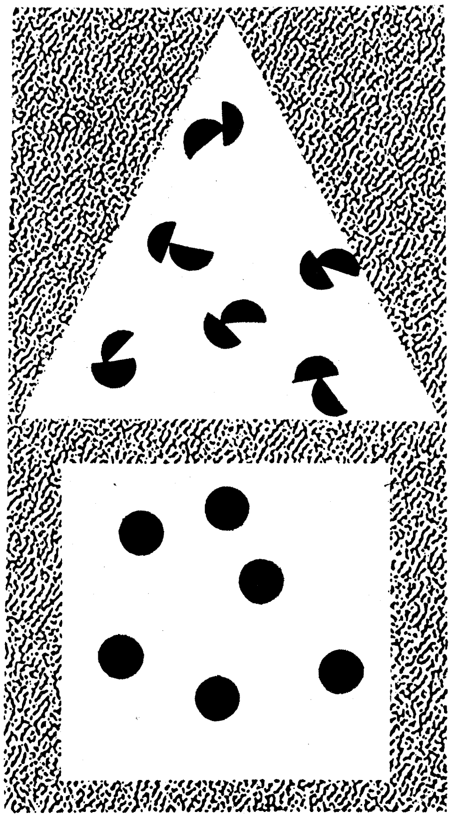

Fig. 1. Two stimuli used in avoidance training and test for interocular transfer. The square stimulus was 1.5 in. high.

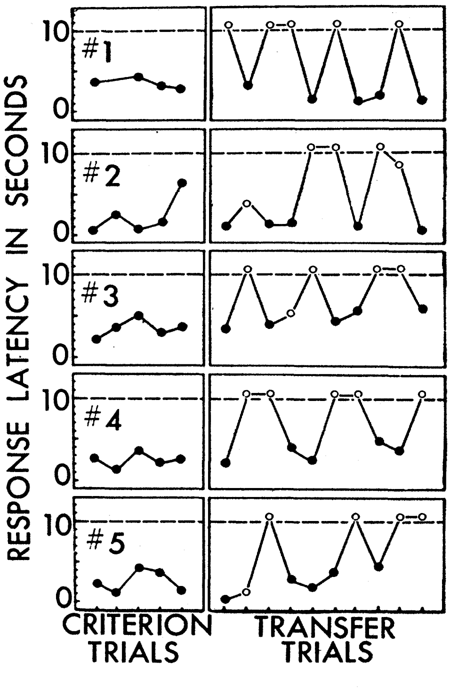

Fig. 2. Avoidance response latencies of five fish during criterion trials for "trained" eye (shown for positive stimulus only) and during test of the contralateral "naive" eye for interocular transfer. Solid circles, responses to positive stimulus; open circles, responses to neutral stimulus. With a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

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.

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*).

ROBERT A. MCCLEARY
Department of Psychology, University of Chicago, Chicago, Illinois
LAYNE A. LONGFELLOW
Department of Psychology, University of Michigan, Ann Arbor

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Radar Observation of Venus

Abstract. Radar observations of Venus during the last close approach have resulted in a value of solar parallax of 8.79460 seconds of arc, corresponding to a value for the astronomical unit of 149,596,000 km. This is in satisfactory agreement with the determinations made, during the same close approach of Venus, at the Millstone Hill Radar Observatory and at Jodrell Bank, which are 149,597,700 km and 149,601,000 km, respectively. The size of the astronomical unit heretofore generally accepted as most authoritative is based upon a 1950 determination by Rabe, and is 149,532,200 km.

The R.C.A. BMEWS pulsed tracking radar system at Moorestown, New Jersey, was employed during the last close approach of Venus in an attempt to measure the size of the astronomical unit. The radar is provided with an antenna 84 feet in diameter; other parameters of the system cannot be stated here because of security classification.

Transmission periods alternated with reception periods, the transmission period in each case being several seconds less than the expected signal travel time to Venus and return, and the reception period being several seconds greater. The target was expected to introduce random depolarization of the signal, so reception was accomplished separately for both vertical and horizontal polarization, the separate wave forms being added after square law detection.

The processing of the received wave form was accomplished by analog methods up to the addition of the two detected wave forms and was then converted to digital form. In processing the data, account was taken of the