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Working Memory in Postmenstrual and Premenstrual Phase: Effect of Menstrual Cycle

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Abstract:

Background: Women experience physical and mental symptoms during the menstrual cycle, which has varied effect on working memory across different phases of menstrual cycle. With medical profession demanding high cognitive ability especially working memory for complex and urgent decision-making, this study to assess the working memory during postmenstrual and premenstrual phase was done on 40 healthy female interns.

Methods: In this cross-sectional study, working memory was assessed with Self-Ordered Pointing test and Brown-Peterson task. Paired t test was carried out for comparison of working memory between the two phases.

Results: On comparing the results of Self-Ordered Pointing test, numbers of errors were significantly higher (p=0.022) in postmenstrual phase (5.3±1.56) compared to premenstrual phase (4.3±1.15). Brown Peterson task showed the total number of letters recalled by the subjects was significantly lower (p=0.041) in postmenstrual phase (26.3±2.16) compared to premenstrual phase (27.2±2.44).

Conclusion: The results indicated that the task performance for the working memory function was good in the premenstrual phase. With the previous evidences supporting the present study results, estrogen secreted in relation to the menstrual phase is thought to be involved in good working memory during premenstrual phase.

Keyword: Women; Menstrual Cycle; Postmenstrual Phase; Premenstrual Phase; Working Memory

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1. Introduction

Women constitute 48% of total Indian population (1). Women in India have come a long way after independence. From just a skilled homemaker, women today have acquired skills and capabilities being at par with their male counterparts (2). However, women have physical and mental symptoms during the menstrual cycle, and the Indefinite menstrual complaint extends to 150–300 kinds. In addition, it is also said that 80–90% of women are aware of their indefinite menstrual complaints (3). Also, within the menstrual cycle, poor work performance in the premenstrual phase is often reported (4-6).

Working memory is a fundamental cognitive ability that supports an array of complex abilities, from problem solving to fluid intelligence (7). Working memory has to function in these cases when humans carry out several tasks in parallel. In other words, working memory entails carrying out important work in order to reach a goal, while retaining information that is temporarily required and at the same time retaining and processing other information (8).

There are few previous studies that discuss the working memory in relation to the menstrual cycle. One study reported that higher performance is shown for language working memory on days 7 and 14 of the menstrual cycle rather than on days 0 and 21 (9). Another study has reported that reduced estrogen levels in premenopausal women are associated with deterioration in working memory (10).

This study aimed to gain fundamental knowledge for the purpose of managing women's occupational health and safety, by examining task performance capability in terms of working memory during postmenstrual and premenstrual phases.

2. Method

2.1. Study design and participants

In the present cross-sectional study, a forty consecutive right-handed healthy female interns aged 23-26 years

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(mean age 24.3±2.1 years,) were included. When contacted, female participants were asked about their menstrual cycle phase and cycle duration and were then assigned a testing date. Only females who reported regular cycle duration (range: 25–35 days, M = 29.0, SD = 1.8) and biphasic body temperature were selected for the study through the prior screening. It was further confirmed that the subjects had not taken hormones, oral contraceptives, or other reserve medicine within 24 hrs of the experiment, that they had never conceived a child, and that they are not currently suffering from any gynecological disorders. It was also confirmed that they received sufficient rest and had not consumed caffeine on the day of the experiment. Ethical clearance from the institute and Written informed consent was obtained from all subjects prior to the study.

2.2. Measurements

The experiment was done at subjects' residence with ambient silence; between 5 pm and 7 pm. Tests for working memory were done twice, during the postmenstrual and premenstrual phases. After resting for ten minutes the tests for working memory-Self-Ordered Pointing test (SOPT) and Brown-Peterson task were done (11).

2.3. Self-Ordered Pointing Test (SOPT)

In this test the same set of stimulus items were arranged in different layouts on as many different pages as there are items and subjects were required to point to a different item on each page without repeating an item already pointed to. Subjects were presented with a binder containing sheets of paper (81⁄2 × 11"), each one showing a single type of stimuli (e.g., representational drawings). The binder was divided into four consecutive sections, consisting of 6, 8, 10, and 12 stimulus sheets, with a blank sheet between each section. A different set of drawings was used for each of the four sections. Within each section, the same drawings were used, but they were arranged differently on each stimulus sheet. The positions of the drawings were randomly determined for each sheet of paper, but the layout remained constant (i.e., for six-item: 2 × 3, for eight-item: 2 × 4). For example, the first six-item section had six pages displaying the same six drawings in a different random order on each sheet. The second eight-item section displayed a new set of eight drawings on eight separate sheets, and so on. The sub ject was not allowed to verbalize items as she points. There was no time limit. An error was recorded each time the subject selects a picture chosen previously in that section. The total number of errors summed across the four sections (6- to 1 2-item sets) was recorded.

2.4. Brown-Peterson task

The typical task requires participants to recall a series of items after variable delays during which they complete an interference task (e.g., mental addition or subtraction). A consonant trigram (e.g., GRX) was presented to the subject verbally at a rate of one letter per second, followed immediately by a two- or three-digit random number (e.g., 167). The subject was asked to count backward, out loud, by threes starting from this number, for interval delays of 9, 18, or 36 s used at random. At the end of the interval, the subject was asked by signaling (a knock on the table) to recall the trigram. 5 trials were given for each delay period, with inter-trial delays of 2 to 5 s. Dependent measures were the total number of letters correctly recalled at each of the three delay intervals. The order in which the consonants were recalled was not considered for scoring purposes. The maximum score at each delay interval was 15 (5 trials, 3 letters). To calculate the total score, add the number of consonants recalled correctly on each trial. The maximum score obtainable was 45(3 delay intervals, 15 score for each delay interval).

