

The Effects of Estrogen on Memory

An Honors Thesis (HONRS 499)

By

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A handwritten signature in black ink, appearing to read 'R. Fischer', with a long horizontal stroke extending to the right.

Ball State University

Muncie, Indiana

April 2008

Graduation Date

May 2008

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Abstract

Many theories have been proposed as to why women are more likely to experience dementia and other memory problems after menopause. One of the more popular theories is that the estrogen that women produce in abundance before menopause but very scarcely after menopause somehow affects memory functioning in women. This study looks to verify this information by looking at whether or not the memory of premenopausal women fluctuates at different stages of the menstrual cycle when hormones are at varying levels. If the same kinds of changes are seen in premenopausal women as are seen in women as they go through menopause then it would lend valuable confirmation to this theory on estrogen. If, on the other hand, little or no changes are seen in premenopausal women then there is perhaps a confounding variable leading to the memory deficits in older women. Although the results of this study are inconclusive, it is still an area that should be researched further in the future. If studied with more women across a greater span of time then a pattern might emerge that could help us to diagnose and treat memory deficits in all women.

Acknowledgements

- I would like to thank Dr. Robert Fischer without his help and advice this project could not be possible.
- I would also like to thank Natalie Borges for reading through this paper and motivating me to continue to work hard.
- Finally, I would like to Dr. James Rohrer for his understanding and assistance through the creation of this whole project.

Introduction

Many women will experience dementia or some type of memory loss as they age. Professionals have not established any concrete reason as to why this type of memory loss occurs in women, but many theories have been proposed. One of these theories is that the estrogen produced naturally by women's bodies may have a beneficial effect upon memory function in premenopausal women; however, after menopause women's bodies stop making this memory enhancing hormone and the women have more memory difficulties than they did before menopause. There has been a lot of research done to test this theory and many different conclusions have arisen. Fernandez and Frick (2004) found that estrogen affects the production nerve growth factor and brain-derived neurotrophic factor which are critical to neocortical and hippocampal synaptic function. Shaywitz et al (1999) found that estrogen positively enhances the verbal memory of women. Unfortunately, most of these studies are performed on either rats or postmenopausal women. Almost no experiments have been done on premenopausal women with their natural estrogen fluctuations. This experiment takes the point of view that estrogen positively affects memory function. It uses the basic hormone cycles of premenopausal women to test for any memory variation in women who are in the follicular phase of their menstrual cycle from their counterparts in the luteal phase of their menstrual cycle. During their follicular phase, estrogen is at its peak in a woman's body, but in the luteal phase the amount of estrogen levels out and its effects are masked by the much increased progesterone in the woman's body (Sherwood 2006).

Methods

This study used the Weschler Memory Scale to measure the memory capacity of young women at Ball State University. It was a group experiment that allowed up to 30 students to participate at any given time. Participants entered a classroom and were directed to desks that had materials necessary for the experiment already laid out on the desktop. On top of the materials was the informed consent document, followed by a demographic sheet that was used to obtain information about the hormonal cycles of the participants and to determine at what point in their cycle the women were in when they participated in the experiment. Next there was a blank sheet of computer paper that was used to record the word pairs and, finally, a standardized test taking sheet which was used to record responses to the faces section.

In order to facilitate a large group in a classroom setting, the Faces of the Weschler Memory Scale were scanned into a computer program and set to present in the correct order. The first 24 faces were shown first over a projector screen. Participants were instructed to watch because they would need to recall

these faces later. The experimenter switched through the slides one by one, leaving each one on the screen for the required two seconds.

After the presentation of the initial faces, the word associations section of the Weschler Memory Scale was given with some minor changes. Since this experiment was done using large groups of up to 30, individual responses could not be taken verbally and corrected as recommended by the test. Instead, the experimenter asked the group to fold their computer paper in half twice and label each square one through four. Then the experimenter asked participants to create a list of numbers 1-8 in each square so that all they would have to write next to the number was the word that they thought was associated with the given word. The experimenter then read the word pairings and asked the participants to recall the second word in the pair by writing it on their computer paper in the square number one. This was repeated for squares two, three and four using lists B, C, and D, respectively, from the Weschler Memory Scale.

