ICNSJ Original Article

Analogy of brain function in men and women with NCCB

Afsaneh Zarghi

Functional Neurosurgery Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

ABSTRACT

Purpose: The cognitive domains are assessed by cognitive tests and these assessments are different between man and woman in every test, this study assessed brain function by cognitive domains among men and women.

Methods: A cross-sectional study was done on a sample of 15 to 75 years old of 80 female and 80 male. All participants did Neuro-Cognitive Computer Battery (NCCB) after training and consent. Participants of both groups were physically and mentally examined and approved by specialist physicians.

Results: According to NCCB was no significant difference between two groups in attention domains (0.05< p).

Conclusion: Findings of current study show a similar attention in mentioned tests.

Keywords: Analogy; brain function; men; women

ICNSJ 2015; 2 (1):16-22 www.journals.sbmu.ac.ir/neuroscience

Correspondence to: Afsaneh Zarghi, MD, MPH, PhD; Department of Neuroscience & Neuro-cognitive Rehabilitation, Functional Neurosurgery Research Center, Shohada hospital, Tajrish Avenue, Tehran, Iran; E-mail: dr.a.zarghi@hotmail.com; Tel/fax: +98(21)22701022

Received: December, 25, 2014 **Accepted:** January, 11, 2015

INTRODUCTION

Hemispheres are different in men and women. Left hemisphere and corpus callosum are thicker in woman. So the communication between the two hemispheres of brain is more synapses[1]. Females are able to use from their two hemispheres during communication. Neural pathways of cognitive domain of attention are involved for each activity. During talking of women is active whole of brain and this ability of women is partly due to a larger corpus callosum which makes easier transferring between the two hemispheres[2,3]. Brain weight of men is more and they have larger physical stature, muscle mass and body size[4]. Their right hemisphere and corpus callosum are thicker than women's, so they use only one portion of their brains when communicating. Attention is a cognitive domain of selectively concentration on one aspect of the environment, while other aspects are ignored[5]. Attention is divided into five sub-domain: selective attention, alternating attention, divided attention, sustained attention, focused attention[6-8]. Selective attention is a processing capabilities of information and related data while repulse irrelevant data[9].

Neural pathways of attention involved connection of cortical structures (frontal, temporal, parietal), sub-cortical (limbic, basal ganglia) and functional systems, includes routes of basal ganglia, thalamus and the frontal lobes[10].

The inferior-parietal lobule (IPL) is an area in parietal cortex which is markedly larger in men. Especially the left part of IPL in men is larger than the right and it is reversed in women. IPL allows brain processes to get help from selective sensory input, perception and attention. Since cognitive functions in men and women take place in different areas of brain which are linked together, these performances are measured by some of domains; such as: attention, executive function, memory, language, visuospatial functioning[6,11].

Assessing of attention is different but we used Neuro-Cognive Computerized Battery (NCCB). These tests are helpful in cognitive measurement and they have low

costs. NCCB are important and measure different degrees of neuro-cognitive impairments and theoretically, can increase productivity, efficiency and knowledge but like other technologies are faced with restrictions[12]. These tests can be in assessing the attention domain separately for every sex. One of these tests is Selective Attention Test (SAT) test which is used for assessing selective attention[13-15] and cognitive flexibility and similar to stroop test[10]. Sustained Attention and Impulsivity Test (SAIT) test assess sustained attention and impulsivity and similar to continues performance test[16-18]. This test has been used in studies related to attention and impulsivity done by different changes in task components[18-20]. Gender differences in cognitive tests have been reported by some researchers. One of the most important factors in these tests, based on previous studies is sex variable[21,22] but not all of them:[23-26]. Hence, the aim of this study was analogy of brain function with attention domain in men and women.

