6. An analogous illusion of continuous body rotation occurs when a visual surround rotates around the observer's vertical axis. In this instance graviceptive information is irrelevant, and because there is no other constraint, the subjective displacement is unlimited (*5*).
7. Such considerations may in part explain the difference in the magnitudes of tilt obtained in our two experiments. In the posture experiment, the observer receives changing graviceptive information from pressure receptors and otoliths, which indicate the actual tilt of his body.
8. We include somatosensory information here because we found that a limited tilt was also induced by the moving display in a patient whose vestibular nerves were severed bilaterally because of a neuroma.
9. B. Clark and A. Graybiel, *J. Comp. Physiol. Psychol.* **44**, 525 (1951).
10. As one consequence, large oscillating visual displays increase postural instability [S. Wapner and H. A. Witkin, *Amer. J. Psychol.* **63**, 385 (1950)]; H. A. Witkin and S. Wapner, *ibid.*, p. 31.

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## Synthetic Rat Scotophobin Induces Dark Avoidance in Mice

Abstract. *Two independent research groups replicate alteration of dark preference to dark avoidance by mice injected with synthetic scotophobin, a pentadecapeptide.*

Several groups of workers have attempted to correlate behavioral changes induced by training rodents or goldfish with the appearance of a new molecular substance in the brain (*1*). One method of detecting this newly formed substance involves a bioassay technique, referred to as the chemical transfer of learned behavior. This method includes preparation of more or less purified brain extracts from trained donors as well as from untrained control or differently trained donors, followed by injection of these brain preparations into naive recipients. The bioassay is considered positive when only the recipients of "trained brain" extracts exhibit behavior resembling that acquired by the trained donors. The problems entailed in experiments of this sort have been pointed out (*2*).

This method was used by Ungar to isolate and assay a factor from rats that transferred dark avoidance to mice (*3*). The identification and synthesis of this factor, a pentadecapeptide named scotophobin, have been reported (*4*). The importance of independent replication of the scotophobin studies has been emphasized in a summary on the state of the art by the Psychopharmacology Research Branch of the National Institute of Mental Health (*5*). Transfer of learned dark avoidance by means of crude or partially purified brain extracts has already been reported by six groups of workers (*6*). The groups, however, reported negative results (*7*). One of us has also observed the dark-avoidance inducing effect of synthetic scotophobin in the goldfish (*8*). We now report the results obtained by two independent research groups at Illinois and Michigan on the dark-avoidance inducing effect of synthetic rat scotophobin in mice.

In both laboratories, male albino Webster mice (obtained from different sources) were housed with a light-dark cycle of 12 hours of light followed by 12 hours of darkness.

The mice weighed about 20 g (Illinois) or 30 g (Michigan). The Michigan group housed mice in individual transparent cages and the Illinois group kept six mice in each transparent or metal cage. The Illinois group handled its animals for a week before screening them, while the Michigan group did not give any special handling to its mice.

Both laboratories used exact replicas of Ungar's test apparatus (*6*). In each test, the mouse is allowed to wander freely for 3 minutes between black and white compartments. The score is the total number of seconds spent in the dark box. All mice were screened for initial dark preference, and mice that did not meet the criterion were discarded. About 90 percent of the Illinois mice met a criterion of 85 percent dark-box time in each of four successive screening trials, while only about 50 percent of the Michigan mice met a lower criterion of 50 percent dark time on a single screening trial.

Scotophobin synthesized by W. Parr was supplied by G. Ungar to both laboratories, but the preparations were treated differently, and the degree of hydrolytic degradation was not identical. The Michigan group received its scotophobin as a solution in methanol (1.0 mg scotophobin per milliliter of methanol) that had been transported at room temperature for several days and was subsequently refrigerated for several weeks during the course of experimentation. The Illinois group received scotophobin as a gummy solid, dried from the methanol solution. The material was dissolved in distilled water at the time of use, and any unused remainder was lyophilized. The preparations ranged from 50 to 80 percent purity. Although the precise purity and the number of decomposition products were not determined during these early experiments, the course of decomposition is now routinely followed by the Illinois group by means of the microdansylation method, followed by two-dimensional chromatographic separa-