According to the Weschler Memory Scale, the time between the initial showing of the faces and the recall of those faces should be at least 20 minutes during which time the participant's memory is still being tested. In order to accomplish this time gap and still only use the two aforementioned scales of the Weschler Memory Scale a scientific paper about hammerhead sharks was read aloud to the participants and they were asked to remember as much as possible for questions that would be asked at the end. The experimenter would read as much of the paper as possible until the 20 minutes were complete and the second set of faces could be shown. If time allowed there were questions over the paper that were asked and participant's responses were recorded on the back of the sheet of paper used for the word associations section.

Finally, the second set of faces was shown in a slideshow that allowed each face to be on the screen for ten seconds. Participants were asked to fill in the circle for letter A if that face had been seen on the previous slideshow and fill in the circle for B if that face had not been on the previous slideshow. After this section, the participants were released and all information was coded in order to keep confidentiality.

Results

The data from the participants were separated into two groups according to the phase of hormonal cycle the participant was in when the data was obtained. The raw scores obtained from participants were compared to the standardized scores of the participants' age group in order to obtain a scaled

score. The scaled scores were then totaled for each stage of the menstrual cycle: follicular and luteal. The results for each test can be seen in the following graphs with hit meaning that they scored the minimum scaled score of seven which is the standardized cut off for possible signs of dementia and memory loss and a miss means that the participant scored lower than a seven and is considered to be suffering from memory loss.

Word Associations

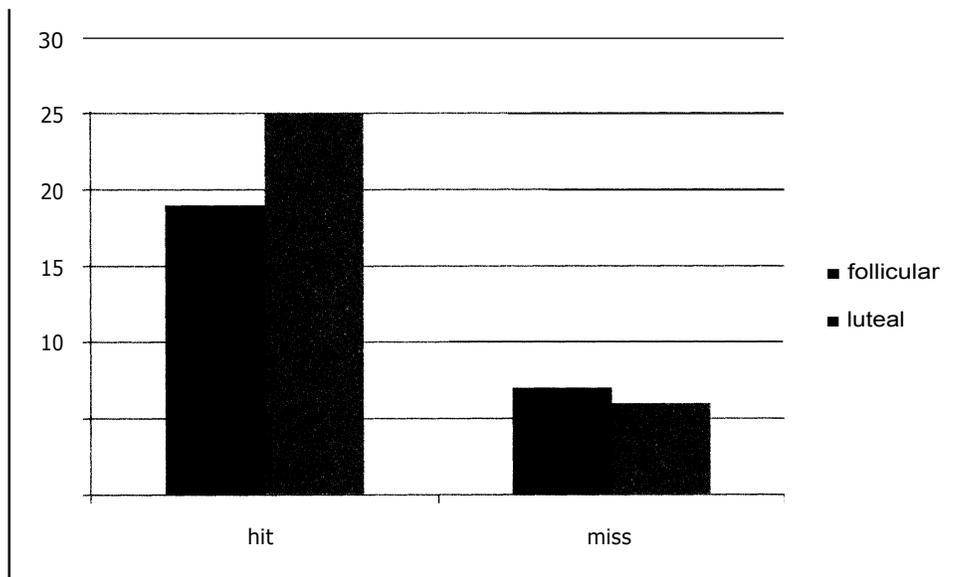


Figure 1: Total hits and misses of the Word Associations section of the Weschler Memory Scale by hormonal phase.

