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The Role of Age in Mandarin-Speaking Children's Performance of Relative Clauses*

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The issue of whether there is subject-object asymmetry in Mandarin-speaking children's performance of head-final relative clauses (RCs) has been controversial. Hypothesizing that age may play a role in contributing to the mixed results found in the past research on children's performance of RCs, we tested three groups of children of different ages (3-year-olds, 4-year-olds, and 5-year-olds) with a sentence imitation experiment. Our results show that while the 3-year-olds and 4-year-olds exhibited inconsistent patterns, the 5-year-olds consistently performed subject-gap RCs better than object-gap RCs. In addition, compared with the 3-year-olds, the 4-year-olds produced fewer fragmental non-target responses, but when compared with the 5-year-olds, they made more errors of dropping the RC marker DE, suggesting that age is critical in children's performance of RC and age four is the transitional period. Based on these findings, we suggest that when children are able to imitate RC sentences stably, usually above age four, their performance of RCs exhibit clear subject-object asymmetry. Our findings imply that both developmental constraints and processing constraints associated with age should be considered when evaluating children's performance of RCs in experiments.

Key words: relative clauses, Mandarin, child language acquisition, age, syntactic development

1. Introduction

Relative clause (RC) construction, a representaive case of complex sentence structure, has been studied extensively in the field of first language acquisition. One of the central issues in RC acquisition concerns children's differential difficulty in performing various types of RCs. Past studies show that young children in general perform better with subject-gap RCs (1a) than with object-gap RCs (1b) in languages with head-initial RCs (i.e. the head precedes the restricting clause) (*English*: Kidd & Bavin 2002, Kidd 2003, Diessel & Tomasello 2005, Zukowski 2009, etc.; *German*: Diessel & Tomasello 2005; *Hebrew*: Friedmann & Novogrodsky 2004, Arnon 2005; *Portuguese*: Corrêa 1995, Costa, Lobo & Silva 2011, etc.).

(1) English head-initial RCs
a. Subject-gap RC: **the boy** [who __ likes the toy]
b. Object-gap RC: **the toy** [which the boy likes __]

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The subject-object asymmetry found in children's performance with head-initial RCs, like in English, can be explained via different accounts, including the canonical word order hypothesis (Bever 1970, Slobin & Bever 1982, Diessel & Tomasello 2005, etc.), the locality-based accounts (i.e. accounts based on the linear distance between the head and the gap, e.g. Gibson 1998, 2000), and the structure-based accounts (i.e. accounts based on the depth of embedding of the gap in the structure, e.g. Keenan & Hawkins 1987, O'Grady 1997, Hawkins 2004, etc.). To test these hypotheses, recent studies have examined the acquisition of head-final RCs, where the head noun follows the restricting clause, as illustrated by the Mandarin examples in (2) (Hsu, Hermon & Zukowski 2009, Kornfilt, Hermon & Ozturk 2009, etc.)

(2) Mandarin head-final RCs

a. Subject-gap RC: [xihuan wanju de] **nanhai**
like toy DE boy
'the boy who likes the toy'

b. Object-gap RC: [nanhai xihuan ___ de] **wanju**
boy like DE toy
'the toy which the boy likes'

Mandarin, similar to English, has an SVO canonical word order and a linguistic element (the morpheme DE) that marks the RC boundary. The RC formation in Mandarin, it has been argued, involves syntactic movements and obeys locality constraints, like the formation of RCs in English (Huang 1982, Aoun & Li 2003, Hsu 2008, Huang, Li & Li 2009, etc.). The only major syntactic difference between Mandarin RCs and English RCs lies in the position of the head noun. This makes Mandarin RCs a particularly good test case to see whether Mandarin-speaking children and English-speaking children show similar patterns in performing subject-/object-gap RCs and to find out relevant factors that contribute to the phenomenon of subject-object asymmetry cross-linguistically. Unfortunately, as Chan, Matthews & Yip (2011) pointed out, past studies on the acquisition of RCs in Mandarin have produced mixed results. Some studies show that Mandarin-speaking children perform better with subject-gap RCs than object-gap RCs, as English children do (Lee 1992, Cheng 1995, Hsu et al. 2009, etc.), but others do not (Chang 1984, Su 2004, etc.). Thus, the issue of whether Mandarin-speaking children show a preference for subject-gap RCs over object-gap RCs still remains controversial and deserves further investigation.

In this paper, we revisit this issue carefully, taking a step back to attempt to

explain some of the inconsistencies in the previous research. In Section 1, we review past studies on the acquisition of RCs in Mandarin, and raise some concerns regarding the materials and the age of participants in the previous experiments. In Section 2 and 3, we report a sentence imitation experiment which used materials that mirrored the patterns observed in the corpus and tested three groups of children of different ages. Lastly, we discuss the implications of the results and comment on some of the limitations.

1.1 Review of past studies on the acquisition of RCs in Mandarin

There are six published studies (five experimental studies and one corpus study) discussed in the literature pertaining to the issue of subject-object asymmetry in child Mandarin. See Table 1 for a brief summary. Early studies focused on Mandarin-speaking children's comprehension of RCs in act-out tasks (Chang 1984, Lee 1992, Cheng 1995), but their findings should be interpreted with caution. The very first study, Chang (1984), as pointed out by Su (2006), mistakenly used passive subject-gap RCs as target object-gap RCs in the experiment, and this seriously contaminated the result patterns. In addition, all of these early studies failed to provide felicitous contexts for the use of RCs in their act-out experiments, and this may have resulted in children's worse performance of RCs (Hamburger & Crain 1982). Later experimental studies used elicited production tasks to examine Mandarin-speaking children's production of RCs (Cheng 1995, Su 2004, Hsu et al. 2009). Their results seem to suggest a preference for subject-gap RCs over object-gap RCs, except for Su (2004). Yet, it should be noted that Su's (2004) study was *not* designed to see how children perform RCs with different gap positions, but was to examine Mandarin-speaking children's use of resumptive pronouns in various types of RC constructions. More than half of the test items in her study were RCs with complicated structures that required the use of resumptive pronouns. Such complexity might have affected the children's performance. Recently, Chen & Shirai (2014) examined young children's RC acquisition from a longitudinal perspective. They analyzed spontaneous speech data from four monolingual Mandarin-speaking children (0;11 to 3;5, that is, eleven months to three years five months) from the Feng corpus collected in Beijing (Min 1994). Interestingly, they found that both children and caregivers produced much more object-gap RCs than subject-gap RCs.

