THE ACQUISITION AND USE OF MANDARIN RELATIVE CLAUSES BY MONOLINGUAL AND BILINGUAL CHILDREN AND ADULTS

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Declaration

I declare that this thesis is my own work completed under the supervision of Dr Silke Brandt and Dr Vittorio Tantucci, and that it has not been submitted, in whole or in part, for the award of a higher degree elsewhere.

Shijie Zhang

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Abstract

Children have been found to understand and use relative clauses (RCs) at an early age. However, not all types of RCs are acquired at the same time, and are used with the same frequency (e.g., Diessel & Tomasello, 2000, 2005). Using corpus-based and experimental methodologies, the three studies presented in this thesis investigate the acquisition and processing of different types of RCs in Mandarin, aiming to understand the mechanisms involved in the acquisition and processing of RC involving varying degrees of complexity.

The first study (Chapter 3) presents a corpus analysis examining the naturalistic production of Mandarin RCs by Mandarin-speaking monolingual and heritage Mandarin-English bilingual children (1;00-5;00). The results show that both monolingual and bilingual children produce more object RCs than subject RCs in Mandarin. This is because Mandarin object RCs resemble simple Subject-Verb-Object (SVO) sentences the children had previously acquired, and occur more frequently than subject RCs in their input. Compared to monolingual children, bilingual children produce more object RCs, suggesting that the acquisition of Mandarin RCs is not only facilitated by SVO transitives in Mandarin, but also SVO transitives in English.

In contrast to the first study, the second study (Chapter 4) reports a subject RC advantage by looking at the comprehension of Mandarin subject and object RCs in heritage Mandarin-English bilingual children (4;00-10;11) and their vocabulary-matched monolingual peers (4;00-5;09). Using a character-sentence matching task, the results reveal that simple SVO transitives hinder children's comprehension of Mandarin object RCs by misleading them to interpret the noun phrase occurring first as the head noun. Compared to monolingual children, bilingual children who are more English dominant make this type of error more frequently for Mandarin object RCs, suggesting that both English SVO transitives and language dominance contribute to cross-linguistic influence.

However, unlike either the subject or object RC advantage shown in children, mixed results are found in the writing of adult Mandarin native speakers (L1) and advanced second language learners (L2) in the third study (Chapter 5). Using conditional inference trees and random forests, the results show that both adult Mandarin L1 and L2 speakers' selection of subject and object RCs heavily depends on the discourse context that RCs are situated in.

The first and second studies (Chapters 3 and 4) are novel in taking Mandarin RCs with omitted head nouns into account. In spontaneous speech (Chapter 3), the results indicate that monolingual and bilingual children as young as two can produce Mandarin RCs with omitted head nouns, and the omission of a head noun does not influence the subject-object asymmetry. Similarly, the absence of a head noun does not influence monolingual and bilingual children's comprehension of Mandarin RCs (Chapter 4), suggesting that they are able to recover omitted head nouns from the context provided.

In addition, the first and third studies (Chapters 3 and 5) also examine the matrix-clause positions in which Mandarin RCs tend to occur. RCs that occur in the non-centre-embedded matrix-clause position (e.g., *The goat saw the horse [that hugged the pig]*) are expected to be easier to process than RCs in the centre-embedded matrix-clause position (e.g., *The horse [that hugged the pig] saw the goat*), as they require lower working memory load (e.g., Gibson, 1998, 2000). Supporting this assumption, in adult Mandarin L1 and L2 speakers' writing (Chapter 5), non-centre-embedded RCs occur more often than centre-embedded RCs. Moreover, the longer the RCs, the higher the possibility they are placed in the non-centre-embedded matrix-clause position. However, in children's spontaneous speech (Chapter 3), both monolingual and bilingual children do not show a tendency to prefer non-centre-embedded over centre-embedded RCs, which may relate to the short length of the RCs they produce. The shorter the RCs, the less memory load is needed to process centre-embedded RCs, and therefore the disadvantage of centre-embedded RCs may diminish.

The three studies of this thesis present mixed findings regarding Mandarin RC processing, but consistently provide evidence to support the usage-based account. That is, the processing of RCs is shaped by an individual's age and language experience, including input frequency, the related structures that have been acquired, language dominance and the discourse contexts that RCs tend to appear in.

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List of Abbreviations

CREED	Construction-based, Rational, Exemplar-driven, Emergent, Dialectic
DOBJ	Direct object in the matrix clause
IShead	Information status of the head noun
ISrc	Information status of the noun phrase within the relative clause
L1	Native/First language
L2	Second language
LCMC	The Lancaster Corpus of Mandarin Chinese
LENmv	Length of the verbal construction in the matrix clause
LENob	Length of the direct-object noun phrase in the matrix clause
LENsu	Length of the subject noun phrase in the matrix clause
NP	Noun Phrase
OBL	Oblique noun phrase in the matrix clause
PN	Predicate Nominal
RC	Relative Clause
RQ	Research Question
SUBJ	Subject in the matrix clause
SUDO	The role of the head noun within the matrix clause
SVO	Subject-Verb-Object
VP	Verb Phrase

Chapter 1: Background Literature

The acquisition of syntax is a process involving incredible complexity. However, children appear to be able to understand and use most of the sentence structures of their language at an early age (e.g., Diessel & Tomasello, 2000, 2005; Diessel, 2004). How children come to be in command of syntactic structures, especially why children acquire some constructions earlier and more easily than others, has become the focus of tremendous interest for researchers in the field of psycholinguistics for decades (e.g., Chomsky, 1959, 1965; Tomasello, 2003; Ambridge & Lieven, 2011; Lieven & Tomasello, 2008).

In comparison to monolingual children, bilingual children and adults seem to face more difficulties during the process of learning the syntactic structures of their two languages. Whether bilinguals learn their two languages in the same manner as monolinguals and the factors that may hinder them from ultimately achieving native-like attainment, are the questions that have also received much attention (e.g., Bley-Vroman, 1990; Ellis, 2006a, b; Ellis & Wulff, 2020; Hulk & Müller, 2000; Schwartz & Sprouse, 1996; Sorace & Filiaci, 2006).

From the point of view of usage-based accounts, this thesis focuses on one of the most extensively studied syntactic structures in the literature: relative clauses (RCs). The complexity and diversity of RCs offer great opportunities to unpack the mechanisms underlying language production and comprehension across languages. In recent decades, considerable attention has been paid to the processing of RCs in European languages such as English, German, and Italian (e.g., Contemori & Belletti, 2012; Contemori & Garraffa, 2010; Diessel & Tomasello, 2000, 2005; Guasti & Cardinaletti, 2003; Kidd & Bavin, 2002; Kidd et al., 2007; Brandt et al., 2008). Most theories being used to explain the RC acquisition and processing have been developed based on findings from European languages (e.g., Gibson, 1998, 2000; Hawkins, 2004; O'Grady, 1997; MacDonald & Christiansen, 2002). So far,

whether RCs in East Asian languages such as Japanese, Cantonese and Mandarin are processed in a similar fashion as in European languages is still not clear (e.g., Ozeki & Shirai, 2007; Chan et al., 2018; Chen & Shirai, 2015; Yip & Matthews, 2007). This thesis builds upon previous research on RC acquisition and processing and seeks to carry out an in-depth investigation into the acquisition and use of RCs in Mandarin.

In this chapter, I begin with a brief overview of the usage-based and generative approaches to syntactic acquisition (Section 1.1), followed by theories of bilingual syntactic development (Section 1.2). Then, I turn to a discussion of the typology of RCs and explain the characteristics of Mandarin RCs that are important for this research (Section 1.3). Next, I review theories of RC acquisition and processing, and whether they can be applied to RCs across typologically different languages like English and Mandarin (Section 1.4). Lastly, this section also highlights potential gaps in the existing research on Mandarin RCs.

1.1 Usage-based and Generative Approaches to Syntactic Acquisition

Given the complexity of language systems, a major debate in child language acquisition is whether children are born with an innate knowledge of linguistic categories and structures or learn it through experience. This section will overview two major contrasting theoretical approaches: the generative and the usage-based approaches, aiming to describe their perspectives on how children acquire syntactic knowledge.

1.1.1 The Generative Approach to Syntactic Acquisition

Up until the early 1990s, the main tenet of the generative approach is that children are endowed with linguistic knowledge (Chomsky, 1959, 1965). This argument was first proposed against Skinner (1957)'s behaviourist theory of language learning. Skinner (1957) claimed that children learn words and sentences and their meanings through imitation and

reinforcement. For example, if children correctly imitate their mother saying a sentence like "I want juice" and the mother responds by giving them a cup of juice (i.e., reward), then they are reinforced to articulate the same type of sentence in the same situation. However, Chomsky (1959) argued that this stimulus-response process is not sufficient to explain how children can understand and produce sentences they have never encountered before, and there must be innate knowledge that allow children to generate (and understand) an infinite number of utterances.

This innate knowledge of language is known as "Universal Grammar". It embodies the idea that all human languages are fundamentally similar in certain structural properties (Chomsky, 1965). The early generative approach (up until the early 1990s) argues for a very rich Universal Grammar, which consists of three components: i) syntactic categories (e.g., noun, verb, adjective) and phrase-structure rules (e.g., a verb phrase (VP) consists of a verb and a noun phrase (NP)), ii) principles that are true for all languages (e.g., structure dependency), and iii) parameters that are set based on the particular language children hear (e.g., the head-direction parameter) (Ambridge & Lieven, 2011). Each of them will be explained in the following paragraphs.

