J Nepal Health Res Counc 2026 Jan-March; 24 (70): 146-150

Changes in Stroop Task Performance Across the Life Span

Reena Kumari Jha,[1] Abadhesh Kumar Mishra,[2] Niraj Chaurasiya,[1]Ojashwi Nepal[1]

[1]KUSMS, Dhulikhel, Kavre, Nepal, [2]Shukraraj Tropical and Infectious disease hospital, Teku, Kathmandu, Nepal.

ABSTRACT

Background: The Stroop test assesses attention and cognition. The selective attention assessed by this test varies in bilingualism, education, gender and advancing age. Thus, this study aimed to examine age related changes in reaction time using the Stroop test.

Methods: A cross-sectional study was conducted at Kathmandu University School of Medical Sciences between March 2025 and November 2025. A total of 210 participants aged 18 – 80 years were recruited through convenience sampling. Participants were categorized into three age groups: Group 1 (18–30 years), Group 2 (31–60 years), and Group 3 (>60-80 years). Each group consist 70 participants, 35 males and females. Each participant was assessed individually and instructed to read the control, congruent, and incongruent Stroop cards. Reaction time was measured using a digital stopwatch for each task.

Results: Reaction time demonstrated a significant age related increase across all task conditions. In the control condition, the mean reaction time increased from 21.19 ± 6.80 seconds to 30.38 ± 10.76 seconds and further to 45.13 ± 12.69 seconds ($p < 0.001$). A comparable pattern was observed in the congruent condition, where mean reaction times rose from 20.41 ± 5.32 seconds to 28.34 ± 9.27 seconds and 41.27 ± 9.69 seconds ($p < 0.001$). The most pronounced differences were evident in the incongruent condition, with reaction times increasing markedly from 63.64 ± 30.72 seconds to 104.48 ± 34.25 seconds and 141.32 ± 47.97 seconds ($p < 0.001$).

Conclusions: Reaction time is significantly influenced by age. Older participants demonstrated slower responses, indicating an age-related decline in executive function and cognitive processing speed.

Keywords: Aging: attention; cognition; reaction time.

INTRODUCTION

The Stroop Color Word Test (SCWT) is commonly used in both healthy individuals and clinical populations to assess attention, processing speed, and executive function.[1] Previous research showed selective attention measured by the Stroop test varies in bilingualism,[1] gender,[2] increasing age[3, 4] and education level.[5]

Advancing age has been consistently associated with a decline in cognitive functions, particularly in attentional control and processing speed.[3] There are large inter-individual differences in executive functioning in older age due to a number of genetic, disease-related, lifestyle-related, demographic, and social factors constituting cognitive reserve.[2]

Despite substantial international research, only a limited number of studies in Nepal have investigated reaction time using the SCWT, and comparisons across different age groups have yet to be conducted. Therefore, the present study aimed to evaluate age-related alterations in reaction time using the Stroop Color Word Test.

METHODS

A cross sectional study was carried out in the Kathmandu University School of Medical Sciences, from March 2025 to November 2025. A total of 210 participants, aged 18 - 80 years were enrolled through convenience sampling. Based on age, all the participants were categorized into three groups, group I (younger group, aged 18 to 30 years), Group II (middle-aged group, 31 - 60 years) and group III (older group, > 60 - 80 years). Younger participants were recruited from medical students of Kathmandu university school of medical sciences and middle-aged & older participants were recruited from

Correspondence: Reena Kumari Jha, Department of Physiology, KUSMS, Dhulikhel, Kavre, Nepal. Email: reena2017dec@gmail.com, Phone: +9779743935051.

staffs, drivers, and attendants of KUSMS and visitors of patients from Dhulikhel hospital. Ethical clearance was taken from Institutional review committee (IRC-KUSMS Approval No.112/25).

Sample size was calculated using standard power analysis (G*Power), Assuming Medium effect size (f = 0.25)[6], number of groups k = 3, significance level α = 0.05 and power (1-ß) = 0.90. Sample size was calculated by using formula given below $\lambda = f^2 * N$. Total sample size, N = 210. Per group sample size n= N/3. Thus the number of sample size required is calculated as 70 participants in each group.

