Intraindividual and interindividual variations in psychomotor task performance in spontaneously menstruating women

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ABSTRACT

الأهداف: تهدف الدراسة الحالية للتقصي على التغيرات الحاصلة في الأداء الحسي الحركي بالإشارة إلى دورة الحيض الشهرية عند النساء.

الطريقة: تم تقييم الأداء الحسي الحركي عند مائة وثمانون أنثى ذوات دورة حيض شهرية منتظمة تلقائية أمدها ٣٠ يوما و٢٠ ذكر في فرع الأدوية ، كلية الطب ، الجامعة المستنصرية خلال ٢٠٠٣.

النتائج: أظهرت النتائج أن الأناث يتصفن بأستجابتهن بدلالة متميزة في فحص الأداء الحسي الحركي بأقل وقت عما هو عليه عند الذكور وبوجود تغاير كبير فيما بينهن ، إضافة إلى ذلك فان الحد العتبي لفحص ترداد رمش–التحام الحرج كان أقل في الأناث مقارنة بالذكور. أن جميع التغيرات الحاصلة في الأداء الحسي الحركي ليس انتقائيا لطور محدد من دورة الحيض الشهرية.

خاتمة: لا تعد الإناث ذوات دورة حيض شهرية تلقائية منتظمة عناصر جيدة لدراسات فحص الأداء الحسي الحركي بسبب وجود اختلافات كبيرة في قياسات متغيرات الفحص فيهن وفي ما بينهما.

Objectives: To examine the variability in psychomotor task performance in women in reference to the menstrual cycle.

Methods: One hundred and eighty young women with spontaneous regular menstrual period of 30 days duration and 20 young men were assessed in the Department of Pharmacology, College of Medicine, Al-Mustansiriya University, Baghdad, Iraq during 2003.

Results: Women had significantly lower recognition as well as motor reaction time than men with wide inter and intraindividual variations. Women also had a lower critical flicker fusion frequency threshold than men with more variation. The changes in psychomotor performance are not specific for a certain phase of the menstrual cycle.

Conclusions: Spontaneously menstruating young women are not good participants for psychomotor performance studies because of wide intra- and interindividual variations.

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Psychomotor performance tests were used to investigate the central effect of psychoactive and sedative drugs.[1] Most studies included both genders in this investigation despite the gender factor possibly exerting an effect on the results of these tests. Menstruation was not acting as stressor by the evidence of a non-significant relationship between the state of menstrual cycle and performance tests of cognitive processing, reaction time, and vigilance.[2] Low et al[3] found a non-significant association between the reproductive period and performance on simple and choice reaction times. Some authors demonstrated the opposite results. Creutzfeldt et al[4] found that reaction times to simple tasks were slightly, but significantly decreased in the spontaneous menstrual cycle during the luteal phase with a minimum on the day before or during menstruation. Performance tests for reaction times were better during the luteal phase when increased estradiol and progesterone levels occur, however, not as good during the immediate preovulatory phase when estradiol levels are high.[5] There was evidence that cortical levels of activation are higher intermenstrually,[6] and the data of critical flicker fusion was correlated to the days of the menstrual cycle.[7] The aim of this work is to investigate the eligibility of spontaneously menstruating young women for psychomotor performance testing using the Leeds Battery tests.

Methods.

Subjects. This study was conducted in the Department of Pharmacology, College of Medicine, Al-Mustansiriya University, Baghdad, Iraq in 2003. Two hundred participants (180 females and 20 males) aged between 20 and 22 years with a median age of 21 years volunteered for the study. All were students of the

College of Medicine and were recruited by circulation of a calling notice. All were in good health at the time of testing and none of the subjects were taking concomitant medications (including non-steroidal anti-inflammatory drugs, anxiolytics, sedatives, and so forth) likely to interfere with the study measures for 2 weeks before the study, as well as during the study. All women had a spontaneous and regular menstruation cycle of 30 days, and 4-5 days menstruation period without any skipped cycles or intra-cycle bleeding. None were previously, or at the time of the study on the contraceptive pill. According to the menstrual cycle calendar of each woman, each 6 women with specific days of the menstrual cycle were grouped to represent the group of that day and were subjected to psychomotor tests on that day. A control (reference) group of male participants, allocated randomly from the same college completed the profile of psychomotor performance tests on 4 separate occasions over 30 days (5 men per each occasion). All subjects were asked to refrain from consumption of social beverages at least 2 hours before entering the study. The local ethics committee of the College of Medicine approved the research, and written informed consent was obtained from the participants prior to carrying out the study.

