Journal of Child Language Acquisition and Development – JCLAD
Vol: 13 Issue: 3 1431-1443, 2025
ISSN: 2148-1997

Assessment of cognitive linguistic skills in Malayalam speaking children

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Received : 15.05.2025
Accepted : 21.10.2025
Published : 30.12.2025
DOI: https://doi.org/10.5281/zenodo.18208835

Abstract

Understanding the relationship between cognition and language is critical for assessing normal child development. However, studies investigating cognitive-linguistic abilities of young children are limited in the Indian context. The present study assessed the developmental pattern of cognitive-linguistic abilities in Malayalam-speaking children. Forty children aged 4–8 years (equal number of males and females) participated, selected from regular schools in Kerala, India. 'Cognitive Linguistic Assessment Protocol for Children in Malayalam', comprising tasks in attention, memory, and problem solving, was administered. Findings revealed age-related improvement in all domains. Performance on memory tasks was comparatively lower than attention and problem-solving domains. The results indicate a progressive developmental trend in cognitive-linguistic abilities among Malayalam-speaking children, which could support early identification and intervention for children with delays.

Keywords: cognitive linguistics; Malayalam-speaking children; attention; memory; problem solving

1. Introduction

In Language is the means through which individuals encode and express thoughts, emotions, and experiences. Cognitive linguistics views language as an integral part of cognition, working in parallel with other cognitive abilities. Previous research across linguistics, psychology, and neuroscience has shown that higher-order functions such as attention, memory, and problem-solving are closely linked to language development (Janda, 2015; Crystal & Glanzman, 2013).

The need for the present study arises from the lack of standardized data on the developmental trajectory of cognitive-linguistic skills in Malayalam-speaking children. Such normative information is essential for evaluating children with suspected developmental or language-related disorders. The present study therefore aimed to assess the development of attention,

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memory, and problem-solving skills among typically developing Malayalam-speaking children aged 4–8 years.

The Sapir-Whorf hypothesis, also known as linguistic relativity, suggests that the structure and vocabulary of a language can shape or influence the way its speakers perceive and think about the world. Researches in this area have explored the extent to which language affects cognitive processes and conceptualization. Language is often considered a cognitive tool that humans use to process and convey information. Cognitive linguistics examines the relationship between language and cognition by focusing on mental processes involved in language use. This includes research on metaphor, conceptual blending, and cognitive semantics, exploring how these cognitive mechanisms are reflected in language. Overall, these studies collectively contribute to our understanding of the intricate relationship between language and cognition, shedding light on how language shapes thought processes and vice versa. Individual biological characteristics and the environment in which a child grows significantly impact cognitive development (Kurashige et al., 2020).

Studies on language acquisition in children have played a crucial role in understanding the relationship between language and cognition. Researchers have shown that the development of language skills in early childhood is closely linked to cognitive abilities. Piaget's theory of cognitive development, for example, considers how language acquisition is intertwined with the development of abstract thinking. The process of acquisition of language has been explained by a number of mechanisms. There have been proposals for imitation of adult speech, reinforcement, and analogy. None of these potential learning mechanisms explains why kids come up with novel phrases that follow language norms or why children make mistakes those others do not make (Fromkin, Rodman & Hyams, 2007).

Mental processes such as perception, memory, and problem-solving are very much interlinked with the language development. Studies in cognitive psychology have explored that how language influences these cognitive processes. Attention, memory, knowledge, decision-making, planning, reasoning, judgment, perception comprehension, language, and visuospatial functions are all examples of high-level intellectual functions and processes (Dhakal & Bobrin, 2023). These elements are primarily considered to be related to cognition; however, these are equally relevant linguistically as well.

The ability to concentrate one's perception and thought on a particular task while ignoring unrelated stimuli is referred to as attention (Erbay, 2013). Recognizing and responding to the environment's essential components is required for learning new skills. According to Richards and Turner (2001) infants are better at paying attention as they get older and spend a higher percentage of their time doing so. The general arousal/attention system undergoes substantial changes in development throughout infancy and early childhood, which is characterized by increases in the size and length of sustained attention periods (Reynolds and Romano, 2016). Several researchers have looked at how attention-executive processes evolve over time in typically developing children. Between the ages of six and ten, attentiveness, sustained attention, and spatial orienting (visual search) improve the fastest, according to numerous studies on children's attention development (Betts et al., 2006). Zimmermann and Fimm (2002) investigated the overall attention development of healthy 5 to 12-year-old children. They found that rapid growth occurred from the ages of 5–6 years to 8–9 years, followed by a developmental plateau with only minor improvement from 8–9 years to 11–12 years.

Memory is the nervous system's ability to learn and retain practical knowledge and skills, allowing organisms to gain from experience (Crystal & Glanzman, 2013). Working memory appears during the preschool years and develops linearly between the ages of 4 and 15, with visual-spatial WM reaching a peak around the age of 11 (Best et al., 2009). In a 2014 study, León, Cimadevilla, and Tascón evaluated the spatial abilities (spatial reference memory and spatial working memory) of children aged 4 to 10. The participants in this study were 50 boys and 50 girls. Overall, the results showed that the 4- and 5-year-old groups performed worse than the older groups". "The ability to keep novel phonological structures in working memory is crucial for the generation of new words throughout the early stages of language acquisition for both native and foreign language learning (Archibald, 2017).

Al-Tarawneh (2012) defines problem-solving as "the process of recognizing a problem, generating possible solution paths, and choosing a suitable course of action." Very basic problem solving skills develop before the age of one year. The preschool years are a critical time for the development of both problem-solving skills and metacognitive abilities (Wang, 2014).

It is important to assess the sequential cognitive linguistic milestones, and also to identify and diagnose cognitive linguistic disabilities in children; and render appropriate interventions for the population lacking these skills. Any such study which focuses upon tapping the cognitive linguistic abilities of children is much needed presently. Cognitive-linguistic tools are needed to confront mental limitations such as memory in tasks such as thinking, learning, and problem-solving.

Understanding the relationship between cognition and language, as well as the pattern of development of cognitive-linguistic abilities in typically developing children is crucial. Studies on cognitive and linguistic abilities in the Indian context are scarce especially in the context of Malayalam to the best of our knowledge. This study attempted to assess the pattern of the development of cognitive linguistic abilities of Malayalam speaking children. Forty children between the age range of 4-8 years participated in the study. Equal number of males and females were included in the study. The participants were chosen from regular schools at Kerala, India. 'Cognitive Linguistic Assessment Protocol for Children in Malayalam' which assesses attention/discrimination, memory, and problem-solving tasks, was used for the study.

2. Methodology

2.1. Participants

The study enrolled typically developing Malayalam-speaking children aged 4;0 to 8;11 years. Participants were divided into four age groups: 4;0–

4;11 years, 5;0–5;11 years, 6;0–6;11 years, and 7;0–8;11 years, with equal numbers of males and females in each group.

There were a total of ten participants (5 males and 5 females) in each subgroup.

2.1.1. Inclusion criteria

For the purpose of selecting participants, the following criteria were used:

1) Participants must be native speakers of Malayalam and studying in English-medium schools in Kerala.
2) Participants should have normal or corrected vision and no significant deficit in hearing sensitivity for speech.
3) During the testing period, participants should be physically fit.

2.1.2. Ethical considerations

Ethical clearance was sought from the Institutional Review Board (IRB) for Bio-Behavioral research involving Human Subjects (SH/IRB/M1.SLP/R 39)

2.1.3. Exclusion criteria

Children with diagnosed developmental, neurological, or psychiatric disorders, uncorrected hearing or vision impairments, or non-native Malayalam speakers were excluded.

2.2. Procedure

Children were comfortably seated and tested in a room with minimal external noise. 'Cognitive Linguistic Assessment Protocol for Children in Malayalam (Joby, Priyadarshi & Abhishek, 2023) was used for the study. Following domains were assessed:

a) Attention, Discrimination, and Perception
b) Memory
c) Problem-solving

The items/tasks within each domain were organized in a hierarchy so that the task complexity increased as the presentation of the levels progressed. The test was conducted on both the auditory and visual sensory modalities. It took around 45 minutes to administer the entire protocol, and then the child's responses were scored. The test material comprised of three domains. Each domain comprised of tasks. Each correct response was given a score of 1. Discrimination task required the participants to differentiate between minimal pairs presented in visual and auditory modality. The memory domain task required the participants to recall the words or digit in forward and backward order. Problem solving required the participants to analyze a scenario and predict the cause or outcome.

3. Findings

Table 1
Subsections of CLAP-C

Sl No.	Domains	Tasks given Auditory mode	Score	Tasks given Visual mode	Score
1	Attention/ Discrimination	Digit count test	5	Odd one out test	5
		Sound count test	5	Letter cancellation	5
		Auditory word discrimination	10	Visual-word discrimination	10
	Total score		20		20
2	Memory	Digit-forward span	5	Alternate sequence	5
		Word recall	5	Picture counting	5
		Digit backward span	5	Story sequencing	5
	Total score		15		15
3	Problem-Solving	Predicting the outcome	10	Association task	5
		Predicting the cause	10	Overlapping test	5
		Compare and contrast	10	Mazes	5
	Total score		30		15

The scores obtained after administering the protocol were totaled for each participant across all age groups for each domain. The mean scores of the children in each age group were compared and tabulated using the SPSS software (Statistical Package for the Social Sciences, Version 26) and then subjected to statistical analysis. The descriptive statistical analyses for the domains are as follows:

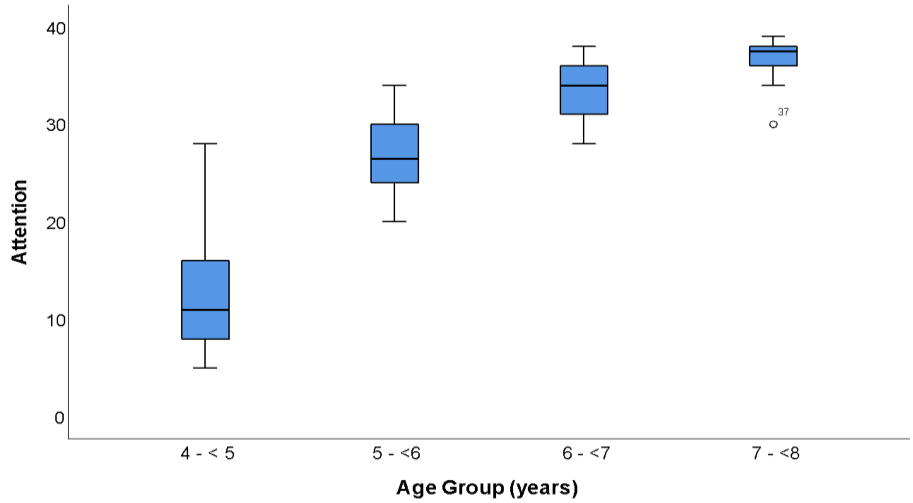
Table 2
Mean and the standard deviation scores of participants across age range for all the domains

Domains	Age group (years)	Mean	SD	N
Attention (%)	4 - < 5 years	33.5000	19.26424	10
	5 - <6 years	67.0000	10.91635	10
	6 - <7 years	82.7500	8.37075	10
	7 - <8 years	91.2500	6.89706	10
	Total	68.6250	25.29284	40
Memory (%)	4 - < 5 years	19.0000	5.67646	10
	5 - <6 years	32.6667	9.78787	10
	6 - <7 years	49.3333	11.41798	10
	7 - <8 years	63.0000	12.51666	10
	Total	41.0000	19.48336	40
Problem Solving (%)	4 - < 5 years	32.0000	18.77453	10
	5 - <6 years	58.0000	8.14478	10
	6 - <7 years	72.8889	13.61029	10
	7 - <8 years	87.11	11.026	10

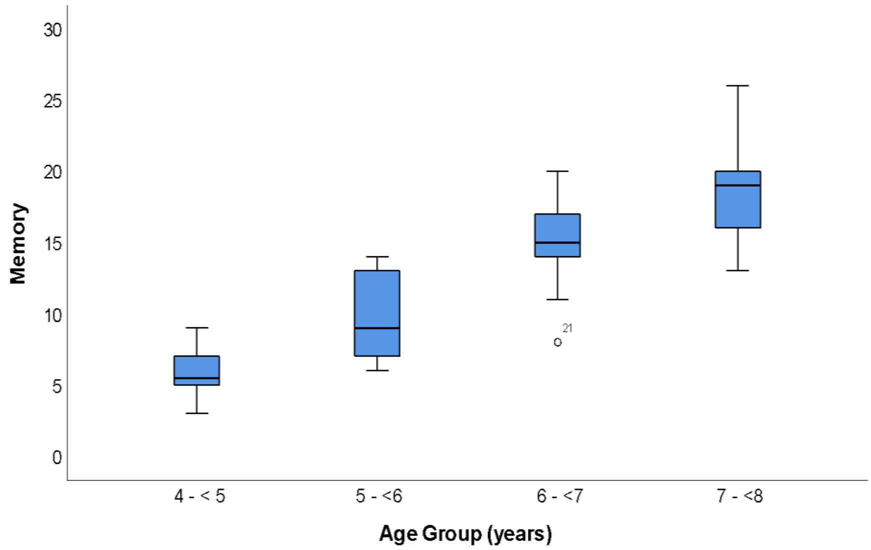
Journal of Child Language Acquisition and Development – JCLAD
Vol: 13 Issue: 3 1431-1443, 2025
ISSN: 2148-1997

	11	84	
Total	62.50 00	24.375 39	40

Mixed ANOVA test was administered to compare the performance of individuals on the domains across age groups and pair wise comparisons among domains. The results were demonstrated.

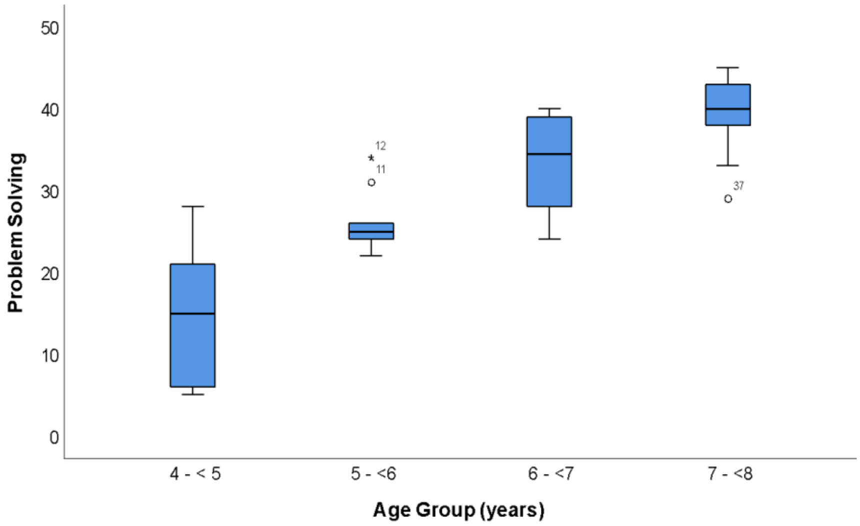


Note: Total scores of attention tasks is displayed on the Y Axis
Figure 1. Performance of Participants in the Attention domain across age groups



Note: Total scores of Memory tasks is displayed on the Y Axis

Figure 2. Performance of Participants in the Memory domain across age groups



Note: Total scores of problem solving tasks is displayed on the Y Axis
Figure 3. Performance of Participants on Problem solving domain across age groups

Figure 1 illustrates the mean attention scores across age groups, demonstrating clear improvements from 4;0 to 8;11 years. Figure 2 presents memory scores showing age-related increases but comparatively lower than attention and problem-solving. Performance of the participants improved as the age range increased from 4- <5years to 7-<8 years old across all the domains. There was a statistically significant difference found for age groups across domains, with F (3, 36) = 50.403, P<0.01, ηp2=0.808. There was a statistically significant difference found between domains as well, with F (2,72) = 125.825, P<0.01, ηp2 (Partial Eta (partial eta squared) = 0.778. An interaction effect was also seen between domains and age groups, with F(6,72)=3.294,P<0.05, ηp2=0.215.This result also revealed that there is significant interaction between the three domains (Attention, Memory and Problem solving) and four age groups (Between 4 and 8 years).

