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Assessment of Selective Attention With CSCWT (Computerized Stroop Color-Word Test) Among Children and Adults

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The SCWT (Stroop Color-Word Test) is a quick and frequently used measure for assessing selective attention and cognitive flexibility. This study determines age, sex and education level influence on attention and cognitive flexibility by CSCWT (Computerized Stroop Color-Word Test) among healthy Iranian children and adults. There were 78 healthy subjects, aged from nine to 69 years, whose selection was done randomly. They have been invited to have physical and mental examinations which were done by neurologist and psychiatrist and then to perform the Stroop test by cognitive neuroscientist. The obtained results pattern showed that the obtained results pattern showed that age, sex and education have no significant impact on selective attention and cognitive flexibility in under studied groups except in few cases which means that personal factors alone have less influence on these measures. The score of selective attention in different age and gender groups and at various educational levels was not similar which indicates that there is no significant correlation between attention level and age, sex and education. These findings were not in line with most recent studies which show the significant influence of demographic variables on Stroop test performance. Personal factors, such as age, sex and education, have no influence on attention and cognition level individually and this measure can be altered through environmental factors like diseases.

Keywods: selective attention, cognitive flexibility, CSCWT (Computerized Stroop Color-Word Test)

Background

The SCWT (Stroop Color-Word Test) (Stroop, 1935) is assessed as a profitable and trustworthy tool in clinical investigations of psychological cognitive neuroscience (Lezak, Howieson, & Loring, 2004). Stroop

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interference test is one measure of executive function which was designed by Stroop in 1935 in order to evaluate selective attention, cognitive flexibility, and also it is often used to assess peoples' ability in shifting cognitive set (Spreen & Strauss, 1998). Processing the task relevant to inputs, thoughts, or actions is possible by selective attention whereas ignoring irrelevant or distracting ones (MacLeod, 1991). Analyzing the way subjects respond to target stimuli in the presence or absence of distracting items is a current method to investigate selective attention. Normally, distractors have different response than the target, so that unintentional processing of the distractors makes interference with the selection of the correct response. Before selecting the correct response, this conflict in responding which results in comparatively bad performance (slower reaction times/or more errors) needs to be solved. For investigating inhibitory processes, Stroop can be considered as a useful mean. The contrast between related (color of the word) and unrelated (name of the word) dimensions of the stimulus on incongruent trials show a complicated task for the selective attentional system. According to recent studies, sensitivity for visual stimuli that were classically thought to be processed pre-attentively, such as color, orientation or motion can be modified by selective attention (Joseph, Chun, & Nakayama, 1997). Excitation of the representations of attended stimuli and inhibition of the representations of unattended stimuli are the two processes of selective attention (Neumann, & DeSchepper, 1991). There are different variations of Stroop: paper-based, multiple languages and computerized versions. RT (reaction time) and RE (response error) are measured on the basis of computerized response. A lot of studies have accepted computerized presentation of stimuli that shows a more accurate measurement of RT and reduces RE for people's trials. RT in most studies is measured by key-press response time (Chen, Wong, Chen, & Au, 2000). The Stroop interference effect is referred to the increase in time that is taken to perform the latter task in compare with the basic task (Davidson, Zacks, & Williams, 2003; Moering, Schinka, Mortimer, & Graves, 2003).

Most studies have shown the lack of speed in information processing as a primitive cognitive deficit in people. Consequently, the aim of this study regarding to usefulness of this paradigm is to determine the selective attention of the representative samples based on their age, education level and sex with new CSCWT (computerized color and word test) among Iranian children and adults.

Method

Subjects

The total number of subjects participated in this study was 78, out of which 31 were male and 47 were female, aged from nine to 69 years, with the average age of 30 and their education level ranged from illiterates to whom have passed 25 years of full-time education. They were healthy referrals who have been invited to the functional neurosurgery research centre of Shohada hospital in Tehran, Iran, through recalling. In doing so, first, the whole subjects filled the demographic questionnaire and the people who were sanitarily, socially, economically, culturally, educationally, nutritionally and mentally similar have been introduced to neurologist and psychiatrist in order to be examined and finally entered the study after they were confirmed physically and mentally by the doctor. On the same day, the experimenter, a cognitive neuroscientist, had a cognitive and introductive interview with the participant in an appropriate place so that to make him/her familiar with the test and then the participant was asked to perform the test. Accordingly, the permission was taken from institutional ethics committee (Shahid Beheshti University) for all subjects.