Design. The study used a repeated measure design. Women participants of the same day of the cycle completed the same tests on each occasion by using a Latin square design. Each subject was familiarized with the study procedures and trained to preclude learning effects.[8]

Procedure. The Leeds psychomotor performance instrument was used to assess the psychomotor performance in term of choice reaction time (CRT) and critical flicker fusion (CFF) thresholds. The CRT task in milliseconds is used as an indicator of sensorimotor performance assessing the ability to attend and respond to a critical stimulus. Subjects place the index finger of their preferred hand on a central starting button, and are instructed to extinguish one of 6 equidistant red lights, illuminated at random, by pressing the response button immediately in front of the light as quickly as possible. The mean of 15 consecutive presentations is recorded as a response measure of 3 components of reaction time: recognition, motor, and total reaction times. Recognition reaction time (RRT) is the time taken for the subject to notice the light, namely, the time between stimulus onset and the subject's lifting his finger from the start button. Motor reaction time (MRT) indicates the movement component of this task and is the time between a subject lifting their finger from the start button and touching the response button. Total reaction time (TRT) is the sum of RRT and MRT. The Leeds psychomotor performance instrument directly measured the TRT and RRT, while the MRT was calculated by the following equation: MRT = TRT-RRT. The CFF task assesses the integrative capacity of the CNS and, more specifically, the ability to discriminate discrete 'bits' of sensory information.[9] Subjects are required to discriminate flicker from fusion, and vice versa in a set of 4 light-emitting diodes arranged in a one-centimeter square. The diodes are held in foveal fixation at a distance of one meter. Individual thresholds are determined by the psychophysical method of limits on 5 ascending (flicker to fusion) and 5 descending (fusion to flicker) scales.[10] The average of ascending and descending flicker-fusion frequency thresholds representing the classical sensory sensitivity criterion was calculated for each subject. In addition, the mean ascending and descending threshold difference [Δ = fusion (ascending) – flicker (descending)] was individually calculated to assess the subjective judgment criterion.[11] A decrease in the CFF threshold signifies a reduction in the overall integrative activity of the CNS.

Statistical analysis. Statistical analysis was carried out using Microsoft Excel 2003. The results are expressed as mean ± SD and coefficient variation (CV) of number of observations. The diversity represented by the group's standard deviation and the variability by using CV measures to control for the difference in group mean were analyzed in this study.[12-14] Interindividual CV is calculated among women on each specific day of the menstrual cycle, while the intraindividual CV limits were calculated in each woman in respect to the specific day of her menstrual cycle. The data were statistically analyzed using the confidence interval (95% CI) of reference data of men.

Results. The result of the TRT for men was 570 ± 35 milliseconds (95% CI: 557.6-582.3), and is significantly higher than women at any day of the menstrual cycle (**Table 1**). The TRT of women fluctuated along the menstrual period and it did not follow a specific pattern of fluctuation in respect to the phases of cycle. The lowest mean of TRT was observed on day 11, while the highest standard deviation was on the 25th day of the cycle. This in turn reflected on the highest CV measure. Intra-individual variation was also demonstrated in women in this work. The RRT of men was 350 ± 24 milliseconds (95% CI: 339.77-360.22). Women showed significantly lower RRT measurements than that of men, but not during all days of the cycle (**Table 2**). During the 3rd, 8th, 9th, 15th, 21st, 23rd, and 26th day, the RRT were not significantly different from men. Again, these days do not represent a specific phase of the menstrual cycle. The inter-individuals CV was 1-15% in comparison with 6.85% in men, and as shown in **Table 2** the intra-individual variations among women were

Table 1 - Total reaction time (milliseconds).

