Social Stress in Female Sprague-Dawley Rats: Open Field

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Background: Introduction to depression

- Research shows that depressive disorders are the most prevalent of all psychiatric disorders within the United States.
- The ratio of depression between males to females is approximately 1:2.
- According to the research, (Brown and Grunberg, 1995; Haller, et al. 1999) stress varies depending on gender
- Stress may include social isolation, social instability, etc. and may be chronic or transient.

Using Animals to study Humans

- Studies concerning depression often use methods that display chronic stress to non-human animals.
- This method not only helps researchers to understand behavioral constraints but also the physiological changes of chronic depression
- Using this approach of animal studies, researchers obtain results without the conflicting issues concerning unethical research among neuroscience and humans.

Chronic Stress: Behavioral Measures

- Researchers often relate human depression by conducting experiments involving Sprague – Dawley rats
- Sprague – Dawley rats are useful when attempting to find behavioral patterns similar to humans.
- When chronic stress occurs for humans as well as Sprague – Dawley rats, they respond by showing a lack of motivation, i.e. *learned helplessness* (Maier, 1984).
- In this experiment Learned Helplessness occurs when female rats were exposed to high levels of chronic stress. The rats responded by having less movement when exposed to a new environment

Chronic Stress: Biological Measures

- Sprague – Dawley rats are also used to show neurological changes in lieu of humans.
- The McEwen's theory of allostatic load suggests changes in hormone functioning (McEwen, 2007).
- McEwen's theory states that chronic stress leads to hormonal adaptations that have long-lasting effects on physiological responses, thus resulting in behavioral changes.
- Another model proposed (Joëls, et al. 2007) is called the chronic stress model (CSM)
- This theory states that CSM is a major factor of depression which affects certain components of the brain, such as the limbic system and hippocampus

Different types of Stress

- Both behavioral and physiological measures were used to show the responses of socially stressed female rats
- Current examples of social stress among female rats experience social isolation (Brown and Grunberg, 1995) and social instability (Haller, et al. 1999)
- Alternatively, male rats undergo chronic stress though social defeat via subordination within an established hierarchy
- In laboratory settings studies typically use mixed-sex housing in a visible burrow system (VBS) (Blanchard and Blanchard, 1990).

- Due to the lack of support for social hierarchies among females, social stress in female rats is often disregarded.
- To support the idea that female rats experience CSM via social stress, we utilize 2 methods. The first involves both females and males with high testosterone levels in semi-crowded housing, via VBS.
- The second involved non-crowded housing in the VBS containing only females
- Our hypothesis was that after social stress was induced results should show behavioral constraints from decreases of activity due to an overload of chronic social stress.

- We attempt to show these results by conducting an open field experiment
- An open field design consists of a 1-2 meter cage which records mobility of the rodent.
- Typical behavior of rats experience most of their exploration around the edges of the cage (thigmotaxis)
- Lack of mobility and thigmotaxis have been shown as an indicator of chronic stress in rats
- We predict that socially stressed female rats should display higher levels of learned helplessness in the open field cages by showing less mobility.

Methods: Conditions

- Twelve Sprague-Dawley rats were grouped into separate conditions
- The control condition involved four female rats, 2 rats per container
- The experimental condition consisted of another eight rats. Four female rats and four castrated male rats implanted with silicon capsules containing testosterone.
- These rats were castrated to control for pregnancy for the females. Each rat in the experimental conditions resided in a VBS, while the control rats resided in shoebox-type containers

Methods: Equipment

- There were four open field cages used for each condition, one rat per cage
- Each cage had a transparent wall made of Plexiglas so that the rat's behavior could be viewed first hand
- At the base of these cages were metal gratings that recorded the rat's behavior throughout the study. These recordings were sent to an adjacent printer.

Measures of Learned Helplessness

- The rat's behavior within the cages measured for differences between the two conditions
- The responses were shown by differences in behavior between the experimental and control conditions. The measures included vertical and horizontal movements as well as resting, immobile behaviors.
- Vertical movements were measured by count and length of bobbing. Horizontal movements measured the distance of travel, and were measured based on time and count. In comparison, immobility measured the amount of time rats spent resting.
- These behaviors determine the amount of exploration while under chronic stress.

