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An experimental study of Children's acquisition of Mandarin recursive locatives

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Abstract

Recursion is widely regarded as a defining property of human language, yet its acquisition remains uneven across domains and languages. While previous research has focused primarily on recursive possessives and prepositional phrases, recursive locative constructions in Mandarin have received relatively little attention. The present study investigates how Mandarin-speaking children aged 3–6 interpret recursive locatives, with 30 adults serving as a comparison group. A total of 127 children completed an auditory picture-comprehension task manipulating the overt realization of the functional marker de (的) across three conditions: fully overt, partially overt, and non-overt. Mixed-effects logistic regression revealed a significant positive effect of age, such that each additional month increased the likelihood of a correct hierarchical interpretation (OR = 1.023, $p < .001$). Crucially, this developmental effect was modulated by surface marking: age-related gains were stronger in the fully overt condition than in the partially overt and non-overt conditions, with a significant Age × Type B interaction ($p = .030$) and a marginal Age × Type A interaction ($p = .057$). Descriptively, younger children were more likely to produce conjunctive interpretations when overt marking was reduced. These findings suggest that overt morphosyntactic marking facilitates, but does not fully determine, the development of recursive locative comprehension in Mandarin.

Keywords: Child language acquisition, Locative recursion, L1 acquisition, Mandarin, Recursion

1. Introduction

Locative meaning concerns location and spatial relations. It should therefore be treated as a cognitive-semantic domain rather than as the exclusive property of any single grammatical device. Languages differ in the morphosyntactic resources they use to express locative meanings, including adpositions, case marking, locative particles, spatial nouns, and other

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structural devices. Although these forms differ formally, they all instantiate the same underlying conceptual domain of space and location. (Talmy, 2000)

Grammatical encodings of locative meaning may be overt or non-overt. Overt encodings include bound morphemes such as inflectional affixes, derivational morphemes, and clitics, as well as free grammatical forms such as determiners. In short, locative meaning can be realized through different formal means, and the presence or absence of overt marking does not alter the fact that the same semantic domain is being expressed.

In Mandarin, recursive locative relations are often expressed through the functional element de. (Mao et al., 2024) A typical two-level recursive locative example is:

花园里的毯子上的小猫
huāyuán-lǐ-de tǎnzi-shàng-de xiǎomāo
"the cat on the blanket in the garden"

In this example, one locative phrase is embedded within another, producing a hierarchical dependency between two spatial relations. The relation is recursive because the locative structure is not a simple flat sequence of phrases; rather, one locative phrase is interpreted as nested inside another. Recursive locatives therefore provide a useful test case for investigating how children acquire nested spatial semantics and how overt surface marking may influence their interpretation of hierarchical structure.

In the present study, "acquisition" refers to children's increasing ability to compute the target hierarchical interpretation in a recursive locative task, as reflected in higher accuracy and fewer conjunctive or omission-based responses. This definition is intentionally operational: it does not assume that acquisition must mean full adult-like mastery at a fixed age, but instead treats acquisition as a developmental increase in the ability to recover the intended nested relation.

The present study is informed by Roeper's IR/DR distinction. (Sevcenco et al., 2015) In broad terms, IR (Indirect Recursion) highlights the role of readily available surface cues, whereas DR (Direct Recursion) refers to abstract hierarchical structure that must be computed beyond the surface string. Applied to Mandarin recursive locatives, this framework suggests that overt realization of de may make the hierarchical relation more accessible, while non-overt realization may reduce surface transparency and increase the likelihood of alternative, non-hierarchical interpretations.

1.1. Empirical findings on locative recursion across languages

Previous research on recursive locatives points to two broad conclusions. First, recursive locative comprehension is typically developmental rather than immediate: younger children often succeed first on simpler or shallower structures, and only later show stable understanding of more deeply embedded configurations. Second, the acquisition of recursive locatives is not uniform across languages. Instead, it varies with morphosyntactic marking, structural transparency, task demands, and possibly broader typological properties of the language. These two conclusions suggest that recursive

locatives are an especially useful domain for examining how children integrate structural complexity with surface cues in comprehension.

1.2. Developmental trajectory of recursive locative acquisition

A first line of research has focused on whether recursive locatives are acquired gradually across age groups. Across a wide range of languages, the general pattern is that younger children do not treat recursive locatives as a fully transparent structure. Rather, they often show a stepwise trajectory in which simpler spatial relations or one-level structures are mastered before more deeply embedded relations.