Procedure

Individual testing of the subjects was done in a separate and an appropriate room inside the functional neurosurgery research centre of Shohada hospital. Paper, pencil, questionnaire and a computer were the materials which have been used. Based on this study, the computerized Stroop test was designed and used to measure selective attention and cognitive flexibility. Stroop test is made in different languages and is performed by different researchers with different alternations in the original test and various ways of performance and scorning. This test was also designed in Persian language in which the number of correct answers, errors, and reaction and interference time was the criteria for scoring in the mentioned test. After the theoretical and practical training of the participants to make them familiar with the test, the performance time started. This test performed in an appropriate place and time, because executive condition influenced psychological processes. Having the best performance, speed and correct answer reveals the ability of participants in doing the task. The experimenter had an interview with the participant before starting the formal experiment. After entering the personal information of the participant in personal identification part, the experimenter gave explanations to the participant by showing him the pageant. After performing this part which was done for making the participant familiar with the process of computerized test implementation, the main part of the test is taught to the participant. By the time, the experimenter was sure that the participant is well understood the procedure and it was the time to start the test. The current test has two stages, first stage is named coloring test: in this stage, participants are asked to choose the color of the mentioned picture (for example, the color of the circle which is shown in four colors of blue, red, yellow and green) that can be selected by keys which are covered with colorful labels (V (blue), B (red), N (yellow), M (green)) on the keyboard, as they are shown on the screen of the monitor. The purpose of this stage is to practice perceiving the colors and place of keys and it has no influence on the final result. The mentioned stage is considered five seconds for all participants. The original performance of Stroop test is the second stage. In this stage, 48 chromatic consonant words and 48 chromatic non-consonants are shown (Consonant word is a word in which the color of the word is the same as its meaning on the monitor and non-consonant word is the word in which the color of the word is not the same as its meaning on the monitor). Totally, 96 consonant and non-consonant chromatic words have been presented randomly and consecutively. The task of the participants is to specify the apparent color of the words regardless of their meaning. The representation time of each stimulant on pageant is two seconds and the distance between two stimulants is 0.800 second. Researchers believe that the color-word task (second stage of test) measures mental flexibility, interference and response inhibition (interference scale is achieved by subtracting the correct number of non-consonant score from the correct number of consonant score).

Statistical Analysis

Fisher test, Chi-square and non-parametric tests like Kruskal-Wallis and Mann-Whitney are utilized in this study. Non-parametric tests are used because in some tests, error statements are not normal and normality of error statements is considered as one of the hypotheses of the test. So, there is a need to change the data to reach the hypothesis of normal error statements. Finally, number of errors, reaction time and test results are investigated and are compared with sex, age and education level through Pearson’s correlation.

Table 1

The Comparison of Sex and Education Variables in Different Age Groups

Age vs. sex		Age groups									Total	*t*	*df*	*Sig.*
		9-14 years	14-19 years	19-24 years	24-29 years	29-34 years	34-39 years	39-44 years	44-49 years	Over 49 years				
Sex	Female	2	6	11	7	5	2	6	3	5	47			
	Male	2	2	4	7	10	1	3	2	0	31			
Total		4	8	15	14	15	3	9	5	5	78	10.6	8	> 0.1
Age vs. education		9-14 years	14-19 years	19-24 years	24-29 years	29-34 years	34-39 years	39-44 years	44-49 years	Over 49 years	Total			
Education	Illiterate	0	0	0	1	0	0	0	0	0	1			
	Diploma	4	8	2	4	6	1	5	2	4	36			
	Associate of science	0	0	3	3	0	0	0	1	0	7			
	Bachelor of science	0	0	10	2	6	2	1	1	0	22	61.8	40	0.0
	Master of science	0	0	0	4	1	0	3	1	0	9			
	Doctors	0	0	0	1	2	0	0	0	0	3			
Total		4	8	15	15	15	3	9	5	4	78			