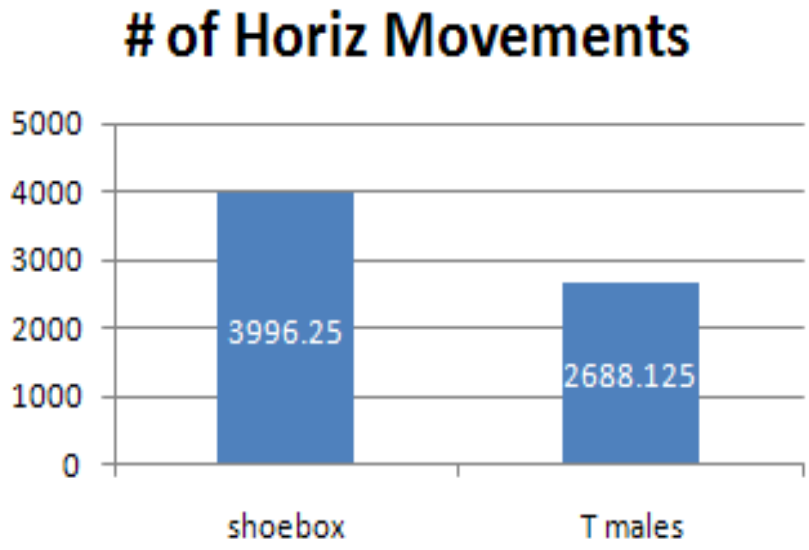
Procedure

- After collecting eight rats for the two conditions, the control condition was placed in their own cage. Incandescence lights were then replaced with safelights (or red light bulbs) to maintain chronic stress.
- Each rat was assigned its own number and this number was marked with the cage number it was in. Four rats were then placed in the cages and covered with a Plexiglas lid.
- The printer was turned on and the recording of behavior began. After ten minutes of recording, the printer printed the results.
- This procedure was then repeated for the experimental group.

Results

- When comparing the two conditions, the amount of behavior between the two was significant.
- The controlled rats portrayed more horizontal movements than the chronic stressed rats

Shoebox (control):
Mean = 3996.5
SD = 1291.3
Testosterone Males/VBS:
Mean = 2688.13
SD = 672.6
P.Value = 0.051

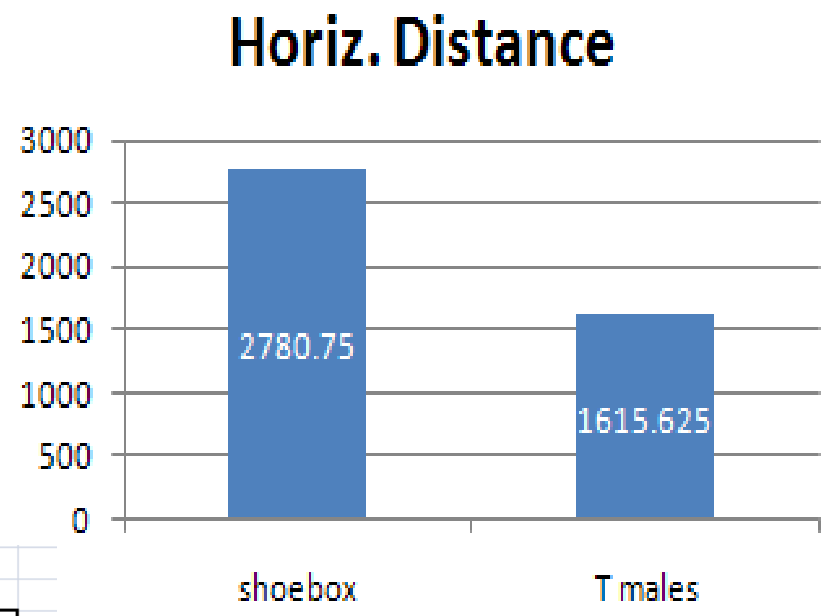


Horizontal movements:

horzmean1		No. animals	Mean	Standard dev.	significance
	shoebox	4	3996.25	1291.31157	
	T males	8	2688.13	672.62417	0.051

- Additionally, the distance travelled in centimeters supported this claim. The shoebox condition travelled more so than the other condition
- This suggests that rats exposed to chronic stress are less likely to explore their environment, which supports the learned helplessness hypothesis

Shoebox (control):
Mean = 2780.75
SD = 656.51
Testosterone Males/VBS:
Mean = 1615.62
SD = 350.22
P-value = .002