MATERIALS AND METHODS

The method of this research is cross sectional and available simple random sampling was used for it. Both male and female were involved, and because of the pilot study the reduction 160 of them, 80 precipitants of each sex, is possible. They are initially examined by neurosurgeons, neurologists and psychiatrists and then after the final recognition, and consent of the patient, the tests of the research such as demographic questionnaire and our designed NCCB is applied. All participants were trained after accepting doing SAT, SAIT of NCCB. Inclusion criteria were as follows: be in age range of 15 to 75 years, inhabitant of Tehran, right-handedness, Persian language speaker, lacking any history of neural and mental disease, surgery and medicine consumption. Exclusion criteria: not in age range of 15 to 75 years, not inhabitant of Tehran, left-handedness, not Persian language speaker, having any history of neural and mental disease, surgery and medicine consumption.

This study was approved in Ethics Committee of Shahid Beheshti University of Medical Sciences in Tehran and approved and implemented in the Functional Neurosurgery Research Center.

In this study we used SAT, SAIT of NCCB.

Variables, technique and results of SAIT of NCCB: In all forms of continuous performance test, subject should pay attention to a collection of relatively simple stimuli, visual or auditory (only visual stimuli is presented in this test) for a while. And in the appearance of the target stimulus persons give their answer by pushing one key. This test should be run in a quite favorable time and place and the testing conditions should be preserved in terms of psychometric matters. The subject should use of his maximum capability and this is the aim and at the same time of having good speed he should have good performance too. Totally 150 stimuli are presented in this test which 20% of it is target stimulus (stimulus which the subject should answer to it and is presented in the forms of star, moon, circle at the monitor screen). Any stimulus duration for representing is 200 ms and the interval between stimuli is 1 second. After entering the personal information in its part, the test runs. Before running the main test, experimental test (as an example) would be presented and then the original one. At the beginning of experimental and main part, the necessary explanations are presented on screen and tester should explain it to participant. When the subject is ready, the test starts. Duration of the trial including the stage is totally 200 seconds. According to the test types and required analysis, the designed computerized test of continuous performance in this study will assess commission, omission, reaction time and interaction of participants' answers of sustained attention on the basis of comparison of response rate[14,27,28].

Variables, technique and results of SAT of NCCB: this test has been designed and used for assessing selective attention and cognitive flexibility and several cognitive assessments[10,29-31]. The used SAT test in this study is according to the used variables in SAT test[10,15] which has been designed by computer[15]. The mentioned test has two trends: the first stage is color naming in which tester wants subject to show one of the letters on the keyboard which has colored labor of the same color. There is a colored circle in one of the four colors of red, blue, yellow and green which is shown alternatively on screen. The aim of first stage is training of test to the subject and it has no effect on the result. The second stage is performance in which 48 congruent colored words and 48 incongruent colored ones are presented. Congruent words are referred to words that word color is the same as word meaning. For example the word blue is the same as blue color. Incongruent word is referred to word that word color is different from word meaning. For example the blue word is shown by red color. Totally 96 congruent and incongruent colored words are displayed on screen randomly and sequentially. And subject by emphasizing on color without considering its meaning should press the related color on the basis of label on keyboard letters. Presentation time of every stimulus is 2

second and interval between two is 800ms. Researchers believe that the category of color-word in the second stage of testing, measures mental flexibility, interference and response inhibition[32]. Interference rate is acquired by subtracting the score of correct numbers of incongruent from correct numbers of congruent ones. In this stage red, yellow, green and blue circle is shown to subject sequentially and he should identify the correct color on keyboard buttons by pushing categorized buttons with colored labels of red, yellow, green with maximum speed. It should be explained to subject that the apparent color of words may be different from their meanings and the focus is on color. Measurable variables include congruent and incongruent errors, congruent reaction time, incongruent reaction time and interference score[10,13,29,30].

The hypothesis of this study was assessing of brain function with attention domain in men and women by SAT, SAIT of NCCB. Statistical analysis was done through software $SPSS_{18}$.

RESULTS

First the variables which may affect performance and the way of testing including age and educations were determined which are shown in Table 1.

Table 1 presents that participants of men and women are similar in education and age groups.

In the previous table equality or non-equality of two groups of men and women's averages was analyzed by independent t test. Since P amount is more than significant level of test (0.05), assumption of equality of averages is accepted. Here the total test variables in man and woman did not show a main difference and it suggests the similarity of scores average of test variables.

Table 3 show analysis with independent t test and it presents the equality of mean in of man and woman in SAT test variables. Also P-value is more than significant level of test (0.05), assumption of equality of means is accepted but This hypothesis is rejected only in mean of

Table 1. Demographic variable of age and education in men and women.

Variables	Healthy	
	Number	Percentage
Gender		
Women	80	50
Men	80	50
Education		
Illiterate		
Women	7	4.35
Men	7	4.35
Diploma		
Women	27	16.85
Men	27	16.85
Upper diploma		
Women	46	28.77
Men	46	28.77
Age groups		
15-24		
Women	15	9.37
Men	15	9.37
25-34		
Women	11	6.87
Men	11	6.87
35-44		
Women	9	5.62
Men	9	5.62
45-54		
Women	25	15.62
Men	25	15.62
55-65		
Women	18	11.25
Men	18	11.25
65-75		
Women	2	1.25
Men	2	1.25

Table 2. Comparative assessment of mean, SD, t and p-value in variables of SAIT test among men and women.

Variables group	M±SD Men	M±SD Women	M±SD Mean differences	t	P-value
Total of test errors for first 50 stimuli	1.01±1.47	50.85±1.16	0.167±0.205	0.814	0.417
Total of non-responding for first 50 stimuli	4.4±3.95	4.36±4.35	0.048±0.642	0.074	0.941
Total of correct answers for first 50 stimuli	46.5±3.49	47.42±2.63	-0.917±0.478	-1.919	0.057
Reaction time of first 50 stimuli for correct answer	400.15±123.11	416.87±142.3	-16.714±20.53	-0.814	0.417
Total of test errors for second 50 stimuli	0.56±0.91	0.35±0.611	0.214±0.12	1.792	0.075
Total of non-responding for second 50 stimuli	4.44±4.03	4.46±4.4	-0.024±0.149	-0.037	0.971
Total of correct answer for second 50 stimuli	45.63±3.15	46.23±2.8	-0.595±0.46	-1.294	0.197
Reaction time of second 50 stimuli for correct answer	429.15±151.83	407.25±119.32	21.91±21.07	1.024	0.3
Total of test errors for third 50 stimuli	0.82±1.46	0.62±1.05	0.202±0.197	1.028	0.3
Total of non-responding for third 50 stimuli	4.44±3.93	4.69±4.35	-0.25±0.64	-0.391	0.696
Total of correct answer for third 50 stimuli	44.43±3.67	44.89±3.56	-0.464±0.558	-0.832	0.407
Reaction time of third 50 stimuli for correct answer	432.25±177.44	432.82±149.11	-0.571±25.28	-0.023	0.982

Table 3. Comparative assessment of mean, SD, t and p-value of variables in SAT test variables among men and women

Variables group	M±SD N=45	M±SD 45=N	M±SD Mean differences	t	P-value
Congruent testing time	58.74±14.96	60.31±16.01	-1.57±2.39	-0.657	0.512
Congruent testing error	2.05±3.12	1.64±2.02	0.583±0.405	1.44	0.152
Non-responding congruent	10.01±10.61	11.61±12.22	-1.59±1.76	-0.904	0.368
Congruent correct answer	38.13±12.83	37.3±14.3	0.833±2.09	0.398	0.691
Average of congruent response time	1213.5±188.99	1202.39±184.696	11.11±28.83	0.385	0.701
Incongruent testing time	60.63±16.7	62.79±17.123	-2.15±2.6	-0.826	0.41
Incongruent testing error	6.82±12.004	3.83±5.64	2.98±1.44	2.065	0.04
Non-responding incongruent	10.52±11.609	12.56±12.84	-2.04±1.88	-1.078	0.283
Incongruent correct answer	32.62±16.22	34.17±15.53	-1.54±2.45	-0.632	0.528
Average of response incongruent time	1149.57±359.36	1246.8±197.47	-97.22±44.74	-2.172	0.031
Interference score	5.8±12.166	3.45±6.287	2.34±1.49	1.57	0.118

incongruent response time and incongruent testing error.

In this study was examined the correlation rate between gender and variables in SAIT and SAT tests by Pearson correlation test and the following correlation matrix was acquired.

In Table 4 is clear that there is no correlation between women and men with under investigation variables and they are almost similar.

Correlation number is always between 1 and -1. Whatever this amount is closer to 1 or -1, this category is a sign of correlation and strong relationship close to a linear one. Negative mark shows a reversed relation and positive mark suggests a direct relation. Also this amount is close to zero, it indicates no relationship.

Table 5 show clear that there is no correlation between women and men with under investigation variables and they are almost similar.

Table 4. Investigating the relationship and correlation values between genders by variables of SAT test

Variables	Man Sample volume = 45	Woman Sample volume = 45
Congruent testing time	r = 0.096 p-value = 0.386	r = 0.026 p-value = 0.812
Congruent testing error	r = -0.124 p-value = 0.26	r = -0.145 p-value = 0.188
Non-responding congruent	r = 0.112 p-value = 0.312	r = 0.000 p-value = 1
Congruent Correct answer	r = -0.078 p-value = 0.478	r = 0.089 p-value = 0.419
Average of congruent response time	r = -0.042 p-value = 0.706	r = -0.019 p-value = 0.865
Incongruent testing time	r = 0.139 p-value = 0.208	r = 0.022 p-value = 0.842
Incongruent testing error	r = -0.277 p-value = 0.038	r = -0.039 p-value = 0.728
Non-responding incongruent	r = 0.126 p-value = 0.255	r = 0.025 p-value = 0.818
Incongruent correct answer	r = 0.055 p-value = 0.621	r = 0.122 p-value = 0.268
Average of incongruent response time	r = 0.256 p-value = 0.019	r = -0.017 p-value = 0.88
Interference score	r = 0.171 p-value = 0.119	r = -0.038 p-value = 0.734

DISCUSSION

Although there is a significant difference between two hemispheres in men and women, it does not result in difference in attention domain. Since brain weight in men is more than women's and flow of communication between two hemispheres in women is more freely than men's, they are able to use from two hemispheres during the communication. Selective, sustained attention domain which is in interaction with cortical areas (frontal, temporal, parietal), sub-cortical (limbic, basal ganglia) and functional systems including basal ganglia courses, thalamus and frontal lobes[33,34] which can be no affected by brain size. The presence of connection paths between two hemispheres in different parts of women's brain can justify attention similarity despite the number of neurons, size and more weight of men's brain. And especially as the left part of IPL in men is bigger than the right one, while it is converse in women which permit the brain processes to get help from input sensory attention and selective perception and previous researches have shown that the right IPL is related to understanding spatial relationships and ability of sense relationships among body organs[35] and it can also indicate interfering processes in developing attention neural paths in women despite size differences. The aim of this study was confirmed through findings. We designed NCCB for cognitive domains assessment and we used from 2 sub test of attention of this battery (SAT, SAIT). These tests can be used well in situations that error reduction, speed, and efficiency are considered[36].

Table 5. the relationship and correlation values between genders by variables of SAIT test

Variables group	Man Sample volume = 45	Woman Sample volume = 45
Total of test errors for first 50 stimuli	r = -0.202 p-value = 0.066	r = 0.135 p-value = 0.220
Total of non-responding for first 50 stimuli	r = -0.187 p-value = 0.088	r = -0.113 p-value = 0.305
Total of correct answers for first 50 stimuli	r = 0.212 p-value = 0.053	r = -0.056 p-value = 0.615
Reaction time of first 50 stimuli for correct answer	r = 0.107 p-value = 0.331	r = -0.024 p-value = 0.083
Total of test errors for second 50 stimuli	r = -0.275 p-value = 0.011	r = -0.128 p-value = 0.247
Total of non-responding for second 50 stimuli	r = -0.082 p-value = 0.475	r = -0.065 p-value = 0.558
Total of correct answer for second 50 stimuli	r = 0.149 p-value = 0.177	r = 0.051 p-value = 0.644
Reaction time of second 50 stimuli for correct answer	r = -0.166 p-value = 0.132	r = -0.061 p-value = 0.583
Total of test errors for third 50 stimuli	r = -0.279 p-value = 0.01	r = -0.123 p-value = 0.266
Total of non-responding third 50 stimuli	r = -0.008 p-value = 0.945	r = -0.069 p-value = 0.535
Total of correct answer for third 50 stimuli	r = 0.089 p-value = 0.421	r = -0.070 p-value = 0.526
Reaction time of third 50 stimuli for correct answer	r = -0.035 p-value = 0.75	r = -0.061 p-value = 0.583