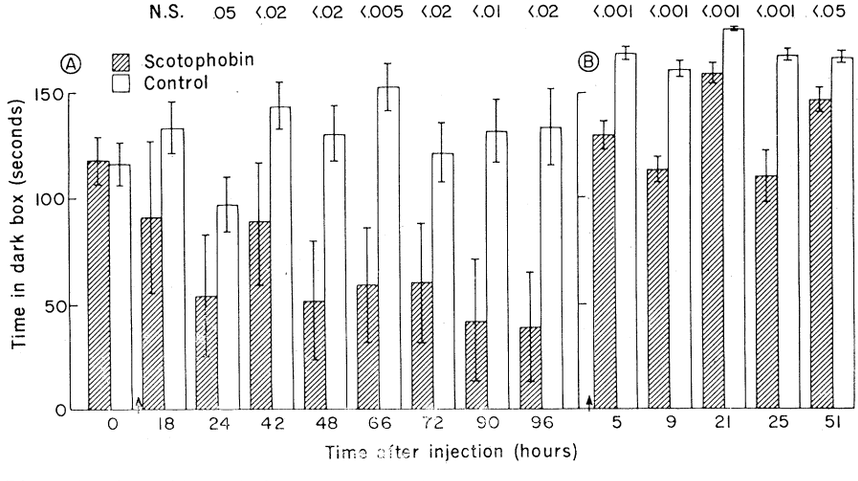


Fig. 1. Dark avoidance induced by synthetic scotophobin. Time of injection is indicated by arrow. Time in the dark box is the number of seconds out of the total time of 180 seconds ± the standard error. Numbers on top indicate *P* values obtained by the U test. N.S., not significant. (A) Michigan results with 3 μg of scotophobin per mouse, $n = 6$ in experimental groups and 11 in control groups. (B) Illinois results with 0.8 μg of scotophobin per mouse, $n = 20$ in all groups.

tion (*9*). All scotophobin solutions were touched only by siliconized glassware, plastic, or stainless steel.

Both groups injected scotophobin intraperitoneally in volumes of 0.1 ml (Illinois) and 0.25 ml (Michigan). Controls received injection of the vehicle (distilled water with methanol as appropriate) only. All mice were coded and the tests were run "blind."

Figure 1 shows the effects of 0.8 $\mu$g of scotophobin (Illinois) and the effects of 3.0 $\mu$g of scotophobin (Michigan) on dark-light preference. Analysis of the data by the nonparametric Mann-Whitney U test shows significant drops in dark-box time in the scotophobin-treated groups as compared to the controls. The Michigan group also found significant and prolonged effects with doses of 1.5 $\mu$g and 2.2 $\mu$g. The Illinois and Michigan mice started out with different levels of dark preference, but in each case there was a shift in the same direction. Our experiments, therefore, confirm the dark-avoidance producing effect of scotophobin.

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### References and Notes

1. E. J. Fjerdingstad, Ed., *Chemical Transfer of Learned Information* (American Elsevier, New York, 1971).
2. G. Adam and J. Faiszt, *Nature* **216**, 198 (1967); G. Ungar, in *Methods in Pharmacology*, A. Schwartz, Ed. (Appleton-Century-Crofts, New York, 1971), p. 479.
3. G. Ungar and E. J. Fjerdingstad, in *Biology of Memory*, G. Adam, Ed. (Plenum, New York, 1971), p. 137.
4. D. M. Desiderio, G. Ungar, P. A. White, *Chem. Commun.* **9**, 432 (1971); W. Parr and G. Holzer, *Hoppe-Seyler's Z. Physiol. Chem.* **352**, 1043 (1971); W. Parr, C. Yang, G. Holzer, *Tetrahedron Lett.* **1**, 101 (1972); G. Ungar, D. M. Desiderio, W. Parr, *Nature* **238**, 198 (1972).
5. R. W. Russell, G. Ungar, E. Usdin, *Psychopharmacol. Bull.* **8**, 5 (1972).
6. R. Gay and A. Raphelson, *Psychonom. Sci.* **8**, 369 (1967); G. Ungar, L. Galvan, R. H. Clark, *Nature* **217**, 1259 (1968); O. L. Wolthuis, *Arch. Int. Pharmacodyn. Ther.* **182**, 439 (1969); A. M. Golub, L. Epstein, J. V. McConnell, *J. Biol. Psychol.* **11**(1), 44 (1969); H. N. Guttman and L. Gronke, *Psychonom. Sci.* **24**, 107 (1971); R. C. Bryant, *J. Biol. Psychol.* **13**(1), 18 (1971).
7. L. D. Hutt and L. Elliott, *Psychonom. Sci.* **18**, 57 (1970); A. Goldstein, P. Sheehan, J. Goldstein, *Nature* **233**, 126 (1971).
8. H. N. Guttman, G. Matwyshyn, G. H. Warriner III, *Nature New Biol.* **235**, 26 (1972).
9. W. R. Gray and B. S. Harley, *Biochem. J.* **89**, 59P (1963); V. Neuhoff, F. von der Haar, E. Schlimme, M. Weise, *Hoppe-Seyler's Z. Physiol. Chem.* **350**, 121 (1969).
10. Thanks to J. V. McConnell and L. K. Oliver for guidance and support of the Michigan research.
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## Observational Learning and Social Facilitation in the Rat

