Indian J Physiol Pharmacol 2010; 54 (4) : 386–390

SHORT COMMUNICATION

A STUDY OF AUDITORY REACTION TIME IN DIFFERENT PHASES OF THE NORMAL MENSTRUAL CYCLE

ASMITA S. NENE AND PUSHPA A. PAZARE

Department of Physiology,
Topiwala National Medical College and B. Y. L. Nair Charitable Hospital,
Dr. A. L. Nair Road, Mumbai – 400 008

(Received on February 2, 2010)

Abstract : Reaction time is an indirect index of processing capabilities of the central nervous system. The present study was carried out to determine if there is any alteration of simple auditory reaction time across the normal menstrual cycle. In this study, reaction time of 100 female medical and paramedical students was recorded in different phases of their menstrual cycle namely premenstrual, menstrual, middle of proliferative, middle of secretory phase and on the expected day of ovulation. Results were expressed as mean, standard deviation and statistically analyzed using student's paired't' test. On comparing each phase with the corresponding adjacent phases auditory reaction time was significantly increased ($P<0.05$) in premenstrual phase and on the expected day of ovulation. Thus fluctuating levels of sex steroids across normal menstrual cycle affect sensory motor association of an individual.

Key words : auditory reaction time menstrual cycle

INTRODUCTION

Reaction time is the time interval between the application of a stimulus and the appearance of appropriate voluntary response by a subject. It involves stimulus processing, decision making and response programming. Reaction time is found to be altered by a number of factors both physiological and pharmacological (1, 2).

Processing speed and motor speed appear to be dependent on cerebral dopaminergic systems and basic neuroscience studies have shown that estrogen influences dopamine release in the nigrostriatal pathway (3, 4). Ovarian steroids have widespread effects throughout the brain regions involved in affective state as well as cognition (5, 6). Changing estradiol levels during menstrual cycle have been shown to affect auditory event related potentials as well as latencies to right and left hemispheres during dichotic listening (7, 8). This provides a possible

*Corresponding Author : Dr. Asmita S. Nene, Department of Physiology, G. S. L. Medical College, NH 5, Lakshmipuram, Rajahmundry – 533 296; E-mail: drasmitasharma@hotmail.com; Phone : 09966534387.

physiological explanation for estrogen influencing reaction time. Since menstrual cycle is associated with varying levels of sex steroids, it was hypothesized that reaction time could be altered across normal menstrual cycle. This study is an effort to determine if there is any alteration of simple auditory reaction time across the normal menstrual cycle.

MATERIALS AND METHODS

The study was conducted in the department of Physiology, Topiwala National Medical College and B.Y.L. Nair Hospital, Mumbai. Approval for the study was taken from Institutional Ethical Committee. The study involved 100 female volunteers comprising of medical and paramedical students within age group of 17–20 years. Only girls with history of regular menstrual cycle of 28–30 days duration for at least last six months and showing normal auditory function on thorough ENT examination were selected.

Subjects with irregular cycles, with any gynecological problems, with well defined PMS, on oral contraceptive pills or any other hormonal treatment, on steroids, psychotropic drugs (sedatives, hypnotics, and tranquilizers), anti-histaminics, anti-epileptics were screened and excluded from the study. Also volunteers known to be consuming alcohol or tobacco in any form and those with history of psychiatric illness or recent psychological trauma or sleep disorders were not included in the study.

All the subjects were instructed to strictly chart their basal body temperature during the study period. All the subjects were asked to have adequate sleep at night and to refrain from any medications throughout the study period.

Simple auditory reaction time was recorded with the help of an audiovisual reaction time apparatus (RTM-608, supplied by Biotech India, Mumbai). For simple ART moderate pitch sound (4000 Hz) was used. Headphone was provided for clarity of sound. All subjects were thoroughly acquainted with the apparatus in advance. The tests were carried out in a secluded room in sitting position between 8:00 am to 10:00 am. Three practice trials were given every time before recording reaction time. The subjects were aware about the type of stimulus being presented and they were asked to respond immediately on hearing the sound by pressing an appropriate button on subject's panel with index finger of their dominant hand. Reaction time was read directly from digital display.

