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Abstract

The Stroop Effect is a demonstration of interference in the reaction time of a task. Females and children are reported to be quicker at reacting to the stroop tests. As age increases the reaction time taken to complete the test also increases. The Stroop Effect is now a mainstay of research on age-related differences in selective attention, automaticity, inhibitory processes and executive control. Stroop tests may be developed as a part of the assessment tool in cases of mild cognitive impairment seen in geriatric population. However, studies relating to the influences of Stroop Effect interferences are lacking in the Indian literature.

The present study is aimed to see the development of Stroop Effect interference in a small group of Malayalam – English bilingual population, and to see whether gender difference exists in Stroop Effect tasks. 16 subjects (8 males and 8 females) in different age groups were taken. Age groups considered were divided into young adults (20 – 40 years), middle aged adults (40 – 60 years) and elderly, above 60 years. The subjects were shown incongruent stroop test mini cards (in which the color terms are written using different ink colors) and were asked to say the colors of the ink, correctly with which the items were written on the cards and the reaction time (RT) taken by each of the subject was measured using a stop watch.

The extensive literature on Stroop Effect has many inconsistencies, were some studies mention that the Stroop Effect does not depend on age while some studies show the influence of aging in Stroop color tasks. Differences in literature are also found with respect to effects of gender.

In the present study, Univariate analysis of variance and t tests were carried out for data analysis. Results indicated that the reaction time (RT) taken to name the incongruent colors showed a significant increase with the increase in age. The increasing trend with respect to time taken and age was apparent and the time taken by males in the entire study showed higher mean RT compared to females. As for the gender differences within age groups, significant differences were seen between males and females till the age of 60 years in naming the incongruent colors. But it was seen that after the age of 60 years there was no significant difference in the reaction time taken between males and females.

The increasing RT seen in the study with respect to increasing age can be accounted for by the general slowing effects seen in the ageing population. This increase in time taken to process the incongruent color terms due to Stroop Effect, as reported in the literature, is supported by the present study. Another finding of the study was the gender difference seen within different age groups, were females were found to outperform males before attaining the age of 60 years. The improved color recognition skills in specific, along with the advanced language flexibility in females can account for this finding. This is in agreement with the studies in literature that supports female advantage in language processing, although the reasons are still debated. The absence of gender effects after 60 years of age may probably be because the female advantage is nullified with advancing age due to general cognitive decline.

INTRODUCTION

The Stroop Effect is a demonstration of interference in the reaction time of a task. When a word such as blue, green, red, etc. is printed in a color differing from the color expressed by the word's semantic meaning (e.g. the word "red" printed in blue ink), a delay occurs in the processing of the word's color, leading to slower test reaction times and an increase in mistakes. The effect is named after John Ridley Stroop who first published the effect in English in 1935.

There are two theories that may explain the Stroop Effect:

1. Speed of Processing Theory: the interference occurs because words are read faster than colors are named.

2. Selective Attention Theory: the interference occurs because naming colors requires more attention than reading words.

It is seen that in monolinguals, reaction times increased in stoop experiments when the foreign language had a close phonological resemblance to the language they used. While in bilinguals, interference was seen in both languages and it was seen that naming was slowest when the naming language and the language of the color names were the same. (Dyer F.N, 1971).

Females are reported to be quicker at reacting to the stroop tests. Females are found to have an advantage over color recognition (Baroun, 2006) along with the fact that females may be somewhat faster, especially in naming colors, due to their general response speed (Jensen, 1965).

The Stroop Effect is now a mainstay of research on age-related differences in selective attention, automaticity, inhibitory processes, and executive control. A major focus of the aging research has been on the relative size of Stroop interference effects in younger and older adults. The typical finding is that, relative to a baseline condition involving the naming of colors of neutral stimuli (e.g., strings of X's), older adults show a greater increase in reaction time and/or errors in naming of the print colors of incongruent color words than do younger adults (Cohen et al. (1984) as cited by Douglas J. Davidson, Rose T. Zacks and Carrick C. Williams, 2003).