Healthy participants with normal or corrected to normal vision were recruited for the study. Individuals who self-reported colour blindness, a history of medical illness, physical disability, or neurological disorders were excluded. Prior to participation, the study protocol was explained in detail and written informed consent was obtained from all participants. Before the commencement of the proper research, participants were instructed to rest quietly for five minutes. Anthropometric measurements were then recorded.

The classical version of the stroop color word test was administered, consisting of three conditions: control, congruent, and incongruent. The control card comprised five colour patches (red, green, blue, purple, and brown) arranged in five columns and ten rows, printed in black ink on a white background. Participants were instructed to name the colours aloud, while the investigator, holding an identical card, verified the responses. The time taken to complete the task was recorded using a digital stopwatch (100 MIN Electronic Timer, China). Subsequently, participants completed the congruent condition, in which colour names were printed in ink matching the semantic meaning of the word (e.g., the word "red" printed in red ink), presented in the same layout. Accuracy and completion time were recorded. Finally, participants performed the incongruent condition, in which colour names were printed in ink that differed from the word meaning (e.g., the word "red" printed in blue ink). Participants were instructed to name the ink colour while ignoring the written word. The investigator recorded response accuracy and task completion time. Across all three conditions, reaction time and the number of errors were documented for analysis.

The collected data was entered into Microsoft excel and analyzed using IBM Statistical Package for Social Sciences version 22.0 software. The data were analyzed using descriptive statistics and have been presented as means, standard deviation, frequency, percentage. ANOVA was used to compare the mean reaction time by SCWT among different age groups. Level of significance was set at the p-value of < 0.05.

RESULTS

A total of 210 participants were enrolled in the study. All the participants were categorized into Group I (aged 18 – 30 years), Group II (aged 31 – 60 years) and Group III (aged >60 – 80 years). Each group consisted of 35 male and 35 female participants. Age, weight and Body mass index (BMI) were higher in older age group compared to middle aged and younger age group participants as shown in table 1. Most of the older participants (74.3%) were wearing glass.

Table 1. Demographic Characteristics of the Study population.

Parameters	18- 30 years (N = 70)	31- 60 years (N = 70)	>60-80 years (N = 70)	p-value
Age in years (Mean±SD)	22.37±3.00	44.62±6.53	67.55±5.26	< 0.001
Height (Meter) (Mean±SD)	1.63±0.07	1.61±0.06	1.64±0.10	0.08
Weight (Kg) (Mean±SD)	59.40±10.12	65.32±9.11	72.60±10.39	< 0.001
BMI (Kg/M2) (Mean±SD)	22.31±3.38	25.05±3.30	26.78±3.20	< 0.001
With lens, N (%)	16 (22.9)	21 (30.0)	52 (74.3)	
Without lens, N (%)	54 (77.1)	49 (70.0)	18 (25.7)	

Table 2 Showed that the duration of reaction time was different in different age groups for all Stroop task conditions (control, congruent, and incongruent cards). The youngest group demonstrated the fastest response followed by the middle-aged group and the oldest group showing the slowest responses. Out of 210 participants, 112 (53.33%) participants made error while reading incongruent card however none of the participants made any error during

control and congruent card reading. Majority (70%) of older participants made errors in reading incongruent card. The time taken to read incongruent card was longer than the control and congruent card. (Table 3)

Table 2. Age wise comparison of reaction time.

	18 – 30 years	31 - 60 years	>60-80 years		
	RT (Sec) (Mean±SD)	RT (Sec) (Mean±SD)	RT (Sec) (Mean±SD)	F-value	p-value
Control card	21.19±6.80	30.38±10.76	45.13±12.69	94.68	< 0.001
Congruent card	20.41±5.32	28.34±9.27	41.27±9.69	111.82	< 0.001
Incongruent card	63.64±30.72	104.48±34.25	141.32±47.97	71.74	< 0.001

Table 3. Comparison of errors between different age groups.