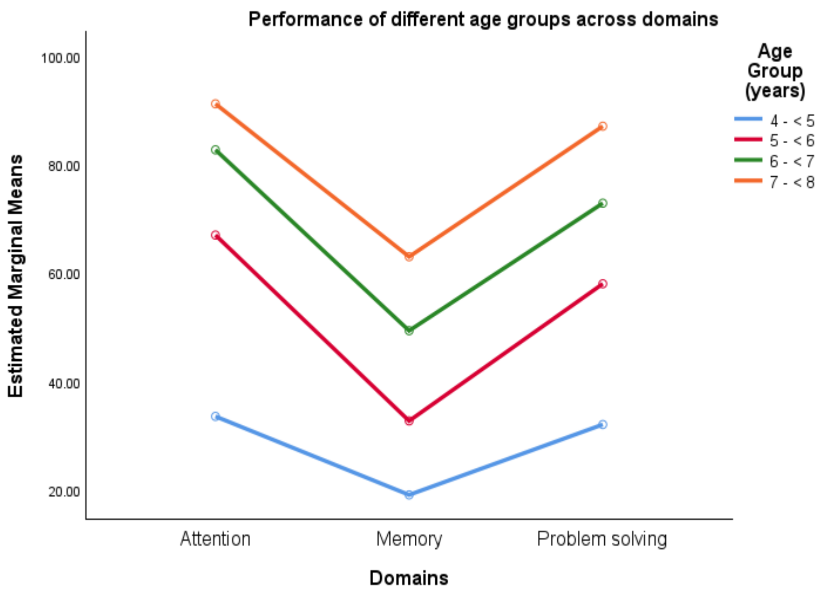


Figure 4. Performance of different age groups across domains

Figure 3 displays problem-solving scores, with steady growth particularly in older children. Figure 4 compares domain performances across age groups, highlighting that the youngest group showed less distinction between domains, while older children showed more domain-specific development patterns. A clear-cut developmental trend can be visualized from this figure. The performance of participants in memory, was reduced compared to other domains of attention and problem solving. Group 1 (4-<5 years) was showing a different pattern compared to the other age groups. There is not much difference between the three domains for participants aged 4-<5 years. Repeated measures ANOVA was done to check the differences among different domains. Bonferroni's adjustment for multiple comparisons was made during pair wise comparisons.

Table 3
Comparison between domains

(I) domain	(J)domain	Mean Difference (I-J)	Std. Error	Sig.[b]
1	2	27.625*	1.933	.000
	3	6.125*	1.833	.006
2	1	-27.625*	1.933	.000
	3	-21.500*	1.715	.000
3	1	-6.125*	1.833	.006
	2	21.500*	1.715	.000

Based on estimated marginal means

*. The mean difference is significant at the 0.05 level.

b. Adjustment for multiple comparisons: Bonferroni

The results suggested that statistically significant differences exist in the performance of participants in different domains. (P <0.05 for all the domains; which means all domains are different from each other).

The interaction effect indicates differing developmental trajectories by domain and age. Younger children (4;0–4;11 years) exhibit less differentiated cognitive-linguistic skills across domains, whereas older children show more specialized development with notably lower memory relative to attention and problem-solving abilities. This reflects neurocognitive maturation and environmental influences on cognitive functions.

4. Discussion

Our findings corroborate previous research showing progressive development of attention, memory, and problem-solving in childhood (Betts et al., 2006; Best et al., 2009). Memory development lagging behind other domains aligns with known protracted maturation of working memory capacity. While cognitive-linguistic assessment studies specific to Malayalam are scarce, similar developmental patterns have been reported cross-linguistically.