Table 2

Mean and Standard Deviation of Variables for Stroop vs. Age Groups

Age vs. Stroop		ERROR 01	TIMEREC 01	ERROR 02	TIMEREC 02	RESULT TEST
9-14 years	Mean ± *SD*	2.8 ± 4.19	1,093.5 ± 237.70	5.0 ± 6.88	1,031.8 ± 74.63	6.3 ± 7.54
14-19 years	Mean ± *SD*	0.5 ± 0.53	1,102.0 ± 180.68	0.9 ± 2.10	1,152.3 ± 183.65	1.9 ± 2.75
19-24 years	Mean ± *SD*	0.9 ± 1.10	1,051.0 ± 129.20	4.1 ± 11.11	1,104.5±206.63	5.2 ± 11.60
24-29 years	Mean ± *SD*	1.6 ± 3.94	994.3 ± 137.35	3.6 ± 8.83	1,052.1 ± 135.14	2.6 ± 9.13
29-34 years	Mean ± *SD*	0.5 ± 0.83	1,125.9 ± 206.52	8.1 ± 15.55	1,206.2 ± 230.07	9.0 ± 15.09
34-39 years	Mean ± *SD*	4.3 ± 6.66	1,174.3 ± 394.53	4.3 ± 6.66	1,207.7 ± 325.93	1.3 ± 4.04
39-44 years	Mean ± *SD*	3.6 ± 9.22	1,164.6 ± 166.14	11.1 ± 15.89	1,208.1 ± 155.02	8.6 ± 12.73
44-49 years	Mean ± *SD*	2.6 ± 3.78	1,066.4 ± 50.11	4.4 ± 7.67	1,081.2 ± 78.81	0.4 ± 2.51
Over 49 years	Mean ± *SD*	1.5 ± 1.00	1,144.0 ± 229.10	4.5 ± 3.11	1,545.8 ± 329.78	8.8 ± 10.47
df		5.2	1.0	13.0	2.7	12.9
Sig		> 0.05	> 0.05	> 0.05	< 0.05	> 0.05

Table 3

Mean and Standard Deviation of Variables for Stroop vs. Sex

Sex vs. Stroop	Female	Male	*df*	*Sig.*
	Mean ± *SD*	Mean ± *SD*		
ERROR 01	2.0 ± 4.89	1.0 ± 1.81	681.5	> 0.1
TIMEREC 01	1071.0 ± 183.50	1112.4 ± 168.57	1.0	> 0.1
ERROR 02	5.1 ± 10.63	5.6 ± 11.73	722.0	> 0.1
TIMEREC 02	1162.9 ± 238.70	1140.0 ± 174.44	0.2	> 0.1
RESULT TEST	4.2 ± 9.79	6.7 ± 11.95	572.0	> 0.1

Results

According to Table 1, the most number of females are included in 19-24 age group and males are mostly scattered in group of 29-34 years. Diploma is a level of education to which the most participants belong and