Careful examination of the abovementioned studies reveals several interesting patterns. First, excluding Chang (1984) and Su (2004) whose experimental results were probably confounded by their test materials, the converging results from the three other experimental studies (Lee 1992, Cheng 1995, Hsu et al. 2009) seem to

suggest a preference for subject-gap RCs over object-gap RCs. Thus, it is possible that the inconsistency in the experimental results is related to variations in the test materials. Second, none of the five past experimental studies considered the prototypical features of child RCs in Mandarin, and this could be a concern. Recent studies have highlighted the importance of understanding the properties of child RCs in spontaneous speech (Diessel & Tomasello 2000, Ozeki & Shirai 2010, etc.). Studies also show that testing children with RCs that mirror those found in child corpora, including features such as head animacy and types of embedded nouns, can provide a more complete picture of young children's performance of subject-/object-gap RCs (Kidd, Brandt, Lieven & Tomasello 2007, Brandt, Kidd, Lieven & Tomasello 2009, Arnon 2010). Thus, a new experiment that incorporates the properties of RC in child Mandarin is called for.

Table 1. Summary of past studies on RC acquisition in Mandarin

Study	Method	Participants	Result patterns
Chang (1984)	Act-out task	N = 48 (Twelve 7-, 8-, 10-, and 12-year-olds)	No significant difference between subject-gap and object-gap RCs across age (pp. 60-61)
Lee (1992)	Act-out task	N = 61 (Twelve 4-, 5-, 6-, 8-year-olds; Thirteen 7-year-olds)	A significant advantage for subject-gap RCs over object-gap RCs across ages (pp. 57-58)
Cheng (1995)	Act-out task	N = 36 (Twelve 3-, 4-, 5-year-olds, mean age 3;8, 4;7, 5;7)	Children had more correct responses for subject-gap RCs than for object-gap RCs across ages, but the difference was not significant (pp. 68-73)
	Elicited Production Task	N = 27 (Nine 3-, 4-, 5-year-olds, mean age 3;12, 4;9, 5;9)	Children produced more subject-gap RCs than object-gap RCs (42 vs. 19%) (p. 107).
Su (2004)	Elicited Production Task	N = 20 (mean age 5;3) N = 20 (mean age 6;1,)	Children had fewer correct responses for subject-gap RCs than for object-gap RCs in both groups (84 vs. 88%; 78 vs. 83%), but the difference is probably not significant. (p. 11)
Hsu et al. (2009)	Elicited Production Task	N=23 (4;0~6;5, mean age of 4;8)	Children produced significantly more correct subject-gap RCs than object-gap RCs (83.5% vs. 38.9%) (p. 338)
Chen & Shirai (2014)	Corpus study	Four children (from 0;11 to 3;5) from Fang corpus	Object-gap RCs appear earlier and more frequently than subject-gap RCs in spontaneous speech

Finally, unlike the pattern found in experiments which show children's preference for subject-gap RCs over object-gap RCs, Mandarin-speaking children are found to produce object-gap RCs earlier and more frequently than subject-gap RCs in their spontaneous speech (Chen & Shirai 2014). Such a discrepancy is intriguing and needs some explanation. We wonder if age plays a role here. Note that in Chen & Shirai's (2014) corpus study, the data were collected from participants under age 4. In the

experimental studies which showed an obvious subject-object asymmetry, Lee (1992) and Hsu et al. (2009) in particular, their participants were all above 4-years-old. Cheng's (1995) experiments included 3-year-old participants, and her results also point to a subject-gap RC preference. Yet, in her act-out experiment, the subject-object asymmetry did not reach significance, and in her elicited production experiment, although the children exhibited clear subject-object asymmetry, the mean age of her 3-year-old participants was actually 4-years-old (mean age: 3;12). Combing the findings of both experimental and corpus studies, we suspect that age may be critical in children's performance of RC, and age four might be a transitional period. Before 4-years-old, whether children perform subject-gap RCs better than object-gap RCs may not be clear, but when they are over 4-years-old, the asymmetry becomes more obvious. We test this hypothesis in our experiment.

1.2 The purpose of the current study

This study was motivated by the issues raised above: First, how would Mandarin-speaking children perform RCs that follow the distributional patterns and features as revealed by the child corpus? Second, would 3-year-olds, 4-year-olds, and 5-year-olds exhibit different patterns in their performance of subject-gap and object-gap RCs? Following Diessel & Tomasello (2005) and Kidd at el. (2007), we used a sentence repetition task in our experiment. Imitation tasks are more difficult than comprehension tasks but easier than elicited production tasks, making them suitable for measuring children's usage of syntactic knowledge (Lust, Flynn & Foley 1996) and sentence processing ability (Potter & Lombardi 1990). Most importantly, such tasks also avoid any potential confounds such as ambiguity and pragmatic bias that may be caused by the head-final structure of Mandarin RCs in comprehension and production tasks.[1] To understand the difficulty children have in imitating RCs, we analyzed not only the result patterns but also the non-target responses across the age groups.

2. Sentence repetition experiment

In this section, we report on a sentence imitation experiment that adopted the features of child RC found in the available public Mandarin corpus, and examine how children perform with subject-gap RCs and object-gap RCs in a controlled setting. We

[1] Su (2006) pointed out that head-final object-gap RCs situated in the object position of the main clause (i.e. OO sentences) involve structural ambiguity that could affect children's comprehension performance. Hsu (2009) suggested that head-final subject-gap RCs may be preferred for its pragmatic bias in the production process. Please refer to these works for more details.

recruited three groups of child participants, 3-year-olds, 4-year-olds, and 5-year-olds, to observe if children of different ages perform RCs differently. In addition, to see how different test materials may affect the patterns of children's performance on RCs, we manipulated the length of RCs to discover whether the children's performance on the long RCs would differ from that on the short RCs.

2.1 Participants

Three groups of children participated in this experiment: fourteen 3-year-olds (mean age: 3;5), eighteen 4-year-olds (mean age: 4;5), and eighteen 5-year-olds (mean age: 5;6). The participants were recruited from four kindergartens in Taiwan. They were all native speakers of Mandarin as spoken in Taiwan and had no known language impairment.

