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Original Article

Gender Differences in Performance on Hindi - English Stroop Task

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Abstract

Stroop task is a well-known neuropsychological test used for assessing cognitive functions such as selective attention and inhibition. Previous studies have shown conflicting evidence regarding gender differences in performance on Stroop task. The present study evaluated gender differences in performance on English-Hindi language versions of Stroop Task. The study was conducted on 30 male and 30 female participants. English and Hindi language versions of the Stroop task was programmed using Superlab5 software. The reaction times in neutral, congruent and incongruent conditions of the Stroop Task were recorded and analysed using SPSS, version 25.

The results of the independent sample t- test showed a significantly shorter reaction time in females as compared to males in both English and Hindi versions of the Stroop task. Further, there were no significant differences in the reaction time across languages. Hence, it was concluded that gender difference in performance on Stroop task is independent of the language. This difference in reaction time could be attributed to biological factors such as a smaller head size and larger areas like callosum and planum temporale in females.

Introduction

Stroop task is a well-known psychological test. This task focuses on understanding fundamental cognitive functions of a person (1, 2). In clinical neuropsychology Stroop task is used as a test for executive functioning (3). The development of Stroop task has been credited to J.R. Stroop (4) who used this task to understand the effect practice on interference. In recent years researchers have studied how individual differences such as gender and age effect Stroop interference.

Research in brain physiology has revealed that many differences exists between males and females, for example females have a larger callosal area and planum temporale as compared to men (6-8). These anatomical differences have shown to influence cognitive functions of both males and females. Females, for example, outperform males in verbal

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and fine motor tasks whereas males are better than females on spatial ability tests (9-11). Stroop Task is one such well-known cognitive task that has interested researchers to understand if gender differences exist in males and females. Mcleod (5) in his review on Stroop task stated that gender differences do not exist on the Stroop Task. Several other studies have also reported similar findings (12-16). On the contrary, other researchers have found that females had shorter reaction time on the Stroop Task as compared to males (17-20). Thus, these results show that no consensus has yet been reached concerning gender difference on Stroop Task.

Bilingualism is very closely associated with Stroop Task. Bloomfield (21) in 1935 defined bilingualism as 'native-like control of two languages. Few researches have also been conducted to understand whether gender differences exist when bilinguals perform Stroop Task (22-24). Jorgenson and his colleagues (22) reported that both monolingual and bilingual females had significantly shorter latencies on the Stroop Task as compared to monolingual and bilingual males. On the contrary, Lee and Chan (23) conducted a study on eighty-five Chinese-English bilinguals and English monolinguals and failed to find any gender differences in performance on the Stroop task in either Chinese or English language. Alansari and Baroun (24) conducted a study on 140 Kuwaiti and 70 British university students and failed to find any gender differences on the Stroop task. Thus, as with monolinguals, studies conducted on bilinguals also show mixed findings.

There is thus shortage of data that reports bilingualism as a factor to understand gender differences on Stroop Task. This study was thus conducted to understand whether Hindi and English speaking males and females differ in their reaction time on Stroop task and if they do whether language or bilingualism plays a role in influencing these gender differences.

Methods

Participants

The study sample consisted of 60 participants of which 30 were males and 30 females. All the participants were between 18-40 years of age. The study was approved by Institutional Ethics Committee and written informed consent was taken from the subjects prior to the study. All the participants were bilinguals and proficient in both Hindi and English language. However, the dominant (Native) language of all the participants was Hindi. For the purpose of inclusion, the participants were asked to rate their proficiency in both English and Hindi language on a scale of 0 to 6. Only those participants with a rating of 4 and above were included in the study. It was also ensured that all the participants included in the study did not have the history of any neurological disease/head trauma, history of drugs or alcohol abuse, history of consumption of sedatives in past three days and history of less than five years of schooling. All The subjects were assessed on Hindi and English language versions of the digital color-word Stroop Task.

Stroop Task

A Digital version of both Hindi and English color-word Stroop Task was designed using Superlab 5 software (Cedrus Corporation). As presented in the traditional color- word Stroop Task, the digital version of the Stroop Task also consisted of three conditions i:e neutral, congruent and incongruent in both English and Hindi language. The Task consisted of a total of six blocks, three for English language and three for Hindi language. Block one was English neutral, block two was English congruent, Block three was English incongruent, block four was Hindi neutral, Block five was Hindi congruent and block six was Hindi incongruent. In all the conditions every block consisted of 48 trials. In all conditions the stimulus was presented on a 14* 14 inch screen. The stimulus words were positioned in the centre of the screen and were typed in 48 font size. The participants were instructed to respond to red color by pressing "Z" key, to green color by pressing the "X" key, to blue color by pressing the ">" key and to yellow color by pressing the "?" key on the keyboard. In all the blocks of both English and Hindi Stroop task the trials were arranged randomly. Participants were given a rest time of 30 minutes in between English and Hindi Stroop Task. In the neutral condition, series of both English and Hindi color- word Stroop Task

"XXXX" were written in red, green, blue and yellow color. In the congruent condition of both the English and the Hindi Stroop Task "RED", "GREEN", "BLUE" and "YELLOW" was written in the respective language in the same color as indicated by the word. In the Incongruent condition of both Hindi and English version of Stroop task "RED", "GREEN", "YELLOW" and "BLUE" was written in both English and Hindi language. However, in the incongruent condition the name of the color- word did not match with the color of the ink and the subjects were required to respond to the color of the ink and not the color-word itself. In all three conditions, the subjects responded by pressing a key on the keyboard that represented a particular color.