only one illiterate is observed among this population. Also, as Table 1 shows, there is no significant difference between sex and age variables ($P > 0.05$). In contrast, education and age variables are significantly different ($P = 0.000$). In Table 2, considering the number of errors, 14-19 years old participants had less errors in consonant error (ERROR 01) ($P > 0.05$, Mean ± SD = 0.5 ± 0.53) and participants of 34-39 year of ages had more errors in consonant errors ($P > 0.05$, Mean ± SD = 4.3 ± 6.66). Similarly, in non-consonant errors (ERROR 02), 14-19 years old participants had less and 39-44 years old ones had more errors, respectively ($P > 0.05$, Mean ± SD = 0.9 ± 2.10), ($P > 0.05$, Mean ± SD = 11.1 ± 15.89). Reaction time of non-consonants among all age groups showed significant correlation ($P < 0.05$). Reaction time of consonant (TIMEREC 01) in 24-29 year of ages was slower than other age groups ($P > 0.05$, Mean ± SD = 994.3 ± 137.35) and in participants of 34-39 year of ages, this was longer than other age groups ($P > 0.05$, Mean ± SD = 1174.3 ± 394.53). Interference score in participants of 44-49 year of ages (RESULT TEST) was less than other age groups ($P > 0.05$, Mean ± SD = 0.4 ± 2.51) and in 29-34 years old participants, this score was more than other age groups ($P > 0.05$, Mean ± SD = 9.0 ± 15.09) (see Table 3). Considering the sex, error consonant (ERROR 01) and the reaction time of non-consonants (TIMEREC 02) among females were more than males, and the reaction time of consonants (TIMEREC 01), non-consonant errors (ERROR 02) and interference score (RESULT TEST) was more among males than females (see Table 4). In assessment of education, error consonant (ERROR 01) in diploma participants was the least ($P > 0.05$, Mean ± SD = 0.3 ± 0.71) and in under-diploma ones was the most ($P > 0.05$, Mean ± SD = 2.3 ± 5.32). Non-consonant errors (ERROR 02) in M.A participants was the least ($P > 0.05$, Mean ± SD = 0.7 ± 0.58) and in under-diploma ones was the most ($P > 0.05$, Mean ± SD = 8.0 ± 13.97). The reaction time of consonants (TIMEREC 01) in illiterate participants was more than other groups ($P > 0.05$, Mean ± SD = 1277.0 ± 0.0) and in diploma ones was the least ($P > 0.05$, Mean ± SD =1006.2 ± 112.6) and similarly, the reaction time of non-consonants (TIMEREC 02) was the most in illiterate groups ($P > 0.05$, Mean ± SD = 1347.0 ± 0.0) and the least in participants who had master of science ($P > 0.05$, Mean ± SD = 1037.7 ± 247.8). The interference score (RESULT TEST) among illiterate participants was zero ($P > 0.05$, Mean ± SD = 0.0 ± 0.00) but in under-diploma ones this score was high ($P > 0.05$, Mean ± SD = 7.5 ± 13.17). Regarding to age and education, there is some exception in TIMEREC 02 performance which is a significant influence and also on the performance of ERROR 01 and TIMEREC 01, and significant impact can be seen by education.

Table 4

Mean and Standard Deviation of Variables for Stroop vs. Education

Education vs. Stroop	Illiterate	Diploma	Associate of science	Bachelor of science	Master of science	Doctors	*df*	*sig*
	Mean ± *SD*	Mean ± *SD*	Mean ± *SD*	Mean ± *SD*	Mean ± *SD*	Mean ± *SD*		
ERROR 01	1.0 ± 0.00	2.3 ± 5.32	0.6 ± 0.98	1.2±2.66	0.3 ± 0.71	0.7 ± 1.15	5.5	> 0.1
TIMEREC 01	1,277.0 ± 0.0	1,113.0 ± 171.6	1,055.6 ± 146.5	1,055.3 ± 165.9	1,006.2 ± 112.6	986.0 ± 208.58	1.3	> 0.1
ERROR 02	1.0 ± 0.00	8.0 ± 13.97	7.3 ± 16.22	2.0 ± 2.69	2.2 ± 4.84	0.7 ± 0.58	3.2	> 0.1
TIMEREC 02	1,347.0 ± 0.0	1,219.1 ± 231.8	1,128.6 ± 251.2	1,084.4 ± 154.8	1,058.9 ± 111.5	1,037.7 ± 247.8	2.0	> 0.1
RESULT TEST	0.0 ± 0.00	7.5 ± 13.17	7.0 ± 17.32	2.4±3.38	2.8 ± 5.12	1.3 ± 2.31	3.2	> 0.1

