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Original Research Article

Connected speech accuracy in native Nepali-speaking preschool children: a comparative study of typically developing children and children with speech sound disorders

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ABSTRACT

Background: Speech sound disorders (SSD) are among the most prevalent communication disorders in preschool-aged children; however, empirical data characterizing connected speech performance in native Nepali-speaking children with SSD remain absent from the international literature. Connected speech analysis offers an ecologically valid complement to conventional single-word assessment paradigms, yet no published normative or comparative framework exists for this population. Objective was to compare connected speech accuracy, operationalized through the percentage of syllables correct (PSC) metric, between typically developing children (TDC) and children with SSD among native Nepali-speaking preschoolers aged 4–5 years.

Methods: A comparative cross-sectional design was employed. Participants (n=30) were native Nepali-speaking children aged 4;0 to 5;00 years recruited from a preschool (TDC; n=15) and clinical setting (SSD; n=15) in Kathmandu. Connected speech samples were elicited via a structured sentence repetition task based on the culturally familiar "thirsty crow" narrative, supported by ten illustrated picture stimuli. PSC was calculated from broad phonetic transcription conducted by a qualified speech-language pathologist with expertise in Nepali phonology. Inter- and intra-rater reliability were established. Group differences in PSC were examined using the Mann–Whitney U test following confirmation of non-normality via the Shapiro–Wilk test.

Results: TDC achieved a mean PSC of 93.58% (SD=6.65), reflecting near-ceiling syllable accuracy. Children with SSD demonstrated substantially reduced performance (mean PSC=63.14%; SD=8.62). The Mann–Whitney U test revealed a highly significant between-group difference ($U=0.000$, $Z=-10.887$, $p<0.001$), with complete absence of distributional overlap.

Conclusions: PSC derived from a structured connected speech task demonstrated high discriminative sensitivity in distinguishing TDC from children with SSD in a Nepali-speaking preschool population. These findings support routine integration of connected speech analysis into early speech-language assessment and provide preliminary normative data for an underrepresented linguistic group.

Keywords: Connected speech, Percentage of syllables correct, Speech sound disorders, Nepali, Preschool children, Phonological development, Cross-linguistic

INTRODUCTION

Speech sound disorders (SSD) represent one of the most prevalent communication disorders in childhood, estimated to affect approximately 8–9% of preschool-aged children.[1,2] These disorders are characterized by persistent difficulties in the accurate production of speech sounds attributable to deficits in phonological representation, speech motor planning, or articulatory execution.[3] Children with SSD frequently exhibit phonological error

patterns—including substitutions, omissions, and distortions—that compromise speech intelligibility and may adversely affect literacy development and academic outcomes when intervention is not provided.[4,5] Traditional SSD assessment has predominantly relied on standardized single-word articulation tests. Although such assessments provide valuable information regarding segmental accuracy, they may underestimate the extent of a child's phonological difficulties in naturalistic communicative contexts. Everyday speech occurs within connected utterances subject to coarticulatory influences, prosodic modulation, and complex phonological interactions between adjacent segments. Researchers have accordingly advocated for the integration of connected speech analysis to achieve a more ecologically valid assessment of children's phonological competence.[6]

Several quantitative indices have been developed for connected speech analysis, including percentage of consonants correct (PCC), percentage of phonemes correct (PPC), and percentage of syllables correct (PSC).[7] PSC has been considered particularly advantageous for use with preschool-aged children, as it captures phonological accuracy at the syllable level and demonstrates sensitivity to developmental variability, including patterns of syllable omission and structural simplification that phoneme-level indices alone may not fully reflect.[8]

Research on speech sound development in South Asian children underscores the importance of language-specific analysis. Studies on Tamil-speaking children have demonstrated that late talkers produce significantly smaller phonetic inventories and rely on simpler syllable structures compared to typically developing peers.[10] Investigations of Tulu-speaking children aged 3–7 years have established the process density index (PDI) as a sensitive clinical measure of phonological development, with younger children exhibiting higher PDI scores reflecting greater phonological process use.[11] Research on Malayalam-speaking children with hearing impairment has further highlighted substitution errors—particularly involving trills, affricates, and fricatives—as prominent articulatory features amenable to detection through speech sample analysis.[12] Collectively, these studies affirm that connected speech analysis and phonological measures constitute essential tools for identifying SSD across diverse Indian language contexts.