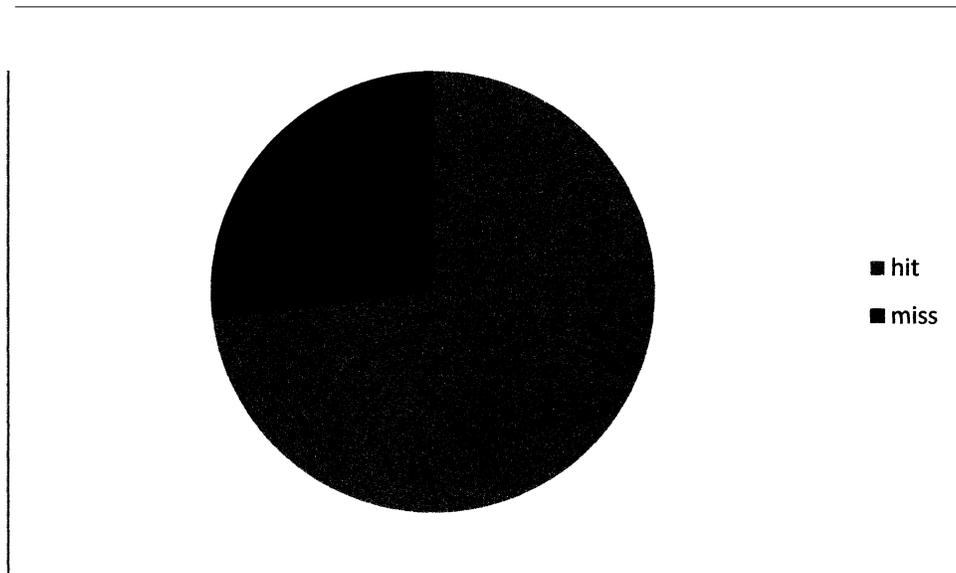


Figure 2: Percentage of participants in follicular phase scoring a hit or a miss on the scaled score of the Word Association test of the Weschler Memory Scale.

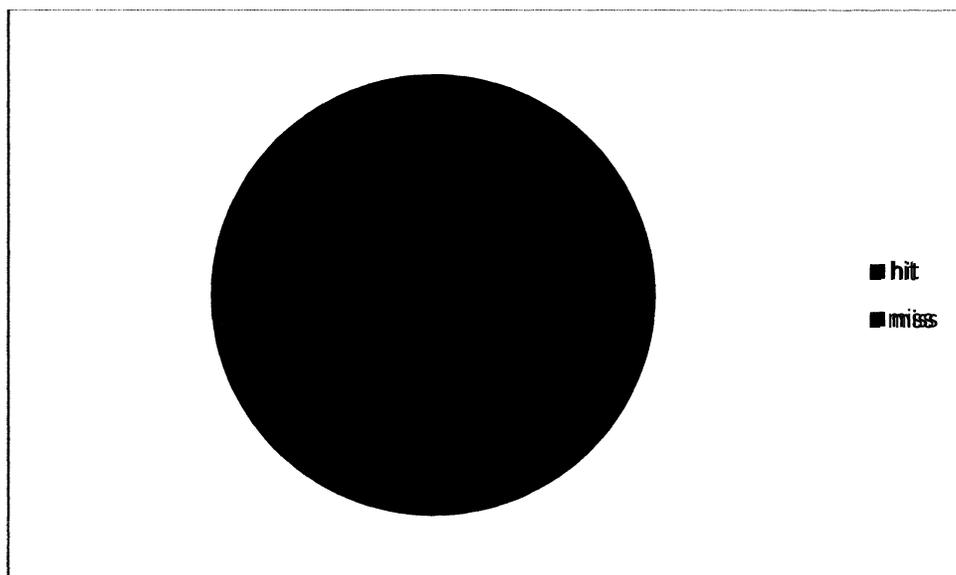


Figure 3: Percentage of participants in luteal phase scoring a hit or a miss on the scaled score of the Word Associations test of the Weschler Memory Scale.