Although these data have sometimes been attributed to general slowing effects (Verhaeghen & De Meersman, 1998), others have argued that the larger Stroop Effects in older than in younger adults support views proposing age deficits in particular cognitive processes (e.g., the inhibition deficit view of Hasher & Zacks, 1988) or neural mechanisms (e.g., the frontal lobe dysfunction view; Perfect, 1997)

With respect to this last point, there is considerable current interest in relating age differences in the Stroop Effect and on other measures of executive function (e.g., task switching,Kramer, Hahn and Gopher, 1999) to neuroanatomical and neuroimaging findings suggesting that aging particularly affects functions served by prefrontal areas of the brain. For example, a recent fMRI study by Milham et al. (2002) found differences in the patterns of neural activity associated with Stroop performance between younger and older adults, including less extensive activity in the dorsolateral prefrontal cortex in the older group. Similarly it was shown that the young adult group and healthy older adult group showed similar activation regions on an fMRI task but older adults exhibited greater activation in numerous frontal areas, including the left inferior frontal gyrus. The results support the recruitment construct and suggest that the inferior frontal gyrus is important for successful inhibition. (Scott A. Langenecker, Kristy A. Nielson and Stephen M. Rao)

In a study done by Peter J. Houx, Jellemer Jolles , Fred W. Vreeling (1993) regarding stoop interference on aging and gender, reaction time taken by elderly population were more while no sex differences were observed, and more highly educated subjects were reported to perform better than less educated subjects. This accounts to the fact that executive function, as measured by the Stroop test, declines with age and that the decline is more pronounced in people with a low level of education. This is consistent with the reserve hypothesis of brain aging (i.e., that education generates reserve capacity against the damaging effects of aging on brain functions).

It is seen that practice reduces interference on the Stroop tasks. Young adults' reduction in Stroop interference was due to general task factors plus the development of a reading suppression response. The old adults' reduction in Stroop interference was attributed primarily to general task factors. Results indicate that old adults have greater difficulty than young adults in developing new automatic processes and modifying existing automatic processes. Thus in addition to automatic processing, attentional mechanisms also must be incorporated to account for the age-related differences. (Cynthia L. Dulaney and Wendy A. Rogers)

The Stroop test has also been used for diagnostic purposes. Dyer (1973) outlined how the Stroop phenomenon has been used to study various perceptual and cognitive processes. Golden (1976) also discussed how the Stroop test has been used to diagnose brain damage.

Stroop tests may be developed as a part of the assessment tool in cases of mild cognitive impairment seen in the geriatric population. It was shown that there was close correlation between the Mini Mental State Examination (MMSE) score and tasks based on Stroop Effects

and that the Stroop Effect did not depend on age. It was concluded that the Stroop Effect was available to diagnose forgetfulness and mild dementia. (Uchiyama Hisashi, 2002)

The extensive literature on the Stroop Test (Stroop, 1935) includes many inconsistencies. Although a number of generalizations concerning the Stroop Effect are accepted, some studies such as Macleod (1991) yielded gender difference on the interference card, while other studies reported that men and women did not display differential interference. Still other studies reported that women were quicker on the Stroop color-word card test than men were (Sarmany, 1977).

Need for the study

Studies relating influences of stoop effect interferences are lacking in the Indian literature. The knowledge regarding the semantic interference in Stroop Effect and its developmental course will help in identifying mild cognitive impairments seen in ageing population. This will also help to broaden our knowledge regarding the language representation and its interconnectivities in the brain.

Regarding the development of Stroop Effect, it is accepted that elderly population will have slower reaction times, the reason for which is attributed to various causes. There are some studies which say that females have faster reaction times than males, while other studies say there is no gender difference seen during stroop color naming tasks.

So the present study is aimed to see the development of Stroop Effect interference in a small group of Malayalam – English bilingual population, and to see whether gender difference exists in the Stroop Effect tasks.

Methodology

Participants selected: 16 subjects (8 males and 8 females) in different age groups were included in the study. Age groups considered were divided into young adults (20 – 30 years), middle aged adults (30 – 60 years) and elderly, above 60 years. All the subjects had Malayalam as their mother tongue and had English exposure at school. All the participants had a minimum educational background up to graduation. All had vision which is normal or corrected to normal

Procedure: The subjects were shown incongruent stroop test mini cards (in which the color terms are written using different ink colors) and were asked to say the ink colors with which the items were written on the cards and the reaction time (RT) taken by each of the subject was measured using a stop watch.

The incongruent stroop test mini cards used for the study is shown below

RED	BLUE	YELLOW	BLACK	GREEN
GREEN	RED	YELLOW	BLUE	BLACK
YELLOW	BLACK	RED	GREEN	BLUE
BLACK	YELLOW	BLUE	RED	GREEN
BLUE	GREEN	BLACK	YELLOW	RED

Results and Discussion

The extensive literature on the Stroop Effect has many inconsistencies were some studies show gender differences in Stroop Effect while some other studies do not and some studies show that the Stroop Effect does not depend on the age.

The subjects included in the present study consisted of 8 males and 8 females in different age groups. They were shown the incongruent stroop mini color cards and were asked to name the colors. The reaction time taken, for naming the incongruent color words by the young adult groups were then averaged and was taken as the base value to which the reaction time taken by middle aged and elderly group were compared. Gender differences in reaction time were also noted to see whether any significant difference was present. The statistical tools used in this study include Univariate analysis of variance to check for the differences in the age group against reaction time scores and t tests to find out whether there was significant difference in RT with respect to gender variations.

The reaction time (RT) taken by males and females of the different age groups are tabulated and the results of the various statistical tools used for the data analysis are shown in the following tables.

Table 1 shows the gender differences in the age group of 20- 40 years with respect to RT in seconds

Table 1

Males	Females
34	32
33	28
32	26
30	25
34	30
32	31
30	27
31	27

Table 2 shows the gender differences in the age group of 40 – 60 years with respect of RT in seconds

Table 2

Males	Females
43	42
44	40
42	41
45	38
48	40
44	39
41	43
44	44

Table 3 shows the gender differences in the age group of 60 years and above with respect to RT in seconds

Table 3

Males	Females
54	60
56	55
58	52
59	54
53	57
60	51
49	48
52	53

Table 4: Results of Univariate analysis of variance

Age	Gender	Mean	Standard deviation
20 – 40	Males	32	1.604
	Females	28.25	2.493
	Total	30.125	2.802
40 - 60	Males	43.875	2.100
	Females	40.875	2.031
	Total	42.375	2.527
Above 60	Males	55.125	3.796
	Females	53.750	3.693
	Total	54.438	3.687

Tests of Between – Subjects Effects:

Age	Subset		
	1	2	3
20 - 40	30.125		
40 - 60		42.375	
60 +			54.438

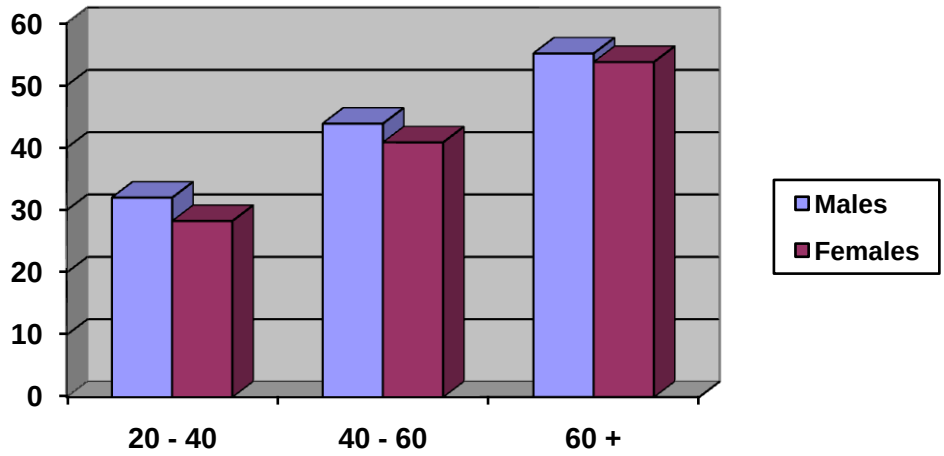
Harmonic mean sample size = 16
Alpha = .05

Table 5: Independent Samples Test data analysis

Age group	t	Sig. (2-tailed)	Mean difference
20 - 40	3.578	.003	3.750
40 - 60	2.904	.012	3.000
Above 60	.734	.475	1.375

The following graph depicts the gender differences in the different age groups in years (on X axis) with respect to the mean reaction time in seconds (on Y axis) during the stroop color naming tasks

Graph 1



As the tables and graph reveals, the increase in the reaction time is obvious as the age increases. It also clearly shows the gender differences and its significance with respect to the different age groups.

Conclusion

The results of the present study supports the earlier literature which mention the increasing reaction time taken to process the color terms due to Stroop Effect with increasing age. This can be attributed to the general slowing effects seen during normal aging.

The results also revealed a significant difference in the performance of males and females till the age of 60yrs, where the mean scores obtained for females were higher than the males. This could be due to the improved color recognition skills, general fast response speeds and the advanced language flexibility skills in females than males.

This is in agreement with the studies in literature that support female advantage in language processing, although the reasons for which are still debated. These advanced verbal skills may probably get nullified with the advancing age due to the general cognitive decline. This may explain why there was less significant gender difference seen after 60 years of age.

This study thus substantiates the differences in Stroop interference between males and females. These same results are needed to be confirmed for monolinguals also for which further studies may be taken up.

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