HEMISPHERIC ASYMMETRY OF FOOD-GETTING BEHAVIOR OF MICE IN A MULTIPLE-CHOICE SYMMETRICAL MAZE

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Progress in the study of functional interhemispheric asymmetry (FIHA) and, in particular, of hemispheric specialization in animals [1-3, 12, 13, 15, 16] is largely dependent on the availability of adequate methods of assessing the role of the right and left cerebral hemispheres in the regulation of various bodily functions. One of the most convenient approaches to the study of this problem is that of training animals in a maze. It enables the various components of complex goal-directed behavior to be investigated, and the characteristics of visuospatial memory, the organization of cognitive maps, and the various tactics used in the search for reinforcement to be studied. A combination of the maze method with unilateral functional hemispheric blocking can shed light on different aspects of the connection of cerebral dominance with different types of motor activity. Comparatively few studies have yet been published in which different modifications of the technique of training in a maze have been used to study spatial-motor preference and FIHA in rodents [2, 8, 9, 17]. Previously, to investigate behavior of animals at different levels of phylogeny, a multiple-choice symmetrical maze was designed [7]. By the use of such a maze it was possible to detect asymmetry of the direction of movement in higher invertebrates (ants), both of single individuals and of test samples as a whole [10].

The aim of the present investigation was to continue the study of interhemispheric asymmetry of motor control [1, 2, 4, 16, 11, etc.]. The role of different parts of the cortex of the right and left cerebral hemispheres in the regulation of various components of the behavior of albino mice in a multiple-choice maze was studied.

METHOD

Experiments were carried out on 17 female BALB/c albino mice in a rectangular experimental Plexiglas chamber measuring 74 x 46 x 19 cm (Fig. 1). It comprised a free zone I and a maze II, consisting of two symmetrical halves. For convenience when describing the trajectory of the animals' movements on a diagram, the principal parts of the apparatus are indicated by letters. A visit by the animal to a zone indicated by a letter will in future be conventionally described as "movement." Entry from the free zone into the maze is possible only through the central door, and the only exits from the maze are through the side doors R and T.
Reinforcement (a piece of cheese) was placed in two feeding bowls A and D. "Mock" feeding bowls B and C, which did not contain reinforcment, were placed symmetrically opposite to A and D. The experiments were carried out on alternate days and each experiment lasted 10 min. The animal was placed in the free zone and allowed to move inside it and into the maze. Gradually the mice were taught to enter the labyrinth through the central door, to take the reinforcement from the feeding bowls, and to return into the free zone. The cycle of movement through the maze included as its essential component the taking of food from one or both bowls. In each cycle reinforcement could be obtained only once from the right and left bowls. A fresh portion of food was put into the bowls immediately after the animal returned into the free zone. A special feature of this method was that throughout the experiment the animal itself controlled the frequency of entry into the maze and the trajectory of its movements in it. Training animals in a symmetrical multiple-choice maze was described previously [6, 7]. In the course of training, the number of cycles in the experiment was increased. Of the many possible versions which the animals undertook, between one and three trajectories which came closest to optimal were reinforced (for example, OvwXwDhut or OvwAESR). Due to a decrease in the number of repeated visits to different parts of the maze and in the number of visits to "superfluous" parts, not lying on the optimal trajectories, the mean number of movements in the cycle was reduced. As a rule during this period the animals took the reinforcement from both bowls. On stabilization of the frequency of cycles and the number of movements in the cycle, experiments were carried out with unilateral hemispheric cortical inactivation. For this purpose, 24 h before the experiment the skull was trephined under superficial ether anesthesia above the parieto-occipital regions, and 20 min before the experiment, a 25% solution of potassium chloride was applied epidurally to one hemisphere [5, etc]. The order of inactivation of the right and left hemispheres varied in different individuals. Between inactivations of the same hemisphere, two or three experiments were carried out until the parameters of movement in the maze had returned to their initial level. Altogether the left hemisphere was blocked 21 times and the right 17 times.

Movement of the animal in sections of the apparatus indicated by letters was observed visually and recorded. To detect spatiomotor asymmetry the frequency of visits to symmetrical parts of the maze was compared. Lateralization of the different parts was determined relative to the OV axis. During analysis of the data parameters obtained in an experiment with hemispheric inactivation were compared with those of the experiments which immediately preceded it. Results for all animals were averaged for the 21 or 17 experiments with inactivation of the left and right hemispheres respectively. The results were subjected to statistical analysis by Student's test. Cases when other methods (the signs test, chi-square test, paired t-test) were used are specifically mentioned in the text.

RESULTS

From 15 to 20 experiments were required to establish a stable skill of passage through the maze. By this time stable levels of the number of cycles in one experiment and the number of movements in one cycle were established, and definite trajectory movements characteristic of each animal were formed. On average, for the two experiments which directly preceded inactivation of the right and left hemispheres, in the course of 10 min the mice completed 10.5 ± 1.1 cycles, with 30.7 ± 3.7 movements per cycle. In 91% of all cycles the animals took the reinforcement from both bowls (A₁ and D₁). "Investigative" approaches to the bowls, when the mice did not take the food or returned to an empty bowl, were examined separately. There were fewer such approaches (A₀ and D₀) than approaches to the bowls and taking the reinforcement (p < 0.05). The "mock" feeding bowls were visited very rarely: only in 3.4% of all cycles in intact animals (after inactivation of the cortex, virtually no such movements were performed).

The frequency of visits to the identified parts of the maze and other parameters of motor activity in the main experiments and in experiments with inactivation of the right and left hemispheres are given in Tables 1 and 2. Intact animals visited parts W and X, leading from the central corridor OV to the feeding bowls, most frequently. There were comparatively few movements in J and M (the first turns of the corridor OV) and in the side corridors S and U. Parts L and Z, K and Y, and F and G, and E and H were visited rather more often, and virtually equally. The number of movements in corresponding parts of the anterior and posterior regions of the maze (L and K, F and E and the corresponding parts of the left half) was essentially the same. Spatiomotor asymmetry was not found in the main experiments as a whole for all parts of the right and left halves of the maze, and was observed only with respect to certain parts.