Spontaneous alternation in normal and brain-damaged gerbils

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Cortically and septally damaged gerbils were compared with normal animals on a task of spontaneous alternation. Both brain-damaged and control gerbils made significantly more alternation than place responses. This behavior contrasts with that of septally damaged rats that alternate less and are better place learners than controls.

Spontaneous alternation may be defined as the tendency of an animal to alternate when it is given a choice of going in either of two directions. Dember & Fowler (1958) have summarized much of the literature concerning spontaneous alternation in rats. A number of theories have been advanced to explain this phenomenon. Response-oriented theories, stimulus-oriented theories, theories of curiosity, exploration, action decrement, and others have been postulated. Spontaneous alternation has also been studied in relation to hippocampal and septal brain damage in rats. Hippocampal lesions have been found to abolish this phenomenon (Douglas & Isaacson, 1964; Roberts, Dember, & Brodwick, 1962). Similar deficits in spontaneous alternation have been obtained after septal lesions (Clody & Carlton, 1969; Douglas & Raphelson, 1966). Dalland (1970), however, found that the perseverative tendencies of rats sustaining septal or hippocampal lesions differed in that the former perseverated stimuli and the latter perseverated responses.

Employing a T-maze, Douglas and Raphelson found that the overall alternation rate of rats sustaining large septal lesions was very close to 50-50 chance expectancies compared to a control group which alternated at a very high rate. Clody & Carlton (1969) report a more marked deficit in spontaneous alternation following more restricted lesions of the medial septal nucleus in rats. By employing a T-maze and a cross-maze, they found that animals with septal lesions were not simply repeating a response (turning), but rather that they were repeatedly going to the same place on any single test. This finding is supported by Dalland (1970). His results suggested that rats sustaining septal lesions are better place learners by reason of their hyperreactivity to certain stimuli.

The Mongolian gerbil has recently received much attention as an experimental animal in behavioral research. The gerbil is an ideal experimental animal as it is generically close to the rat and is more easily maintained in a laboratory than is the rat. A variety of studies indicate, however, that the behavioral picture presented by these two animals is different (e.g., Walters, Pearl, & Rogers, 1963; Wise & Parker, 1968). To date, no studies (to my knowledge) of spontaneous alternation have been done using the gerbil as a S. In light of the studies done by Douglas and Raphelson, Clody and Carlton, and Dalland, it is of interest to ask how brain-damaged gerbils will perform on a task of spontaneous alternation.

METHOD

Twenty male Mongolian gerbils (*Meriones unguiculatus*), approximately 100 days old, were used. Four groups of five Ss each were formed. These were gerbils receiving a septal lesion, a cortical lesion, a control operation, or no operation. Six days postoperatively, all Ss were used in a metabolism experiment. (This was a measure of resting metabolism; i.e., the animals were in a resting nonfood-deprived state.) Three weeks after the metabolism measure was taken, the Ss were used in this experiment. All Ss were housed individually and given food and water ad lib.

Fifteen of the Ss were anesthetized with Nembutal (30 mg/kg of a 50 mg/ml solution), and 10 animals (septal and cortical groups) sustained stereotaxically placed lesions. The remaining five (operated-control group) received only burr holes in the skull. Bilateral septal and cortical lesions were produced electrolytically by passing 90 V (positive to electrode, negative to ear bars) for 1.5 sec through a 0.01-in. stainless steel electrode, insulated except for 1.5 mm of its tip. Following the experiment, all of the operated Ss (10), two operated-control Ss, and two control (unoperated Ss) were given an

overdose of Nembutal and sacrificed. These Ss were perfused intracardially with physiological saline, followed by 10% formalin in physiological saline. The brains were frozen, sectioned at 50 micra, mounted, stained with cresyl violet, and examined under the microscope to evaluate brain damage.

