

Spatial Language Development in Preschool Mandarin-Speaking Children with Hearing Loss

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Abstract

This study compares preschool children with hearing loss (HI) and typically developing (TD) peers in Mandarin spatial language, focusing on motion expressions. Using a picture-book elicitation task, we transcribed children's narratives and derived three measures: motion-clause productivity, clause packaging, and motion-verb diversity. A staged separation emerged across ages four to six. TD children consistently produced more motion clauses. Syntactically, SVCs remained the default for TD children, whereas HI children showed a gradual decline in SVC use with age — evidence of weaker consolidation of this Mandarin-specific pattern as discourse demands increased. Lexically, the groups appeared similar early on but diverged by the end of the preschool window, with TD children displaying a broader and more differentiated motion-verb repertoire. Overall, HI children demonstrated early access to the relevant forms but slower consolidation, identifying clear targets for monitoring and support.

Keywords

Mandarin-speaking children with hearing loss; Spatial language; Serial verb constructions (SVCs); Clause packaging; Motion-verb diversity.

1. Introduction

Spatial language offers a clear window on how cognition, perception, and grammar interact. Although spatial understanding draws on universal embodied experience such as the perception of direction, gravity, and movement, languages differ strikingly in how they package these meanings (Talmy, 2000; Slobin, 2004). This raises a basic developmental question: do children primarily follow general cognitive determinants, or do they adapt early to language-specific grammatical patterns?

Within spatial language, a central domain is how speakers express motion, that is, how movement, direction, and change of location are encoded in clauses and narratives. Mandarin Chinese provides a clear test case because it relies heavily on serial verb constructions (SVCs) to express motion. These constructions license both manner-path or path-path sequences and are pervasive in adult and child speech (e.g., tiào-jìn “jump-enter”, diào-xià-lái “fall-down-come”) (Chen, 2005; Wen & Shan, 2021). By chaining two or more verbs within a single clause, speakers can compactly encode figure, path, manner, and cause. Prior work shows that hearing Mandarin-acquiring children use SVCs early, with productive use around age three (Ji & Hohenstein, 2018).

What remains unclear is whether children with hearing impairment — despite early cochlear implantation or hearing-aid fitting — take up these motion-specific patterns to the same extent as their hearing peers. Much of the literature on hearing loss emphasizes global outcomes,

domain-general morphosyntactic accuracy, or rehabilitation measures (Connor et al., 2006; Wake et al., 2005; Geer et al., 2016; Yoshinaga-Itano et al., 2018), with comparatively few studies specifically on motion expressions. In Mandarin, commonly used assessments (e.g., omnibus scores, sentence repetition) do not directly capture how children package motion in clause structure or how they build a motion-verb repertoire. As a result, it is not well established whether children with hearing loss deploy SVCs at rates typical for the language or whether they develop a comparably rich set of motion verbs.

To address this gap, the present study asks whether Mandarin-speaking children with hearing loss take up the language-specific pattern for describing motion to the same extent as their hearing peers. We focus on three observable outcomes in elicited production: (i) productivity of motion clauses, (ii) clause packaging for motion — single-verb versus SVCs, and (iii) lexical diversity of motion verbs. Using a cross-sectional design at ages four, five, and six, we examine whether group differences emerge on these measures and how each develops with age within each group. Our aim is not only to test for a potential lag in children with hearing loss relative to their hearing peers, but also to characterize age-related development in motion-clause productivity, clause packaging, and verb diversity in Mandarin motion expression.

2. Methodology

2.1. Participants

The study adopted a cross-sectional design with two groups of monolingual Mandarin-speaking children: a typically developing group (TD) and a group of children with hearing loss (HI). All HI participants met WHO (2021) criteria for severe (65–79 dB HL) or profound (80–94 dB HL) bilateral sensorineural hearing loss. To ensure comparable access to auditory input during early acquisition, only children who received cochlear implantation or digital hearing aids before 24 months were included. Children with additional developmental, neurological, or cognitive diagnoses were excluded. The HI group comprised 23 children recruited from rehabilitation centers: 8 four-year-olds, 5 five-year-olds, and 10 six-year-olds. The TD group comprised 30 children with normal hearing thresholds from mainstream kindergartens in the same urban region, with 10 children in each age bracket, aged four, five and six. All participants were native speakers of Mandarin and came from broadly comparable socioeconomic backgrounds. Written informed consent was obtained from parents or legal guardians prior to participation.

2.2. Materials

Narratives were elicited with a picture book that contains rich and sequential depictions of motion such as running out of a house, climbing trees, and jumping from high places. The continuous storyline naturally evokes path, manner, and causal links, making it suitable for analyzing SVCs. All children viewed the same printed edition in a fixed page order and received no additional verbal or visual prompts.

2.3. Procedure

Children were tested individually in a quiet room at their kindergarten or rehabilitation center. The experimenter asked the child to “tell the story so that someone who cannot see the pictures would understand what is happening”. To avoid influencing lexical or syntactic choices, no verb models or corrective feedback were provided. When needed, minimal non-leading prompts were used (e.g., “What happens next?” “Then what?”). HI children could request repetition or clarification when necessary; all prompts remained auditory to preserve task comparability. Each narration was audio-recorded using a high-sensitivity microphone and later transcribed for analysis.

2.4. Transcription and Coding

Recordings were transcribed verbatim by trained native speakers. Clauses were segmented according to Mandarin syntactic criteria, and only clauses that expressed motion were retained. For each child we derived three measures: (i) motion-clause productivity (total number of motion clauses), (ii) clause packaging (single-verb vs. SVC; e.g., *diào shuǐ lǐ* vs. *diào-jìn shuǐ lǐ*; per-child SVC proportion computed), and (iii) motion-verb diversity (the count of distinct motion-verb types across the narrative). All coding decisions — motion-clause identification, clause-structure classification, and verb identification/type — were independently checked by a second researcher; inter-rater agreement exceeded 0.90 for clause classification and verb identification, and clause counts were reconciled by audit.

3. Results

3.1. Productivity of Motion Clauses

A consistent and large difference in narrative productivity was observed between TD and HI children across all age groups; see Figure 1.

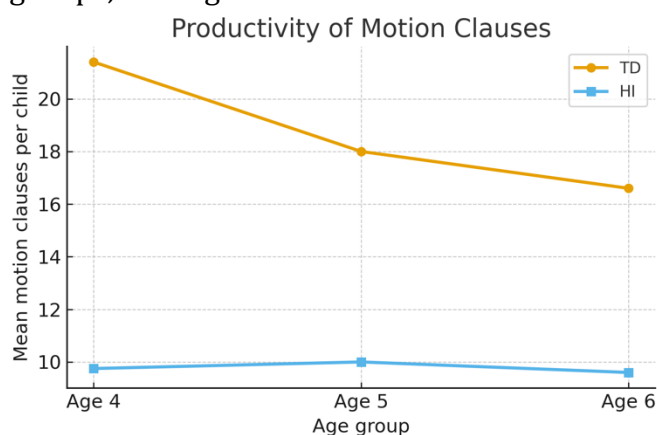


Figure 1. Motion-clause productivity by age and group (TD vs. HI)

At age four, TD children ($n = 10$) produced a mean of 21.40 motion clauses per child, more than twice the output of their HI peers ($n = 8$), who produced a mean of 9.75 clauses per child (TD: HI rate ratio = 2.19). This gap remained through the preschool years. At age five, TD children ($n = 10$) produced 18.00 clauses per child, while the HI group ($n = 5$) produced 10.00. Interpretation at this age is tempered by the small HI sample size, but the direction and scale are consistent with the age-four pattern (rate ratio = 1.80). By age six, with equal group sizes ($n = 10$ per group), the difference was still clear: TD children produced 16.60 clauses per child, compared to 9.60 for HI children (rate ratio = 1.73).

The slight decline in TD clause counts from ages four to six likely reflects a shift toward longer clauses and more condensed motion packaging rather than reduced ability. In contrast, the flat profile in the HI group indicates that overall narrative output did not increase to meet the growing demands of storytelling, a limitation that provides crucial context for interpreting their lexical and syntactic development.

3.2. Clause Structure: Serial-Verb vs. Single-Verb Packaging

As shown in Figure 2, the analysis of clause structure revealed a clear developmental divergence: TD children consistently used SVCs as their default strategy, whereas HI children showed a marked decline in SVC use with age.