First, the generativist approach assumes that instead of generalizing from individual words, new-born children come equipped with innate knowledge of syntactic categories, and basic rules to construct phrases and sentences (e.g., Chomsky, 1965). Take a simple sentence such as *I play guitar*. It consists of a subject NP *I*, and a VP containing the verb *play* and an object NP *guitar*. The subject NP only has an obligatory pronoun (termed the head) *I*, while the VP includes not only the head *play* but also an argument (termed the complement) *guitar.* To form the sentence, children first select the verb *play* from the lexicon. Each lexical item (e.g., *play*) is associated with a lexical entry that contains its syntactic category (e.g., verb) and the arguments that it requires. Semantically, the verb *play* needs an agent (the one who

played) and a patient (the one being played). Syntactically, the verb *play* requires a subject and an object NP (Ambridge & Lieven, 2011).

To support the generative view, a number of studies have looked for evidence that children already possess abstract categories and rules in their early development (e.g., Bencini & Valian, 2008; Ferndandes et al., 2006; Lidz & Gagliardi, 2015; Lidz et al., 2003; Messenger & Fisher, 2018; Valian, 2014). For example, Messenger and Fisher (2018) examined 3-year-old English-speaking children's comprehension of passive sentences with novel verbs. In a preferential-looking experiment, children were asked to watch two novel events. One was a causal-action event, in which one person performed an action on another person (i.e., indicating a transitive verb). The other was a simultaneous-action event, in which two people acted individually performing solo actions (i.e., indicating an intransitive verb). Children have been found to look at the causal-action event longer than the simultaneous-action event when hearing a sentence like *She's getting snedded!*. This indicates that children interpreted novel verbs like *snedded* as transitive verbs when presented in a passive construction. In other words, children have the ability to generalize novel verbs presented through a passive sentence frame. Based on this finding, Messenger and Fisher (2018) suggested that children are in possession of abstract syntactic categories.

Second, the generativist approach proposes that there are some innate principles or constraints which limits the number of hypotheses children need to consider in acquiring a language (e.g., Chomsky, 1981, 1986). For example, generativists argue that the input they receive is not sufficient for children to know how to form complex interrogative sentences (e.g., Chomsky,1980; Crain & Nakayama, 1987). Based on the input of some declarative sentences and simple interrogative sentences (see examples (1a, b)), children could simply generalize the rule: moving the auxiliary (e.g., *is*) of the corresponding declarative statement to the start of the sentence can form an interrogative sentence. However, they will have

difficulty in applying this rule when encountering declarative statements with more than one auxiliary (i.e., complex sentences) (Ambridge & Lieven, 2011). Compare examples (2) and (3):

(1) a. He is a student.

b. Is he a student?

(2) a. The boy who is running is a student.

b. Is the boy who is running a student?

(3) a. The teacher is looking for the boy who is running.

b. Is the teacher looking for the boy who is running?

In example (2), in order to turn the declarative sentence (2a) into an interrogative sentence (2b), children will need to move the second auxiliary *is*. However, in example (3), it is the first auxiliary *is* in the declarative sentence (3a) that needs to be moved in order to form the interrogative sentence (3b). How are children able to hypothesize which is the correct auxiliary to move? The generativists propose that instead of a hypothesis based on linear order (i.e., move the first or second auxiliary), children's language acquisition relies on innate structure-dependent knowledge, that is, moving the auxiliary in the matrix clause to the start of the sentence (Chomsky,1980).

Third, in addition to the grammatical categories and principles that are the same for all languages, there are some language-specific features in each language (e.g., Chomsky, 1981, 1986). For example, in an English VP like *play guitar*, the head *play* occurs before the complement *guitar*, while in Japanese and Korean, the head comes after the complement.

How do children acquire this type of knowledge? The generativist account assumes that children's innate knowledge contains various parameters such as a head-direction parameter. On the basis of only a minimal amount of input of their language, children can set the parameter correctly regarding whether the language is head-initial or head-final (Chomsky, 1981; Hyams, 1986).

As discussed above, children born with Universal Grammar are assumed to be able to form structural representations rapidly and effortlessly despite the lack of rich and detailed information in the input data (Chomsky, 1965). However, children indeed make grammatical errors that do not occur in adult language. To explain these, some generative linguists suggest that they could be attributed to children's performance errors (Chomsky, 1965). That is, due to "memory limitations, distractions, shifts of attention and interest, and errors (random or characteristic)" (Chomsky, 1965, p. 3-4), children may make errors in applying the innate knowledge in actual performance.

For example, it has been found that roughly from 20 to 25 months, children acquiring a non-null subject language such as English, Dutch and German produce sentences with missing subjects (e.g., **Falled in the briefcase*) (e.g., Behrens, 1993, De Haan & Tuijnman, 1988; Haegeman 1995; Hyams, 1986). By looking at English-speaking children's early utterances, Bloom (1990) and Valian (1991) suggested that children's subject omission is a performance deficit instead of a competence deficit. The reason children omit subjects in their early years is that they can only produce utterances of a certain length, and "subject omission is the least costly way to reduce utterance length given that the subject often represents old information" (Roeper & Rohrbacher, 1994, p. 4).

Different from performance accounts, some other generativists hold that children's syntactic errors are related to an incorrect setting of a parameter (Hyams, 1986). Hyams (1986) suggested that the null subject error could be because children start out with a null

subject parameter, and later reset the parameter once they encounter more input and identify related grammatical structures. In support of this assumption, Orfitelli and Hyrams (2012) found that in a truth-value judgment experiment, younger children (2;06-2;11) preferred assigning a declarative interpretation to null subject sentences like *play with blocks*. With increasing age (3;00-3;05; 3;06-3;11), children became more adult-like by correctly assigning an imperative interpretation to null subject sentences.

In addition to performance errors and incorrect parameter setting, the absence of certain principles of Universal Grammar in children's early grammars has also been proposed to explain children's errors (Structure building theory, Radford, 1990a, b, 1996). Radford (1995) argued that when children around 20-24 months schematically omit determiners like *the*, *a*, it could be because they have not developed functional categories like determiners, auxiliaries (e.g., *is*, *has*) and inflectional morphemes (e.g., past tense *-ed*) at this stage.

In sum, the early generative approach provides a detailed specification of Universal Grammar that are innate in children's brains, though they have not reached an agreement on why children are unable to achieve adult-like performance in acquiring certain structures. However, in the relatively recent version of the generative approach, Universal Grammar has undergone a radical slimming down, which includes the property of recursion as "the only uniquely component of the faculty of language" (Hauser et al., 2002, p.1569). Moreover, the recent version gives experience and general cognitive mechanisms potentially bigger roles (Chomsky, 2005), and it does not reject the possibility that "communicative factors might have helped to fine-tune grammatical structure" (Berwick & Chomsky 2016; Hauser et al., 2002; Newmewyer, 2021, p.292), which stands closer with the usage-based ideas.

1.1.2 The Usage-based Approach to Syntactic Acquisition

The usage-based account argues that children are not hardwired with any innate knowledge of grammar, though the ability to learn language is assumed to be innate (Ambridge & Lieven, 2011). Instead, language structures emerge from one's experience of language (e.g., Bybee, 2006; Bybee & Scheibman, 1999; Tomasello, 2000). However, recall that the generative approach claims that innateness is inevitable as the input is not sufficient for children to fully capture all structures. How does the usage-based approach solve this issue?

First, unlike the generative approach that adopt a purely formal and abstract point of view, the usage-based account sees any linguistic unit as a construction: a pairing of form with its associated semantic, pragmatic and discourse functions (Croft, 2001; Fillmore et al., 1988; Goldberg, 1995; Langacker, 1987). In other words, children are motivated to learn syntactic structures as they can be used to convey meanings or perform communicative functions (e.g., Casenhiser & Goldberg, 2005; Goldberg et al., 2004, 2007; Goldberg, 2006). For example, Goldberg et al. (2004) conducted a corpus-based study looking at children's early uses of constructions containing a verb. They found that in children's early speech, there was a high-frequency single verb in each of the constructions analysed. Moreover, the earliest and most frequent verbs in each construction directly encode the meaning of that construction. For example, 54 percent of the instances of verb-locative construction (e.g., *I go to the shop*) in the children's speech used the verb *go* to express "someone/something moving to a new place/direction". 31 percent of the instances of verb-object-locative construction (e.g., *He put it on the table*) used the verb *put* to express "someone causing something to move to a new place/direction". This indicates that instead of having innate principles that guide children in developing syntactic structures, children rely on high-frequency verbs in a particular construction to learn the mapping of that construction and its meaning.

