



## **Developmental changes in narrative productivity and complexity: A T-unit analysis of storytelling in typically developing Kannada-speaking children**

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### **Abstract**

**Background:** Narrative discourse is a sensitive index of school-age language development and is closely linked to literacy, academic achievement, and social-pragmatic competence in children. However, quantitative studies of oral storytelling in non-English, Indian languages remain limited, particularly those that track microstructural development across narrow age bands in typically developing (TD) children.

**Aims:** This study aimed to investigate age-related changes in narrative productivity and syntactic complexity in TD Kannada-speaking children aged 5–10 years, using T-unit-based measures. Specific objectives were to (a) examine developmental trends in number of clauses, number of T-units, words per clause, and words per T-unit across five one-year age groups, and (b) explore the influence of age and gender on these measures.

**Methods:** The study included 150 neurotypical Kannada-speaking children (5–10 years old), divided into five age groups, recruited from schools and community settings in Mysuru, India. Children met strict inclusion criteria based on caregiver report, standardised language screening and language background. Narrative discourse was elicited through self-generated storytelling which was further video-recorded, transcribed verbatim, and segmented into T-units. Data were analysed using a three-way mixed ANOVA with age group and gender as between-subjects factors and narration as the discourse task, followed by Tukey's HSD post-hoc tests.

**Results:** T-unit measures showed gradual increases from 5 to 10 years, with older children producing more clauses and T-units and demonstrating longer, more elaborated clauses and T-units than younger peers. Boys and girls displayed broadly similar performance trends. The omnibus ANOVA revealed significant main effects of age group for all T-unit indices, whereas gender effects were non-significant and interactions were minimal. Post-hoc comparisons indicated overlapping age subsets, suggesting continuous rather than stage-like developmental change.

**Conclusions:** The findings provide preliminary age-referenced T-unit norms for Kannada-speaking school-age children between 5 and 10 years. These data offer a useful quantitative reference for narrative assessment in Kannada and lay

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the groundwork for future comparisons with children who have language or learning difficulties.

**Keywords:** Narrative discourse, discourse, development, school-aged children, T-unit analysis

## 1. Introduction

Narrative discourse offers an insightful window into children's developing language system because it places simultaneous demands on lexical, syntactic, and discourse organisation skills. Quantitative narrative research typically distinguishes microstructure, which includes local lexical and syntactic characteristics, from macrostructure, which encompasses global story grammar and coherence, but both levels are tightly linked to literacy and broader academic achievement in the school years. Within microstructure, T-unit-based indices have become a standard way of quantifying children's structural language in storytelling; a T-unit, defined as one main clause plus all its dependent clauses and non-clausal modifiers, captures the basic propositional units through which children encode events and relationships (Hunt, 1970; Justice et al., 2006). Measures such as number of clauses, number of T-units, mean length of T-unit in words, and related indices are sensitive to age, language impairment, and intervention effects and are widely used in narrative research and clinical assessment (Justice et al., 2006; Petersen et al., 2019; Ukrainetz, 2015).

A substantial body of work in English and other major languages has documented age-related increases in narrative microstructure measures from early to late primary school. Studies using T-unit or closely related indices consistently show that typically developing children produce more clauses and T-units and longer, more syntactically complex T-units as they grow older, with school-age samples generally demonstrating parallel gains in narrative productivity and complexity (Justice et al., 2006; Petersen et al., 2019). For example, large-scale investigations underlying the Index of Narrative Microstructure (INMIS) reported that productivity measures (word output, lexical diversity, T-unit output) and complexity measures (mean T-unit length, proportion of complex T-units) both increase steadily between approximately 5 and 12 years, providing age and grade-based norms for clinical use (Heilmann et al., 2010; Petersen et al., 2019). Similar patterns have been observed in studies comparing typically developing children with those who have developmental language disorder or other neurodevelopmental conditions, where microstructure variables such as total clauses, T-units, and mean T-unit length reliably differentiate groups and often yield medium to large effect sizes (Spencer et al., 2020; Petersen et al., 2019; Miller et al., 2023). These findings underscore the diagnostic and descriptive value of quantitative T-unit analysis in narrative assessment.