Variables	Incongruent card		
	Group I N=70	Group II N=70	Group III N=70
Errors	0 - 7	0 - 15	0 - 25
No of participants making errors	22	33	49
% of participants making errors	31.42	47.14	70

The duration of reaction time was prolonged in both males and females old aged group compared to middle aged and younger group. In control card, young aged and old aged male responds faster than female participants however in incongruent card condition, female participants showed fast response than males in older age group. Both gender took long duration to read incongruent card compared to congruent card (Table 4).

Table 4. Gender- wise comparison of reaction time.

		18 – 30 years	31 - 60 years	>60-80 years		
		RT (Sec) (Mean±SD)	RT (Sec) (Mean±SD)	RT (Sec) (Mean±SD)	F -value	P-value
Control card	Male	19.52±4.77	29.22±9.05	41.70±10.94	57.78	< 0.001
	Female	22.86±8.09	31.53±12.26	48.56±13.53	44.96	< 0.001
	p-Value	0.03*	0.37	0.02*		
Congruent card	Male	18.57±3.31	27.08±8.16	39.18±9.94	63.73	< 0.001
	Female	22.25±6.29	29.59±10.22	31.73±12.30	53.21	< 0.001
	p-Value	0.00*	0.26	0.07		
Incongruent card	Male	63.05±29.70	107.38±32.74	156.22±55.38	45.40	< 0.001
	Female	64.23±32.13	101.60±35.94	126.42±33.85	29.64	< 0.001
	p-Value	0.87	0.48	< 0.001*		

*Indicates significant difference

DISCUSSION

This study assessed age related variations in performance on the strop color word test (SCWT) among participants aged 18 – 80 years. The findings demonstrate a progressive increase in reaction time with advancing age across all Stroop conditions, with the most pronounced delay observed during the incongruent task. Our findings are supported by several studies that showed age and education affects the performance during Stroop test.[5,7,8] These results reflect an age associated decline in processing speed and executive functioning, which is consistent with established evidence on cognitive aging.[2,3]

Reaction times increased significantly from younger to older age groups in control, congruent, and incongruent conditions, indicating a generalized slowing of cognitive processing with age. This pattern supports Salthouse's processing speed theory, which attributes age related cognitive decline primarily to reduced efficiency of information processing, even during relatively simple tasks.[3] The prolongation of reaction times in the control, congruent and incongruent conditions suggests slowing of basic perceptual, motor processes and impairments in higher order executive control mechanisms.[9]

The incongruent Stroop condition elicited the longest reaction times and highest error rates across all age groups, with errors increasing notably among middle aged and older participants. This reflects increasing difficulty in inhibiting automatic word reading responses and resolving cognitive conflict with advancing age. The enhanced Stroop interference observed in older adults supports the inhibitory deficit hypothesis, which proposes that aging compromises the ability to suppress irrelevant information, resulting in reduced selective attention and cognitive flexibility.[9] These findings are consistent with prior neuropsychological research demonstrating the sensitivity of Stroop performance to frontal lobe function and age related neurobiological changes.[9,10]

Error analysis further indicated that basic reading ability and color recognition remained preserved across all age groups, as evidenced by the absence of errors in control and congruent conditions. In contrast, errors were predominantly observed during the incongruent task, suggesting that aging selectively affects executive functions rather than fundamental perceptual or linguistic skills. Similar observations have been reported by Scarpina and Tagini, who highlighted the diagnostic value of the incongruent Stroop condition in identifying executive dysfunction.[9]

As age increases, the brain undergoes structural changes, including overall reductions in size[11] and volume of both gray and white matter. Gray matter loss is most pronounced in the prefrontal and medial temporal lobes, including the hippocampus, while white matter decline is especially notable in the frontal lobes and the corpus callosum.[12]