Using experimental studies, Casenhiser and Goldberg (2005) also observed form-meaning mapping. They created novel constructions that associated the Subject-Object-Verb (SOV) word order with the meaning of appearance. In the training phrase, children were divided into non-control and control groups. In the non-control condition, children watched video clips depicting the meaning of appearance (e.g., a rabbit appears out of a hat), along with audio descriptions of the scene using a novel verb in a SOV word order (e.g., *the rabbit the hat moopoed*). In the control condition, children watched the same videos without audio. After training, children were asked to watch new video clips, and match them with the sentence being played. More specifically, two new video clips were presented side-by-side on the screen: one depicting an object/character appearing on the screen, while the other depicted the same object/character remaining constant on the screen (e.g., a sailor sails into the screen; a sailor sailing while being constantly on the screen). At the same time, an audio description of one out of two clips using a new novel verb was played (e.g., *the sailor the pond neebos*). The results showed that children trained in the non-control group were significantly better than children in the control group in pointing out the correct clip that corresponded to the audio description. This result suggests that children were able to learn to map the novel construction onto its meaning quickly.

Second, how do children develop their syntactic knowledge from input? According to the usage-based framework, children are not born with abstract grammatical categories (e.g., verb, nouns) and structure rules (e.g., a VP consists of a verb and a NP) (e.g., Ambridge et al., 2005; Lieven et al.,1997; Pine et al., 1998; Pine, et al., 2013; Rowland & Pine, 2000; Theakston et al., 2005; Tomasello, 1992). Instead, they develop the constructions through a continuous process of abstraction (Lieven, 2016). For example, Lieven et al. (1997) looked at utterances in children's speech between the ages of one and three. They found that rather than using syntactic rules to generate productive utterances, children start out with lexically

specific items surrounded by particular frames such as *I/me want X*, *Daddy X it*, and *take X out*. Similarly, Theakston et al. (2012) investigated the transitive SVO construction in a single child's speech from two to three years. The results indicated that the child's earliest SVO utterances were organized around a small number of verbs with proper noun subjects and pronominal objects (e.g., *I see you*). With increasing age (2;07-3;00), the child was able to utter more abstract SVO constructions. For example, they used more lexical objects (rather than pronominal ones) that combine with verbs (e.g., *The car knocked my drink over!*).

Supporting evidence for abstraction was also found in experimental studies (e.g., Abbot-Smith et al., 2001; Akhtar, 1999; Bannard et al., 2009; Matthews et al., 2005). In Abbot-Smith et al. (2001), children aged two to three were invited to play experimental games. In the games, children watched a single toy animal performing an action and heard a verbal description. The verbal description contained a novel verb with the canonical English SV word order (e.g., *The cow baffed*), or with an odd VS word order (e.g., *Meeked the duck*). Then, they were asked elicitation questions like "*What's happening?*". The results revealed that when hearing verbal descriptions with an odd VS word order, children at 3;09 corrected them to the canonical SV word order 66 percent of the time, while children at 2;04 corrected them only 21 percent of the time. Similar results were found by Akhtar (1999). Akhtar (1999) used the same method and found that children at 4;04 corrected noncanonical SOV or VSO word orders to the canonical English SVO word order almost all of the time, while children at 2;08 and 3;06 only corrected them around half of the time. These findings support the idea that instead of being innate, linguistic categories and schemas are generalized gradually.

Third, constructions "can be as small as morphemes and as large as whole utterances" (Lieven & Brandt, 2011, p. 282). How are children able to generalize all of them? Usage-based accounts emphasize that rather than learning all constructions at the same time, children learn them gradually by building up new constructions based on constructions they

have already acquired (Abbot-Smith & Behrens, 2005; Ambridge & Lieven, 2011; Lieven & Tomasello, 2008; Theakston et al., 2012; Tomasello,1992, 2003; Diessel & Tomasello, 2000, 2005). For example, Diessel and Tomasello (2005) looked at the development of RCs in English-speaking children's spontaneous speech (1;09-5;02). They found that subject RCs in copular constructions like *That's doggy turn around* emerge earlier than other types of RCs, as they are similar to simple sentences.

Nevertheless, it should be mentioned that the related constructions that children have previously acquired could not only facilitate but also hinder the acquisition of complex constructions (e.g., Abbot-Smith & Behrens, 2006; Rowland et al., 2014). Rowland et al. (2014) examined the acquisition of ditransitive constructions in English and Welsh using forced-choice comprehension tasks. In English, there are two relatively frequent ditransitives: the double object dative and the prepositional dative. As shown in examples (4) and (5), these two constructions can be used to express similar meanings, but they have different word orders. Different from English, Welsh only has the prepositional dative. The results showed that English children do not acquire both the double object dative and the prepositional dative until age 4, while Welsh children have already acquired the prepositional dative by age 3. This result indicates that the existence of two semantically similar, but structurally different constructions could delay children's acquisition of them.

[English double object dative construction]

(4) The boy gave the girl the book.

[English prepositional dative construction]

(5) The boy gave the book to the girl.

(Examples (4) and (5) from Rowland et al. (2014))

Lastly, in addition to the piecemeal learning of constructions, the usage-based account also considers the input frequency of constructions as an important factor in children's syntactic acquisition (see Ambridge et al., 2015). In children's spontaneous speech, it has been reported that the early use of constructions in children's spontaneous speech resembles what their input is providing (e.g., Cameron-Faulkner et al., 2003; Theakston et al., 2001; Theakston et al., 2002; Theakston et al., 2012). For example, Theakston et al. (2001) investigated the acquisition of verb-argument structures in English-speaking children's early speech. They found that although mixed verbs like *eat* can be used in both the transitive and intransitive frames (e.g., *I am eating* (*an apple*)), children tended to produce them in only a single frame. Moreover, the frame being used resembled the one used with that verb in the input. In addition to concrete constructions, Theakston et al. (2012) revealed that children were also sensitive to the frequency of abstract cues such as animacy. The vast majority of transitives in the input of the child they studied used animate subjects and inanimate objects. The same animacy configuration was also found in the child's early transitives (2;01-2;06).

High-frequency constructions in input have been found to lead to early acquisition, all other things being equal (e.g., McCauley et al., 2019; Rowland et al., 2003; Theakston et al., 2002; Theakston et al., 2004). For instance, Rowland et al. (2003) looked at the order of acquisition of *wh*-questions by English-speaking children (2;00-3;00). They found that input frequency was the most important determinant of the acquisition order of *wh*-questions. Specifically, children acquired *Wh*-questions like *What is he doing*? and *Where is he going?* earlier, due to the high-frequency combination of specific *wh*-words (e.g., *what*, *where*) and verbs (e.g., *be*, *go*) that occurred in the children's input. McCauley et al. (2019) also looked at *wh*-questions in children's early spontaneous speech, but focused on the non-inverted ungrammatical *wh*-questions they produced (see examples (6) and (7)). They found that the

non-inversion errors children made could be predicted by the frequency of non-inverted sequences in the input (e.g., "*she is going*" in example (7)). The more frequently the sequences held together as a chunk in the input, the less likely children would break up the chunk and invert the auxiliary *is* (i.e., utter an inverted grammatical *wh*-question).

(6) What is she going to do?

(7) *What she is going to do?

(Examples (6) and (7) from McCauley et al. (2019))

A great number of experimental studies have also revealed the effects of frequency at different levels. Higher frequency constructions have been found to be used more correctly and comprehended better than those with lower frequency. In Brandt et al. (2009), German-speaking children comprehended subject RCs that were uttered more often in child-directed speech better than object RCs. In Bannard and Matthews (2008), English children also comprehended four-word combinations (i.e., chunks) with high frequency in the input (e.g., *sit in your chair*) better than those with low frequency (e.g., *sit in your truck*). Constructions with high frequency lexical items have also been found to be learned better than constructions with low frequency lexical items. For instance, Casenhiser and Goldberg (2005) observed that children learned the meaning of a particular construction better when the construction frequently occurred with the same novel verb instead of with several novel verbs with equal frequency.

Moreover, constructions with familiar abstract cues (e.g., animacy, word order, and case marking) are comprehended better than those without familiar cues (e.g., Abbot-Smith et al., 2001; Buckle et al., 2017; Chan et al., 2009; Dittmar et al., 2008; Gertner et al., 2006;

Ibbotson et al., 2011; Matthews et al., 2005, 2007; Scott & Fisher, 2009). Chan et al. (2009) conducted an act-out task examining how Cantonese-, German-, and English-speaking children assign thematic roles of agent/patient in transitive sentences with novel verbs. In Cantonese, German and English, both word order and animacy cues can be used to indicate agent-patient relations. That is, they all have the dominant SVO word order and prefer the agent to be animate and the patient to be inanimate. The results showed that three groups of children from age 2;06 found prototypical transitives with both word order and animacy cues easy to comprehend, reflecting the tendency shown in their input (see example (8)).

(8) The horse tams the telephone.

(From Chan et al. (2009))

However, as shown in example (9), when the word order cue was in conflict with the animacy cue (inanimate agent and animate patient), three groups of children tended to use the word order cue than the animacy cue to assign agent and patient roles. That is, they chose inanimate noun occurring at the beginning of the sentence as the agent. This result could be explained by cue availability (i.e., whether a cue is always present) (Bates & MacWhinney, 1989). Unlike word order, an animacy cue is not always present in transitive sentences such as *the dog chases the cat*.

(9) The present tams the chicken.

