

Reaction time in Stroop test in Nepalese Medical Students

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ABSTRACT

Background: Stroop test is one of the widely used tests in cognitive psychology. It is used both in healthy population and also in patients to assess the selective attention. The selective attention as assessed by it is also found to be altered in bilinguals. In Nepal, most of the students are bilingual since most of the courses are in English language. Thus, they learn English language along with their native languages. This study is aimed to assess the selective attention in healthy Nepalese medical students.

Objective: To study the reaction time in stroop test in medical students of Nepal.

Materials and Methods: This study was conducted on 30 healthy male students aged 23.1±2.8 yrs. They were asked to read congruent (red printed in red ink) and incongruent (red printed in blue ink) tests in classical stroop cards. The reaction times for

both the tests were calculated. Median with inter-quartile range was obtained for reaction time. Wilcoxon's Sign Rank Test was used to compare reaction time and errors between congruent and incongruent cards.

Results: The subjects took 82.10 (63.75-107.76) sec longer to read incongruent stroop test ($p < 0.001$). The error made was 0 in congruent stroop test and 1.5 (0-3) in incongruent stroop test ($p < 0.001$). No students made error in the congruent test but 60% (18) of students made error in incongruent test ($p < 0.001$) and interference percentage in incongruent was 157 (115.32-213.50)%.

Conclusion: The reaction time and interferences were more in incongruent stroop test than congruent test. The interference was very high than that of previous literature's value. This indicates that Nepalese students have delayed attention while performing classical English version of stroop test.

Keywords: Delayed reaction time, Nepalese medical students, Stroop test

INTRODUCTION

The Stroop Color-Word Test (named after J. Ridley Stroop) is a test in cognitive psychology. This test is used to assess selective attention. In this test, subjects are required to name the color of the word printed in different ink colors. e.g (red printed in blue ink has to be read as blue). Interference between word meaning and ink color occurs, which prolongs reaction time. This is because they automatically encode the written words in addition to visual colors [1]. Studies suggest that the color- and picture-word Stroop tests measure different cognitive functions [2]. Some studies have shown that performance decreases with increasing age [2] and lower levels of education [3]. However, practice-related improvement in performance on the Stroop task has been reported [4]. Studies were also conducted in bilinguals. In a study done on Spanish English bilinguals, those participants who were Spanish-dominant bilinguals were significantly slower in all the stroop test conditions in English, and the English-dominant bilinguals were slower in the stroop test condition in Spanish [5]. But, in one of the study of English-Dutch bilinguals who had fluency and proficiency in both languages, researchers found that participants took the same amount of time to complete the Dutch Stroop task and the cross-language English Stroop task [6]. It was also suggested that interference between languages could be similar as that within languages, but that depended on relative familiarity with the two languages [7]. Nepalese students are also bilinguals. In Nepal, English language is used in Education field. Large numbers of Nepalese students complete their schooling from English medium schools. In Government schools also English is taught as a compulsory subject. Higher education in Science and Technology, medical and engineering field and other courses are only in English language. Because of this need, Nepalese students learn English language along with Nepalese language, and other local languages. Many of the intelligent quotient (IQ) test and other attention tests in English are also used to assess Nepalese students. Since English is widely used, we conducted the study in classical English version of congruent and incongruent stroop test to assess reaction times (selective attention) and interferences.

MATERIALS AND METHODS

This cross-sectional study was conducted on 30 healthy male students of age group 23.1±2.8 years with normal eye sight or corrected to normal eye sight having normal color vision. Male subjects with history of medical illness, physical disability, neurological disorder, color blindness were excluded from the study. Before the beginning of experiment, subjects were asked to relax for 5 minutes. After detailed medical history, physical examination and anthropometric measurements subjects were familiarized with the laboratory setup. We used the classical version of original Stroop test. [Table/Fig-1].

- Control card with congruent words (e.g., the word green written in green ink)
- Experimental card with incongruent words (e.g., the word green written in blue ink or the word red written in green ink).

The experimental card consisted of ten columns and ten rows printed in five different colors. Words were in same order in both cards. In the control card subject had to read the word written in congruent words. In experimental cards subject had to name the color of the printed word in incongruent words. Colors used were red, blue, green, brown, and purple. The colors were arranged so as to avoid any irregularity of occurrence and so that each color would appear twice in each column and in each row, and that no color would immediately succeed itself in either column or row. The words were also arranged so that the name of each color would appear twice in each line. No word was printed in the color it named but an equal number of times in each of the other four colors; i.e. the word 'red' was printed in blue, green, brown, and purple inks; the word 'blue' was printed in red, green, brown, and purple inks; etc. No word immediately succeeded itself in either column or row [8].