The response time of each trial in all conditions and in both languages Hindi and English language was noted for every subject. The facilitation, inhibition and Stroop effect was calculated for all the participants in both English and Hindi language based in their response times. Facilitation was calculated by subtracting reaction time on the congruent condition from reaction time on neutral condition. Inhibition was calculated by subtracting reaction time on the incongruent condition from reaction time on neutral condition and the Stroop effect was calculated by subtracting reaction time on the incongruent condition from reaction time on the congruent condition. The response times in both Hindi and English language of the neutral condition, congruent condition, incongruent condition, facilitation, inhibition and Stroop effect were then compared between males and females.

Results

The present study compared 30 males and 30 females on Hindi and English color- word Stroop Task. The mean age of participants was 24.2±3.6 years. The mean language proficiency reported by participants was 6 in Hindi and 5.23 in English on a scale of 0-6. Independent Samples t-test was used for comparing response time of males and females on Hindi and English language Stroop task. The results were calculated using SPSS version 25.

The results of the independent samples t-test (Table I) indicated that the mean reaction of males (*N*=30 and females (*N*=30) was statistically significant in the English neutral condition [t (58) = 6.556, p<.001], Hindi neutral condition [t (58) = 5.851, p<.001], English congruent condition [t (58) = 3.805, p<.001], Hindi congruent condition [t (58) = 3.814, p<.001], English incongruent condition [t (58) = 3.868, p<.001], Hindi incongruent condition [t (58) = 4.744, p<.001], English Stroop Effect [t (58) = 2.556, p<0.05] and Hindi Stroop Effect [t(58) = 2.231, p<0.05. Thus the results indicated that in all these conditions females had significantly shorter reaction times as compared to males.

Discussion

This study compared the response time of Hindi and English speaking bilingual males and females on Hindi and English language version of the Stroop

TABLE I: Reaction Time (in ms) in different conditions of Stroop Task

Reaction time (ms)		*Mean*	*SD*	*Sig (2-tailed)*
English Neutral	Male	907.374	90.930	0.000**
	Female	762.484	79.915	
Hindi Neutral	Male	900.682	100.414	0.000**
	Female	771.794	66.893	
English Congruent	Male	995.867	121.586	0.000**
	Female	886.601	99.781	
Hindi Congruent	Male	1018.638	102.601	0.000**
	Female	917.666	102.470	
English Incongruent	Male	1221.474	223.694	0.000**
	Female	1023.044	169.993	
Hindi Incongruent	Male	1135.583	127.654	0.000**
	Female	973.835	136.301	
English Facilitation	Male	88.493	57.091	0.111
	Female	124.116	106.286	
Hindi Facilitation	Male	117.957	77.831	0.223
	Female	145.872	96.667	
English Inhibition	Male	314.100	165.934	0.224
	Female	260.560	171.748	
Hindi Inhibition	Male	234.901	108.005	0.321
	Female	202.041	143.763	
English Stroop Effect	Male	225.607	150.371	0.013*
	Female	136.444	117.926	
Hindi Stroop Effect	Male	116.944	95.380	0.030*
	Female	56.167	114.756	

**p<0.01, *p<0.05

Task. All the participants were more proficient in Hindi as compared to English.

Independent Sample t- test was used to make comparisons between males and females on the Hindi and the English Stroop Task. The results indicated that females had significantly shorter latencies as compared to males on Neutral condition, Congruent condition, Incongruent condition and Stroop effect in both English and Hindi languages. Thus, these results indicate that females are better in colour naming abilities as compared to males. The fact that females had shorter latencies than males in neutral condition provides support for the fact that they process colour faster as compared to males.

The second major finding of this study was that gender differences appeared in the same way between male and females across both Hindi and English language. These results indicated that gender differences on Stroop task are independent of 'bilingualism'.

Studies have shown that differences in colour vision in males and females are the result of spectral sensitivities of photoreceptors in the retina that are determined by genes on the X chromosome. In addition to causing colour vision deficiencies that are inherited in humans- especially males, this genetic difference causes possibilities for females to express multiple types of the same photo pigments, thus putting them at an advantage for colour perception. Another probable explanation for shorter latencies in females as compared to males can be attributed to anatomical differences between males and females. Although males have a larger brain size as compared to females, females have a more convoluted cerebral cortex with higher neuronal density as compared to males (25). Females have a larger callosal area and planum temporale as compared to males (6, 7, 8). These differences have thus shown to influence cognitive functions in both males and females. Researchers have also shown that line communication from color receptors to the tectum, superior colliculus, and pulvinus might provide an explanation for faster color processing in females, while a retinal geniculostrialtal route might serve for fine-grained word-pattern analysis (26).