Japanese studies provide one of the clearest examples of this developmental pattern. Terunuma et al. (2017) report that children find recursive locatives more difficult than recursive possessives, and that performance drops as the number of embedded levels increases. This suggests that recursive locatives are not merely hard because they are "relational"; they are specifically vulnerable to increasing structural depth. Similar findings have been reported in other studies of Japanese recursive structures, where younger children may manage a basic nested relation but struggle once the structure requires the integration of more than one layer of embedding. What this shows is that children's difficulty is not random: it is tied to the computational load created by recursion itself.

English data (Sevenco et al., 2015; Peterson et al., 2015; Perez-Leroux et al., 2018, 2024) point in the same direction. Studies of recursive prepositional phrases and related structures show that children may succeed on simpler forms, but accuracy declines when the structure requires a more explicit hierarchical analysis. The developmental profile is therefore not "all or nothing." Instead, children tend to move from interpretations that are compatible with surface linear order toward interpretations that require deeper structural computation. This is important because it suggests that recursive locatives are acquired gradually and that the presence of more than one embedding layer creates a measurable developmental burden.

French results (Roberge et al., 2018) likewise support a staged developmental path. Younger children typically perform below adult levels, while older children begin to approximate the adult pattern. The fact that this age-related shift appears even when the surface structure is similar to that of other languages suggests that recursive locative acquisition is not simply a matter of memorizing a construction. Rather, children appear to be learning how to map a surface form onto a nested spatial relation. Taken together, the evidence from Japanese, English, and French supports the view that recursive locative comprehension develops incrementally and that deeper embedding is consistently harder than shallower structure.

These findings matter for the present study because they show that age is likely to be a meaningful predictor of performance in recursive locative comprehension. However, the literature also shows that age alone cannot explain everything. Children of the same age may perform very differently across languages, which means that the developmental trajectory of recursion must be interpreted together with language-specific structural factors.

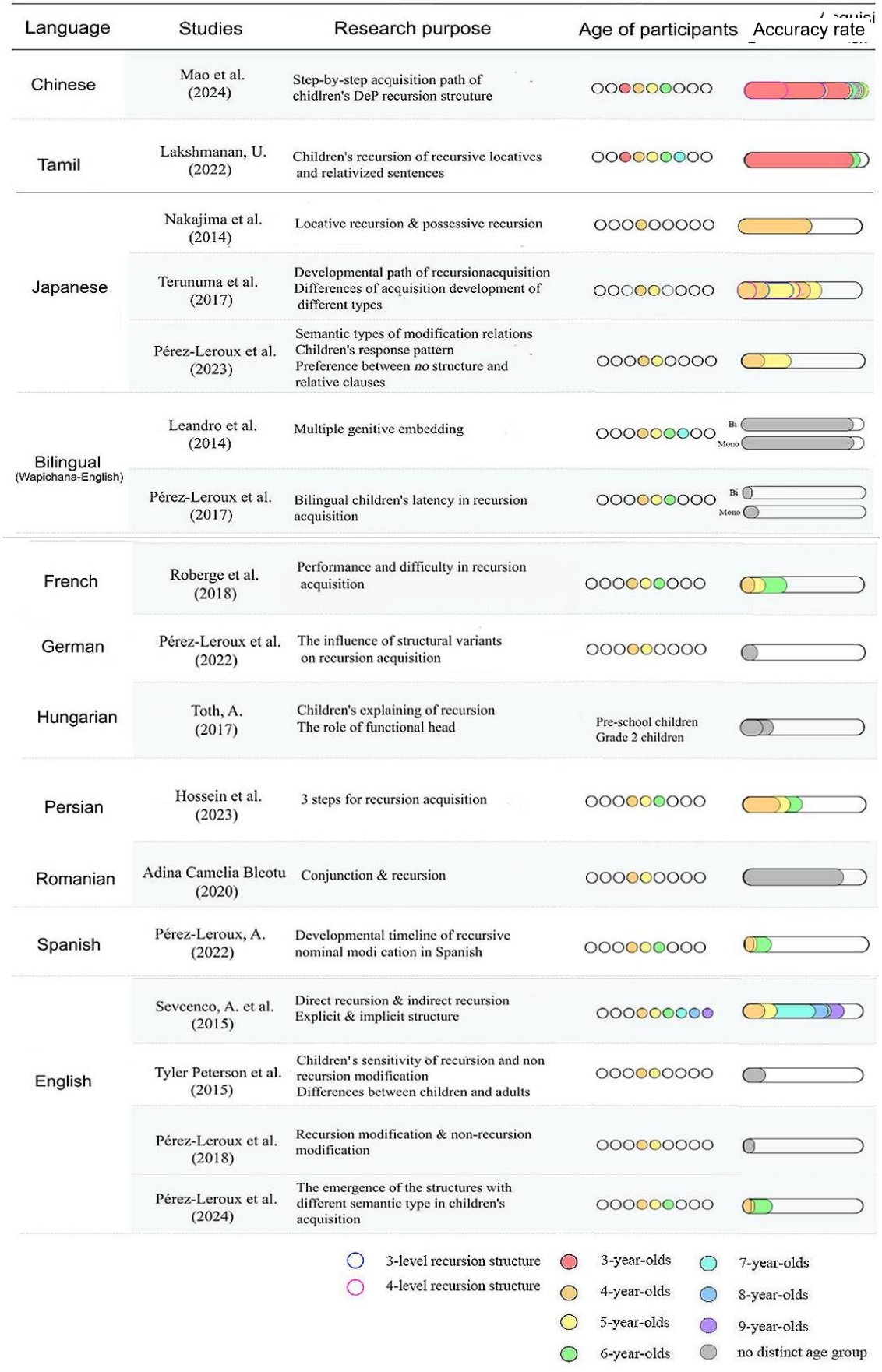

Figure 1. Summary of key research

1.3. Overt morphosyntactic marking and recursive interpretation

A second line of research has examined whether overt morphological or syntactic marking affects how children interpret recursive structures. This issue is especially relevant because recursion may be signaled more or less explicitly at the surface level. When overt cues are present, they may help children identify hierarchical relations; when such cues are weak, absent, or reduced, children may be more likely to rely on linear or conjunctive interpretations.

Sevcenco et al. (2015) provide an important starting point for this line of inquiry. Their work suggests that children often prefer conjunctive readings when recursive structure is not strongly supported by overt marking, whereas explicit structural cues can increase the likelihood of target-like recursive interpretations. The broader implication is not simply that overt marking "helps" in a vague sense. Rather, overt marking may provide the parser with a cue that makes hierarchical structure more accessible and reduces the likelihood of treating the string as a sequence of coordinated elements.

This issue becomes especially relevant in languages where recursive locatives can be realized in more than one way. In such cases, the same underlying relational meaning may be expressed with different degrees of overt marking, and these differences may affect children's interpretation. If children are sensitive to surface transparency, then structures with more explicit marking should be easier than those in which the relevant marker is absent or reduced. If children are already able to recover hierarchical structure independently of surface cues, then the presence or absence of overt marking should matter less.

Research on Mandarin recursive structures is directly relevant here because the functional element de may appear overtly in some forms but not in others. This creates a natural contrast between more explicit and less explicit marking. The literature suggests that such differences are not trivial: even when the intended meaning is the same, reduced overt marking may increase the risk of linear or conjunctive interpretation. This is precisely why Mandarin recursive locatives are a useful testing ground. They make it possible to ask whether children rely on overt morphosyntactic cues when computing nested locative meanings, or whether they can recover the target relation even when the surface form is less explicit.

The present study builds on this literature by treating overt realization not as a peripheral detail, but as a central variable. This matters because it allows us to examine whether children's comprehension reflects sensitivity to the formal visibility of recursion itself.

1.4. Cross-linguistic variation and possible sources of difference

A third line of research highlights the fact that recursive locatives do not behave identically across languages. Some languages appear to support earlier or more accurate comprehension, whereas others show persistent difficulty. This variation suggests that recursive acquisition is shaped not only by general developmental factors, but also by the specific structural and typological properties of each language.

Tamil is a useful example. Some studies (Lackshmanan, 2022) report that Tamil-speaking children show relatively strong performance on recursive

structures, which has been linked to the language's typological profile and to the transparency of relational marking. Persian has also been reported to show relatively strong performance compared with some other languages. These findings suggest that the shape of the input and the visibility of relational structure may facilitate earlier access to recursion. In other words, when a language provides more consistent or more transparent cues to hierarchical relations, children may be better able to interpret recursive locatives.

By contrast, other languages show stronger task effects or weaker target performance. Romanian studies (Sevcenco et al., 2015), for example, indicate that children's responses can differ depending on whether the task prompts recursive or coordinative interpretations. This suggests that recursive comprehension is not only a matter of competence, but also of how the task frames the available interpretations. Similarly, bilingual acquisition (Leandro & Amaral, 2014; Perez-Leroux et al, 2017) studies show that response patterns may diverge from monolingual patterns, not because recursion is unavailable, but because children must manage competing structural systems and potentially different cue distributions. These findings remind us that recursive acquisition is sensitive to both linguistic environment and experimental design.

For Mandarin, this variation is particularly important because recursive locatives may be realized with different degrees of overt marking. This means that Mandarin allows us to ask a more precise question than many other languages: is children's difficulty driven primarily by recursion itself, or by the overt visibility of the recursive markers? If children perform better when de is overtly realized, then overt marking may be functioning as a structural support for hierarchical interpretation. If performance remains stable across conditions, then children may already be able to compute recursion independently of overt cues. Either outcome would be theoretically informative.

The cross-linguistic literature therefore points to a gap that the present study is designed to address. Although previous work has shown that recursive locatives are developmentally difficult and cross-linguistically variable, fewer studies have isolated the specific role of overt versus non-overt marking in Mandarin recursive locatives across a narrow child age range. This is the gap to which the present study responds.

2. Methodology

The present study builds on this literature by focusing on Mandarin-speaking children aged 3–6 and asking how age and overt morphosyntactic marking shape the comprehension of recursive locatives. Previous research on recursive structures suggests that acquisition is gradual, but the timing and form of this development vary across languages and tasks. In Mandarin, this issue is especially important because recursive locatives can be realized with different degrees of overt de marking, making it possible to examine whether surface transparency affects children's interpretation of nested spatial relations.

The current study is guided by two central questions. The first concerns development: Do Mandarin-speaking children's comprehension of recursive

locatives improve with age across the 3–6 range? The second concerns form: Does the overt versus non-overt realization of de influence children's tendency to compute hierarchical interpretations versus conjunctive interpretations? These questions are logically connected but analytically distinct: the first asks whether age matters, whereas the second asks whether overt structural marking matters.

Within Roeper's IR/DR distinction, overt morphosyntactic cues may support children's access to the intended hierarchical relation, whereas reduced or absent overt marking may make the structure less transparent. On this view, the study of Mandarin recursive locatives offers a particularly clear opportunity to test how children respond to differences in surface realization while keeping the underlying semantic domain constant.

The present study therefore examines three conditions that vary in the overt realization of de: a condition with no overt de, a condition with one overt de, and a condition with both de markers overtly realized. By comparing children's responses across these conditions and across age groups, the study aims to clarify how recursive locative comprehension develops in Mandarin and whether overt morphosyntactic marking facilitates hierarchical interpretation.

Accordingly, the present study addresses the following two research questions:

Do Mandarin-speaking children aged 3–6 show an age-related improvement in the comprehension of recursive locatives?

Does the overt versus non-overt realization of de affect children's interpretation of recursive locatives, particularly hierarchical versus conjunctive readings?

The experiment used a picture-based listening-and-response act-out task. Before the main experiment, each child completed a familiarization stage to ensure that the lexical items used in the task were understood and that no additional comprehension difficulty arose from unfamiliar vocabulary. The pretest was administered two days before the experiment in class and also as homework via Microsoft PowerPoint. During the main task, the stimuli were presented as slides. Each trial consisted of a picture accompanied by an auditory prompt, and each prompt was played twice with a 15-second interval between repetitions. A beep at the end of the prompt indicated that the child should answer the question. The entire experiment lasted approximately 8–11 minutes and consisted of 41 slides.

2.1. Participants

We recruited 127 monolingual Mandarin-speaking children and 30 adults for this experiment. The child sample included 30 three-year-olds, 35 four-year-olds, 29 five-year-olds, and 33 six-year-olds. The manuscript currently reports the group mean ages as 3.83, 4.60, 5.58, and 6.45 years for the child groups, and 25.54 years for the adult group; these values are means, not an age range, and should be reported accordingly. If the standard deviations and actual minimum–maximum ages are available from the raw dataset, they should be added here in order to make the participant description fully reproducible. The children were recruited from Wuyishan Baihua Kindergarten in Fujian Province, and data collection was conducted

by two researchers in January 2024. All participants were reported to have no visual or auditory impairment.

Table 1
Number and Mean age of Each Age Group

Group	Number	Mean Age
1 (three-year-olds)	30	3.83
2 (four-year-olds)	35	4.60
3 (five-year-olds)	29	5.58
4 (six-year-olds)	33	6.45
Adult	30	25.54

2.2. Materials

Following Terunuma et al. (2017), we adapted the stimulus set and designed an auditory picture-comprehension task to examine Mandarin two-level locative recursion. The experimental materials consisted of 15 test items and 26 fillers, which were included to reduce carry-over effects and prevent participants from relying on a simple response pattern. The 15 test items were divided into three conditions that manipulated the overt realization of the functional head de in recursive locative structures. Type A contained no overt de in either of the two locative phrases; Type B omitted the first de but retained the second de; and Type C realized both occurrences of de overtly. In other words, the three conditions formed a continuum from fully covert marking to partially overt marking and then to fully overt marking.