Abstract. *Learning by rats was facilitated when response-relevant cues were provided by other rats; learning increased as a function of number of cues provided. These results suggest that rats can learn by imitation. Learning by rats that observed conspecifics not emitting response-relevant cues was retarded compared to learning by rats that did not observe conspecifics. This indicates that a conspecific's presence can also inhibit learning, a result consistent with social facilitation theory.*

The effects of a conspecific's presence on the behavior of observers are typically viewed as energizing (that is, social facilitation) or directive (that is, observational learning). A theory (*1*) that clarified existing research on social facilitation and stimulated new empirical (*2*) and theoretical (*3*) work suggests that the "mere presence" of others arouses general drive, which, in turn, enhances emission of dominant responses (those responses most likely to occur). If the dominant response is correct, performance improves; if the dominant response is incorrect, performance suffers.

Observational learning, analyzed from several theoretical perspectives (*4–6*), has been demonstrated in several species, including rats (*4, 7*). However, learning by rats that observe conspecifics performing the response to be learned may be attributable, not to directive cues emitted by the model, but rather to the energizing effects of the model's "mere presence" (*8*). Thus, observational learning as a general phenomenon in lower animals is still in dispute 30 years after Miller and Dollard's work (*6*).

The purpose of the present study was to unambiguously separate the relative contributions of observational learning and social facilitation to acquisition of the bar-press response by rats. Naive rats observed (i) rats that made both instrumental (bar-press) and consummatory (drinking) responses; (ii) rats that made only consummatory responses; (iii) rats that made neither instrumental nor consummatory responses (that is, provided "pure" social facilitation); or (iv) an empty box. We expected that, compared to observation of the empty box, observation of rats making both instrumental and consummatory responses would facilitate learning (because of observational learning) and that observation of naive rats would inhibit learning (because of social facilitation of incorrect dominant responses). Also, we predicted that the group observing rats making only consummatory responses would learn somewhat faster than the groups observing naive rats or an empty box because the drinking response would provide a partial directive cue.

Fifty-five male Long-Evans rats, approximately 100 days old, were deprived of water; access to water (15 minutes daily) was permitted 30 minutes after each experimental session. Animals, housed individually, were tested in an apparatus consisting of two rat test boxes, each with a microswitch bar and liquid reinforcement dipper mounted on the front wall. Test boxes were adjacent, with unobstructed vision between boxes through Plexiglas sidewalls. Front walls of the two boxes were aligned so that rats oriented toward the bars in both boxes would face the same direction. All vertical walls of the two-box unit except the common wall between boxes were opaque. A 7-watt lamp on top of each box provided the only illumination.

Fifteen naive rats were randomly assigned to three groups of five each. Animals in group B (bar-press demonstrator) were trained to drink whenever the water dipper (0.1 ml) was raised in the operant box, and then trained to press the bar on a continuous schedule of reinforcement (CRF). After training, each rat in group B was placed in the operant box for daily 30-minute periods for 8 days to establish consistent bar-pressing behavior. At the end of this period all rats pressed the bar at least eight times per minute.

Rats in group D (drinking demonstrator) were similarly trained to drink from the dipper, but were not trained to press the bar. Any bar-presses by these rats had no effect on reinforcement. After dipper training, each rat in group D was placed in an operant box that was yoked to a group B box (in a separate two-box unit), such that each bar-press by a group B rat raised the dipper in the box of the yoked group D rat. Animals in group D received eight 30-minute yoked drinking sessions to establish consistent drinking.

Animals in group N (naive demonstrator) were given no training and thus made neither instrumental nor