Spontaneous alternation and middle ear disease[1]

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Rats with middle ear disease and control Ss from the same population with the same history were tested for spontaneous alternation in the T maze, with and without the presence of odor trail cues. The results indicated that the middle ear group had a normal odor trail avoidance tendency but entirely lacked alternation when these cues were removed. These results support the hypothesis that spontaneous alternation is a combination of odor trail avoidance and spatial direction alternation, with the latter tendency being based on vestibular information.

The term "spontaneous alternation" refers to the tendency of the rat to make alternate responses at the choice point of a T maze on two consecutive unrewarded trials (see Dember & Fowler, 1958). From the results of experimental manipulation, using intact rats, Douglas (1964) concluded that spontaneous alternation is the result of the addition of two independent factors. The more important of these is a tendency to turn in opposite spatial directions at the choice point, and the weaker factor is a tendency to avoid the odor trail from the first trial. Elimination of either odor trail or the opportunity to make turns in opposite spatial directions resulted in a reduced alternation rate, while removal of both entirely eliminated alternation. It was found that rats do not "compensate" for the loss of one factor by increasing alternation to another one. The present study was undertaken as a verification of those findings through the observation of alternation in rats with middle ear disease, a condition which profoundly disrupts the vestibular system. It was assumed that the vestibular system must be necessary for spatial direction alternation, but irrelevant as far as odor trial avoidance is concerned. If this assumption is true, then rats with vestibular disturbances should retain their odor trail avoidance tendency but have a greatly reduced tendency to turn in opposite spatial directions. The following procedure was used to test this assertion.

METHOD

Subjects

All Ss had previously been used in bar press studies, but at least 1 mo. had elapsed since the last test. All were male rats weighing between 350 and 400 gm, and were individually housed, with food and water ad lib. Six Ss were made available to the experimenter upon the detection of middle ear disease, along with six control animals from the same original source, and with the same histories in the lab. Middle ear disease was diagnosed by the presence of a chronic tilt of the head and a powerful tendency to twist when held by the tail. There is no ambiguity in this test, as the condition is unmistakable. Since vestibular disturbances were judged on the basis of behavior, the brains were not examined in detail histologically. Gross dissection of one S revealed a pus-filled degeneration of the region of the middle and inner ear on one side.

Apparatus

A T maze of the following dimensions was used: Main and cross alleys were 16 in. long, 4 in. wide, and 5 in. high. The first 6 in. of the main alley was used as a start box, and was separated from the rest of the maze by a sliding door. Sliding doors were also located at the entrances to the side alleys. The maze was covered with wire mesh, but did not have a built-in floor. The maze was placed directly over a piece of heavy opaque paper which was placed on top of a table. Illumination was provided by overhead fluorescent lights.

Procedure

All Ss were first tested with odor trail cues present, or with the same paper floor used on all trials in a session. The paper was changed between sessions and Ss. Following this, odor trail cues were eliminated by changing the paper floor between each trial. Only three pairs of Ss were available for this second test because the others had been prematurely disposed of through a misunderstanding of instructions. On the first test S was placed in the start box and, after a 10 sec. wait, the door to the main alley was raised. When S's whole body was present in one of the side alleys, the door to that alley was lowered and the response scored. After 10 sec. in the side alley, S was removed and replaced in the start box for the next trial. Ss were given consecutive trials until their response latency was 1 min. or more, or until 11 trials had been run. At this point Ss were returned to their home cages until the next day. This procedure was repeated until each S had 25 opportunities to alternate the response of an immediately preceding trial, with the time interval between successive responses being always less than 1 min.

Three days after completion of the first test, alternation was tested with odor trail cues removed. The procedure was similar to that above except that a new paper floor was used for each trial, with S being gently placed in a cardboard box for the few seconds required for the change. Ss were given only 15 opportunities to alternate in this condition, as both groups were becoming maze resistant. Each S was given a total score under both conditions, and data were also analyzed by trials and days.

RESULTS

Ss with middle ear disease were found to alternate at a mean rate of 60.7% when odor trail cues were present,

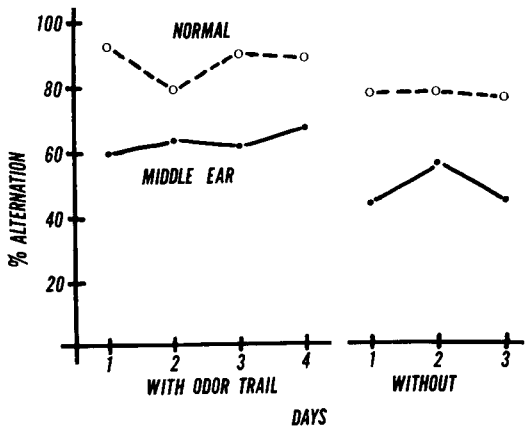

Fig. 1. Alternation over daily sessions with and without odor trail cues.

while the normals alternated at a much higher rate of 86.3% ($t = 6.6$, $p < .001$). The middle ear rate was, however, significantly above a chance 50% ($t = 2.8$, $p < .05$), and was very close to that reported by Douglas (1964) for odor trial avoidance (middle to low 60s). The middle ear Ss tended to make more responses per session, but the difference was not significant. There was no detectable relation between scores obtained on longer and shorter sequences, and differences between days were negligible, as can be seen in Fig. 1.

When odor trail cues were eliminated alternation in the middle ear Ss dropped abruptly to a mean of 45.3%, which does not differ from a chance 50%. This rate was significantly lower than that of the normals' 75.3% ($t = 4.0$, $p < .02$). The drop in performance in the middle ear group was also significant, despite the small number of Ss ($t = 3.1$, $p < .05$, 1 tail). These results are shown in Fig. 1.

DISCUSSION

These results are in close agreement with the findings of Douglas (1964) which were discussed earlier, and all of these figures are comparable to his. These results suggest that middle ear disease does not merely disrupt behavior in general, as these Ss appeared to retain normal odor trail avoidance tendencies.

It was suspected that this test might prove to be invalid because of the possibility that the middle ear rats might tend to turn preferentially in the direction of head tilt, or to "bank" around the turn. This did not prove to be the case, however, as the three animals with heads tilted to the right made almost the same number of right turns as did those with heads tilted to the left, with the total tendency to turn in the direction of head tilt being only 54.3% on the initial trials. Thus, the present results are not due to a turn bias, and are more probably due to a lack of spatial direction alternation due to a disturbance of the vestibular system.

References

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Note

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