Journal of Child Language Acquisition and Development

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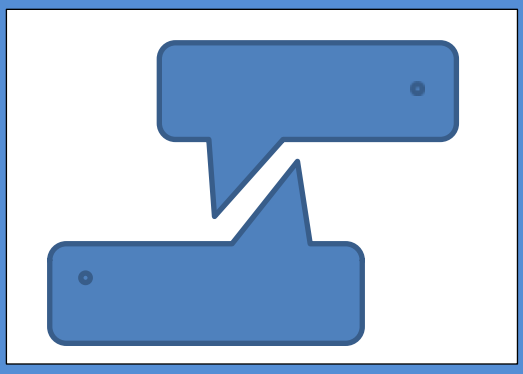

2025 Vol: 13 Issue: 2 ISSN: 2148-1997

Journal of Child Language Acquisition and Development – JCLAD
Vol: 13 Issue: 2 2025
ISSN: 2148-1997

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Vol: 13 Issue: 2 1198-1214, 2025
ISSN: 2148-1997

Developing a Persian version of the *Wug Test* to assess children's morphological knowledge

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Received : 25.05.2025
Accepted : 11.08.2025
Published : 30.08.2025
DOI: https://doi.org/10.5281/zenodo.17008773

Abstract

Assessing children's linguistic knowledge is essential for understanding the processes underlying language acquisition and development. To this end, Berko (1958) developed the Wug Test, a tool to evaluate English-speaking children's morphological knowledge and to identify potential language impairments. Inspired by this approach, the present study aimed to develop a comparable assessment tool tailored to the Persian language, in order to evaluate morphological knowledge in Persian-speaking children. Due to structural differences between English and Persian, the authors conducted a comprehensive linguistic analysis to generate novel words aligned with Persian morphological rules. Following five iterative rounds of refinement, the final version of the test was administered to 90 children aged five to seven years. The findings indicated significant age-related differences in morphological knowledge, with seven-year-old children outperforming younger participants, thereby demonstrating more advanced acquisition of Persian morphological rules. No significant differences were observed based on gender. These findings demonstrate the developmental trajectory of morphological knowledge in Persian-speaking children and support the adapted Wug Test as a reliable diagnostic tool.

Keywords: first language acquisition, language development, morphology, Persian, Wug test

1. Introduction

Morphology, the study of word formation and structure, plays a crucial role in understanding children's language development. Its significance lies in its capacity to reveal how learners acquire and internalize linguistic structures, even in the absence of explicit instruction. Dominguez (1991) argues that previously held limitations regarding morphology are no longer valid, noting that morphological rules extend beyond earlier

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assumptions. This perspective highlights how morphology reveals children's acquisition of new words through implicit learning processes (Anglin, 1993; Carlisle & Fleming, 2003; Nagy & Anderson, 1984; Taft & Kougious, 2004). Similarly, Akande (2003) emphasizes the integral role of morphological knowledge in mastering the grammatical system of a language. Effective communication, as he notes, requires an understanding of how words are constructed and combined to form meaningful sentences.

Akande (2003) distinguishes between inflectional morphemes—which express grammatical features like tense, number, and case without changing a word's core meaning or category—and derivational morphemes, which alter both meaning and grammatical category, noting that a word can have multiple derivational but only one inflectional morpheme; he also classifies inflectional morphemes into noun, verbal, and adjectival types. These distinctions inform two competing hypotheses about morphological processing: the whole-word representation hypothesis, which holds that words are stored as complete units, and the fully decomposed representation hypothesis, which argues that words are analyzed into morphemes, especially for novel forms (Anglin, 1993; Nagy & Anderson, 1984), a view that underpins Berko's Wug Test, designed to assess children's ability to generalize morphological rules to unfamiliar words.

A growing body of research supports the idea that morphemes are stored in memory and play a critical role in word recognition (Schreuder, Grendel, Poulisse, Roelofs, & van de Voort, 2012; Schreuder & Baayen, 1995; Taft, 2003; Taft & Zhu, 1995). For instance, Reichle and Perfetti (2003) demonstrate that morpheme recognition is enhanced through repeated exposure to varied word contexts. Carlisle and Stone (2005) also find that repeated encounters with base words significantly strengthen their mental representations. Furthermore, knowledge of common affixes has been shown to facilitate the recognition of derived words, thereby supporting reading development (Laufer & Cobb, 2020). Thus, morphology constitutes a foundational component of language development, particularly in children. Its contribution to word recognition, grammar acquisition, and reading comprehension underscores its importance in both theoretical and applied linguistic contexts. Therefore, its role should not be underestimated in the study of child language acquisition.

1.1. Standardized Tests in Speech and Language Therapy

Standardized assessments play a crucial role in speech and language therapy by enabling clinicians to compare individual performance against established normative data, thus facilitating accurate diagnoses (Moyse et al., 2020). According to Spaulding et al. (2006), such tools are instrumental in distinguishing between typical variations in language development and actual speech or language disorders, thereby supporting timely and effective early intervention. As Bishop (1997) highlights, early diagnosis of language disorders significantly enhances the potential for intervention and improvement in children's communicative abilities. Consequently, various assessment methods have been developed to examine first language acquisition.

Among the most widely used tools for assessing receptive vocabulary is the Peabody Picture Vocabulary Test (PPVT), originally introduced by Dunn (1959). It has been employed in numerous studies over the years (e.g., Goriot et al., 2021; Ingvalson et al., 2023; Vance & Stone, 1989; Washington & Craig, 1999). Another prominent instrument is the MacArthur-Bates Communicative Development Inventory (MCDI), designed for children aged 8 to 36 months. The MCDI assesses vocabulary, gestures, and early sentence development, typically through caregiver reports or direct observation (Ambridge & Rowland, 2013; Hoff, 2014). In the domain of morphological development, Mean Length of Utterance (MLU) is frequently employed to evaluate linguistic proficiency. It measures the average number of morphemes per utterance in spontaneous speech samples, thereby serving as a useful tool for comparing age groups and identifying potential language disorders (Hoff, 2014; Miller & Chapman, 1981; Eisenberg et al., 2001).

To date, there is no known Persian adaptation of the PPVT for assessing receptive vocabulary in young children. However, the MCDI has been translated and used in Persian in several studies (e.g., Ebtedaei et al., 2023; Ghanbari et al., 2016; Mokhtari et al., 2022). Similarly, MLU has been applied in both research and clinical settings to examine the development of Persian as a first language (e.g., Kazemi et al., 2013; Ouryadi et al., 2006; Yeganeh & Kamari, 2020).

Despite their widespread application, these tools have been subject to various criticisms. For example, Hewitt et al. (2005) contend that MLU primarily captures utterance length, rather than grammatical accuracy, and argue that syntactic complexity does not necessarily correlate with utterance length. Eisenberg et al. (2001) further emphasize that assessment tools like MLU must be accompanied by clear guidelines for administration, including a clearly defined purpose, detailed scoring procedures, comprehensive descriptions of normative samples, reference data, and demonstrated reliability and validity. The absence of such elements in MLU has posed challenges for clinicians in evaluating its practical utility and appropriateness.

The MCDI has also faced scrutiny regarding its validity. Eriksson (2023) notes that most studies employing the MCDI are exploratory in nature, use varied versions of the instrument with inconsistent cutoff scores, apply multiple reference measures, rely on small sample sizes, and rarely report confidence intervals. As a result, the diagnostic accuracy of the MCDI for clinical applications remains inconclusive, and no version of the MCDI has yet been validated as an effective screening tool for identifying language difficulties. In light of these criticisms, the present study aims to address these methodological limitations through the development of a Persian adaptation of the Wug Test.

1.2. Berko's Wug Test

The Wug Test, originally developed by Berko (1958), is a widely recognized tool for evaluating children's morphological development (Bialystok & Friesen, 2012; Cuskley et al., 2015; Zhang et al., 2011). This test employs invented, non-existent words to examine children's understanding and internalization of morphological rules. For instance,

when a child pluralizes a novel noun (e.g., "wug" → "wugs"), it demonstrates that the child has abstracted the morphological rule rather than simply relying on memorized word forms. As Drake (2018) explains, the Wug Test reveals children's implicit knowledge of word structure and their subconscious application of morphological rules.

Selby (1972) used the Wug Test to demonstrate that children between the ages of 4 and 12 show progressive improvement in mastering most morphological rules, with the exception of derivational, comparative, and superlative forms. Similarly, Becker et al. (2012) investigated pluralization in English and found that participants applied morphological rules consistently across both short and long words. Hayes and Londe (2006) employed the Wug Test to examine the application of vowel harmony in Hungarian, concluding that native speakers follow predictable phonological patterns.

Research on the Wug Test has also extended to Korean. For example, Jun (2010) analyzed noun endings and found a preference for [s] in coronal obstruents (e.g., [s], [ch], [th], [c], [t]). Ito (2014) further applied the Wug Test to investigate phonological influences on the intensification of the second onset in Korean compound nouns, particularly within the Yanbian dialect. The test has also been applied to other East Asian languages. Zhang et al. (2011), for instance, examined Taiwanese reduplication and found that native speakers tend to overlearn phonetic effects, underlearn opaque tone sandhi patterns, and correctly internalize lexical statistical patterns. Similarly, Yan and Zhang (2016) used the Wug Test to assess awareness of tone changes in Wuxi Chinese. Their findings revealed that while the initial tone change may vary, the spreading component of the tonal alteration remains consistent. These studies collectively illustrate the versatility and applicability of the Wug Test across different languages and linguistic phenomena. The present study builds upon this body of research by developing and validating a Persian adaptation of the Wug Test to assess morphological rule acquisition in Persian-speaking children.

1.3. The Persian Language

Persian, also referred to as Farsi, is the official language of Iran and is widely spoken in other countries such as Afghanistan and Tajikistan. It employs a modified version of the Arabic script for its written form (Baluch, 2013; Mehrani, 2018). From a typological perspective, Persian is categorized as a "pro-drop" language, meaning that pronominal subjects are often omitted because the grammatical subject is marked through verb inflection. For example, the verb form raft-am ("went-I") conveys the meaning "I went" (Samadi & Perkins, 1998). A study conducted by Ebtedaei et al. (2023) on Persian-speaking toddlers aged 12 to 16 months revealed that patterns of word learning among Persian-speaking children closely resemble those observed in English-speaking children. This finding suggests potential cross-linguistic similarities in early lexical development. As this study involves the adaptation of the Wug Test into Persian, a comprehensive understanding of Persian morphology is crucial. To this end, in the following we present some of the primary morphological features of Persian that are relevant to the adaptation of the Wug Test. In doing so, we mainly rely on the study conducted by Mahmoodi-Bakhtiari (2018).

1.4. Key Morphological Features in Persian

Persian employs a variety of agentive suffixes, including -kār, -mand, -var, -ande, and -bān. The suffixes -gar and -kār attach to both noun and verb stems to indicate professions or roles (e.g., kār-gar "worker"). Suffixes such as -mand and -var are limited to noun roots (e.g., honar-mand "artist"), while -ande attaches to present verb stems to indicate the doer of an action (e.g., āmuz-ande "learner"). The suffix -bān typically denotes a guardian or occupational role (e.g., mehr-bān "kind," literally "guardian of affection"). Additionally, suffixes such as -chi and -bāshi, borrowed from Turkish, are used to indicate professions or ranks (e.g., shekār-chi "hunter", āsh-paz-bāshi "chef").

The plural morphology of Persian reflects significant influence from Arabic. Loaned suffixes such as -in and -āt are frequently observed in borrowed words (e.g., motarjem-in "translators", il-āt "tribes"), and the concept of "broken plurals"—a non-concatenative plural formation common in Arabic—has also entered Persian (e.g., asbāb "tools", amāken "places"). In addition to these, Persian employs several native plural markers. According to Karimidustan (2004), the most commonly used native suffixes include -hā (or -ā), -ān, and -āt, with less frequent variants such as -gān, -yān, -vān, -yāt, and -jāt.

Diminutives in Persian are commonly formed using the suffixes -ak and -che. The suffix -ak typically denotes a diminutive meaning, as in pesar-ak ("little boy"), but may also yield words with connotative meanings, such as tefl-ak ("poor fellow"). In contrast, -che is used almost exclusively as a diminutive marker (e.g., ketāb-che "booklet"), although it is considered less productive than -ak in modern usage.

Comparative and superlative adjectives in Persian are formed using the suffixes -tar and -tarin, respectively. For instance, zibā-tar means "more beautiful," and zibā-tarin means "the most beautiful."

In the formation of the simple past tense, Persian attaches personal suffixes to the past stem of the verb (e.g., did-am "I saw"). For the present indicative tense, which is particularly relevant to the current study, the structure consists of a prefix (mi-) followed by the present stem and a personal ending (e.g., mi-bin-ad "he is seeing").

1.5. Purpose of the Present Study

Despite the significance of standardized linguistic assessment tools, no comprehensive instrument currently exists to evaluate the application of morphological rules in Persian, particularly within the context of speech and language therapy. This gap in assessment resources has substantial implications for clinical practice: speech therapists lack reliable tools to assess children's morphological competence or to identify potential challenges in morphological rule application. As a result, they often rely on informal measures or tests adapted from other languages, which may introduce inaccuracies and reduce diagnostic reliability (Harrison & McLeod, 2010; Mehrani, 2018).

The Wug Test - a widely recognized tool designed to assess the productive use of morphological rules in children - has been successfully adapted and used in numerous languages (e.g., Hayes & Londe, 2006;

Kawahara, 2013; Liu, 2022; van Wijk, 2002; Zhang et al., 2011). Originally developed by Berko (1958), the Wug Test examines children's ability to apply morphological rules to novel words, thus providing insight into their implicit grammatical knowledge. The utility of such tools extends to morphologically rich languages like Persian, where early detection of morphological difficulties can significantly enhance intervention outcomes.

A Persian-adapted version of the Wug Test would offer clinicians a reliable tool for evaluating morphological development in Persian-speaking children. Furthermore, it would contribute valuable data to the broader field of first language acquisition and allow for cross-linguistic comparisons in morphological rule application (Paradis, 2005). Accordingly, the primary aim of this study is to develop and validate a Persian version of the Wug Test. This adapted instrument is intended to examine how Persian-speaking children apply morphological rules to novel forms and to elucidate the cognitive mechanisms underlying such applications. The ultimate goal is to provide speech-language pathologists with a linguistically and culturally appropriate tool for assessment and intervention planning.

1.6. Research Questions

1. How do Persian-speaking children demonstrate their understanding of morphological rules through a Persian-adapted version of the Wug Test?
2. To what extent does the Persian-adapted version of the Wug Test distinguish between the morphosyntactic knowledge of children aged five to seven?

2. Methodology

2.1. Participants

This study included both adult and child participants to evaluate the appropriateness of the adapted Wug Test for use with children. Thirteen adult participants (five males and eight females) were recruited through random sampling from the researchers' personal networks in Mashhad, Iran. All adult participants were monolingual Persian speakers with a minimum of a high school diploma.

Child participants, also native speakers of Persian, were selected from four kindergartens and three elementary schools. Initially, children aged four to seven were considered; however, four-year-olds were excluded during the pilot phase due to their difficulty in providing coherent or relevant responses. The final sample consisted of 90 children aged five to seven, with an approximately equal distribution of male and female participants. All children were reported to have normal hearing and vision and no known language impairments. Verbal consent for participation was obtained from relevant institutional authorities prior to data collection.

2.2. Data collection and processing

The primary instrument used in this study was a Persian adaptation of the Wug Test. Table 1 presents the original items from the English version of the test, each of which was carefully translated and matched with an equivalent Persian lexical item and an accompanying illustration. Participants were shown these images and asked to complete the sentences

read aloud by the researcher using the appropriate word or word form. Responses provided by adult participants served as the benchmark for evaluating the children's performance.

Table 1
The Original Wug Test (Berko, 1958)

Morphological Elements	Affixes	Real Words	Artificial Words
Plural	-s, -es	glass	wug, gutch, kazh, tor, lun, niz, cra, tass, heaf[a]
Past Tense	-ed	ring, melt	spow, rick, mot, bod, gling[b], bing[c]
Diminutive	-let, -ie, -ette, -ling		wug[d]
Compounded or Derived Words	-ery		wug[e]
Derived Adjective	-y		quirk
Third Person Singular	-s, -es		naz, loodge
Singular Possessive	-'s		niz, wug, bik
Plural Possessive	-s'		niz, wug, bik
Comparative Adjectives	-er		quirk
Superlative Adjectives	-est		quirk
Progressive Tense	-ing		zib
Derived Agentive	-er		zib
Compound Nouns		afternoon, airplane, birthday, breakfast, blackboard, fireplace, football, handkerchief, holiday, merry-go-round, newspaper, sunshine, Thanksgiving, Friday	

[a]Both "heafs" and "heaves" are considered to be correct. [b]Both "glinged" and "glang" are considered to be correct. [c]Both "binged" and "bang" are considered to be correct. [d]Some adults also offered "little wug." [e]Most of the adults formed "wughouse."

2.3. Data analysis

The process of adapting the Wug Test for Persian began with an extensive review of Persian morphological rules to ensure the creation of plausible and contextually appropriate novel words. Given the nature of the test - requiring the generation of inflected or derived forms for unfamiliar lexical items - the researchers first sought to establish a set of normative adult responses to serve as the basis for evaluating children's answers.

In total, 13 adults (eight females and five males) participated in the adaptation phase. The first version of the test was administered to seven adults, while the second and third versions were completed by three adults each. Following each round, the responses were analyzed and used to refine the test. As most major flaws were identified in the first iteration, fewer participants were needed in the subsequent rounds. To avoid any order effects, the sequence of items was randomized in each version.

The test underwent three rounds of revision to arrive at a version deemed suitable for child participants. Modifications were made after each iteration with the aim of eliciting consistent, unambiguous responses from adults. Although there was some variation in responses, most items yielded consistent and morphologically valid answers, which are summarized in Table 2.

Table 2
Overview of the Adults' Responses in the First Three Versions of the Test

Morphological Elements	Number of Responses (Acceptable/Total)	Response(s)
Past Tense (nāpidan)	7/13	nāpid (5), mināpid (2)
Diminutive (muf)	9/13	bache muf (3), mufak (3), mufche (1), mufe kuchak (1), mufe kheili kuchik (1)
Compounded/Derived (muf)	10/13	khāneye muf (7), lāneye muf (1), muf khāne (1), manzele muf (1)
Third-Person Singular (parhidan)	9/13	miparhad (7), miparharānad (2)
Singular Possessive (muf)	11/13	kolāhe muf
Plural Possessive (muf)	10/13	kolāh hāye mufhā (8), kolāh hāye muf (2)
Progressive Form (zobidan)	11/13	mizobad
Plural (muf)	4/6	mufhā
Plural (zim)	5/6	zimhā
Plural (shāj)	5/6	shājhā
Plural (karbak)	5/6	karbakhā
Derived Adjective (zig)	3/6	zigi (1), zigru (1), zigdār (1)
Derived Agentive (kāpidan)	4/6	kāpande (2), kāpkār (1), kāpzan (1)
Comparative Adjective (zigi)	2/6	zigitar
[a]Superlative Adjective (zigi)	3/6	zigitarin
Compounded/Derived (karbak)	3/6	khāneye karbak (2), karbak khāne (1)
Diminutive (shāj)	6/6	shāj kuchulu (2), shāje kuchak (1), shājak (1), bache shāj (1), shāje kheili kuchak
Past Tense (sāridan)	4/6	sārid (3), misārid (1)

[a]Two participants responded "zigitarin" after provided with "zigitar" for the first blank.

To further assess the test's comprehensibility and appropriateness for children, two pilot versions (the fourth and fifth versions) were developed. The fourth version provided useful insights for refining the test, while the fifth version was ultimately deemed unsuccessful due to children's inability to engage with its content meaningfully. Table 3 presents children's responses to both versions. Based on the findings, the sixth and final version of the test focused on five core morphological categories that children aged five to seven were expected to have acquired: plural formation, diminutive derivation, possessive construction (singular and plural), third-person singular verb forms, and progressive verb forms.

Table 3
Overview of the Children's Responses in the Fourth and Fifth Versions of the Test

Morphological Elements	Number of Responses (Acceptable/Total)	Response(s)
Past Tense (nāpidan)	1/9	nāpid
Diminutive (muf)	4/9	mufe kuchak (2), mufe kuchik (1), mufe kuchulu (1)
Compounded/Derived (muf)	1/9	khāneye muf
Third-Person Singular (parhidan)	6/9	miparhad
Singular Possessive (muf)	7/9	kolāhe muf
Plural Possessive (muf)	7/9	kolāh hāye muf (5), kolāh hāye mufhā (2)
Progressive Form (zobidan)	7/9	mizobad
Plural (muf)	1/9	mufhā
Plural (zim)	0/9	-
Plural (shāj)	0/9	-
Plural (karbak)	0/9	-
Derived Adjective (zig)	0/9	-
Derived Agentive (kāpidan)	0/9	-
Comparative Adjective (zigi)	0/9	-
[a]Superlative Adjective (zigi)	0/9	-
Compounded/Derived (karbak)	0/12	-
Diminutive (shāj)	3/9	shāje kuchak
Past Tense (sāridan)	1/9	sārid

For each morphological category, two prompt sentences accompanied by corresponding illustrations were developed, resulting in a total of 10 items. All illustrations were in color, with a few exceptions rendered in black and white. For the plural item, the prompt sentence used in the fifth version of the test was retained due to its clarity and suitability for young children. For the remaining items, the same prompt sentences used with adult participants were employed.

Ninety children aged five to seven completed the final version of the test. Following data collection, it was determined that seven participants failed to provide any responses that could be considered linguistically valid. As linguistic competence was a key inclusion criterion, these individuals were

classified as outliers and excluded from the dataset. To preserve the reliability of the results, seven additional children were selected to replace them.

3. Findings

As explained above, during the pilot phase, the adapted Persian version of the Wug Test underwent three rounds of revision to ensure its suitability for assessing children's morphological knowledge. In each round, the test was refined to elicit consistent and unanimous responses from adult participants. While some variation was observed, most items yielded convergent answers aligned with Persian morphological rules.

Several test items remained unchanged or were only minimally altered across different versions. These included: the past tense form of nāpidan, the diminutive and derived/compounded forms of muf, the third-person singular form of parhidan, the singular and plural possessive forms of muf, and the progressive tense form of zobidan. Since 13 adults participated across these test versions, the number of acceptable responses for these specific items is reported out of 13.

For the past tense form of nāpidan, five participants responded with nāpid and two with mināpid, yielding seven acceptable responses. In the case of the diminutive form of muf, three participants produced bache muf, three said mufak, one said mufe kuchak, and another said mufche, resulting in eight acceptable responses. For the derived/compounded form of muf, responses included khāneye muf (7), lāneye muf (1), manzele muf (1), and muf khāne (1), totaling 10 acceptable responses. The third-person singular form of parhidan received seven miparhad and two miparharānad responses, totaling nine acceptable answers. For the singular and plural possessive forms of muf, 11 participants responded with kolāhe muf (singular), and 10 responded with kolāhhāye muf(hā) (plural). Finally, 11 participants produced mizobad for the progressive form of zobidan.

Following the initial version, several items were either added or modified to reduce ambiguity. These included: plural forms (muf, zim, shāj, karbak), derived adjectives (zig), agentive forms (kāpidan), comparative and superlative adjectives (zigi), compounded/derived forms (karbak), diminutive (shāj), and past tense (sāridan). Since only six participants contributed to the second and third versions combined, the total number of responses for these items is reported out of six.

For the plural forms, five participants used the Persian plural marker -hā across most items, though only four applied it to muf. For the derived adjective zig, responses included zigi (1), zigru (1), and zigdār (1), totaling three acceptable answers. The derived agentive form of kāpidan yielded kāpande (2), kāpzan (1), and kāpkār (1)—a total of four. The comparative and superlative forms of zigi received zigitar (2) and zigitarin (3), with two of the superlative responses provided after assistance from the data collector. For the derived form of karbak, responses included khāneye karbak (2) and karbak khāne (1). Diminutive forms of shāj included shāj kuchulu (2), shāje kuchak (1), shājak (1), and bache shāj (1), totaling five acceptable responses. For the past tense of sāridan, three participants responded with sārid and one with misārid.

After finalizing the adult responses and refining the test accordingly, a pilot study was conducted with young children. The fourth and fifth versions were tested, but the fifth version proved ineffective and was thus excluded from further analysis. However, the fourth version provided valuable insight and significantly contributed to the design of the final test version. This version of the test was administered twice. Initially, it was tested on three children aged four, six, and seven. The four-year-old was unable to comprehend the task, leading to the exclusion of children under five from subsequent testing. During the second administration, five six-year-olds and four seven-year-olds participated.

Based on pilot results, the sixth and final version of the adapted Wug Test focused on five morphological rules: plural, diminutive, singular and plural possessive, third-person singular, and progressive. These forms were selected based on the assumption that children aged five to seven had already acquired them. Additionally, the pilot phase demonstrated that children under five were unable to meaningfully engage with the test, prompting the researchers to limit the target population to children aged five to seven.

The final version included two prompt sentences for each of the five morphological rules, accompanied by relevant illustrations - resulting in 10 test items. Most illustrations were in color, though a few were in black and white. For the plural item, the prompt sentence from the fifth version was retained due to its clarity and age-appropriateness. For all other items, the prompts used for adults were also administered to children. A total of 90 children within the specified age range participated in the final version.

Following data collection and analysis, seven participants were identified as outliers for failing to provide any justifiable responses. Given that linguistic competence was essential for inclusion, these participants were excluded from the dataset. To maintain the study's reliability, seven additional children were recruited as replacements.

To examine performance differences across age groups, a one-way ANOVA was conducted, followed by a Tukey HSD post-hoc test. The ANOVA yielded a statistically significant result ($F = 19.48$, $p < .001$), indicating notable differences among the three age groups. The post-hoc analysis revealed significant differences between five- and seven-year-olds ($p < .001$), as well as between six- and seven-year-olds ($p < .001$). No significant difference was observed between five- and six-year-olds ($p = .185$).

4. Discussion and conclusion

The findings of the present study differ from those reported by Klafehn (2013), who found that Japanese-speaking children aged five and six produced correct morphological forms only 8% of the time, and even older participants (up to age 71) performed correctly only 30% of the time. In contrast, the current study revealed greater morphological accuracy and clearer differentiation across the three age groups, with seven-year-olds consistently outperforming both five- and six-year-olds across all tested categories.