In each volunteer, recording was done in :

1. One or two days prior to the expected date of menstruation, referred to as premenstrual phase.
2. 1st/2nd day of menstruation referred to as menstrual phase.
3. Middle of proliferative phase (10th – 12th day).
4. On the expected day of ovulation (BBT showing rise) referred to as ovulatory phase.
5. Middle of secretory phase (21st–23rd day).

The results were expressed as Mean±SD and analyzed using Student's paired t-test for comparison of means. 'P' value of less than 0.05 was considered significant.

RESULTS

Table I shows study group consisting of 100 volunteers with mean age 18.06±1.11 years, age range 17 to 20 years, mean weight 49.62±6.77 kgs, weight range 38 to 67 kgs, and mean BMI 21.73±4 kg/m^2.

Table II shows that ART was highest in pre menstrual phase and lowest in mid secretory phase the values being 233.37 msec and 210.64 msec respectively. There was a significant increase in ART during premenstrual phase as compared to that in the adjacent phases i.e. menstrual phase (P=0.048) and secretory phase (P=0.000). Also in the ovulatory phase ART increased significantly as compared to its adjacent phases i.e. proliferative (P=0.049) and secretory phase (P=0.010).

TABLE I: General Characteristics of the study subjects.

Parameters	*Study Group (n=100)*
Age (years)	18.06±1.11
Weight (kg)	49.62±6.77
BMI (kg/m^2)	21.73±4

Results are expressed as Mean±SD.

DISCUSSION

Simple reaction time is the time interval between the onset of the stimulus and the initiation of the response under the condition that the subject has been instructed to respond as rapidly as possible. It evaluates the processing speed of CNS and the coordination between the sensory and motor systems (9). Reaction time measurement includes the latency in sensory neural code traversing peripheral and central pathways, perceptive and cognitive processing, a motor signal traversing both central and peripheral neuronal structures and finally the latency in the end effector activation (i.e. muscle activation) (10). So any change in reaction time indicates presence of a peripheral and/or central disturbance.

Neurophysiologic studies have shown that the brain regions involved in affective state as well as cognition are widely affected by ovarian steroids (5, 6). These ovarian steroids (estrogen and progesterone) undergo cyclic changes in a normal menstrual cycle. During proliferative phase progesterone production is low and estrogen levels increase gradually. While in ovulatory phase,

TABLE II: Auditory reaction time (ART) in msec of study subjects in different phases of menstrual cycle.

Phases of menstrual cycle	*PM*	*M*	*P*	*O*	*S*
Mean±SD	233.37±50.63	221.88±31.92	212.22±41.58	223.48±33.17	210.64±34.25
P value	PM vs M 0.048	M Vs P 0.081	P vs O 0.049	O Vs S 0.010	S Vs PM 0.000

Results are Mean±SD. PM: Premenstrual phase; M: Menstrual phase; P: Mid-proliferative Phase; O: Ovulatory phase, S: Mid-secretory phase.

there is exponential increase in levels of estrogen. After ovulation, progesterone levels also begin to rise. During secretary phase, both estrogen and progesterone are increased with prominent increase in progesterone. Late in this phase i.e. in premenstrual phase both the hormones decrease (11). Though measurement of hormones was not done in this study, from existing knowledge it can be expected that hormonal changes during normal menstrual cycle, mainly fluctuating levels of estrogen and progesterone might affect the reaction time.

Studies of weight changes and balances of sodium, water and potassium across normal menstrual cycle have shown occurrence of sodium and water retention in premenstrual phase (12). Various mechanisms like progesterone withdrawal, increased secretion of aldosterone and ADH during premenstrual phase have been postulated to be responsible for these changes (13). This retention of water and sodium might influence the process of axonal conduction and availability of neurotransmitter at synapses in auditory pathway resulting in delayed conduction and hence increased ART in premenstrual phase (14).

