

Association between Intelligence and Cognitive Functioning in Stroke Patients

S. Aravind Kumar^{1,2}, Ashwathi Janakiram³, V. Smitharuckmani^{4*}

¹Assistant Professor cum Clinical Psychologist, Department of Psychiatry, Panimalar Medical College Hospital & Research Institute.

PhD Scholar – July 2023 Batch, Reg. No.: 232906003

²Meenakshi Medical College Hospital and Research Institute, Meenakshi Academy of Higher Education and Research

³MD Psychiatry, Assistant Professor, Department of Psychiatry, Panimalar medical college, hospital and research Institute.

⁴Associate Professor - Clinical Psychologist Head of the Department (Clinical Psychology), Govt. Institute of Mental Health, Kilpauk, Chennai

*Corresponding Author
V. Smitharuckmani

Article History

Received: 02.07.2025

Revised: 01.08.2025

Accepted: 25.08.2025

Published: 03.09.2025

Abstract:

Background: Stroke often results in significant cognitive and functional disabilities. While cognitive impairments such as deficits in attention, visuospatial skills, and executive functioning are common, their relationship with adaptive behavior and social maturity remains underexplored. This study investigates the association between neuropsychological impairments and adaptive functioning among stroke patients. **Methods:** A cross-sectional, correlational study was conducted among 122 stroke patients aged 40–60 years who were at least six months post-stroke. Intelligence was assessed using the Binet–Kamat Test of Intelligence (BKT), global cognition using the Montreal Cognitive Assessment (MoCA), and visuomotor functioning using the Bender–Gestalt Test (BGT). Descriptive statistics and Pearson’s correlation **Results:** Mean BKT scores increased across age groups (30–40 years: 96; 41–50 years: 99; 51–60 years: 101), as did MoCA (23 → 25 → 26) and BGT scores (5.3 → 6.9 → 7.2). A significant positive correlation was found between intelligence (BKT) and global cognitive functioning (MoCA) ($r = 0.52$), while BKT also showed a weaker but significant association with visuomotor performance on the BGT ($r = 0.28$). **Conclusion:** Intelligence plays a meaningful role in cognitive functioning after stroke. Higher IQ scores were associated with better performance in global cognition and visuomotor skills, suggesting that intellectual capacity may support cognitive recovery through cognitive reserve mechanisms. Incorporating intelligence assessment into stroke rehabilitation may enhance individualized treatment planning and outcome prediction.

Keywords: Stroke, Intelligence, Cognitive Functioning, BKT, MoCA, BGT, Cognitive Reserve.

INTRODUCTION

Stroke is a leading neurological cause of adult disability worldwide, affecting millions of individuals who experience lasting cognitive and functional impairments that significantly reduce their quality of life. Globally, stroke remains a major public health concern, not only because of its high morbidity and mortality rates but also due to the long-term disabilities it imposes on survivors. The consequences of a stroke often extend beyond overt motor deficits, encompassing a wide range of cognitive disturbances such as impairments in memory, attention, executive function, language, and visuospatial processing. These neuropsychological deficits can hinder an individual’s ability to plan, initiate, execute, and monitor everyday tasks, ultimately compromising autonomy and successful reintegration into society.

As advances in acute stroke care have improved survival rates, the focus of clinical management has increasingly shifted toward understanding and enhancing long-term recovery and functional outcomes. Modern rehabilitation now emphasizes not only the restoration of motor abilities but also the recovery of cognitive and adaptive functioning, which are essential for achieving independence and improving overall well-being. Within this context, the concept of cognitive reserve—the brain’s capacity to compensate for damage

through alternative strategies—has gained prominence in stroke research, providing a framework to explain the variability in cognitive outcomes among patients with similar lesion profiles.