Despite this progress, several gaps remain in the quantitative literature on narrative microstructure, particularly as it relates to oral storytelling in diverse linguistic contexts. First, most T-unit-based narrative studies have been conducted in English or other Indo-European languages, with relatively



few investigations examining narrative clauses and T-units in typologically different or under-represented languages such as Kannada (Hema et al., 2017). Existing Indian work has tended to focus on tense marking, discourse markers, or adult bilingual samples, rather than providing systematic, age-banded T-unit norms for typically developing school-age children (Srihari et al., 2022). Second, even in the international literature, many studies either aggregate wide age ranges (e.g., 5–8 or 7–12 years) or use cross-sectional designs with relatively coarse groupings, limiting the ability to trace fine-grained changes in productivity (number of clauses, number of T-units) and complexity (words per clause, words per T-unit) across narrow one-year intervals in the early school years (Gillam et al., 2017; Petersen et al., 2019). Third, much of the quantitative work integrates multiple narrative genres or focuses primarily on macrostructure, with microstructure reported more briefly, leaving fewer detailed descriptions of how specific T-unit indices evolve within a single, ecologically valid storytelling context such as self-generated oral narration (Westerveld & Vidler, 2021; Justice et al., 2006).

The present study addresses these gaps by providing a detailed quantitative analysis of narrative microstructure using T-unit measures in typically developing Kannada-speaking children aged 5–10 years. Narratives were elicited through self-generated storytelling and analysed in terms of number of T-units, number of clauses, words per clause, and words per T-unit, allowing a comprehensive view of both productivity and syntactic complexity within a single discourse genre. By sampling five consecutive one-year age bands with balanced gender distribution and applying a consistent T-unit framework, the study tried to offer fine-grained developmental data that can serve as preliminary age-referenced norms for Kannada narrative discourse and as a quantitative baseline for future comparisons with children who have language or learning difficulties.

### *1.1. Aim of the study*

The aim of this study is to investigate the developmental trajectory of narrative microstructure in typically developing Kannada-speaking children aged 5–10 years using quantitative T-unit analysis. Specifically, the study seeks (a) to examine age-related changes in number of clauses, number of T-units, words per clause, and words per T-unit in self-generated oral narration across five one-year age bands, and (b) to determine the extent to which age and gender influence these T-unit-based indices of narrative productivity and syntactic complexity.

## **2. Methodology**

### *1.1. Participants*

A total of 150 neurotypical Kannada-speaking children aged 5–10 years participated, divided into five one-year subgroups: 5–6, 6–7, 7–8, 8–9, and 9–10 years, each comprising 30 children with equal gender distribution. Children were recruited from residential areas, daycare centres, kindergartens, and primary schools in different localities of Mysuru, Karnataka, India, and all were reported by caregivers to have no history of significant sensory, neurological, or motor developmental difficulties.

Language ability was screened using the Kannada Language Test (KLT) for children aged 5–7 years (Shyamala et al., 2003) and the Linguistic Profile Test (LPT) for children aged 8–10 years (Karanth, 1980); only children who achieved a pass (i.e., met the cut-off criterion) were included.

Additional inclusion criteria required that children were not receiving special education services, had no parental concerns about language development, belonged to middle socioeconomic status as determined by the NIMH Socioeconomic Status Scale (Venkatesan, 2009), and were right-handed native speakers of Kannada with regular exposure to Kannada as their first language (L1); exposure to additional languages was documented as L2, L3, L4, and so on. For narrative elicitation, three procedures were piloted: (a) retelling a story presented via four-picture sequences narrated by the examiner, (b) narrating a story after viewing a 3–5-minute video clip, and (c) producing a self-generated story based on prior knowledge or personal experience (e.g., “Tell me a story you know” or “Tell me about your visit to the doctor/market”). Pilot results showed that self-generated narration elicited the greatest amount of discourse, so this method was adopted as the primary narration task in the main study.

### 1.1. *Ethical consideration*

The present study was approved by the Ethical Committee for bio-behavioral research involving human subjects at the All India Institute of Speech and Hearing (AIISH), Mysuru, India (Reference code: SH/IRB/P.12/2025-26). The participants were recruited for the study only after obtaining the written consent from their caregivers or school authorities as per the ethical guidelines for bio-behavioral research involving human subjects of the All India Institute of Speech and Hearing (Basavaraj & Venkatesan, 2009). All the caregivers were informed about the need, procedure, and approximate duration of the tasks. They were assured of safety during testing and confidentiality regarding their details.

