Behavior Genetic Analysis of Water-T-Maze Learning in Inbred Strains of Mice, their Hybrids, and Selected Second Generation Crosses

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Summary. The Water-T-Maze was used to investigate the genetically determined apparatus-dependent behavior of mice. Special importance was attached to the mode of inheritance involved. For this purpose we used NMRI, C3H/HeJ, Balb/c, Balb/cN, DBA/2, C57Bl/6 inbred mouse strains, together with their offspring and the F2-hybrids of C3H/HeJ and DBA/2. Furthermore investigations were carried out to examine the effect of the environment on the expression of behavior.

After these experiments had proved that there is a predominantly genetic derivation for behavioral expression, a possible relationship between the conditioning effect and the age of the animals was investigated. The animal's age has quantitative effects on the expression of behavior, but it does not lead to any qualitative behavioral changes. Nevertheless early conditioning of the animals apparently manifests itself in long-term memory. On the whole the mode of inheritance in Water-T-Maze learning appears to imply a polygene-dependent model in which clear dominant effects are present, as shown in the results of the F2-generation. No sex-related differences were observed. In general, the results demonstrate a definite involvement of genetic factors in the areas of conditioning and behavior.

Introduction

Investigations on water escape learning were first carried out by Essman and Jarvik in 1961. The authors described the basic experimental set-up as a suitable model for investigating orientation ability in mice. Since then behavioral studies using this system have been carried out by Winston (1964), Winston and Lindzey (1964), and Meier and Foshee (1965). In these experiments the investigations mainly concerned the effect of albinism on the expression of learning behavior. More recent investigations on water escape learning were carried out by Festing in 1973 and 1974. However, in all the works cited so far the conditionings determined by the apparatus differed clearly from ours, since they only served to measure the ability to get away from a simple pool via an escape ramp. The experimental set-up used in the studies presented here differs from the previous ones in that a T-Maze system was introduced. Similar systems (without the use of water, however) were employed by various other authors, such as Stasik (1970), Henderson...
(1972), Padeh and Soller (1976) for avoidance conditioning with electric shocks or 'reward feeds.' The Water-T-Maze, which was similar in form to our set-up was introduced into literature on behavioral genetics by Waller et al. (1960). In contrast to the other water escape systems, the Water-T-Maze enables us to obtain experimental data with less scatter, since the animals are compelled to show some sort of behavioral expression. Moreover, the authors consider conditioning with this system to be more suitable, since the increased demands placed on the animal enable us to carry out a differential analysis on behavioral expression.

Materials and Methods

Experimental Set-up

The Water-T-Maze was used as the testing system (Fig. 1). It consists of a PVC trough measuring $80 \times 50 \times 20$ cm, which is filled with water to a height of 10 cm. The interior of the container consists of an E-shaped passage system with a passage width of 10 cm. The starting point is located in the central passage; escaping from the water is possible via a ramp, which can be positioned either in the right-hand or in the left-hand passage, as required. Our evaluation was based on two parameters:
1) The swimming time from the starting position until actually touching the escape ramp.
2) The number of errors. (The test was assessed as 'correct' if the laboratory animal swam from the starting position to the ramp without making a $180^\circ$ turn; if this criterion was not fulfilled, the test was registered as 'wrong'.)

The testing period lasted five days. Every animal was conditioned three times daily in the morning and three times in the afternoon. The exit ramp was placed in the right-