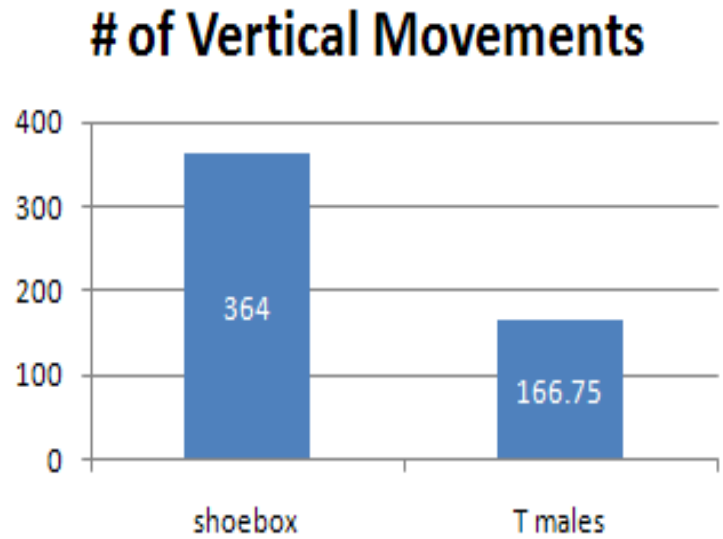


Distance traveled (cm) in the horizontal direction:

distancemean1	shoebox	4	2780.75	656.51422	
	T males	8	1615.63	350.22133	0.002

- Vertical movements (bobbing up and down) had similar results. Rats in the experimental condition displayed less vertical movements

Shoebox (control):
Mean = 364
SD = 139.74
Testosterone Males/VBS:
Mean = 166.75
SD = 40.98
P-value = .000

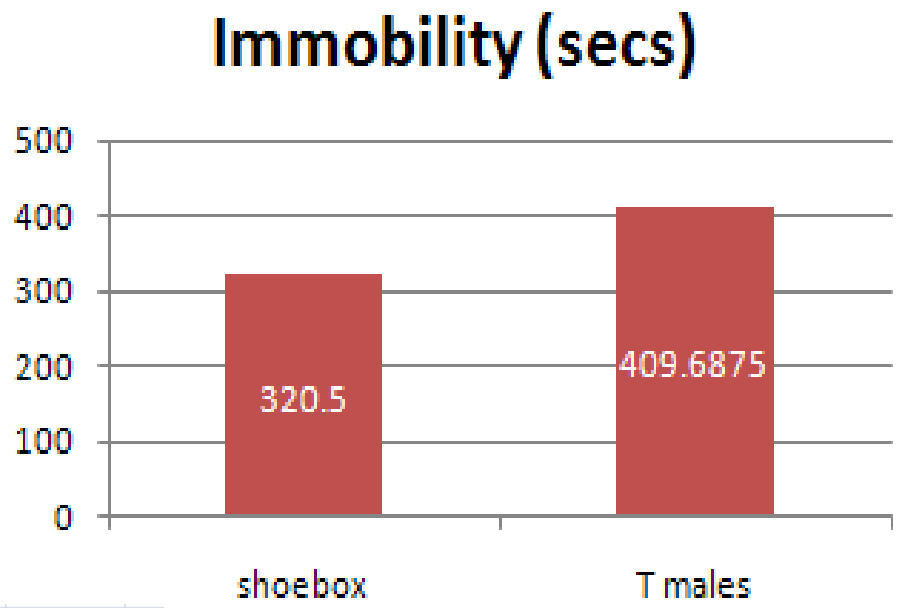


Number of vertical movements:

verticalmean1	shoebox	4	364	139.74978	
	T males	8	166.75	40.98345	0

- Lastly, the females that resided with the castrated males demonstrated more immobility than females that resided in the low social stress condition

Shoebox (control):
Mean = 320.5
SD = 44.67
Testosterone Males/VBS:
Mean = 409.68
SD = 40.03
P-value = .004



Amount of time (sec) that they spent immobile:

restmean1	shoebox	4	320.5	44.67848	
	T males	8	409.688	40.03832	0.004

Discussion

- The statistics show statistical significance for all behaviors, thus the results are supportive of social stress in females.
- The open field experiment was just one of the studies supporting the theory on social stress in female rats. Other experiments are currently held at Appalachian State University. These studies demonstrate the biological aspects of social stress in females.

References

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