Across the three conditions, the lexical content, locative relation, and overall question format were kept as constant as possible, so that the critical manipulation was the surface realization of de rather than a change in lexical meaning or discourse context. Each test item was presented as an auditory prompt accompanied by a corresponding picture, and participants were required to answer a question targeting the interpretation of the nested locative relation, such as "What color is the butterfly on the strawberry on the corn?" The same task structure was used throughout the experiment to ensure that differences in performance could be attributed to the recursive configuration rather than to changes in task demands.

A potential concern is whether the Type A structures (with no overt de) are fully grammatical in Mandarin. In standard written Mandarin, the possessive/locative marker de is often required in nested locative phrases. However, in colloquial speech and certain structural contexts, de may be omitted when the locative relation is sufficiently recoverable from the noun-locative particle sequence (e.g., *zhuōzi-shàng* 'on the table') (Li & Thompson, 1981; Zhu，1982). More importantly, prior experimental studies on Mandarin recursive possessives have successfully used zero-marking conditions to examine children's sensitivity to overt vs. covert realization (Mao et al., 2024). All Type A stimuli in the present study were pre-tested on five adult native speakers of Mandarin (not part of the main experiment), who judged them as acceptable in the context of the picture-matching task. Thus, while Type A represents a less explicit surface form, it remains a legitimate instance of two-level locative recursion in the experimental register used here.

Because children may sometimes respond by dropping one of the locative phrases or by interpreting the two locative phrases conjunctively rather than hierarchically, these response patterns were anticipated in advance and later coded separately during analysis. Therefore, the materials were specifically designed to isolate the effect of overt morphological marking on the comprehension of recursive locative structures while minimizing unrelated lexical variation and keeping the experimental format uniform across conditions.

2.3. Data analysis

(1) 2-LOC (Type A):

[Yumi shang -LOC (de)] DeP [Caomei shang -LOC (de)] DeP Hudie shi shenme yanse?

玉米上草莓上蝴蝶是什么颜色？

What color is the butterfly on the strawberry on the corn?

Figure 2. 玉米上草莓上蝴蝶

(2) 2-LOC (Type B):

[Eyu xia -LOC (de)] DeP [pangxie xia -LOC de] DeP xiaoyu shi shenme yanse?

鳄鱼下螃蟹下的小鱼是什么颜色？

What color is the fish under the crab under the crocodile?

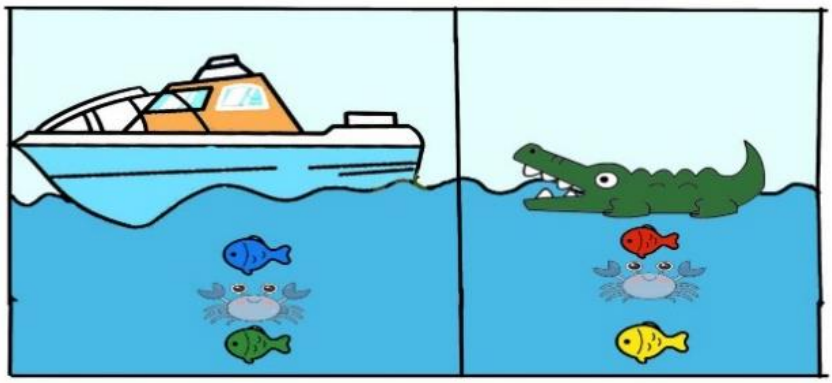

Figure 3. 鳄鱼下螃蟹下的小鱼

(3) 2-LOC (Type C):

[Huayuan li -LOC de] DeP [tanzi shang -LOC de] DeP xiaomao shi shenme yanse?

花园里的毯子上的小猫是什么颜色？

What color is the cat on the blanket in the garden?