Discussion and Conclusions

In the current study, at first the variables which affect the performance of Stroop were determined, i.e., age, sex and education. It is also very crucial to determine the impact of personal and environmental factors on test performance and it is referred to the popularity of the Stroop test in research (Lezak et al., 2004). Previous studies

have shown little information about the impacts of demographic variables on Stroop test performance. Although many authors reported age as a significant factor on Stroop, in some studies, the same as ours, no age effect has been observed on interference measure in these paradigms (Moering et al., 2003; Wright & Wanley, 2003; Jerger et al., 1993; Van Boxtel, Ten Tusscher, Metsemakers, Willems, & Jolles, 2001; Hameleers et al., 2000). Table 2 indicates that at any ages, the influence on Stroop test performance is not significant except in one measure which is TIMEREC 02. However, it shows no significant impact on other four variables of performance than the one mentioned. Naming times and number of errors on the Stroop test increased regularly from color to word and eventually to incongruous conditions. This is a classic example which has been found in adult, youth (Spreen & Strauss, 1998; McLeod, 1991) and children's (Comalli, Wapner, & Werner, 1962) Stroop activities. According to what Macleod said, there is only minor effect of sex on Stroop test performance in all age groups (McLeod, 1991). In other words, accuracy variables (ERROR 01, ERROR 02, TIMEREC 01, TIMEREC 02 and RESULT TEST) were slightly under the influence of sex (see Table 3). These results are not in line with some previous studies that indicated age effects on time scores of the Stroop test (Moering et al., 2003; Van Boxtel et al., 2001; Martin & Franzen, 1989). The participants' education level which ranged from illiterate to doctors made no difference on performance of Stroop test. This is what Table 4 shows that the impact of both a low education level and a high education level as compared with the average were not significant on Stroop performance. This result is not consistent with the cognitive reserve hypothesis and people in this hypothesis are considered less sensitive to the cognitive decline which is related to age and pathological brain processes (Stern, Zarahn, Hilton, Flynn, DelaPaz, & Rakitin, 2003). An example of such factors is education (Dufouli, Alperovitch, & Tzourio, 2003; Le Carret, Lafont, Letenneur, Dartigues, Mayo, & Fabrigoule, 2003). Pearson's correlation is used for expressing the correlation between age and existing variables. The correlation between education and other variables is stated by Spearman method. This method can be used when one variable is ordinal, such as education. Regarding the males and females community, average equality method was used to indicate the correlation between sex and other existing variables. Therefore, it can be observed that there is no significant difference between males and females mean in each variable (see Table 5). However, regarding age and education, there is some exception in TIMEREC 02 performance which is a significant influence on the performance of ERROR 01 and TIMEREC 01 and significant impact can be seen by education. As a result, the impact of age on interference may be due to the improvement of attention not just the automaticity of response reading (Wright, Waterman, Prescott, & Murdoch-Eaton, 2003; Gestardt, Hong, & Diamond, 1994; Welsh, Pennington, Groisser, 1991; Diamond & Taylor, 1996). Finally, it can be said that personal factors, such as age, sex and education have no influence on attention and cognition level individually and this measure can be altered or affected through environmental factors like diseases.

Table 5

Correlation of Age, Education and Sex With Variables of Stroop

Correlations	Age		Education		Sex	
	r	*p*-value	*r*	*p*-value	*t*	*p*-value
ERROR 01	0.1	> 0.1	-0.3	0.0	1.0	> 0.1
ERROR 02	0.1	> 0.1	-0.2	> 0.1	-0.2	> 0.1
TIMEREC 01	0.1	> 0.1	-0.3	0.0	-1.0	> 0.1
TIMEREC 02	0.4	0.0	-0.3	0.0	0.5	> 0.1
RESULT TEST	0.1	> 0.1	-0.2	> 0.1	-1.0	> 0.1

References

Chen, E. Y. H., Wong, A. W. S., Chen, R. Y. L., & Au, W. Y. (2000). Stroop interference and facilitation effects in first-episode schizophrenic patients. *Schizophrenic Research, 48*(1), 29-44.

Comalli, P. E. J., Wapner, S., & Werner, H. (1962). Interference effects of Stroop color-word test in childhood, adulthood and ageing. *Journal of General Psychology, 100,* 47-53.

Davidson D. J., Zacks, R. T., & Williams, C. C. (2003). Stroop interference, practice and aging. *Aging Neuropsychology and Cognition, 10,* 85-98.

Diamond, A., & Taylor, C. (1996). Development of an aspect of executive control: Developmental abilities to remember what I said and to do as I say not as I do. *Developmental Psychobiology, 29,* 15-334.

Dufouli, C., Alperovitch, A., & Tzourio, C. (2003). Influence of education on the relationship between white matter lesions and cognition. *Neurology, 60,* 831-836.