Adult participants, aged 18 and above, demonstrated more than 50% accuracy across most morphological categories, with the exception of derived

adjectives, comparative and superlative adjectives, and derived/compounded forms-items which were subsequently excluded from the final version due to their complexity and inconsistency.

Consistent with the original Wug Test, first graders in the current study significantly outperformed preschoolers. However, cross-linguistic comparisons between the English and Persian versions revealed notable variations, likely reflecting language-specific morphological features and exposure patterns. The findings underscore the critical role of age in first language development and suggest that school attendance enhances children's ability to generalize morphological rules, likely due to increased exposure to linguistic input.

Although some prior studies (e.g., Bouchard et al., 2009; Umek et al., 2008) have reported a linguistic advantage for girls at younger ages, our findings, in line with the original Wug Test, showed no significant gender differences. This suggests that gender does not significantly influence the acquisition of Persian morphological rules. Studies by Mehrani (2018) and Rinaldi et al. (2023) further supports this observation, noting that even when gender differences are observed, they tend to be small and most pronounced in early developmental stages. Thus, the absence of a gender effect in this study aligns with broader patterns reported in the literature.

Persian, despite its morphological richness, has often been overlooked in first language acquisition studies. Unlike languages such as English, which benefit from a wide range of standardized assessment tools for various linguistic domains, Persian lacks both such diagnostic instruments and the resources necessary for their development. Consequently, researchers have been compelled to adapt tools originally designed for other languages, such as English, to suit the specific linguistic features of Persian. The present study aimed to adapt the Wug Test for Persian to assess Persian-speaking children's ability to apply morphological rules when transforming artificial words for use in appropriate syntactic contexts.

The findings revealed a clear developmental distinction between preschoolers and first-grade students. Specifically, seven-year-old children demonstrated a significantly greater ability to apply Persian morphological rules compared to their younger peers. These results highlight the practical utility of the Persian-adapted Wug Test as a diagnostic tool for evaluating morphological competence in young Persian-speaking children. If children are unable to produce appropriate morphological transformations in response to the test prompts, it may indicate underlying morphosyntactic difficulties. In such cases, language practitioners can intervene early, providing targeted support to address these linguistic challenges.

Moreover, the study found no significant gender-based differences in performance, supporting the view that early morphological development in Persian is not influenced by gender. This aligns with findings from previous research indicating that while some studies report a slight linguistic advantage for girls, such differences are often marginal and primarily evident at very early stages of language development (Mehrani, 2018; Rinaldi et al., 2023).

In conclusion, this study contributes to our understanding of morphological development in Persian-speaking children and emphasizes the

importance of using culturally and linguistically appropriate tools for language assessment. The observed age-related differences—particularly the contrast between seven-year-olds and younger children—underscore the critical period of linguistic development that occurs around school entry age. While the results are promising, future research should address several limitations, including the need for larger and more diverse sample sizes across different dialectal and socioeconomic backgrounds. Further investigations into Persian morphological acquisition would enhance the reliability and generalizability of the findings and refine the Persian Wug Test as a clinical and educational assessment tool. Finally, while this study focused on urban Persian-speaking children, dialectal or regional morphological variations were not examined and should be explored in future adaptations.

While the present study focused on urban Persian-speaking children, it did not account for potential dialectal or regional variations in morphological use. Persian is spoken across diverse linguistic and sociocultural contexts, and morphological forms may vary subtly across dialects or regions. These differences could influence children's responses to the test items. Therefore, future adaptations of the Persian Wug Test should aim to include participants from a wider range of dialectal and geographic backgrounds to enhance the generalizability and clinical applicability of the findings.

Ultimately, this research supports the use of adapted linguistic assessments in clinical settings and schools to identify children-especially first graders-who may be at risk for language development disorders. Early identification, followed by evidence-based intervention, can substantially improve language outcomes and academic success for children experiencing linguistic difficulties.

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Journal of Child Language Acquisition and Development – JCLAD
Vol: 13 Issue: 2 1215-1237, 2025

ISSN: 2148-1997

Diversity within complex syntax: Complex syntax tokens of children with Developmental Language Disorder

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Received : 19,11,2024
Accepted : 08.07.2025
Published : 30.08.2025
DOI: https://doi.org/10.5281/zenodo.17008878

Abstract

Constructivist accounts of children's acquisition of complex syntax make a distinction between children's initial complex syntax tokens and later-produced complex syntax tokens. Children's initial complex syntax tokens are concrete expressions or lexically-specific constructions (e.g., *Remember, I like chocolate*). Later-produced complex syntax tokens are built from constructional schemas that contain abstract syntactic categories. The purpose of this study was to explore whether 5-year-old children with developmental language disorder (DLD) produce a lower percentage of later-produced complex syntax tokens as compared to same-age peers with typical language development (TD). Using language sample analysis, we categorized the complex syntax productions of 28 preschool children (DLD n = 14) as early-produced or later-produced complex syntax tokens. Coded complex syntax productions included complement clauses, relative clauses, and subordinate conjunction clauses. We compared the percentage of later-produced complex syntax tokens by language group. Children with DLD produced a lower percentage of later-produced complement clause and subordinate conjunction clause tokens in child–adult conversation than TD children. However, there was no language group difference in children's production of later-produced relative clauses. Further consideration of the balance between early-produced and later-produced complex syntax tokens for children with DLD as compared to same-age TD peers is warranted. The reliance on early-produced tokens for preschool children with DLD as compared to their TD peers may mean that children with DLD are limited in their use of complex syntax.

Keywords: complex syntax; language development; formulaic language; developmental language disorder; relative clauses

1. Introduction

Complex syntax is a well-documented area of weakness for preschool and early school-age children with developmental language disorder (DLD). Complex syntax refers to utterances that include one or more dependent clauses (Barako Arndt & Schuele, 2013). Preschool and early school-age

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children with DLD produce fewer instances of complex syntax and produce more grammatical errors within complex syntax utterances than do same-age peers (Barako Arndt & Schuele, 2012; Owen, 2010; Owen & Leonard, 2006; Schuele & Tolbert, 2001). Because complex syntax encompasses multiple types of dependent clauses, it is possible that preschool children with DLD are challenged differentially across complex syntax types. To explore this issue, we conducted a granular analysis of complement clause, subordinate conjunction clause, and relative clause productions in the language samples of 5-year-old children with and without DLD. To evaluate the hypothesis of Diessel and colleagues (Diessel, 2004; Diessel & Tomasello, 2000, 2001) that child complex syntax productions can be classified as early-produced or later-produced, we evaluated whether 5-year-old children with DLD produce a lower percentage of later-produced tokens as compared to their language typical same-age peers. Early-produced tokens were differentiated from later-produced tokens on the basis of diversity of grammatical features and propositional status.

1.1. Complex syntax development by children with typical language

Diessel (2004) asserted that children's initial complement clause, subordinate conjunction clause, and relative clause tokens contain a single proposition and do not involve true embedding or subordination. These utterances include complement clauses like *I bet it's mine*, subordinate conjunction clauses like *Because I'm tired*, and relative clauses like *It's the one that spins*. Children's first utterances with complex syntax occur before children have acquired abstract representations of complex syntax structures, limiting children's complex syntax to tokens built around either concrete expressions or lexically-specific constructions. Concrete expressions are rote-learned expressions that are stored as a single unit, such as the matrix clause *I bet* in the utterance *I bet it's mine* (Diessel, 2004). Lexically-specific constructions are partially productive schemas, or frames, that are associated with particular meanings or communicative functions. Lexically-specific constructions contain some recurring elements that are fixed and some open slots that can be filled with variable elements, such as the relative clause *Here's a ___ that ____* (Ambridge & Lieven, 2011; Diessel, 2004).

Later-produced complex syntax tokens are not built around concrete expressions or lexically-specific constructions but are built from constructional schemas that contain abstract syntactic categories. Children gain access to complex syntax constructional schemas, in part, by analogizing across lexically-specific constructions on the basis of formal similarities between tokens (Ambridge & Lieven, 2011). Abstract complex syntax knowledge is acquired gradually as children become productive with complex syntax constructional schemas (Diessel, 2004). Productivity can be defined as the likelihood that a constructional schema will be activated for constructing a novel expression rather than a competing constructional schema (Langacker, 2000). However, the production of later-produced complex syntax tokens do not simply replace early-produced tokens (Diessel, 2004). Instead, later-produced complex syntax tokens come to coexist with tokens built around concrete expressions and lexically-specific constructions in children and adults' expressive repertoire of complex syntax tokens.

1.2. Complement clause development

Children's first complement clauses emerge in the second year of life (Bloom et al., 1989; Limber, 1973). Complement clause sentences contain a matrix clause (e.g., *I know*) and a sentential complement clause (e.g., I know *Mary needs my keys*) or a WH-complement clause (e.g., I know *where Mary's keys are*). At 3;0, children frequently produce three verbs with complement clauses: *think*, *know*, and *see*. As children develop, they continue to add to their repertoire of complement clause-taking verbs (Diessel, 2004).

Children's initial complement clauses have fixed semantic and syntactic attributes. Nearly all complement clause verbs produced at the start of the third year of life co-occur in a matrix clause with a first-person or second-person pronoun subject (e.g., the matrix clause *I think* in the utterance *I think it's a ball*). Diessel and Tomasello (2001) referred to these matrix clauses as formulaic matrix clauses. Syntactically, formulaic matrix clauses do not have auxiliaries, modals, adverbs, or prepositional phrases in the main clause verb phrase and sentential complement sentences do not include a complementizer. For example, the formulaic matrix clause *I think* is a simple first-person pronoun-verb combination with no adverbial modifiers and is in the present indicative active. The matrix clause of early-produced complement clause sentences may precede or follow the complement clause (e.g., *It's a crazy bone, I think*). Semantically, formulaic matrix clauses act as attention getters or convey degree of certitude or likelihood, behaving much like a modal as in *I think it's a ball* (Thompson & Mulac, 1991). Formulaic matrix clauses contain no additional propositional content and therefore do not present a second state of affairs (e.g., an event occurring independently of the event described in the complement clause).

By the end of their third year, children begin to produce complement clause sentences that are syntactically and semantically distinct from early-produced complement clause sentences. Syntactically, later-produced complement clause sentences contain matrix clauses that are composed of varied noun phrases in the subject position and grammatical morphemes in the predicate (e.g., inflectional morphology is present on the matrix verb; Bloom et al., 1989; Diessel & Tomasello, 2001). The matrix clause of later-produced complement clause sentences occurs in the utterance-initial position and the optional complementizer *that* may be produced following the matrix clause. These syntactic features signal a change in the semantics of the matrix clause, indicating that the matrix clause presents an independent second state of affairs. These later-produced complement clause sentences exist side by side with early-produced complement clause sentences in children's spontaneous spoken language. See Figure 1 in the Methodology section for a further description.

1.3. Subordinate conjunction clause development

Children begin to produce subordinate conjunction clauses around the age 2;6 (Clark, 1971; Diessel, 2004). Subordinate conjunction clauses are a complex syntax type that joins a dependent clause with a main clause with a subordinate conjunction such as *because*, *when*, or *if* (Schuele, 2009). First productions of subordinate conjunction clauses include the conjunction

because and generally occur in response to *why* questions (Diessel, 2004). Prior to children's third birthday, the subordinate conjunction *so* emerges. The primary function of the conjunction *so* is to provide additional information to children's immediately prior utterances (e.g., *It opened. So [that] the horsie could get out* [Nina 2;9]). At the age of three, *because, so,* and *when* are the most frequent subordinate conjunctions and are produced in more than 80% of children's subordinate conjunction clauses (Diessel, 2004).

Children's initial subordinate conjunction clauses have fixed semantic and syntactic attributes. Children's initial productions of subordinate conjunction clauses are nonembedded utterances that relate to a preceding utterance, linking across speaker turns. For example, if a parent asks *Why did you hit your brother?*, a child might respond *because he laughed at me* (Diessel, 2004; Weiler & Schuele, 2014). Often, early subordinate conjunction clauses occur in specific conversational routines. Nearly all of children's initial subordinate conjunction clauses are single clauses semantically related to an utterance produced somewhere else in the discourse (Diessel, 2004).

In the months after their third birthday, children begin to produce subordinate conjunction clauses that are syntactically and semantically distinct from early-produced subordinate conjunction clauses. They begin to produce *because, so,* and *when* in biclausal tokens, expressing causal relations and temporal relations intrasententially. They also begin to produce additional subordinate conjunctions that express specific temporal relations, such as *before* and *after*, as well as conditional relations, such as *if* (Bloom et al., 1980). Over the first five years of life, more than eighty percent of subordinate conjunction clauses expressing specific temporal or conditional relations are biclausal tokens (Diessel, 2004). See Figure 2 in the Methodology section for a further description.

1.4. Relative clause development

Like complement clauses, children's initial relative clauses emerge in the second year of life (Diessel & Tomasello, 2000). Relative clauses are dependent clauses that modify noun phrases (Quirk et al., 1985). Overwhelmingly, children's initial relative clauses are either isolated noun phrases or presentational relative clauses (Diessel & Tomasello, 2000). Isolated noun phrases are relative clauses which consist only of a noun phrase and a relative clause (e.g., *The meal that you eat* [Adam 4;1]). Presentational relatives contain pronouns as the matrix clause subject and a copula *be* verb as the matrix clause verb (Diessel & Tomasello, 2000, 2005). The early production of isolated noun phrase relatives and presentational relatives may be influenced by their relatively high frequency in the ambient language environment (Roland et al., 2007). However, Diessel hypothesized that isolated noun phrase relatives (e.g., *The toy I like*) and presentational relatives (e.g., *This is the toy I like*) occur early in child language transcripts due to the propositionally reduced nature of those structures.

Children's first relative clauses have fixed semantic and syntactic attributes. The main clause of presentational relatives consists of three components: (1) a deictic pronoun (i.e., *this, that, here, there, it*), (2) the copula *be* in the present tense form, and (3) a predicate nominal, which functions as a slot that can be filled by any noun or pronoun (e.g., *This is the one I*

got). Semantically, early-produced relative clauses function to establish a referent in the focus position whereas the main clause of the sentence remains propositionally empty. Early-produced relative clauses contain only a single proposition with unfamiliar information expressed after the isolated noun phrase or predicate nominal (e.g., *The toy I like; This is the toy I like*).

By age 4;0, children produce relative clauses that are syntactically and semantically distinct from early-produced relative clauses. Syntactically, the matrix clauses of later-produced relative clause tokens may have a variety of noun phrases. The verb phrases in the predicate are no longer exclusively the copular *be* (Diessel & Tomasello, 2000). As with complement clauses, syntactic changes also signal a change in the semantics of the matrix clause. Later-produced relative clause tokens possess a matrix clause that expresses its own independent state of affairs (e.g., *What happened to the thing that I went to* [Adam 4;3]). In later-produced relative clauses, the independent proposition of the matrix clause is modified by the relative clause proposition (Diessel, 2004). Between the age of four and five, children begin to produce object and subject relative clauses that are rare in children's utterances within adult-child conversation, including relative clauses where the head is located in a prepositional phrase (e.g., oblique-object relative clauses such as *Change it to the one you love best* [Adam 4;4]). However, presentational relatives and isolated noun phrase relatives constitute more than half of 5-year-olds' spoken relative clauses (Diessel & Tomasello, 2000). See Figure 3 in the Methodology section for a further description.

1.5. Children with DLD and complex syntax development

A small body of evidence suggests that children with DLD have difficulty producing complex syntax tokens which require abstract knowledge of complex syntax (Novogrodsky & Friedmann, 2006; Owen & Leonard, 2006; Schuele & Dykes, 2005). Frizelle and Fletcher (2014) found that 6-year-old children with DLD were better at imitating presentational relative clauses than biclausal relative clauses. It is plausible that children with DLD are delayed in producing later-produced complement clause, subordinate conjunction clause, and relative clause tokens in their spontaneous spoken language as compared to same-age TD peers.

We proposed that the study of early-produced and later-produced complex syntax tokens in children with DLD was an important next step in understanding complex syntax developmental progression for children with DLD. A granular analysis of preschool children's complex syntax productions may provide evidence that children with DLD remain in a protracted period of complex syntax development where predominately early-produced complex syntax tokens are generated. Such evidence would align with profiles of DLD that posit a protracted period of grammatical process or principle acquisition (Deevy et al., 2017; Grela & Leonard, 1997; Leonard, 1995; Rice et al., 1995; Rice et al., 1998). By revealing that children with DLD produce a lower percentage of later-produced complex syntax tokens, we aimed to provide evidence that 5-year-old children with DLD were more likely to produce complex syntax tokens built around concrete expressions and lexically specific constructions than TD peers.

Our study of children's production of spontaneous spoken language investigated the later-produced complex syntax tokens of 5-year-old children with DLD and same-age TD children. We investigated whether language group status influences the percentage of later-produced complex syntax tokens in children's spontaneous spoken language. One research question was addressed: Is there a between language group difference in children's percentage of later-produced complex syntax tokens?

2. Methodology

2.1. Participants

Twenty-eight monolingual English-speaking early school-age children (13 females, 15 males) completed eligibility and experimental tasks. See Table 1 for parent reported maternal education and race/ethnicity information.

Fourteen participants were children with DLD (female = 5, male = 9). The age of these participants ranged from 4;10 (4 years, 10 months) to 5;11. Inclusion criteria for children with DLD included: (a) could not score -2 standard deviations (SD) below the mean on the Primary Test of Nonverbal Intelligence (PTONI; Ehrler & McGhee, 2008), (b) standard score below 85 on the Structured Photographic Expressive Language Test Preschool–Second Edition (SPELT-P 2; Dawson et al., 2005), (c) score below the chronological age criterion on the Test of Early Grammatical Impairment Screener Probes, Third Person Singular and Past Tense (TEGI; Rice & Wexler, 2001); and (d) per parent report no history of autism or hearing loss.

Table 1
Participant demographic characteristics by diagnostic group

	Group	
Characteristic	DLD (n = 14)	TD (n = 14)
Age in months		
M (SD)	63.71 (5.01)	66.93 (3.12)
Maternal education		
High school or GED	6	3
Bachelor's degree	7	8
Post-baccalaureate	1	3
Race/ Ethnicity		
White/Caucasian	9	7
African American	0	2
Latino/Hispanic	5	5

Fourteen children with typical language development (male = 6, female = 8) were included as a comparison group. The age of participants ranged from 5;0 to 5;10. Inclusion criteria for children with typical language included: (a) could not score -2 SD below the mean on the Primary Test of Nonverbal Intelligence (PTONI; Ehrler & McGhee, 2008), (b) standard score above 87 on the Structured Photographic Expressive Language Test Preschool–Second Edition (SPELT-P 2; Dawson et al., 2005), (c) score at or above the chronological age criterion on the Test of Early Grammatical Impairment Screener Probes, Third Person Singular and Past Tense (TEGI; Rice & Wexler,

2001); (d) no enrollment in speech-language or other special education services; and (e) per parent report no history of autism or hearing loss.

2.2. Language samples

Language samples were collected using the Hadley Interview Protocol for Eliciting Text-Level Discourse (Hadley, 1998). The Hadley Protocol elicits personal narratives and retellings of fictional stories from memory. The Hadley Protocol elicited language samples of at least 200 utterances during a brief session with the first author. In the event that the interview protocol did not elicit an adequate language sample, a play-based language sample collection protocol was administered. The play-based language sample protocol elicited language samples during a brief, 45-minute play session with the first author. In the event that more than 200 utterances were elicited using the protocols, the first 200 utterances were included for analysis. Language samples were collected at the participants' elementary school sites.

Although most participants provided 200-utterance samples during administration of the Hadley Protocol, there were participants that required the supplemental play-based language sample protocol. Five participants in the DLD participant group and three participants in the TD group required the supplemental play-based language sample protocol to reach 200 utterances. When considering differences in percentage of complex syntax produced during the Hadley Protocol and the play-based language sample protocol, we found no evidence of protocol type effects (Mann-Whitney U= 69.00, p = .45).

Language samples were transcribed and coded for grammatical morphology following the conventions for the Systematic Analysis of Language Transcripts (Miller & Chapman, 2008). Utterances were segmented using sentence boundaries, pauses, and intonation changes (Schuele, 2009). For example, when a child paused before finishing a grammatically complete utterance, this utterance was segmented and considered abandoned. Transcription reliability of all samples was examined at the utterance boundary and morpheme level. All collected utterances were transcribed and coded by the first author as well as secondary transcribers. Secondary transcribers (MA students who had extensive child language transcription experience) resolved any transcription differences with the primary transcriber through mutual consensus.

2.3. Study specific coding

We identified utterances that were coded for complement clause, subordinate conjunction clause, and relative clause complex syntax structures. Early-produced complex syntax tokens were operationally defined as complex syntax utterances that possess the syntactic attributes of the initial complement clause, relative clause, or subordinate conjunction clause productions as described in Diessel (2004). Early-produced complement clause tokens use a simple first-person pronoun-unmarked complement clause-taking verb combination in the matrix clause, like the clause *I think*. Coding of early-produced and later-produced complement clauses were determined using the criteria in Figure 1.

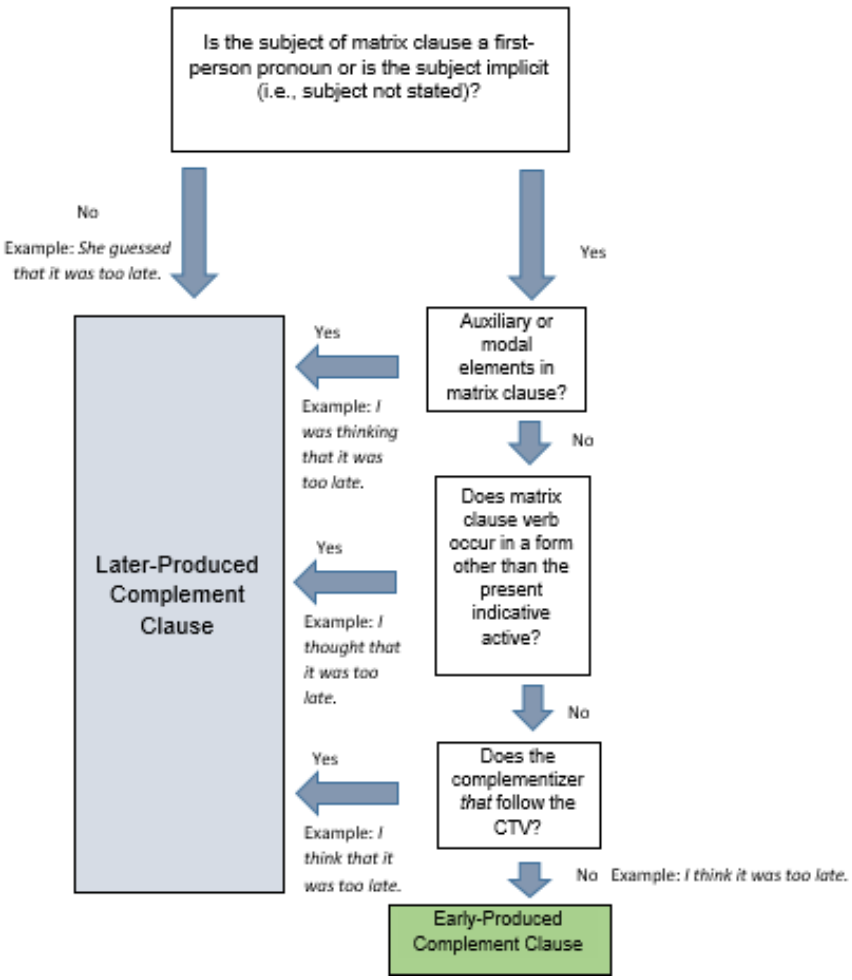

Figure 1. Decision Tree Assigning Later-Produced Complement Clause Status from Diessel & Tomasello (2001) Proposed Criteria

Early-produced subordinate conjunction clause tokens are non-embedded dependent clauses that start with a subordinate conjunction, as seen in the subordinate conjunction clauses *Because I'm tired* and *So [that] the horsie could get out*. We categorized all complex syntax tokens that do not share these attributes as later-produced complex syntax tokens. Coding of early-produced and later-produced subordinate conjunction clauses were determined using the criteria illustrated in Figure 2.

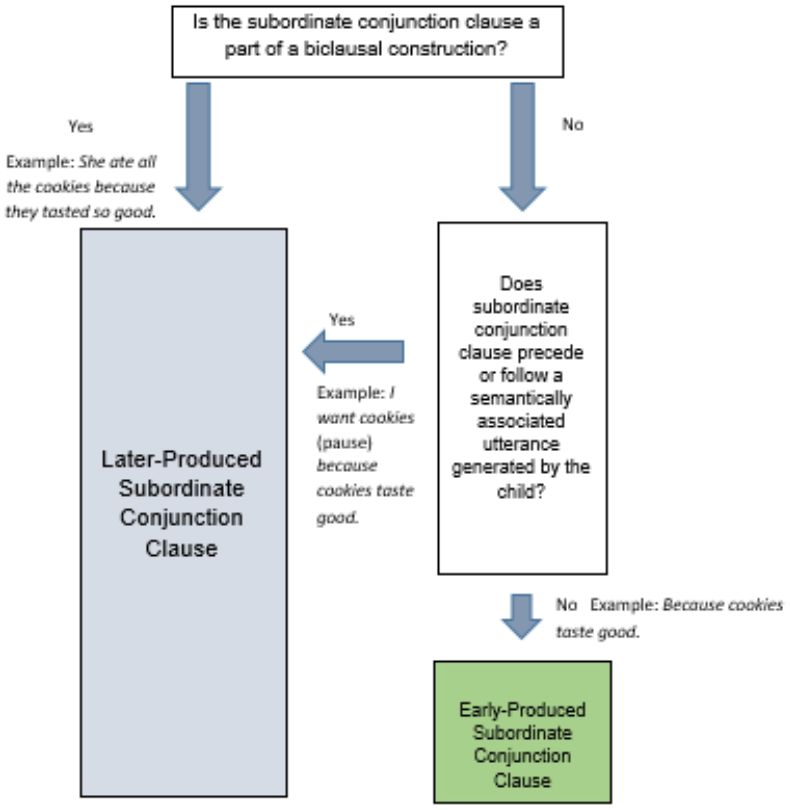

Figure 2. Decision Tree Assigning Later-Produced Subordinate Conjunction Clause Status from Diessel (2004) Proposed Criteria

Early-produced relative clause tokens are presentational relatives that consist of a deictic pronoun, a copula *be* in the present tense form, and a predicate nominal, as seen in the presentational relative *This is the thing that spins*. Nominal relative clauses ([nrc]; e.g., *This is where I put my shoes*; Schuele, 2009) were included in some conditions as outlined in Coding Manual (Appendix A). In addition, if a child produced a relative clause modifying an isolated noun phrase, this instance was also coded as an early-produced relative clause token. Coding of early-produced and later-produced relative clauses were determined using the criteria illustrated in Figure 3.