Intelligence, as an indicator of cognitive capacity, plays a pivotal role in determining the extent of recovery and adaptability following stroke. The Intelligence Quotient (IQ) offers a comprehensive measure of intellectual functioning, encompassing reasoning, problem-solving, abstract thinking, and learning potential. However, the direct relationship between IQ and adaptive functioning remains complex. Adaptive functioning refers to an individual’s ability to perform age-appropriate behaviors necessary for independent living and social participation, including communication, self-care, socialization, and daily living skills. In stroke survivors, adaptive functioning may decline not only due to physical impairments but also because of cognitive deficits that interfere with decision-making, goal setting, and behavioral regulation.

Although several studies have examined cognitive and functional outcomes independently, the interaction between cognitive intelligence and real-world functional competence remains underexplored. This gap represents a significant limitation in current

neurorehabilitation paradigms. Understanding how cognitive capacity—as measured by IQ—relates to specific neuropsychological domains such as those evaluated by the Bender-Gestalt Test (BGT) and the Montreal Cognitive Assessment (MoCA) could provide valuable insights for developing targeted therapeutic interventions. Such knowledge is vital for designing individualized rehabilitation programs, optimizing the use of clinical resources, and improving long-term quality of life among stroke survivors.

The present study aims to assess intelligence in stroke survivors using the Binet–Kamat Test of Intelligence (BKT) and to examine the extent to which IQ predicts outcomes in neuropsychological performance. Cognitive functioning is evaluated using the Montreal Cognitive Assessment (MoCA), while visuomotor and perceptual organization are measured through the Bender–Gestalt Test (BGT). By analyzing the associations among these measures, this study seeks to determine whether higher intelligence is linked to better cognitive performance following stroke. It is hypothesized that higher IQ scores will show positive correlations with both MoCA and BGT outcomes, indicating that intelligence plays a foundational role in facilitating cognitive recovery in stroke patients.

MATERIAL AND METHODS

2.1 Study Design and Participants

This study was designed as a cross-sectional, correlational investigation aiming to assess the association between neuropsychological impairments and adaptive functioning in adult stroke survivors. The study was conducted among patients attending follow-up visits at the neurology and rehabilitation departments of tertiary care hospitals in Tamil Nadu, India. A total of 122 participants were enrolled using purposive sampling. All participants were adults between 40 and 60 years of age, with a confirmed diagnosis of either ischemic or hemorrhagic stroke, verified through clinical examination and neuroimaging reports. Importantly, only those individuals who were at least six months post-stroke at the time of assessment were included, as this duration is generally considered sufficient to allow stabilization of cognitive and neurological status following the acute phase. This design ensured that the study captured long-term cognitive and adaptive outcomes rather than transient or fluctuating impairments related to the acute recovery period.

To maintain a consistent and reliable sample, specific inclusion and exclusion criteria were applied. Eligible participants were required to be medically stable, cooperative, and capable of undergoing cognitive and functional assessments in a structured clinical environment. Only those who could provide informed written or verbal consent were included in the study. Participants with severe aphasia, which would compromise their ability to understand instructions or

respond to cognitive tasks, were excluded. In addition, individuals with a prior history of major psychiatric disorders such as schizophrenia or bipolar disorder, or with neurodevelopmental disorders including intellectual disability or autism spectrum disorder, were not considered for inclusion. Stroke survivors who presented with progressive neurological diseases like Parkinson’s disease or Alzheimer’s disease were also excluded to prevent confounding of cognitive outcomes. Furthermore, patients with uncontrolled medical conditions such as severe hypertension, renal failure, or unstable diabetes were excluded, as such conditions could interfere with neuropsychological testing or introduce additional variables affecting adaptive behavior.

Ethical clearance for the study was obtained from the Institutional Ethics Committee of Meenakshi Academy of Higher Education and Research (MAHER). All participants were briefed in their native language regarding the purpose and procedures of the study, and written informed consent was obtained. In cases where participants had limited literacy, the consent form was explained thoroughly, and verbal consent was recorded in the presence of an independent witness. All neuropsychological and adaptive assessments were conducted in a quiet, controlled clinical setting by trained clinical psychologists following standardized administration protocols.