In the resent studies[37] and our study is a correlation between variables of computerized tests of SAIT. In present survey there is no significant difference between compared variable means in SAIT in man and woman (Table 5). It is worth noting that these tests are usable as tools with appropriate sensitivity to a wide range of clinical conditions related to cognitive deficits[12,13,38].

Individual factors are so important in doing these computerized tests which is a sign of test popularity in researches[39]. In our study the mentioned test measures were evaluated by sex variable. In some studies SAT and SAIT variables did not show a significant difference between man and woman. SAIT tests are reliably investigated in healthy subjects who are identical in terms of age, sex and race[40]. SAIT and SAT test performance is a little helpful in identifying sex. So the present findings make clear a few limitations in using SAT and SAIT[41]. There is no significant relationship between sex variable and SAIT test variables. There is no sexual interaction among participants in every functional scale. The mentioned subject is according to the research results[42]. These results have been approved in some studies in which there is no significant relationship between SAIT test measures and sex variable. It is clear that there is a similar performance (the more omission and commission errors, the more response time) for all of our subjects. This category is rejected by stimulating effect of sex on attention and information processing.

There is a relationship between man and woman in all age groups and SAT test scales in resent study[9] which the result of present study (Table 4) indicates no correlation. Although cognitive functions in man and woman take place in different parts of brain, they are different in neural relations. Since cognitive functions in man and woman take place in different parts of brain which are related together, these functions are assessed by different domains such as attention and its assessment in two sexes suggests neural function in man and woman. Attention is a cognitive trend which is related to information processing capability[9,43]. This study confirms that mentioned computerized neuro-cognitive tests such as NCCB have many benefits like any other technology in compared with conventional psychological tests and can assess neuro-cognitive function in man and woman[13,44,45]. It is suggested that future studies can be concentrated on other tests in man and woman about comparative assessment of neuro-cognitive function.

REFERENCES

1. Sowell ER, Peterson BS, Kan E, Woods RP, Yoshii J, Bansal R, et al. Sex differences in cortical thickness mapped in 176

healthy individuals between 7 and 87 years of age. Cereb Cortex. 2007 Jul;17(7):1550-60.

