The effects of epinephrine and chlorpromazine on visual cliff behavior in hooded and albino rats*

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Infant hooded and albino rats were tested on the visual cliff and observed for a 5-min period after receiving injections of epinephrine, chlorpromazine, or a placebo. Hooded animals chose the shallow side of the visual cliff more often than albinos and spent more time on that side. They were also more emotional, as measured by fecal bolus counts. Albinos explored more, as indicated by their higher activity and crossover scores. Epinephrine tended to increase the emotionality of the albinos and markedly facilitated the response of avoiding the deep side of the visual cliff. Strain differences evident in visual cliff behavior were discussed in terms of differences in emotionality rather than ability to perceive depth.

Various aspects of visual depth perception, as evidence by avoidance of a visual cliff, have been explored in great detail (Walk & Gibson, 1961; Walk, 1965). Species comparisons in most visual cliff studies have primarily focused attention on the sensory capacities of the organisms under study and the perceptual variables presumed to determine preferences for the shallow or deep sides of the cliff (O'Sullivan & Spear, 1964; Routtenberg & Glickman, 1964b; Davidson & Walk, 1969). However, Routtenberg & Glickman (1964a), in an experiment comparing adult albino and hooded rats, have suggested that differences in visual cliff behavior between these two strains can be partially accounted for by differences in "emotionality." Specifically, hooded animals were more emotional as measured by fecal bolus counts (Hall, 1934; Candland & Campbell, 1962) and spent more time on the shallow side of the cliff than albinos, although no differences with respect to place of first descent were found. Based on this information, Routtenberg and Glickman suggested that "It seems possible that hooded animals were more afraid of the cliff, and that although the albino animals perceive depth adequately, they were not so fearful as to inhibit their exploration of the optically deep side [1964a, p. 142]." In a similar analysis, Lore & Sawatski (1969) have pointed out that the absence of shallow side preferences is not always indicative of a failure to perceive depth, and suggested that "fear of depth" might be necessary to generate the avoidance response. Routtenberg & Glickman (1964a), in a second experiment, found that infant hooded rats descended significantly more often to the shallow side of the cliff than did albinos, as well as spending more time on that side, but no emotionality measures were obtained. These differences, found for infant rats by Routtenberg and Glickman (especially place of first descent), were presumed to reflect differences in visual acuity. However, it is quite possible that emotionality factors play a role here as well as in other aspects of visual cliff performance.

Many studies have pointed toward the direct relationship between the activity of the sympathetic nervous system and emotionality (Schacter & Singer, 1962; Schacter & Wheeler, 1962). Appropriate injections of drugs, such as chlorpromazine, a sympathetic blocking agent (Jarvik, 1965), and epinephrine, a sympathetic activator (Innes & Nickerson, 1965), have been found to alter fear-motivated behavior in avoidance situations (Latané & Schacter, 1962). Similar effects have been noted, utilizing more direct measures of fear (Singer, 1963). If, as indicated above, avoidance of the deep side of the visual cliff is, in part, related to fear or emotionality in hooded and albino rats, then drug-induced manipulation of sympathetic activity should produce changes in visual cliff behavior.

SUBJECTS

Seventy-two infant rats, 36 Sprague-Dawley albino and 36 Long-Evans hooded, approximately 25-32 days old, served as Ss. There was an equal number of males and females.

APPARATUS

Each animal was tested on a visual cliff apparatus similar to Walk & Gibson's Model II (1961). The apparatus consisted of a 16 x 28 in. glass-bottomed box with 12-in. walls. This box was divided into two equal sections by a 3½-in.-wide centerboard raised 2¾ in. above the glass. The walls and centerboard were painted flat gray. A red and white checkerboard-patterned material (¾-in. checks), providing optical support, was placed immediately beneath the glass on one side (shallow) and 16½ in. below the entire apparatus on the other (deep) side. Each glass panel could be easily removed to permit cleaning and switching of positions.

PROCEDURE

The Ss within each strain were assigned randomly to one of three drug conditions (i.e., six conditions, N = 12), with the constraint that there be an equal number of males and females in each condition. (However, since no sex differences were obtained, analyses were conducted on pooled data.) Twenty-four hours before testing, Ss were placed in individual cages on an ad lib food and water schedule. One hour prior to the experiment, Ss were injected and returned to their cages until testing. Each S was placed on the visual cliff for a 5-min trial, with the following measures being recorded: (1) initial place of descent, (2) time spent on each side of the cliff, (3) crossovers—total number of times the animal crossed from one side of the cliff to the other, (4) defecation—total number of fecal boluses eliminated during the 5-min trial. Two Os, seated at either end of the centerboard, also recorded the following measures: (1) facewashing—total number of occurrences of S rubbing face with paws, (2) activity or exploration—animals were rated once each minute on a scale from 1 to 5 (low to high), (3) trembling—animals were also rated on a 1-5 scale (low to high) once each minute. Activity and trembling scores were summed over the five observation periods to yield a total score for each measure for each animal. Throughout the experiment, the Os were unaware of the drug conditions, and the overall mean interreliability coefficient was .92.