(From Chan et al. (2009))

In the third condition, when animacy was neutralized and merely the word order cue was provided (see example (10)), English-speaking children had the earliest (from 2;06) and

largest reliance on word order, followed by German-speaking and Cantonese-speaking children. This could be because children were sensitive to cue reliability (i.e., whether a cue is always associated with the correct interpretation) in a specific language (Bates & MacWhinney, 1989). Compared to English, the cue reliability of word order is weaker in German, as it allows more non-canonical word orders (e.g., OVS, OSV, VOS, VSO). In the case of Cantonese, it not only allows several word order variations (e.g., OVS, OSV, VOS, SOV), but also allows arguments to be omitted. That is, in Cantonese, the word order is not reliable and is not always available to mark agent-patient relations.

(10) The cow tams the giraffe.

(From Chan et al. (2009))

In addition, high frequency constructions in the input have also been found to allow children to retreat from making syntactic errors (Ambridge et al., 2008; Ambridge et al., 2009; Brooks et al., 1999; Rowland & Pine, 2000; Theakston, 2004, 2012; Wonnacott et al., 2008). It has been observed that children make different kinds of errors in their early production like the incorrect usage of an intransitive verb (e.g., **The magician disappeared the rabbit*) (Ambridge et al., 2015; Ambridge et al., 2008; Rowland & Pine, 2000). Unlike the generative approach, usage-based linguists claim that syntactic errors occurring in a certain construction are partially related to the frequency of specific lexical items in that construction in the input (Braine & Brooks, 1995). For example, in Ambridge et al. (2008), children (5;03-6;04, 9;03-10;03) were asked to judge if transitive/intransitive sentences with high, low and novel frequency verbs were grammatical. The results showed that children in both age groups were more tolerant of ungrammatical sentences with low frequency verbs (e.g., **The magician vanished Bart)* than those with high frequency verbs (e.g., **The magician*

disappeared Bart). It suggests that when children frequently encounter a verb in a particular construction, they are less likely to make overgeneralization errors for that verb.

To conclude, the usage-based approach is fundamentally different from the generative approach in arguing that "all things flow from the actual usage events in which people communicate linguistically with one another" (Tomasello, 2000, p. 61). Moreover, the usage-based approach views children's syntactic learning as a piecemeal, bottom-up process and emphasizes the role of input frequency.

1.2 Theories of Bilingual Syntactic Development

Concerning syntactic development in bilingual children and adults, one central issue is whether they are on a par with their monolingual peers regarding the rate and route of development in each language. Although some studies reported no difference between bilinguals and their age-matched monolinguals (e.g., Jia & Paradis, 2018; O'Grady et al., 2011; Polinsky, 2011), other studies indeed observed that acquiring two languages leads to cross-linguistic influence, delay, and acceleration in the syntactic acquisition and processing (e.g., Cintrón-Valentín & Ellis, 2016; Ellis & Sagarra, 2010, 2011; Flores & Barbosa, 2012; Herschensohn, 2000; Hulk & Müller, 2000; Rinke & Flores, 2014).

Before turning to an overview of the generative and usage-based approaches to bilingual syntactic development, different types of bilingualism will initially be mentioned. Based on the age of first exposure and the order of acquiring two languages, bilinguals are mainly categorised as early/late bilinguals, and simultaneous/consecutive bilinguals (see Montrul, 2008). Early bilinguals usually refer to bilinguals who acquire their two languages before puberty, while late bilinguals acquire their second language (L2) after puberty. Early bilinguals can further be divided into simultaneous and consecutive early bilinguals. The former are bilinguals who acquire both their languages simultaneously from birth, while the

latter usually refers to bilinguals exposed to their L2 after establishing their first language (L1) around the age of 3-4.

Compared to late bilinguals, early bilinguals are considered to be more successful in gaining the ultimate attainment of L2 grammar (Unsworth, 2008). However, not all early bilinguals are the same. As a special case of early bilinguals, heritage bilinguals often display different outcomes. Specifically, although they sequentially or simultaneously acquire their heritage language in the home environment and the societal majority language outside the home from an early age, they rarely reach native-like competence in their heritage language (Montrul, 2009, 2018).

1.2.1 The Generative Approach to Bilingual Syntactic Acquisition

Under the framework of the generative approach, the core question regarding bilingual language acquisition is whether L2 acquisition is constrained by Universal Grammar in the same way as L1 acquisition. Several accounts have been proposed to answer this question, but their predictions are not in agreement. Accounts like the Fundamental Difference Hypothesis (Bley-Vroman, 1990) claim that late bilinguals, as opposed to early bilinguals, cannot access Universal Grammar due to the late age of onset (see also Lenneberg (1967)'s Critical Period Hypothesis). Instead, adult L2 acquisition relies on domain-general cognitive systems.

For example, DeKeyser (2000) examined the comprehension of English morphosyntactic knowledge (e.g., past tense, *wh*-questions, word order) by L1 Hungarian-L2 English speakers. They were asked to participate in an oral grammaticality judgment task and a Hungarian language learning aptitude test. The results showed that speakers' grammaticality judgment test scores were significantly related to their age of arrival. Specifically, speakers who came to America before age 16 (i.e., early bilinguals) all reached

high scores in the grammaticality judgment task, regardless of their verbal aptitude. However, for speakers who arrived after age 16 (i.e., late bilinguals), only those with above-average verbal aptitude were able to perform as well as early bilinguals. Supporting the Fundamental Difference Hypothesis, the results suggest that the age of arrival was critical to second language acquisition and late bilinguals relied on general cognitive abilities like analytical ability (as predicted by the language learning aptitude test) to achieve a higher level of competence in morphosyntax.

However, the effect of age of onset was challenged by some findings from heritage bilingual children (e.g., Au et al., 2002; Benmamoun et al., 2010; Keating et al., 2011; Knightly et al., 2003; O'Grady et al., 2001). It has been reported that although heritage bilinguals acquired their heritage language early at home, they showed no advantage over adult L2 learners in the development of some aspects of knowledge, such as morphosyntax and inflectional morphology (e.g., Au et al., 2002; Benmamoun et al., 2010; O'Grady et al., 2001). For example, O'Grady et al. (2001) looked at the comprehension of subject and object RCs in Korean by adult L2 Korean learners and heritage language learners of Korean. They found that these two groups of participants were alike in terms of their ability to use morphosyntactic clues such as case markers in the interpretation of RCs.

Moreover, in contrast to the Fundamental Difference Hypothesis, some accounts argue that Universal Grammar is still fully/partially accessible to adult L2 learners (e.g., Minimal Trees Hypothesis, Vainikka & Young-Scholten, 1994, 1996a, b; Weak Transfer Hypothesis, Eubank, 1993/94, 1996; Full Access/Transfer Model, Schwartz & Sprouse, 1996). Experimental findings supporting this assumption provide evidence that adult L2 learners possess knowledge that they cannot acquire from the input they receive, that is, must derive from Universal Grammar (e.g., Clahsen, 1990; Cook, 2003; Jenkins, 1988; White, 1989; Ying, 1999). For example, Cook (2003) investigated L2 learners' knowledge of

structure dependency by looking at their comprehension of complex interrogative sentences. Recall that to form a question, the principle of structure dependency requires the auxiliary in the matrix clause to be moved (*Is Joe [the dog that is black]?*), instead of the auxiliary in a particular linear position. The results showed that in the grammatical judgment task, L2 learners with diverse L1 backgrounds were all able to reject the sentences that violated structure dependency (**Is Joe is [the dog that black]?*).

In addition to the accessibility of Universal Grammar, another widely discussed issue in bilingual language acquisition is how bilinguals' L1 and L2 interact with each other. Although most researchers suggest that bilingual children appear to be able to differentiate between their two language systems from an early age (De Houwer, 1990; Genesee, 1989; Meisel, 1989), they do not exclude the possibility that the two systems are in contact with each other at some level (Hulk & Müller, 2000; Serratrice et al., 2004). Under the framework of the generative approach, the interaction of bilinguals' L1 and L2 is addressed from the perspective of linguistic interfaces.

"Interface" refers to the connection between modules of grammar (e.g., syntax-semantics, syntax-morphology), and between grammatical modules and grammar-external components such as discourse and pragmatics (e.g., syntax-pragmatics, syntax-discourse) (see Sorace & Serratrice, 2009). The former are ascribed to internal interfaces, while the latter are external interfaces. The basic idea is that syntactic structures involving an interface are less likely to be acquired completely by L2 learners, and are more susceptible to cross-linguistic influence than those located in a specific domain like syntax or semantics (e.g., Sorace, 2005, 2006).

However, "not all interfaces are created equal" (Sorace, 2011, p. 7). Based on the Interface Hypothesis put forward by Sorace and Filiaci (2006), linguistic phenomena at the external interfaces tend to be particularly susceptible to cross-linguistic influence than those

at internal interfaces for both child and adult bilinguals, as they integrate properties of language and pragmatic- or discourse-related information (Hulk & Müller, 2000; Serratrice et al., 2004; Serratrice, 2007; Sorace et al., 2009; Sorace & Filiaci, 2006).