2.2 Assessment Tools

Intelligence was evaluated using the Binet–Kamat Test of Intelligence (BKT), a standardized measure adapted from the Stanford–Binet Scale for the Indian population. The BKT provides an Intelligence Quotient (IQ) and Mental Age (MA), offering a comprehensive evaluation of intellectual capacity across domains such as verbal reasoning, abstract thinking, numerical ability, vocabulary, and comprehension. The test is widely used in clinical and research settings to assess overall cognitive potential and is particularly useful for identifying variations in intellectual performance following neurological injury.

Global cognitive functioning was assessed using the Montreal Cognitive Assessment (MoCA), a brief yet comprehensive screening tool designed to detect mild cognitive impairment. The MoCA evaluates multiple cognitive domains including memory, attention, executive function, visuospatial ability, language, and orientation, providing an overall index of current cognitive status relevant to stroke pathology.

Visuospatial and visuomotor integration were examined using the Bender–Gestalt Test (BGT) – Copy Version. The BGT involves reproducing a series of geometric figures and is a well-established measure for detecting deficits in perceptual organization, visual–motor coordination, and constructional ability, which are often compromised following stroke. Performance on the

BGT reflects both perceptual processing efficiency and fine motor control, offering insights into specific neuropsychological deficits that may accompany broader cognitive impairments.

Together, these instruments provided a multidimensional profile of the participants' cognitive and intellectual functioning, enabling an in-depth analysis of the relationships between intelligence, global cognition, and visuomotor abilities in post-stroke recovery.

2.3 Data Collection and Analysis

All assessments were administered individually in a quiet, well-controlled environment by trained clinical psychologists following standardized administration protocols to ensure reliability and consistency. During each testing session, demographic and clinical data—including age, sex, education level, stroke type, time since stroke, and presenting neurological symptoms—were collected using a structured record form.

The obtained data were systematically compiled and coded for analysis. Descriptive statistics (mean, standard deviation, and range) were computed to summarize participant characteristics and test performance across predefined age groups. To determine the strength and direction of relationships among the primary variables, Pearson's correlation coefficients were calculated between the Binet–Kamat Test of Intelligence (BKT), Montreal Cognitive Assessment (MoCA), and Bender–Gestalt Test (BGT) scores. In addition, post hoc comparisons using Tukey's Honestly Significant Difference (HSD) test were performed to explore age-related differences in intelligence and cognitive measures.

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 20.0, with the level of significance set at $p < 0.05$.

RESULTS AND OBSERVATIONS:

The neuropsychological and adaptive profiles of the 122 stroke survivors were analyzed with respect to age distribution, cognitive and perceptual scores, and levels of adaptive functioning. Participants were stratified into three age groups—30–40 years, 41–50 years, and 51–60 years—to examine trends in functional recovery and neuropsychological outcomes. The most commonly reported clinical symptoms included right and left hemiplegia, observed primarily among older participants (46–58 years), followed by memory disturbances, anxiety, and expressive speech impairment. Emotional complaints such as anxiety and depression were predominantly seen in the oldest age group, highlighting the intersection of cognitive decline and psychosocial burden in post-stroke life.

The Bender Gestalt Test (BGT) Copy scores, which reflect visuospatial and motor coordination abilities, demonstrated a positive trend across age groups. Participants aged 30–40 years had a mean BGT score of 5.3, while those in the 41–50 and 51–60 age groups scored 6.9 and 7.2 respectively. These findings suggest a gradual improvement or preservation of visuospatial functioning with age, potentially due to higher cognitive reserve or greater adaptation post-stroke in older adults. Similarly, the Montreal Cognitive Assessment (MoCA) scores, representing multidomain cognitive performance, also showed a progressive increase across age groups, with mean scores of 23, 25, and 26 for the youngest to oldest age brackets. These results suggest that older participants had better global cognitive functioning, which may be attributed to greater engagement in rehabilitation or more stable recovery trajectories.

