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Research Paper

Effect of Cognitive Training on Processing Speed of School Going Children: An Intervention Study with 3X3 Rubik Cube

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ABSTRACT

The experimental study was conducted to see the effect of cognitive training on school students. The sample for this study consisted of 30 school students (11 to 13 years) from "Ek Pahel" (NGO) working in Agra. The school was conveniently selected and the students were selected using simple random sampling with replacement technique. Digit Symbol and Symbol Search tests from the Wechsler Adult Intelligence Scale (WAIS-III) were used to measure processing speed of the subjects. The 3x3 Rubik Cube was used to give cognitive training to the above-mentioned subjects for one hour a day, six days a week, for a total period of 30 days. The subjects were taught to solve the 3x3 Rubik's Cube using layer by layer method in seven different steps. They were also taught to make seven different designs on the 3x3 Rubik Cube. Pre and Post-test design was used to evaluate the result of the intervention. Wilcoxon paired signed rank test was used for statistical analysis. The result shows that there is a significant effect of cognitive training on the processing speed of school students. (Z value 4.82, $p < 0.01$).

Keywords: *Cognitive Training, Processing Speed, School going children, 3X3 Rubik's Cube, Intervention*

Processing speed in cognition is a fundamental and intricate facet of how our brains operates, influencing our ability to swiftly and efficiently absorb, analyze, and respond to the vast array of information encountered in our daily lives. This critical cognitive function forms the foundation for various mental processes, from basic sensory input to higher-order executive functions.

Processing speed also plays a pivotal role in working memory, the cognitive system responsible for temporarily holding and manipulating information. The speed at which information can be processed influences the efficiency of constantly updating and managing information in working memory. As we embark on an exploration of processing speed in cognition, we delve into the neural intricacies that orchestrate this phenomenon, its foundational role in various cognitive tasks, and the profound implications it holds for our understanding of human cognition. Individual differences in processing speed are believed to reflect variations in neural speed, efficiency, and capacity (Birren & Fisher, 1995; Mendelson & Ricketts, 2001), as well as age-related changes in neural processing, including the

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development and decline of axonal myelination across the lifespan (Charlton et al., 2006, 2008). Processing speed predicts automaticity, fluency, and variability of cognitive performance across a wide variety of tasks (Bryan & Luszcz, 2001; Finkel, Reynolds, McArdle, & Pederson, 2005; Kail & Salthouse, 1994; Salthouse, 2005). Processing speed was capable of predicting fluid intelligence when visual working memory was controlled in Psychiatric Patients (Kim & Park, 2018).

Binet (1905) defined it as the speed at which an individual can perceive, understand, and respond to stimuli.

Luria (1973), a neuropsychologist, defined processing speed as the pace at which mental processes occur, encompassing sensory perception, attention, memory, and decision-making. He emphasized the role of neurological functioning in processing speed.

Objective

To study the effect of cognitive training on processing speed of school students.

Hypothesis

There is a no significant effect of cognitive training on processing speed of school students.

METHOD

Sample and Sampling Technique

A school from Agra was conveniently selected. Then, in school simple random sampling with replacement technique was used. A sample of 30 students of "Ek Pahel" (NGO) school who have passed 8th standard, were selected and given the aforesaid intervention.

Inclusion Criteria

- Age - Above 10 years.
- Education - 8th pass.
- Language - English / Hindi.

Exclusion Criteria

- Psychiatric disorders.
- Disability of hands.
- Colour blindness.

Procedure

In this research, a Pre and Post-test design was used utilized in conjunction with the intervention of a 3x3 Rubik's cube. To assess participants' cognitive abilities before and after the intervention, we employed a test developed by Wechsler in 1997, which consists of 14 sub-tests, encompassing seven verbal and seven non-verbal assessments. Specifically, we used two of these sub-tests, namely digit symbol and symbol search for measuring the processing speed.

The intervention incorporated the use of a 3x3 Rubik's Cube as a tool. The intervention was given for 30 days, one hour per day. The participants were taught to solve the 3x3 Rubik's cube using layer by layer method in seven steps each having separate algorithmic equations. Each step was taught for two days. Subsequently, for the remaining duration of 16 days of the

intervention, participants were further taught to make various designs, each of which had a separate algorithm. Also, the subjects were encouraged to solve the 3x3 Rubik's Cube/make the design as fast as possible. Feedback was given to the students by timing their efforts.