Each animal received an intraperitoneal injection of approximately .1 cc of one of the following drugs: (1) epinephrine—Ss were injected with a solution containing .125 mg/kg body weight of epinephrine suspended in sterile peanut oil (epinephrine was suspended in oil to retard the onset of its effect to a time which approximates that of

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Table 1
Percentage of Descents on the Visual Cliff

	Drugs								
	Epinephrine			Placebo			Chlorpromazine		
Strain	Shallow	Deep	No Descent	Shallow	Deep	No Descent	Shallow	Deep	No Descent
Hooded	58.3	41.7	0	75.0	16.7	8.3	66.7	33.3	0
Albino	75.0	25.0	0	25.0	75.0	0	50.0	33.3	16.7

chlorpromazine); (2) placebo—half of the Ss in the placebo condition (N = 12) were injected with physiological saline, and the remaining 12 Ss in this condition received injections of sterile peanut oil; (3) chlorpromazine—Ss were injected with a solution containing 2.0 mg/kg body weight of chlorpromazine hydrochloride dissolved in physiological saline.

RESULTS

Table 1 summarizes the visual cliff performance for albino and hooded animals. For the placebo condition, hooded rats descended significantly more often to the shallow side than did albinos ($\chi^2 = 7.42$, $p < .01$). Drugs had no significant effect on place of first descent for hooded animals. For albinos, however, the injection of epinephrine produced a significant increase in descents to the shallow side of the cliff when compared to the placebo group ($\chi^2 = 6.0$, $p < .025$).

A Mann-Whitney U test indicated, as expected (all tests are one-tailed unless otherwise specified), that hooded animals spent significantly more time on the shallow side of the cliff than did albinos ($z = 2.56$, $p < .005$). Although epinephrine increased the amount of time spent on the shallow side of the cliff, especially for albinos (see Fig. 1), statistical significance was not reached (Kruskal-Wallis $H = 4.89$, $p < .06$).

Hooded animals had a higher mean fecal bolus count than did albinos (Mann-Whitney U, $z = 2.89$, $p < .001$). Defecation increased as a direct function of sympathetic arousal, although it was not significant (Kruskal-Wallis $H = 3.84$, $p > .10$). It appears, however, that the peanut oil had a constipating effect, as indicated by a significantly greater amount of defecation in the saline placebo condition compared with the oil placebo condition (Mann-Whitney $U = 29.5$, $p < .02$, two-tailed). (These two groups were not differentiated in any other way.) This suggests that the epinephrine animals may have reduced the effect of the drug with regard to defecation, since epinephrine was always suspended in peanut oil.

The effects of strain and drug on number of crossovers and total activity are illustrated in Fig. 2. Strain produced a significant effect on total activity ($F = 8.66$, $df = 1/66$, $p < .01$) and crossovers (Mann-Whitney U, $z = 1.64$, $p < .05$) as well as trembling ($F = 20.39$, $df = 1/66$, $p < .01$) but not facewashing ($F = 1.16$, $df = 1/66$). A drug effect was evident for all measures: (1) total activity ($F = 10.44$, $df = 2/66$, $p < .01$), (2) crossovers (Kruskal-Wallis $H = 11.43$, $p < .01$), (3) facewashing ($F = 8.29$, $df = 2/66$, $p < .01$), (4) trembling ($F = 6.7$, $df = 2/66$, $p < .01$). Individual comparisons of means, determined by the Newman-Keuls (Winer, 1962) and Mann-Whitney U tests, revealed that the main effect of drugs was due to differences between chlorpromazine and the other drug conditions. No significant interactions were found.

DISCUSSION

It appears that emotionality, either drug induced or strain linked, is related to visual cliff behavior in a number of ways. For the placebo condition, infant hooded rats descended more often to the shallow side of the visual cliff and spent more time on that side than infant albinos. These results are completely consistent with those of Routtenberg & Glickman (1964a). Furthermore, with respect to emotionality, our result that hooded animals have a higher fecal bolus count than albinos extends these author's findings to infants. Albinos also tended to explore more of the cliff, as indicated by their higher total activity and crossover scores in comparison to hooded animals.