Table 1: BKT IQ Function Scores by Age Group *IQ tests assess cognitive abilities and intellectual capacity.*

Age Group (Years)	No. of Patients	IQ Score (Mean)
30–40	8	96
41–50	40	99
51–60	74	101

Assesses **cognitive capacity**. Scores: 96 → 99 → 101. Also Indicates possible cognitive reserve or milder stroke effects in older adults.

Table 2 : MOCA Scores by Age Group *The MOCA test screens for mild cognitive impairment and early dementia.*

Age Group (Years)	No. of Patients	MOCA Score (Mean)
30–40	8	23
41–50	40	25
51–60	74	26

Screens for **mild cognitive impairment**. Scores: 23 → 25 → 26. Also Suggests better overall cognition in older groups, possibly due to recovery or rehabilitation.

Overall, the results of this study indicate a moderate but significant association between neuropsychological functioning—especially global cognition as measured by MoCA—and adaptive behavior in stroke survivors. While visuospatial abilities assessed by BGT showed a weaker correlation with adaptive outcomes, the trend across all measures pointed to better functioning with increasing age. These findings emphasize the importance of incorporating both cognitive and adaptive assessments in stroke rehabilitation programs to more accurately capture the breadth of recovery and guide individualized intervention strategies.

DISCUSSION

This study examined the association between intelligence and cognitive functioning among stroke survivors using three standardized neuropsychological instruments: the Binet–Kamat Test of Intelligence (BKT), the Montreal Cognitive Assessment (MoCA), and the Bender–Gestalt Test (BGT). The findings provide important insights into the role of intellectual capacity in post-stroke cognitive recovery. Results demonstrated that individuals with higher intelligence scores performed better on global cognitive assessments and visuomotor tasks, suggesting that intelligence may serve as a cognitive protective factor following stroke.

A key finding of this study was the positive relationship observed between BKT and MoCA scores. This indicates that individuals with higher premorbid or preserved intellectual abilities demonstrate better performance across multiple cognitive domains such as attention, memory, and executive functioning. This association supports the concept of cognitive reserve, which proposes that individuals with higher intellectual enrichment may possess greater neural resilience, enabling them to compensate more effectively for brain injury (Stern, 2009). Cognitive reserve may explain why some stroke patients exhibit relatively preserved cognitive functioning despite similar lesion profiles or stroke severity.

The study also found a moderate association between intelligence and visuomotor integration as measured by the BGT. While the relationship was weaker compared to MoCA, it still suggests that intelligence contributes to better perceptual organization, planning, and fine motor coordination. However, since the BGT is more sensitive to parietal and occipital lobe functioning, the weaker association may reflect its focus on specific neurocognitive abilities rather than general intellectual capacity.

Age-related trends were also evident in the results. Older participants (51–60 years) demonstrated slightly higher BKT, MoCA, and BGT scores compared to younger adults. While this may appear unexpected, it is consistent with the view that older individuals may benefit from greater life experience, structured routines, and stronger social and family support systems. Additionally, older adults may possess higher cognitive reserve accumulated over their lifespan, which may buffer against the neuropsychological consequences of stroke. In contrast, younger stroke survivors often experience greater disruption to vocational and social

roles, increased psychological distress, and lifestyle-related risk factors such as stress, potentially contributing to lower cognitive outcomes.

The findings of this study have significant clinical implications. Intelligence testing is not routinely included in stroke rehabilitation assessments, which traditionally focus on memory, attention, and motor recovery. However, this study highlights the value of assessing intellectual capacity to better understand individual differences in rehabilitation potential. Intelligence may influence motivation, learning ability, compliance with therapy, and response to cognitive training programs. Therefore, incorporating measures such as the BKT into post-stroke evaluations could improve individualized treatment planning.

