Retrograde memory for a spatial task in rats with full hippocampal lesions

Brittany Strohm, Class of 2012

Humans and animals with hippocampal damage exhibit temporally graded retrograde amnesia, which is characterized by intact memory for remote events but impaired recollection of recent events (Eichenbaum, 2000). Such findings suggest that the hippocampus is essential for the acquisition and initial storage of new memories, which are then consolidated into the neocortex over time. However, studies involving the Morris Water Maze, in which rats learn the location of a hidden platform in a circular pool of water relative to distal cues, have consistently yielded a similar impairment in spatial memory regardless of the time elapsed between training and hippocampal lesions (Clark et al., 2005). Thus, spatial memory may be different from other kinds of memory in that it always depends on the hippocampus.

Another possible explanation for this phenomenon is that the hippocampus is always necessary for memory expression in the water maze due to navigational demands of the task (Clark et al., 2005). Thus, this study employed a dry-land radial maze with distinct arms, since it may provide a less demanding test of spatial memory. A 1998 study using a 4-arm plus maze did yield a temporal gradient, such that rats with a longer training-surgery interval performed better than those that had learned the goal arm’s location just before surgery. However, the majority of the lesions in this study were small, calling into question whether they eliminated hippocampal function.

Thus, to determine whether temporally graded retrograde amnesia can be found regarding spatial memory in the plus maze, this project measured the performance of rats that underwent complete hippocampal lesions. Throughout preoperative training, which consisted of 8 trials per day for 18 days, the location of the maze arm containing a food reward was consistent relative to distal cues (Ramos et al., 1998). During each trial, the rat was placed at the end of a randomized starting arm and given one minute to choose and travel halfway along any arm, after which the trial ended. A trial was considered correct if the rat chose the rewarded arm. After training, the rats were split into four surgery groups, such that there were no pre-operative differences between groups (p= 0.5547; see figure 1). There were 4 groups of 7 rats each: a sham group and hippocampal lesion group that underwent surgery 1 day after training, and a sham and lesion group that will undergo surgery 64 days after training.

According to the standard consolidation model, rats initially use the hippocampus to learn the location of the goal arm, but spatial memory is consolidated to the neocortex over time. Thus, because the 1-day training-surgery interval did not provide ample time for consolidation, the 1 day hippocampal lesion group was significantly impaired compared to the 1 day sham group during post-operative testing (p= 0.0078; see figure 2). On the other hand, the 64-day interval between training and surgery should be sufficient for consolidation outside the hippocampus; therefore, we expect that after hippocampal lesions, those rats will exhibit an intact spatial memory, thus confirming the presence of temporally graded retrograde amnesia in the plus maze.

Faculty Mentor: Seth Ramus

Funded by the Kibbe Fellowship

References: