



Children's acquisition of recursive possessives in Mandarin

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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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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%
6-year-old (n=34)	87.5%	2.94%	5.15%	4.41%
5-year-old (n=28)	75%	11.61%	5.36%	8.04%
4-year-old (n=34)	67.86%	7.14%	11.43%	13.57%
3-year-old (n=30)	65%	5.04%	14.28%	15.97%

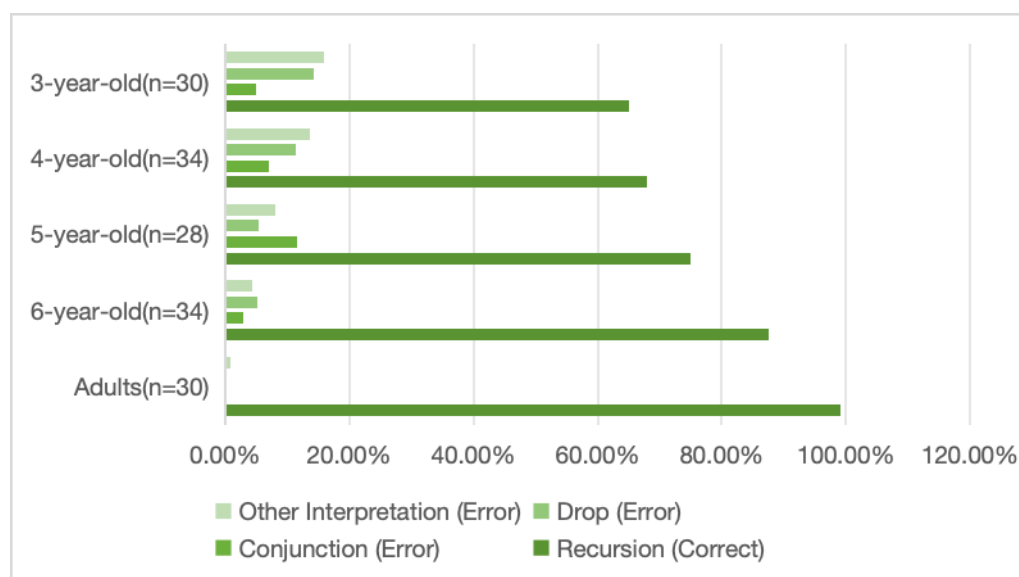


Figure 3. Correct percentage and incorrect percentage of answers

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

Age	Recursive Possession	
	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.

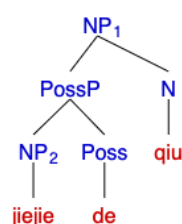


Figure 4. Dropping interpretation 1

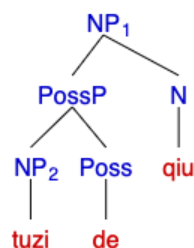


Figure 5. Dropping interpretation 2

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.

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