2.2 Materials

Inspired by recent studies which incorporated the features of child RCs revealed by corpus analyses and showed that head animacy and types of embedded nouns affect children's RC performance (Kidd et al. 2007, Brandt et al. 2009, Arnon 2010), we conducted a small-scale corpus analysis to identify these relevant properties of RCs in child Mandarin. We used the database of the Taiwan Corpus of Child Mandarin (TCCM, Cheung, Chang, Ko & Tsay 2011), and analyzed the spontaneous speech data of eight children in the data set "HTC01" contributed by Cheung (1998). First, we extracted from the database utterances that contained a verb and the morpheme DE, two necessary elements in Mandarin RCs. Then, since our study only focused on typical RCs that serve to modify nouns, we filtered out utterances with cleft focus constructions, pseudo-cleft constructions, and ambiguous structures. Table 2 presents the basic information for each child.

The distribution of different RC types and the head animacy across the RC types are presented in Table 3. Among a total of 65 RCs produced by the children, headed RCs (44/65, 67.7%) outnumber headless RCs (21/65, 32.3%).[2] There were more object-gap RCs (30/44, 68.2%) than subject-gap RCs (14/44, 31.8%) for headed RCs, but the pattern was reversed for headless RCs. Also, it was found that the distribution of subject-/object-gap RCs was highly correlated with the animacy of the heads, such that subject-gap RCs tend to appear with animate heads (12/14, 85.7%) while object-gap RCs tend to appear with inanimate heads (28/30, 93.3%). Table 4 presents

[2] Mandarin allows headless RCs, where the head noun is dropped. It is common to drop the head noun when its referent is clear. Therefore, we included this part in our analyses.

the distribution of different types of embedded nouns for the two types of RCs. For subject-gap RCs (SR), the majority of the embedded objects were lexical NPs (21/29, 72.4%); for object-gap RCs (OR), about half of the embedded nouns were lexical NPs (19/36, 52.8%), followed by the pronouns (38.9%).

Table 2. Summary of the eight children and their use of RC based on the data from Taiwan Corpus of Child Mandarin (TCCM)

Child	Age Range	Number of RC	Age of First RC Use	First RC
CHENG	3;01~3;11	13	3;2	SR
CHOU	2;01~3;04	3	3;3	OR
PAN	2;00~3;09	11	2;6	SR
WANG	2;05~3;04	17	2;5	OR
WU	1;07~2;10	8	2;0	OR
WUYS	2;07~3;10	11	2;7	OR
XU	1;06~2;05	1	2;5	SR
YANG	1;05~2;04	1	2;4	OR

Table 3. Frequency of animate/inanimate heads across subject-/object-gap RCs

	Headed RC			Headless RC	Total
Head Animacy	Animate	Inanimate	Total	NA	
Subject-gap RC	12	2	14	15	29
Object-gap RC	2	28	30	6	36
Total	**14**	**30**	**44**	**21**	**65**

Table 4. Frequency of different types of embedded nouns across subject-/object-gap RCs

	Intransitive Verb	Drop	Lexical NP	Pronoun	Unclear	Total
Subject-gap RC	7	1	21	0	0	29
Object-gap RC	0	3	19	14	1	36
Total	**4**	**3**	**40**	**14**	**1**	**65**

Note: "Intransitive verbs": They only appear in subject-gap RCs and do not require embedded nouns.

"Drop": The embedded noun (either the subject or object) is dropped. For example, the embedded subject is dropped in *xihuan de gushishu* 'the story-book that (I) like.'

"Lexical NP": The embedded noun is a full lexical NP, such as *Mama* 'mother'

"Pronoun": The embedded noun is pronominal, like *wo* 'I', *ni* 'you', and *women* 'we', etc.

"Unclear": In one case, the child said something as the embedded noun, but it was unintelligible.

We adopted the patterns found in the above corpus analyses, and created test materials that matched these features. Note that our purpose was not to test how head animacy and embedded noun types may affect Mandarin-speaking children's performance of RCs, but, instead, was to test how children perform subject-gap RCs and object-gap RCs when they mimic the features found in the child corpus. First, the test sentences were all headed RCs, as they appear more often in child Mandarin. Second, in all test sentences, the embedded subjects/objects were all lexical NPs, as they are found to be the most prevalent in Mandarin child RCs. Third, in the test sentences, all subject-gap RCs contained animate head nouns, such as *nühai* 'girl', and all object-gap RCs contained inanimate head nouns, such as *liwu* 'gift'. That is, the animacy of the head referents was controlled and matched to the preferred animacy pattern found in the corpus. See the examples in Table 5.[3]

Table 5. Examples of test sentences for each condition

Condition	**Sentence**
A. Short	[___ Dakai na-he liwu de] nühai yijing huijia-le.
Subject-gap RC	open that-CL gift DE girl already go.home-ASP
	'The girl that opened the gift has gone home already.'
B. Short	[Na-wei nühai dakai ___ de] liwu yijing bujian-le.
Object-gap RC	that-CL girl open DE gift already gone-ASP
	'The gift that the girl opened has disappeared already.'
C. Long	[___ Dakai na-he shengri liwu de] nühai huijia-le.
Subject-gap RC	open that-CL birthday gift DE girl go.home-ASP
	'The girl that opened the birthday present has gone home.'
D. Long	[Na-wei duanfa nühai dakai ___ de] liwu bujian-le.
Object-gap RC	that-CL short-haired girl open DE gift gone-ASP
	'The gift that the short-haired girl opened has disappeared.'

Note: Abbreviations used in the English gloss: CL = classifier; ASP = aspect.