Six types of complex syntax tokens were included in our study specific analysis: (1) early-produced complement clauses [C-EDV], (2) early-produced subordinate conjunction clauses [S-EDV], (3) early-produced relative clauses [R-EDV], (4) later-produced complement clauses [C-LDV], (5) later-produced subordinate conjunction clauses [S-LDV], and (6) later-produced relative clauses [R-LDV]. Additional coding criteria was provided in the coding manual, located in Appendix A.

2.4. Analysis plan

We conducted a Mann-Whitney U test to compare the percentage of later-produced complex syntax tokens of children with TD and DLD; the Mann-

Whitney U test was selected due to the non-normal distribution of the data. If there was a significant between group difference, we planned three follow-up comparisons of later-produced complement clause, subordinate conjunction clause, and relative clause tokens. Follow-up group comparisons would be conducted with a Bonferroni correction (.05/3). Each variable was derived by dividing the total number of later-produced complex syntax tokens for each complex syntax type by the total number of complex syntax tokens for each complex syntax type and converting that proportion into a percentage. Although we based our analysis plan on the analysis performed by Marinellie (2004), we elected to use a non-parametric statistical analysis to account for the non-normal distribution of the data. Analyses were completed within IBM SPSS Statistics (Versions 23-25).

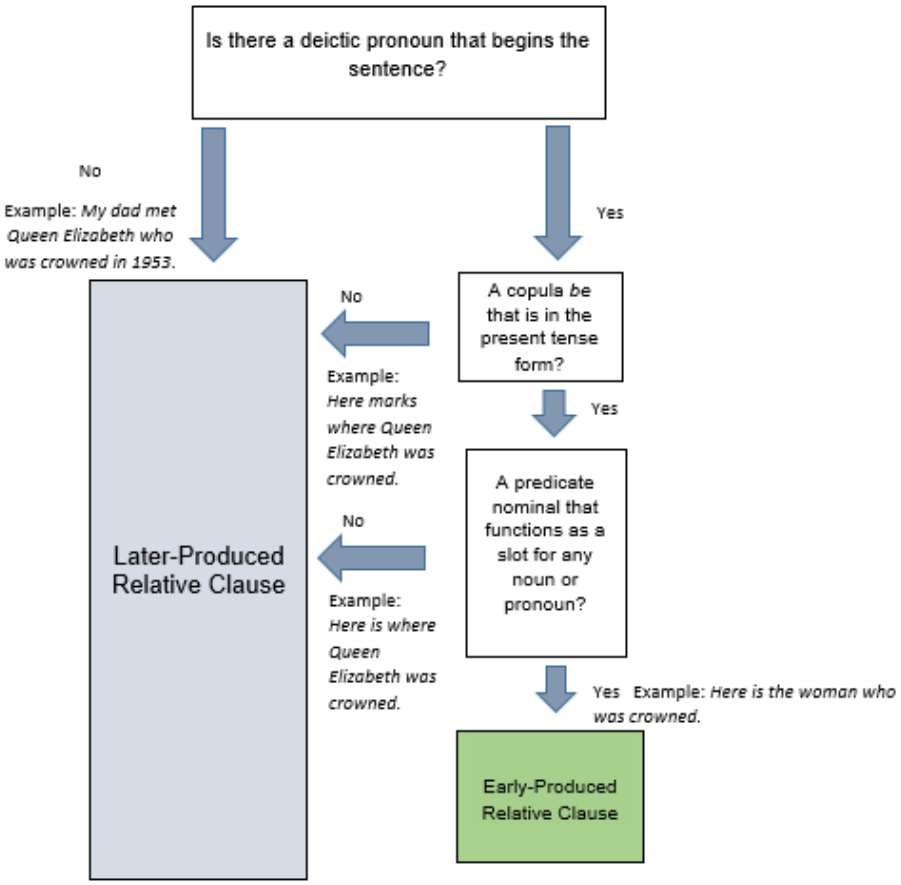

Figure 3. Decision Tree Assigning Later-Produced Relative Clause Status from Diessel & Tomasello (2000) Proposed Criteria

3. Findings

Table 2 provides the median percentage (and percentage range) of later-produced and earlier produced complex syntax tokens by complex syntax type. Because complex syntax token production were not normally distributed based on the Shapiro-Wilk test (ps < 0.05), we report the median data for each condition.

Table 2
Median Percentage and Percentage Range of Later-Produced and Early-Produced Complement Clause, Subordinate Conjunction Clause, and Relative Clause Tokens by Language Group

	TD (n = 14)		DLD (n = 14)	
	Median	Range	Median	Range
% of later-produced complex syntax tokens	64	35-85	43	0-78
% of later-produced complement clause tokens	67	17-100	40	0-82
% of later-produced subordinate conjunction clause tokens	100	0-100	50	0-100
% of later-produced relative clause tokens	58	20-100	49	41-70
% of early-produced complex syntax tokens	36	18-65	57	22-100
% of early-produced complement clause tokens	32.5	0-100	63	31-100
% of early-produced subordinate conjunction clause tokens	0	0-33	48	29-71
% of early-produced relative clause tokens	43	0-69	50	0-100

Note: TD = typically-developing; DLD = developmental language disorder.

When comparing the mean ranking of children with TD (55.50) to children with DLD (29.50), there was a significant between group difference for percentage of later-produced complex syntax tokens (Mann-Whitney U=336.00, p > .001). Thus, the percentage of later-produced complex syntax tokens of the TD group was larger than the percentage of later-produced complex syntax tokens of the DLD group.

Due to the significant between group difference for percentage of later-produced complex syntax tokens, three follow-up Mann-Whitney U tests were performed to investigate potential between group differences within complement clause, subordinate conjunction clause, and relative clause types. When comparing the mean ranking of children with TD (21.18) to children with DLD (7.82), there was a significant between group difference in children's production of later-produced complement clauses (Mann-Whitney U= 4.50, p < .001).

Similarly, when comparing the mean ranking of children with TD (18.54) to children with DLD (10.46), there was a significant between group difference in children's production of later-produced subordinate conjunction clauses

(Mann-Whitney U= 41.50, p = .01). However, there was no significant between group difference in children's production of later-produced relative clauses (Mann-Whitney U= 93.50, p = .83).

The percentage of early-produced complex syntax tokens followed the opposite pattern, whereby children with DLD produced more early-produced complex syntax tokens than children with TD. Indeed, there was a significant overall between group difference (Mann-Whitney U=127.50, p = .008), with significant differences for complement clauses (Mann-Whitney U= 7.50, p = .003) and subordinate conjunction clauses (Mann-Whitney U= 35.50, p = .007) but not for relative clauses (Mann-Whitney U= 69.00, p = .88).

4. Discussion

4.1. General discussion

We investigated the later-produced complex syntax tokens of 5-year-olds with DLD and TD by comparing the percentage of later-produced complex syntax tokens. We then conducted follow-up group comparisons of three complex syntax types: the percentage of later-produced complement clause tokens, the percentage of later-produced subordinate conjunction clause tokens, and the percentage of later-produced relative clause tokens.

Five-year-old children with DLD produced an overall lower percentage of later-produced complex syntax tokens in child–adult conversation than TD children. Our finding provides preliminary support for a qualitative between language group difference in preschool complex syntax production. As compared to TD children, children with DLD produced a higher percentage of complex syntax tokens built around concrete expressions and lexically-specific frames. For example, children with DLD were more likely to produce a higher percentage of utterances like "I think it's mine" than "Sam thought that it was time to go." Thus, our study provides evidence that the spoken language of preschool children with DLD contained a lower percentage of later-produced complex syntax tokens within complex syntax types. Our finding is in contrast with claims that language groups primarily differ in the quantity but not quality of complex syntax productions (Marinellie, 2004). We further explore the between language group difference in complex syntax in the theoretical implications section provided below.

Although children with DLD produced an overall lower percentage of later-produced complex syntax tokens in child–adult conversation than TD children, group differences did not apply for each complex syntax type. There was a significant between group difference in percentage of later-produced complement clauses and subordinate conjunction clauses. However, there was no significant between group differences for relative clauses, providing little evidence for a between group difference in the percentage of later-produced relative clause tokens. We next examine our findings for each complex syntax type.

The language samples of 5-year-old children with DLD contained a lower percentage of later-produced complement clauses than those of TD peers. Our findings supply evidence that children with DLD produce a greater percentage of complement clauses with formulaic matrix clauses than TD peers (i.e., early-produced complement clauses). Such a delay among 5-year-olds aligns with evidence that 4- to-6-year-old children with DLD are less likely than TD

peers to include the optional complementizer *that* in complement clause elicitation tasks (Owen & Leonard, 2006). Production of complement clauses with the optional complementizer *that* may provide evidence that the complement clause is syntactically subordinated to the matrix clause and the matrix clause expresses some propositional content (Diessel, 2004; Morton & Schuele, 2021). It is possible that preschool children with DLD produce formulaic matrix clause features due to a delay relative to TD peers in acquiring matrix clauses that express propositional content (Morton et al., 2025). In our theoretical implications section, we further explore how our findings relate to the developmental trajectory of complement clauses for children with DLD.

Our findings supply evidence that children with DLD produce a greater percentage of monoclausal subordinate conjunction clause utterances than TD peers. Challenges with biclausal subordinate conjunction clauses among 5-year-old children with DLD aligns with evidence that 7-to-10-year-old children with DLD produced fewer biclausal subordinate conjunction clauses than typically developing peers in conversation and spoken narratives (Greenhalgh & Strong, 2001; Marinellie, 2004). A deficit in later-produced subordinate conjunction clauses may indicate that preschool children with DLD have a more restricted means of expressing temporal, causal, or adversative relationships as compared to TD peers (Greenhalgh & Strong, 2001). In our theoretical implications section, we further explore how our finding relates to the developmental trajectory of subordinate conjunction clauses for children with DLD.

The language samples of 5-year-old children with DLD did not contain a lower percentage of later-produced relative clauses than those of TD peers. Our finding does not supply evidence that children with DLD produce a greater percentage of presentational relatives and isolated noun phrase relatives than TD peers. These results contrast with studies of relative clauses produced by children with DLD using elicited imitation and conversation language sample analysis (Frizelle & Fletcher, 2014; Marinellie, 2004). However, it is important to consider that children in both the TD and DLD groups produced a very limited number of relative clause tokens as compared to complement clauses and subordinating conjunction clauses. Additionally, children with and without language impairment do not necessarily demonstrate their full expressive complex syntax ability in conversation (Eisenberg, 2005; Steel et al., 2013). Relative clauses are infrequent in young children's spontaneous language when compared to the production of simple sentences (Diessel, 2004; Steel et al., 2013). Thus, language samples alone may not provide a full picture of children's competency with these structures (Eisenberg, 2005). Alternative elicitation methods, such as sentence imitation, could provide a means of circumventing the limitations of spontaneous language sampling and provide children more opportunities to produce complex syntax structures.

4.2. Theoretical implications

Because we did not include a younger, language-matched TD group in our study, it remains unclear whether the later-produced complex syntax

profile of children with DLD parallels that of TD children, but at a lower performance level. Despite this shortcoming, our findings supply preliminary evidence that preschool children with DLD may undergo a longer period than same-age peers where most complex syntax tokens are built around concrete expressions and lexically-specific frames. When compared to same-age TD children, 5-year-old children with DLD produced a lower percentage of complement clause and subordinate conjunction clause tokens that show evidence of abstract complex syntax knowledge. However, if we are to argue for a between language group difference in abstract complex syntax knowledge, two points must be addressed. First, we discuss why the lower percentage of later-produced complex syntax tokens of the DLD group suggests a delay in producing tokens generated from abstract complex syntax knowledge. Second, we discuss the potential contributing factors for a between language group difference.

According to Diessel (2004), abstract complex syntax knowledge is acquired gradually over the preschool years. A between language group difference suggests that children with DLD are further behind TD peers in the gradual process of becoming productive with complex syntax constructional schemas. However, we do not argue that abstract complex syntax knowledge is absent from 5-year-old children with DLD. Because they produced some later-produced complex syntax tokens, we acknowledge that 5-year-old children with DLD must have a degree of abstract complex syntax knowledge. Instead, the between language group difference suggests that the likelihood that a complex syntax constructional schema will be activated depends on language group.

The finding of a between language group difference raises the question of what possible contributing factors underlie this difference. We next evaluate two potential contributing factors. First, linguistic environmental factors may have contributed to the between language group difference. Diessel asserted that a complex syntax constructional schema is learned through exposure to multiple exemplars of a complex syntax type with various items (e.g., words) in the positions, or slots, of a lexically-specific frame. Home linguistic environments offer opportunities for exposure to these multiple exemplars (Vasilyeva et al., 2006). However, the amount of exposure may vary depending on the nature of the home linguistic environment and the language learning abilities of the child. For example, preschoolers with a history of typical language development receive more maternal complex syntax input than preschoolers with a history of receptive-expressive language delay within the home (Huttenlocher et al., 2010). Therefore, it is possible that children with language impairment may not receive the same degree of exposure to multiple exemplars of complex syntax types, limiting their development of abstract complex syntax knowledge.

Second, differences in vocabulary acquisition may have influenced the between group difference in later-produced subordinate conjunction and complement clause production. Some complex syntax vocabulary words, such as subordinating conjunctions and complement clause verbs, occur more frequently in later-produced tokens than other complex syntax vocabulary words. Unlike utterances containing *because* and *so*, child utterances containing temporal and conditional conjunctions like *while* and *if* occur in

biclausal tokens in more than eighty percent of the subordinate conjunction clauses (Diessel, 2004). Similarly, some complement clause verbs, such as *pretend* and *show*, rarely occur in formulaic matrix clauses (Diessel & Tomasello, 2001). Owen Van Horne and Lin (2011) suggested that early school-age children with DLD produce fewer different complement clause verbs and are less likely to combine low-frequency verbs with a complement clause than their TD peers. It is possible that children with DLD have more difficulty acquiring the complex syntax vocabulary necessary for later-produced subordinate conjunction and complement clauses. Thus, a deficit in vocabulary may contribute to lower percentage of later-produced complex syntax tokens of the DLD group.

4.3. Limitations

It is important to recognize that there are potential limitations to our study that should be considered when interpreting our findings. First, although there was not a statistically significant age difference between our DLD and TD groups ($t(26) = 1.05$, $p = .15$), we note that the mean age of TD participants was numerically larger than that of our DLD participants. Second, we recognize that future group design studies should recruit larger participant samples. Although our collected sample was adequately powered to detect a group difference between our participant groups, we plan to set larger participant recruitment goals moving forward. Finally, more mothers of children in the TD group received a bachelor's degree or advanced degree than mothers of children in the DLD group. We acknowledge that differences in maternal educational level may have played a role in the frequency and variety of complex syntax structures heard by children in the DLD and TD groups. Indeed, Huttenlocher and colleagues (2010) found differences in maternal educational levels and care giver speech that may mediate language growth over children's first four years of life. Future studies of the complex syntax productions of children with and without DLD should attempt to control for maternal educational level.

5. Conclusion

Our results support previous findings that five-year-old children with DLD produce fewer instances of complex syntax and fewer types of complex syntax in their spontaneous spoken language than same-aged peers. However, we also found that children with DLD produce fewer instances of later-emerging complex syntax tokens than same-aged peers, providing preliminary evidence that later-emerging complex syntax is especially challenging for children with DLD. Future observational and experimental studies will further investigate how children with DLD acquire and master later-emerging complex syntax types.

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Journal of Child Language Acquisition and Development – JCLAD
Vol: 13 Issue: 2 1215-1237, 2025
ISSN: 2148-1997

Appendices

Appendix A: Coding Manual

Database description: The current study involves an analysis of clinician-child language audio recordings.

What utterances were eligible for secondary complex syntax coding?

- Based on Schuele (2009)
  a. Two or more clauses form an utterance with the clauses combined with a coordinate or subordinate conjunction.
  b. Two or more clauses form an utterance with one clause embedded or dependent on the other clause (i.e., main clause and dependent clause).
  c. An utterance that includes only a subordinate conjunction and the dependent clause.
  d. The main clause or independent clause has been elided by the speaker as conversational discourse allows such elision.
  e. An utterance that includes only the relative clause because the NP appears elsewhere in the discourse.

Secondary Complex Syntax Coding

1. **What complex syntax types receive secondary complex syntax coding?**
   a. The following **primary** complex syntax types were included in our study:
      i. full propositional complements [fpc],
      ii. WH-finite complement clauses [wfc],
      iii. WH-nonfinite complement clauses [wnfc],
      iv. subject relative clauses [src],
      v. other relative clauses [rc],
      vi. subordinating conjunction clauses [sc].

   See Table below for description of complex syntax types.

CS Type	Notes	Examples
[sc] subordinate clauses with subordinating conjunctions:	Code if two clauses joined with subordinate conjunction or if subordinate conjunction + clause. Did not include adverbial conjuncts (e.g. however, though, so, thus, therefore; see Quirk et al. 1985).	*I went to the store because I needed a new dress.* *Because he wanted the cookie.*
[fpc] full propositional	Embedded clause may be headed by complementizer *that, if, whether* (Haegeman, 1994). In some utterances	*Mary knew the boys would leave at 4:00.*

clause (sentential complement)	complementizers are obligatory, in others optional.	*The old man wondered whether they were going.*
[wfc] WH finite clause or WH clausal complement	The embedded clause is a verb complement that contains a WH pronoun and a finite verb.	*I wondered where we were going on Saturday.* *I know who Jim was going to the dance with.*
[wnfc] WH non-finite clausal complement	The embedded clause is a verb complement that contains a WH pronoun and a non-finite verb.	*He doesn't know where to go.*
[src] subject relative clause	Subject in relative clause is relativized. Can modify noun in any position of utterance. Relative marker (e.g. who, that, which) is obligatory. Relative marker may be deleted as a developmental error.	*The man drove the car that crashed.*
[rc] relative clause	Object or other non-subject phrase in relative clause is relativized.	*I saw the toy Mary brought to show-n-tell.*

2. What secondary complex syntax codes are provided?

a. The following **secondary** complex syntax types were included in our study:

i. early-produced complement clauses [C-EDV],
ii. early-produced relative clauses [R-EDV],
iii. early-produced subordinate conjunction clauses [S-EDV],
iv. later-produced complement clauses [C-LDV],
v. later-produced relative clauses [R-LDV],
vi. later-produced subordinate conjunction clauses [S-LDV]

See Table below for description of complex syntax types.

Secondary CS Type	Notes	Examples
[C-EDV] Early-produced complement clauses	Code if (a) [fpc], [wfc], or [wnfc] matrix clause contains a first-person pronoun, second-person pronoun, or has an implicit subject, (b) main verb is unmarked on the surface for tense or is accompanied by a	*I think I get one.* *Remember, it's my turn?* *You know who got a pet?*

	model, auxiliary, or adverb, **and** (c) does not have complementizer *that*	
[C-LDV] Later-produced complement clauses	Code if (a) [fpc], [wfc], or [wnfc] matrix clause contains subject that is not a first-person pronoun, second-person pronoun, or has an implicit subject, (b) main verb is not unmarked on the surface for tense and/or has a model, auxiliary, or adverb, **or** (c) has a complementizer *that*	*He bet I would lose.* *She thinks I'm going to move.* *I think that I need a snack.* *I can remember the first pet I had.*
[R-EDV] Early-produced relative clauses	Code if (a) [src] or [rc] utterance is an isolated noun phrase modified by a relative clause Or if (b) i. [src] or [rc] utterance has a main clause that contains a pronoun like *it*, *he*, *there, this, where, here*, etc., ii. main verb is copula like *is, are, was, were*, etc., **and** iii. a predicate nominal is the modified NP [See Coding Exceptions regarding nrc]	*The one that spins.* *Here is the toy I just got.* *He is the kid that moved to my school.* *Big dogs that my mom rescues.*
[R-LDV] Later-produced relative clauses	Code if (a) [src] or [rc] utterance has a main clause that contains a subject that is not a pronoun **or** ii. main verb is not copula. [See Coding Exceptions regarding nrc]	*My dad was the last player that was picked.* *He sees the dog that jumps.*
[S-EDV] Early-produced subordinate conjunction clauses	Code if (a) subordinate conjunction clause appears outside of a biclausal token, meaning the child produced the clause without an adjoined clause.	*A: Why did you leave?* *C: Because I was hungry.* *A: Why did you do that?* *C: So (that) I could win.*
[S-LDV] Later-produced subordinate	Code if (a) subordinate conjunction clause appears in a biclausal token, meaning the child produced two adjoined	*I got a present because it was my birthday.*

conjunction clauses	clauses that are linked by a subordinate conjunction.	*I left after everyone got there.* *To get one because I love pizza.*

Exceptional Coding Situations

Nominal relative clauses. Diessel (2004) does not provide guidance regarding whether [nrc] can occur in early-produced relative clauses. At issue is whether the WH- pronoun is a predicate nominal like those contained in presentational relatives. Because this information cannot guide our decision-making, we do not provide [nrc] additional coding.

UPDATE: 8/12/2020. [nrc] coding is proposed for inclusion using the criteria below:

Secondary CS Type	Notes	Examples
[R-EDV] Early-produced relative clauses	Code if (a) [nrc] utterance has a main clause that contains a pronoun like *it*, *he*, *there, this, where, here*, etc., **and** ii. main verb is copula like *is, are, was, were*, etc.	*This is where the babies get changed?*
[R-LDV] Later-produced relative clauses	Code if (a) [src] or [rc] utterance has a main clause that contains a subject that <u>is not</u> a pronoun **or** ii. main verb <u>is not</u> copula.	*You got whoever got back to here first.*

Subordinate conjunction clauses that are separated by more than Interjections, Fillers, or Filled Pauses. [S-LDV] coding should be assigned to an utterance if it is truly biclausal or if an intervening adult utterance is limited to an interjection, filler, or filled pause. For example:

C: I wanna stand up.

A: (okay)

C: Cause my legs hurt [cs][sc][S-LDV].

In contrast, subordinate conjunction clauses that are separated by more than interjections, fillers, or filled pauses should be coded as [S-EDV]. For example:

C: I wanna stand up.

A: Why?

C: Cause my legs hurt [cs][sc][S-EDV].

Do not code any other types of complex syntax. This instruction extends to [pc], [cc] and any other types of complex syntax that do not apply to our complement clause, relative clause, and subordinate conjunction clause coding scheme.

Notes and clarifications

A note on *say*. We acknowledge that the complement clause verb *say* can be used to embed a complement clause (e.g., *He said (that) it was time to go*) or to convey a direct quotation (e.g., *He said, "It's time to go"*). Although it is plausible that the direct quotation use of *say* does not reflect an instance of embedding, we apply the same complement clause coding criteria. The purpose of C-EDV is not to code all instances of complement clauses that evidence a hierarchical relation between main and complement clauses. Rather, they describe a specific type of complement clause utterance, as described in the **secondary coding table**.

A note on *why*. Diessel (2004) indicates that the most S-EDV tokens are *because* clauses that are responses to *why* questions. Due to this fact, the number of why questions posed to a child may influence the number of S-EDV tokens produced. We take this as an instance of contextual factors that influence the production of production of complex syntax (Fox & Thompson, 1990). Because adult presentation of why questions may artificially influence the production of S-EDV, we encourage that LSA findings be corroborated with elicitation studies of early- and later-produced complex syntax tokens.

Journal of Child Language Acquisition and Development – JCLAD
Vol: 13 Issue: 2 1237-1251, 2025

ISSN: 2148-1997

The impact of counselling on caregivers' readiness to use Augmentative and Alternative Communication: A pre-post survey study

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Received : 18.08.2024
Accepted : 21.07.2025
Published : 30.08.2025
DOI: https://doi.org/10.5281/zenodo.17009566

Abstract

The success of AAC implementation for regular communication at home primarily depends on caregivers' perceptions and attitudes towards AAC. However, misconceptions and negative attitudes influence caregivers' attitudes to use AAC with their children. So, appropriate counselling and guidance might help in changing caregivers' perceptions and attitudes towards AAC. Hence, the present study was conducted to check for the change in the perception of caregivers to use AAC post-counselling. A descriptive survey with pre-post comparison method was used. The data was collected from a total of 83 caregivers of children with special needs of two speech and hearing institutes from Karnataka. The study was conducted in three phases. In the first phase, an e-survey was conducted using a checklist. Based on the scoring pattern for each question, the participants were divided into sub-categories and the percentage was calculated. In the second phase, caregivers were given counselling according to the categories. In the third phase, caregivers rechecked for their readiness to use AAC through a feedback form. Percentage of pre-post counselling comparison of readiness to use AAC was calculated. Post-counselling, 100% of participants had high readiness to accept the use of AAC compared to pre-counselling. This change could be due to increase in caregivers' awareness and knowledge about AAC during the counselling sessions as well as while self-administering the checklist. The present study thus indicates the vital role of counselling in reducing negative attitudes and myths towards the use of AAC.

Keywords: AAC, counselling, perceptions about AAC, acceptance and readiness.

1. Introduction

ASHA states that, "Augmentative and Alternative Communication (AAC) includes all forms of communication (other than oral speech) that are used to

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express thoughts, needs, wants, and ideas" (ASHA,1997). It includes mainly two types of AAC system, that is, aided and unaided communication. Aided communication refers to the use of aids external to the communicators body that can be either low tech or high tech (Beukelman & Light, 2020); for example, objects, symbol cards, written letters/ words, or speech-generating device. On the other hand, unaided communication refers to communication that is entirely established without external aids such as natural speech, sign language, or gesturing (Loncke, 2022). The primary aim of AAC intervention is to facilitate a child's communicative competence through the use of multiple communication modalities that are by their very nature supplementing ("augmentative") or replacing ("alternative") natural speech (Light, Beukelman & Reichle, 2003). AAC can be utilized to support a variety of communication difficulties in children who have difficulty expressing their needs (Constransitch, 2021). The research suggests that AAC has benefits on functional communication skills, challenging behaviours, language development (both receptive and expressive skills), and speech production of young children with CCN (Drager, Light & McNaughton, 2010).

