The Effects of apparatus design and test procedure on learning and memory performance of C57BL/6J mice on the Barnes maze

Timothy P. O'Leary and Richard E. Brown
Psychology Department, Dalhousie University, Halifax, NS, Canada, tpoleary@dal.ca

Introduction

The Barnes maze is a visuo-spatial learning and memory task originally designed for rats and consists of an elevated circular surface with holes around the edge [1]. On the Barnes maze, rats use extra-maze visual cues to locate an escape hole that allows them to escape from open space and bright light into a dark box beneath the maze. The original Barnes maze and test procedure used with rats have been altered in a number of ways for use with mice. As a result, Barnes mazes used with mice differ in size, number of holes, and stimuli used for aversive motivation, while the test procedures differ in the amount of habituation training and the number of acquisition training trials. The present experiment determined if Barnes maze design (maze diameter and presence of a wall and intra-maze visual cues) and test procedure (amount of habituation training) influence learning and memory performance of mice. In particular, we tested whether mice used visuo-spatial cues to learn the location of the escape hole on three different versions of the Barnes maze.

Methods

After receiving either 1 or 4 habituation trials, male (N=30) and female (N=30) C57BL/6J mice were tested on each of three Barnes maze designs; (1) the original design for rats (122 cm diameter), (2) the small maze design (69 cm diameter) and (3) the Pompl maze design (69 cm diameter and a wall with intra-maze cues around the edge) [2]. Mice completed an acquisition phase (15 training days, 2 trials/day) to assess learning, and a probe trial (5 min) to assess memory for the location of the escape hole. The visuo-spatial nature of each maze design was assessed in three ways: (1) a probe trial with a curtain to block extra-maze cues, (2) recording the search strategies used by mice to locate the escape hole and (3) with a reversal test having 5 training days with the escape hole moved to the opposite side of the maze and a probe trial.

Results

The results suggest that the number of habituation trials does not influence learning and memory on the Barnes maze, as performance of mice given one habituation trial did not differ from mice given four habituation trials. Apparatus design did influence maze performance, however, as mice on the large and small mazes spent more time near the escape hole than mice on the Pompl maze during probe trials with visible extra-maze cues. Blocking extra-maze cues during the probe trial with a curtain disrupted performance of mice on the large and small mazes, but not on the Pompl maze. Mice on the large and small mazes also showed greater latency and error reversal effects than mice on the Pompl maze after the escape hole was moved to the opposite side of the maze. Finally, mice on the large maze used the spatial search strategy, which requires the use of extra-maze visual cues to locate the escape hole, whereas mice on the Pompl maze used the serial strategy, which does not require extra-maze cue use. Mice on the small maze used both the spatial and serial search strategies.

Conclusions

These results show that apparatus design influences performance of mice on the Barnes maze. The large maze is the optimal Barnes maze design for testing visuo-spatial learning and memory in mice, as mice reliably use extra-maze visual cues and a spatial search strategy to locate the escape hole. The small maze is a less effective test of visuo-spatial learning and memory than the large maze, as mice on the small maze use extra-maze visual cues, but use both the spatial and serial search strategies to locate the escape hole. The Pompl maze design does not appear to be a visuo-spatial learning and memory test, as mice do not use extra/intra-maze visual cues nor do they use a spatial search strategy to locate the escape hole. Mice on the Pompl maze may not use visual cues because the wall around the edge of the maze promotes thigmotaxis and use of the serial search strategy.

References

1. Barnes, C. A. (1979). Memoy deficits associated with senescence: a neurophysiological and behavioral study in the rat. *Journal of Comparative and Physiological Psychology*, **93**, 74-104.
2. Pompl, P. N., Mullan, M. N., Bjugstad, K. and Arendash, G. W. (1999). Adaptation of the circular platform spatial memory task for mice: use in detecting cognitive impairment in the APP_{sw} transgenic mouse model for Alzheimer's disease. *Journal of Neuroscience Methods*, **87**, 87-95.