In addition, we also manipulated the length of the RCs in our design. The logic behind this is that it is possible that short RCs may be too easy and will not reveal any meaningful or clear differences between subject-gap RCs and object-gap RCs. It has

[3] One reviewer raised the concern that the animacy pattern used in our materials may confound with the gap position in the design. We acknowledge this possibility. Yet, we think that such a design is better than a design that used all animate head nouns or all inanimate head nouns. If only animate heads or only inanimate heads were used in the design, the difficulty children have with subject-gap RCs or object-gap RCs may be caused by the less preferred animacy of the head, not because of the gap position. Thus, the preferred heads as revealed from the corpus data were adopted for subject-gap RCs and object-gap RCs respectively in our materials. That to be said, we consider this potential confound as one limitation of our study, and suggest a way for improvement for future studies. See Section 4.3.

been suggested that longer RCs take more processing resources in working memory (Gibson 1998, 2000). Studies also show that Mandarin-speaking adults have more difficulty processing RCs that contain a longer linear distance between the gap and the head noun (Hsiao & Gibson 2003, Chen, Ning, Bi & Dunlap 2008). Thus, we assume that children need to employ more cognitive resources when imitating longer RCs, and this would help to induce clear asymmetry in their performance between the subject-gap RCs and object-gap RCs. To this end, we added a modifier to the embedded nouns inside the test RCs to create long RC conditions (such as *shengri* 'birthday' and *duanfa* 'short-haired' in C/D in Table 5). To counterbalance the total length of the target sentences across all conditions, an adverbial (such as *yijing* 'already' in A/B in Table 5) was added to the main clause of the short RC conditions. Sixteen test sentences and eighteen filler sentences were constructed. They were randomly intermixed to create six lists of items with different orders, with each participant using one of the lists.[4]

2.3 Procedure

A scenario was created to tempt children to imitate given sentences naturally. Each participant was first introduced to two puppet characters, and was told that they were from different planets and would like to talk to each other. The participant was asked to help the puppets communicate by repeating the sentences uttered by one puppet to the other puppet. In this way, the child participant was induced to imitate the sentences he/she heard naturally. A brief practice session was given prior to the experiment to make sure that each child understood the task. The experimenter provided positive feedback after each response regardless of the child's performance. If a child did not respond to a test sentence, the experimenter repeated the sentence once, and then moved on. The whole experiment was videotaped and lasted about 25 to 30 minutes.

2.4 Data scoring

Three native speakers transcribed the recording data and reached agreement in every response. Following the scoring scale used in Diessel & Tomasello (2005) and Kidd at el. (2007), we assigned the children's responses a score of 1, 0.5, or 0. The higher the score was, the more accurate the response was. A response was scored "1"

[4] Unlike previous sentence repetition studies, we used the same verbs and nouns for the agent-patient relation across all the four conditions in the test paradigm. This was to avoid any potential differences caused by the different lexical items. We acknowledge that the lexical overlap in the stimuli between conditions might bring about priming or interference across trials. This will be discussed in Section 4.

if it was essentially correct. Changes that did not alter the structure or the meaning of the target sentence were permitted, such as variations in aspect markers (e.g. *na-le* 'carry-PAST' for *na-zhe* 'carry-Progressive'), variations in determiners and classifiers (e.g. *yi-zhi* 'one-CL', *na-yi-zhi* 'that-one-CL', *na-zhi* 'that-CL'),[5] and adding extra determiners, adjectives or adverbs (e.g. *hongse-de pingguo* 'red apple' for *pingguo* 'apple'). A score of "0.5" was given if the response contained minor deviations from the target. Such deviations included lexical substitutions (e.g. *tangguo* 'candy' for *pingou* 'apple'.), and omissions of adverbs, adjectives, determiners, and head nouns. A score of "0" was assigned to ungrammatical/uninterpretable/ambiguous responses, and to responses that changed the structure or the meaning of the target sentence. There were a total number of 800 (50 participants x 16) responses, with 200 responses under each condition. Three responses were discarded due to the experimenter's own error. The analyses reported below were based on the remaining 797 responses.

3. Results and discussion

This section is divided into two parts. The first part focuses on the analyses of the rating scores, and the second part focuses on the analyses of non-target responses the child participants produced.

3.1 Score analyses

3.1.1 Results

Table 6 presents the frequency of each scoring category (0, 0.5, 1) under each condition for each age group. As shown in Table 6, the number of responses which scored "1" increased from the 3-year-olds to the 5-year-olds across all conditions, while the number of responses which scored "0" decreased from the 3-year-olds to the 5-year-olds under each condition except for the Object-gap Long RC condition. Such a pattern suggests that there is clear progress in Mandarin-speaking children's performance of RCs from 3- to 5-years-old. In the 3-year-old and 4-year-old groups, there were more "0" responses than "1" responses under both the subject-gap and object-gap conditions, regardless of the length of the RCs, suggesting that Mandarin-speaking children of 3- to 4-years-old produce many non-target responses in imitating RCs. For the 5-year-olds, the pattern reversed: the "1" responses outnumbered the "0" responses across all conditions, except for the Object-gap Long RC condition. This suggests that there is a great improvement in imitating RCs for the

[5] We did not consider misuses of classifiers as incorrect, because it is not until age of five that Mandarin-speaking children have a full grasp of classifiers (Li, Huang & Hsiao 2010).

5-year-olds, although the long object-gap RCs remain difficult for them.

The sum scores are presented in Table 7 and the average scores are summarized in Table 8. Overall, the older children obtained higher scores than the younger children, and the short RC conditions scored higher than the long RC conditions. The 3-year-olds exhibited unstable patterns and were almost equally poor across all conditions. The 4-year-olds had higher scores for the subject-gap RCs than for the object-gap RCs when the RCs were long, but their scores were similar for the short RCs. The 5-year-olds gained higher scores for the subject-gap RCs than for the object-gap RCs under both short and long RC conditions. The observed patterns were tested for significance with a three-way mixed model ANOVA based on the average scores: age (3) x gap position (2) x RC length (2). The analysis revealed significant main effects of gap position ($F(1,47) = 5.097$, $p = .029$), RC length ($F(1,47) = 9.635$, $p = .003$), and age group ($F(2,47) = 7.134$, $p = .002$). There were no interactions among the three factors or between any of the two factors (ps > .05). Overall, the children performed significantly better with subject-gap RCs than with object-gap RCs (0.413 vs. 0.346, $p < .05$), and significantly better with short RCs than with long RCs (0.418 vs. 0.340, $p < .05$). Regarding the effect of age, further pairwise comparisons show that the 5-year-olds performed significantly better than the 4-year-olds and the 3-year-olds (.535 vs. .389, $p = .045$; .535 vs. .214, $p < .001$), and the 4-year-olds performed marginally better than the 3-year-olds (.389 vs. .214, $p = .0$ 73).