Day of menstrual cycle (n=6)	Mean	Standard deviation	Inter-individual coefficient variation among women in each day	Intra-individual coefficient variation limits in each woman	Median
1	525	3.1	0.6	6.6-10.4	524
2	514	29.1	5.7	5.8-8.90	518
3	529	42.3	8.0	7.2-10.9	551
4	509	12.2	2.4	6.0-12.7	511
5	517	13.5	2.6	6.4-10.1	518
6	512	36.7	7.2	7.4-9.80	518
7	503	40.9	8.1	6.6-10.6	499
8	514	22.5	4.4	8.3-10.6	513
9	535	65.9	12.3	6.1-13.4	507
10	523	38.8	7.4	9.2-16.8	531
11	449	56.9	12.7	7.9-9.70	413
12	490	51.9	10.6	4.0-9.50	500
13	529	47.9	9.1	6.2-10.3	520
14	527	15.5	2.9	5.9-12.6	529
15	554	69.5	12.5	5.5-9.20	529
16	503	12.1	2.4	5.3-10.8	504
17	473	49.0	10.4	6.8-12.1	436
18	468	25.1	5.4	8.8-13.6	457
19	490	21.9	4.5	6.7-8.50	494
20	472	46.1	9.8	5.1-15.6	439
21	543	23.8	4.4	6.2-11.8	541
22	518	55.9	10.8	6.2-7.00	505
23	515	30.5	5.9	8.1-14.3	513
24	510	34.4	6.7	6.3-11.2	510
25	524	92.8	17.7	6.7-13.6	580
26	505	8.8	1.7	7.3-8.00	502
27	515	34.7	6.7	6.1-11.5	489
28	501	56.2	11.2	7.3-11.6	512
29	500	8.6	1.7	6.5-8.70	493
30	500	43.0	8.6	5.8-9.90	486

Table 2 - Recognition reaction time (milliseconds).

Day of menstrual cycle (n=6)	Mean	Standard deviation	Inter-individual coefficient variation among women in each day	Intra-individual coefficient variation limits in each woman	Median
1	314	18.3	5.8	7.8-28.6	308
2	334	18.0	5.4	6.8-15.3	330
3	341	27.2	8.0	7.8-18.0	334
4	348	19.4	5.6	7.2-14.6	359
5	323	38.2	11.8	8.2-17.2	340
6	325	32.6	10.0	9.8-11.4	316
7	316	11.9	3.8	9.9-15.0	312
8	342	13.5	3.9	6.3-14.3	333
9	360	57.1	15.9	8.0-16.9	349
10	321	32.6	10.2	4.3-9.90	315
11	309	39.6	12.8	6.0-13.4	290
12	320	32.6	10.2	6.5-10.6	323
13	338	54.0	16.0	8.9-14.0	317
14	335	3.3	1.0	7.6-18.6	332
15	368	26.0	7.1	7.8-11.9	371
16	323	15.8	4.9	9.7-12.2	312
17	316	30.5	9.7	6.4-9.50	302
18	325	22.5	6.9	8.2-16.9	311
19	320	31.9	10.0	6.0-10.5	318
20	323	38.3	11.9	9.8-15.5	302
21	366	28.9	7.9	9.0-14.4	372
22	342	52.5	15.4	8.3-9.30	335
23	340	26.9	7.9	8.7-14.6	339
24	338	23.4	6.9	9.1-15.3	340
25	330	40.3	12.2	7.3-13.3	328
26	356	14.9	4.2	9.4-18.1	349
27	363	21.2	5.8	9.3-13.2	363
28	316	43.5	13.8	8.6-16.3	303
29	328	20.3	6.2	9.4-11.6	317
30	322	30.7	9.5	7.5-15.1	303

Table 3 - Motor reaction time (milliseconds).

Day of menstrual cycle (n=6)	Mean	Standard deviation	Inter-individual coefficient variation among women in each day	Intra-individual coefficient variation limits in each woman	Median
1	211	17.2	8.2	10.9-18.7	216
2	180	12.2	6.8	10.9-15.4	174
3	188	24.2	12.9	14.6-27.4	175
4	161	12.7	7.9	13.4-38.0	147
5	194	45.5	23.5	10.2-20.0	183
6	187	37.2	19.9	9.4-19.0	185
7	187	52.7	28.2	9.0-13.0	193
8	172	29.4	17.1	8.1-16.9	166
9	175	11.6	6.7	15.3-25.2	173
10	202	21.5	10.6	6.9-15.3	205
11	140	17.7	12.6	10.3-23.5	129
12	170	40.2	23.6	8.6-22.0	158
13	191	21.9	11.5	8.7-14.6	203
14	192	12.4	6.5	11.3-31.1	178
15	186	68.2	36.7	11.0-22.4	171
16	180	24.6	13.7	10.6-20.5	175
17	157	21.3	13.6	12.1-30.2	149
18	143	8.8	6.2	13.4-37.8	148
19	170	31.2	18.4	13.9-18.8	157
20	149	11.4	7.7	11.6-34.0	131
21	177	35.6	20.1	11.0-20.7	176
22	176	3.4	1.9	9.3-11.4	175
23	175	9.3	5.3	6.9-13.2	169
24	172	23.8	13.8	7.3-14.6	169
25	194	59.5	30.7	11.4-27.3	205
26	149	6.2	4.2	13.5-23.8	151
27	152	16	10.5	11.5-13.6	139
28	185	22.2	12.0	9.3-13.6	187
29	172	19.5	11.3	9.1-18.5	164
30	178	30.1	16.9	9.3-20.0	178