Nepali, an Indo-Aryan language spoken natively by approximately 17 million individuals, presents distinctive phonological features—including dental–retroflex consonantal contrasts and phonemic aspiration distinctions—that may influence speech sound acquisition and the error patterns observed in children with SSD. Empirical investigation of SSD in Nepali-speaking children remains markedly limited. Emerging case-based evidence has documented language-specific phonological error patterns in this population, including substitution of/r/with/l/and replacement of retroflex consonants with dental counterparts.[9] Such findings highlight the necessity of population-specific research and underscore the risk of uncritically applying normative frameworks derived from typologically distinct languages.

No published study has systematically examined connected speech performance in Nepali-speaking children with SSD. The absence of normative and comparative data constitutes a meaningful barrier to accurate differential diagnosis. The present study therefore aimed to compare connected speech accuracy, operationalized through PSC, between TDC and children with SSD among native Nepali-speaking preschoolers aged 4–5 years, with the aim of contributing foundational empirical evidence to support evidence-based clinical practice in an underrepresented linguistic population.

METHODS

Study design

A comparative cross-sectional study design was employed to investigate differences in connected speech accuracy between typically developing (TDC) children and children diagnosed with SSD, enabling efficient and systematic comparison of speech production performance across well-defined diagnostic categories at a single point in time.

Participants

Participants comprised native Nepali-speaking children aged 4;0 to 5;00 years recruited from preschool—City Montessori and speech-language pathology clinic Neo Health Clinic in Kathmandu. Two groups were constituted typically developing children (TDC), and children with SSD. The total participants recruited were 30 out of which 15 were TDC and 15 SSD. The data were collected from 10 January 2026 to 10 February 2026. Children with SSD were identified by qualified speech-language pathologists in their educational or clinical settings. Children were eligible for inclusion if they met all of the following criteria: chronological age between 4;0 and 5;00 years at assessment; Nepali as the primary home language; and capacity to comprehend and follow simple, age-appropriate verbal instructions as confirmed by the examining clinician. Children were excluded if they presented with peripheral hearing impairment; neurological disorder or acquired brain injury; intellectual disability established through prior clinical assessment; structural anomalies of the oral or vocal tract with potential bearing on speech production (e.g., repaired or unrepaired cleft palate); or substantive daily linguistic input from a language other than Nepali.

Stimulus development

Connected speech stimuli were derived from a narrative adapted from the traditional fable "the thirsty crow," a story well known within the Nepali cultural milieu. The narrative was structured into ten discrete sentences, each corresponding to a sequential event within the story.

Sentence length and lexical complexity were calibrated to be developmentally appropriate for the target age range. Ten full-colour illustrations were commissioned from a professional artist, each depicting the event described by the corresponding sentence. Prior to administration, all stimuli were subjected to content validation by a panel of three experienced speech-language pathologists, who evaluated each item for linguistic appropriateness, cultural relevance, and transparency of correspondence between each illustration and its associated sentence. Revisions were incorporated iteratively until consensus was achieved.

Procedure

Each child was assessed individually in a quiet, distraction-minimized environment, either within the clinical setting or in a designated room at the child's educational facility. The examiner presented each picture stimulus while simultaneously producing the corresponding target sentence at a natural conversational rate. The child was then instructed to repeat the sentence as accurately as possible. No additional modelling or prompting was provided beyond the initial presentation. All speech responses were audio-recorded using a calibrated digital recorder at a consistent microphone-to-mouth distance for subsequent perceptual transcription and analysis.

Speech analysis

Connected speech accuracy was operationalized using PSC, calculated as follows.

$$PSC = (Number\ of\ correctly\ produced\ syllables \div total\ syllables\ attempted) \times 100$$

Syllable-level transcription was conducted using broad phonetic notation by a qualified SLP with expertise in Nepali phonology. A syllable was scored as correct if it conformed to the target syllable shape and phonemic composition without substitution, omission, or distortion of any constituent segment.

Reliability

To establish inter-rater reliability, a randomly selected 10% of all audio recordings were independently transcribed and scored by a second qualified SLP blinded to group membership. Intra-rater reliability was assessed by the primary transcriber through re-analysis of a selected subset of recordings conducted at a minimum interval of two weeks following initial scoring, to minimize recall bias. Both indices are reported to permit evaluation of transcription consistency.

