The effects of drive level on cues utilized in spontaneous alternation¹

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The experiment investigated the interaction between drive level (0, 6, 22, and 36 h of food deprivation) and the utilization of specific cues (olfactory, visual, and spatial) by the white rat in a spontaneous alternation situation. There were five cue groups in each of the four drive conditions; one for each single cue, an all-cue control group, and a no-cue control group. A total of 200 animals were given one pair of alternation trials per day for 5 days. Generally, it was found that as drive increased, utilization of the cues increased. Visual and direction cues proved most effective under high drive, while olfactory cues were weak under most drive conditions. The energizing and organizing effects of drive are discussed in relation to the Dember & Earl (1957) theory of stimulus selection.

A series of experiments by Douglas (1966b) delineated the cues utilized by rats in the spontaneous alternation task. Douglas, using only satiated Ss, reported that odor trails and spatial direction cues were utilized and visual cues were not important. A study by Baker & Franken (1967), subsequently reanalyzed by Franken & Baker (1967), suggested that drives influenced which cues were utilized in the spontaneous alternation task and that visual cues were, in fact, important. In this study, spatial cues were not controlled and odor cues were only partially eliminated. In order to test the hypothesis that drives affect which cues are utilized, it is necessary to be able to neutralize certain cues which appear to govern alternation (Douglas, 1966b) while making other cues available to Ss. It was assumed, following Douglas (1966a), that animals with middle-ear disease were lacking in spatial direction cues necessary for alternation behavior. By changing the metal sheet beneath the maze and wiping the wire-mesh floor with a mild disinfectant between the first and second trials, the odor trails can be eliminated. Visual cues were manipulated by the introduction of new or novel stimuli in the unentered goal-arm between Trials 1 and 2.

The following hypotheses were suggested by Franken & Baker (1967). These hypotheses are based on the assumption that drive levels affect the specific cue utilized rather than the number of cues and that organisms tend to approach the previously

unexperienced alternative in order to optimize complexity as suggested by Dember & Earl (1957): (a) Visual cues will be utilized under high drive. (b) Odor trails will be a weak cue under all drive levels. (c) When all cues are present, alternation will be high irrespective of drive level. (d) When all cues are eliminated, alternation will be low. No data were available to make specific predictions concerning the utilization of spatial direction cues.

SUBJECTS

Subjects were 200 gentled naive male Sprague-Dawley rats weighing from 150 to 175 g, supplied by Canadian Research Animal Farm, Bradford, Ontario. Of the 200 Ss, 120 had middle-ear disease to such an extent that the spatial direction cue mediated by the vestibular system was probably disrupted (Douglas, 1966a). The Ss were assigned to 20 groups, 10 per group, representing four drive levels (0, 6, 22, and 36 h of food deprivation). The assignment to groups was random except with respect to the middle-ear-diseased and normal Ss being selected for their appropriate cue conditions.

APPARATUS

The apparatus was a single T maze with dimensions after Douglas (1966b). Access to the maze arms and to the maze proper from the start box was controlled by remotely operated overhead doors. The floor of the maze was of ½-in. wire mesh. The entire maze was raised 2 in. above the supporting surface to facilitate changing of the metal sheets beneath. The maze was shielded from direct light, and room cues were eliminated by a large translucent sheet supported 8 in. above the upper level of the maze.

DESIGN

There were five cue groups. The visual-cue group (V) had only visual cues available. Spatial cues were eliminated by using middle-ear rats and odor cues were neutralized by changing metal sheets beneath the wire-mesh floor and wiping the wire-mesh floor with a mild disinfectant between Trials 1 and 2. The goal arms of the maze were medium gray on Trial 1. Between Trials 1 and 2 a black and white checkerboard insert, covering the three walls of the goal box, was placed in the unentered alternative. The checkerboard was made of white cardboard on which 1-in. black squares were painted. The direction-cue group (D) were normal littermates of the middle-ear animals. No visual change was manipulated and odor was eliminated as above. The odor-cue group (O) used

middle-ear animals, no visual changes were made, and odor trails were allowed to remain between trials. The all-cue group (VDO) had all the cues available. A control group (C) used middle-ear-diseased animals and eliminated odor and visual change as above.

PROCEDURE

The Ss were adapted and run under the following deprivation conditions. The 0-h group was fed ad lib both prior to and during the experiment. The 6-h group was deprived for 22 h and then fed for 2 h for the 7 days prior to the experiment. On the 5 testing days the Ss were run after 6 h of food deprivation, then deprived for an additional 16 h before being fed for 2 h. The 22-h group was deprived for 22 h a day and fed for 2 h on the 7 adaptation days. On testing days the Ss were run after approximately 22 h of food deprivation. The 36-h group was deprived for 22 h on the first day of adaptation training. In the next three adaptation periods (involving 6 days), the Ss were deprived for 44 h and fed for 4 h. On testing days, the rats were run every other day, but testing occurred after the Ss had been deprived for 36 h. They were deprived for an additional 8 h following the two daily trials and then were fed for 4 h. The different schedules were so arranged that the Ss were tested at approximately the same time each day.

The Ss were gentled for 10 min a day for 2 days in groups of four on the 2 days prior to testing. This procedure was intended to accustom the Ss to being handled while deprived. The separate drive-level Ss were run successively at approximately one drive group per week.