Table 4 - Ascending CFF (critical fusion frequency).

Day of menstrual cycle (n=6)	Mean	Standard deviation	Inter-individual coefficient variation among women in each day	Intra-individual coefficient variation limits in each woman	Median
1	23.1	1.8	7.8	0.9-6.1	22.1
2	23.4	1.8	7.7	0.8-6.5	22.8
3	29.1	1.3	4.5	4.6-9.6	28.1
4	23.4	2.3	9.8	2.1-7.2	22.7
5	23.5	0.9	4.0	2.5-8.9	23.4
6	29.2	4.0	13.7	0.4-10.0	29.2
7	24.0	0.3	1.3	0.9-2.8	23.9
8	26.1	1.0	3.8	3.5-9.4	26.3
9	25.4	3.8	15.0	4.8-9.4	23.0
10	25.5	2.3	9.0	3.9-7.6	25.0
11	25.0	6.0	24.0	1.3-5.1	24.5
12	24.8	3.1	12.5	1.1-9.1	23.7
13	26.7	2.0	7.5	1.7-7.8	26.5
14	29.4	2.0	6.8	3.5-8.4	28.7
15	26.5	3.2	12.1	1.6-6.4	25.2
16	26.7	6.9	25.8	2.0-5.1	26.8
17	27.4	2.8	10.2	2.4-15.8	28.4
18	23.8	2.8	11.8	1.0-9.7	23.4
19	27.5	5.6	20.4	1.6-12.4	27.5
20	26.3	0.4	1.5	0.8-7.4	26.3
21	25.0	4.6	18.4	1.1-11.0	25.5
22	24.2	0.4	1.7	2.2-6.9	24.2
23	24.6	1.3	5.3	1.3-3.6	24.4
24	24.4	1.4	5.7	1.6-3.3	24.1
25	24.1	2.8	11.6	0.2-6.4	24.4
26	25.6	4.3	16.8	2.2-3.2	25.6
27	26.9	3.4	12.6	0.6-4.9	24.9
28	27.2	2.2	8.1	1.0-8.3	27.1
29	27.5	3.6	13.1	0.8-3.0	27.8
30	26.3	3.3	12.5	1.6-4.2	27.5

Table 5 - Descending CFF (critical flicker frequency).

Day of menstrual cycle (n=6)	Mean	Standard deviation	Inter-individual coefficient variation among women in each day	Intra-individual coefficient variation limits in each woman	Median
1	28.8	1.1	3.8	2.8-4.1	29.0
2	29.2	1.1	3.8	3.2-5.8	29.5
3	30.1	1.0	3.3	0.7-9.5	30.4
4	29.3	0.7	2.4	2.9-3.4	29.5
5	28.7	2.9	10.1	1.7-14.5	27.2
6	29.2	1.7	5.8	1.4-9.0	29.7
7	28.1	3.3	11.7	3.1-12.9	27.4
8	26.1	3.3	12.6	1.1-4.0	25.1
9	27.9	1.9	6.8	0.5-3.8	27.9
10	28.0	2.2	7.9	0.9-2.9	28.2
11	32.3	6.5	20.0	1.2-5.2	28.6
12	27.3	2.0	7.3	0.4-8.6	27.5
13	29.3	1.4	4.8	2.3-6.8	29.2
14	31.3	1.5	4.8	1.5-10.9	31.4
15	29.2	1.3	4.5	0.2-6.0	28.4
16	28.2	3.2	11.3	1.7-10.1	29.5
17	29.1	3.0	10.3	0.5-7.9	29.7
18	27.8	2.7	9.7	1.7-4.3	27.0
19	30.2	4.1	13.6	3.6-10.1	30.3
20	29.4	1.2	4.1	1.0-4.0	29.7
21	27.5	3.0	10.9	2.8-6.8	25.5
22	29.8	1.1	3.7	3.2-7.2	29.2
23	29.6	1.3	4.4	3.6-8.6	29.2
24	28.7	1.9	6.6	4.6-7.9	28.8
25	27.2	2.8	10.3	2.2-4.9	26.5
26	28.0	4.2	15.0	1.1-1.3	28.1
27	28.0	2.3	8.2	0.7-11.8	28.2
28	29.2	3.1	10.6	2.2-6.8	28.9
29	29.5	2.4	8.1	2.7-7.8	28.9
30	30.2	3.4	11.3	2.6-4.3	30.5