Faces I

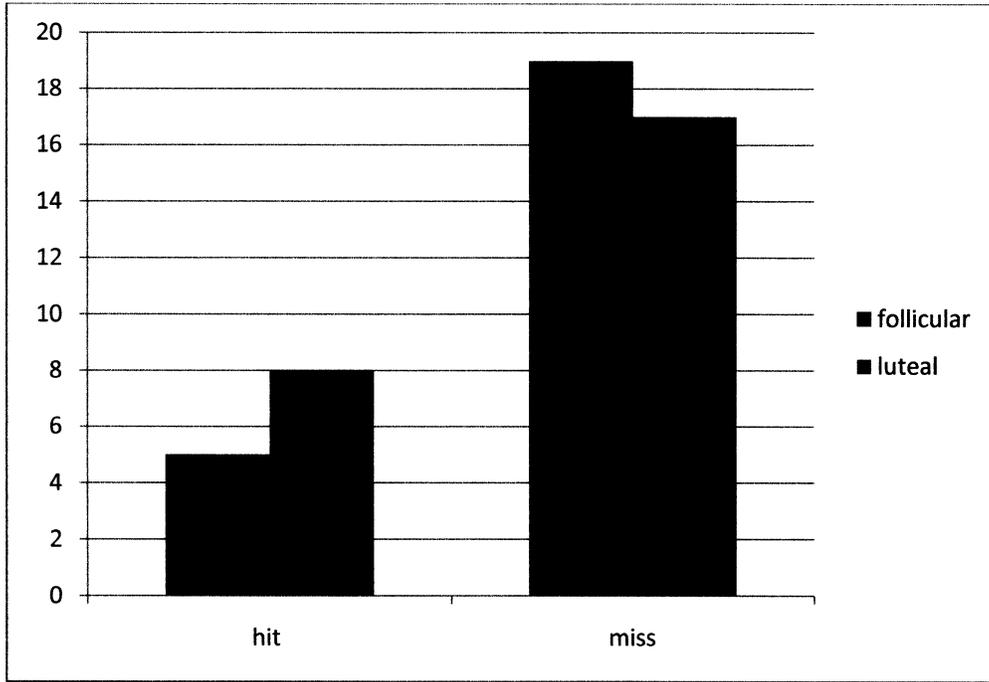


Figure 4: Total hits and misses for the Faces I recognition test of the Weschler Memory Scale by phase.

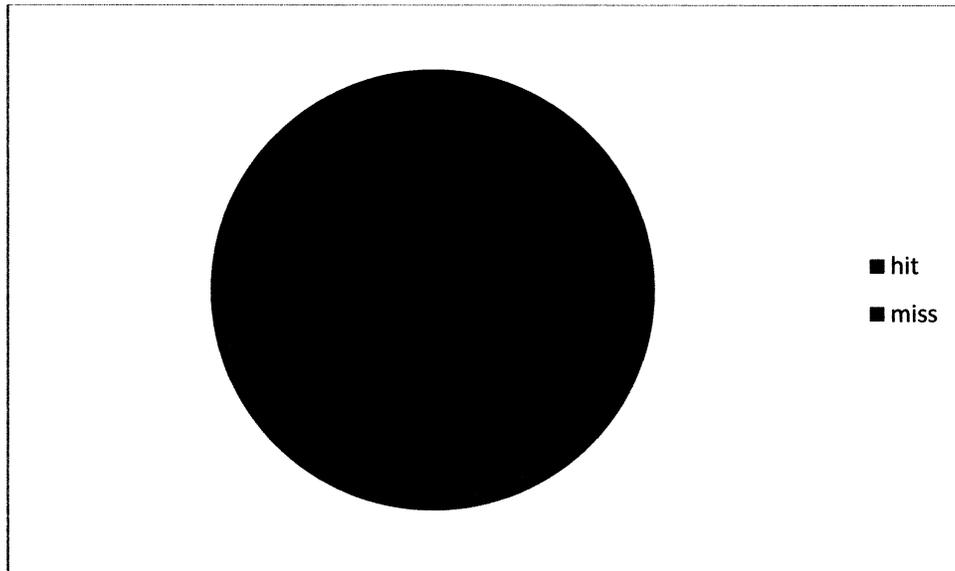


Figure 5: Percentage of participants in follicular phase scoring a hit or a miss on the scaled score of the Faces 1 test of the Weschler Memory Scale.