### 1.2. *Procedure*

Data collection was carried out in a quiet room with minimal distractions. Each child was seated comfortably with adequate lighting throughout the assessment. All parents and participants were informed in advance that discourse samples would be video recorded, and recording was initiated only when the child was ready and comfortable.

The recording of discourse samples was conducted in two phases. In Phase I, an initial interaction period of 4–5 minutes was carried out to establish rapport and reduce inhibition. This interaction was informal and was not recorded. In Phase II, discourse samples for the actual tasks were recorded. By this stage, the participants were more familiar with the investigator and demonstrated improved conversational engagement. For the narration task, participants were asked to narrate a story of their choice. Minimal prompting was provided to encourage elaboration when required. Participants were instructed to communicate casually and to respond only in Kannada (L1). A minimum discourse sample of approximately 100–250 words was collected from each child. Probe questions were used whenever, especially for younger children who were unable to produce the minimum



required number of words spontaneously. These probes were prepared and administered by the investigator. Probing was used only when necessary and was restricted to general prompts such as clarification requests and expansion cues to ensure natural discourse production. All sessions were video recorded using a digital video recorder for subsequent transcription and analysis.

### *1.3. Analyses of discourse samples*

For the T-unit-based analysis, the video-recorded discourse samples were transcribed verbatim and verified for accuracy. The video samples were analyzed individually, with each recording reviewed one at a time. Every utterance produced by the child was transcribed sequentially. Following transcription, the data were systematically coded to determine the number of clauses, the number of words per clause, the number of T-units, and the number of words per T-unit. This procedure was carried out separately for each child and for each task to ensure precise and task-specific analysis. The basic unit for data segmentation was the T-unit, defined as one independent clause along with its dependent modifiers (Hunt, 1970). A clause was considered a part of a sentence, and two main types of clauses were identified: independent (main clauses) and dependent (subordinate clauses). An independent clause was defined as a complete sentence containing a subject and a verb and expressing a complete thought (e.g., the police said). Independent clauses could be joined by coordinating conjunctions to form compound or complex sentences. A dependent (subordinate) clause was defined as a clause that contained a subject and a verb but did not express a complete thought and depended on another clause for meaning (e.g., I will give this gold to the one that can do it).

The discourse samples were analyzed in terms of discourse grammar. The variables used for analysis included the number of T-units (NTU), number of words per T-unit (NWPTU), number of clauses (NC), and number of words per clause (NWPC). During quantitative analysis, errors related to speech intelligibility, linguistic fluency, suprasegmental features, dialectal variations, code-switching, and style-shifting were not excluded from the word count. However, errors such as phrase repetitions and irrelevant propositions were not included in the clause count. Following verbatim transcription, these errors were excluded and were not considered for T-unit analysis. Tangential shifts from one theme to another were treated as separate T-units.

### *1.4. Statistical analyses*

Statistical analyses were conducted using Statistical Package for Social Sciences version 26.0 (SPSS Inc, Chicago). Non-parametric tests were predominantly employed due to the non-normal distribution of the data, as indicated by the Shapiro-Wilk test of normality. In cases where the data did not deviate from normality, parametric tests were utilized. Descriptive statistics, including mean, median, standard deviation, interquartile range, minimum, and maximum, were calculated. Three way mixed ANOVA was performed to examine the influence of discourse task, age group, and gender on the quantitative T-unit measures. Post-hoc comparisons using Tukey's

HSD test were conducted to follow up on the significant main effect of age group on the T-unit measures.

### 3. Findings

Descriptive statistics, including mean, standard deviation, median, interquartile range, minimum, and maximum, are presented in Tables 1 and 2 separately for males and females across age groups for the outcome measures of T-unit analysis.