Auditory brainstem responses studied across menstrual cycle have shown that sex steroids modulate auditory neural conduction and central processing of auditory sensation probably by influencing GABA secretion in auditory pathway. Estrogen may enhance the inhibitory effects of GABA by stimulating its secretion during estrogen peak midcycle phase and thereby delaying conduction. Conversely, progesterone may decrease the sensitivity of neurons and may blunt the estrogen potentiated GABA release (13, 15). This is in accordance with the present finding of significant increase in ART during ovulatory phase where estrogen concentration is highest (13, 15). This also explains changes in ART across other phases of menstrual cycle like mid secretory when changing levels of estrogen and progesterone are taken into account.

Thus we can conclude that fluctuating levels of ovarian hormones (estrogen and progesterone) across the normal menstrual cycle influence auditory reaction time which is an indirect measure of sensory- motor association of an individual. This fact can be taken into consideration in neurological and behavioral assessment of women. This is a preliminary study, substantiation of its results by measuring the hormonal levels over the menstrual cycle is recommended in further studies.

REFERENCES

1. Madan M, Thombre DP, Das AK, Subramanian N. Reaction time in clinical diabetes mellitus. *Ind J Physiol Pharmacol* 1984; 28: 311–314.
2. Malathi A, Parulkar V, Dhavale HS, Pinto C. A preliminary study of reaction time in schizophrenics. *Ind J Physiol Pharmacol* 1990; 34: 54–56.
3. McEwen B. Estrogen action throughout brain. *Recent Prog Hormon Res* 2002; 57: 357–384.
4. Mc Dermott JL. Effects of estrogen on dopamine release from corpus striatum of young and aged female rats. *Brain Res* 1993; 606: 118–125.
5. Asso D. The relationship between menstrual

cycle changes in nervous system activity and psychological behavior and physical variables. *Biol Psychol* 1986; 23: 53–64.

6. Asso D, Braier JR. Changes with menstrual cycle in psychophysiological and self report measures of activation. *Biol Psychol* 1982; 15: 95–107.
7. Tillman GD. Estradiol levels during the menstrual cycle differentially affect latencies to right and left hemispheres during dichotic listening: an ERP study. *Psychoneuroendocrinol* 2010; 35: 249–261.
8. Walpurger V, Pietrowsky R, Kirschbaum C, Wolf OT. Effects of the menstrual cycle on auditory event-related potentials. *Horm Behav* 2004; 46: 600–606.
9. Shenvi D, Balasubramanian P. A comparative study of visual & auditory reaction times in males and females. *Ind J Physiol Pharmacol* 1994; 38: 229–231.
10. Botwinik J, Thompson LW. Premotor and motor components of reaction time. *J Exp Psychol* 1966; 71: 9–15.
11. Genuth SM. The reproductive glands. In: Physiology. Berne RM, Levy MN, eds. 4th Ed. Mosby Publications. USA 1998: 990–991.
12. Bruce J, Russell GFM. Premenstrual tension: a study of weight change and balances of sodium, water and potassium. *Lancet* 1962; 11: 267–271.
13. Yadav A, Tandon OP, Vaney N. Auditory evoked responses during different phases of menstrual cycle. *Ind J Physiol Pharmacol* 2002; 46: 449–456.
14. Das S, Gandhi A, Monal S. Effect of premenstrual stress on audiovisual reaction time and audiogram. *Ind J Physiol Pharmacol* 1997; 41: 67–70.
15. Yadav A,.Tandon OP, Vaney N. Long latency auditory evoked responses in ovulatory & anovulatory menstrual cycle. *Ind J Physiol Pharmacol* 2003; 47: 179–184.

NEWS AND ANNOUNCEMENTS

Sri Aurobindo Ashram - Delhi Branch

Announces 4th Study Camp on

Mind-Body Medicine and Beyond

For Doctors, Medical Students and other Health Professionals

Venue : **Nainital Centre, Sri Aurobindo Ashram (Van Niwas)**

2–9 July 2011

The camp, consisting of lectures, practice, and participatory and experiential sessions, will help the participants get better, feel better, and bring elements of mind-body medicine into their practice. The camp will be conducted by Prof. Ramesh Bijlani, M.D., former Professor, AIIMS, founder of a mind-body medicine clinic at AIIMS, and the author *of Back to Health through Yoga.* For more details, contact the ashram reception in Delhi (011-2656-7863) or e-mail Dr. Bijlani (rambij@gmail.com).