For example, Sorace et al. (2009) examined the comprehension of null and overt subject pronouns by school-age Spanish-Italian and English-Italian bilingual children and their monolingual peers. In Italian and Spanish, the preference for null and overt subject pronouns largely depends on the discourse-pragmatic context. In example (11), a null subject pronoun is the pragmatically-optimal option, as it is assigned to the antecedent (e.g., *Minnie*) in the matrix subject position, which is mostly interpreted as the topic. Conversely, in example (12), an overt subject pronoun is more pragmatically appropriate than a null subject pronoun, as its antecedent (e.g., *Daisy*) is not the topical subject in the matrix clause. Unlike Italian and Spanish, English subject pronouns are not allowed to be omitted no matter whether they refer to a topical subject antecedent or not. The results showed that in an acceptability judgment task, both bilingual groups were more tolerant of grammatically inappropriate overt and null subject pronouns in Italian than monolinguals (i.e., overt subject pronouns referring to topic subject antecedents; null subject pronouns referring to non-topic and non-subject antecedents). This suggests that bilinguals, regardless of their combination of languages, found the null and overt subject pronouns at the external syntax-discourse interface harder to acquire than monolinguals.

(11) Minnie: sono caduta!

"I've fallen!"

Donald: Minnie ha detto che è caduta.

"Minnie has said that (she) has fallen."

(12) Minnie: Daisy è caduta!

"Daisy has fallen!"

Mickey: Minnie ha detto che lei è caduta.

"Minnie has said that she has fallen."

(Examples (12) and (13) from Sorace et al. (2009))

In contrast, the coordination of syntax and semantics (i.e., an internal interface) has been found to be less problematic (e.g., Tsimpli & Sorace, 2006; Serratrice et al., 2009). Serratrice et al. (2009) looked at the comprehension of specific and generic NPs at the syntax-semantic interface by school-age Spanish-Italian and English-Italian bilingual children and their monolingual peers. In English, plural NPs in subject position require a definite article when they occur in specific contexts as in *Here the strawberries are red*. However, when they occur in generic contexts, no definite article is required as in *In general sharks are dangerous.* Different from English, Italian and Spanish do not accept bare plural NPs in subject position regardless of their semantic interpretation. The results showed that English–Italian bilingual children were more tolerant of ungrammatical bare nouns in generic contexts in Italian compared to monolinguals, while Spanish–Italian bilinguals performed similarly with monolinguals. Since Spanish-Italian bilinguals were able to consistently reject sentences with bare nouns in Italian, it suggests that the syntax-semantics interface itself is not vulnerable to cross-linguistic influence. Instead, English–Italian bilingual children's English knowledge influenced their ability to distinguish between grammatically correct and incorrect sentences in Italian (Sorace & Serratrice, 2009).

Apart from linguistic interfaces, Hulk and Müller (2000) and Müller and Hulk (2001) also emphasize the role of structural overlap. They predict that cross-linguistic influence is likely to happen when there is a partial structural overlap between the two languages at the

surface level involving the syntax–pragmatics interface. Specifically, if there is a surface overlap between Languages A and B for a certain structure, and Language A (potentially) allows Analyses 1 and 2 for the structure, but Language B allows only Analysis 1, then the overlapping Analysis 1 is predicted to be selected more often by bilinguals than monolinguals (Serratrice, 2013). As shown in the example of null and overt subject pronouns above (Sorace et al., 2009), Italian/Spanish allows both null and overt subject pronouns depending on the discourse-pragmatic context, while English only allows overt subject pronouns. Based on Hulk and Müller's hypothesis, overextension of overt pronouns resulting from the influence from English to Italian/Spanish is predicted. Indeed, in Sorace et al. (2009)'s study, English-Italian bilingual children accepted more pragmatically inappropriate overt subjects in Italian than monolinguals. However, Spanish-Italian bilingual children performed similarly to English-Italian bilingual children, indicating that cross-linguistic influence also occurred when there was complete structural overlap across the two languages. This result posed a challenge to the partial structural overlap condition proposed by Hulk and Müller (2000) and Müller and Hulk (2001).

In fact, the Interface Hypothesis (Sorace & Filiaci, 2006) also faces some challenges. Some studies have reported that L2 learners were able to show native-like performance of certain linguistic properties at the external interfaces (e.g., Borgonovo et al., 2006; Domínguez, 2013; Montrul & Rodríguez-Louro, 2006). Other studies also found that cross-linguistic influence occurred outside the external interfaces (e.g., Cuza, 2012; Hui & You, 2018; Yuan, 2010). For example, Domínguez (2013) looked at the production and comprehension of subject inversion in Spanish by L2 English learners. In Spanish, subjects are allowed to occur in both preverbal and postverbal positions, which is determined by both the discourse-pragmatic context (external syntactic-pragmatic interface), and type of verb (internal syntactic-semantic interface). When the sentence is constructed in a broad focus

context, subjects that occur with an unergative verb like *llamó* “called” are preverbal (see example (13)). However, when the focus in on the subject (narrow focus), subjects with an unergative verb can be either in the preverbal or the postverbal position (see examples (14a, b)). In the case of subjects with an unaccusative verb like *llegó* “arrived”, subjects are typically in the postverbal position irrespective of the contexts (see examples (15) and (16)).

[Broad focus with an unergative verb]

(13) ¿Qué pasó?

“What happened?”

Daniela llamó.

“Daniela called.”

[Narrow focus with an unergative verb]

(14) ¿Quién llamó?

“Who called?”

a. Daniela llamó.

“Daniela called.”

b. Llamó Daniela.

“Called Daniela.”

[Broad focus with an unaccusative verb]

(15) ¿Qué pasó?

“What happened?”

Llegó Daniela.

“Arrived Daniela.”

[Narrow focus with an unaccusative verb]

(16) ¿Quién llegó?

"Who arrived?"

Llegó Daniela.

"Arrived Daniela."

(Examples (13)-(16) from Gondra (2020))

Using a corpus-based study, Domínguez (2013) found that although Spanish learners, even at an advanced level, produced less postverbal subjects than native speakers, they were able to use them pragmatically appropriately. However, unlike native speakers who used postverbal subjects mostly with unaccusative verbs, some advanced L2 learners tended to use postverbal subjects with unergative verbs. In other words, advanced L2 learners did not show the pragmatic deficit predicted by the Interface Hypothesis, but they may have a possible syntactic deficit. Similarly, in a grammatical judgment study, advanced learners had a native-like comprehension of subjects with unergative verbs in both narrow- and broad-focus contexts. However, advanced learners accepted significantly fewer postverbal subjects with unaccusative verbs than native speakers in both contexts. Again, the comprehension data provided evidence that instead of a pragmatics deficit, the syntactic knowledge of subject-related properties in advanced L2 learners may be impaired.

To conclude, this section discussed two main questions in bilingual syntactic development from the perspective of the generative approach. The first question was whether Universal Grammar is still accessible to the L2 learners, over which the predictions and findings have failed to converge. The second question was under which conditions the

interaction between bilinguals' L1 and L2 leads to cross-linguistic influence. Among others, the Interface Hypothesis and the idea of structural overlap have been discussed, but neither seems sufficient to predict all conditions in which cross-linguistic influence occurs.

1.2.2 The Usage-based Approach to Bilingual Syntactic Acquisition

Under the framework of the usage-based approach, L2 acquisition is similar to L1 acquisition in the following two assumptions. The first one is that an L2 is learned on the basis of input exposure (Ellis & Wulff, 2020). For example, Schwartz and Causarano (2007) investigated the use of the English infinitive (e.g., *He loves to walk in the rain*.) and gerund (e.g., *He loves walking in the rain.*) constructions in the writing of native speaking Spanish university students. They found that students produced significantly more infinitives and made fewer errors for infinitives than gerunds, and suggested that this may be related to input frequency. According to the British National Corpus, infinitives are used by native English speakers almost nine times more than gerunds.

The second assumption is that L2 learning is also shaped by general learning and cognitive mechanisms such as generalization and associative learning (i.e., form-function mapping) (Ellis & Wulff, 2020). For example, Ellis and Ferreira-Junior (2009) examined English verb-argument constructions in the conversation of L2 English learners. English verb-argument constructions are defined as "abstract, schematic constructions that are considered to encode basic human event construals" (Hoffmann, 2020, p. 1), including verb-locative constructions (e.g., *I go to the shop*), verb-object-locative constructions (e.g., *He put it on the table.*), and verb-object-object constructions (e.g., *I give him the pen*). They found that the verbs that were acquired first by L2 English learners in each construction were those appearing more often in that construction in the input. Moreover, for each construction, one exemplar verb occupied the major part of all productions of that construction, and the

exemplar was also the one carrying the prototypical meaning. For example, for the verb-object-object construction, the verb *give* was used 64 percent of the time, indicating "someone causing someone to receive something" (Ellis & Ferreira-Junior, 2009).

Despite of these similarities, learners rarely achieve the ultimate attainment of their L2 like L1. How exactly is L2 syntactic acquisition different from L1 acquisition? Among other reasons, the inadequate input has been proposed to explain the limited attainment of L2 (e.g., Paradis, 2010; Paradis et al., 2017; Thordardottir et al., 2006). For example, Paradis (2010) looked at the production and comprehension of English verb morphology (e.g., third-person singular and past tense) by French-English bilingual children (mean age = 6;10) in elicitation and grammaticality judgment tasks. She found that children who had been exposed mainly to French at home performed worse than children who had had more exposure to English at home. Paradis et al. (2017) analysed the spontaneous and elicited production of complex sentences (e.g., RCs, adverbial clauses) in English L2 children with different L1 backgrounds (mean age=5;10). The results also indicated that children's production of English complex sentences was significantly related to input. That is, the longer children were exposed to English in school, and the richer the English environments outside school they were exposed to (e.g., reading, playing with friends), the better they used complex sentences.