AAC users communicate with a variety of communication partners who have different responsibilities in their life (Kent-Walsh & Mcnaughton, 2005). The National Joint Committee for the Communicative Needs of Persons with Severe Disabilities (1992) has noted the importance of identifying communication partners who are most critical to various communication environments. To have successful communication interactions with individuals who use AAC, communication partners must be able to give and receive messages (Kent-Walsh & Mcnaughton, 2005). Significant commitment and support from the entire family unit is critical for the positive integration of AAC (Glacken et al., 2019)

Caregivers' are the primary people engaging and interacting with infants on a consistent basis; consequently, caregivers are seen as a child's first teacher (Safwat & Sheikhany, 2014). Therefore, they must be members of the AAC team, at all levels of assessment and implementation (Beukelman & Mirenda, 2005). It has been highlighted that caregiver involvement in AAC is important (Huer & Lloyd, 1990). Caregivers have a vital role in deciding whether or not to accept AAC system for their child (Moorcroft et al.,2019, 2021; Park, 2020; Park et al.,2020). Hence, it is very essential to enhance and clear Caregivers' perspectives towards AAC (Park, 2021).

Caregivers' awareness and attitude towards AAC have influence of its use at home and in society (Marshall & Goldbart, 2008). However, caregiver's misconception eventually results in abandonment or rejection of AAC. There are many myths in the minds of caregivers' about AAC such as AAC should be considered as the last resort for communication, AAC hinders the development of speech and so on. Several studies claim that caregivers' who accept AAC treatment approaches for their children are more determined to support their child's success with these interventions (Goldbart & Marshall, 2004; McNaughton, 2008; Parette et al., 2000). These caregivers' are reported to actively promote their children's use of AAC in their everyday lives and actively engage in identifying the AAC device selections and establishing the intervention goals (Marshall & Goldbart, 2008). In contrast, caregivers' with a pessimistic outlook and little understanding are more likely to believe in

misconceptions about AAC and frequently favour relying only on conventional therapy methods to enhance their children's speech output (Kim et al., 2021). Through in-depth interviews with mothers of children with disabilities who were not utilizing AAC discovered that there was a lack of information and misconceptions about AAC (Oh, 2018).

The success of AAC implementation for regular communication at home primarily depends on caregivers' perceptions and attitudes towards AAC (Shin & Lee, 2016). Caregivers' being the major communication partners, they are required to have sufficient knowledge and readiness to accept the use of AAC with their children (Marshall & Goldbart, 2008; McNaughton et al., 2008). There might be caregivers' who are not at all aware of AAC, whereas others might know but still not have the readiness to use AAC with their children (Park, 2020; Park, 2021) Because of their limited understanding of AAC, caregivers are more likely to accept myths, which might prevent them from providing their children with the right intervention (Kim et al., 2021). Given the critical role of caregiver in AAC implementation and the influence of their perceptions and knowledge, it is essential to address these aspects through adequate support. Hence, the present study aimed to examine whether counselling can positively influence caregivers' perceptions of (AAC) and increase their readiness to use AAC with their children.

2. Methodology

2.1. Participants

A total of 83 caregivers' of children with special needs served as participants for the study. Caregivers' who were already using AAC to communicate with their child and/or allowing their child use AAC to communicate were excluded and only those caregivers who have still not opted for an AAC system were included. The study complied with the AIISH Bio-Behavioral Sciences Ethics Committee Guidelines for Human Subjects (Basavaraj & Venkatesan, 2009). The selection and involvement of caregivers' adhered to all moral requirements. Before testing, written consent was obtained from the participants after explaining the purpose of the study.

2.2. Data collection and processing

2.2.1. Setting

Information was gathered from caregivers' whose children were receiving speech and language therapy. These data were collected from two speech-language pathology Institutes of Karnataka.

2.2.2. Materials

AIISH Checklist for caregivers' of Novel AAC Users on Awareness and Knowledge about AAC and Readiness to Use AAC (Divya & Amulya, 2023) was used. The developed checklist was subjected to content validity to seek input from eight speech-language pathologists who had at least five years of clinical experience in the assessment and management of children using Augmentative and Alternative communication. The content validity was measured in terms of relevancy, clarity, simplicity and ambiguity parameters. Based on the CVI calculation, it was found that S-CVI/Avg (S CVI/Ave = sum of I-CVI scores/number of item) of eight professionals for 20 questions was 0.875, meeting the satisfactory level of agreement, 0.83 (Lynn, 1986).

During counselling, videos about AAC were shown to the caregivers'. Also, a feedback form was provided to caregivers' to check for their readiness to use AAC after counselling.

2.2.3. Research Design

The study adopted a quasi-experimental design, incorporating a descriptive survey with a pre-post comparison.

2.2.4. Procedures

The study was conducted in three phases. In the first phase, an e-survey was conducted in order to understand caregivers' level of awareness and knowledge about AAC and readiness to use AAC. For this, the AIISH Checklist for caregivers' of Novel AAC Users on Awareness and Knowledge about AAC and Readiness to Use AAC (Divya & Amulya, 2023) was used. This is a self-rating checklist with two parts or sections. Part A consists of questions related to awareness and knowledge about AAC and part B has questions related to the readiness to use AAC. Based on the type of options provided for each question, the obtained responses were scored in two ways; 0 or 1 to indicate the absence and presence of awareness, knowledge about AAC and readiness to used AAC respectively; or 0, 1 and 2, where 2 indicated the presence of high awareness, knowledge about AAC and readiness to use AAC and 0 indicated absence of the same. Bloom's cut-off point (Bloom, 1956) was used, where the caregivers' who scored ≥80% was considered as having high awareness and knowledge, 60%-79% as moderate awareness and knowledge and 59% or less as having low awareness and knowledge. The reason for using ≥80% cut-off for awareness and knowledge was by considering that the caregivers' must have got to know the information through counselling by speech-language pathologist/special educators, internet sources or webinars. For readiness, a cut-off score of ≥90% was considered. Less than 90% was considered as not having readiness. However, in the present study, the caregivers' who scored less than 90% were divided further into having moderate readiness (60-89%) and low readiness (59% or less). The reason behind using ≥90% cut-off for readiness was by considering the fact that it is difficult to ascertain the readiness amongst the caregivers who come under the category of 'moderate readiness' to use AAC. Based on this scoring pattern, caregivers' were divided into the following sub-categories: into (1) low awareness, knowledge and low readiness, (2) low awareness, knowledge and moderate readiness, (3) low awareness, knowledge and high readiness, (4) moderate awareness, knowledge and low readiness, (5) moderate awareness, knowledge and moderate readiness, (6) moderate awareness, knowledge and high readiness, (7) high awareness, knowledge and low readiness, (8) high awareness, knowledge and moderate readiness and (9) high awareness, knowledge and high readiness. Later, the percentage of caregivers' under each category was calculated.

Before counselling, the caregivers' were divided into broader categories like not having awareness and knowledge, having awareness and knowledge but not the readiness to use AAC and having awareness, knowledge and readiness but unaware of how to use AAC. These broader categories included sub-categories. Based on this, caregivers' were given counselling according to

the categories they were grouped under in the second phase, which is mentioned in the Table 1. For caregivers' under all the categories the videos about AAC and its use for communication were shown for their better understanding.

Table 1
Counselling caregivers' based on the categories

Categories	Sub-categories	Counselling
Not having awareness and knowledge	• Low awareness, knowledge and low readiness • Low awareness, knowledge and moderate readiness • Low awareness, knowledge and high readiness	Caregivers were counselled about: • what AAC is • about various modes of communication (aided and unaided). • how it can benefit the child in developing speech and language skills • cleared their misconceptions
Having awareness and knowledge but not the readiness to use AAC	• High awareness, knowledge and low readiness • Moderate awareness, knowledge and low readiness	• Explained using examples of those who improved using other modes of communication • Cleared their misconceptions and negative attitude towards AAC
Having awareness, knowledge and readiness but unaware of how to use AAC	• High awareness, knowledge and high readiness • High awareness, knowledge and moderate readiness • Moderate awareness, knowledge and high readiness • Moderate awareness, knowledge and moderate readiness	• Provided them with the strategies and videos in order to understand better and to in turn implement the use of AAC with their child

In the third phase, caregivers' readiness to use AAC with their child was rechecked. A feedback form was also provided to fill in order to know whether the counselling was effective. This form which is mentioned in Table 2,

contained three questions out of which first and second question was provided more weightage as it tapped the readiness aspect.

Table 2
Feedback form

Questions	Options
1. Now, do you think AAC might help your child to improve speech?	a. Yes b. No
2. Now, would you want your child to use other modes of communication to communicate?	a. Yes b. No
3. Would you like to know more about other modes of communication/AAC?	a. Yes b. No

2.3. Data analysis

The obtained responses for these questions were given a score of 0 or 1 to indicate the presence or absence of readiness. Bloom's cut-off score (Bloom, 1956) of ≥90% was hence used to check for the participants who were highly ready to accept the use of AAC. Percentage of caregivers who are ready to use AAC post-counselling was calculated and a pre-post counselling comparison of readiness to use AAC was carried out. The analysis was limited to descriptive statistics to summarise the data and highlight observable trends, as the dataset was insufficient to support the appropriate inferential statistical tests.

3. Findings

The results of the first phase, which are mentioned in Table 3 of the study, are reported as follows:

3.1. Low Awareness, knowledge and low readiness

Among 10% in low awareness, knowledge and low readiness, 75% had no awareness that the other mode of communication is called "Augmentative and Alternative Communication (AAC)". It was observed that 62.5% remained neutral to the fact that using other modes would reduce stress. Also, 50% agreed that using other modes of communication will stop their child from developing speech and other 50% were neutral about the same.

3.2. Low awareness, knowledge and moderate readiness

In this category, 18% had low awareness, knowledge and moderate readiness. Among these caregivers', 100% reported that they had never heard of the term "AAC," and 73.33% had never been previously recommended to use other modes of communication with their children. Despite this, 66.66% caregivers' expressed that using other modes of communication will not hinder their child's speech development, and 60% were comfortable using other modes of communication with their child.

3.3. Low awareness, knowledge and high readiness

Caregiver having low awareness and knowledge but high readiness (1.20%) was reported to have misconception that speaking is the only way through which their child can communicate, had no awareness of the term AAC and was not recommended other modes of communication earlier. This caregiver was shown to have high readiness. The results are as follows: this caregiver was comfortable to use other modes of communication with the child, believed that it would help the child to interact in the outdoor environment, would get enough support from their family members and using AAC would not be against their culture.

3.4. Moderate awareness, knowledge and low readiness

Further, 12% were in the category of moderate awareness, knowledge and low readiness. These caregivers' (60%) preferred both aided and unaided communication modes that could aid their child to communicate. Also, 70% of caregivers' reported that their child can use other modes of communication only when the child has limited speech and cannot speak at all. With moderate awareness and knowledge, 90% of parents were still in the notion that their child will be left alone when other modes of communication are used to communicate in the outdoor environment. In addition, 70% of caregivers' were unsure whether they would get enough support from the family members to use other modes of communication with their child, resulting in low readiness.

3.5. Moderate awareness, knowledge and moderate readiness

Majority of the caregivers' were reported in the category of moderate awareness, knowledge and moderate readiness (29%) Within this category, 54.16% believed that speaking is not the only way a child can communicate. These caregivers' (66.66%) also shared that they had received recommendations to use other modes of communication and were aware that they (58.33%) could seek support from speech-language pathologists to learn how to use augmentative and alternative communication (AAC) systems. Also, 46% were of the opinion that using other modes of communication would reduce both their own and their child's stress. At the same time, 29.16% felt

that other modes of communication should only be used when the child is completely unable to speak.

3.6. Moderate awareness, knowledge and high readiness

It can be seen in the results that among 6.05% in moderate awareness, knowledge and high readiness, 40% were of the opinion that speaking is not the only mode through which the child can communicate. These caregivers further mentioned both, aided and unaided would help the child to communicate. Further, 60% of caregivers' reported "all of the above" (that is, the child can use other modes of communication a) when the child cannot speak at all, b) has limited speech, c) unclear speech and d) can speak), 80% were earlier recommended to use other modes of communication and 40% felt that only parents and child should learn other modes of communication. With this moderate awareness and knowledge, 100% of caregivers' felt that using other modes of communication would help in developing speech, will help in improving vocabulary, understanding and communication, child will not look different compared to his/her age group children because of using other modes of communication, using it in the outdoor environment would help in interaction, will get support from the family members and will not be against their culture.

3.7. High awareness, knowledge and low readiness

Other, 3.6% were in the category of high awareness, knowledge and low readiness. Among 3.6% of caregivers', it was observed that 100% of the caregivers' were previously recommended to use other modes of communication, had awareness and knowledge that they can take help from speech language pathologist and special educators to learn how to use AAC communication system and also knew that the whole family must be involved in implementing AAC to a child. Further, 66.66% of caregivers' knew that using other modes of communication would reduce stress on both sides (parent and child). However, caregivers' here, having high awareness and knowledge were still in the misconception that using other modes of communication will stop developing their child's speech (100%), will not be comfortable in communicating with their child using other modes (100%) and their child would look different compared to his/her age group children because of using other modes of communication (100%). Also, they had a fear of their child being bullied or teased in the outdoor settings for using AAC (66.66%).

3.8. High awareness, knowledge and moderate readiness.

In this category,18% caregivers' (73.33%) believed that speaking is not the only mode through which a child can communicate. About 80% knew that other modes would reduce stress, 73.33% had an idea that they could take help from speech-language pathologist and special educators to learn how to use AAC communication system and 93.33% felt that whole family must be

involved while implementing AAC to a child. Caregivers' with high awareness and knowledge still demonstrated only moderate readiness. The results from the survey found that only 46.66% of caregivers' would get enough support from their family members to use AAC, and 60% reported that other modes of communication would improve their child's communication, understanding and vocabulary.

3.9. High awareness, knowledge and high readiness

Among 2.4% of caregivers', 100% knew that other mode of communication is called AAC, were previously recommended to use other modes, were aware that AAC would reduce stress and reported that to use other modes of communication whole family should be involved. These caregivers' also had high readiness, which is mentioned as follows: 100% caregivers' were of opinion that using modes would not stop developing speech, will help in improving vocabulary, understanding and communication, would be comfortable in using other modes with their child, will not look different compared to his/her age group children because of using other modes of communication, using it in the outdoor environment would help in interaction, will get support from the family members and will not be against their culture.

Table 3
Percentage of caregivers' having various levels/degrees of awareness, knowledge and readiness

Sub-categories	Percentage
Low awareness, knowledge and low readiness	10%
Low awareness, knowledge and moderate readiness	18%
Low awareness, knowledge and high readiness	1.20%
Moderate awareness, knowledge and low readiness	12%
Moderate awareness, knowledge and moderate readiness	29%
Moderate awareness, knowledge and high readiness	6.05%
High awareness, knowledge and low readiness	3.6%
High awareness, knowledge and moderate readiness	18%
High awareness, knowledge and high readiness	2.4%

In the second phase, post counselling, readiness of the caregivers to accept the use of AAC was rechecked through the feedback form and the percentage of pre- and post-counselling was carried out. Pre-counselling, 70% of participants believed that AAC might help their child improve speech, whereas post-counselling, this increased to 100%. Similarly, pre-counselling, 51.8% of participants were willing to use other modes of communication, which rose to 100% post-counselling. This is mentioned in figure 1 and 2.

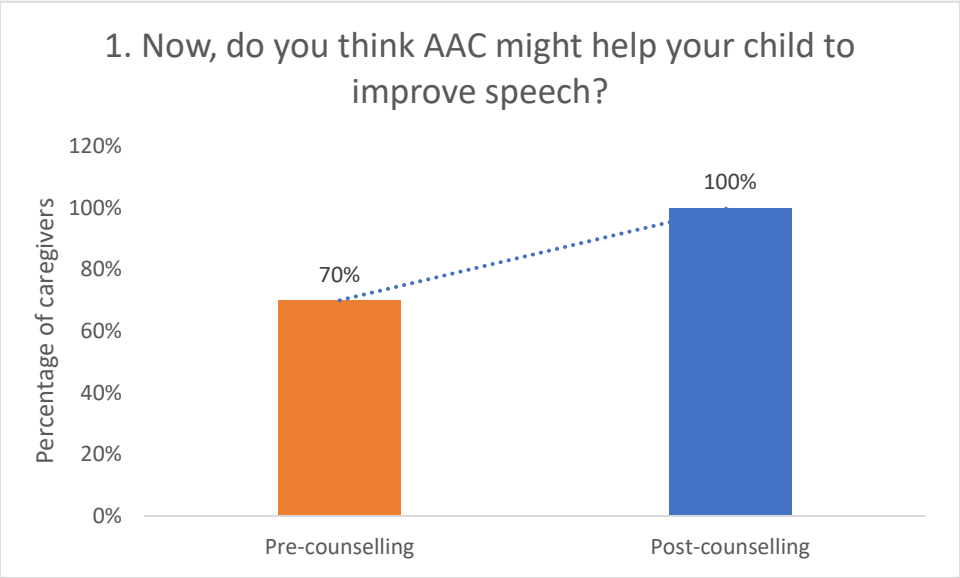

Figure 1. Readiness of caregivers' to use AAC pre- and post-counselling

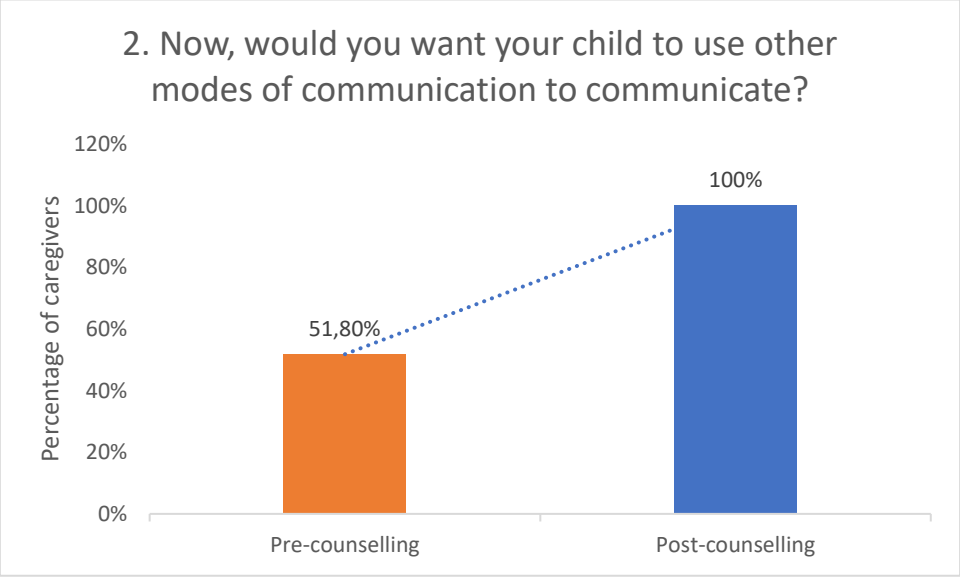

Figure 2: Readiness of caregivers' to use AAC pre- and post-counselling

4. Discussion

Majority of the caregivers' in the category of moderate awareness, knowledge and moderate readiness might have been recommended about other modes of communication by professionals, or might be in the notion that other modes of communication can help their child communicate better, but may not be clear or hesitant to use it. The literature also supports the same, that when parents came across AAC, they went through situations of accessibility problems, mistrust and hesitations to use the same (Park, 2021).

Least number of caregivers' were seen in the category of high awareness, knowledge and high readiness and low awareness, knowledge and high

readiness. Caregivers' in this category might be highly aware about other modes of communication but might not be aware about how to use it. Literature reveals that parents were able to comprehend that there are many various ways to communicate with their children and that speaking is simply one of many forms of communication (Park, 2021). However, we can observe from the present study that only a few caregivers' are under this category and they still do not have knowledge or expertise on how to use AAC. A study reports that in order to better understand their children's needs and wants, parents believed that a high and ongoing level of assistance was necessary, as well as further training for therapists in AAC systems (Berenguer et al, 2022). This high and ongoing level of assistance can be provided out through counselling the parents. Also, only 1 caregiver was seen in the category of low awareness, knowledge and high readiness. Through this it can be noted that pre-counselling, factors like low awareness and knowledge, misconceptions, cultural inappropriateness and less family support might have hindered the caregivers' readiness to accept the use of AAC. Also, clinicians not providing appropriate information to caregivers while attending speech therapy might be the result of caregivers' having low readiness. This helps in understanding that caregiver education plays a vital role in accepting the use of AAC for their children (Kim et al., 2021). The change in this perception and attitude towards AAC can be attributed to the fact of increase in caregivers' awareness and knowledge about AAC during the counselling sessions as well as while self-administering the checklist. A study also states that there was a positive perception towards the use of AAC once their misconceptions were eradicated (Kim et al., 2021).

5. Conclusion

The present study highlights the importance of counselling in reducing negative attitudes toward the use of AAC. Counselling serves to educate caregivers' effectively and offer appropriate perspectives on adopting AAC, thereby dispelling common myths and misconceptions. It is essential to emphasize the role of speech-language pathologists (SLPs) in guiding and educating caregivers' and families about AAC (Moorcroft, 2019; Baxter et al., 2012) to eliminate misinformation and prevent delays in initiating early intervention. The findings underscore the need to integrate structured counselling modules as part of AAC intervention programs to support caregivers' understanding and readiness.

This study was conducted as a preliminary step to explore the readiness of caregivers' of children with special needs who have not yet begun AAC use by sampling caregivers' from only two speech and hearing institutes. Future research should aim to replicate this study with a larger and more diverse sample across various geographic regions and clinical settings. Additionally, longitudinal follow-up and the inclusion of clinicians' perspectives would offer a more comprehensive understanding of the long-term impact of counselling on AAC adoption and implementation.

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Journal of Child Language Acquisition and Development – JCLAD
Vol: 13 Issue: 2 1252-1270, 2025
ISSN: 2148-1997

Pattern of language recovery relating to bilingualism in Ao Naga and English language: A case presentation

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Received : 17.02.2025
Accepted : 11.08.2025
Published : 30.08.2025
DOI: https://doi.org/10.5281/zenodo.17009613

Abstract

Background: Most of the population of the world is bilingual and the language emergence process in bilingual aphasics can be indifferent based on various factors. The similarity between First Language (L1) and Second Language(L2), age of second language(L2) acquisition, and usage of L2 are some of the possible factors that might contribute in the emergence of languages in Aphasic patients. The aim of the study is to introspect the early intervention of language therapy in a bilingual aphasic with Ao Naga as the L1 and English as L2.

Case Presentation & Methods: A n adult 42-year-old male was referred to a tertiary health centre with a complaint of altered sensorium. Later the patient was referred to the Otolaryngologist and SLP(Speech Language Pathologist) with the complaint of limited speech and language skills and difficulty in swallowing. When the SLP assessed the patient with WAB-R(Western Aphasia Batter-Revised) and N-DAT(Newcastle Dysarthria Assessment) and MASA(Mann Assessment of Swallowing Ability),he was diagnosed with Broca's Aphasia with Spastic Dysarthria and Oro-pharyngeal Dysphagia.

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Results: WAB-R scores improved when assessed after post-therapy of 10 sessions of 45 minutes duration and showed significant ($p<0.01$) strong positive correlations and significant differences on the pre and post-therapy WAB scores. Parallel emergence of L1 and L2 was seen during and post-therapy in the patient.

Conclusion: The study concludes that in bilingualism aphasia, both the L1 and L2 can emerge at the same time. The L2 might in fact, contribute more in recovering the L1 based on usage, proficiency, and exposure.

Keywords: bilingualism, aphasia, language therapy, language

1. Introduction

Aphasia is rarely a pure neurological syndrome and often is subjected to multidimensional aspects. There are different studies which highlight the fact about bilingualism in Aphasia and its possible difficulties. The most important issue to be addressed is the effect of aphasia affecting the structure of first language(L1) and Second language (L2), and to what extent and possible early probability of emerging of the either L1 or L2, post-stroke, after extensive language therapy in bilingual aphasics. There are different literature focusing on conceptual descriptions of aphasia in two languages, that is, L1 and L2 and different possible factors involved in emerging of the same during recovery. The neuropsychological approach in understanding the bilingual language processing would be remarkable in understanding the same (Beaton et. al, 2007; Weekes et.al,2008).

According to clinical studies, multilingual aphasia results in dissociations between L1 and L2 processing, with one language processing more poorly than the other. In some situations, a distinct recovery pattern is seen, with L2 regained just subsequent to L1. Another pattern is alternating antagonism, in which patients speak spontaneously in one language while suppressing the other for brief intervals of time (Abutalebi et. al, 2007). The compensatory behaviours in bilingual aphasia are a consequence of improved language control that aligns with the concept proposed by Green (1998) (Penn et. al,2007). There are also studies that depict that semantic system is involved in both forward (L2 → L1) and backward translation (L1 → L2) (Kroll et al,1994).

Whether L1 or L2 should be utilized in treatment with bilingual speakers is a question raised by Ansaldo and colleagues. They contend that Green's approach provides an explanation for language preference and provide an example using a bilingual customer who switches between Spanish and English without conscious thought. To address involuntary language switching, Ansaldo et al. use a self-regulated technique called Switch Back through Translation, which involves cueing the target language to translate name mistakes. Their findings confirm the presence of inhibitory processes proposed by Green's model, which includes an external suppression mechanism that enables naming and an internal suppression mechanism that facilitates translation. As with gestures, mimicry, and drawing, preserved Language Switching (LS) and Language Mixing (LM)abilities should be strengthened and taken into consideration as a

compensatory strategy to offset the unavailability of linguistic information, given that mixing and switching are distinctive pragmatic features in bilingual communication. Additionally, even in pathological situations, LM and LS may be used in conjunction with translation to prevent misunderstandings and promote target word access (Ansaldo et. al, 2008).

The switching between the languages involves general executive processing with overlapping areas of the brain and increased activity of Dorsolateral Prefrontal Cortex as well (Hernandez et. al, 2001).

Damage to the right hemisphere impacts lexical retrieval, prosodic processing, semantic processing, and a variety of pragmatic skills thought to be necessary for effective communication in Bilingual Aphasics (Puente et. al, 1992).

The overall cortical area of the L1 and L2 representations was comparable, but their anatomical distributions differed markedly. While the L1 and common sites were distributed across the mapped regions, the L2-specific sites were located only in the posterior temporal and parietal regions. When compared to the distribution of language sites in monolinguals, bilinguals', seven peri-sylvian language zones showed a marked underrepresentation of L2 locations. The L1 and L2 sites had different functions (Paradis et. al,2004).