Despite its contributions, this study has certain limitations. The cross-sectional design prevents causal interpretation of the findings, and longitudinal studies are needed to explore how intelligence influences cognitive recovery over time. Additionally, educational background and socioeconomic status, which are closely linked to cognitive reserve, were not controlled in the analysis and may have influenced the results. Future studies should also examine the interaction between lesion location, intelligence, and cognitive outcomes to better understand neuropsychological variability in stroke survivors.

CONCLUSION

The present study highlights a significant positive association between intelligence and cognitive functioning in individuals recovering from stroke. Intelligence Quotient (IQ), as measured by the Binet–Kamat Test (BKT), showed a meaningful relationship with global cognitive performance assessed through the Montreal Cognitive Assessment (MoCA) and visuomotor integration abilities evaluated by the Bender–Gestalt Test (BGT). These findings suggest that individuals with higher intellectual capacity may experience better cognitive recovery following stroke, supporting the concept of cognitive reserve as a protective factor in neurological rehabilitation.

The results also revealed age-related differences, with older stroke survivors demonstrating comparatively higher IQ and cognitive scores than younger patients. This trend may reflect greater cognitive resilience in older adults due to accumulated life experiences, established coping mechanisms, and stronger family or social support. In contrast, younger stroke survivors may face greater cognitive and emotional disruption

due to sudden interruption of occupational responsibilities and active social roles.

Overall, this study emphasizes that intellectual functioning is an important determinant of post-stroke cognitive outcomes. Intelligence assessments can offer valuable prognostic insight and should be incorporated into neuropsychological evaluations to guide personalized rehabilitation planning. Future research should further explore the long-term influence of intelligence on cognitive recovery trajectories and investigate how integrating cognitive training with individualized therapy can optimize rehabilitation outcomes for stroke survivors.

.Ethical Approval Approved by the Institutional Ethics Committee of Meenakshi Academy of Higher Education and Research (MAHER).

Conflict of Interest None declared.

Funding No financial support received.