obvious. **Table 3** shows that the MRT value of women was significantly lower than corresponding men (220 ± 18, 95% CI: 211.14-228.85) during all days of the cycle. These data reflected on significant lower TRT values during all days of the cycle. Women showed large inter-individual variations in MRT (1.9-37.6 milliseconds) as compared with 8.18 milliseconds in men. The results of critical flicker and fusion thresholds (CFFT) in men were 31.37±2.9 Hz (95% CI: 30.02-32.72) and 30.33 ± 2.4 Hz (95% CI: 29.21-31.5). The mean value of CFFT was 30.85 Hz and the difference between fusion (ascending) and flicker (descending) threshold was -1.04. In women, the critical fusion (ascending) threshold was significantly lower than the lower limit of mens' 95% CI, except for the values of day 6 (at the end of menstruation) and day 14 (at the presumed day of ovulation) (**Table 4**). The flicker (descending) threshold of women during the 12th, 14th, 20th, and 30th days were not significantly different from the lower limit of mens' 95% CI (**Table 5**). The intra- and inter-individuals variations in CFFT measured were lower in men in comparison with women. The mean value of CFFT threshold (a measure of classical sensory sensitivity criterion) in women during all days of the cycle was less than the corresponding measure in men. Also, there was an obvious variation in the value of subjective judgment criterion in women.

Discussion. The present results show that spontaneously menstruating women have significantly better psychomotor performance than men, but are inferior to men in integration of CNS activity. These responses are observed along the cycle phases with wide intra-and inter-individual variations. This finding evokes a non-specific relationship between menstrual phases and the psychomotor performance. Therefore, several methodological limitations have to be considered. Firstly, the higher intra-and inter-individuals coefficient variations reflect the more non-consistent performance. Such variations may limit the inclusion of women participants in studies that screen the sedative effect of new drugs.[15] Also, the significantly better psychomotor performance in women makes them inappropriate for screening psychoactive compounds, such as serotonin reuptake inhibitors.[1] Secondly, there is no specific phase in the cycle that shows consistent results in psychomotor performance. This finding shares some of the results reported by others. Becker et al[16] reported shorter reaction time to auditory stimulus (tone) during periovulatory and perimenstrual times. Hampson[17] also

found better motor skills during the luteal phase when there is a high level of gonadal steroids, while Cockerill et al[18] found that perceptual motor tasks did not vary with the menstrual cycle. Thirdly, both components of CRT should be considered in interpretation of the psychomotor performance data rather than the TRT. The variation in RRT during the menstrual cycle may be related to the fluctuation of reproductive hormones.[19] The present results are in agreement with that of Hampson & Kimura[20] who demonstrated reciprocal changes in human perceptual-spatial test and motor skills. Fourthly, the integrative capacity of CNS, classical sensitivity criterion and subjective judgment criterion are apparently impaired in most days of the cycle because of wide intra- and inter-individual variations in CFFT measures.[21] The differences between ascending (fusion) and descending (flicker) thresholds are higher than those reported by others.[22-24] This in turn is reflected on pseudo-impairment in subjective judgment criterion. Therefore, it is enough not to make a decision about the value of women's CFFT measure in research.

In conclusion, spontaneously menstruating young women are not good participants for psychomotor performance studies because of wide intra- and inter-individual variation. Further study is recommended to test the psychomotor performance of menopausal women.

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