Table 6. The frequency of Score "0, 0.5, 1" under each condition for each age group

	Short RC						**Long RC**					
	Subject-gap			**Object-gap**			**Subject-gap**			**Object-gap**		
Score	**0**	**0.5**	**1**	**0**	**0.5**	**1**	**0**	**0.5**	**1**	**0**	**0.5**	**1**
3-year-olds	39	6	11	41	8	7	38	14	4	33	21	1
4-year-olds	38	9	25	37	7	28	36	14	21	36	27	9
5-year-olds	14	17	41	27	14	31	24	18	29	35	18	19

Table 7. The sum score under each condition for each age group

	Short RCs		**Long RCs**		
	Subject-gap	**Object-gap**	**Subject-gap**	**Object-gap**	**Total**
3-year-olds	14	11	11	11.5	47.5
4-year-olds	29.5	31.5	28	22.5	111.5
5-year-olds	49.5	38	38	28	153.5

Table 8. The average score (standard deviation) under each condition for each age group

	Short RCs		Long RCs		
	Subject-gap	**Object-gap**	**Subject-gap**	**Object-gap**	**Total**
3-year-olds	.250 (.086)	.196 (.058)	.196 (.065)	.211 (.044)	.214 (.064)
4-year-olds	.410 (.079)	.438(.088)	.396 (.072)	.313 (.059)	.389 (.056)
5-year-olds	.688 (.053)	.523 (.073)	.537 (.073)	.389 (.065)	.535 (.056)

Note: The average scores were calculated by averaging the mean scores across the participants under each condition within each age group.

3.1.2 Discussion

The analyses of the scores yielded several findings. First, the significant main effect of gap condition suggests that Mandarin-speaking children perform better with subject-gap RCs than with object-gap RCs. Yet, when averaging across length conditions for the subject-/object-gap conditions, as shown in Figure 1, we see that the asymmetry is only most evident in the 5-year-old group.

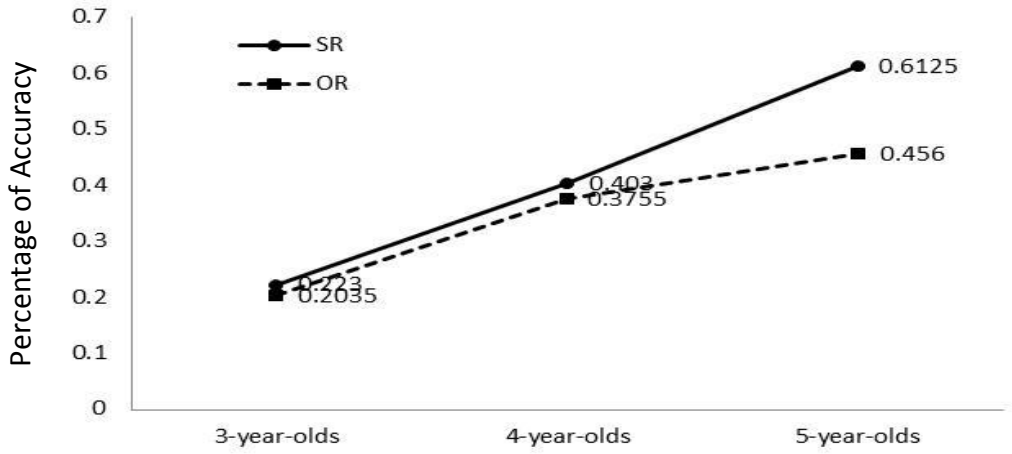

Figure 1. The interaction pattern between the age group and the gap condition

Thus, despite of the lack of significant interaction between the gap condition and the age group, the result patterns suggest that it is probably the 5-year-old group who exhibited clear subject-object asymmetry in their performance that contributed most to the overall significant main effect of gap position. Since our test RCs were matched to those found in the corpus and not biased toward either type of RC, such a finding suggests that the asymmetry found in the 5-year-olds might be attributed to the

different gap position in the RC structure.

Secondly, the 5-year-olds performed RCs better than the 4- and 3-year-olds, indicating a clear developmental progress in RC acquisition. The 3-year-olds and the 4-year-olds showed inconsistent patterns for the short RCs and the long RCs, suggesting that they have difficulty in imitating RCs successfully. Not until 5-years-old can Mandarin-speaking children stably imitate RCs. Lastly, as predicted, long RCs are harder than short RCs for children, yet no interaction between the gap and the length was found. This could be because the number of participants was not big enough to yield significant interactions, or because these factors are independent and do not interact. We leave this issue open for future research.

Interestingly, we also found that 3-year-olds and 4-year-olds exhibited different patterns when tackling the short and the long RCs. For the 3-year-olds, the scores for both short RCs and long RCs were all very low, less than 25% of correct imitations, and the differences between the subject-gap RCs and the object-gap RCs were also very small (*differences* < .055). However, the 4-year-olds showed interesting differences between the short RCs and the long RCs. For the short RCs, their performance on object-gap RCs was slightly better than on subject-gap RCs (.438 vs. .410), although the difference was not obvious. For the long RCs, their performance on subject-gap RCs was much better than on object-gap RCs (.396 vs. .313). One possible reason for this result pattern from the 4-year-olds is that the short RCs were too easy to elicit obvious differences, while the long RCs were difficult enough to elicit clear subject-object asymmetry. However, this explanation is challenged by the result pattern of the 5-year-olds, which exhibited clear subject-object asymmetry for both short and long RCs. If the short RCs were too easy to elicit differences, the 5-year-olds should have performed similarly on both the short subject-gap RCs and the short object-gap RCs, as did the 4-year-olds. Yet, this was not what we found. In other words, the contrast between the 4-year-olds and the 5-year-olds implies that age four is the critical period for Mandarin-speaking children to develop and improve their performance of RCs. At 4-years-old Mandarin-speaking children still struggle to imitate RCs whilst they become much better at 5. Our finding suggests that it is when Mandarin-speaking children can imitate RCs stably (i.e. when they are 5-years-old) that they show clear subject-object asymmetry consistently. This pattern of results confirmed our hypothesis that age plays a role in children's performance of RCs.