Table 1

*Descriptive statistics for the outcome measures of t-unit analysis across age groups in Males*

Measure	Age group	Mean	Median	SD	Min	Max	IQR
Number of Clauses	5-6	6.13	6.00	2.56	2.00	12.00	3.00
	6-7	6.33	7.00	1.72	3.00	9.00	2.00
	7-8	7.20	8.00	2.04	4.00	10.00	3.00
	8-9	8.60	8.00	2.47	4.00	12.00	4.00
	9-10	9.33	9.00	2.58	5.00	13.00	3.00
Number of words per clause	5-6	4.90	4.67	2.39	1.50	11.00	3.17
	6-7	4.90	4.71	1.51	2.00	7.50	2.17
	7-8	5.57	5.67	1.41	3.44	7.22	1.37
	8-9	6.65	6.29	1.15	4.71	9.00	1.86
	9-10	6.83	6.86	1.58	4.71	10.00	2.71
Number of T-units	5-6	3.27	3.00	1.83	1.00	7.00	3.00
	6-7	3.27	3.00	1.83	1.00	7.00	3.00
	7-8	3.80	3.00	1.44	1.00	6.00	2.75
	8-9	5.27	5.00	1.63	3.00	10.00	1.00
	9-10	6.47	6.00	1.87	4.00	11.00	2.00
Number of words per T-unit	5-6	8.27	8.00	2.17	4.00	12.00	3.00
	6-7	6.52	6.00	2.26	3.13	13.50	3.17
	7-8	6.63	6.00	1.88	4.00	10.33	3.50
	8-9	7.35	8.00	1.93	4.88	10.50	3.11
	9-10	7.34	6.54	2.67	4.00	13.00	5.11



Note. SD = Standard deviation; Min = Minimum; Max = Maximum; IQR = Interquartile range

Table 2  
*Descriptive statistics for the outcome measures of t-unit analysis across age groups in Females*

Measure	Age group	Mean	Median	SD	Min	Max	IQR
Number of Clauses	5-6	5.53	5.00	1.73	3.00	10.00	1.00
	6-7	6.40	6.00	2.38	3.00	11.00	4.00
	7-8	6.80	6.00	2.66	4.00	12.00	4.00
	8-9	8.27	8.00	2.86	4.00	13.00	4.00
	9-10	12.00	12.00	4.65	4.00	20.00	4.00
Number of words per clause	5-6	4.49	4.73	2.04	2.00	6.33	2.25
	6-7	5.12	5.11	1.23	2.25	8.11	2.00
	7-8	6.05	5.88	2.03	3.00	11.00	2.67
	8-9	5.87	5.43	1.52	3.08	8.50	2.99
	9-10	6.90	6.13	1.90	4.00	11.00	2.17
Number of T-units	5-6	4.00	4.00	1.30	2.00	7.00	2.00
	6-7	4.67	4.00	2.29	1.00	9.00	3.00
	7-8	4.33	4.00	2.29	2.00	10.00	2.00
	8-9	5.87	5.00	1.88	3.00	10.00	3.00
	9-10	10.47	9.00	4.78	3.00	20.00	4.00
Number of words per T-unit	5-6	6.77	6.00	2.09	1.00	11.00	2.25
	6-7	6.59	7.50	2.17	1.00	10.00	3.00
	7-8	7.98	8.00	2.47	2.50	15.75	3.75
	8-9	7.24	7.00	1.69	4.43	10.00	3.25
	9-10	9.37	8.55	3.92	5.00	20.00	4.60

Note. SD = Standard deviation; Min = Minimum; Max = Maximum; IQR = Interquartile range

In males, all four measures showed age-related increases, indicating that older children produced longer and somewhat more complex narratives.

For number of clauses, mean values increased demonstrating that the older groups consistently narrated with more clauses. For words per clause, clauses became progressively more elaborated with age. For number of T-units, the younger groups produced fewer independent predicate units and reached the highest level at 9–10 years, showing that older children's narratives contained more complete propositions. For words per T-unit, the youngest group already used relatively long T-units (5–6 years, mean = 8.27), but the mean dropped at 6–7 years (mean = 6.52) and remained similar at 7–8 years (mean = 6.63); it then increased again at 8–9 years (mean = 7.35) and 9–10 years (mean = 7.34), suggesting that while T-unit length fluctuated across ages, older groups tended to converge on moderately long narrative T-units.