Apart from the quantity and quality of the input, the type of input has been proposed to differentiate L1 and L2 syntactic acquisition. Using elicited production and acceptability judgment tasks, Year and Gordon (2009) looked at the learning of the English ditransitive dative construction (e.g., *John gave Mary a pen*) by Korean schoolchildren via classroom instruction. Children were randomly assigned to two groups that then received different input frequencies. In one group, children learned the ditransitive dative construction with the verb *give* much more often than that with the verbs *pass, sell, throw* and *toss* (i.e., skewed

frequency). While in the other group, children learned the ditransitive dative construction with evenly distributed verbs (i.e., balanced frequency). The results showed that balanced, rather than skewed, input facilitated children's greater use of the target construction and better long-term retention. A similar result was found by Mcdonough and Nekrasova-Becker (2014). They investigated Thai university students' comprehension of English dative constructions, and also found that balanced input promoted their comprehension of English dative constructions compared to skewed input.

These findings from L2 learners (Year & Gordon, 2009; McDonough & Nekrasova-Becker, 2014) contrast with the results of L1 acquisition in Goldberg and colleagues' studies (Casenhiser & Goldberg, 2005; Goldberg et al., 2004, 2007; Goldberg, 2006). Based on a corpus study of mothers' and children's early speech, Goldberg et al. (2004) found that each of the constructions tends to occur with a single verb with very high frequency, such as *give* in ditransitive constructions, instead of several evenly distributed verbs. They suggested that such high-frequency prototypical verbs aid children in generalizing constructions from input. In comprehension tasks, the results also show that skewed input speeds up construction learning (Casenhiser & Goldberg, 2005).

It has been suggested that the different findings from L1 and L2 learning may partially relate to different ways of learning (Year & Gordon, 2009; McDonough & Nekrasova-Becker, 2014). That is, L2 learners adopt a more explicit learning style in a classroom, while native speakers rely on more implicit learning (Ellis, 2002, 2015). Specifically, explicit learning may help L2 learners to develop more analytical mindsets, and therefore they can detect the pattern from the balanced input, while the implicit learning of L1 knowledge is based on lexical items (McDonough & Trofimovich, 2013; Zhang & Dong, 2019).

In addition to the effects of input, the interaction between an L2 learner's L1 and L2 has also been argued to influence L2 learning. Under the framework of the usage-based approach, various theories have been proposed to explain this issue. For instance, the competition model suggests that "decisions in sentence interpretation are made by evaluating the relative weights of the cues present in the stimulus" (Bate et al., 1984, p. 344; Bates & MacWhinney, 1982; MacWhinney et al., 1984; MacWhinney & Bates, 1989). Cues refer to a variety of surface structure features (i.e., forms), which serve to activate functions. When L1 and L2 share similar cues, L2 learners are predicted to rely on the cues that are more dominant in their L1 in the early stages of learning. The dominance of cues is related to their frequency and contingency (i.e., form-function mapping) of usage. For example, in English, the most dominant cue for subject assignment is the canonical SVO word order, whereas Spanish has very flexible word orders. Specifically, in addition to the canonical SVO word order, it also allows OVS, SOV, and VSO word orders. In Spanish, subject assignment in Spanish relies upon subject-verb agreement and clitic placement. Morett and MacWhinney (2013) observed that L1 English-L2 Spanish undergraduates with lower fluency in Spanish were more likely to select the first noun as the subject according to the SVO word order (i.e., the dominant cue in English) for both English and Spanish sentences. With increasing fluency, undergraduates displayed a tendency to rely on multiple cues.

On the other hand, when L1 and L2 differ (i.e., use different cues to express the same meaning), a negative transfer from L1 to L2 may occur. Erdocia and Laka (2018) compared the comprehension of SVO and OVS sentences in Basque by adult L1 Spanish - L2 Basque speakers and L1 Basque. As just mentioned, Spanish has the canonical SVO and non-canonical OVS word orders. However, both word orders are not canonical (but grammatical) in Basque. The electrophysiological results showed that SVO and OVS sentences were easier

for L2 Basque speakers to process than for L1 Basque speakers. In other words, L2 Basque speakers performed differently from L1 Basque speakers due to the influence of their L1.

Similar to the competition model, the associative-cognitive CREED[1] theory has also proposed that the salience of cues plays an important role in cross-linguistic influence (Ellis, 2006b). Salience here refers to "a factor that makes something easier to perceive" (Gass et al. 2018, p. 1). For example, both lexical cues like *yesterday* and grammatical inflections like past tense *-ed* can be used to express time. However, the latter are less salient as they tend to be short and unstressed, which are predicted to be harder for L2 learners to perceive (Cintrón-Valentín & Ellis, 2016). Jo and Oh (2021) looked at the use of verb-argument constructions by Korean learners of English and native English speakers in a verbal fluency task. They identified that unlike native English speakers who preferred specific motion verbs like *run*, *jump*, and *walk* in motion constructions like "V into N" and "V through N", Korean learners of English tended to use general verbs like *be*, *go*, and *do*. They suggested that it was due to the influence of Korean. Korean as a verb-framed language encodes the motion in the verb root like "*tulekata* (GO entering)", and therefore motion is less salient among Korean speakers.

The salience of cues could also be explained from the perspective of learned attention (Ellis, 2006a). L2 learners have a prior knowledge of their L1, that is, they have known the association between a particular form and its meaning. This prior association is predicted to be harder for them to learn further associations (Ellis, 2006a; Wulff & Ellis, 2018; Ellis & Wulff, 2020). For example, if they frequently use lexical cues like *yesterday* to express time in their L1, this could lead them to look for similar cues in learning an L2. In other words, such cues are likely to block their learning of less salient verb tense markers like *-ed* in the

[1] CREED stands for "Construction-based, Rational, Exemplar-driven, Emergent, and Dialectic" (Ellis, 2006b, p. 100), which was proposed as the major principles governing second language learning (see Ellis (2006b) for details)

L2. Moreover, learners do not have to rely on verb tense markers to correctly interpret a sentence, and therefore verb tense markers may attract less attention (Cintrón-Valentín & Ellis, 2016).

For example, Cintrón-Valentín and Ellis (2016) looked at the learning of Latin verb tense by adult L1 Chinese speakers not previously exposed to Latin. Of note, unlike Latin, Chinese does not have grammatical markers of tense. Participants were divided into four groups: involving verb pretraining, verb grammar, and verb salience, and a control group. During the pretraining session, the verb pretraining group received training in verb inflections, while the verb grammar group was provided with a short lesson on Latin tense morphology. The verb salience and control groups did not receive any training. After the pretraining, all groups were involved in sentence training. Sentences included a temporal adverb and a verb with a tense marker. For the verb salience group, the verb tenses were highlighted in red and bold to make them more salient, while they were not highlighted for the other three groups. In the comprehension task, the results showed that compared to other groups, the control group was influenced the most by adverbs in comparison to verb inflections, supporting the assumption that the more salient cues in L1 could hinder the learning of less salient cues in L2. In contrast to the control group, the verb pretraining group had a better use of the verb tense markers, which indicated that the learning of an isolated cue (during the pertaining phrase) could attract learners' attention to that cue. Similar results were also found in Ellis and Sagarra (2010, 2011) and Cintrón-Valentín and Ellis (2015).

To sum up, the usage-based approach assumes that as in L1 acquisition, L2 acquisition also relies on general learning and cognitive mechanisms and their input. However, compared to L1 acquisition, the quantity and quality of the input L2 learners receive is generally limited, which could prevent them from attaining native-level ability in the target language. Moreover, L2 learners already have knowledge of their L1. L1

knowledge could facilitate or hinder the (early) acquisition of L2 depending on their typological distance and the salience of certain cues in each language.

1.3 The Typology of RCs

A RC is "a subordinate clause that modifies a head noun or noun phrase" in a matrix clause (Diessel & Tomasello, 2000, p. 132). It is usually classified based on two structural features: the syntactic role of the head noun within the RC, and the syntactic role of the head noun within the matrix clause (Diessel & Tomasello, 2000). Based on the role of the head noun within the RC, RCs are mainly classified into subject and object RCs. Examples (17) and (18) are subject RCs, as the head noun *the horse* is coreferential with the RC-internal subject (i.e., the element that is relativized inside of the RC is the subject), while examples (19) and (20) are object RCs, as the head noun *the pig* is coreferential with the RC-internal object. RCs are indicated in square brackets and relativized positions are underscored.

[English subject RC in the matrix subject position]

(17) The horse [that _ hugged the pig] saw the goat.

[English subject RC in the matrix direct-object position]

(18) The goat saw the horse [that _ hugged the pig].

[English object RC in the matrix subject position]

(19) The pig [that the horse hugged _] saw the goat.

[English object RC in the matrix direct-object position]

(20) The goat saw the pig [that the horse hugged _].