Gestardt, C. L., Hong, Y., & Diamond, A. (1994). The relationship between cognition and action: Performance of children 3, 5 to 7 years old on a Stroop like day-night test. *Cognition, 53,* 129-153.

Guttentag, R. E., & Haith, M. M. (1978). Automatic processing as a function of age and reading ability. *Child Development, 49,* 707-716.

Hameleers, P. A. H. M., Van Boxtel, M. P. J., Hogervorst, E., Riedel, W. J., Houx, P. J., Buntinx, F., & Jolles, J. (2000). Habitual caffeine consumption and its relation to memory, planning capacity and psychomotor performance across multiple age groups. *Human Psychopharmacology: Clinical and Experimental, 15,* 573-581.

Jerger, S., Stout, G., Kent, M., Albritton, E., Loiselle, L., Blondeau, R., & Jorgenson, S. (1993). Auditory Stroop effects in children with hearing impairment. *J Speech Hear Res, 36,* 1083-1096.

Joseph, J. S., Chun. M., & Nakayama, K. (1997). Attentional requirements in "preattentive" feature search task. *Nature, 387,* 805-807.

Le Carret, N., Lafont, S., Letenneur, L., Dartigues, J. F., Mayo, W., & Fabrigoule, C. (2003). The effect of education on cognitive performances and its implication for the constitution of the cognitive reserve. *Developmental Neuropsychology, 23,* 317-337.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment* (4th ed.). New York: Oxford University Press.

MacLeod, C. M. (1991). Half of a century of research on the Stroop effect: An integrative review. *Psychological Bulletin, 109,* 163-203.

Martin, N. J., & Franzen, M. D. (1989). The effect of anxiety on neuropsychological function. *International Journal of Clinical Neuropsychology, 11,* 1-8.

McLeod, C. M. (1991). Half a center of research on the Stroop effect: An integrative review. *Psychological Bulletin, 109,* 163-203.

Merril, E. C., Sperber, R. D., & McCauley, C. (1981). Differences in semantic encoding as a function of reading comprehension skill. *Memory and Cognition, 9,* 618-624.

Moering, R. G., Schinka, J. A., Mortimer, J. A., & Graves, A. B. (2003). Normative data for elderly African Americans for the Stroop Color and Word Test. *Archives of Clinical Neuropsychology, 607,* 1-11.

Neumann, E., & DeSchepper, B. G. (1991). Costs and benefits of targets activation and distractor inhibition in selective attention. *Journal of Experimental Psychology: Learning, Memory and Cognition, 17,* 1136-1145.

Spreen, O., & Strauss, E. A. (1998). *Compendium of neuropsychological tests: Administration, norms, and commentary* (2nd ed.). New York: Oxford University Press.

Stern, Y., Zarahn, E., Hilton, H. J., Flynn, J., DelaPaz, R., & Rakitin. (2003). Exploring the neural basis of cognitive reserve. *Journal of Clinical and Experimental Neuropsychology, 25,* 691-701.

Stroop, J. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18,* 643-662.

Van Boxtel, M. P. J., Ten Tusscher, M. P. M., Metsemakers, J. F. M., Willems, B., & Jolles, J. (2001). Visual determinants of reduced performance on the Stroop color-word test in normal aging individuals. *Journal of Clinical and Experimental Neuropsychology, 23,* 620-627.

Visser, M., Das-Smaal, E., & Kwakman, H. (1996). Impulsivity and negative priming: Evidence for diminished cognitive inhibition in impulsive children. *British Journal of Psychology, 87,* 131-140.

Welsh, M. C., Pennington, B. F., & Groisser, D. B. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology, 7,* 131-149.

Wright, B. C., & Wanley, A. (2003). Adults' versus children's performance on the Stroop task: Interference and facilitation. *British Journal of Psychology, 94,* 475-485.

Wright, I., Waterman, M., Prescott, H., & Murdoch-Eaton, D. (2003). A new Stroop-like measure of inhibitory function development: Typical developmental trends. *J Child Psychol Pschiatry, 44,* 561-575.