In females, all four measures showed clear age-related increases, indicating that older children produced longer and more complex narrations. For number of clauses, the mean had risen steadily from 5–6 years (mean = 5.53) with the highest values at 9–10 years (mean = 12.00), showing that the oldest group produced substantially more clauses than the younger groups. For words per clause, younger children used shorter clauses at 5–6 years (mean = 4.49) and peaked by 9–10 years (mean = 6.90), suggesting gradual elaboration of clause content with age. For number of T-units, the 5–6-year-olds produced relatively few T-units and increased throughout all ages, indicating that the oldest children generated many more independent predicate units in their descriptions. For words per T-unit, T-unit length was moderate at 5–6 years (mean = 6.77) and 6–7 years (mean = 6.59), increased further at 7–8 years (mean = 7.98), remained substantial at 8–9 years (mean = 7.24), and reached the highest level at 9–10 years (mean = 9.37), showing that older children not only produced more T-units but also had more words in each one. The comparison between males and females for all the parameters of T-unit analysis is presented in Figures 1, 2, 3, and 4.

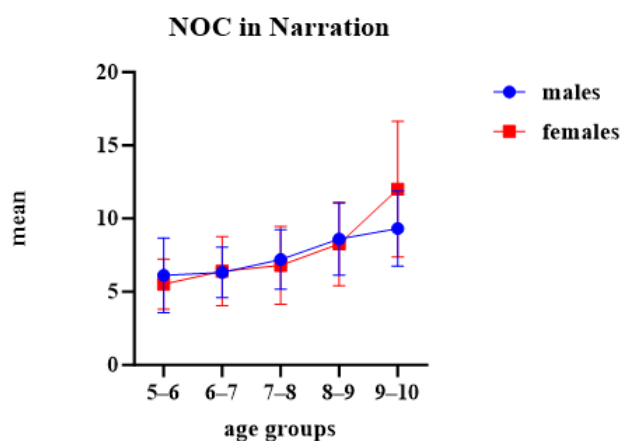


Figure 1  
Comparison of Number of Clauses between males and females

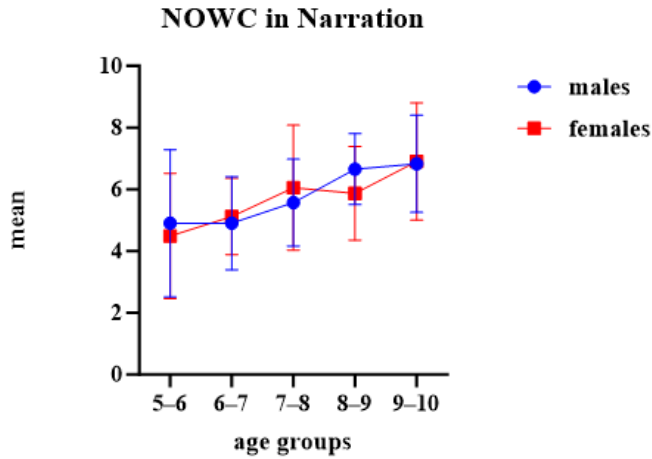


Figure 2  
Comparison of Number of Words per Clause between males and females

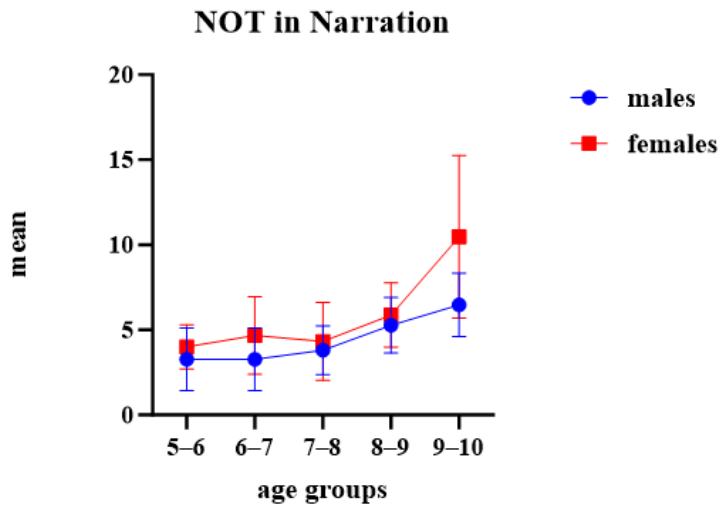


Figure 3  
Comparison of Number of T-units per Clause between males and females

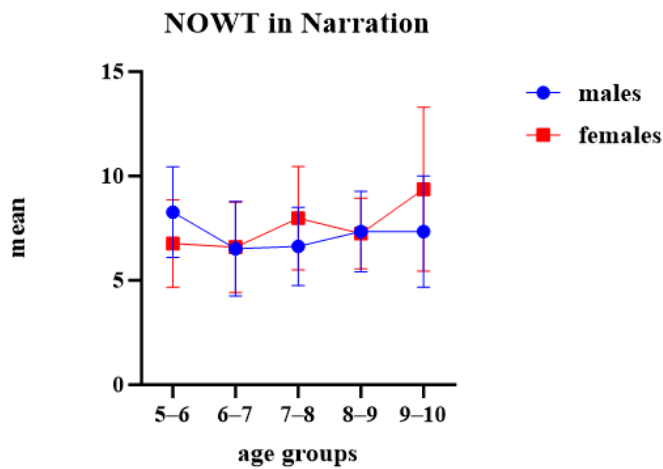


Figure 4  
Comparison of Number of Words per T-unit between males and females

These descriptive trends were supported by a three-way mixed ANOVA with discourse task as a within-subjects factor and age group and gender as between-subjects factors. There was a significant main effect of age group on all four T-unit measures: number of clauses,  $F(4,140)=25.004, p<.001, \eta^2=.417$ ; number of words per clause,  $F(4,140)=6.312, p<.001, \eta^2=.153$ ; number of T-units,  $F(4,140)=20.342, p<.001, \eta^2=.368$ ; and number of words per T-unit,  $F(4,140)=2.692, p=.034, \eta^2=.071$ , confirming significant developmental gains in narrative productivity and complexity from 5 to 10 years. Gender did not yield a significant main effect for any T-unit measure (all  $p>.05$ ), but a significant age group  $\times$  gender interaction emerged for number of clauses,  $F(4,140)=3.310, p=.013, \eta^2=.086$ , suggesting some differential age-related patterning for boys and girls on this measure; no other interaction terms reached significance, indicating that overall growth trajectories were largely parallel across genders. Follow-up Tukey HSD post-hoc tests for age group differences showed that, despite the clear descriptive increases, pairwise comparisons between specific age bands did not reach statistical significance after correction. For number of clauses, age groups formed three overlapping subsets, with means rising from each age group, but none of the subset comparisons yielded  $p<.05$ . A similar pattern was observed for words per clause; however, all adjusted p-values for the three subsets exceeded .33, indicating non-significant pairwise differences. For number of T-units, means increased across age groups, yet the three overlapping subsets again showed non-significant comparisons (all adjusted  $p>.26$ ). Finally, for words per T-unit, the age groups were arranged into two overlapping subsets, with means progressing from 6.01 (6–7 years) through 6.31 (5–6 years), 6.35 (7–8 years), 6.68 (8–9 years), to 7.51 (9–10 years); here too, subset p-values of .655 and .118 indicated that none of the pairwise age contrasts met the significance threshold. Thus, the inferential analyses support a pattern of gradual, continuous growth in narrative T-unit productivity and complexity from 5 to 10 years, without sharp statistically significant jumps between adjacent age bands.

#### 4. Discussion

A clear developmental progression in both productivity and complexity was observed, and they closely match what is reported for narrative development in typically developing children in the previous studies. Age-related increases in number of clauses and number of T-units for boys and girls indicate that older children can sustain longer storylines and encode more propositions per narrative, which is consistent with work showing that school-age narratives grow in length and propositional density from early to late primary school (Bliss et al., 1998; Liles, 1993). The fact that clause length (words per clause) and T-unit length (words per T-unit) also increase with age, especially evident in females by 9–10 years suggests not only that children are telling longer stories but that their individual clauses and T-units are becoming more elaborated, in line with studies reporting gradual growth in mean length of T-unit and clausal embedding across this age range (Scott & Windsor, 2000; Nippold et al., 2005).