Based on the role of the head noun within the matrix clause, RCs that modify head nouns in the matrix subject position (SUBJ RCs) and in the matrix direct-object position (DOBJ RCs) are the two main types that are widely investigated. In examples (17) and (19), head nouns occupy the subject position in the matrix clause, while in examples (18) and (20), head nouns are located in the matrix direct-object position.

The main typological difference that distinguishes RCs across languages is the position of the head noun in relation to the RC (i.e., head direction). In European languages like English (see examples (17-20)), the head nouns precede the RCs (i.e., head-initial RCs). By contrast, in East Asian languages like Mandarin and Japanese (see examples (21-24)), the head nouns follow the RCs (i.e., head-final RCs). According to Dryer (2013), 98 percent of languages with canonical SVO word order have head-initial RCs like English, while around half of SOV languages have head-initial RCs like Japanese, and the other half have head-final RCs like Basque. Only five languages provide the rare combination of canonical SVO word order with head-final RCs. There are Mandarin, Cantonese, Hakka, Bai and Amis.

[Mandarin subject RC in the matrix subject position]

(21) [_ 抱 小猪] 的 小马 看到 山羊。

bao xiaozhu de xiaoma kandao shanyang

hug pig DE horse see goat

"The horse [that hugged the pig] saw the goat."

[Mandarin subject RC in the matrix object position]

(22) 山羊 看到 [_ 抱 小猪] 的 小马。

shanyang kandao bao xiaozhu de xiaoma

goat see hug pig DE horse

“The goat saw the horse [that hugged the pig].”

[Mandarin object RC in the matrix subject position]

(23) [小马 抱 _] 的 小猪 看到 山羊。

xiaoma bao de xiaozhu kandao shanyang

horse hug DE pig see goat

“The pig [that the horse hugged] saw the goat.”

[Mandarin object RC in the matrix object position]

(24) 山羊 看到 [小马 抱 _] 的 小猪。

shanyang kandao xiaoma bao de xiaozhu

goat see horse hug DE pig

“The goat saw the pig [that the horse hugged].”

Apart from the head direction, Mandarin is also different from English in allowing frequent argument omission. In Mandarin RCs, subject/object arguments and head nouns can be omitted when they are known to both speakers and hearers (e.g., Lin & Bever, 2010; Huang & Phillips, 2021). For example, when a child has just finished watching a cartoon, the mother may ask him “*Which one is the cartoon you watched?*”. In Mandarin, the mother can ask this question without providing the subject argument *ni* “you*”* and the head noun *donghuapian* “cartoon” (indicated in parentheses in example (25)). However, English RCs do not allow the omission of either the argument or the head noun.

(25) [（你） 看_] 的 （动画片） 是 哪 一个？

(ni) kan de (donghuapian) shi na yige

you watch DE cartoon is which one-CL

"Which one is (the cartoon) (you) watched?"

1.4 Theories of RC Acquisition and Processing

In RC acquisition and processing, some RCs tend to be easier to acquire and to process than others. For example, although subject RCs (e.g., *the horse [that hugged the pig])* and object RCs (e.g., *the pig [that the horse hugged])* can be used to describe the same event, for head-initial languages like English, there is a strong consensus that subject RCs are acquired earlier and are processed more easily than object RCs (e.g., Diessel & Tomasello, 2000, 2005; Friedmann & Novogrodsky, 2004; Gibson, 1998; King & Just, 1991; King & Kutas, 1995; Traxler et al., 2002; Wells et al., 2009). A number of theoretical accounts have been put forth to explain the subject RC advantage in English and other head-initial languages. However, these accounts are in conflict on whether there is a universal subject preference in head-final languages like Mandarin.

In the following sections, the Noun Phrase Accessibility Hierarchy (NPAH; Keenan & Comrie, 1977) and a number of structure-based accounts (e.g., Friedmann et al. 2009; Hawkins, 2004; O'Grady, 1997; Rizzi, 1990, 2004) that propose a subject RC preference across all languages are introduced first. Then, the accounts that predict a language-specific preference will follow, including linear distance-based accounts (e.g., Gibson, 1998, 2000), canonicity effects (e.g., Bever, 1970; MacDonald & Christiansen, 2002), and input frequency (e.g., Ambridge et al., 2015; Roland et al., 2007).

1.4.1 Noun Phrase Accessibility Hierarchy

The NPAH was originally proposed as a cross-linguistic generalization of the relativizability of NPs in different syntactic positions (Keenan & Comrie, 1977). The hierarchy is formulated at (26) below. On the basis of typological observations from around 50 languages, Keenan & Comrie (1977) found that if a language allows one syntactic position to be relativized, it will also allow all syntactic positions to its left in the hierarchy to be relativized. This means that if a language allows direct objects to be relativized, it must also allow subjects to be relativized. However, grammatical positions to its right like indirect objects may not be allowed to be relativized (Lau & Tajaka, 2021).

[Noun Phrase Accessibility Hierarchy]

(26) subject > direct object > indirect object > oblique > genitive > object of comparison

Subsequent works extended the NPAH to account for the order of difficulty in the acquisition and processing of RCs (e.g., Doughty, 1991; Eckman et al.1988; Gass, 1979; Hawkins, 2007). That is, the further a syntactic position is to the left, the easier (and more frequently) it is for it to be acquired and processed. In Keenan & Comrie's framework the subject occupies the left-most position, therefore subject RCs are considered easier to acquire and to process than object RCs and other types of RCs cross-linguistically.

Previous studies of English have provided corpus-based and experimental evidence to support the NPAH hypothesis. For example, Diessel and Tomasello (2000) investigated the acquisition of RCs in the naturalistic speech of English-speaking children (1;09-5;02). They found that subject RCs (mainly with intransitive verbs) were acquired earlier than direct-object RCs, followed by oblique RCs. Similarly, using a sentence repetition task, Diessel and Tomasello (2005) also observed that children (4;07-4;09) repeated subject RCs (with both

intransitive and intransitive verbs) more accurately than direct-object RCs, followed by indirect-object RCs, oblique RCs and genitive RCs.

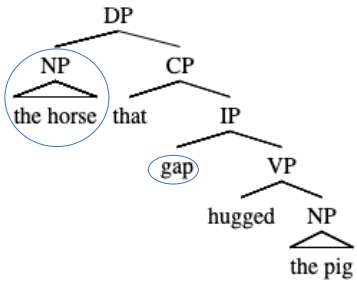
However, the NPAH hypothesis does not always hold for Mandarin. Chen and Shirai (2015) looked at RCs in the naturalistic speech of Mandarin-speaking children (0;11-3;05) and found that direct-object RCs were the earliest acquired RC type, and were predominant in both child and child-directed speech. However, in the sentence repetition task, four- and five-year-old Mandarin-speaking children found subject RCs (with both intransitive and intransitive verbs) were easier than direct-object RCs, while prepositional dative indirect object RCs were more difficult than oblique RCs (Yang, 2019). That is to say, the experimental result in Yang (2019) partially supports the NPAH hypothesis.

1.4.2 Structure-based Accounts

Following the generative approach, structure-based accounts also imply a universal subject RC preference (Friedmann et al.,2009; Hawkins, 1999, 2004; Lin & Bever, 2006; O'Grady, 1997; Rizzi, 1990, 2004). Two types of structural factors are discussed in the literature. One is the structural distance between the head noun and its relativized position (i.e., gap) (Hawkins, 1999, 2004; Lin & Bever, 2006; O'Grady, 1997). It claims that the longer the structural distance between a head and its gap, the deeper the gap is embedded in the hierarchy structure, and the more processing effort required. As subjects appear higher in syntactic structures than direct objects across languages, subject RCs are predicted to be more accessible than object RCs (see English examples (27-28), and Mandarin examples (29-30)).

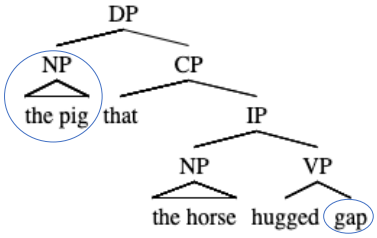
[English subject RC]

(27) the horse that hugged the pig



[English object RC]

(28) the pig that the horse hugged



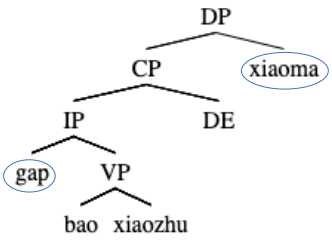
[Mandarin subject RC]

(29) [_ 抱 小猪] 的 小马

[_ bao xiaozhu] de xiaoma

hug pig DE horse

“the horse that hugged the pig”



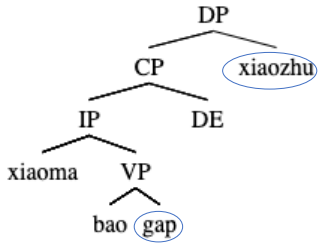
[Mandarin object RC]

(30) [小马 抱 _] 的 小猪

[xiaoma bao _] de xiaozhu

horse hug DE pig

“the pig that the horse hugged”



Another structural factor is the structural intervention between a head noun and its gap. The notion of structural intervention is built on the idea of relativized minimality (Rizzi 1990). Relativized minimality claims that “Y cannot be related to X if Z intervenes and Z has certain characteristics in common with X” (Rizzi, 2001, p. 89), as illustrated in the configuration at (31). The intervention means that Z c-commands Y but does not c-command X (Rizzi, 2018).