Preferring one language over the other, a bilingual patient with aphasia may have a differentiated recovery that leads to a greater functional brain recovery. Additionally, the increasing usage of one language may harm the process for language choice or selection, as well as functionally improve its network and gradually isolate it from the other language. In a similar vein, a selective improvement might be sparked by the separation of the meanings of words from their coding (Dupont,1992).

Overall, 40% of bilingual aphasics experienced parallel recovery, 32% showed better recovery of L1 than L2, whereas 28% showed more improvement in L2 than in L1(Dupont et. al,1992). A recent study included machine learning models in treating treated language improvement (TLI) and transfer to the untreated language (cross-language generalization, CLG) with an aim to identify the key predictive features (eg, patient severity, demographics, and treatment variables) aligning with clinical evidence. The study concluded that factors such as patient severity and demographics predict TLI and CLG after therapy in Spanish-English bilingual individuals with poststroke aphasia (Marte et al.,2025).

The study was done to introspect the effectiveness of early intervention of language therapy in bilingual aphasic patients speaking Ao as the first language (L1) and English as the second language (L2).

2. Case Presentation and Methodology

An adult male of 42 years referred in our hospital with the complaint of altered sensorium, from a local Primary Health Care centre where CT scan was done and when repeated which revealed Intracerebral haemorrhage in left frontal lobe, left ganglio-capsular region and left insular cortex. Minimal subarachnoid haemorrhage in left temporal region and chronic lacunar infarct was also observed.

Patient was presented to the Otolaryngologist and Speech and Language Pathologist (SLP) due to difficulty in swallowing ability and limited speech and linguistic skills.

Patient when assessed presented with complaint of limited speech and language skills with comparatively good auditory comprehension. Patient could follow simple step commands as well as simple sequential commands. The patient could point to the objects when given stimulus (common lexical items) without cues. The oro-motor difficulties seen were limited tongue protrusion and extension, poor tongue kinematics, deviation of the angle of mouth towards right side, inadequate labial closure with mild drooling. Patient was able to repeat few monosyllables with respect to that produced in Ao Naga language. Patient also had swallowing difficulty for liquids with mild aspiration.

Patient was assessed with WAB (Western Aphasia Battery) and N-DAT (Newcastle Dysarthria Assessment) and was diagnosed with Broca's Aphasia and Spastic Dysarthria. The WAB scores for Fluency was 0.6, Auditory Comprehension was 6.4, for Repetition was 0 and for Naming was 1 respectively. The patient was evaluated for motor-speech and oro-motor functions using N-DAT (Newcastle's Dysarthria Assessment) and was diagnosed with Spastic Dysarthria and the persistent clinical symptom for the same was abnormal MPD (Maximum Phonation Duration), Pitch glide. Voice was perceived as wet and gurgley with monopitch and monoloudness, poor breathing pattern. Tongue function test revealed the Level 2 with presence of fasciculation of the tongue and deviation of the tongue towards right side.

Swallowing ability was assessed using MASA (Mann Assessment of Swallowing Ability) was the obtained score was 150 which was suggestive of Moderate Dysphagia and had prolonged Oral Transit Time (OTT), inadequate hyolaryngeal movement, impaired bolus capture with spilling of bolus and poor cough reflex.

When patient was assessed with WAB (Western Aphasia Battery) in which the duration of assessment was approximately one and half hour in English. Though the L1(First Language) of the patient was Ao and the L2(Second language) was English, WAB was administered in English due to the unavailability of the test in the L1.

The four sub domains of the WAB-R are (1) spontaneous speech; (2) auditory comprehension; (3) repetition; and (4) naming. The purpose of these sub-domains is to assess the severity of language impairment, identify the kind of linguistic deficiency, and establish whether aphasia is present. The total score for spontaneous speech is 20, which takes into account both information content and fluency. The total points for auditory comprehension is 200 consisting of 60 points for Yes–No questions, 60 points for auditory word recognition, and 80 points for sequential commands. The total score for repetition is 100. A total of 100 points are given for naming, including 60 points for object naming, 20 points for fluency of words, 10 points for sentence completion, and 10 points for responsive speech. The total points are first converted into minimum score by considering 10% for repetition and naming and 20 % of score for comprehension.

The patient scored 12 for spontaneous speech,6.4 in comprehension,1 in naming and 0 in repetition task respectively. When the Aphasia Quotient (AQ) was calculated using the formulae

$$AQ = (Spontaneous + Comprehension \div 20 + Repetition \div 10 + Naming \div 10) \times 2,$$

and the score obtained was 24.84 which determined Very Severe Broca's Aphasia (Yan et. al,2022). The scores were awarded based on the participant's response to the stimulus provided during the test.

The non-verbal skills assessment that is reading and writing, praxis, construction was excluded during the testing considering the bedridden condition of the patient. The pre-therapy WAB scores are given in the Table 1.

Table1
Pre-therapy WAB scores in the four domains

	Fluency	Auditory comprehension	Repetition	Naming
Maximum Score for Broca's Aphasia	0-4	4-10	0-7.9	0-8
Patient Score	0.6	6.4	0	1

2.1. Therapeutic techniques incorporated

2.1.1. Melodic Intonation Therapy

The subject was only exposed to the first to monosyllables and combination of those monosyllables making it into a meaningful word in Ao language (eg. /ya/ and /yu/ combination resulting in /yayu/ meaning Sister) through singing after the SLP stated it once to explain the process. The participant was given singing instructions after the SLP repeatedly modelled the monosyllables thus turning into bisyllabic words. In addition to providing an extra cue during singing, the SLP helped the participant tap the rhythm of the words with his or her left hand. This is thought to help with motor planning for vocalizing the phrase (Thaut, 2005). In the sessions that followed, the SLP decided whether or not to add a new word. Only the first 3 words were covered in the second session; however, in the third session, the participant was given the opportunity to learn phrases with the different combinations of Consonant and Vowel (CV) combinations to make it into meaningful words in L1(Ao) would help along with L2(English).

The same process was carried out in L2, for example /ma/ and /ma/ combination resulting into /mama/ in L2 and L1 as well.

2.1.2. Semantic Therapy tasks included

2.1.2.1. Semantic Associated Matching

The subject was shown the target image along with two additional object photographs, one of which had semantic similarities to the intended recipient. When given a choice between a fork and a chimney, the participant

was asked to name the corresponding visual, such as "which one goes with the knife?" Binary choices were given along with the targeted stimulus. The stimulus was provided in both L1 and L2 and then cues were provided for the same using pictures and explaining the function of the targeted stimulus.

2.1.2.2. Functional Questions

The subject was shown the target image along with two closed, standard-format questions, such as "Can you verb a target?" and "Can you kick a football?" or "Can you eat a football?" The patient was encouraged to answer in either Ao Naga or English, whatever was preferable for him.

2.1.2.3. Naming to definition

A target picture and its definition were shown to the participant. Carrots, for instance, were defined in English as "a type of root vegetable." Rabbits enjoy eating them because they are orange, slender, and lengthy. It was up to the participant to identify the image. The SLP provided cues for the name if he was unable. Semantic Priming was incorporated to elicit the targeted responses in either L1 or L2

2.1.2.4. Semantic Feature Analysis

After seeing the target image, the participant was asked to characterize its semantic elements. The SLP used appropriate cue questions, including "Where would you find it?" and "What would you do with it?" In addition, the SLP offered qualities that the patient could choose to embrace or reject. A fresh target image was provided after the previous targeted stimuli has been correctly elicited or answered by the patient.

2.1.3. Phonological therapy task included

The participant was asked to repeat the spoken name after seeing the target picture.

a) Phonological queuing

The subject was asked to construct the word after seeing a target picture and hearing a phonological cue that included the word's first phoneme or cluster.

Rhyme judgement:

A rhyme question, such as "Does this word rhyme with parrot?" (for the target word "carrot") was provided with the target picture. There were an equal number of questions that required answers of "yes" or "no." For instance, a participant might be asked, "Does this word rhyme with hammer?" (for the target word "carrot") on another occasion. The minimal pair combinations were provided mostly in L2 as English has lot of contrast minimal pair as well, e.g.- combination of bat and cat and replacement of phoneme /b/ and /k/ was easy w.r.t pictures.

b) Syllable counting

The participant was shown the target picture. If they were able to give it a name, they did; if not, the SLP did. Next, the subject was asked to specify

how many syllables were in the term. If not, the therapist encouraged her or him to count the syllables by tapping out the number. The temporal aspects were also incorporated for the syllables and L1 syllables and L2 syllables were combined separately and responses were elicited whichever was preferable for the patient to comprehend and express.

c) Initial phoneme judgement

The participant was shown the target image along with the spoken name. He or she was instructed to pronounce each word's initial sound, such as "this word is potato." What is the potato's initial sound? When a patient was having trouble, the therapist would say, "The word begins with /p/. /p/ for potato". The task was carried out in L1 and L2 to make the patient more familiar of the different combinations of vowels and consonants and the place of occurrence of the same in the respective languages.

2.1.4. Verb Network Strengthening Treatment (VNeST)

Verb Network Strengthening Treatment is a semantic treatment which aims to improve the lexical retrieval of content words in sentence context by promoting semantic retrieval of verb and the respective thematic roles. For those with moderate aphasia, VNeST may be useful in helping them advance from single word naming to connected speech (Edmonds et. al, 2009). VNeST has been proved to be beneficial for bilinguals, so in this case as well, VNeST was incorporated (Li et. al, 2021).

The verbs of the probe stimuli were presented in random order for elicitation of naming and no semantically related verbs were presented consecutively. For every sentence probe image, the subjects were asked to make sentence/phrases which included him in the action with the experimenter pointing to the agent, verb, and patient (Edmonds et al., 2009) in either L1or L2.

2.1.5. Response Elaboration Training (RET)

The goal of RET is to improve the verbal productivity with respect to content and length of utterances. The changes included practicing complex utterances repeatedly, using integral stimulation, and providing more clinical modelling. The picture sets were provided to the patient and was asked to tell as much as he can about the picture either in AoNaga or English. After the patient completed the task, he was asked to say about any extra information that he would like to provide regarding the same. Personal recounts were also provided (e.g. Talking about anything that happened yesterday at least for 5 minutes). Across the measurement circumstances, treatment administration was counterbalanced (e.g., Picture Set 1 → Picture Set 2 → Personal Recount; Personal Recount → Picture Set 2 → Picture Set 1).

Post-therapeutic Language Intervention the patient scored 3 in Fluency, 10 in auditory comprehension,7.5 in repetition and 6.5 in naming tasks.

The patient had persistent difficulty in Naming but improved with cues. Paraphasic affecting metrical information of speech was observed. Phonemic paraphasia with preservative, epenthetic and substitution errors seen in L1

and relatively less in L2. Neologistic Paraphasia was also observed while answering in long sentences in both L1 and L2.

3. Findings

The patient was previously provided with speech and swallowing therapy during his hospital stay; later after discharge the language therapy was initiated. The priority was given to the speech and swallowing abilities rather than linguistic skills considering the medical intervention and feeding abilities to be intervened first. But during the hospital stay patient was provided stimulus for improving comprehension of common lexical categories that is required in ADL (Activities of Daily Living).During that patient was communicating using gestures.

Swallowing therapy included postural modifications, dietary modifications and manoeuvres and swallowing exercises and there was a good prognosis within the duration of 5 days, thus RT (Ryle's Tube) was removed and oral diet was initiated. Speech therapy included improvement of tongue kinematics and labial kinematics with respect to the movements of the same at rest and during speech. Oro-motor exercises were incorporated and thus improvement in the tongue and labial kinematics was observed.

After discharge from the hospital patient was provided language therapy for 10 sessions. There was a gap of almost 10 days when from the day when language therapy started and discharge from the hospital. Then, the language therapy was commenced when the patient was physically stable and was willing to attend the language therapy. The language therapy was scheduled to be thrice in a week for 45 minutes and was provided with Home training as well. The WAB scores were obtained during hospital stay and before the language therapy began where language domains like the fluency, auditory comprehension, naming and repetition improved. The overall interventional aspects provided to the patient along with the duration and short term therapy goals are described in the Table 2.

Table 2

Overall interventional aspects provided considering the short term goals, therapeutic techniques, treatment schedule and day-to-day scores in the four main domains of WAB of the patient

Short-term goal of therapy	**Therapeutic strategies used**	**Treatment schedule (day and duration)**	**Stimulus provided**	**Post therapy scores w.r.t days**
1.To Improve Comprehension and Expression of Common Lexical Categories 2.To Improve Propositional Speech	MIT (Melodic Intonation Therapy) -Semantic Therapy Verb Network Strengthening Treatment	DAY 1 45 MINS	- Semantic associating matching - Semantic feature analysis - Repetition of target (picture	Fluency-03 Auditory Comprehension-10 Repetition-3 Naming-2

			naming) with cues	
3.To Improve Comprehension and Expression of Common Lexical Categories 4.To Improve Propositional Speech	-MIT -Semantic Therapy Verb Network Strengthening Treatment	DAY 2 45 MINS	Semantic associating matching - Semantic feature analysis	Fluency-03 Auditory Comprehension-10 Repetition-3.75 Naming-2.75
5.To Improve Comprehension and Expression of Common Lexical Categories	Verb Network Strengthening Treatment Semantic Therapy	DAY 3 45 MINS	Semantic feature analysis - Repetition of target (picture naming) with cues	Fluency-03 Auditory Comprehension-10 Repetition-4.50 Naming-3.75
6.To Improve MLU (Up to 3 Words) Using Nouns and Pronouns	Verb Network Strengthening Treatment, -Semantic Therapy	DAY 4 45 MINS	Semantic feature analysis - Repetition of target (picture naming) with cues	Fluency-3.75 Auditory Comprehension-10 Repetition-5.2 Naming-4.0
7.To Improve MLU (Up to 3 Words)Using Verbs And Adjectives	-Verb Network Strengthening Treatment, -Response Elaboration Training	DAY 5 45 MINS	- Semantic associating matching - Semantic feature analysis - Functional questions	Fluency-03 Auditory Comprehension-10 Repetition-5.75 Naming-4.75
8.To improve MLU (up to 3 words) using minimal pairs, opposites, Naming 9.To improve lexical retrieval of content words in sentence context by promoting systematic retrieval of verbs (e.g., *measure*) and their	Verb Network Strengthening Treatment, - Semantic Therapy -Response Elaboration Training	DAY 6 45 MINS	- Phonological therapy including phonological cueing, rhyme judgement - Semantic associating matching - Semantic feature analysis	Fluency-3.75 Auditory Comprehension-10 Repetition-6.0 Naming-5.2

thematic roles—i.e., agent				
10.To Improve MLU (Upto 3 Words) -To improve lexical retrieval of content words in sentence context by promoting systematic retrieval of verbs (e.g., *measure*) and their thematic roles—i.e., agent	Verb Network Strengthening Treatment, -Semantic Therapy -Response Elaboration Training	DAY 7 45 MINS	- Functional questions -Naming to definition Semantic associating matching - Semantic feature analysis	Fluency-3.75 Auditory Comprehension-10 Repetition-6.25 Naming-5.45
11.To Improve Phonological and Grammatical Efficiency	Phonological Component Analysis (using Rhyming words, first sound, number of syllables, another related word) -Semantic Therapy	DAY 8 45 MINS	Phonological therapy including phonological cueing, rhyme judgement	Fluency-3.75 Auditory Comprehension-10 Repetition-6.50 Naming-5.75
12.To Improve Phonological and Grammatical Efficiency	Phonological Component Analysis (using Rhyming words, first sound, number of syllables, another related word) - Semantic Therapy	DAY 9 45 MINS	Phonological therapy including phonological cueing, rhyme judgement	Fluency-3.75 Auditory Comprehension-10 Repetition-6.75 Naming-6.25
13.To Improve Phonological and Grammatical Efficiency	Phonological Component Analysis (using Rhyming words, first sound, number of syllables, another related word) - Semantic Therapy	DAY 10 45 MINS	Phonological therapy including phonological cueing, rhyme judgement	Fluency-3.75 Auditory Comprehension-10 Repetition-7.5 Naming-6.5

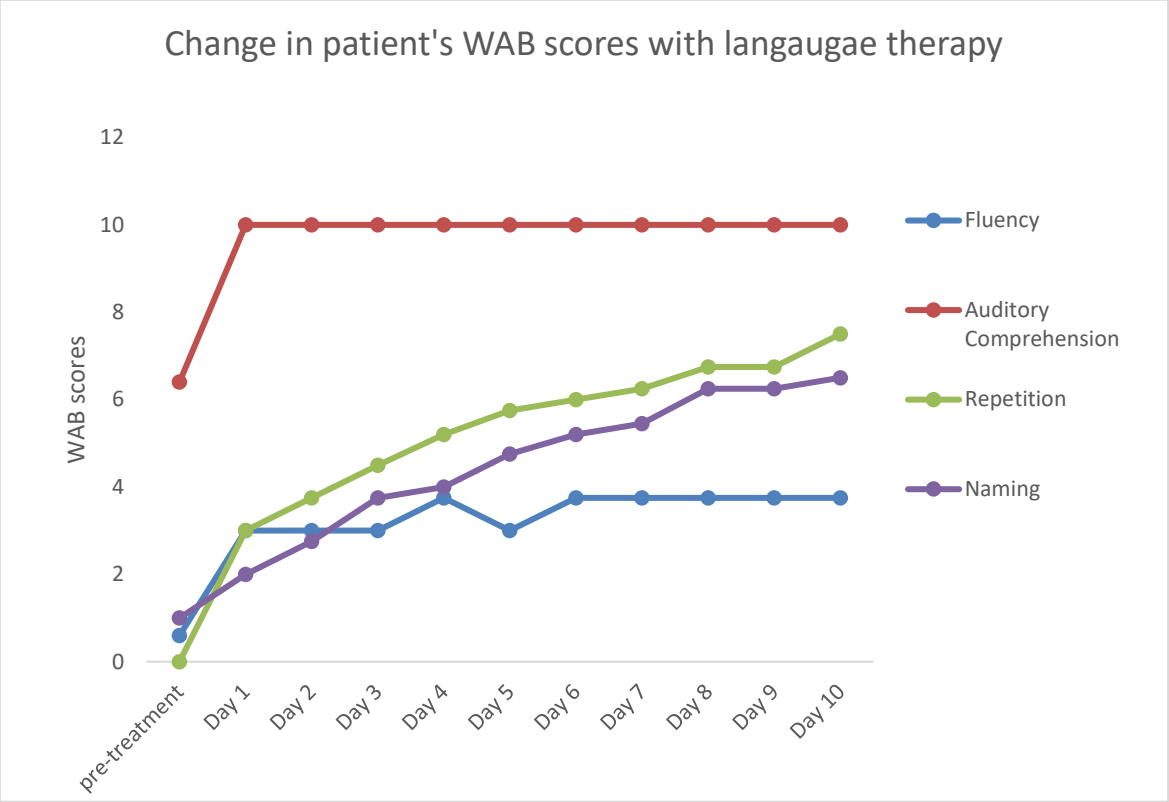


Figure 1. Improvement in WAB scores in different domains of language with the language therapy provided to the patient from day 1 to day 10

The variables in the study (all except auditory comprehension since it had unanimous values on all days) were initially evaluated for their distribution pattern using Kolmogorov-Smirnov test. Most of the parameters (days of therapy, repetition and naming) were normally distributed. However, fluency was not found to be normally distributed. The progression of therapy was correlated with patient outcomes. All correlations were found to be significant ($p<0.01$) strong positive correlations. The correlogram depicting same has been depicted in the following diagram. All domains of language i.e. comprehension, repetition, naming and fluency improved significantly over time with the language therapy intervention.

It can be seen that auditory comprehension improved spontaneously from the day the patient was assessed till the day the language therapy was completed in both Ao Naga and English. The repetition and naming ability of the patient improved with progression the days of therapy in both the languages. Positive reinforcement (verbal appreciation) was provided whenever the patient could successfully produce the targeted responses in any of the languages. Fluency improved with improved MLU (2-3 words) and intelligibility, where the patient was able to respond to the spontaneous speech with proper information content regarding the relevant questions asked. Post therapy (on the 10thday) the patient responded in L1and L2 or at times used words from both the languages. Neologistic paraphasia, following the word was observed while answering long sentences mostly in L1 and sometimes in L2 as well. Phonemic Paraphasia was also observed with persevarative, epenthesis and substitution errors in L1 and L1. Naming

improved but difficulties still persisted and cueing was seen to be helpful for eliciting response in the patient in both L1 and L2. The correlogram given below depicts the language therapy progression and the language domains (Fig. 2)

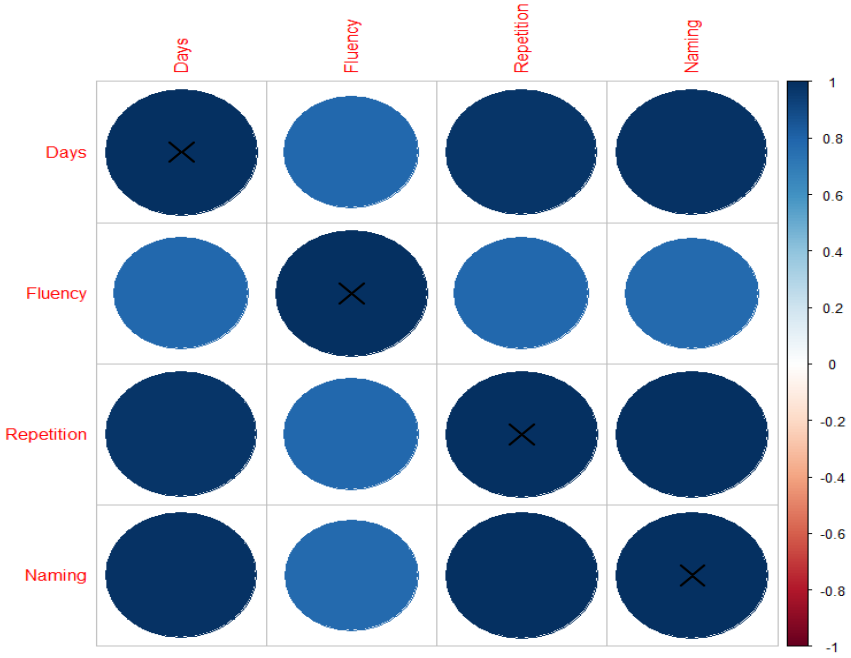
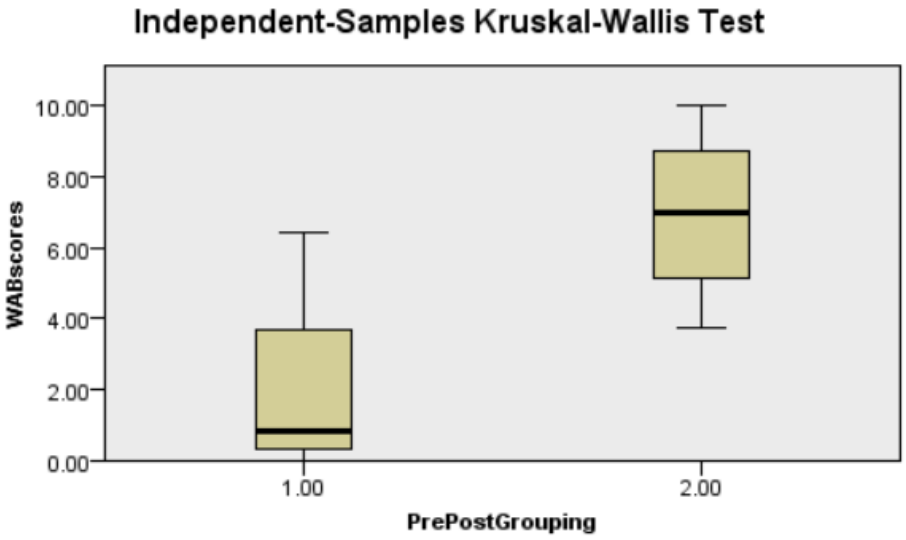


Figure 2. Correlogram depicting correlation between language therapy progression and language domains

The pre- and post- language therapy WAB scores were significantly different, in all the four domains of language; based on non-parametric Kruskal-Wallis ANOVA (test-statistic= 4.083, df=1, $p<0.05$), the results have been represented in the following Figure 3.



Total N	8
Test Statistic	4.083
Degrees of Freedom	1
Asymptotic Sig. (2-sided test)	.043

1. The test statistic is adjusted for ties.

Figure 3. Non-parametric Kruskal-Wallis ANOVA depicts significant improvement in pre and post therapy WAB scores

The WAB was administered post-therapy and the patient scored 7.5 for spontaneous speech,10in comprehension,6.5 in naming and 6.5 in repetition task respectively. When the Aphasia Quotient (AQ) was calculated using the formulae

AQ = (Spontaneous + Comprehension ÷ 20 + Repetition ÷ 10 + Naming ÷ 10) × 2,

the score was obtained was 39.8 which determined Severe Aphasia. Post-Therapy WAB scores are given in Table 3.

Table 3
Post-therapy WAB scores in the four domains

	Fluency	Auditory comprehension	Repetition	Naming
Maximum score for Broca's aphasia	0-4	4-10	0-7.9	0-8
Patient score	3.75	10	7.5	6.5

The patient was later kept in the criteria of Transcortical Motor Aphasia because more fluent speech output was observed with respect to words, phrases and sentences than spontaneous speech in both L1 and L2.The patient had persistent difficulty in initiating speech and had echolalia and naming difficulties as well (14).The pre and post-therapy WAB scores with respect to AQ is given in Table 4.

Table 4
Pre and Post therapy WAB scores with respect to AQ scores

Wab scores	Fluency	Auditory comprehension	Repetition	Naming	Aq
Pre-therapy	12	6.4	0	1	24.84 (very severe)
Post-therapy	18	10	7.5	6.5	39.8 severe)

The patient was provided with Home Training materials (as they decided to head back to their native place) for continuing the language therapy to improve. Inference as non-fluent Aphasics are reported to have better inference than fluent aphasics (Wright et. al,2004).

4. Discussion (or Discussion and conclusion)

The aim of the study was to understand the understand the effectiveness of early intervention of language therapy in bilingual aphasic patient speaking Ao as the first language (L1) and English as the second language (L2).

In contrast to monolinguals, bilingual aphasic patients have a higher probability to improve their processing speed during rehabilitation, resulting in a shortening of the Mismatch Negativity (MMN) latency over time, which sometimes progresses toward the normative values (De Letter et. al,2021).

Across the board, bilingual speakers with post-stroke aphasia performed better in L1 than in L2, according to a study; however, the extent of this difference varied depending on when L2 was learned: bilinguals who learned L2 before the age of seven demonstrated similar performance in both languages, while bilinguals who learned L2 after the age of seven demonstrated better performance in L1 than in L2. These strong results were somewhat mitigated by premorbid proficiency and frequency of use (Kuzmina et. al,2019).