For males, the pattern of relatively stable clause length at 5-6 and 6-7 years, followed by a steady rise from 7-10 years, supports the idea that early school-age children initially focus on adding more clauses before substantially increasing the internal complexity of each clause. This sequencing has been noted in longitudinal work where younger children first extend narratives by chaining more simple propositions, and only later begin to pack more information into each T-unit via modifiers and subordinate clauses (Liles, 1993; Paul et al., 1996). The temporary dip in words per T-unit at 6-7 years, with recovery and convergence on moderately long T-units by 8-10 years, may reflect a transitional phase in which children are experimenting with new syntactic structures and narrative strategies; similar non-linear fluctuations have been described when children begin to introduce more complex clause types, leading to short-term variability before stabilisation at higher complexity levels (Nippold et al., 2005).

For females, the steeper increases, particularly the sharp rise in clause counts and T-unit length by 9-10 years, suggest that girls in this sample reached especially high levels of narrative productivity and elaboration by late primary school. Some narrative studies have reported that girls, on average, tend to produce longer and more detailed stories, often with richer descriptions and evaluations, than boys of the same age (McCabe & Rollins, 1994; Pavlenko, 2017). The current pattern, where older girls exhibit very high numbers of clauses and T-units, as well as the longest T-unit lengths, is consistent with the existing literature, although the basic upward trajectory is shared by both genders. At the same time, other research using more structurally focused measures has found minimal gender differences in core narrative microstructure (Bliss et al., 1998; Scott & Windsor, 2000), so any apparent advantage for girls here is best interpreted as a difference in degree rather than a fundamentally different developmental pattern.

Overall, the T-unit data support the view that, between 5 and 10 years, typically developing children move from producing relatively short, less elaborated narratives to generating stories that are both longer and structurally richer. The increases in clauses and T-units capture children's growing ability to sustain coherent storylines and include more events, while the growth in words per clause and words per T-unit reflects increasingly complex sentence construction and denser information packaging. These findings are therefore in line with established models of narrative development and reinforce the usefulness of T-unit analysis for capturing both productivity and microstructural complexity in school-age children's narratives.

## **5. Conclusion**

A The study examined narrative discourse in 150 typically developing Kannada-speaking children aged 5–10 years, using T-unit-based quantitative measures to track developmental changes in productivity and syntactic complexity across five one-year age bands. The findings indicated a gradual, continuous increase in narrative productivity and microstructural complexity from 5 to 10 years, with older children producing more clauses and T-units and showing longer, more elaborated clauses and T-units than younger peers. Boys and girls followed broadly similar developmental

trajectories. Nevertheless, differences between adjacent age bands were subtle rather than sharply distinct, consistent with a smooth developmental progression rather than discrete stage-like shifts. Taken together, the study supports the view that self-generated narrative is a sensitive window into the ongoing refinement of children's structural language skills in the early school years. The study provides preliminary age-referenced T-unit norms for Kannada-speaking school-age children, which should, however, be interpreted cautiously.

The discourse analysis conducted in this study has important clinical implications for both assessment and benchmarking. By examining measures such as clauses, T-units, and words per unit, clinicians can obtain a clearer understanding of a child's expressive language abilities beyond standard test scores. These metrics can serve as sensitive indicators of linguistic complexity and organization, aiding in the identification of subtle language difficulties. Additionally, the findings can contribute to the development of normative benchmarks for similar populations, enabling clinicians to compare an individual child's performance against expected patterns and track progress over time or in response to intervention.

A key strength of the present study is the inclusion of children aged 5–10 years and the analysis of age-group-specific patterns within a developmental framework. This approach allows for the examination of impairment in relation to the normal developmental trajectory of discourse skills. Rather than focusing solely on group differences, the study highlights how discourse abilities typically evolve across the primary school years. Adopting this developmental perspective enhances the clinical relevance of interventions by informing the timing and nature of intervention planning. Despite its strengths, the present study has limitations. The cross-sectional design restricts the ability to draw conclusions about individual developmental changes over time, as age-related patterns were inferred rather than directly observed. Future research employing longitudinal designs and a broader range of discourse tasks would provide a more comprehensive understanding of discourse development and impairment.

**Author contribution statement:**

HN conceptualized and formulated the study.

PC was responsible for data collection, analysis, and manuscript writing.

YC contributed to manuscript by writing and revising.

**The usage of GenAI:** GenAI was not used at any stage of this research and article.

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