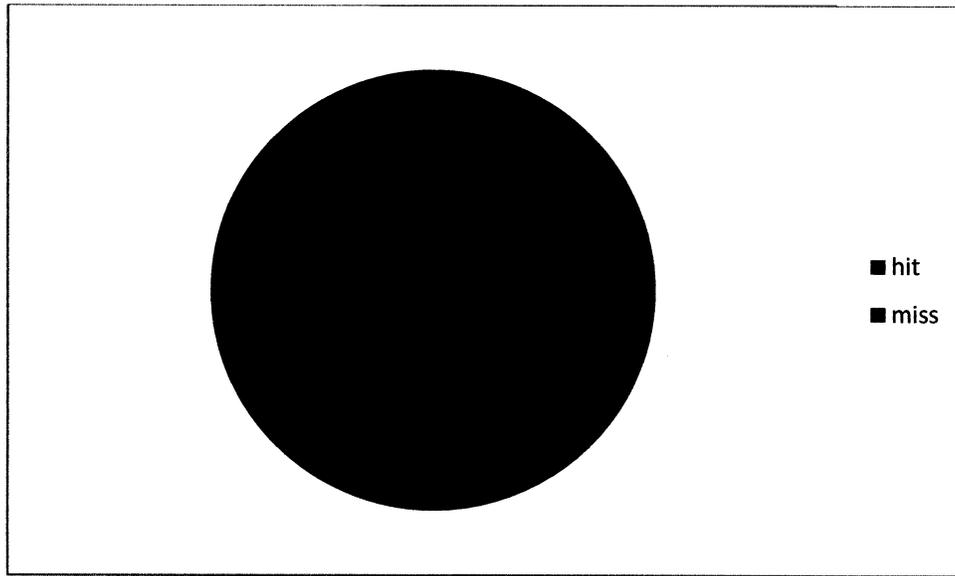


Figure 6: Percentage of participants in luteal phase scoring a hit or a miss on the scaled score of the Faces I of the Weschler Memory Scale.

Discussion

There turned out to be no significant differences between the women in the follicular phase and the women in the luteal phase of their cycles. In fact, a significant number of women were scored below the cutoff of a standard score of 7, meaning that they are already having significant mental problems. Also, the data for many women could not be used because their demographics sheet was filled out incorrectly, or they used a form of birth control that did not include both estrogen and progesterone and therefore did not mimic the natural hormonal cycle of women not on birth control. The probable reason for this discrepancy is that the study was conducted at the end of a spring semester on a college campus. The participants were drawn from Psychology 100 courses that required students to participate in experiments in order to receive credit for the course. The fact that the study was run at the end of a semester means that the participants were unmotivated and did not put their full effort into the study. They are most likely not overachieving and in fact are probably only participating in this study because it is required. Therefore, the results cannot be taken at face value and the small n value makes it impossible to draw any general conclusions on the data that was collected.

Further studies of this kind should be performed. It is important to study what happens to the memory of women before menopause because that is one way to eliminate possible confounding variables having to do with old age rather than hormone changes in older women with memory problems. A case study format would also give reliable data if it could be feasible to do with a large number of women. It would include subjecting these women to memory testing at different phases of their cycle to get the baseline memory for an individual person and observe if and/ or how it varies across the whole cycle rather than trying to generalize memory scores for a group of women in different stages of their hormonal cycle. Also, if this study could have had a greater n then it would not have been as affected by the amount of data that had to be thrown out.

This study was an exploration of a great untapped resource in the discovery of postmenopausal hormone changes: premenopausal women. Women who have not yet experienced menopause have hormones that are fluctuating every month (on average) and this fluctuation can give insight into the effects of these hormones in many capacities on the bodies of women. This insight could be the key to unlocking untold information about the complete life cycle of women and the development of better treatments for women who do not naturally make hormones.

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