3.2 Analyses on the non-target responses

3.2.1 Results

To further understand children's difficulty in imitating RCs, we analyzed their non-target responses systematically. We identified the major features from all responses that received a "0" score, and classified them into nine categories. The definitions for these nine types of non-target responses are listed in (3). An example for each type is provided, with references to the target-like responses in Table 5.

(3) Nine types of non-target responses and their definitions

A. Dropping DE: The RC marker DE was dropped.

拿著	那個	玩偶	女孩	已經	回家了。
*Nazhe	na-ge	wanou	nühai	yijing	huijia-le.
hold	that-CL	doll	girl	already	go.home-ASP

'(Intended) The girl who held that doll has gone home already.'

B. Dropping embedded noun: The embedded noun inside the RC was dropped.

打開 (??)	的	那一個	女孩	已經	回家了。
*Dakai	de	na-yi-ge	nühai	yijing	huijia-le.
open	DE	that-one-CL	girl	already	go.home-ASP

'(Intended) The girl that opened (the gift) has gone home already.'

C. Resumptive NP: The gap was filled with an NP.

女孩	拿著	玩偶	的	玩偶	髒掉了。
*Nühai	nazhe	wanou	de	wanou	zangdiao-le.
girl	hold	doll	DE	doll	dirty-ASP

'(Intended) The doll which the girl held (the doll) got dirty.'

D. Wrong RC type: The expected object-gap RC (I) was replaced by a subject-gap RC in the actual response (II), and vice versa.

I. Expected response (object-gap RC)

那位	老師	踩到	___	的	樹枝	好像	斷掉了。
Na-wei	laoshi	caidao	___	de	shuzhi	hoaxing	duandiao-le.
that-CL	teacher	step-on		DE	branch	seem	broken-ASP

'The branch that the teacher stepped on seemed broken.'

II. Actual response (subject-gap RC)

那位	___	踩到	老師	的	樹枝	斷掉了。
Na-wei		caidao	laoshi	de	shuzhi	duandiao-le.
that-CL		step-on	teacher	DE	branch	broken-ASP

'The branch that stepped on the teacher was broken.'

E. Wrong head: The positions of the head noun and the embedded noun were switched, as exemplified in (I-II) below.

I. Expected response

打開	那盒	禮物	的	女孩	回家了。
Dakai	na-he	liwu	de	nühai	huijia-le.
open	that-CL	gift	DE	girl	go.home-ASP

'The girl that opened the birthday gift went home.'

II. Actual response

打開	那個	女孩	的	禮物	回家了。
Dakai	na-ge	nühai	de	liwu	huijia-le.
open	that-CL	girl	DE	gift	go.home-ASP

'The gift that the opened the girl went home.'

F. Ungrammatical use of DE: The ungrammaticality involved the misuse of DE.

那位	女孩	的	打開	的	禮物	已經	不見了。
*Na-wei	nühai	de	dakai	de	liwu	yijing	bujian-le.
that-CL	girl	DE	open	DE	gift	already	gone-ASP

'(Intended) The gift that the girl opened has disappeared already.'

G. Fragments: Syntactically incomplete responses

踩到	……	受傷了
*Caidao	……	shoushang-le
step-on		hurt-ASP

H. Uninterpretable utterances: Incomprehensible responses

打開	的	禮物	回家了。
Dakai	de	liwu	huijia-le.
open	DE	gift	go.home-ASP

I. Non-RC responses: Responses that used other constructions yet with similar meanings, such as possessive construction.

那位	男孩-的	蘋果	壞掉了。
Na-wei	nanhai-de	pingguo	huaidiao-le.
that-CL	boy-DE	apple	rotten-ASP

'The boy's apple was rotten.'

The participants' responses were coded for the above nine major non-target types. A response was coded for more than one type if it associated with two or more non-target types. The counts for these non-target types under each gap condition and for each age group are summarized in Table 9. Overall, the most frequent non-target response for both types of RC across all age groups was dropping the RC marker DE. This accounted for 38.9% (174/447) of all the non-target responses. Interestingly, the

number of dropping DE for SR was higher than that for OR in the 4-year-old group (44 vs. 29), but this pattern was reversed in the 5-year-old group (16 vs. 38). The second most frequent non-target response found across all age groups was dropping the embedded noun, accounting for 19% of the errors (85/447). In contrast, Resumptive NP and Wrong RC type were the two least frequent non-target types, accounting for about 3% of errors.

Across the age groups, different non-target types dominated two different gap conditions. *Dropping embedded noun*, *Wrong head*, and *Ungrammatical DE* appeared more often under the SR condition than under the OR condition, while the *Resumptive NP*, *Wrong RC type*, and *Non-RC response* appeared more often under the OR condition than under the SR condition. Moreover, differences were observed among each age group in terms of the non-target types. In the 3-year-old group, one major non-target type was "Fragments" (39 counts), yet the number of this type decreased dramatically in the 4-year-old and 5-year-old groups. In addition, the 3-year-olds produced more uninterpretable sentences under the SR condition than under the OR condition, but this pattern was reversed for the 4-year-olds and 5-year-olds.

Table 9. The frequency of each non-target type under each gap condition for each age group

	3-year-old		4-year-old		5-year-old		
Category	**SR**	**OR**	**SR**	**OR**	**SR**	**OR**	**Total**
Dropping DE	25	22	44	29	16	38	**174**
Dropping embedded noun	21	9	23	18	9	5	**85**
Resumptive NP	0	0	0	2	0	3	**5**
Wrong RC type	0	5	1	2	0	2	**10**
Wrong head	3	2	8	0	5	0	**18**
Ungrammatical DE	5	1	3	2	7	2	**20**
Fragments	18	21	5	4	1	3	**52**
Uninterpretable	17	5	7	10	4	6	**49**
Non-RC response	4	14	0	11	0	5	**34**
SUM	**93**	**79**	**91**	**78**	**42**	**64**	**447**

Note: SR = subject-gap; OR = object-gap

3.2.2 Discussion

Analysis of the non-target responses yields some very interesting findings. First, the major difference between the 4-year-olds and the 5-year-olds is "Dropping DE". Opposite patterns regarding the error of Dropping DE probably suggest that the key to

marking the different performance on RCs between the 4-year-olds and the 5-years-olds depends on whether the children keep the RC marker DE in constructing the two types of RCs. One possible reason why the 4-year-olds did not show obvious subject-object asymmetry is because they dropped DE much more often under the SR condition than under the OR condition. This is contrary to what the 5-year-olds did.