Design

In present research Pre and Post-test design was used to study the effect of cognitive training on processing speed of school students.

Variable

Independent Variable

Cognitive Training intervention (solving 3x3 Rubik Cube and making various designs).

Dependent Variable

Processing speed.

Test / Tools

Wechsler Adult Intelligence Scale (WAIS – III) – This test was developed by Wechsler in 1997. This test consists of 14 sub-tests encompassing seven verbal and seven non-verbal assessments. Specifically, two of these sub-tests, namely digit symbol and symbol search were used to measure the processing speed. The test-retest reliability ranges from 0.70 (7 subscales) to 0.90 (2 subscales). Inter-scorer coefficients are very high, all being above 0.90. The WAIS correlated highly with the Stanford-Binet IV test (0.88) and had high concordance with various measures: memory, language, dexterity, motor speed, attention, and cognitive ability.

Statistical Technique

Wilcoxon Paired Signed Rank test was used to compare the change after the intervention in processing speed.

RESULT

This research study deals with one independent variable which is processing speed and the statistical technique used is the Wilcoxon Paired Signed Rank Test. Wilcoxon test is a non-parametric test and is an alternative to t-test. Though the data is normally distributed, since our sample size was not large enough, therefore, Wilcoxon Paired Signed Rank Test was used.

Wilcoxon Signed Rank Test Summary

Total N (Sample Size)	30
Test Statistic	465.00
Standard Error	48.19
Standardized Test Statistic (Z)	4.82
Asymptotic Sig. (2-sided test)	.01

The test yielded a positive Z value of 4.82, indicating that the second value (post-intervention) in each pair tended to be larger than the first value (pre-intervention), signifying an increase or improvement in the measured variable. This finding underscores the positive impact of the cognitive training program on enhancing processing speed in the student population under investigation.