Both sustained and selective attentions were evaluated using CLAP-C (Malayalam). Digit count tests, sound count tests, and auditory word discrimination were used as tasks for auditory attention. The findings revealed that children's attention abilities improve with age. However, as the levels progressed, the participants' performance deteriorated. The visual attention tasks used in this study were the odd one out test, letter cancellation (LC), and visual word discrimination, all of which required sustained attention. A clear pattern of hierarchy was observed. When compared to lower age group children, higher age group children performed better on the more difficult items.

Between the ages of 6 and 10, attentiveness, sustained attention, and spatial orienting (visual search) improve the fastest, according to numerous studies on children's attentional development (Betts et al., 2006). The level of cerebral maturation has the greatest influence on attentional functions, as it does on all cognitive mechanisms. Zimmermann and Fimm (2002) investigated the overall attention development of healthy 6 to 12-year-old children. They found that, despite unavoidable inter-individual differences, getting older invariably improved attentional test performance, and that these levels of performance, which were at first highly heterogeneous, tended to stabilize. Flexibility, which is necessary for controlling the focus of attention, increases with child maturation. Rapid growth occurred from the ages of 5–6 to 8–9 years, followed by a developmental plateau with only minor improvement from 8–9 to 11–12 years. According to research by Posner & Rothbart in 2007, the central executive attention network significantly improves during the preschool years.

The tasks used to evaluate memory in the auditory modality were word recall, digit forward span, and digit backward span. The main purpose of digit span tests was to evaluate working memory. Results showed that as children get older, their ability to recall more items increases. Working memory appears during the preschool years and develops linearly between the ages of 4 and 15, with visual-spatial WM reaching a peak around the age of 11 (Best et al., 2009). No matter whether the tasks are digit or word span or object or spatial span, various cross-sectional studies have found that the number of items retained varies from 3 to 5 years of age. However, capacity for both digit-word and object-spatial spans improves after preschool (e.g., from 4 blocks at 5 years to 14 blocks at 11 years) (Garon, Bryson & Smith, 2008). Between the ages of 3 and 5 years, the number of items that children can remember backward expands from 1.58 to 2.88 items and beyond (Carlson, 2005).

The visual memory tasks used in this study were Alternate Sequence Tasks, Picture Counting, and Story Sequencing. Memory capacity increases along with a consistent rise in chronological age. Supporting the research findings on rehearsal strategies may help explain why children from older groups perform relatively well. It has been established that as children grow older, there appears to be an improvement in their recall strategies. Supporting the research findings on rehearsal strategies may help explain why children from older groups perform relatively well. It has been established that as children grow older, there appears to be an improvement in their recall strategies.

In this study, auditory problem-solving tasks included predicting the outcome, predicting the cause, and comparing and contrasting. Association tasks, overlapping test and Mazes were the tasks done to assess memory in the visual modality According to the findings of this study, there was a significant difference across age groups for all problem-solving tasks. The findings revealed that as one gets older, one's problem-solving abilities improve even more.

In essence, the findings in this domain revealed that problem-solving abilities such as reasoning, thinking, and so on develop, as a child grows older. The environment to which the child is exposed is also crucial to the development of these skills. Younger children appeared to exert more effort when planning, as evidenced by the fact that they paused for longer periods of time than older children. Children under the age of five have a hard time following instruction when performing 'tower tasks' (Baughman & Cooper, 2007) or using standard computer interfaces, like those required for 'maze navigation planning tasks' (Miyata, Itakura, & Fujita, 2009). Cognitive linguistic skills in Malayalam has not been carried out in Malayalam using the same tests or tests meant for the same purpose to correlate the findings of the current study with previous findings.

5. Conclusion

The findings of this study highlight several points of interest. The development of cognitive-linguistic skills in children tested using this assessment tool was discovered to follow a developmental trend. Within all age groups, basic attention tasks such as digit count and odd one out were the easiest and showed high accuracy, even among younger children. More complex tasks involving working memory (digit backward span, story sequencing) and problem-solving (predicting outcomes or causes) were the hardest, with gradual improvement observed with age yet remaining challenging. The findings also indicated that as the complexity of the stimulus increased, the children's performance decreased. This study will help in identifying the sequential cognitive linguistic milestones, which can further help in diagnosing cognitive linguistic disabilities in Malayalam speaking children, and allow intervention based on the developmental schedule.

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