Each S received two trials a day for five consecutive deprivation periods. On Trial 1 the S was individually placed in the start box and retained for 15 sec before the door to the stem was opened. The S was then allowed to proceed down the stem and make a "free choice" of either of the goal arms. A choice consisted of a four-legged entry into one arm. The retracing door was then closed and the S retained in the goal arm for 15 sec. The S was removed and returned to the start box and retained for 15 sec or as long as it took to make the between-trial adjustments to the maze. The start-box door was then opened and the S was again allowed to make a "free choice" of either arm. The S was retained for 15 sec in the arm selected before being returned to a holding cage. This procedure was used for all Ss over all 5 days of the experiment.

RESULTS

The results presented in Table 1 are the percentage of trials on which the Ss alternated. Analysis of alternation data is somewhat difficult when group comparisons are involved, especially since Trial 1 and Trial 2 of the daily trials are not

Table 1
Per Cent Alternation for All Groups

	Satiated	6 h Depriva- tion	22 h Depriva- tion	36 h Depriva- tion
V	26	56	52	66
D	70	72	72	84
O	46	56	72	50
VDO	90	88	92	86
C	30	36	38	34

independent events. Douglas (1964) has argued that the best indicator of whether an individual S will alternate under certain stimulus conditions is to use the group mean. The fact that an individual S does not alternate on a given pair of trials does not change the probability of that animal's alternating on a following pair of trials. We found no difference between days and found that all Ss in a given condition alternated at approximately the same rate. Douglas (1964) further argued that repeated trials can be considered independent as far as the analysis of alternation data is concerned. Thus, while the individual trials in a pair may not be independent, the results of a number of pairs for a given S are assumed to be independent. Following this line of argument, the data were pooled over Ss rather than days and an arcsin transformation was applied to the proportion scores. Analysis of variance showed significant effects for both drive level ($F = 4.47$, $df = 3/80$, $p < .01$) and cue condition ($F = 59.23$, $df = 4/80$, $p < .01$). The Drive Level by Cue Group interaction was also significant ($F = 2.26$, $df = 12/80$, $p < .05$). A Duncan range test between drive levels revealed a significant difference between the satiated Ss and all deprived animals but no significance was found between the different deprivation levels when all cue groups were combined. There were no significant differences across drive levels within the all-cue VDO group or the no-cue C group, but the C group had significantly lower rates of alternation than the VDO group, as predicted. The consistently below-chance performance of the C group raises some questions about the assumption that chance behavior is 50% in a two-choice task, at least when middle-ear-diseased animals are used.

In order to analyze the interaction, the Student *t* test was used although the use of the *t* under these conditions violates some of the assumptions of the test. There are 40 comparisons of which 36 were significantly different ($p < .05$, one-tailed test). The four nonsignificant comparisons were the following: C-V for 0 h deprivation, O-V for 6 h deprivation, O-D for 22 h deprivation, and VDO-D for 36 h deprivation.

DISCUSSION

The low alternation rates of the V, O, and

C groups may be due in part to the fact that the middle-ear-diseased rats were under some form of stress and therefore were less inclined to alternate. The fact remains that these Ss do respond to visual and odor cues and therefore the results cannot be accounted for solely in terms of the fact that some of the animals used in the experiment were "sick." Since food deprivation may also be considered a type of stress, it is interesting to note that alternation increased under certain levels of this type of "stress."

The results of the present study provide evidence that the extent to which cues are utilized in the spontaneous alternation situation is directly affected by the drive level of the organism. Generally, an increase in drive may be said to increase the effectiveness of specific cues, with the exception of the odor, at high drive levels. The predictions were generally confirmed and the results were generally consistent with Douglas's earlier work on satiated rats. The effectiveness of visual stimuli at higher drive levels and the increased effectiveness of other cues extend the Douglas findings and provide evidence for the contention that drive may have an organizing effect. The results question Bruner, Matter, & Papanek's (1955) and Easterbrook's (1959) contention that increased drive leads to a reduction in the number of cues utilized.

Douglas argues that the Dember & Earl (1957) model of stimulus selection does not account for his data. Dember and Earl suggest that organisms respond to the changed or more novel aspect of the stimulus situation rather than avoid that aspect of the stimulus situation the organism has previously experienced. Whether response to the more novel is governed by odor or direction cues is immaterial. When

appropriate procedures are used to insure that the visual stimulus for one alternative is more novel than the visual stimulus of the other alternative, response to visual change is observed. Drive levels appear to influence whether a given cue or combination of cues is effective in guiding alternation. At least for the present data, the Dember and Earl theory still remains a parsimonious and viable explanation of the alternation phenomenon.

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NOTE

1. This investigation was supported in part by the National Research Council of Canada, Grant APA-170, to the first author. Part of the data was reported by J. B. Baker in a thesis submitted in accordance with the requirements for the MA degree of the University of Calgary.

Early experience and visual cliff behavior in the Mongolian gerbil (*Meriones unguiculatus*): II

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Exposure of male and female gerbils to "flat" and "cliff" living environments from 30 to 51 days of age modifies subsequent

visual cliff behavior. Prior experience with a cliff decreases latency to respond. This is especially apparent if the early environment has a pattern similar to the visual cliff on which the test is made. Descent from a deep cliff is more apt to occur in animals with previous cliff experience with a minimum of visual depth cues.