Second, the other very frequent non-target response – dropping the embedded noun – was found to appear more frequently under the SR condition than under the OR condition across age groups. That is, the children tended to drop the embedded objects in the subject-gap RCs more than the embedded subjects in the object-gap RCs. Such asymmetry seems to counter the grammatical constraints on the occurrence and the interpretation of null pronouns in Mandarin. Although Mandarin Chinese allows the use of null arguments in both subject and object positions, it has been proposed that the distribution of null arguments is more restricted in the object position than in the subject position inside embedded clauses (Huang 1984, 1989).[6] However, to examine how the dropping of embedded arguments by children may be relevant to the grammar is beyond the scope of this paper, and is an issue worthy of further research.

Third, the major non-target response that separates the 3-year-olds from the other two groups (4-/5-years-olds) is "Fragments." The high production of fragments by the 3-year-olds provides clear evidence that Mandarin-speaking children of this age have serious trouble in constructing and imitating RCs successfully.

Finally, there was a certain consistency in the strategies that the children used to deal with the difficulty of the two types of RCs. Putting the 3-year-olds aside, we found that in the 4- and 5-year-olds, the responses of resumptive NPs and non-RC responses are only found under the OR condition but not under the SR condition, while the wrong head responses were found under the SR condition, but not under the OR condition. Currently, we are unsure if these strategies correlate with the position of the gap and the head noun in the RC structure. More evidence and data are needed for further investigation.

4. General discussion and implications

This study on RC acquisition in Mandarin is significant in several regards. In terms of the test materials, it is the first study to consider the prototypical RC features in child Mandarin. By embedding the features of head animacy and types of embedded nouns in the test materials, we not only avoid potential material bias in the

[6] Huang (1984, 1989) proposes that while both null subjects and null objects in embedded clauses may be interpreted as a variable, only null subjects (not null objects) in embedded clauses can be co-indexed with the matrix subject and interpreted as a null pronominal (*pro*).

experimental outcome, but also get to see how Mandarin-speaking children perform these typical RCs in an experimental setting. In terms of the task, it is the first study to employ a sentence imitation task in testing Mandarin-speaking children's RC performance. This task removes some inherent confounds associated with act-out comprehension tasks and elicited production tasks, and allows us to examine Mandarin-speaking children's performance of RCs in a more impartial way. Lastly and most importantly, our study manipulated RC length in conjunction with gap position, and tested Mandarin-speaking children of different ages. This design offers a way to look into how Mandarin-speaking children's performance of RCs may vary according to age. Below, we discuss the implications of our findings.

4.1 The subject-object asymmetry in RC acquisition in Mandarin

Our study started out by noticing inconsistencies in the previous findings on the issue of whether Mandarin-speaking children show a preference for subject-gap RCs over object-gap RCs. As reviewed in Section 1.1, materials used in past experiments had a lot of variations and did not take into account the lexical features of typical child RCs. Furthermore, the observed discrepancy between the patterns found in child corpora (Chen & Shirai 2014) and the patterns found in experiments (e.g. Hsu et al. 2009) made us wonder if age may play a role here. By addressing these concerns in our experiment, our findings provide some insights into this issue.

First, our sentence imitation experiment shows that only the 5-year-old children exhibit clear subject-gap advantage consistently, not the 3-year-olds and the 4-year-olds. To be more specific, 3-year-old Mandarin-speaking children have pretty low accuracy in their performance of both subject-gap and object-gap RCs, and 4-year-old Mandarin-speaking children are in a transitional period and show unstable performance of RCs. It is not until 5-years-old that Mandarin-speaking children can imitate the structure of RCs stably (above 50% of accuracy), and the subject-object asymmetry in RC performance emerges consistently. This finding is important because it suggests that there is no direct answer to the question of whether there is subject-object asymmetry in RC acquisition in Mandarin. Instead, it depends on the age of which children are able to imitate and construct RC structures stably. That is, when children are above age four and can imitate RC sentences successfully, their performance of RCs show a clear subject-object asymmetry. In other words, when children are too young, it is not easy to observe such asymmetry (the possible reasons are discussed in the next section). Thus, our finding suggests that Mandarin-speaking children, like English-speaking children, show an advantage for subject-gap RCs over object-gap RCs, but at a later age.

Second, our finding of the 5-year-old children's clear advantage for subject-gap RCs over object-gap RCs speaks against proposals solely based on surface word order to explain subject-object asymmetry. This is because these proposals incorrectly predict the opposite pattern, that object-gap RCs should be easier than subject-gap RCs for Mandarin-speaking children because the former (object-gap RC: [N-V _de] N), but not the latter (subject-gap RC: [_V-N de] N), has similar word order to the canonical sentences ([N-V-N]) in Mandarin. Since the canonical word order hypothesis (Diessel & Tomasello 2005, etc.) is not supported by the subject-object assymetry found in our study, the construction-based analysis which was developed based on the surface word order to explain the acquisition of Chinese RCs (Diessel 2007, etc.) may also need to be reconsidered.

Third, our finding of clear subject-object asymmetry in 5-year-old Mandarin-speaking children endorses the structure-based accounts because they correctly predict that object-gap RCs are harder than subject-gap RCs in Mandarin. According to the structure-based accounts, object-gap RCs are harder than subject-gap RCs because object gaps are more deeply embedded in the hierarchical structure than subject gaps (Keenan & Comrie 1977, O'Grady 1997, etc.). Following this, our finding also has some implications for linguistic analyses of RC constructions in Mandarin. Currently, linguists have two different approaches to explain the formation of Mandarin RCs. One approach is based on a generative framework which analyzes Mandarin head-final RCs as being derived via syntactic movement that involves gap creation, similar to English head-initial RCs (Aoun & Li 2003, Huang 1982, Huang, Li & Li 2009, etc.). The other approach, proposed by Comrie, argues that head-final RCs such as Mandarin RCs should be considered as a subset of noun-modifying constructions involving no syntactic operations like movement and gaps (Comrie 1996, 1998, 2002, etc.). According to Comrie, Mandarin RCs are like other noun-modifying clauses and are formed by attaching the clause to the head noun based on semantic-pragmatic relations. Since our finding supports structure-based accounts of subject-object asymmetry which assume the existence of gap, it indirectly favors the syntactic movement analysis over the semantic-pragmatic analysis of Mandarin head-final RCs.