Figure- (a) represent the scores of Pre test

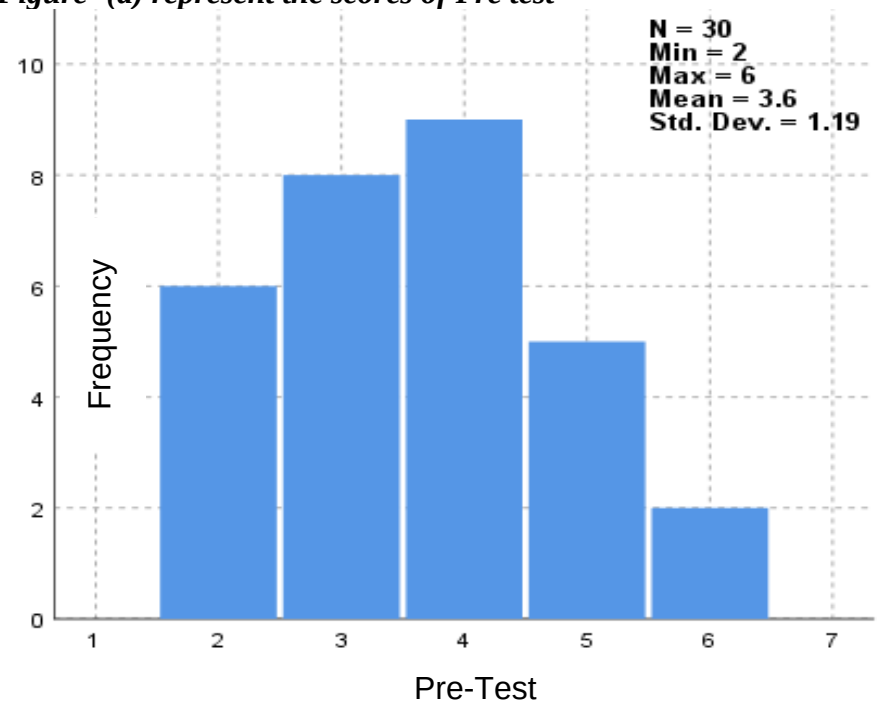


Figure- (b) represent the scores of Post test

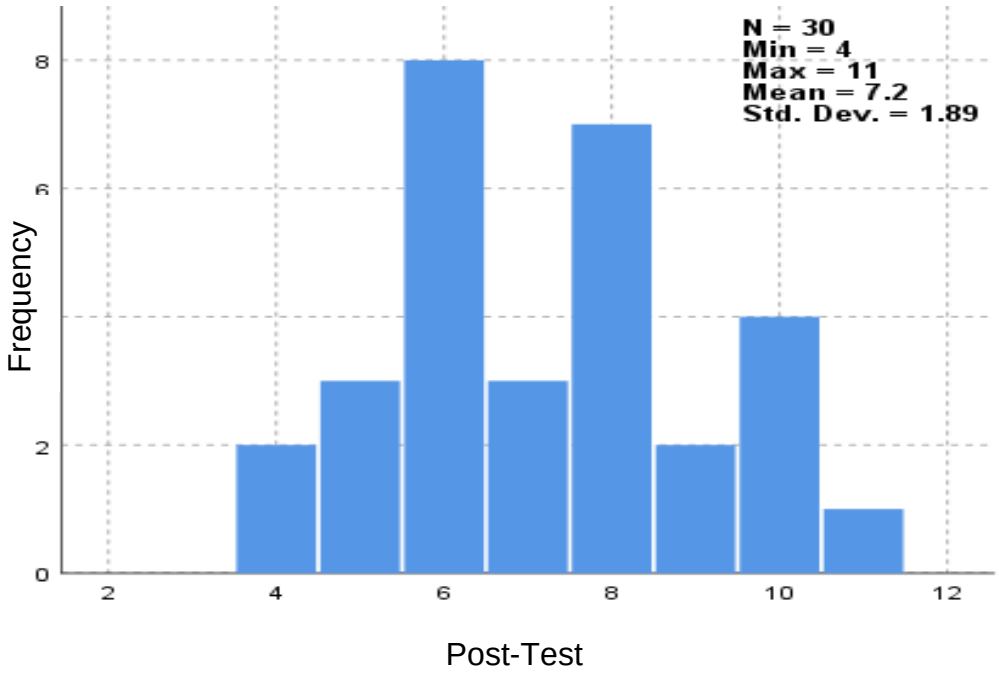
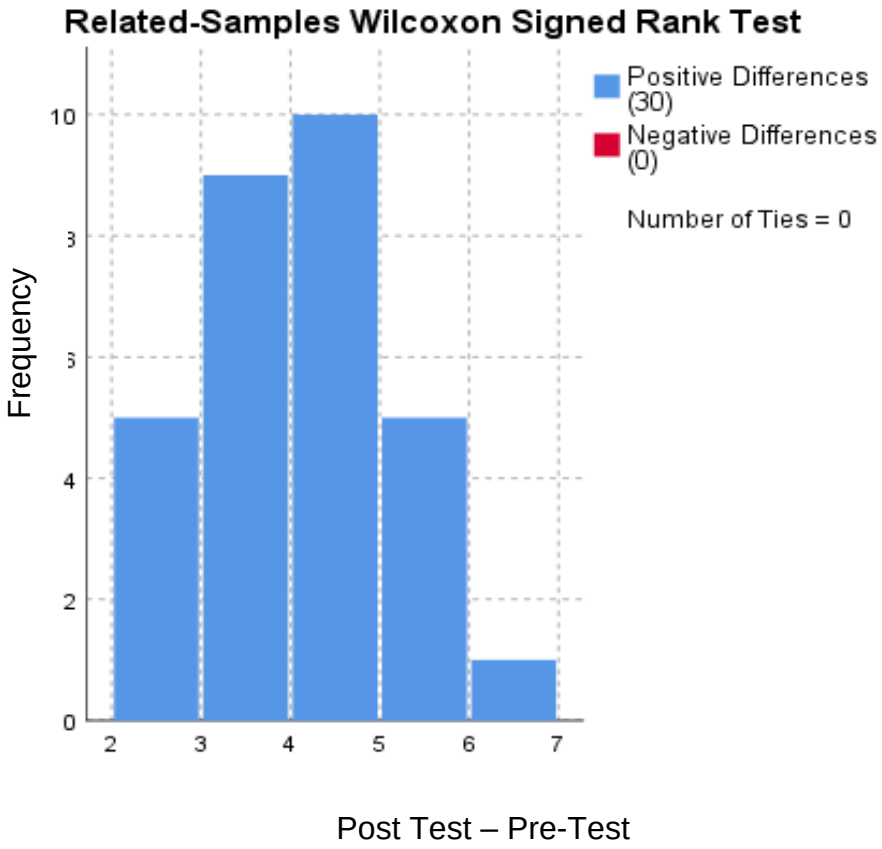