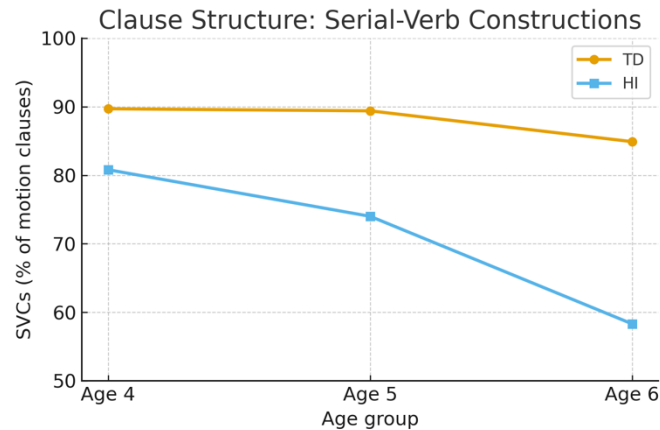


Figure 2. Proportion of SVCs by age and group (TD vs. HI)

At age four, TD children ($n = 10$) produced SVCs in 89.7% of motion clauses (192/214), demonstrating early mastery of the Mandarin pattern that integrates manner and path (or path and path) within a single clause. The HI group ($n = 8$) also showed strong initial ability, using SVCs in 80.8% of clauses (63/78).

By age five, the trajectories began to diverge. The TD group maintained a high level of SVC usage (89.4%, 161/180), while the HI group declined to 74.0% (37/50), widening the group difference to about 15 percentage points (Cohen's $h \approx 0.41$).

The divergence became pronounced at age six. TD children continued to rely predominantly on SVCs (84.9%, 141/166). In stark contrast, the HI group's SVC usage fell to 58.3% (56/96), a gap of about 27 percentage points (Cohen's $h \approx 0.61$). This widening gap, which is a proportional measure and thus independent of overall output, signifies a fundamental difference in syntactic development. TD children automated SVCs as a routine grammatical tool, whereas HI children increasingly diverged from this language-specific pattern as narrative demands increased.

3.3. Lexical Diversity of Motion Verbs

The development of the motion verb repertoire showed early superficial similarity followed by clear divergence (see Figure 3).

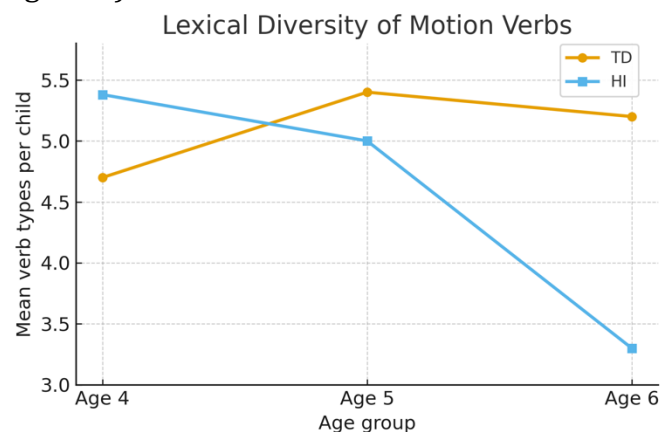


Figure 3. Motion-verb types by age and group (TD vs. HI)

At age four, the mean number of verb types per child was comparable between TD ($M = 4.70$; total = 47) and HI ($M = 5.38$; total = 43). However, this apparent parity was an artifact of much lower narrative productivity in the HI group ($M = 9.75$ vs. 21.40 clauses per child), which inflated type-token ratio. Qualitatively, HI children relied heavily on a few high-frequency, general-purpose verbs (e.g., *lái* "come", *qù* "go"), whereas TD children produced a more varied set of verbs from the outset.

By age five, the developmental paths began to separate. TD children expanded their repertoire ($M = 5.40$ types/child; total = 54) while maintaining substantial output ($M = 18.00$ clauses/child), incorporating more specific manner verbs (e.g., *pá* “climb”, *fēi* “fly”). The HI group’s mean ($M = 5.00$; total = 25), based on a very small sample ($n = 5$), showed little growth, and verb choice remained dominated by generic items (e.g., *dǎo* “fall”, *diào* “drop”), indicating limited semantic refinement.

At age six, a reliable group difference emerged. TD children maintained a diverse verb repertoire ($M = 5.20$ types/child; total = 52), whereas HI children showed a notable decline ($M = 3.30$ types/child; total = 33). An independent-samples t-test confirmed that TD children used a significantly greater number of unique verb types than their HI peers, $t(18) = 2.85$, $p = .010$. This difference does not arise because HI children spoke less at age six — their total clause count actually increased relative to age five. Rather, the rate at which new verbs entered HI narratives did not keep pace with longer, richer storytelling, producing a plateau in lexical growth.

In summary, HI children are not characterized by a deviant onset of lexical acquisition, but by a delayed and slowed expansion. The lexical gap emerges not from regression, but from an inability to transition to a more diversified and semantically precise verb repertoire at the expected developmental point.