2.5. Measured phases of the menstrual cycle and measurement period

The experiment was carried out in both the postmenstrual and premenstrual phases. Measurement in the postmenstrual phase was done when the female hormones were stable (3–7 d after cessation of bleeding), and in the premenstrual phase when the symptoms of premenstrual syndrome (PMS) were most likely to appear (3–10 d before the onset of menstruation). Measurement of the basal body temperature was started in April, subjects reported the menstruation starting date, the measurement period was adjusted, and then the experiment was completed in a month and a half from July. The basal body temperature was measured until completion of the experiment.

2.6. Statistical analysis

SPSS version 16.0 was used for statistical analysis. For comparing the scores of working memory tests between postmenstrual and premenstrual phases, paired t test was carried out. The level of statistical significance was $p<0.05$ for all tests.

3. Result

Results for the tests for working memory – SOPT and Brown Peterson task and their comparison between the phases of menstrual cycle - postmenstrual and premenstrual

Table 1: Working memory task performance in postmenstrual and premenstrual phases (n=40)

Task	Postmenstrual phase		Premenstrual phase		p value
	Mean	SD	Mean	SD	
Self-Ordered Pointing test (No of errors)	5.3	1.56	4.3	1.15	0.022*
Brown-Peterson task (Total score/45)	26.3	2.16	27.2	2.44	0.041*

SD: standard deviation.

phase, are tabulated in Table 1. There was a significant difference in the number of errors done by the subjects in SOPT between postmenstrual and premenstrual phases (p=0.022). Numbers of errors were significantly more in postmenstrual phase (5.3±1.56) compared to premenstrual phase (4.3±1.15).
The total number of letters recalled by the subjects, in all 3 delayed intervals of Brown Peterson task was significantly lower (p=0.041) in postmenstrual phase (26.3±2.16) compared to premenstrual phase (27.2±2.44).

4. Discussion

In this study we found that the SOPT task error was significantly more in the postmenstrual phase than in the premenstrual phase. The score in Brown Peterson task was significantly lower in the postmenstrual phase than in the premenstrual phase. The results indicated that the task performance for the working memory function was good in the premenstrual phase.
The Rosenberg study is one of few studies which demonstrated improved performance during phases of the menstrual cycle that are characterized by high estrogen levels (9). In addition, Jacobs and D'Esposito, in fact, demonstrated that working memory task performance was modulated by an interaction between COMT Val158Met and estradiol levels. In the presence of high estradiol levels, an improved cognitive performance was found in Val/Val carriers (which putatively is associated with lower frontal dopamine levels). Increased working memory demands leads to increased synaptic dopamine release in prefrontal cortex. Thus, verbal working memory seems to be a task where estradiol load is important (12).
There is also evidence that estrogen treatment protects verbal working memory in surgically postmenopausal women (13), whereas it has no effect when initiated more than a decade after the menopause. Possibly the hormonal changes across the menstrual cycle are too swift to detect an impaired performance in the relatively short early follicular phase, especially since extremely low estradiol levels (in the postmenopausal range) not are seen in all women, and if seen, only for a few days. Evidence for this assumption may be drawn from a study on young women treated with gonadotropin releasing hormone agonists, which resulted in suppressed estradiol levels. Following eight weeks of treatment, the estradiol suppression obtained was associated with impaired working memory performance (14).
Finally, working memory is also a prefrontal cortex-dependent cognitive function and the performance appears superior at times of high estradiol levels (9, 12).
One more study which supports the present study results showed that there was a significantly lower error rate for working memory tasks in the premenstrual phase, suggesting that task performance was good. Authors found Mild premenstrual symptoms had no effect on working memory function of the premenstrual phase. The estrogen sex hormone secreted from the ovaries in relation to the menstrual cycle was thought to be involved in the working memory function rather than the indefinite menstrual complaint (15). However, estrogen values were not measured in this study, but it is known that production of estrogen is 10–200 pg/ml in the middle of the premenstrual phase and 10–80 pg/ml in the first half of the postmenstrual phase, with the premenstrual phase having a value up to 2.5 times higher (15).
With the evidences supporting the present study results, estrogen secreted in relation to the menstrual phase is thought to be involved in good working memory during premenstrual phase.
From the above, to prevent human error from occurring during medical care, it is important for doctors to practice self-care through the understanding of error occurrence and psychosomatic changes due to the differences between the phases of the menstrual cycle, and for administrators to promote health education in the workplace from the viewpoint of occupational safety. Not only the postmenstrual and premenstrual phases, but all three phases including the menstruation phase should be examined in future study, and estrogen levels also should be measured.

5. Conclusion

This study aimed to examine task performance capability in terms of working memory during postmenstrual and premenstrual phases among medical professionals, interns. The results indicated that the task performance for the working memory function was good in the premenstrual phase.

6. Acknowledgment

None.

7. Conflict of interest

The authors declare that there is no conflict of interests regarding publication of this paper

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9. Author contribution

Varsha SV passed four criteria for authorship contribution based on recommendations of the International Committee of Medical Journal Editor.

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