There are studies which supports the fact that L1 was better preserved in Aphasics than L2, depicting that early learned language is more resistant to brain injury (Ribot et. al,1887; Abutalebi et. al,2007). The other study affirm that language production in bilinguals is a dynamic process involving cortical and sub cortical structures that use inhibition to resolve lexical competition and choose the intended language, and that the neural representation of a L2 converges with the representation of that language learned as L1(Abutalebi et. al,2007).

Few studies also highlight the fact that the co-relation between language proficiency and language use as well. The speaker that uses the language regularly are said to be more proficient in that and thus may be more efficient in that language with respect to usage, linguistic proficiency and similarity (Goral et. al,2010). Whereas, few studies also focus on the fact that the proficiency maybe greater in L2 because of its greater usage and early acquisition of L2 may play an important factor for the same (Kuzmina et. al, 2019). But at the same time, the study also highlighted the little role the language proficiency plays a great role in language representation and processing in the bilinguals but usage of L2 in educational aspects but prove to be an additional proficiency for L2.

Then another factor to focus on is the fact that the similarity between L1 and L2 can influence the compatibility in bilingual aphasics because of common lexico-semantic representation and other grammatical aspects in both the languages. But few studies provide contrasting results for this hypothesis inferring that there might be a very little possibility of the similarity between L1 and L2 (Munoz, 2003; Alsando, 2010).

The age of language acquisition of the L2 may also play an important role and the individual might have more ability in potentially processing the L2 (Giussani, 2007). Also, a study considered the age 7 year as a 'natural-breaking point' as the child starts learning L2 at the school age (Kuzmina, 2019). Similarly, another study also considered age 6 and bilingualism was considered as advantage of cognitive control functions in adults (Lehtonen, 2018).

There are six distinct patterns that matched the most often seen language characteristics of bilingual aphasia recovery. Recovery may be classified as either selective when only one damaged language recovers, differential when stronger recovery is shown in one over the other, mixed when inappropriate LM takes place, or parallel when both impaired languages improve to a comparable degree and simultaneously. Additionally, rehabilitation may be antagonistic when the recovery of L1 and L2 follows different patterns and one language improves while the other regresses, or sequential when the recovery of one language is completed before the other.

Here, in the present study the patient had similar kind syntactical and semantical errors in both L1 and L2.The patient showed greater comprehension and while undergoing intervention ,the patient was more reluctantly dependent on L2 rather than L1.Patient was able to comprehend instructions in L2 than L1 and naming errors were less prevalent in L2 than L1.The possible reason behind this can be considered as language proficiency in L2 as well as early language acquisition in L2(Manuel et. al,1994).

Another important factor to be highlighted here in that Ao Naga(L1) belongs to the Tibeto-Burman Language family which is spoken in Mokochung district of Nagaland state of North Eastern India (Mukherjee, 2020; Coupe, 2007). The Ao Naga lacks individual script and is dependent on L2 (English)which is also the official language in the state of Nagaland. This draws inference to the fact mostly used and preferred language for the patient since childhood. The schooling of the patient started in L2 rather than L1 and was widely used for communication before stroke.

Another possible reason to highlight the efficiency of the patient in L2 can be considered due to Language Transfer Theory which maybe positive and negative, playing an important role in L2. Positive Language transfer is basically the influence of L1 concept helps in acquisition of L2 and negative Language Transfer is L1interrupting the acquisition of L2 (Coupe,2007).

Moreover, the recovery of L1 and L2, parallel pattern was observed, maybe due to the age, proper home-training and the therapy being provided in both L1 and L2 by the care-giver and SLP. The cognitive deficits or probability of having poor memory skills was less severe than the geriatric population may also have contributed in the good prognosis in the patient.

The Revised Hierarchical model of bilingual representation that is said to represent two different levels of representation (lexical and conceptual) and thus accommodating independent lexical representations for both L1 and L2 but with similar conceptual representation, might have also played a significantly role in emerging of the L1 and L2 in the patient (Wang et. al, 2010)

The limitation of the study is that more samples are required to understand the lexical representation and grammatical similarity in the bilinguals knowing both Ao Naga and English; whether parallel recovery will be observed with other kind of Aphasias.

Another perspective to be considered in the recovery of language functions following left gangliocapsular injury in Broca's aphasia most likely reflects reorganization within a distributed cortico-subcortical network rather than restitution within a single locus. Anatomical evidence from diffusion tractography demonstrates direct corticostriatal and cortico-thalamic connections linking Broca-region cortex with basal ganglia nuclei, providing a structural substrate for coordinated subcortical and frontal plasticity (Ford et al., 2013; Booth et al., 2006). Longitudinal studies of pure subcortical aphasia reveal substantial behavioural recovery accompanied by reactivation of perilesional left frontal cortex, and in some cases contralesional recruitment, suggesting that cortical reorganization can proceed in parallel with subcortical recovery (Lahiri et al., 2020; Thompson & den Ouden, 2008). Furthermore, large treatment-based fMRI investigations demonstrate that therapy induces domain-specific recruitment of ipsilesional frontal networks, reinforcing the view that functional gains emerge from dynamic changes across both gangliocapsular and left frontal nodes (Barbieri et al., 2023). Recent lesion–disconnection analyses also support a distributed network model of Broca's aphasia, in which recovery depends on the integrity and plasticity of interconnected cortical and subcortical components (Pracar et al., 2025).

5. Conclusion

The study concludes that in bilingualism aphasia, both the L1 and L2 can emerge at the same time during the spontaneous recovery stage. The L2 might in fact, contribute more in recovering of the L1 based on usage, proficiency and usage and exposure. The similarity in lexico-semantic structures of both the language may also help in recovery of both the L1 and L2. Early intervention, age, and proper home-training have also helped in the effectiveness of the therapeutic aspects. Moreover, the therapeutic

strategies provided during the intervention phase were also important in highlighting the fact of positive recovery. As the therapeutic strategies mainly consisted of the fact of strengthening the lexicon, priming and semantic aspects of both the L1 and L2 in the mental network, which might have help in improving the language structure in both L1 and L2. Instead of approaching on the elaborative way of intervention, the basics of the morpho-semantic structure should be considered and later on morpho-syntactic structure as a part of the lexical architecture should be focused upon. Moreover, the phonological therapy in aphasics may help in strengthening the mapping between the semantic and phonological lexicon based on various degree cognitive and linguistic difficulties (Waldron et. al, 2011). In addition to pattern of recovery and therapeutic strategies, the site of lesion in the brain and severity and type of aphasia also play a pivotal role in determining the course and outcome of bilingual recovery.

Author Contributions

KD- conceptualization, writing of original draft**, HBN-**resources and project administration**, RM-**statistical analysis **DV-**writing of draft and editing, methodology**, DD-** writing of draft and editing, methodology

Conflict of Interest: None

Funding: None

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Journal of Child Language Acquisition and Development – JCLAD
Vol: 13 Issue: 2 1271-1287, 2025
ISSN: 2148-1997

Children's acquisition of recursive possessives in Mandarin

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Received : 05.05.2025
Accepted : 10.08.2025
Published : 30.08.2025
DOI: https://doi.org/10.5281/zenodo.17107415

Abstract

This study investigates the developmental stages in the acquisition of two-level possessive recursive structures by Mandarin-speaking children aged 3 to 6. Using the 'answering a question while seeing a picture' task, it was found that children begin to accurately understand two-level possessive recursions at around six years old, with an accuracy rate nearing that of adults. Besides, the research highlights a gradual developmental trajectory in language acquisition. The results indicate a gradual, protracted development of recursive possession in Mandarin, aligning with maturation theory. The findings suggest that while the computational capacity for recursion is innate, its acquisition timeline is modulated by language-specific morphological and syntactic factors.

Keywords: recursion; possessives; L1 acquisition; Mandarin; Maturation Theory

1. Introduction

1.1. Recursion

Language is the cornerstone of human communication, and the complexity of language lies in the diversity and recursion of its structure. Following early formalisation by Chomsky (1957), recursion is widely regarded as a core design feature that allows a finite grammar to generate an infinite set of hierarchical expressions. In Corballis' (2014) words, the claim that recursion is the essence of natural language has been a continuing theme of Chomsky's work since his 1957 book *Syntactic Structures*. This theme is reiterated in Hauser et al. (2002), proposing that the faculty of language in the narrow sense only includes recursion, the only uniquely

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human component of the faculty of language. This proposal is summarized as the "recursion-only hypothesis" in Jackendoff and Pinker (2005: 212), which highlights the importance of recursion in linguistics.

While definitions of recursion remain heterogeneous, most current work distinguishes at least two types: (i) grammatical recursion (e.g., [[[A]B]⋯]), (ii) category recursion (e.g., [[[A]A]⋯]) (Dékány, 2019: 319-320). The present paper focuses exclusively on category recursion, also termed indirect recursion in Roeper's terminology, exemplified by the English possessive structure [[[N's] N's] N] (Elmo's sister's ball) (Roeper, 2011).

1.2. Definition of recursive possessive

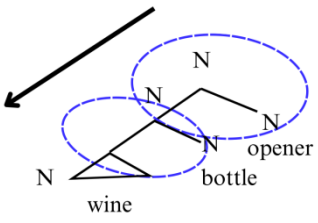
The recursive rule "$\alpha \rightarrow <\alpha$ W>" is left-branching (i.e., left-expanding), in which the non-terminal symbol α in the brackets is on the left of the terminal symbol W (note: the Latin letters are non-terminal while the capital letters are terminal). The recursive rule "$\beta \rightarrow <\beta$ M>" is also left-branching. In contrast, recursive rules like "$\alpha \rightarrow$<W α>" and "$\beta \rightarrow$<M β>" are right-branching. Left- or right-branching rules are one-direction tail-recursion rules. Besides, rules like "$\alpha \rightarrow <\alpha$ β>" and "$\beta \rightarrow <\beta$ α>" can be combined into the rule in (1a), which further combines with (1b) to produce the recursive rule in (1c). Rules such as the one in (1c) are (potentially) two-direction (both left and right-branching) tail-recursion rules (Rohrmeier et al., 2014).

(1a) $\alpha \rightarrow <\alpha <\beta \ \alpha>>$ (1b) $\beta \rightarrow$M (1c) $\alpha \rightarrow <\alpha$ <M $\alpha>>$

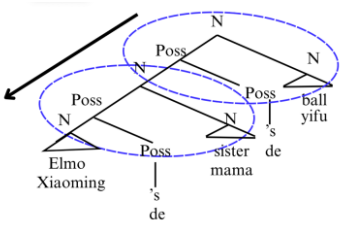
As shown in (2a), the left-tail-recursion rule "N→N N" is used twice consecutively by way of "N→[N N] N", with terminals to generate two-level tail-recursion sequences like *wine bottle opener*. In this diagram, circles symbolize recursive rules that are repeatedly employed, and arrows indicate the direction of expansion in a top-down manner.

Also, as shown in (3a) below, the potentially left and right tail-recursion rule "N→N Poss N" (which results from the combination of the two rules "N→ Poss N" and "Poss→N Poss") is used twice consecutively by way of "N→[N Poss N] Poss N", which is further filled with terminal words to generate two-level tail-recursion sequences such as *Elmo's sister's ball* and *Xiaoming de mama de yifu* 'the clothes of Xiaoming's mother'.

(2a)



(3a)



1.3. Previous acquisition studies on recursive possessives

Figure 1 provides a comprehensive overview of the developmental stages in children's acquisition of possessive recursion sequences, with the majority of participants being between the ages of three and six. The data presented in the figure indicate that the acquisition of recursive possessive is a phenomenon observed across various languages.



Figure 1. Summary of key research

Early research by Gentile (2003) established a picture-selection paradigm to assess comprehension. Children were shown pictures of characters (e.g., Cookie Monster and his sister) and asked questions like "Can you show me Cookie Monster's sister's picture?" This approach, focusing on identifying the correct referent, revealed that mastery of this structure is a developmental achievement. Subsequent studies adopted and adapted this paradigm. For instance, Limbach and Adone (2010) and Pérez-Leroux et al. (2012) incorporated short narratives alongside picture-viewing tasks to test the interpretation and production of structures like Elmo's sister's ball. Their findings consistently suggested that English-speaking children typically master two-level possessive recursion around the age of five.

This line of inquiry has been extended to other languages, providing a cross-linguistic perspective. Research on Japanese marks possession with a particle "の". Fujimori (2010) and other scholars (Terunuma et al., 2017, 2018) have used story-based questions containing two-level recursive possessives like (4a) and (4b) to test comprehension. Findings from Japanese indicate that children can reach adult-like comprehension of these structures around age of four, further highlighting potential cross-linguistic variation in developmental timelines.

(4a) Mika no otōto no kutsu wa nan iro desu ka
Mika-Poss brother-Poss boots is what color-Q
What color is Mika's brother's boots?

(4b) Ani-san no usagi no kasa wa nan iro desu ka
Brother-Poss rabbit-Poss umbrella is what color-Q
What color is brother's rabbit's umbrella?

Building upon this foundation, the academic field has also shown interest in the acquisition of recursive possessive structures in Mandarin. The experiments by Shi et al. (2019) and Giblin et al. (2019) utilized an elicited production task with a truth - value judgment component to explore the output of two level recursive possessive structures (5a). The findings supported the idea that children fully master this structure around the age of 4 in the early stage, thereby lending support to the Recursion Only Hypothesis.

Furthermore, the work of Li et al. (2020) provides critical theoretical insights into the mechanisms underlying the acquisition of recursion. In their study, they employed an elicited production task for Mandarin-speaking children. During a familiarization phase, experimenters described pictorial possessive relationships like (5b). This was followed by a test phase where children were prompted to produce recursive possessive recursions of increasing complexity (from one- to three-levels). Their key finding was that accuracy for two-level structures remained below 70% in children under six years old. Crucially, Li et al. (2020) move beyond this descriptive result to propose a theoretical model for how recursion is acquired. They posit a feature-driven computational mechanism whereby children do not merely imitate input but actively analyze and compute syntactic features from the linguistic data they encounter. They argue that the acquisition of recursive possessives is not just about recognizing a pattern but involves the computational isolation of the relevant syntactic category and its combinatory potential. This mechanism explains the gradual nature of acquisition, as children must accumulate sufficient evidence to solidify the abstract recursive rule. Their account offers a more formal and explanatory framework for understanding the developmental path, suggesting that acquisition is driven by the interaction between innate computational capacities (UG) and feature-based analysis of specific linguistic input. This perspective aligns with the broader goal of identifying the precise computational steps children take in mastering syntactic recursion.

(5a) hàidào de qīng wā de bǐng gān
pirate-Poss frog-Poss cookie
pirate's frog's cookies

(5b) Jīqìrén de shé de shīzi de bǐng gān
robot-Poss snake-Poss lion-Poss cookie
robot's snake's lion

Based on previous theoretical and empirical background, the development of embedded linguistic recursion in children is a vital field for understanding the nature of human language. A significant body of work in acquisition research has therefore involved category recursion sequences. Among these structures, the acquisition of recursive possessives is one of the most frequently studied problems. However, conclusions about its developmental trajectory have varied. For instance, while some studies point to mastery in four-year-olds (Giblin et al., 2019; Fujimori, 2010), others believed that it is acquired relatively late (Roberge et al., 2018). These divergent findings highlight the significant influence of experimental design (e.g., comprehension versus production tasks) and cross-linguistic factors. Thus, this study tries to investigate the acquisitive pathway of recursive possessives in Mandarin-speaking children and explore the factors underpinning the acquisition.

Furthermore, research examining whether the developmental trajectories of children's recursive computational mechanisms are consistent across typologically diverse languages remains limited. This gap echoes a fundamental question raised by Hollebrandse and Roeper (2014): do children from different linguistic backgrounds follow identical pathways in acquiring syntactic recursion. This question probes the interplay between innate cognitive capacities and language-specific input in shaping the development of hierarchical syntactic processing. If, as Chomsky (2002: 7) contends, "the course and character of language development in children living in disparate environments are largely determined by the initial state of the human brain," it becomes empirically imperative to compare acquisition studies across different languages, particularly concerning complex recursive structures.

In summary, prior studies have neither characterized age-related changes in the underlying processing mechanisms of recursion comprehensively nor extended their focus beyond children acquiring English or Japanese. Building upon the modified methodology of Terunuma et al. (2017), the current study aspires to extend the research on the acquisition of recursive possessives to ascertain the developmental timeline during which children grasp this structure and the trajectory of its acquisition. To accomplish these objectives, the study addresses the following three pivotal questions:

1. How does the accuracy with which Mandarin-speaking children comprehend two-level recursive possessive structures vary across the age range of 3 to 6 years?
2. What error patterns do children exhibit when processing these structures?

3. Do Mandarin-speaking children and children from other language backgrounds follow identical developmental trajectories in the acquisition of recursive computational mechanisms?

2. Methodology

The following sections describe the design and methodological components of our study.

2.1. Participants

One hundred and twenty-seven children in ages between 3 and 7 years participated in the experiment. One participant did not complete the session and was removed from the analysis. They were divided into four age groups: 3-year-olds (N = 30, M = 3;08, SD=0.17, range = 3;05 - 3;11), 4-year-olds (N = 35, M = 4;06, SD=0.28, range = 4;00 - 4;11), 5-year-olds (N=28, M = 5;05, SD=0.27, range = 5;01 - 5;11) and 6-year-olds (N = 34, M = 6;08, SD=0.25, range = 6;00 - 6;10). The children were recruited from a Kindergarten in Fujian Province. All of them were monolingual speakers of Mandarin. No participant had any history of speaking or hearing difficulties or cognitive impairment. Gender and socioeconomic status were not considered. Thirty adults aged 21 to 53 (M=25;05, SD=9.13) also participated in the study serving as control group.

2.2. Materials and procedures

We adapted the "answering a question while seeing a picture" designed by Terunuma et al. (2017) without story to investigate the children's comprehension of recursive possessives. The naming of the objects and characters were based on their original characters, which relieves memory burden. The participants' task was to answer a question while seeing a picture. The task targeted understanding of 4 two-level recursive possession (6) with 5 nominal recursion questions (e.g. The second green car misses tires, is that right?) as fillers to avoid familiar effect. The experiment consists of two stages, pre-test and test-phase. In the pre-test stage, the experimenter showed the participants the objects and characters that would appear separately without involving possessive relationships, so as to prevent the participants from not knowing the objects in the experiment topics during the experiment. There is no pre-test phase for adult.

(6) 2-POSS

jiějie-de	tùzi-de	qiú	shì	shénme	yán sè?
sister-Poss	rabbit-Poss	ball	is	what-Q	color

What color is the girl's rabbit's ball?

The comprehension of two-level recursive possessives was assessed using the "answering a question while seeing a picture" task accompanied by auditory prompts. During the test phase, participants were presented with a series of trials on a computer screen. Each trial consisted of a visually displayed image depicting multiple entities in a possessive relationship, paired with a pre-recorded auditory question played The prompting voice of the test questions was made by AI (CapCut 5.2.0), and each question was

played twice, and the participants were asked to answer after listening to the question twice. For example, for Figure 2, the question is "What color is the girl's rabbit's ball?" After the question was played twice, the participants required to answer the question.



Figure 2. Sample picture for 2-POSS

Since it has been reported that there is possibility that children often drop one of the recursive phrases or make conjunctive response in their comprehension of recursive structures (Gentile 2003; Limbach & Adone, 2010), we took into consideration possible conjunctive and dropping interpretations of the target sentences when we design entities in the pictures. The task was designed to evaluate the interpretation of two-level recursive noun phrases (e.g., the girl's rabbit's ball). Each test image contained referents that allowed for the differentiation between target recursive interpretations and known non-adult-like parsing strategies commonly reported in the literature, such as conjunction (e.g., interpreting "the girl's rabbit's ball" as referring to "the girl's ball and the rabbit's ball") or reduction (e.g., dropping one level of recursion, resulting in "the rabbit's ball" or "the girl's ball") .

There were 4 questions with two-level possessive recursion. To control for order effects, the presentation sequence was counterbalanced across participants: half received the trials in one order, and the other half in the reverse order. This applied to both child and adult participants.

Throughout the test phase, the experimenter provided neutral positive feedback (e.g., "Good job!") regardless of the accuracy of the response to maintain participant engagement. No corrective feedback was provided. Responses were recorded in two ways: digitally via a mobile phone or camera for subsequent verification, and in real-time by the experimenter using a structured scoring sheet. Each testing session was conducted individually in a quiet room and lasted approximately five minutes per participant.

2.3. Data coding

In the study, children's responses to the inquiry questions corresponding to each recursion type were meticulously transcribed and systematically categorized based on their accuracy and the nature of any errors. Upon the experiment's culmination, the researchers discerned a variability in the children's responses; some participants provided answers upon the initial posing of a question, whereas others either reiterated their previous responses or altered them when the question was reiterated. The experiment incorporated a lenient coding strategy, wherein participants were awarded a single point for a correct response, irrespective of whether it was their first or second attempt. Conversely, participants received zero points for two consecutive incorrect responses. Among the erroneous responses,

further classification was conducted into three categories: Conjunction (indicating the sequential interpretation of the two determiner phrases by the participants), Drop (denoting the omission of at least one genitive determiner phrase), and Other Interpretation (encompassing all other types of incorrect responses). Following the coding process, data analysis was conducted utilizing R studio (4.4.3) and the ensuing experimental outcomes are delineated in the subsequent sections.

3. Results

The independent factor in this study was age group (3-year-olds, 4-year-olds, 5-year-olds, 6-year-olds, and adults). The dependent factor was participants' accuracy scores, representing the number of correct responses out of 4 items on the two-level recursive possessive comprehension task.

Statistical analyses were performed using R software (version 4.4.3). Preliminary Shapiro-Wilk tests indicated that accuracy scores for all age groups significantly deviated from normality (all $p < .001$), justifying the use of non-parametric statistical methods. A Kruskal-Wallis test was first conducted to examine overall differences between age groups. Subsequently, post-hoc pairwise comparisons were performed using Dunn's test with Bonferroni correction for multiple comparisons. Effect sizes were calculated using both Cohen's d and effect size r ($r = Z/\sqrt{N}$, where Z is the Dunn test statistic and N is the total sample size), with 95% confidence intervals for effect size r computed using bootstrapping methods with 1000 iterations.

3.1. Analysis of targeted answers

Table 1 and Figure 3 present the distribution of response types across various age groups for tests involving recursive possessive constructions. Notably, the responses from the six-year-old children (87.5%) closely resembled those of adults. In contrast, the responses from the three-, four-, and five-year-old children significantly diverged from the adult responses.

The acquisition of recursive possessives by Mandarin-speaking children is characterized by a gradual developmental trajectory. As depicted in Figure 3, there is a discernible upward trend in the accuracy of responses for recursive possessives with increasing age, signifying a progressive mastery of these linguistic construct.

Table 1
Percentage of answers of recursive possession

	Recursion (Correct)	Conjunction (Error)	Drop (Error)	Other Interpretation (Error)
Adults(n=30)	99.17%	0%	0%	0.83%
year-old (n=34)	87.5%	2.94%	5.15%	4.41%
year-old (n=28)	75%	11.61%	5.36%	8.04%
year-old (n=34)	67.86%	7.14%	11.43%	13.57%
year-old (n=30)	65%	5.04%	14.28%	15.97%

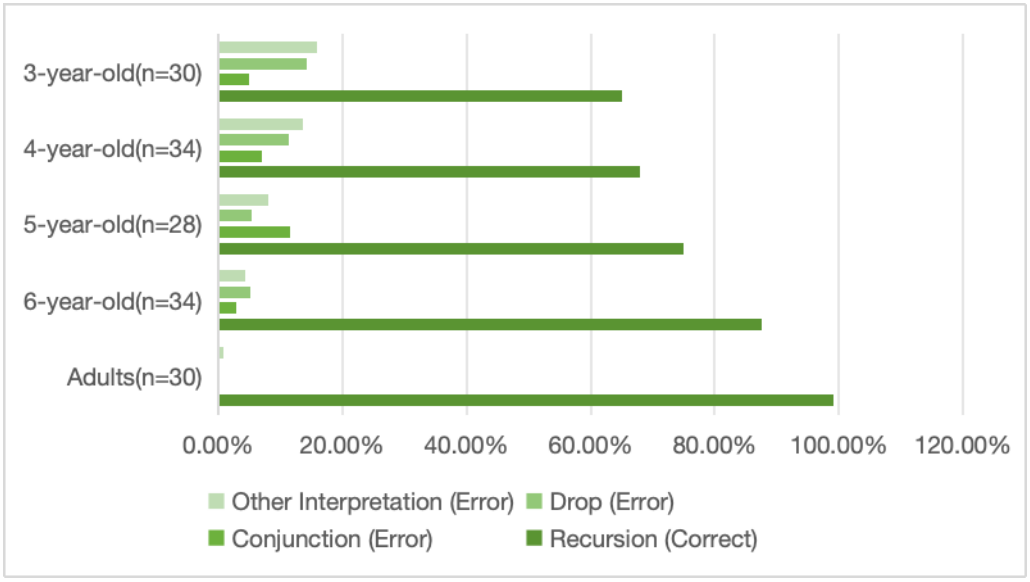


Figure 3. Correct percentage and incorrect percentage of answers

3.2. Comparison between children and adults

We, then, examined the difference between children and adults. Specifically, based on the mean accuracy score (out of 4 items) of different types (Table 2) and standard derivation, further analysis of the data was conducted in R studio (4.4.3) to shed light on characteristics in the process by which Mandarin-speaking children acquire recursive possessives.

Table 2
The mean value and standard derivation of the accuracy of recursive possessive

	Recursive Possession	
Age	Mean	S.D.
3 years(n=30)	2.60	1.22
4 years(n=34)	2.71	1.15
5 years(n=28)	3.00	1.09
6 years(n=34)	3.50	0.56
Adults(n=30)	3.97	0.18

Preliminary Shapiro-Wilk tests indicated that the accuracy scores for several age groups significantly deviated from normality (all $p < .05$), justifying the use of non-parametric statistical methods for subsequent analyses. Therefore, we used the Kruskal-Wallis test to compare the comprehension performance of five groups of participants (four groups of children aged 3 to 6 and the adult control group) in the two-level recursive possession test questions respectively.