4. Discussion

This study tracked three connected parts of children’s motion language: how much they talk about motion (clauses per child), how they package motion in a clause (serial-verb vs. single-verb), and how many different motion verbs they use (verb types). The same picture book and procedures were used for all children. Three facts stand out. First, TD children produced more motion clauses at every age (about 1.7–2.2× more). Second, TD children kept SVCs as their default across ages, while HI children showed a steady drop in SVC use, with a ~27-point gap by age six. Third, the size of the motion-verb repertoire separated clearly by age six: TD children used more unique motion verbs than their HI peers.

These findings for the TD group are consistent with prior descriptions of Mandarin child speech showing a language-specific preference to express motion with SVCs, a pattern that children adopt early and then use routinely in narratives (Ji et al., 2011). Our TD group mirrors this profile: they produced many clauses, relied on SVCs across ages, and maintained a reasonably broad set of motion verbs by age six. In short, the present data support a picture of early access to the Mandarin SVC pattern followed by steady consolidation, rather than late emergence.

The HI group did not consistently follow this Mandarin-specific pattern. Our results accord with reports that children with hearing loss produce shorter utterances in narrative tasks, as measured by mean length of utterance (MLU), compared with normal hearing (Koehlinger et al., 2013; Werfel, 2018). In our data, the HI group contributed far fewer clauses per child at every age. Once total output and MLU are lower, the number of motion clauses naturally drops as well, because motion descriptions must compete with other narrative needs (setting, characters, causes, outcomes) for limited clause “slots”. This simple accounting explains why the TD group, who produced more language overall, also delivered more motion sentences and more opportunities to describe motion.

Prior work also shows that children with hearing loss tend to use simpler clause structures in narratives (Botvin & Sutton-Smith, 1977; Werfel et al., 2021), and our data converge with that evidence. The proportion of SVCs remained high and stable for TD children, but declined steadily with age in the HI group. Because an SVC requires selecting, ordering and integrating two or more verbs within a single clause, it imposes greater coordination demands than a single-verb clause. As children include more steps, links, and details in their narratives with age,

these demands increase; when planning pressure rises, children who have not fully consolidated the SVC pattern tend to default to simpler, single-verb packaging even if they know the form. Importantly, our SVC index is a proportion within the same task, so the decline cannot be attributed to shorter narratives per se. A parsimonious account is that the form is accessible but not yet automatized; evidence from our instructional interventions supports this point, showing that learners who know the internal structure of Chinese verb compounds still underuse them in connected speech until practice is sufficiently frequent and varied. In this sense, our HI group reflects early access without consolidation.

Furthermore, our findings align with a long line of work reporting vocabulary lag in children with hearing loss (Tomblin et al. 2015; Walker et al. 2019), especially for lower-frequency, meaning-rich verbs. At age four the groups looked similar on types per child, but by age six the TD group used many more distinct motion verbs. This late-emerging separation is exactly what a lexical lag predicts: when the active verb set remains small and generic, children repeat the same motion verbs across scenes and have fewer opportunities to combine precise manner verbs with path elements. In contrast, TD children added manner-specific verbs across ages five to six, so their verb set stayed broader and their SVCs remained informative and frequent.

5. Conclusion

This study offered a focused look at Mandarin-speaking preschoolers' motion talk by linking three indicators within one narrative task: productivity of motion clauses, clause structure (serial-verb vs. single-verb), and lexical diversity of motion verbs. The split is staged rather than simultaneous: overall output separates earliest, the SVC proportion widens progressively with age, and verb-type diversity separates most clearly by six. Taken together, the results show that children with hearing loss lag behind their hearing peers in spatial language production and, specifically, in mastering Mandarin's language-specific preference for SVCs as a routine way to express motion.

Since these patterns pinpoint where trajectories diverge, the findings also indicate how progress can be supported and tracked. The same three indicators — motion-clause productivity, SVC proportion, and the number of distinct motion verbs — provide a simple, sensitive readout from short picture-book retells. Moreover, activities that invite children to express what happened in a single clause using SVCs, while steadily extending a small set of useful manner verbs that combine with common path elements, follow directly from the profile we observed and are likely to foster more regular use of SVCs in narration.

Several limitations should be noted. The study was cross-sectional and relied on a single picture-book task, so it does not show how individual children change over time or how they would speak in other tasks, such as video-based elicitations. The HI subgroup at age five was also small, so estimates for that age should be interpreted with caution. Future studies should track the same children longitudinally with shorter sampling intervals so that growth in motion-clause productivity, SVC use, and verb variety can be observed within child rather than inferred from age groups. The elicitation context should also be diversified, for example, by adding a short video retell, or a brief play-based narration, so that findings are not driven by task format.

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