Are female rats prone to the same stress-induced memory deficits as male rats in a visible platform task in the Morris Water Maze?

Katherine L. Wooten, Timothy A. Warner and Robert C. Drugan
Psychology Department, University of New Hampshire, Durham, NH 03824, USA

Introduction
Depression is an illness that affects about 121 million people worldwide (1). Besides existing psychological effects that interfere with daily activities, depression usually manifests itself in physical symptoms such as fatigue, lethargy, and in some cases suicidal thoughts or actions. Though great strides have been made in developing pharmacological treatments, only about 50% of depressed patients show full recovery in response to the current treatments (2).

The hippocampus complex is a neural structure regulating mood and cognition. Depression, as well as other mood disorders, has been found to compromise cognitive functions, including learning and memory, associated with the hippocampus (3). More specifically, clinical studies have illustrated that major depressive episodes are correlated with significant memory deficits and reduction in hippocampal volume (4,5).

Even though women are 70% more likely than men to experience depression during their lifetime (6), few animal models of depression include females (7).

The intermittent swim stress (ISS) paradigm has been found to be valid in creating endpoints of depression and cognitive deficits associated with depression in the Morris Water Maze (MWM), which is a hippocampal-dependent task (8,9). Previous work in our lab shows that there are sex differences in performance deficits in the MWM (10).

However, these results are seen with a submerged platform. Visitable task needs to be tested in this paradigm to ensure that there are no motor or perceptual deficits in the animals during the learning task. The current study will evaluate learning and memory effects of ISS in both males and females.

Method

Animals
16 male and 16 female Sprague-Dawley rats served as subjects. Rats were randomly assigned to either CC or ISS group.

Intermittent Swim Stress Apparatus
All treatments were administered in Perspex cylinders with wire mesh floor, suspended over a tank of 15°C water. On a swim trial, the cylinders were lowered into the water. Space between the water and the cylinder during inter-trial intervals. The apparatus was controlled by a computer with MedPC hardware and software.

Morris Water Maze (MWM) Apparatus
Spatial learning and memory tests were conducted in a circular pool filled with water at a constant temperature of 29°C. The pool was divided into four equal quadrants. The visible portion of the platform was black, extending 2 cm above the surface of the water and had a 1 cm diameter. Each wall of the pool was painted with distinct symbols. All memory probes were recorded using a video camera, HVS Image tracking system, and computer. Data was analyzed using closed model ANOVA in learning trials and 2x2 factorial ANOVA was used to analyze the memory probe tests.

Procedure

Day 1: Intermittent Swim Stress
- ISS rats were exposed to 100 trials of cold water swim.
- CC rats were placed in the swim apparatus and put through the same intermittent procedure, but in the absence of water.

Day 2: Spatial Learning
- Rats were exposed to a total of 18 learning trials in the MWM.
- Each trial began at a different cardinal direction (N, S, E, W) and all learning trials followed the same randomization order with regard to the starting location for the MWM.
- If the rat failed to find the visible platform in 60 seconds, the animal was guided to the platform. Each rat was allotted 10 seconds to remain on the platform at the conclusion of each trial.

1 Hour Memory Probe
- 1 hour after the last learning trial on Day 2, each rat was given a memory probe test.
- The platform was removed from the pool and determined if the rat could remember where the platform was previously located.
- All rats were placed in the west quadrant and the swim path was recorded for 60 seconds.
- Time spent in target quadrant was determined by tracking underwater movements on a computer.
- Learning and memory tests were performed by an experimenter blind to the treatment conditions of rats.

Results

Figure 1: MWM learning trials.

Figure 2: MWM memory probe. Significant difference between CC/Females and CC/Males for passes over the platform [p = .029] and proximity [p = .029]. There was also a significant difference between CC/Females and CC/Males for passes over the platform [p = .039].

Conclusions

- There was no impact of ISS compared to CC on learning on either sex.
- ISS males showed memory deficits at the 1-hour time point, whereas females did not.
- There was no difference in swim speed across conditions.
- These findings provide evidence that there are sex differences in stress-induced deficits in spatial memory.

References

Acknowledgements
Funding for this research was provided by the Hamel Center for Undergraduate Research.

All behavioral procedures were reviewed and approved by the University of New Hampshire Institutional Animal Care and Use Committee (IACUC).