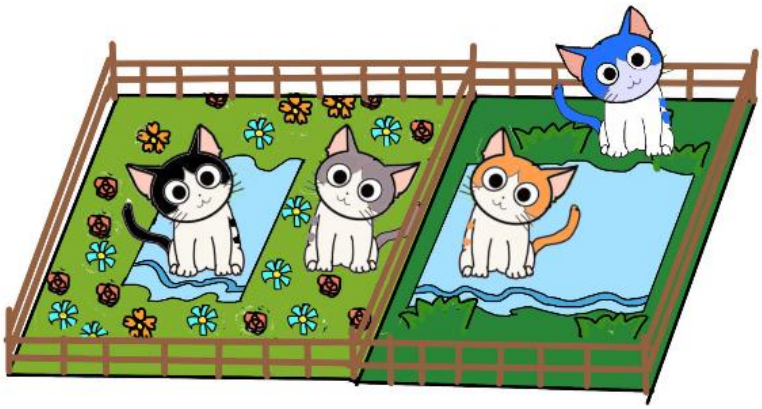

Figure 4. 花园里的毯子上的小猫

2.4. Coding

Children's answers were transcribed verbatim and coded for accuracy and response type. We used a permissive scoring rule: a response was scored as correct if the child produced the target interpretation on either the first or the second attempt; two consecutive incorrect responses were scored as 0. Incorrect responses were further classified as Conjunction (a sequential or coordinated interpretation), Drop (omission of at least one genitive/locative phrase), or Other Interpretation (any other non-target response). This coding scheme should be retained because it makes the scoring rule explicit and allows readers to reconstruct how accuracy and error categories were derived.

3. Findings

Trial-level responses were analyzed with mixed-effects logistic regression in R 4.5.1, with accuracy coded as 1 for correct responses and 0 for incorrect responses. Age was treated as a continuous predictor in months, and Recursion_Type was coded using treatment coding, with Type C as the reference level. This means that the coefficients for Type A and Type B represent contrasts against Type C, and the interaction terms represent condition-specific differences in the age effect relative to Type C. The fixed-effects structure was therefore age_months * Recursion_Type.

We first attempted a participant-slope model, (1 + Recursion_Type | participant) + (1 | item), but the maximal model failed to converge or was singular. The random-effects structure was then simplified stepwise, and the final model retained random intercepts for participants and items only: (1 | participant) + (1 | item). The main text should report this simplification explicitly rather than simply presenting the final model as if it were the initial model.

Because age was modeled continuously, the table of fixed effects should not label the age term as "Age Group (Ref: Adult)." That label is inconsistent with the model specification and can mislead readers into thinking that age was entered as a factor. Instead, the table should report the coefficient as age_months and use the adult group only in descriptive predicted-probability plots, where model-based predictions can be evaluated at the mean age of each group for visualization purposes. Likewise, the interaction terms should be relabeled unambiguously as age_months × (Type A vs. Type C) and age_months × (Type B vs. Type C) rather than "Age × Type A/B."

3.1. Descriptive analysis

Table 2 summarizes the raw accuracy patterns by age group and recursion type. Adults performed near ceiling across all three conditions: Type A yielded 141/150 correct responses (94.0%), Type B yielded 139/150 (92.7%), and Type C yielded 148/150 (98.7%). Children showed a lower and more variable performance pattern, with accuracy generally increasing with age and with the overt realization of de in Type C. For the 3-year-old group, proportions correct were .37 in Type A, .41 in Type B, and .44 in Type C. For the 4-year-old group, the corresponding proportions were .34, .25, and .45. For the 5-year-old group, they were .40, .39, and .55. For the 6-year-old group, they were .40, .48, and .66. Descriptively, the clearest developmental increase appears in the fully overt condition (Type C), especially among the older child groups.

Table 2 Descriptive counts and proportion correct by age group and recursion type (N trials, N correct, proportion correct). Source: trial-level data.

Table 2
The raw accuracy patterns by age group and recursion type

Age Group	Recursion Type	N Trials	N Correct
3-year-olds	A	110	41
	B	110	45
	C	110	48
4-year-olds	A	190	65

	B	190	47
	C	190	86
5-year-olds	A	165	66
	B	165	64
	C	165	90
6-year-olds	A	170	68
	B	170	82
	C	170	113
Adults	A	150	141
	B	150	139
	C	150	148

3.2. Mixed-effects logistic regression

To test whether age predicted correct hierarchical interpretation and whether the realization of de modulated that developmental pattern, trial-level responses were analyzed with a mixed-effects logistic regression model. The dependent variable was binary accuracy (correct = 1, incorrect = 0). The fixed effects included age_months and Recursion_Type, with Type C as the reference level. Random intercepts were included for participants and items.