2. Bishop KM, Wahlsten D. Sex differences in the human corpus callosum: myth or reality? Neurosci Biobehav Rev. 1997; 21(5): 58-601.
3. Leonard CM, Towler S, Welcome S, Halderman LK, Otto R, Eckert MA, et al. Size matters: cerebral volume influences sex differences in neuroanatomy. Cereb Cortex. 2008; 18(12): 2920-31.
4. Cosgrove KP, Mazure CM, Staley JK. Evolving knowledge of sex differences in brain structure, function, and chemistry. Biol Psychiatry. 2007 Oct 15;62(8):847-55.
5. Anderson JR.Cognitive psychology and its implication. Worth Publishers. 2004; p. 519.
6. Cynthia A, Riccio, Cecil R, Reynolds, Lowe P, Jennifer J, et al. The continuous performance test: a window on the neural substrates for attention? Arch Clin Neuropsychol. 2002 Apr;17(3):235-72.
7. Fisher JL, Schwartzbaum JA, Wrensch M, Wiemels JL. Epidemiology of brain tumors. Neurol Clin. 2007 Nov;25(4):867-90, vii.
8. Mahone EM, Pillion JP, Hoffman J, Hiemenz JR, Denckla MB. Construct Validity of the Auditory Continuous Performance Test for Preschoolers. DEVELOPMENTAL NEUROPSYCHOLOGY. 2005; 27(1): 11–33.
9. MacLeod CM. Half of a Century of research on the Stroop effect: An integrative review. Psychol Bull. 1991 Mar;109(2):163-203.
10. Stroop J. Studies of interference in serial verbal reactions. Journal of Experimental Psychology. 1935; 18, 643-662.
11. Bosma I, Douw L, Bartolomei F, Heimans JJ, van Dijk BW, Postma TJ, et al. Synchronized brain activity and neurocognitive function in patients with low-grade glioma: a magnetoencephalography study. Neuro Oncol. 2008; 10(5):734-44.
12. Gualtieri CT, Johnson LG: Reliability and Validity of a computerized neurocognitive test battery, CNS Vital Signs, Arch Clin Neuropsychol. 2006; 21: (7) 623-643.
13. Zarghi A, Zali A, Tehranidost M, Ashrafi F, Zarindast MR, Moazezi M, et al. Assessment of Selective Attention with CSCWT (Computerized Stroop Color-Word Test) Among Children and Adults. US-China Education Review A. 2012; 1: 121-127.
14. Zarghi A, Zali A, Tehranidost M, Zarindast MR, Ashrafi F, Khodadadi M. Comparative assessment of neuro-cognitive impairments among patients with brain tumor and healthy adults. Turkish Neurosurgery. 2012; 22(3):309-316.
15. Zarghi A, Zali A, Tehranidost M, Zarindast MR, Ashrafi F, Doroodgar S, et al. The Relationship between Age, Sex and Education Variables with Selective, Sustained Attention and Planning through Cognitive Tasks among Healthy Adults. Basic and Clinical Neuroscience. 2011; 2(3): 58-67.
16. Beck LH, Bransome ED Jr, Mirsky AF, Rosvold HE, Sarason I. A continuous performance test of brain damage. J Consult Psychol. 1956; 20(5):343-50.
17. Conners CK, MHS Staff (Eds.). Conners' Continuous Performance Test II: Computer Program for Windows Technical Guide and Software Manual North Tonwanda, NY: Mutli-Health Systems. 2000.
18. Lin CC, Hsiao CK, Chen WJ. Development of sustained attention assessed using the continuous performance test among children 6-15 years of age. J Abnorm Child Psychol. 1999; 27(5):403-412.
19. Greenberg LM, Waldman ID. Developmental normative data on the Test of Variables of Attention (TOVA). J Child Psychol Psychiatry. 1993 Sep;34(6):1019-30.
20. Zarghi A, Zali A, Ashrafi F, Moazezi M. Neuroscience and Neuro-cognitive Rehabilitation. Basic Research Journal of Medicine and Clinical Sciences. 2013; 2 (8):83-87.
21. Hameleers PAHM, Van Boxtel MPJ, Hogervorst E, Riedel WJ, Houx PJ, Buntinx F, et al. Habitual caffeine consumption and its relation to memory, planning capacity and psychomotor performance across multiple age groups. Hum Psychopharmacol. 2000 Dec;15(8):573-581.
22. Moering RG, Schinka JA, Mortimer JA, Graves AB. Normative data for elderly African Americans for the Stroop Color and Word Test. Arch Clin Neuropsychol. 2004 Jan;19(1):61-71.
23. Houx PJ, Jolles J, Vreeling FW. Stroop Interference: Aging effects associated with the Stroop Color-Word Test. Exp Aging Res. 1993 Jul-Sep;19(3):209-24.
24. Klein M, Ponds RW, Houx PJ, Jolles J. Effect of test duration on age-related differences in Stroop interference. J Clin Exp Neuropsychol. 1997 Feb;19(1):77-82.
25. Swerdlow NR, Filion D, Geyer MA, Braff DL. "Normal" personality correlates of sensimotor, cognitive, and visuospatial gating. Biol Psychiatry. 1995 Mar 1;37(5):286-99.
26. Trenerry M, Crosson B, DeBoe J, LeberW. Stroop Neuropsychological Screening Test manual. Adessa, FL: Psychological Assessment Resources (PAR). 1989.
27. Barkley RA. A new theory of ADHD. The ADHD Report. 1993; 1: (1) 1–4.
28. Ricco CA, Reynolds CR, Lowe P, Moore JJ. The continuous performance test: a window on the neural substrates for attention? Arch Clin Neuropsychol1. 2002;7: (3) 235-72.
29. Aman CJ, Roberts RJ Jr, Pennington BF. A neuropsychological examination of the underlying deficit in attention deficit hyperactivity disorder: frontal lobe versus right parietal lobe theories. Dev Psychol. 1998; 34(5):956-69.
30. Ehlis AC, Herrmann MJ, Wagener A, Fallgatter AJ. Multi-channel near-infrared spectroscopy detects specific inferior-frontal activation during incongruent SAT trials. Biol Psychol. 2005; 69(3):315-31.
31. Stuss DT, Floden D, Alexander MP, Levine B, Katz D. Stroop performance in focal lesion patients: dissociation of processes and frontal lobe lesion location. Neuropsychologia. 2001; 39(8):771-86.
32. Wecker NS, Kramer JH, Wisniewski A, Delis DC, Kaplan E. Age effects on executive ability. Neuropsychology. 2000 Jul;14(3):409-14.