Both control and experimental Stroop cards were printed in A3 size paper with font size 28 for each word. For control card, errors were checked by similar card written in black ink whereas for incongruent card the check card was substituted with word matching the color

CONGRUENT STROOP CARD

RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE
BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED
GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE
BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN
PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN
RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE
BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED
GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE
BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN
PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN

INCONGRUENT STROOP CARD

RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE
BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED
GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE
BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN
PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN
RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE
BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED
GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE
BROWN	PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN
PURPLE	RED	BLUE	GREEN	BROWN	PURPLE	RED	BLUE	GREEN	BROWN

[Table/Fig-1]: Congruent and incongruent stroop card

Age (years)	23.1±2.8
Height (cm)	172.4±7.37
Weight (kg)	63.76±7.39
BMI (Kg/m ²)	21.44±2.14
SBP mmHg	119.73±13.98
DBP mmHg	77.26±5.42
RR/min	13.56±1.30
HR/min	74.7±8.06
O ₂ Sat %	97.3±0.74

[Table/Fig-2]: General characteristics of subjects., BMI = Body mass index, SBP = Systolic blood Pressure DBP= Diastolic blood pressure, RR = Respiratory rate, HR = Heart rate, O₂ Sat = Oxygen saturation, n= Number of subjects

subject had to speak e.g., (if the experimental card contained green written in blue ink, the check card had blue word written in it). The subjects were asked to correct the error if they made it.

Ten sample words from both control and experimental cards were given to read to make the subject acquaint with procedure. Subjects were asked to sit down and feel comfortable in a chair. The Card was held in front of subject at about 50 cm from eye level. Then on the signal "1, 2, 3 go" the subjects were instructed to read aloud congruent words. After completing the congruent test, subjects were asked to read experimental incongruent card. All the procedures adopted were similar in both the tests except the colors of the words, which were to be called in succession in incongruent tests. (red word printed in blue color had to be called blue).

Ethics: Ethical clearance was obtained from Institutional Ethical review board.

STATISTICS

The total time taken to read the whole card was taken as reaction time for each card. The total reaction time divided by number of stimuli was used to calculate average time for each word. If any error was left uncorrected, twice the average response time per item was added to a subject's total reaction time for every uncorrected error [7].

Variables	Congruent card, n=30 median (interquartile range)	Incongruent card, n=30 median (interquartile range)	p value
Errors	0	1.5 (0-3)	<.001
No. of subjects making error	0	18	<.001
% of subjects making error	0	60%	<.001

[Table/Fig-3]: Comparison of errors between congruent and incongruent Stroop test., p<.05 is significant

Variables	Congruent card, n=30 median (interquartile range)	Incongruent card, n=30 median (interquartile range)	Difference in reaction time	Interference percentage	p-value
Time taken to read before error correction (seconds)	56.5 (48.5-73.5)	144.5 (121.5-156)	82.10 (63.75-97.0)	152% (105.50-196.62)%	<.001
Time taken to read after error correction (Seconds)	56.5 (48.5-73.5)	146.32 (124.59-166.92)	82.10 (63.75-107.76)	157% (115.32-213.50)%	<.001

[Table/Fig-4]: Comparison of reaction time between congruent and incongruent Stroop test and interference effect., p<.05 is significant

Since distribution of data was non- parametric, the reaction times in both congruent and incongruent card for all the subjects were expressed in median with interquartile range. Wilcoxon's Sign Rank Test was used to compare reaction time and errors between congruent and incongruent cards.

RESULTS

The general characteristics of students are given in [Table/Fig-2]. None of the subjects made any error during congruent card reading. But, 60% subjects left errors uncorrected during incongruent card reading [Table/Fig-3] the time taken to read incongruent card was longer than the congruent card. The interference percentage was more in incongruent test [Table/Fig-4].

DISCUSSION

We assessed selective attention ability in Nepalese medical students of BPKIHS, Nepal using classical English version of Stroop test. Studies have suggested that age, sex and education affects the performance during Stroop test [3,9-12]. Also it is observed that the reaction time in stroop test in different phases of menstrual cycle varies [13,14]. Since our purpose was to calculate only the reaction time, we chose only male students so as to avoid confounding factors. Also Mclead in his review suggested that language proficiency could affect the performance of stroop test [7]. Thus, we selected medical students who had similar level of education in English background.

In our study, students took similar time to read the congruent card as published in previous studies, however, they took longer time to read incongruent Stroop card and interference was also high than the Stroop's study published by Stroop [8] and MacLeod [7]. The vast difference between two tests in our study might be Nepalese are non native English speakers. So, they find more difficulty in reading incongruent tests made for English person and the interference increases. It is also supported by the previous studies, which have shown that the interference is more if the second language is non-dominant one [5]. Mc-lead also suggested in his review that the fluency and proficiency of language determines the interference percentage in stroop test [7]. We took the Nepalese medical students, who were taught English from early ages, and we assumed that they can perform the English stroop test well but our results showed longer reaction time for incongruent task and interference was also high. However, for the congruent task time taken was similar as in published studies. Thus, our results indicate,

as selective attention and task difficulty increases for Nepalese students, the interference percentage also increases. Though English language is used widely in education in Nepal, it is not spoken commonly. This could be one of the reasons for increased reaction time and interferences. This study is giving an important fact for Nepalese students that as task difficulty increases in English the understanding and capacity to perform the work decreases. In addition it is also seen that English version of stroop test cannot assess selective attention in Nepalese students. Nepalese version of stroop test should be made and compared with English version and interference should be tested.

LIMITATION

Since in Nepal we could not find native English speakers, we had to compare our value with previous literatures values. Nepalese version of stroop card should be prepared and reaction time can be compared between Nepalese version and English version of stroop test. We took only 30 students so as to find out the preliminary values in our test. This study can be used to calculate reaction time in large population.

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CONCLUSION

We found longer reaction time and more interference in Nepalese medical students in classical English version of stroop test, which

indicated delayed selective attention in these students. This may be because they are non-native English speakers.

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