4.2 The factor of age in the performance of RC

How should we explain Mandarin-speaking children's early usage of object-gap RCs found in Chen & Shirai's (2014) corpus study and the preference of subject-gap RCs over object-gap RCs in the 5-year-olds in our imitation experiment? It is possible that developmental and processing constraints associated with age are involved. Chen

& Shirai's (2014) corpus study on spontaneous speech data showed that Mandarin-speaking children under age four produce predominantly more object-gap RCs than subject-gap RCs. Chen & Shirai (2014) attributed such object primacy to the similarity to SVO word order in simple sentences and to the distributional pattern from the caregivers. However, given our findings, we may need to rethink Chen & Shirai's (2014) data and their proposals.

First, if object-gap RCs are easier because of their similar word order to simple sentences, why would 5-year-old Mandarin-speaking children perform subject-gap RCs better than object-gap RCs as is shown in both our imitation experiment and other experiments? Could it be possible that children under age four rely more on the surface word order in their production of RCs, and when they turn from 4 to 5-years-old, they gradually begin to rely on the abstract structural representation of RCs? Although this shift may appear a bit strange, it is not entirely impossible because abstract concepts and representations are usually developed later in childhood. More careful investigation is needed to further explore this possibility.

Second, it is also possible that some extra pragmatic factors involved in spontaneous conversations but not in controlled experiments play a role in explaining the different patterns found between Chen & Shirai's (2014) corpus study and our experimental study. Chen & Shirai suggested that young children's predominant usage of object-gap RCs is a reflection of caregivers' input because Mandarin-speaking adults also use far more object-gap RCs than subject-gap RCs in their conversations with young children. Yet, this contradicts the findings from several corpus studies which consistently show that Mandarin-speaking adults use far more subject-gap RCs than object-gap RCs (Hsiao & Gibson 2003, Pu 2007, Wu et al. 2011, etc.). Recently, Hsu (2014) looked into why more object-gap RCs are used in caregiver-child conversations in Mandarin, and found that the majority of the object-gap RCs are associated with the so-called "cleft construction", which typically puts a particular constitent into focus. That is, pragmatic factors such as getting attention in natural conversations may induce caregivers and chidlren to use the cleft RC structure for focus effect, resulting in children and caregiver's high production of object-gap RCs. Insterestingly, Hsu (2014) found that when focusing on typical noun-modifying RCs that involve no focus effect, the proportions of subject-gap and object-gap RCs produced by children and caregivers were similar. In our imitation experiment, we removed any potential pragmatic factors, and tested children with only typical noun-modifying RCs. We found no object primacy in the performance of RCs. Instead, we observed a clear progress in children's imitation of RCs from 3- to 5-years-old. Importantly, we see a clear preference for subject-gap RCs over object-gap RCs in 5-year-old children, and this suggests that age is relevant to subject-object assymetry

in Mandarin-speaking children's performance of RCs.

Lastly, the limited processing abilities associated with age in relation to the performance of RCs in children should be discussed. In our study, we found that Mandarin-speaking children, across different age groups, performed short RCs significantly better than long RCs. This finding supports the proposal that longer RCs take more processing resources and therefore are harder. In addition, recall that the analysis of the non-target responses (Table 9) showed that younger children produce more non-target responses of each type. In particular, the 3-year-old children produced a lot more fragmental responses, and 4-year-old children made of lot of Dropping DE errors. Since younger children have a smaller working memory capacity than older children, we suspect that the limited cognitive recourses in younger children made them perform worse in the sentence imitation task. This is because such a task requires them to first memorize the given test sentences and then repeat them directly. It is also possible that the lexical overlap in our test materials caused some interference or priming effects which affected the younger children more than the older children. As the processing abilities are associated with age as well as cognitive development in children, these are all potentially contributing factors regarding younger children's difficulty in imitating and constructing RCs successfully.

4.3 Limitations and concluding remarks

This study provides a new perspective to look at the issue of subject-object asymmetry in RC acquisition in Mandarin. That is, it is important to consider the effect of age in children's performance of RCs. Both developmental constraints and processing constraints associated with age may affect children's performance in experiments. Usually, when children reach a certain age, they are able produce RCs correctly and their differential preference for subject-gap RCs over object-gap RCs may emerge clearly. One limitation of our study is that the animacy of the head nouns of the subject-/object-gap RCs in our test materials matched the preferred animacy pattern found in the child corpus, and this could be a potential confounding factor in the design. We suggest that further studies with a balanced number of animate heads and inanimate heads within each gap condition should be carried out to better understand the issue. Overall, our findings imply that the issue of subject-object asymmetry is not just a simple yes-no question, but is more complex than it first appears.

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年齡在漢語兒童表現關係子句上扮演的角色

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以中文為母語的兒童是否於主要名詞在後的中文關係子句表現上有主賓不對稱的現象，一直以來廣受爭議與討論。根據過去的研究結果，本研究假設年齡為影響因素，以語句模仿實驗測試三個年齡組（分別為三歲、四歲、及五歲）的兒童。實驗結果顯示，五歲兒童組在主語關係子句（subject-gap RCs）的表現較賓語關係子句（object-gap RCs）為佳，其他兩組兒童則無此顯著表現。此外，與三歲兒童組比較，四歲兒童組的表現較少為片斷式語句，但四歲兒童組又較五歲兒童組容易丟失關係子句之標記「的」；這些現象說明年齡在關係子句的表現上具有關鍵性，且四歲是關係子句表現的過渡時期。綜合以上可知，當兒童能穩定地模仿關係子句，通常在四歲之後，他們的關係子句表現能展現明顯的主賓不對稱；另外，我們的研究結果建議在評估兒童的關係子句表現時，應將與年齡相關的發展制約（developmental constraints）以及認知處理制約（processing constraints）納入考量。

關鍵詞：關係子句、漢語、兒童語言習得、年齡、句法發展