Figure- (c) shows the difference between the Post and Pre Test



DISCUSSION

The result of the present study shows that there is a significant effect of cognitive training on processing speed. Processing speed is an important factor in our life. Processing speed directly influences our major areas of life which include learning and problem-solving, daily functioning, safety and reaction time, work productivity, reaction time, and safety.

The present study is supported by the study of Nouchi, Taki, Takeuchi, Hashizume, Nozawa, Kambara, and Sekiguchi (2013) in which commercial brain training game was found to improve executive functions, working memory, and processing speed in young adults. Moreover, the popular puzzle game can engender improvement in attention and visual-spatial ability compared to playing the brain training game. A study scientifically showed the beneficial effect that the brain training game had on cognitive functions (executive functions, working memory, and processing speed) in healthy young adults.

The present result is supported by the study of Nouchi, Saito, Nouchi, and Kawashima (2016), here the results revealed that PSTG (Processing Speed Training Game) improved performances in processing speed and inhibition compared to KQTG (Knowledge Quiz Training Game), but it did not improve reasoning, shifting, short term/working memory, and episodic memory. Moreover, PSTG reduced the depressive mood score as measured by the Profile of Mood State compared to KQTG during the 4-week intervention period, but it did not change other emotional measures.

CONCLUSION

The present study aimed to study the effect of cognitive training on the processing speed of school students. After analyzing the result, we can conclude that there is a significant effect of cognitive training on the processing speed of school students.

Limitations and Suggestions for Further Research

Keeping in view the fact that the result of the study can not be generalized without considering the limitations of the study following are some of the limitations and important suggestions for the future studies.

1. The current study focused on a restricted sample size of 30 students who were from same school in Agra. To generalize the findings, it is recommended that future research with a large sample may be done. A broader and more diverse sample encompassing multiple schools across various cities in Uttar Pradesh should be considered. This geographical and cultural diversity would provide a more nuanced understanding of the factors influencing students' processing speed, as different regions and cultures may exhibit unique characteristics.
2. The study lacked a gender-based analysis, and a future investigation should include a comparative assessment to explore potential variations in processing speed between male and female students.
3. The current study was confined to an urban setting, specifically Agra City. To obtain a comprehensive perspective, researchers should extend the study to include both rural and urban populations. This rural-urban comparison is essential for capturing potential disparities, if any, in processing speed influenced by environmental factors.
4. Measuring the processing speed of the same subjects after six months can tell whether the increase in processing speed is lasting or not.
5. The current study has concentrated on a younger age group, and to enhance the breadth of our findings, future research could incorporate a broader range of age groups. This would provide a more comprehensive understanding of how processing speed evolves across different life stages, contributing to a more nuanced and generalized knowledge base.
6. The present study did not utilize any brain imaging technique such as functional magnetic resonance imaging (fMRI) to investigate the neural mechanisms underlying the processing speed. Including fMRI in future research endeavors would enable a deeper exploration of the specific brain regions responsible for controlling processing speed. This advanced imaging technique may shed light on the neurobiological processes involved, offering a more intricate and detailed perspective on the cognitive aspects influencing processing speed.
7. Future studies could delve into the impact of neurodegeneration on processing speed. Investigating whether certain exercises or interventions contribute to improvement or preservation or decline in deterioration of processing speed in the face of neurodegenerative processes would be valuable. This could provide insights into potential strategies for maintaining cognitive function in individuals experiencing neurodegeneration.

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Conflict of Interest

The author(s) declared no conflict of interest.

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