In terms of the understanding performance of the two-level recursive structure, there was a certain difference in the number of correctly understood questions among the five groups of participants. A Kruskal-Wallis test revealed a significant main effect of age group on accuracy scores for recursive possessive structures, $H(4) = 36.36$, $p < .001$. Post-hoc pairwise

comparisons using Dunn's test with Bonferroni correction showed significant differences between several age groups. Post-hoc pairwise comparisons using Dunn's test with Bonferroni correction revealed significant differences in recursive possessive comprehension between all child groups and adults. Specifically, 3-year-olds performed significantly worse than adults ($Z = -5.15$, $p < .001$), with a large effect size (Cohen's $d = -1.52$; 95% CI [-2.12, -0.92]; effect size $r = -0.42$). Similarly, 4-year-olds showed significantly poorer performance compared to adults ($Z = -5.10$, $p < .001$; Cohen's $d = -1.47$; 95% CI [-2.04, -0.90]; effect size $r = -0.41$). Five-year-olds also demonstrated significantly lower accuracy than adults ($Z = -3.80$, $p = .001$; Cohen's $d = -1.21$; 95% CI [-1.79, -0.62]; effect size $r = -0.31$). While there is no difference between 6-year-olds and adults ($Z = -2.69$, $p = .072$), the effect size remained large (Cohen's $d = -1.11$; 95% CI [-1.66, -0.57]; effect size $r = -0.22$). These findings suggest that the recursive possessive structure had been acquired by the children at age of 6, whereas children younger than 6 did not acquire this type of structure. The large effect sizes between child and adult groups further indicate that complete mastery of these structures at the age of six, consistent with proposals that complex syntactic structures require extended developmental periods for full acquisition.

In conclusion, it is discovered that age does play a critical role in the comprehension of recursive possessives and is a key factor that affects children's language development, which can also be observed in other studies (e.g., Pérez-Leroux et al., 2012; Yang et al., 2022; Yang et al., 2023).

3.3. Comparison between children of different ages

Analysis of differences among child age groups revealed a more nuanced developmental pattern. No significant differences were found between any adjacent age groups after Bonferroni correction: 3-year-olds versus 4-year-olds ($Z = -0.25$, $p = 1.000$; Cohen's $d = -0.12$; effect size $r = -0.02$), 4-year-olds versus 5-year-olds ($Z = -1.06$, $p = 1.000$; Cohen's $d = -0.23$; effect size $r = -0.09$), and 5-year-olds versus 6-year-olds ($Z = -1.28$, $p = 1.000$; Cohen's $d = -0.53$; effect size $r = -0.10$). However, examination of effect sizes revealed meaningful patterns. Comparisons between non-adjacent age groups showed medium to large effects: 3-year-olds versus 6-year-olds demonstrated a large effect size (Cohen's $d = -0.90$; 95% CI [-1.44, -0.37]; effect size $r = -0.21$) with marginal statistical significance ($Z = -2.63$, $p = .086$). Similarly, 4-year-olds versus 6-year-olds showed a large effect size (Cohen's $d = -0.81$; 95% CI [-1.31, -0.30]; effect size $r = -0.20$) though not reaching statistical significance ($Z = -2.47$, $p = .134$). The comparison between 3-year-olds and 5-year-olds showed a small effect (Cohen's $d = -0.33$; effect size $r = -0.10$) that was not statistically significant ($Z = -1.26$, $p = 1.000$). This pattern suggests a gradual developmental progression in recursive possessive comprehension throughout early childhood, with substantial improvement occurring between non-adjacent age groups rather than between consecutive years.

The experimental data show that there is no significant difference between the adjacent two age groups in the acquisition of recursive possessive structure, but the significance increases with the increase of age gap, implying that only subtle changes happen within a period of one year. Combined with the above analysis of adult and child data, six years old is a

crucial time node for the acquisition of recursive possessive structure. More importantly, this finding clearly shows that children's linguistic output matures bit by bit and that language, in essence, is "an organ of the body, a mental organ" (Berwick & Chomsky, 2017:56). In other words, language acquisition is not an overnight process, but a gradual one.

3.4. Analysis of untargeted answers

Furthermore, the study's results, which include responses that diverge from the expected answers, underscore that children under the age of six have not yet internalized the two-level recursive structures. This difficulty in understanding is further evidenced by their inability to process two-level recursion with the ease observed in adults. The majority of the children's responses were structured around the topic but did not understand the anticipated syntactic structure. The responses can be categorized into three types: conjunction, dropping, and other interpretations. In the analysis of inaccurate responses, particular attention was given to the patterns of non-target interpretations, specifically focusing on conjunction and dropping errors.

Within the recursive possessive structure, the conjunction error accounted for 6.68% of the total non-target responses, while the drop error, characterized by the omission of at least one noun phrase, represented 9.06%.

Regarding "conjunction" errors, participants tend to understand the solution of the two-level recursive possessive structure as a semantic omission. This kind of interpretation needs to be achieved through the reanalysis of syntax and semantics. This way of understanding is actually an expansion and decomposition of the original sentence, regarding it as two independent ownership relationships. For instance, interpreting "the sister's rabbit's ball" as "the sister's (ball) and the rabbit's ball" is to avoid the recurrence of the ball, so the first "ball" that appears is omitted. In the experiment, the incidence of such errors escalated from 5.04% in 3-year-olds, peaking at 7.14% in 5-year-olds–a rate considerably higher than that of omissions during the same period–before declining to their lowest rate of 2.94% by the age of 6.

In the context of "dropping" errors, participants often omit a possessive structure during comprehension, perceiving the sentence as a single-layer recursive construct. For instance, they might interpret structures such as "[NP [PossP [NP sister] [Poss 's]] [N ball]] / the sister's ball" (Figure 4) or "[NP [PossP [NP rabbit] [Poss 's]] [N ball]] / the rabbit's ball" (Figure 5) as simplified, one-level recursion. This error type was particularly pronounced in 3-year-olds, constituting 14.28% of their responses. However, as children grow, the frequency of this error type diminishes significantly, dropping to merely 5.15% by the age of 6.

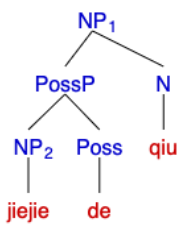


Figure 4. Dropping interpretation 1

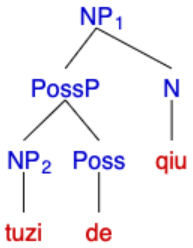


Figure 5. Dropping interpretation 2

4. Discussion

The primary objective of this investigation was to determine the developmental stage at which Mandarin-speaking children, aged 3 to 6, are capable of accurately comprehending two-level possessive recursive constructions. Utilizing the "answering a question while seeing a picture" methodology, the study revealed that the acquisition of such syntactic structures emerges around the age of six. In the experimental tasks, the proficiency of the six-year-old was evidenced by an accuracy rate of 87.5% on the test items (see Table 1), showing no significant difference compared to that of adult participants.

Meanwhile, the percentages of Mandarin-speaking children of each age group in Table 1 who correctly understood the structure of the two-level recursive possession were consistent with the results of post-hoc pairwise comparisons afterwards. The recursive ability of 3-year-old children is still in an unstable development stage, which is manifested in the fact that some children can answer questions correctly. The recursive ability of 4-year-old and 5-year-old children has further developed, which is manifested in that although there is no significant change compared with the previous age group, but the accuracy rate is improving. The 6-year-old child has fully reached the level of adult. In this sense, for research question 1: The accuracy of Mandarin-speaking children ' s comprehension of two-level recursive possessive structures increases steadily with age and children can fully acquire the two-level recursive possessive structure at the age of six. This is consistent with the results of some previous studies (Matthei 1982; Roeper 2007, 2011; Pérez-Leroux et al. 2012 ; Limbach et al., 2010; Yang et al., 2022; Yang, 2014; Roberge et al. 2018), in which children are not able to properly understand two-level or higher recursive structures until a relatively late stage of language development. Despite evidence that four-year-olds can comprehend and produce one-level recursive constructions(Shi et al., 2019; Giblin et al. 2019), the current study indicates that children do not grasp two-level recursion until they reach the age of six. As two-level recursion is considered the true hallmark of recursion, the mastery of this level is indicative of a child's full recursion capability (Roeper, 2011; Martins & Fitch, 2014). The experimental findings of this paper thus suggest a relatively late acquisition of recursion skills in children.

Furthermore, through the accuracy rate of children's understanding of the two-level recursive possessive, we can find that children need to go through an important stage to acquire this structure. When a 3-year-old child has already acquired one-level recursive ability (Shi et al., 2019; Mao et al. 2024), four-year-old children cannot fully acquire two-level recursive

structures. Children need to be at least six years old to acquire two-level recursive structures, that is, to truly master the recursive competence. Research has found that there are two distinct acquisition stages in the process of children acquiring recursive possessive structures: children acquire one-level recursive sequences at an earlier age (before the age of 3), but it takes a longer time, at a later age, to acquire two-level recursive sequences. The data in this paper support the view in previous studies that the acquisition of a one-level recursive sequence does not immediately trigger the re-invocation of the corresponding two-level recursive sequence (Pérez-Leroux et al., 2012; Hollebrandse et al., 2014; Yang et al., 2023). There is still a significant difference in the accuracy rate of understanding the two-level recursive possessive between four-year-old children and adults, while there is no significant difference in the understanding of this structure between six-year-old children and adults. This can indicate that children independently acquire one-level and two-level recursive sequences at different ages.

Our analysis revealed two primary error patterns in children's comprehension of two-level recursive possessive structures: (1) conjunctive interpretation errors, and (2) structural reduction errors through dropping of recursive elements. Consistent with previous literature, children in our study frequently misinterpreted recursive structures as conjunctive constructions. We found that 5.04%, 7.14%, and 11.61% of children aged 3, 4, and 5 years, respectively, interpreted recursive possessives as conjunctive structures. This pattern aligns with Matthei's (1982) finding that over 50% of 3- to 4-year-olds interpreted "the [second [green ball]]" as "the [second and green] ball," as well as Gentile's (2003) observation that approximately 33% of 3- to 4-year-olds interpreted "Cookie Monster's sister's picture" as "Cookie Monster's and sister's picture." The increasing prevalence of conjunctive interpretations with age in our data (from 5.04% to 11.61%) similarly corresponds with Limbach and Adone's (2010) findings of 9%, 17%, and 22% conjunctive interpretations among 3-, 4-, and 5-year-olds, respectively. The second predominant error pattern involved structural reduction through dropping of recursive elements. In our data, 14.28%, 11.34%, and 5.36% of children aged 3, 4, and 5 years, respectively, simplified two-level recursive structures to one-level constructions by dropping either the first or second possessive marker. This finding is consistent with Li et al. (2020), who reported that 26% and 11% of 4- and 6-year-olds, respectively, perceived two-level recursive sequences as one-level structures. Notably, we observed an inverse developmental relationship between these two error types: as children grew older, the percentage of dropping errors decreased while conjunctive interpretations increased. This pattern suggests distinct cognitive factors underlying these error patterns. The decreasing rate of structural reduction errors may reflect developing memory capacity that enables children to process longer syntactic structures without simplification. Conversely, the increasing prevalence of conjunctive interpretations may indicate children's developing sensitivity to structural relationships while still defaulting to cognitively less demanding conjunctive parsing strategies. These findings support Roeper's (2011:65) Acquisition Default hypothesis, which posits that children initially interpret recursive

structures as conjunctive constructions. However, our data further specify that this default strategy becomes more pronounced as children's cognitive capacities develop enough to attempt but not yet fully master recursive parsing, while simple structural reduction decreases with increasing processing capacity.

At this point, an inescapable and deeper question is why children's recursive language mechanisms develop periodically as the language operation mechanism gradually matures? According to Martins and Fitch (2014), a child's recursion ability is ascertained by their capacity to innovatively acquire two-level recursive structures that they have not previously encountered, based on their understanding of one-level internal recursion. The findings of this study indicate that while Mandarin-speaking children rapidly develop the ability to comprehend one-level recursive structures, they do not exhibit the creative capacity to grasp two-level recursion until around the age of 6. During the interval between ages 3 to 6, there is a notable increase in the number of children achieving two-level recursion proficiency with little relative input (Shi et al., 2019). This developmental trajectory of internal recursion aligns with the tenets of the Maturation Theory (Wexler, 2004), which posits that children's linguistic faculties, akin to other physiological systems, undergo a specific maturation process. In the maturation approach, development is determined primarily by internal factors that are controlled by genes. Developmental change is assumed to be based solely on a maturation blueprint; the actual sequence is invariant, but the rate is variable (Aylward, 2020). According to this perspective, recursion is an innate faculty that necessitates a gradual developmental trajectory and unfolds naturally at a predetermined stage, analogous to the natural timing of physiological milestones such as the eruption of permanent teeth around the age of 6. In this model, development depends entirely on neurological and physical maturation, and it proceeds in fixed sequences. The child is seen as an immature or incomplete organism that moves in predictable patterns of behavior during the course of continuous maturation. It is a linear model, with development seen as quantitative gains in competencies.

Additionally, by extending the language background of the children's participants and broadening the empirical evidence obtained from examining the recursive types and levels of language classes, it was found that there are indeed similarities in the development paths of recursive language mechanisms among children with different language backgrounds. From the perspective of theoretical exploration of language acquisition, the experimental results confirm that the development path of children's language mechanisms does indeed have a high degree of uniformity in a cross-language environment. This explanation answers research question three. Nevertheless, Mandarin-speaking children exhibit both a lower accuracy rate and a later developmental schedule in the comprehension of two-level recursive possessives than their Japanese- and English-speaking peers. The delay cannot be attributed to paucity of input simply for two-level recursive possessives are virtually unattested in Mandarin child-directed corpora (Shi et al., 2019). The differences in developmental timing can be attributed to language-specific characteristics that either alleviate or add to

the cognitive processing load required for parsing recursion. Japanese uses a single, invariant particle "の" to mark possession. This consistency provides a clear and reliable cue for the parser, likely facilitating earlier acquisition. English also has a dedicated possessive morpheme 's, though its phonetic variability (e.g., /s/, /z/, /ɪz/) might add slight complexity. Mandarin's possessive marker *De* is highly frequent but also homophonous with other functional uses (e.g., a relative clause marker). Furthermore, the potential for noun-noun compounds and the interaction with classifiers might create ambiguity, forcing children to rely more heavily on pragmatic and contextual cues, thereby prolonging the acquisition process.

5. Conclusion

This study investigates the developmental stages in the acquisition of recursive possessive structures by Mandarin-speaking children aged 3 to 6. Through the 'answering a question while seeing a picture' task, it was found that children achieve accurate comprehension of two-level possessive recursions around the age of six, with an accuracy rate nearing that of adults. The research underscores the underlying factors in language development and supports the theory that recursion is an innate faculty that unfolds gradually and the developmental trajectory of recursion is universal.

Funding acknowledgement: This work was supported by The National Social Science Fund of China [Grant Number: 23BYY170].

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Journal of Child Language Acquisition and Development – JCLAD
Vol: 13 Issue: 2 1288-1307, 2025
ISSN: 2148-1997

Bridging audiology and emergent literacy: SLP students' application of LING 6 sounds in early childhood education

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Received : 19.02.2025
Accepted : 13.08.2025
Published : 30.08.2025
DOI: https://doi.org/10.5281/zenodo.17115060

Abstract

This study investigates how online pre-master's speech-language pathology (SLP) students incorporate the LING 6 sounds (/mm/, /ah/, /s/, /sh/, /ee/, /oo/) into emergent literacy activities aimed at enhancing early childhood language acquisition and phonemic awareness. Twelve students in an introductory audiology course participated in pre- and post-surveys to assess their understanding and confidence in using these sounds to enhance early literacy development. The results showed a significant increase in both knowledge and confidence after students designed and presented multisensory literacy activities integrating auditory discrimination and phonemic awareness. While students effectively utilized multisensory strategies to reinforce auditory skills, they encountered challenges in adapting activities to the varying language development stages of children and managing classroom dynamics, which underscores the complexity of applying auditory training to support language development across developmental levels. These findings highlight the importance of experiential learning in bridging audiology and literacy development within SLP education. The study emphasizes the potential of integrating auditory training into early childhood education, with significant implications for children at risk for language delays or reading disorders. Recommendations include enhancing SLP curricula to focus on the practical application of auditory training, multisensory teaching strategies, and classroom management. The study also calls for future research exploring the long-term effects of integrating auditory training into early literacy development and its broader impact on children's literacy outcomes, particularly for those with hearing impairments or language delays.

Keywords: auditory training, speech-language pathology, emergent literacy, language development, education preparation

1. Introduction

Auditory discrimination and phonemic awareness are fundamental to early language acquisition and literacy development, both of which are central to speech-language pathology (SLP). Auditory discrimination—the ability to distinguish between different sounds—forms the foundation for phonological awareness, a key skill for recognizing sound-letter correspondence in emergent literacy. Research has consistently shown that auditory processing skills correlate with reading abilities, especially for children facing reading difficulties or developmental delays (Sadoussi et al., 2018). Phonemic awareness, as a critical subset of auditory discrimination,

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allows children to manipulate and identify sounds in spoken words, which is essential for decoding text and understanding the alphabetic principle (Melby-Lervåg et al., 2012). Interventions targeting phonemic awareness have been shown to significantly improve early literacy outcomes, including reading and spelling (Melby-Lervåg et al., 2012).

In the context of SLP, the LING 6 sounds—/mm/, /ah/, /s/, /sh/, /ee/, and /oo/—are commonly used to assess auditory discrimination and enhance phonemic awareness. These sounds span a range of frequencies and articulatory features, making them particularly useful for evaluating a child's ability to distinguish between sounds, especially in children with hearing impairments or speech disorders (Burigo, 2024). By helping children identify, segment, and blend sounds, the LING 6 sounds support phonemic awareness, a critical skill for emergent literacy. This manuscript explores how SLP students integrate the LING 6 sounds into early childhood education to bridge the gap between auditory discrimination and literacy development. Specifically, the study examines how these students incorporate multisensory approaches to promote phonemic awareness in young children. The research aims to contribute to improving therapeutic outcomes for children with auditory processing challenges and fill a gap in the literature regarding the integration of auditory discrimination tools in literacy interventions, especially in the early stages of language acquisition.

1.1. Literature Review

1.1.1. Theoretical Framework

Auditory discrimination and phonemic awareness are foundational cognitive skills critical for early literacy and language acquisition (Zahira, 2023). Phonemic awareness enables children to manipulate sounds in spoken words, supporting decoding, alphabetic understanding, and vocabulary growth (Melby-Lervåg et al., 2012). Theories such as Vygotsky's Sociocultural Theory and Piaget's Cognitive Development Theory emphasize how social interaction and cognitive maturation underpin language skills development (Hughes, 2021; Carlson et al., 2013). These frameworks highlight that phonemic awareness evolves through guided learning and cognitive readiness, underscoring the importance of early intervention for children with auditory processing difficulties.

1.1.2. LING 6 Sounds and Auditory Discrimination

The LING 6 sounds (/mm/, /ah/, /s/, /sh/, /ee/, /oo/) serve as an effective tool in audiology and SLP to assess and promote auditory discrimination, especially in children with hearing impairments or language delays (Burigo, 2024). Covering a broad frequency range, these sounds help evaluate children's sound differentiation abilities and support phonological awareness—key for literacy development (Alcock et al., 2017; Baker et al., 2010). Integrating LING 6 sounds into interventions facilitates early detection of auditory processing disorders and strengthens phonemic awareness.

1.1.3. Multisensory Strategies to Phonemic Awareness

Multisensory teaching—combining auditory, visual, and kinesthetic elements—enhances phonemic awareness and literacy development by engaging multiple cognitive pathways (Wilsenach, 2019; Patscheke et al., 2016). Activities such as sound sorting paired with visual aids or kinesthetic cues increase engagement and support children with auditory processing disorders (APD) or language delays (Melby-Lervåg et al., 2012; Clayton et al., 2019). This approach promotes deeper learning, aiding sound recognition and manipulation critical for literacy.

1.1.4. Integration of Audiology and Literacy in SLP Training

Effective SLP interventions depend on bridging audiology and literacy development, particularly for children with speech, language, or hearing difficulties (Boyes et al., 2017). Auditory processing training using tools like the LING 6 sounds can improve phonemic awareness, letter-sound correspondence, and word recognition (Shetake et al., 2011). SLP curricula that integrate audiology-based strategies better prepare students to address auditory barriers in literacy acquisition, enabling comprehensive support that fosters phonological skills and vocabulary growth (Burgoyne et al., 2019).

1.1.5. Emergent Literacy and Auditory Processing

Emergent literacy—early skills before formal reading and writing—strongly predicts later literacy success (Snow, 2010; Hulme et al., 2012). Phonemic awareness is central, aiding decoding and word recognition (Sénéchal et al., 2011). Children with hearing impairments or auditory processing challenges benefit from integrated auditory and phonemic awareness interventions, using tools like LING 6 sounds to develop foundational literacy skills (Zahira, 2023; Shetake et al., 2011).

1.1.6. The Role of SLP Students in Early Childhood Education

SLP students are vital to promoting early literacy development, especially for children with speech, language, and hearing difficulties. Their training, which integrates audiology and language development, equips them to provide targeted interventions for children with auditory processing challenges, thereby fostering emergent literacy skills. However, research suggests that many SLP students feel unprepared to incorporate audiology effectively into literacy interventions, particularly when it comes to phonemic awareness (Baker et al., 2010). To address this, SLP programs should emphasize the integration of audiology-based strategies within literacy instruction, ensuring that students gain practical experience with phonological awareness exercises, multisensory activities, and auditory discrimination tasks. SLP students who receive this comprehensive training are better prepared to design and implement effective interventions for children at risk for literacy difficulties, including those with auditory processing issues or language delays (Pieretti et al., 2014). By integrating audiology-based knowledge, SLP students can support the development of phonological skills, which are crucial for later language and literacy success.

1.1.7. Challenges and Strategies in Integrating Audiology into Literacy Interventions

Integrating auditory discrimination with phonemic awareness presents challenges, including adapting activities to diverse developmental stages and managing classroom dynamics (Landgraf et al., 2012; Drosos et al., 2024). Many SLP students feel underprepared for this integration, highlighting the need for experiential training such as mock sessions and clinical practice (Baker et al., 2010; Pieretti et al., 2014). Emphasizing multisensory, individualized instruction—such as scaffolding and differentiated teaching—can enhance intervention effectiveness, ensuring children with auditory processing challenges develop critical phonemic and literacy skills (Melby-Lervåg et al., 2012).

2. Methodology

2.1. Participants

The study involved twelve online students enrolled in an introductory audiology course, which is a prerequisite for the SLP program. Participants ranged in age from 22 to 60 years (M = 29). A purposive sampling method was employed to ensure a diverse representation in terms of ethnic backgrounds and language experiences. Specifically, 70% of participants identified as Hispanic, 20% as Asian, and 10% as Caucasian. A majority of the participants were non-native English speakers, offering a unique perspective on how language background may impact their experience with auditory processing and phonemic awareness tasks. Given the linguistic diversity, non-native speakers might encounter additional challenges, such as phonetic discrepancies between languages, affecting their auditory discrimination skills. Moreover, the students came from varied academic backgrounds, including linguistics, psychology, and education, which likely influenced their prior exposure to audiology concepts and their initial understanding of auditory processing. This variability in baseline knowledge was considered a relevant factor when evaluating how students engaged with the LING 6 sounds and integrated them into literacy activities.

2.2. Research Design

A pre-post design was employed to assess the impact of integrating LING 6 sounds into the participants' understanding of auditory processing and phonemic awareness. Initially, students completed a pre-implementation survey, designed to assess their baseline knowledge and confidence in applying the LING 6 sounds. Following this, students underwent an experiential learning process. This process included reviewing the LING 6 sounds, understanding their role in auditory training, and designing age-appropriate literacy activities incorporating these sounds. As part of this experiential learning, students then delivered mock teaching sessions to their peers, facilitating real-world application of the concepts learned. After the mock sessions, participants completed a post-implementation survey to assess shifts in their knowledge, confidence, and perceived challenges regarding the integration of LING 6 sounds in literacy activities. The design of the study allowed for the collection of both quantitative and qualitative data, which provided a comprehensive

understanding of how the students' engagement with the LING 6 sounds evolved over time.

2.3. Survey Design

Two surveys were developed for the study: one pre-implementation survey and one post-implementation survey. Both surveys included Likert-scale items ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) to assess participants' perceptions of their familiarity with and confidence in using the LING 6 sounds in literacy activities. The pre-implementation survey aimed to capture participants' initial knowledge of auditory processing concepts, as well as their confidence in applying these concepts to literacy instruction. For example, one item asked, "How familiar are you with the LING 6 sounds and their role in phonemic awareness?" Additionally, open-ended questions were included to capture qualitative insights, such as "What are your expectations for using the LING 6 sounds in your teaching?" These questions helped to assess anticipated challenges and expectations prior to the experiential learning process. The post-implementation survey mirrored the pre-survey but added questions to evaluate the students' experiences during the mock teaching sessions. For instance, participants were asked, "How confident do you feel using the LING 6 sounds in future literacy teaching?" and "What challenges did you encounter when designing or implementing your literacy activity?" Open-ended questions in the post-survey allowed for deeper reflections on the students' learning experiences, including the strategies they found most effective for engaging young learners with the LING 6 sounds.

2.4. Data Collection and Analysis

Both quantitative and qualitative data were collected via pre- and post-surveys. The quantitative data responses from the pre-established Likert-scale were analyzed to examine changes in students' familiarity and confidence levels with educational concepts related to auditory processing and phonemic awareness. To statistically assess the effect of the intervention, paired t-tests were conducted on the pre- and post-survey scores to determine whether the observed changes were statistically significant. Additionally, effect sizes (Cohen's d) were calculated to measure the magnitude of the intervention's impact. Change scores were also calculated by subtracting pre-survey responses from post-survey responses, providing insight into the direction and extent of change for each participant. To add an objective measure of learning and application, I observed students during their mock teaching sessions. These sessions were assessed using an informal rubric focused on instructional clarity, alignment with phonemic awareness goals, and use of auditory discrimination strategies. Observations provided insight into how effectively students translated theoretical understanding into practical teaching performance. The qualitative data from the open-ended survey questions were analyzed using thematic analysis (Merriam & Tisdell, 2016). I independently coded the data by identifying recurring themes and patterns in participants' responses, which provided an understanding of the challenges faced, the strategies that were most effective, and participants' overall perceptions of the learning

experience. Thematic analysis allowed for a nuanced exploration of the students' reflections on integrating auditory discrimination into literacy activities, revealing insights that were not captured through quantitative measures alone.