Age-related changes also occurs in neuronal structure, such as reduced dendritic length, spine loss, and decreased synaptic density. Synaptic loss is a critical marker of aging and correlates with cognitive decline, with dementia symptoms appearing when cortical synapses decline by approximately 40%. [13]

Gender based analysis revealed no significant differences in reaction time between males and females in younger and middle aged groups. However, among participants older than 60 years, females demonstrated significantly shorter reaction times during the incongruent condition compared to males, suggesting a potential gender related advantage in executive control in later adulthood. Previous studies have reported inconsistent findings regarding gender differences in Stroop performance, with some attributing superior performance in females to differences in attentional strategies or verbal processing abilities.[4] Further investigation is warranted to clarify gender specific patterns of cognitive aging.

This study was limited to evaluate the impact of age on the Stroop test, a simple and effective tool for assessing age-related changes in attention and executive function. Early detection of slowed processing speed may facilitate timely identification of cognitive decline. Future studies employing longitudinal designs, computerized Stroop assessments, and adjustment for educational variables are recommended.

CONCLUSIONS

The study showed that selective attention assessed by stroop test decline with increasing age. Older participants took significantly longer time to respond than middle-aged and younger participants in all stroop cards. In all age groups, reaction time was prolonged for incongruent stimuli (eg. the word "green" printed in blue ink). This confirms age-related decline in executive function and cognitive processing speed.

CONFLICT OF INTEREST

Authors declare there are no any conflicts of Interest.

REFERENCE

1. Ghimire N, Paudel BH, Khadka R, Singh PN. Reaction time in Stroop test in Nepalese Medical Students. J Clin Diagn Res. 2014 Sep;8(9):BC14-6. [PubMed | Full Text | DOI]

2. Whalley LJ, Deary IJ, Appleton CL, Starr JM. Cognitive reserve and the neurobiology of cognitive aging. Ageing Res Rev. 2004 Nov;3(4):369-82. [PubMed | Full Text | DOI]

3. Salthouse TA. Aging and measures of processing

speed. Biol Psychol. 2000 Oct;54(1-3):35-54. [PubMed | Full Text]

4. Gautam Y. Comparison of stroop colour-word test among male and female students in a medical college of Nepal. J Kathmandu Med Coll. 2023;12(1):65-9. [Full Text | DOI]

5. Van der Elst W, Van Boxtel MPJ, Van Breukelen GJP, 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. 13(1):62-79.[PubMed |Full Text | DOI]

6. Cohen J. Quantitative methods in psychology A Power primer. J of Psychology. 1962; 112(1):155-159. [Full Text]

7. Comalli PE, Wapner S, Werner H. Interference effects of Stroop color-word test in childhood, adulthood, and aging. J Genet Psychol. 1962 Mar;100:47-53. [PubMed | Full Text | DOI]

8. Golden CJ. Sex differences in performance on the Stroop Color and Word Test. Percept Mot Skills. 1974;39:1067-70.doi: https://doi.org/10.2466/pms.1974.39.3.1067[Full Text]

9. Scarpina F, Tagini S. The Stroop Color and Word Test. Front Psychol. 2017 Apr 12;8:557. [PubMed | FullText]

10. Stroop JR. Studies of interference in serial verbal reactions. J Exp Psychol 1935;18:643-62. doi: https://doi.org/10.1037/h0054651 [Full Text]

11. Harada CN, Natelson Love MC, Triebel KL. Normal cognitive aging. Clin Geriatr Med. 2013 Nov;29(4):737-52. [PubMed | Full Text]

12. Madden DJ, Spaniol J, Costello MC, Bucur B, White LE, Cabeza R, et al. Cerebral white matter integrity mediates adult age differences in cognitive performance. J CognNeurosci. 2009 Feb;21(2):289-302. [PubMed | Full Text]

13. Sonnen JA, Larson EB, Crane PK, Haneuse S, Li G, Schellenberg GD, et al. Pathological correlates of dementia in a longitudinal, population-based sample of aging. Ann Neurol. 2007 Oct;62(4):406-13. [PubMed | Full Text]