Albino animals injected with epinephrine chose the shallow side of the visual cliff significantly more often than did albino placebos. Available evidence indicates that fear-motivated and fear-related behavior can be increased with the dosage of epinephrine given to animals in this experiment (Latané & Schacter, 1962; Singer, 1963). The higher fecal bolus counts for the epinephrine group did suggest that they were more fearful, and this may have facilitated the avoidance response to the deep side of the cliff. This implies that infant albinos, although probably inferior in visual acuity to hooded animals (Munn, 1950), are capable of discriminating depth in the visual cliff apparatus. It is possible, however, that epinephrine, instead of facilitating an avoidance response, as suggested above, may have simply altered the animals' preference for the projected sizes of the patterned elements (Dehart, 1969), or perhaps enhanced depth discrimination. At present, there does not appear to be any evidence to support either alternative.

The place of first descent measure indicated that the epinephrine injection may have interfered with performance for hooded rats. Since these animals were already quite fearful, the additional epinephrine was perhaps sufficient to increase their state of arousal to a point where performance was impaired (Hebb, 1955; Malmo, 1959; Manto, 1967). Chlorpromazine did not affect choice of shallow or deep sides of the cliff but markedly reduced overall arousal for both strains, as indicated by the crossover and activity scores. The

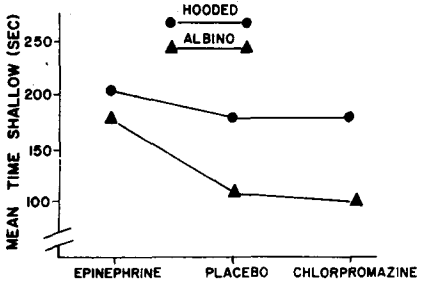

Fig. 1. Time spent on the shallow side of the cliff as a function of drugs for albino and hooded rats.

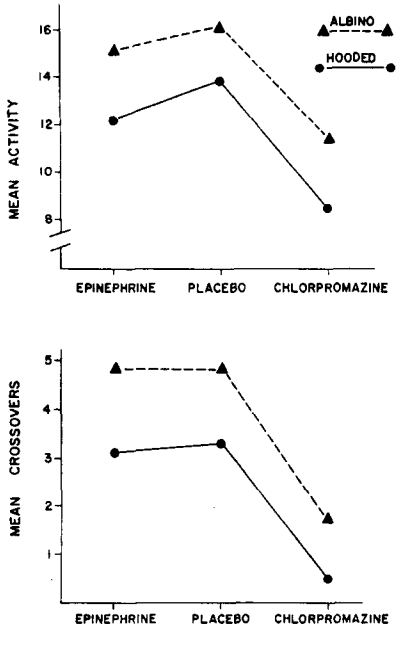

Fig. 2. The effects of drugs on activity (2a) and crossovers (2b) for albino and hooded rats.

dosage employed here apparently had a slight sedative effect and reduced exploratory behavior (Marriott & Spencer, 1965).

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D-amphetamine and palatability of a saccharin solution*

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Twenty-four female albino rats were assigned randomly to receive a 7-day series of 3.0-mg/kg injections of either d-amphetamine sulfate in isotonic saline or saline IP. Half of each group drank .13% sodium saccharin solution, the other half water. Fluid intakes were analyzed as intake per unit body weight. No differences were found among groups prior to drug administration. The prediction that d-amphetamine would produce a more taste-conscious animal was not substantiated. D-amphetamine produced a *decrease* in saccharin intake and an *increase* in water intake relative to saline controls.

Animals with medial hypothalamic (VMH) or lateral hypothalamic (LHA) damage show a change in preference behavior, such that their intake of foodstuffs and fluids seems highly dependent upon hedonic value (Teitelbaum, 1955; Nachman, 1967; Teitelbaum & Epstein, 1962). D-amphetamine sulfate has been suggested to have its well-known anorexic effect either through increasing the electrical activity of the VMH (Grossman, 1967; Rosen, 1968) or through direct influence on LHA (Goodman & Gilman, 1965, p. 502). In either case, causing an upset in the balance between these regulatory "centers" produces an animal that behaviorally appears satiated.

According to a common sense approach to the regulation of intake, an animal that behaviorally appears satiated should be more highly sensitive to taste factors than if sated (Angelo & Bauer, 1970). According to this reasoning, an animal injected with d-amphetamine ought to appear behaviorally satiated and, therefore, show less depression of drinking when a highly palatable fluid (.13% sodium saccharin) is presented than when the fluid presented is water. This experiment was designed to test this prediction.

METHOD

The Ss were 24 female albino DUB/SDD rats (Flow Laboratories), approximately 100 days of age at the onset of the experiment. Half of the Ss were assigned randomly to the d-amphetamine sulfate[1] group (1.0 cc/kg body weight of 3.0 mg/cc in a .9% saline solution IP) and half to a physiological saline injection control group (1.0 cc/kg body weight of the .9% saline solution IP). Each of these

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