The model revealed a robust positive effect of age. Each additional month of age increased the log-odds of a correct hierarchical interpretation (β = 0.0231, SE = 0.00388, z = 5.96, $p < .001$), corresponding to an odds ratio of approximately 1.023 per month (95% CI $\approx$ [1.0155, 1.0308]). The main effects of Recursion_Type were not significant at the reference age: Type A did not differ significantly from Type C ($\beta = -0.142$, SE = 0.354, $z = -0.402$, $p = .688$), and Type B likewise did not differ significantly from Type C ($\beta = -0.090$, SE = 0.352, $z = -0.257$, $p = .797$). However, the interaction terms showed that the age-related gain differed across conditions. The Age × Type B interaction was significant ($\beta = -0.00905$, SE = 0.00417, $z = -2.17$, $p = .030$), indicating that the age-related gain in accuracy was smaller in Type B than in Type C. The Age × Type A interaction showed the same directional pattern but was only marginal ($\beta = -0.00801$, SE = 0.00422, $z = -1.90$, $p = .057$). Full fixed-effect estimates are reported in Table 3.

Model-based predicted probabilities were consistent with this pattern. Adults were near ceiling in all three conditions, while 6-year-olds showed a higher predicted probability of a correct hierarchical interpretation in Type C ($\approx$ 0.625) than in Type B ($\approx$ 0.458) or Type A ($\approx$ 0.464). These predicted probabilities are descriptive and should be interpreted together with the fixed-effect estimates rather than as separate inferential evidence. Diagnostic checks showed no evidence of overdispersion (Pearson dispersion $\approx$ 0.987), and DHARMa residual checks plus QQ plots did not reveal gross model misfit.

In short, accuracy increased with age, and the developmental gain was larger when both occurrences of de were overtly realized (Type C). The significant Age × Type B interaction indicates that omission of the intermediate de attenuated age-related gains relative to the fully overt condition. The Age × Type A effect showed the same direction but did not reach conventional significance.

Table 3
Fixed-effect parameter estimates from the mixed-effects logistic regression predicting correct responses

Predictor	β	SE	Odds Ratio	95% CI for OR	z	p
Intercept	-1.296	0.292	0.274	[0.154, 0.485]	-4.441	< .001
age_months	0.023	0.004	1.023	[1.016, 1.031]	5.962	< .001
Recursion Type (Ref: Type C)						
Type A	-0.142	0.354	0.867	[0.433, 1.737]	-0.402	.688
Type B	-0.090	0.352	0.914	[0.4581, 1.821]	-0.257	.797
Interaction term: Age × Type						
age_months × (Type A vs. Type C)	-0.008	0.004	0.992	[0.984, 1.000]	-1.901	.057
age_months × (Type B vs. Type C)	-0.009	0.004	0.991	[0.983, 0.999]	-2.171	.030

Note. Age was centered at the sample mean (64.5 months) before analysis.

The intercept therefore represents the predicted log-odds of a correct response for a child of mean age in the reference condition (Type C).

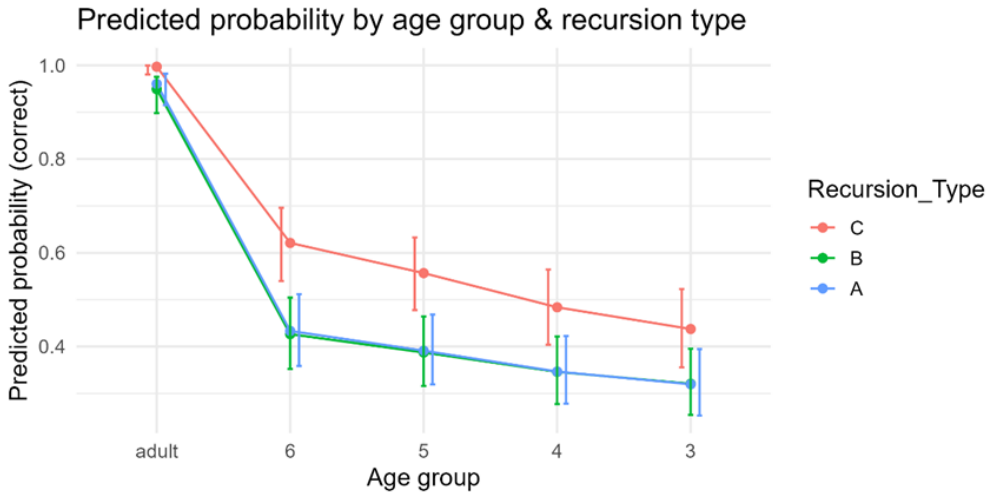

Figure 6. Predicted probability by age group and recursion type

Diagnostics. Pearson dispersion (sum of squared Pearson residuals / df) was ≈ 0.987, indicating no evidence of overdispersion. DHARMa simulation residual checks and visual inspection of deviance residuals and random effect QQ plots revealed no gross departures from model assumptions; adult ceiling

performance is noted as a limitation for interpretation (see Supplement for full diagnostic plots and DHARMa output).