All Ss were tested in a cross-maze measuring 45 x 45 in. along the length of the arms and 10 in. deep. The width of the arms was 5 in. The arms were covered with wire mesh and illuminated by nine .63-A bulbs, which were suspended from the wire mesh and spaced approximately every 5 in. along the length of the arms. Each S received two sessions consisting of 10 trials each. The sessions were separated by a 3-h interval. On the first trial, the S was placed in the startbox of one arm and, after approximately 10 sec, the door was raised. The door opposite the start arm was closed, thus presenting a T-maze situation to the animal. When the S had entered (including the tail) one of the side arms, the door was lowered and the response recorded. After approximately 10 sec, the S was removed from the endbox, re-placed in the startbox of the opposite arm, and the next trial begun. An alternation was scored if the S made the same turn (right or left) on two consecutive trials, and a place response was scored if the S alternated turns on two consecutive trials, i.e., went to the same endbox on each trial.

RESULTS AND DISCUSSION

Histologically, none of the normal control or operated-control Ss sustained any brain damage. All of the cortical lesions were bilateral, small, and situated above the genu of the corpus callosum. Two of the Ss with septal lesions sustained large bilateral lesions which completely ablated the septal area. The three other experimental animals sustained smaller bilateral lesions which damaged only the lateral nuclei of the septum. All of the Ss with septal lesions had some damage to the cortex and corpus callosum (mainly electrode tracks).

The total number of alternation and place responses, out of a possible 100, are shown in Table 1. As no difference was found between any of the groups

Table 1
Total Number of Alternation and Place Responses (Out of 100) Made by Control, Operated Control, Cortical, and Septal Groups. The N of each group is 10.

Group	Alter-nate	Place
Normal Control	57	43
Operated Control	53	47
Cortical Control	62	38
Experimental (Septal)	61	39

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on alternation or place responses, a binomial test was run on the alternation responses vs the place responses of the combined groups. These scores differed significantly ($p < .001$, $z = -2.95$). Both control and brain-damaged gerbils made more alternation than place responses. These results differ from the findings of Douglas & Raphaelson (1956) and Clody & Carlton (1969), who reported that in rats, control Ss alternated at a higher rate than did the Ss sustaining septal lesions.

Dember & Fowler (1958) have suggested that the initial response may be a biasing factor. This, however, was not the case in this study (the difference between 17 initial left turns and 23 initial right turns is not significant).

As the gerbil is a less domesticated species than the laboratory rat, it is possible that the handling (from endbox to startbox) had the effect of aversive reinforcement. This could explain why there was a tendency for the brain-injured animals to alternate more than controls, i.e., the brain lesion added to the upset condition of the animal. Subjectively, the Ss sustaining septal lesions appeared to be somewhat more active and perhaps more fearful than the other groups, but there was no indication of the rage syndrome (biting and vicious behavior) that is characteristic of rats sustaining septal lesions. Carlson & Thomas (1968) found that mice sustaining

septal lesions reacted in a similar manner, i.e., with exaggerated fearfulness and an aversion to handling, but were not particularly savage.

This view (aversive reinforcement) contrasts with that of Schwentker (1963), who has described the gerbil as having little fear but a tremendous curiosity. The gerbils in this study may have been perseverating a response (Dalland, 1970), but it is equally possible that the alternation response was a result of the gerbil's curiosity about his environment. There are studies to suggest that the gerbil explores more than does the rat under similar conditions (Nauman, 1968; Walters et al, 1963). Wise & Parker (1968), however, have shown that the rat is superior to the gerbil on a task of discriminative maze learning. With regard to this study, it would seem that the gerbils were either more curious about their environment or were less capable of learning a place response.

Studies employing a more distinctly defined place response would be of value in clarifying the species difference noted in this study. For purposes of behavioral research, however, it is important to know that on tasks such as spontaneous alternation, the gerbil presents a different behavioral picture than does the rat. Also, as Carlson & Thomas (1968) have suggested for mice, the gerbil responds differently to brain

lesions that encompass a comparable area in the rat.

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