Statistical analysis

All statistical analyses were performed using IBM statistical package for the social sciences (SPSS) statistics. Descriptive statistics—including means, medians, standard deviations, ranges, and interquartile ranges—were computed separately for each group. The Shapiro–Wilk test was applied to assess distributional normality given the relatively modest sample sizes. Where normality assumptions were violated, the non-parametric Mann–Whitney U test was employed to examine between-group differences in PSC. Statistical significance was set at $\alpha=0.05$.

RESULTS

This section presents findings from the comparative examination of connected speech performance in TDC and children with SSD among native Nepali-speaking preschoolers aged four to five years. The primary outcome measure was the PSC, derived from a structured sentence repetition task based on the thirsty crow narrative. Results are organized sequentially, beginning with descriptive statistics, followed by normality assessment, inferential group comparison, and a synthesis of key findings.

Demographic and clinical characteristics of participants

A total of 30 children participated in the study, comprising 15 TDC and 15 children with SSD. All participants were native Nepali speakers aged between 4;0 and 5;0 years, ensuring linguistic homogeneity across groups. The mean age of the TDC group was 4;6 years (SD=0;3), while the SSD group had a mean age of 4;7 years (SD=0;4), indicating comparable age distribution between the two groups. In terms of gender distribution, the TDC group consisted of 8 males (53.3%) and 7 females (46.7%), whereas the SSD group included 9 males (60%) and 6 females (40%). Children in the SSD group were identified by qualified speech-language pathologists working in their respective preschools. All participants met the inclusion criteria and none presented with hearing impairment, neurological disorders, intellectual disability, structural anomalies of the speech mechanism, or significant exposure to languages other than Nepali. Overall, the two groups were comparable in demographic characteristics, supporting the validity of subsequent group comparisons.

Descriptive statistics

Descriptive statistics were computed to characterize the distribution of PSC scores within each group and to provide an initial comparison of central tendency and variability (Table 2). The TDC group demonstrated substantially higher PSC scores relative to the SSD group across all descriptive indices. Children in the TDC group attained a mean PSC of 93.58% (SD=6.65), indicative of near-accurate syllable production in connected speech. The median score of 93.29% closely approximated the mean, suggesting a relatively symmetrical distribution within this group. The minimum TDC score was 78.05%, confirming that even the lowest-performing typically developing child retained functionally adequate phonological accuracy in connected speech.

Table 1: Demographic characteristics of participants.

Characteristic	TDC (n=15)	SSD (n=15)	Total (n=30)
Age (years)			
Mean age (years; months)	4.6 (0.3)	4.7 (0.4)	4.6 (0.4)
Age range	4.0 – 5.0	4.0 – 5.0	4.0 – 5.0
Gender			
Male, N (%)	8 (53.3)	9 (60)	17 (56.7)
Female, N (%)	7 (46.7)	6 (40)	13 (43.3)
Language background			
Native Nepali speakers, N (%)	15 (100)	15 (100)	30 (100)
Identification source			
Identified by speech-language pathologist, N (%)	15 (100)	15 (100)	15 (100)
Hearing status			
No known hearing impairment, N (%)	15 (100)	15 (100)	30 (100)
Neurological status			
No neurological disorder, N (%)	15 (100)	15 (100)	30 (100)
Structural oral anomalies			
None reported, N (%)	15 (100)	15 (100)	30 (100)

Table 2: Descriptive statistics for percentage of syllables correct (PSC) by group.

Group	Mean PSC (%)	Median	SD	Min	Max	Range	IQR
TDC	93.58	93.29	6.65	78.05	100.00	21.95	12.20
SSD	63.14	63.78	8.62	45.95	75.68	29.73	14.75

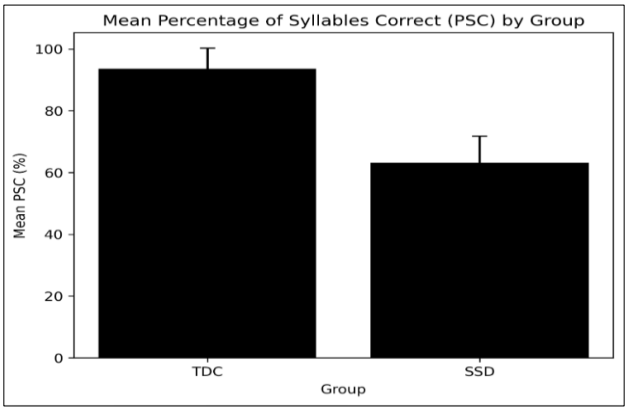

Figure 1: Mean percentage of syllables correct by group.