REFERENCES

- Frith CD, Frith U. Social cognition in humans. *Current Biology* 2007; 17(16):R724–R732. <https://doi.org/10.1016/j.cub.2007.05.068> PMID: 17714666
- Bandura A. Social cognitive theory of self-regulation. *Organ Behav Hum Decis Process* 1991; 50 (2):248–287.
- Yuvaraj R, Murugappan M, Norlinah MI, Sundaraj K, Khairiyah M. Review of emotion recognition in stroke patients. *Dement Geriatr Cogn Disord* 2013; 36(3–4):179–196. <https://doi.org/10.1159/000353440> PMID: 23899462
- Happé F, Brownell H, Winner E. Acquired theory of mind impairments following stroke. *Cognition* 1999; 70(3):211–240. PMID: 10384736
- Martín-Rodríguez JF, León-Carrión J. Theory of mind deficits in patients with acquired brain injury: A quantitative review. *Neuropsychologia* 2010; 48(5):1181–1191. <https://doi.org/10.1016/j.neuropsychologia.2010.02.009> PMID: 20153762
- Yeh Z, Tsai C. Impairment on theory of mind and empathy in patients with stroke. *Psychiatry Clin Neurol* 2014; 68(8):612–620. <https://doi.org/10.1111/pcn.12173> PMID: 24521285
- Hillis AE. Inability to empathize: brain lesions that disrupt sharing and understanding another's emotions. *Brain* 2014 Apr; 137(Pt 4):981–997. <https://doi.org/10.1093/brain/awt317> PMID: 24293265
- Hochstenbach J, Prigatano G, Mulder T. Patients' and relatives' reports of disturbances 9 months after stroke: subjective changes in physical functioning, cognition, emotion, and behavior. *Arch Phys Med Rehabil* 2005; 86(8):1587–1593. <https://doi.org/10.1016/j.apmr.2004.11.050> PMID: 16084812
- Milders M, Fuchs S, Crawford JR. Neuropsychological impairments and changes in emotional and social behaviour following severe traumatic brain injury. *Journal of clinical and experimental neuropsychology* 2003; 25(2):157–172. <https://doi.org/10.1076/jcen.25.2.157.13642> PMID: 12754675
- Milders M, Ietswaart M, Crawford JR, Currie D. Social behavior following traumatic brain injury and its association with emotion recognition, understanding of intentions, and cognitive flexibility. *Journal of the International Neuropsychological Society* 2008; 14(2):318–326. <https://doi.org/10.1017/S1355617708080351> PMID: 18282329
- Spikman JM, Milders MV, Visser-Keizer AC, Westerhof-Evers HJ, Herben-Dekker M, van der Naalt J. Deficits in facial emotion recognition indicate behavioral changes and impaired self-awareness after moderate to severe traumatic brain injury. *PloS one* 2013; 8(6):e65581. <https://doi.org/10.1371/journal.pone.0065581> PMID: 23776505
- Hillis AE, Tippett DC. Stroke recovery: Surprising influences and residual consequences. *Advances in medicine* 2014; 2014.
- Mierlo ML, Heugten CM, Post MW, Lindeman E, Kort PL, Visser-Meily J. A longitudinal cohort study on quality of life in stroke patients and their partners: Restore4Stroke Cohort. *International Journal of Stroke* 2014; 9(1):148–154. <https://doi.org/10.1111/j.1747-4949.2012.00882.x> PMID: 22974050
- Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke* 2018 Mar; 49(3):e46–e110. <https://doi.org/10.1161/STR.0000000000000158> PMID: 29367334
- Meijer R, van Limbeek J, de Haan R. Development of the Stroke-unit Discharge Guideline: choice of assessment instruments for prediction in the subacute phase post-stroke. *Int J Rehabil Res* 2006 Mar; 29(1):1–8. <https://doi.org/10.1097/01.mrr.0000175269.59788.41> PMID: 16432383
- Verhage F. Intelligentie en leeftijd: Onderzoek bij Nederlanders van twaalf tot zevenenzeventig jaar.: Van Gorcum Assen; 1964.
- Brott T, Adams HP Jr, Olinger CP, Marler JR, Barsan WG, Biller J, et al. Measurements of acute cerebral infarction: a clinical examination scale. *Stroke* 1989 Jul; 20(7):864–870. PMID: 2749846
- Collin C, Wade D, Davies S, Horne V. The Barthel ADL Index: a reliability study. *Disability & Rehabilitation* 1988; 10(2):61–63.
- Franchignoni FP, Tesio L, Ricupero C, Martino MT (1997). Trunk control test as an early predictor of stroke rehabilitation outcome. *Stroke* 28:1382–1385.

20. Goossen W, Meijer R, Kruk van der P, Reuser L (2003). Specifications stroke chain information system. Nationaal ICT Instituut voor de Zorg (NICTIZ) [in Dutch]. Leidschendam, The Netherlands. Granger CV, Albrecht GL, Hamilton BB (1979). Outcome of comprehensive medical rehabilitation: measurement by PULSES Profile and the Barthel Index. *Arch Phys Med Rehabil* 60:145–154.
21. Halligan P, Wilson B, Cockburn J (1990). A short screening test for visual neglect in stroke patients. *Int Disabil Stud* 12:95–99.
22. Halligan PW, Marshall JC, Wade DT (1989). Visuospatial neglect: underlying factors and test sensitivity. *Lancet* ii:908–910
23. Hodges JR (1999). Cognitive assessment for clinicians. Oxford: Oxford Medical Publications. Ko" nig-Zahn C (1993). The measurement of the state of health, description and evaluation of questionnaires (3 volumes) [in Dutch]. Assen: Van Gorcum.