Although the explanation for female and advantage on Stroop Task can be attributed to the physiological and anatomical differences in males and females, this study was unable to pinpoint the exact mechanism underlying these differences. Hence, extensive further research is needed to understand the biological basis for such differences.

Conclusion

The present study indicated that females had significantly shorter latencies as compared to males on the neutral, congruent and Incongruent conditions and Stroop effect in both English and Hindi language, thereby indicating that females processed colours faster than males probably due to anatomical differences in size and representation of different areas of brain.

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References

1. Mani A, Mullainathan S, Shafir E, Zhao J. Poverty Impedes Cognitive Function. *Science* 2013; 341(6149): 976–980.
2. Egner T, Hirsch J. The neural correlates and functional integration of cognitive control in a Stroop task. *Neuroimage* 2005; 24(2): 539–547.
3. Lezak MD, Howieson DB, Loring DW, Hannay HJ, Fischer JS. Neuropsychological assessment. Oxford University Press Inc, New York, USA, 2004; p. 365–367.
4. Stroop JR. Studies of interference in serial verbal reactions. *J Exp Psychol* 1935; 18(6): 643–662.
5. Macleod CM. Half a century of research on the Stroop effect: An integrative review. *Psychol Bull* 1991; 109(2): 163–203.
6. Burke HL, Yeo RA. Systematic variations in callosal morphology: The effects of age, gender, hand preference, and anatomic asymmetry. *Neuropsychology* 1994; 8(4): 563–571.

7. Kimura D. Are men's and women's brains really different?. *Can Psychol* 1987; 28(2): 133.
8. Goy RW, McEwenBS.Sexual differentiation of the brain, MIT Press, Cambridge, 1980.
9. Watson NV, Kimura D. Nontrivial sex differences in throwing and intercepting: Relation to psychometrically-defined spatial functions. *Pers Individ Dif* 1991; 12(5): 375–385.
10. Harris LJ. Sex-Related Differences in Spatial Ability: A Developmental Psychological View. In: C Kopp (Ed) Becoming Female: Perspectives on development, Plenum, New York 1979; p. 133–181.
11. Maccoby EE, Jacklin CN. The psychology of sex differences. Stanford, CA, Stanford University Press, 1978.
12. Singh SP. Sex differences in cognitive functioning. *Psycho-Lingua* 1991; 21(1): 47–50.
13. Naish P. Phonological recoding and the Stroop effect. *Br J Psychol* 1980; 71(3): 395–400.
14. Waber D. Sex differences in cognition: a function of maturation rate? *Science* 1976; 192(4239): 572–574.
15. Bone RN, Eysenck HJ. Extraversion, Field-Dependence, and the Stroop Test. *Percept Mot Skills* 1972; 34(3): 873–874.
16. Peretti PO. Cross-sex and cross-educational level performance in a color-word interference task. *Psychon Sci* 1969; 16(6): 321–323.
17. Baroun K, Alansari B. Gender Differences in Performance on the Stroop Test. Social Behavior and Personality: *An International Journal* 2006; 34(3): 309–318.
18. Elst WVD, Boxtel MPJV, Breukelen GJPV, Jolles J. The Stroop Color-Word Test: influence of age, sex and education; and normative data for a large sample across the adult age range. *Assessment* 2006; 13(1): 62–79.
19. Mekarski JE, Cutmore TRH, Suboski W. Gender Differences during Processing of the Stroop Task. *Percept Mot Skills* 1996; 83(2): 563–568.
20. Strickland TL, Delia LF, James R, Stein R. Stroop color-word performance of African Americans. *Clin Neuropsychol* 1997; 11(1): 87–90.
21. Bloomfield L. Language. New York: Holt, Rinehart & Winston, 1935.
22. Jorgenson CB, Davis J, Opella J, Angerstein G. Hemispheric asymmetry in the processing of stroop stimuli: An examination of age and gender differences. *Int J Neurosci* 1981; 13(2-3): 113–116.
23. Lee TMC, Chan CCH. Stroop Interference in Chinese and English. *J Clin Exp Neuropsychol* 2000; 22(4): 465–471.
24. Alansari BM, Baroun K. Gender and cultural performance differences on the Stroop Color and Word test: A comparative study. *Social Behavior and Personality: An International Journal* 2004; 32(3): 233–243.
25. Willerman L, Schultz R, Rutledge J, Bigler ED. Hemisphere size asymmetry predicts relative verbal and nonverbal intelligence differently in the sexes: An MRI study of structure—Function relations. *Intelligence* 1992; 16(3-4): 315–328.
26. Strominger NL, Demarest, RJ, Laemle LB. Noback's Human Nervous System,7th edition, Humana Press, New York, 2012.