3. Findings

3.1. Student Understanding of the LING 6 Sounds (Pre-Implementation Survey)

The pre-implementation survey revealed that participants had moderate familiarity with the LING 6 sounds, with an average familiarity rating of 3.2 on a Likert scale from 1 (not familiar) to 5 (very familiar). This suggests that while students were somewhat aware of the sounds, they had limited in-depth understanding (see Table 1).

Table 1
LING 6 Understanding (Pre- vs Post-Implementation)

Survey Question	Pre-Implementation	Post-Implementation	Change (Δ)
Average familiarity with the LING 6 sounds	3.2	4.4	+1.2
Confidence in using the LING 6 sounds in literacy activities	2.9	4.2	+1.3

Note. In the qualitative responses, students generally recognized the LING 6 sounds but were unsure how to effectively integrate them into literacy activities. Common themes included confusion regarding the relationship between these sounds, auditory discrimination, and phonemic awareness in young children.

Several students indicated a basic awareness of the LING 6 sounds but expressed gaps in understanding how these sounds contribute to phonemic awareness and auditory discrimination. One student shared: *"I'm familiar with the LING 6 sounds in theory, but I'm unsure about how to incorporate them into activities for young children. I don't know how to make the connection between the sounds and phonemic awareness in a practical setting."* Another participant remarked: *"I know these sounds are important, but I feel like I haven't yet grasped how they can be applied to literacy, especially in children who have speech or hearing difficulties."*

These responses suggest that while students had a foundational understanding, they needed more concrete examples and hands-on experience to fully grasp the role of these sounds in early literacy development.

3.2. Engagement with Literacy Activities (Pre-Implementation Survey)

The pre-implementation survey also assessed students' confidence in incorporating the LING 6 sounds into literacy activities. On average, students rated their confidence at 2.9, indicating that most felt somewhat unprepared to apply these sounds in practical settings (see Table 2).

Table 2
Students' Confidence in Incorporating LING 6 Sounds in Literacy (Pre- vs Post-Implementation)

Survey Question	Pre-Implementation	Post-Implementation	Change (Δ)
Confidence in implementing auditory-based literacy activities	2.9	4.1	+1.2
Familiarity with designing literacy activities incorporating LING 6 sounds	2.8	4.0	+1.2

Note. Qualitative data revealed that while students had been exposed to literacy activities in prior coursework, they lacked experience in designing activities specifically to integrate auditory discrimination and the LING 6 sounds. Several students mentioned feeling unsure about how to connect the two concepts in practice.

Students expressed concerns and uncertainties in the pre-survey about linking auditory discrimination with literacy activities. One participant explained: *"While I've seen literacy activities before, I'm not sure how to link them with sound discrimination, especially for young learners. I've never considered how sound recognition could help children with reading and writing before."* Another commented: *"I've done some activities with letter-sound recognition in the past, but I've never thought about it from the perspective of auditory discrimination. I'm used to visual or tactile cues, so adding auditory components seems challenging."* These reflections underscore the unfamiliarity many students felt about integrating auditory and visual components in literacy activities, especially for young children or those with hearing impairments.

3.3. Changes in Understanding (Post-Implementation Survey)

Following the mock sessions, students reported a significant increase in their understanding of how the LING 6 sounds contribute to auditory processing and literacy development. The average rating of understanding increased to 4.4, indicating a high level of confidence and comprehension (see Table 3).

Table 3
Student Comprehension and Confidence in LING 6 (Pre- vs Post-Implementation)

Survey Question	Pre-Implementation	Post-Implementation	Change (Δ)
Understanding of how LING 6 sounds support literacy and phonemic awareness	3.2	4.4	+1.2
Confidence in using LING 6 sounds in future practice	3.3	4.5	+1.2

Note. Qualitative responses highlighted that students now understood the theoretical basis for integrating the LING 6 sounds into literacy activities. Many students noted that the mock sessions helped them see how these sounds can facilitate phonemic awareness and auditory discrimination in early literacy contexts.

Reflecting on their post-implementation experiences, students emphasized the practical benefits of using the LING 6 sounds in literacy activities. One student noted: *"I now understand that these sounds aren't just random—they are essential for building the foundations of reading and writing. Once I started using them in my activity, I saw how they helped children break down words into individual sounds, which is crucial for reading comprehension."* Another student added: *"I feel much more confident now in using these sounds with young learners. It's amazing how something as simple as repeating sounds can help them with phonemic awareness and eventually reading. It's like the 'sound-to-symbol' connection becomes much clearer."* These reflections suggest a deeper understanding of the connection between auditory training and literacy development, with students expressing eagerness to incorporate these methods into future practice.

3.4. Perceived Challenges and Adaptations (Post-Implementation Survey)

Despite the positive gains in understanding, participants faced several challenges during the implementation of their literacy activities (see Table 4). The most common difficulties were designing age-appropriate activities and engaging young children in auditory discrimination tasks.

Table 4
Student Challenges and Adaptations (Pre- vs Post-Implementation)

Survey Question	Post-Implementation
Challenges in implementing LING 6 sounds effectively	58% reported challenges related to engaging children and designing activities suited to developmental levels.
Adaptations made during implementation	65% adapted activities by using visual or kinesthetic cues and incorporating games and songs to maintain engagement.

Note. Qualitative responses indicated that preschoolers, in particular, struggled to distinguish the LING 6 sounds. To address this, many students incorporated multisensory strategies, such as using visual aids or body movements to reinforce the sounds, helping to engage children more effectively.

A significant portion of students (58%) reported that young children had difficulty distinguishing between similar sounds, leading to frustration. Many adapted their activities by integrating multisensory strategies. For example, one student explained: *"At first, the children couldn't differentiate between the sounds. I had to slow down and use hand motions or visual aids like pictures to help them understand. Incorporating physical movements like clapping along with the sounds seemed to make a difference."*

Another student noted: *"One challenge was engaging children who were distracted easily. To hold their attention, I used songs and rhymes that involved the LING 6 sounds. This kept them more focused, and they were more*

motivated to participate." These responses highlight the importance of multimodal teaching strategies in overcoming developmental challenges, especially when working with young learners or children with language delays.

3.5. Reflections and Suggestions for Improvement (Post-Implementation Survey)

Overall, students reported that integrating the LING 6 sounds into literacy activities enhanced their understanding of auditory processing and phonemic awareness (see Table 5). However, they also suggested several areas for improvement.

Table 5
Student Perceptions of LING 6 and Literacy Activity (Post-Implementation)

Survey Question	Post-Implementation
Reflections on effectiveness of activities	75% of students felt that integrating the LING 6 sounds into literacy activities improved their understanding of both auditory processing and phonemic awareness.
Suggestions for improvement	58% suggested adding more interactive and game-based elements, while 42% emphasized the need for more training on behavior management and meeting diverse learning needs.

Note. Students highlighted the importance of repetition and active engagement to reinforce the LING 6 sounds. Several also expressed a desire for more resources or training on creating individualized interventions to address the diverse learning styles and needs of young children.

One student remarked: *"The activities were effective, but I think we could make them even more engaging with more games and fun challenges. Something like a sound-matching game or a musical activity would help the kids stay focused and make learning feel less like a lesson and more like play."* Another student shared: *"I think the activity was great, but I felt a bit unprepared to handle some of the more challenging behavior that came up during the mock session. More training on behavior management or handling disruptions would be really helpful for future sessions."* These reflections underscore the need for additional training in classroom management and differentiated instruction, especially for students who may work with children facing behavioral or developmental challenges.

4.6 Observed Teaching Performance During Mock Sessions

In addition to survey responses, students were observed during their mock teaching sessions to assess their ability to apply auditory processing concepts in practice. Observations were guided by an informal rubric focused on three key areas: (1) instructional clarity, (2) alignment with phonemic awareness goals, and (3) effective use of auditory discrimination strategies. Overall, students demonstrated increased confidence and competence in applying the LING 6 sounds within literacy activities. Most participants successfully designed and delivered developmentally appropriate lessons that integrated auditory discrimination in engaging ways. Notably, 83% of students incorporated at least one multisensory

strategy (e.g., visual aids, gestures, songs) to support children's engagement and understanding.

Table 6
Observed Teaching Practices During Mock Sessions

Observed Behavior	% of Students Demonstrating
Clear articulation of LING 6 Sounds	91%
Integration of auditory discrimination tasks	87%
Use of multisensory supports (Visual/kinesthetic)	83%
Alignment with phonemic awareness goals	79%
Responsiveness to student engagement needs	74%

Students who initially reported low confidence in pre-surveys showed notable growth in their ability to design and implement effective lessons. For example, one student who had previously expressed uncertainty about using the LING 6 sounds was observed using interactive sound games and visual cues to help children identify and produce target sounds. In field notes, common strengths included thoughtful sequencing of activities, the use of repetition to reinforce key sounds, and flexibility in adapting instruction based on children's responses. Challenges primarily involved classroom management and maintaining attention, which mirrored students' own reflections in post-surveys. These observational findings triangulate the self-reported data and provide objective evidence that the intervention supported not only conceptual understanding but also practical teaching competence.

4.7 Summary of Statistical Findings

To complement the qualitative findings, paired-sample t-tests were conducted to determine whether the observed changes in students' understanding, confidence, and application of the LING 6 sounds were statistically significant. Results showed significant increases across all six survey items from pre- to post-implementation, with all effect sizes in the large range (see Table 7).

Table 7
Paired-Sample t-Test Results for Pre- and Post-Survey Scores (n = 12)

Survey Item	*t*(11)	*p*	Cohen's *d*
Familiarity with LING 6 sounds	4.27	< .01	1.23
Confidence using LING 6 in literacy activities	4.56	< .001	1.32
Implementing auditory-based literacy activities	4.12	< .01	1.19
Designing literacy activities with LING 6 sounds	4.05	< .01	1.17
Understanding LING 6's role in phonemic awareness	4.34	< .01	1.25
Confidence in future use of LING 6	4.47	< .01	1.29

Note. All tests were two-tailed. Cohen's d values ≥ 0.8 represent large effect sizes.

These statistical results triangulate the qualitative and observational data, providing strong evidence that the intervention was effective in

improving students' conceptual understanding and teaching application of auditory discrimination strategies in literacy development.

4. Discussion

This study underscores the critical role of integrating audiology-based auditory training—specifically the LING 6 sounds—into early literacy interventions for SLP students. By exploring students' understanding and application of auditory discrimination in literacy tasks, the findings illuminate how bridging auditory processing and phonological awareness enriches SLP education and ultimately enhances early language development outcomes. Rather than focusing on general literacy theories, this research highlights a practical and underexplored intersection where targeted auditory training strengthens foundational literacy skills.

4.1. SLP's Unique Impact Through Audiology-Literacy Integration

A key insight is that hands-on experience with the LING 6 sounds significantly improves SLP students' confidence and competence in applying auditory discrimination to literacy tasks. This integration equips future clinicians with the tools to address auditory processing challenges that often underlie reading difficulties, especially in children with hearing impairments or language delays. The findings emphasize that auditory discrimination is not a peripheral skill but a central element in phonemic awareness development—a critical bridge connecting audiology and literacy that has been insufficiently addressed in SLP training programs. By embedding audiological principles into literacy instruction, SLP students are better prepared to implement evidence-based interventions that support decoding, phonological skills, and early reading success.

4.2. Addressing Practical Challenges in Developmentally Appropriate Auditory Training

While the study confirms the benefits of integrating auditory discrimination into literacy education, it also reveals challenges in adapting activities to children's developmental stages. Designing auditory tasks that are both accessible and engaging for preschool-aged learners requires careful scaffolding—a process supported by multisensory strategies. These challenges highlight the necessity for SLP training to emphasize not only the theoretical importance of auditory-linguistic integration but also the practical skills to tailor interventions to diverse developmental levels. Multisensory approaches that combine auditory input with visual and kinesthetic cues are essential to making auditory training meaningful and effective, reinforcing the unique contribution of audiology-informed literacy education.

4.3. Theoretical and Practical Implications of Bridging Audiology and Literacy

This research contributes to theoretical models of language acquisition by illustrating how auditory discrimination training using the LING 6 sounds directly facilitates phonological awareness, an indispensable literacy precursor. Unlike approaches focusing solely on visual or tactile phonemic

awareness techniques, this study positions auditory input as a foundational and active component in early literacy development. The practical implications are profound: incorporating audiological tools into literacy curricula enhances SLP students' readiness to address real-world challenges faced by children with auditory processing issues. Experiential learning methods—such as mock teaching sessions—demonstrated that students can effectively translate this integrated knowledge into instructional practice, improving literacy outcomes through enhanced auditory discrimination.

5. Implications

This study offers valuable insights with broad implications for fields beyond SLP education, extending to early childhood education, parent training, and public policy, particularly for children with hearing impairments or those at risk for language and literacy delays. Integrating the LING 6 sounds into literacy activities is essential not only for training future SLPs but also for improving early childhood education and intervention programs. This research underscores the pivotal role that developing auditory processing and phonemic awareness plays in fostering early literacy development, particularly for children at risk for reading disorders, language delays, or speech impairments. The inclusion of these auditory skills in SLP training enhances the ability of future clinicians to collaborate more effectively with early childhood educators, promoting multisensory, evidence-based approaches to language learning. These approaches are particularly beneficial for children facing challenges in phonemic awareness, a key predictor of later reading success.

5.1. Implications for Early Childhood Education and Intervention

This study advocates for the integration of auditory discrimination training, such as the use of LING 6 sounds, into early childhood education and intervention programs. Developing these skills in young children—particularly those with developmental language delays or hearing impairments—supports their ability to decode, understand, and produce sounds, forming the foundation for literacy development. Preschool programs that prioritize both auditory processing and phonemic awareness offer a comprehensive framework for nurturing foundational literacy skills. These programs can play a crucial role in equipping children with the cognitive tools they need to bridge gaps in early literacy, ultimately supporting positive academic trajectories. The findings suggest that early and consistent exposure to auditory-based literacy tasks will better prepare children to tackle later literacy challenges, making early intervention a critical step in preventing language and reading delays.

While this study focuses on early childhood education, it's also important to recognize the relevance of auditory discrimination training at the elementary school level. Many children who have not had sufficient early intervention may still face challenges in phonemic awareness and literacy development. Incorporating auditory training at the elementary level, especially for children who struggle with reading, could provide them with the skills necessary to catch up and succeed academically. These interventions can bridge the gap for students who continue to face literacy

challenges as they grow older, underscoring the importance of integrating auditory discrimination activities into curricula at various stages of learning.

5.2. Implications for Parent Training and Involvement

The study also holds significant implications for parent training. By educating parents about the connection between auditory discrimination and literacy development, they can become active participants in their child's language growth. Parents trained in techniques that incorporate the LING 6 sounds into daily routines can reinforce auditory learning outside of formal educational settings, providing a rich, supportive home environment for literacy development. For example, parents can integrate the LING 6 sounds into everyday activities such as reading aloud, singing songs, or even playing simple auditory games that focus on differentiating sounds. By embedding these exercises in natural, fun contexts, parents can help solidify the phonemic skills their children need while creating a more interactive learning environment. Parental involvement has long been recognized as a key factor in boosting children's phonemic awareness and early literacy skills (Weihing et al., 2015). As parents gain a deeper understanding of auditory processing and its role in language acquisition, they can become proactive in addressing potential delays, ensuring that children with language or reading risks receive the early support they need to thrive. Parent education initiatives, therefore, can have a profound effect on children's linguistic development, and ultimately, their academic success.

5.3. Policy Implications for Early Literacy Frameworks

At the policy level, this study calls for the inclusion of auditory training—including activities like those using LING 6 sounds—as a foundational element in early childhood education programs. The research supports the argument for integrating auditory discrimination into national early literacy frameworks, especially for children at risk for hearing impairments, language delays, or reading difficulties. Evidence-based interventions that combine auditory discrimination training with phonemic awareness can provide lasting benefits for children, particularly those with developmental delays, and should be prioritized in public policy to ensure that all children have access to high-quality, multisensory educational interventions. These policies should also emphasize the need for early screenings and targeted interventions that identify children at risk for literacy challenges, ensuring that these children receive timely support and services to prevent long-term academic struggles.

5.4. Long-Term Benefits of Early Auditory and Phonemic Awareness Interventions

Beyond immediate academic benefits, integrating auditory discrimination and phonemic awareness into early childhood education holds significant long-term advantages for language development and reading outcomes. These foundational skills—critical for decoding, reading comprehension, and fluency—are closely linked to later literacy success. Research consistently shows that early interventions targeting phonological skills, such as phonemic awareness and auditory discrimination, can have a

profound impact on children's academic trajectories, especially those at risk for reading disorders, speech delays, or hearing impairments (Landgraf et al., 2012; Burgio, 2024). For children with hearing loss, early auditory training is crucial in bridging the phonemic awareness gap, helping them catch up with their typically developing peers. Likewise, children with language delays or dyslexia benefit from interventions focused on phonemic awareness, as difficulties with sound identification can impede reading and writing progress (Baker et al., 2010). Furthermore, early exposure to auditory and phonemic skills has been shown to predict later reading success (National Reading Panel & National Institute of Child Health and Human Development, 2000). The findings of this study suggest that the integration of LING 6 sounds into literacy activities is particularly important for children who are at risk of falling behind in phonological processing skills. Longitudinal studies could further substantiate the lasting impact of auditory discrimination training by tracking the reading and writing progress of children who receive early interventions compared to those who do not, thus providing further evidence of the long-term benefits of early auditory training in improving literacy outcomes.

5.5. Practical Strategies for Overcoming Barriers

Building on the challenges identified in this study, several practical strategies can support educators, clinicians, and students in overcoming barriers related to developmental adaptation and linguistic diversity:

(1) Developmentally Tailored Activities: To address difficulties in adapting auditory discrimination tasks for young children, educators should employ multisensory, age-appropriate strategies that align with children's cognitive stages. For example, incorporating songs, movement, and visual aids alongside the LING 6 sounds can make abstract auditory tasks more concrete and engaging. Scaffolding activities within the child's Zone of Proximal Development ensures that tasks are challenging yet achievable, supporting sustained attention and learning.

(2) Resources for Non-Native Speakers: Given the varied linguistic backgrounds of both SLP students and the children they serve, providing additional language supports is essential. These may include phoneme-specific pronunciation guides, culturally relevant examples, and bilingual materials that familiarize learners with the LING 6 sounds in diverse language contexts. Language exposure activities and explicit instruction on sound contrasts common in different languages can enhance auditory discrimination skills for non-native speakers.

(3) Behavioral and Classroom Management Strategies: Incorporating training in behavior management within SLP curricula can equip students to better handle common classroom challenges encountered during auditory training activities. Using positive reinforcement, structured routines, and interactive games can improve engagement and reduce frustration, particularly with young or developmentally diverse learners.

(4) Collaborative Learning and Peer Support: Encouraging collaboration among students in planning, delivering, and reflecting on auditory training activities fosters peer learning and mutual support. This collaborative approach can also help generate creative solutions to practical barriers, such as developmental adaptation and linguistic diversity.

Implementing these strategies can enhance the effectiveness of auditory discrimination interventions and support more inclusive, developmentally appropriate literacy instruction for diverse learners.

6. Limitations

While this study provides valuable insights into the integration of auditory skills—specifically the LING 6 sounds—into early literacy activities for SLP students, several limitations must be acknowledged.

6.1. Sample Size and Generalizability

A primary limitation of the study is the relatively small sample size (n = 12), which limits the generalizability of the findings to the broader SLP student population. While the sample was diverse in terms of ethnic background, age, and prior academic experience, a larger cohort would provide more robust data and increase confidence in the broader applicability of the results. Furthermore, linguistic background—especially for participants with non-native or diverse linguistic experiences—could have influenced how they engaged with the LING 6 sounds. Students from different linguistic backgrounds may have varied levels of familiarity with certain phonemic distinctions, affecting their ability to apply auditory training effectively. This introduces variability in their responses, which may limit the extent to which the findings can be generalized across populations with different language proficiencies or cultural backgrounds. Future studies could address this limitation by including a larger and more linguistically diverse sample, thereby enhancing the external validity of the findings and providing a more representative view of how SLP students from various linguistic backgrounds engage with auditory training.

6.2. Short-Term vs Long-Term Effects

Another limitation is the study's focus on short-term changes in students' understanding and confidence. The study primarily used pre- and post-implementation surveys to assess the immediate impact of integrating the LING 6 sounds into literacy activities. While these measures provided valuable insights into students' gains in knowledge and confidence, they do not assess the long-term impact of these interventions on students' clinical competencies or their effectiveness in real-world settings. Additionally, the study did not measure the long-term effects on children's literacy development—a critical component in evaluating the broader implications of auditory training for young learners. Future research could extend the timeline of assessments to capture both the sustainability of student learning and the lasting impact of early auditory interventions on children's language and literacy outcomes. Longitudinal studies could track not only

the evolution of SLP students' skills over time but also how children who participate in auditory training programs progress in their literacy development. By following these students and children beyond the intervention, researchers could provide deeper insights into the effectiveness of integrating auditory discrimination training over the long term and its ultimate impact on children's literacy trajectories.

6.3. Self-Report Data and Response Bias

The reliance on self-reported data from surveys, including Likert scale ratings and open-ended questions, introduces the possibility of response bias. Participants may have been influenced by social desirability, providing answers they believed were expected by the researchers, or they may have found it challenging to accurately reflect on their own experiences. Although qualitative data provided useful context and insights into students' experiences, the limitations of self-report data mean that these accounts may not fully capture the complexities of their learning processes or the specific challenges they faced during the integration of auditory training into literacy tasks. Future research could address this limitation by employing observational methods, such as ethnographic observation, case studies, or video analysis. These approaches would allow researchers to gather data in real-time, providing richer insights into the learning environment and participants' interactions with both the LING 6 sounds and children. Structured interviews, coupled with these observational methods, could also offer a more nuanced understanding of students' experiences and challenges. Triangulating data from multiple sources would help minimize bias and enhance the credibility of the findings.

6.4. Duration of the Intervention

The study's relatively short duration—limited to a series of mock sessions—restricted the scope of its findings. While students reported increased confidence and understanding of the LING 6 sounds and their application in literacy activities, the short-term nature of the intervention did not allow for an assessment of whether the skills acquired were retained and effectively applied in real-world clinical or educational settings. Future studies could extend the duration of the intervention to assess how well these auditory training skills are maintained over time and whether they translate into long-term improvements in clinical practice and literacy outcomes for children. Longitudinal studies could also examine how skills learned in controlled academic settings are transferred to clinical placements or professional environments, offering a more nuanced understanding of how well these skills integrate into SLP curricula and early childhood education frameworks.

6.5. Impact on Curriculum Development

Future research could explore how auditory discrimination training can be embedded in SLP curricula or early childhood education programs, assessing its effectiveness over time. Exploring the integration of auditory training techniques such as the LING 6 sounds within educational frameworks could provide evidence to support more widespread adoption of

these methods. Curriculum evaluations could focus on how effectively such training influences students' clinical practices and improves literacy outcomes for children, particularly those at risk for speech, language, or literacy delays. By examining how these strategies can be institutionalized in educational settings, future studies could highlight best practices for embedding auditory discrimination and phonemic awareness training into professional development programs, potentially leading to policy changes that prioritize these skills in early childhood and special education curricula.

6.6. Unexamined Variables and Critical Reflections

This study did not specifically examine how students' linguistic backgrounds influenced their engagement with and understanding of the LING 6 sounds. Given that phonemic perception and auditory discrimination can vary depending on one's native language or dialect, this represents a notable gap. Future research should more closely investigate how linguistic diversity impacts students' ease or difficulty with auditory training to tailor interventions more effectively. Additionally, while the study highlights significant gains in student understanding and confidence, it places less emphasis on aspects that did not work or areas of struggle. A more critical discussion of these challenges—such as which instructional strategies were less effective, or what specific components of the activities posed persistent difficulties—would provide a more balanced and nuanced perspective. Addressing these limitations openly can help refine teaching approaches and better prepare SLP students for the complexities of real-world clinical practice.

6.7. Classroom Management and Behavior Training Needs

This study identified classroom management as a notable challenge for many participants during the implementation of literacy activities incorporating the LING 6 sounds. However, it did not explore in depth the specific behavioral issues encountered or how SLP curricula might better prepare students to manage these challenges effectively. Given that behavior management is critical for maintaining engagement and delivering effective interventions with young children, future research should investigate how training in behavioral strategies can be integrated into SLP education. This would enable students to handle diverse classroom dynamics and support learning outcomes more efficiently.

7. Conclusion

This study explored how online pre-master's SLP students integrate the LING 6 sounds into literacy activities, underscoring the critical role of auditory training in early literacy development. The findings provide several significant insights. First, students began the study with a moderate understanding of the LING 6 sounds, but through hands-on engagement in designing and implementing literacy activities, their knowledge and confidence grew considerably. This demonstrates the effectiveness of experiential learning, bridging the gap between theoretical knowledge and its real-world application. Second, while students made notable progress in incorporating the LING 6 sounds into literacy activities, they faced

challenges in adapting these tasks to different developmental stages and ensuring sustained engagement among young children. These challenges emphasize the importance of multisensory, interactive, and age-appropriate strategies, particularly in the context of early literacy development. The adaptations students made—such as using visual cues, songs, and kinesthetic activities—highlight the value of a multimodal approach, which is essential for working with young children or those with diverse learning needs. This aligns with constructivist theories of language acquisition, which advocate for language learning that is rooted in rich, sensory experiences appropriate for the child's developmental stage (Vygotsky, 1978; Piaget, 1952).

The significance of these findings lies in their demonstration of how SLP students can bridge the fields of audiology and literacy through innovative teaching practices. By enhancing students' understanding of the vital role auditory discrimination plays in early literacy development, SLP programs can better prepare future clinicians to implement evidence-based strategies that promote phonemic awareness and reading skills. This study strongly advocates for the inclusion of hands-on learning experiences in SLP education, particularly those that combine both auditory training and literacy development, to prepare students for effective support of children's language and literacy growth. In conclusion, this study reinforces the essential role that SLP students can play in linking audiology and literacy development. As future clinicians, SLPs have a unique opportunity to integrate auditory and linguistic skills in innovative ways, ensuring that all children—especially those at risk for language delays—develop strong foundational skills for reading and communication. By refining SLP curricula to prioritize experiential learning, multimodal teaching strategies, and a focus on early auditory and literacy development, SLP programs can more effectively equip students to address the complexities of auditory processing and literacy acquisition. Ultimately, these efforts will enable SLPs to make a lasting impact on the literacy and language skills of the children they serve, contributing to improved outcomes, particularly for those at risk of language and literacy delays.

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