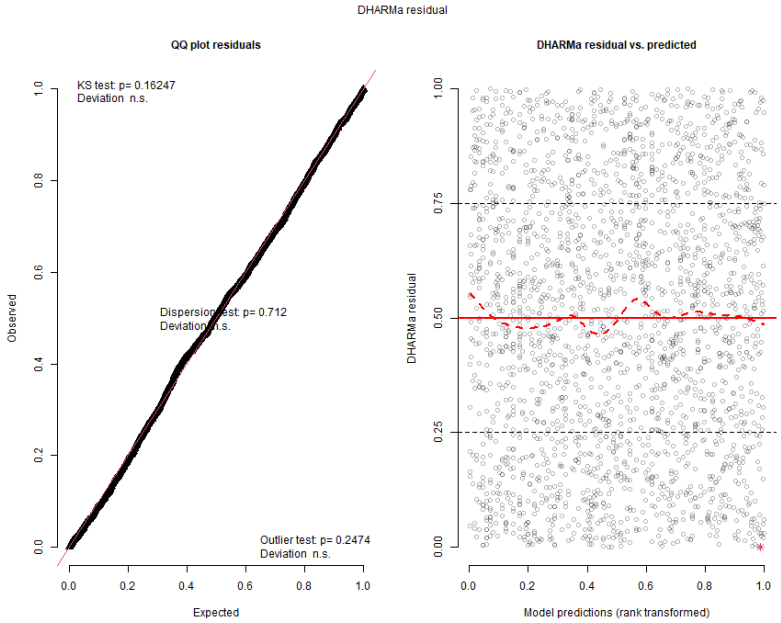

Figure 7. Residuals and random-effect QQ plots

4. Discussion and conclusion

The present study examined whether Mandarin-speaking children's comprehension of two-level locative recursion improves with age and whether the overt realization of de affects their interpretation of hierarchical structure. The results show a clear developmental trend: older children were more accurate than younger children, and adults performed near ceiling across conditions. This pattern indicates that recursive locative comprehension develops gradually rather than appearing all at once.

The results also suggest that overt morphosyntactic marking plays a facilitative role. Although the main effects of recursion type were not significant at the reference age, the interaction pattern showed that age-related improvement was strongest in the fully overt condition (Type C). By contrast, the age-related gain was weaker when one or both occurrences of de were absent. This means that overt marking does not simply determine success or failure, but it does appear to support children's progress toward the target hierarchical interpretation.

These findings are consistent with the idea that overt surface cues can make nested structure more accessible during development. In the present data, children's performance was highest when both de markers were overt, and the predicted probabilities for 6-year-olds were correspondingly higher in Type C than in Type B or Type A. At the same time, the data do not require a single explanation. The facilitative effect of overt marking may reflect greater surface transparency, reduced processing load, or both. The current study

cannot distinguish these possibilities directly, so it would be too strong to claim that the results prove one account over the other.

The error pattern is also informative. Some younger children produced conjunctive or linearized responses, which suggests that non-target interpretations remain available during early development. However, because the present analysis focuses on overall accuracy rather than a separate inferential model of error categories, these responses should be treated as qualitative support rather than as independent evidence for a particular theoretical claim. What the data do support is a cautious conclusion: overt de facilitates hierarchical parsing, but it does not automatically yield adult-like performance.

The study has several limitations. Adult performance was near ceiling, which compresses variability in the comparison group and makes the child–adult gap look especially large. The task measured comprehension rather than production, so the findings speak to children's interpretation of recursive locatives in this experimental setting, not to their full productive mastery. In addition, the sample came from a single regional context, so replication in other Mandarin-speaking populations will be important. Even with these limitations, the present results show that recursive locative comprehension in Mandarin develops gradually and that surface morphosyntactic marking is part of what shapes that development.

In sum, the present study shows that comprehension of Mandarin recursive locatives improves with age and that this improvement is modulated by the overt realization of de. Children do not simply move from failure to success in a single step; rather, they show a gradual increase in their ability to recover hierarchical structure, with the fully overt condition providing the clearest support for target interpretations. The findings are consistent with the broader claim that recursive comprehension depends both on developmental growth and on the availability of explicit surface cues.

Author contribution statement:

Wang Xiaoyi: making the experimental materials; collecting and coding the experimental data; writing part of the paper

Fu Chenxi: collecting the experimental data, doing statistical analyses, and writing part of the paper

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