In marked contrast, children in the SSD group attained a mean PSC of 63.14% (SD=8.62), reflecting substantially compromised syllable accuracy in connected speech. The SSD group also exhibited greater variability, as evidenced by a wider range (29.73 versus 21.95) and a larger standard deviation. The minimum PSC score in the SSD group was 45.95%, indicating that some children produced fewer than half of all syllables correctly during the connected speech task.

Confidence interval analysis reinforced these group-level differences. The 95% confidence interval for the TDC group ranged from 92.27% to 94.90%, whereas the corresponding interval for the SSD group was substantially lower, spanning 60.99% to 65.29%. The absence of overlap between these intervals provided preliminary evidence of a clear and meaningful distinction between the two groups.

Assessment of normality

Prior to conducting inferential analyses, the distributional properties of PSC scores were examined using the Shapiro–Wilk test, which is well established as an appropriate normality test for moderately sized samples in behavioural and clinical research (Table 3).

The Shapiro–Wilk test indicated a statistically significant departure from normality in the TDC group ($W=0.843$, $p<0.001$). The SSD group similarly violated the assumption of normality ($W=0.947$, $p=0.008$). As PSC scores in both groups failed to satisfy the normality requirement, non-parametric inferential procedures were adopted for subsequent group comparisons, in accordance with standard statistical practice.

Group comparison: Mann–Whitney U test

Given the violation of normality in both groups, the Mann–Whitney U test was employed to determine whether statistically significant differences in PSC scores existed between TDC and SSD children. This non-parametric test is appropriate for comparing two independent groups when distributional assumptions are not met (Table 3).

The Mann–Whitney U test revealed a highly significant difference in PSC scores between the TDC and SSD

groups (U=0.000, Z=−10.887, p<0.001). The U statistic of zero indicates a complete lack of distributional overlap between the two groups: every child in the TDC group outperformed every child in the SSD group on the PSC measure. The large standardized Z value (−10.887) further confirms the magnitude of this between-group distinction. These findings unequivocally demonstrate that children with speech sound disorders produced significantly fewer correct syllables in connected speech compared to their typically developing peers.

Table 3: Mann–Whitney U test results for group comparison of PSC scores.

Comparison	Mann–Whitney U	Z	P (2-tailed)
TDC versus SSD	0.000	−10.887	<0.001

Summary of findings

The analyses reported in this section converge to reveal a marked and statistically robust disparity in connected speech accuracy between typically developing children and children with speech sound disorders. Key findings are as follows.

Typically developing Nepali-speaking children aged four to five years achieved near-ceiling levels of syllable accuracy (mean PSC≈93.6%) in connected speech, consistent with expected phonological attainment at this developmental stage.

Children with speech sound disorders demonstrated substantially reduced syllable accuracy (mean PSC≈63.1%), reflecting clinically meaningful impairment in connected speech production.

The between-group difference was statistically highly significant (U=0.000, Z=−10.887, p<0.001), with no distributional overlap between the groups.

Non-normal score distributions in both groups, as established by the Shapiro–Wilk test, justified the application of non-parametric statistical procedures.

Collectively, these results support PSC derived from connected speech as a sensitive and clinically viable indicator for distinguishing typical phonological development from speech sound disorder in Nepali-speaking preschool children.

DISCUSSION

Differences in connected speech performance

The TDC group exhibited high PSC scores (mean≈93.6%), consistent with the broader developmental phonology literature indicating that most children achieve substantial mastery of the core phonological system during the preschool years.[1] The SSD group demonstrated markedly lower PSC scores (mean≈63.1%), reflecting persistent difficulties in phonological organization and speech motor execution. Children with SSD frequently experience difficulty sustaining phonological accuracy across longer utterances, because connected speech necessitates the concurrent integration of phonological planning, lexical retrieval, and motor execution across multiple syllables and morphological boundaries.[2] This confluence of demands amplifies the manifestation of phonological errors, rendering connected speech a particularly diagnostically sensitive environment.