33. Piefke M, Weiss P, Markowitsch H, Fink G. Gender differences in the functional neuroanatomy of emotional episodic autobiographical memory. Hum Brain Mapp. 2005 Apr;24(4):313-24.

34. Sabbatini RME. Are there differences between the brains of males and females? Brain Mind Mag October/December. 2000.

35. Frederikse AL, Aylward E, Barta P, Pearlson G. Sex Differences in the inferior parietal lobule. Cereb Cortex. 1999; 9(8): 896-901.

36. Culberston WC, Zillmer EA. Tower of London performance in children and adolescents: Relationships to neuropsychological measures of frontal lobe functioning. Arch Clin Neuropsychol. 1995; 5: 314.

37. Baker EL, Letz RE, Fidler AT, Shalat S, Plantamure D, Lyndon M. A computer-based neurobehavioral evaluation system for occupational and environmental epidemiology: methodology and validation studies. Neurobehav Toxicol Teratol. 1985 Jul-Aug;7(4):369-77.

38. Zarghi A, Zali A, Ashrafi F, Moazzezi S, Lotfi M. Promotion of Neuro-cognitive domains with working memory computerized test (WMCT) among healthy adult. Int J EngTech Res. 2014; 2: 333-337.

39. Lezak MD, Howieson DB, Loring DW. Neuropsychological assessment (4th ed.). New York: Oxford University Press.2004.

40. Advokat C, Martino L, Hill BD, Gouvier W. Continuous Performance Test (CPT) of college Students with ADHD, Psychiatric Disorders, Cognitive Deficits, or No Diagnosis. J Atten Disord. 2007; 10(3):253-6.

41. Schatz AM, Ballantyne AO, Trauner DA. Sensitivity and specificity of a computerized test of attention in the diagnosis of attention-deficit/hyperactivity disorder. Assessment. 2001; 8(4)357-365.

42. Schulz PK, Fan J, Magidina O, Marks JD, Hahn B, Halperin MJ Does the emotional go/no-go task really measure behavioural inhibition? Convergence with measures on a non-emotional analog. Arch Clin Neuropsychol. 2007 Feb;22(2):151-60.

43. Halperin JM. The clinical assessment of attention. Int J Neurosci. 1991 Jun;58(3-4):171-82.

44. Herrmann JM, Aranda D, Ellgring H, Mueller JT, Strik KW, Heidrich H, et al. Face-specific event-related potential in humans is independent from facial expression. Int J Psychophysiol. 2002 Sep;45(3):241-4.

45. Kropotov JD. Quantitative EEG, Event-related potentials and neurotherapy; Elsevier, Amsterdam. 2009.