The Mann–Whitney U analysis revealed a complete absence of distributional overlap between the two groups (U=0.000), signifying that every TDC child outperformed every SSD child on PSC. This degree of group separation is notable and suggests that connected speech accuracy may constitute a high-discriminability indicator of phonological competence in young children. Comparable findings have been reported in English-speaking populations, in which connected speech metrics such as PCC and PSC have demonstrated strong sensitivity in distinguishing children with SSD from typically developing peers.[3,15]

Clinical primacy of connected speech assessment

A central implication of these findings pertains to the clinical importance of evaluating speech production in connected speech contexts. Conventional articulation batteries relying on single-word elicitation tasks risk underestimating the true extent of a child's speech production difficulties, because children with SSD consistently perform better on single-word tasks than in connected speech.[6] Phonological errors that remain latent or infrequent in isolated word productions may emerge systematically in extended utterances. Seminal work by Shriberg and colleagues has established that connected speech analysis provides a more ecologically valid representation of communicative functioning and that phonological error rates in connected speech frequently exceed those observed in single-word sampling.[7,15]

The sentence repetition task used in this study clearly and consistently differentiated children with SSD from their typically developing peers, and the PSC measure captured systematic, clinically meaningful reductions in syllable accuracy in the SSD group. The deployment of picture-supported sentences derived from a culturally familiar narrative provided a structured yet contextually engaging elicitation framework that maintained participant engagement and reduced memory load. These characteristics support the integration of such tasks into routine early speech assessment protocols in Nepali-speaking contexts.

Cross-linguistic considerations

An important contribution of this study is its focus on Nepali-speaking children, a population for which

empirical data on connected speech development remain largely absent from the international literature. Phonological development is inherently influenced by the phoneme inventory, syllable structure, phonotactic constraints, and prosodic characteristics of the ambient language.[13,16] Cross-linguistic research confirms that language-specific patterns can influence both the types and frequencies of speech errors at different developmental stages.[13] Clinical norms derived exclusively from English-speaking populations cannot be uncritically applied to children acquiring typologically distinct languages such as Nepali. Language-specific reference data are therefore an essential prerequisite for valid and equitable clinical assessment.[14,16]

The PSC values observed in the TDC group (mean≈93.6%) provide preliminary normative reference data for connected speech performance in Nepali-speaking children aged 4–5 years. Although these data require replication and extension across broader age ranges and larger samples, they represent an important initial contribution and may offer clinicians a useful benchmark for identifying deviations from typical phonological development in this population.

Several methodological limitations warrant consideration. PSC was the sole outcome measure, and complementary indices—such as PCC, percentage of vowels correct (PVC), phonological mean length of utterance (pMLU), and whole word proximity (WWP)—may provide additional diagnostic information regarding the nature, distribution, and severity of phonological errors. Additionally, the sentence repetition paradigm may not fully capture spontaneous speech variability, as children may rely partly on phonological short-term memory during repetition, and the study's restriction to a 4–5-year age range limits generalizability; future research combining structured and spontaneous elicitation tasks alongside longitudinal designs would facilitate more comprehensive connected speech analysis and age-referenced normative benchmarks for Nepali-speaking populations.

CONCLUSION

This study provides robust evidence that connected speech accuracy differs substantially and significantly between typically developing children and children with speech sound disorders among Nepali-speaking preschoolers. Typically developing children exhibited near-ceiling syllable accuracy in connected speech, whereas children with SSD demonstrated markedly reduced performance, with no distributional overlap between the two groups. These findings affirm the diagnostic sensitivity of PSC derived from connected speech tasks and reinforce the clinical imperative of assessing speech production in naturalistic, contextually embedded conditions. The study contributes preliminary normative evidence for connected speech performance in Nepali-speaking children—an underrepresented population in the international literature—and underscores the urgent need for language-specific assessment instruments and normative frameworks to support accurate, culturally responsive, and equitable clinical practice. Future research should replicate and extend these findings across broader age ranges, larger and more diverse samples, and a wider range of connected speech measures, with the goal of establishing a comprehensive evidence base to guide the assessment and management of SSD in Nepali-speaking children.

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