(31) X...Z...Y

In the case of RCs, if there is a structural intervener Z between the head noun and gap, and the structural intervenor Z shares the same featural specifications (e.g., NP) as the head noun, then the dependency between the head noun and its gap is hard to establish (Friedmann et al. 2009). For example, both English and Mandarin object RCs such as (28) and (30) have an intervener *the horse* between the head noun *the pig* and its gap, and the intervener has the same feature (i.e., NP) required by the head noun. By contrast, English and Mandarin subject RCs have no intervener (see examples (27) and (29)). Therefore, subject RCs are predicted to be favoured over object RCs cross-linguistically.

For English, the structural-based accounts, as well as all other accounts, predict a subject RC advantage, which makes it harder to distinguish the structural-based accounts from others. However, for Mandarin, the structural-based accounts predict a subject RC advantage, while linear distance-based accounts that will be mentioned in the following sub-section suggest an object RC advantage. Therefore, several experimental studies on Mandarin that found a subject RC advantage claimed to support the structural-based accounts (e.g., Hsu et al., 2009; Hu et al, 2016a; Hu et al., 2016b). For example, Hsu et al. (2009) conducted an elicited production task examining the production of Mandarin RCs by young Mandarin-speaking children (mean age=4;08). They observed that children produced more subject RCs than object RCs. Moreover, children made more errors in producing object RCs. Using a character-sentence matching task, Hu et al.(2016b) also found a subject RC advantage in children's comprehension of RCs (3;00-8;00).

1.4.3 Linear Distance-based Accounts

In contrast to structure-based accounts that see language processing as a structure-dependent process, linear distance-based accounts claim that sentence processing depends on cognitive

abilities like working memory (Dependency Locality Theory, Gibson, 1998, 2000). Working memory cost includes both storage and integration costs. Storage cost is quantified by the number of incoming syntactic elements that need to be stored in working memory, while integration cost refers to how an incoming syntactic element is integrated into an existing structure. In this view, the longer the linear distance between a head noun and its gap, the greater the working memory cost.

As shown in examples (32) and (33), English subject RCs have a shorter linear distance between the head noun and its gap than object RCs, and therefore subject RCs should be processed more easily than object RCs. In contrast, an object RC advantage is predicted for Mandarin. Due to the head-final property, Mandarin object RCs (34) have a shorter linear distance between a head noun and its gap than subject RCs (35).

[English subject RC]

(32) The horse [that _ hugged the pig]

[English object RC]

(33) The pig [that the horse hugged _]

[Mandarin subject RC]

(34) [_ 抱 小猪] 的 小马

bao xiaozhu de xiaoma

hug pig DE horse

"the horse that hugged the pig"

[Mandarin object RC]

(35) [小马　　抱 _]　的　　小猪

xiaoma　bao　　de　　xiaozhu

horse　　hug　　DE　　pig

“the pig that the horse hugged”

In addition to subject-object asymmetry, linear distance-based accounts can also be used to explain the difficulty of centre-embedded RCs. As shown in example (17), rewritten as (36), English RCs that modify head nouns in the matrix subject position (SUBJ RCs) fall right in the centre of the matrix clause (i.e., they are centre-embedded), and therefore have a long linear distance between matrix subjects with matrix verbs. When processing SUBJ RCs, speakers or readers need to store the matrix subject *the horse* in working memory and then retrieve it while encountering the matrix predicate *saw the goat*. On the other hand, RCs that modify head nouns in the matrix direct-object position (DOBJ RCs) are not centre-embedded and have a shorter linear distance between matrix subjects and matrix verbs (see example (18), rewritten as (37)). When processing DOBJ RCs, the store-retrieval task is not necessary as the whole matrix clause *the goat saw the horse* can be processed first. Previous studies of English show that DOBJ RCs are easier to acquire and to process than SUBJ RCs (e.g., Diessel & Tomasello, 2000; Kidd & Bavin, 2002; McElree, et al., 2003; Santi et al., 2019).

[English SUBJ RC]

(36) The horse [that _ hugged the pig] saw the goat.

[English DOBJ RC]

(37) The goat saw the horse [that _ hugged the pig].

Unlike for English, linear distance-based accounts predict an easier processing of SUBJ RCs in Mandarin, as they have a shorter linear distance between matrix verbs and matrix objects[2] than DOBJ RCs (see examples (21) and (22), rewritten as (38) and (39)). However, evidence from Mandarin does not fully support this idea. In Chen and Shirai (2015), only one out of four Mandarin-speaking children produced SUBJ RCs earlier than DOBJ RCs in their spontaneous speech. The other three children produced these two types of RCs in the same age range, and the total numbers of these two types of RCs were very low. In adults' writing, Mandarin native speakers consistently produced more SUBJ RCs than DOBJ RCs, supporting the linear distance-based accounts (e.g., Hsiao & Macdonald, 2013; Li et al., 2010; Lin & Bever, 2006; Pu, 2007; Wu, 2009). However, a preference for DOBJ RCs and no preference for either type of RCs have been found in Mandarin L2 learners' writing (e.g., Li & Wu, 2013; Chang, 2017).

[Mandarin SUBJ RC]

(38) [_ 抱 小猪] 的 小马 看到 山羊。

bao xiaozhu de xiaoma kandao shanyang

hug pig DE horse see goat

"The horse [that hugged the pig] saw the goat.

[Mandarin DOBJ RC]

(39) 山羊 看到 [_ 抱 小猪] 的 小马。

shanyang kandao bao xiaozhu de xiaoma

[2] Of note, due to their different head directions, the distance between matrix verbs and matrix subjects was measured in English, while the distance between matrix verbs and matrix objects was measured in Mandarin.

goat see hug pig DE horse

"The goat saw the horse [that hugged the pig]."

An explanation suggested for the different results shown for adult Mandarin native speakers and L2 learners has been the length of RCs (Li & Wu, 2013). Compared to adult native speakers, adult L2 learners, especially those with a lower level of proficiency, may use shorter RCs in their writing like *chouyan de ren* "people who smoke". When centre-embedded RCs (i.e., Mandarin DOBJ RCs) are shorter, less working memory is needed to process them, and therefore they do not have to be harder to process than non-centre-embedded RCs. Another possibility is that people may treat short RCs as an unanalysed chunk or phrase. In this case, centre-embedding does not play a role. As far as I know, there is no previous research that addresses whether the length of RCs influences their processing in Mandarin, which will be one of the questions explored in this thesis (Chapter 5).

1.4.4 Canonicity Effects

Within the usage-based framework, the canonical word order hypothesis proposes that children employ schemas of canonical sentences to guide their comprehension and production of more complex syntactic structures (Bates & MacWhinney, 1982; Bever, 1970; MacDonald & Christiansen, 2002; Sekerina, 2003; Slobin & Bever, 1982; Townsend & Bever, 2001). To clarify, canonical word order refers to the most frequent word order pattern in a language (see Levshina at al., 2021). In English, subject RCs (40) share a similar canonical SVO word order with simple transitives, whereas object RCs (41) exhibit a non-canonical OSV word order. Both corpus data and experimental evidence suggest that children acquire subject RCs earlier and more easily than object RCs (e.g., Bever, 1970; Diessel & Tomasello, 2000, 2005; Kidd et al., 2007).

[English subject RC]

S V O

(40) The horse [that hugged the pig]

[English object RC]

S O V

(41) The pig [that the horse hugged]

In contrast, Mandarin subject RCs (42) exhibit a non-canonical VOS word order, while Mandarin object RCs (43) follow the canonical SVO word order. Corpus-based studies have found that Mandarin-speaking children produce object RCs more often and earlier than subject RCs (e.g., Chen & Shirai, 2015; Hsu, 2014; Liu, 2015).

[Mandarin subject RC]

V O S

(42) **[抱 小猪]** **的** **小马**

[bao xiaozhu] de xiaoma

hug pig DE horse

“the horse that hugged the pig”

[Mandarin object RC]

S V O

(43) **[小马 抱]** **的** **小猪**

[xiaoma bao] de xiaozhu

horse hug DE pig

“the pig that the horse hugged”

However, it is unclear from previous studies whether the object RC advantage in Mandarin still hold when the head nouns of RCs are omitted (Liu, 2015, Hsu, 2014). As mentioned in Section 1.3, Mandarin RCs allow head nouns to be omitted if they have been mentioned in the previous context. Similarly, Mandarin SVO transitives allow a discourse-based omission of subject or object arguments. Therefore, based on the canonical word order hypothesis, a similar object RC advantage is predicted for RCs with omitted head nouns. However, previous studies show mixed results. Liu (2015) found an object RC advantage in Mandarin-speaking children’s spontaneous speech regardless of the presence or absence of head nouns, while Hsu (2014) reported that the Mandarin object RC advantage only held when the head nouns of RCs were present.

Moreover, although Mandarin object RCs follow canonical SVO word order and agent-verb-patient thematical order, the object/patient rather than the subject/agent is the head noun. Using a character-sentence matching task, a number of studies revealed that children have a problem identifying the correct head noun for Mandarin object RCs (e.g., Tsoi et al., 2019). Specifically, in this task, children were asked to point out the character (i.e., out of a set of cartoon animals) that corresponds to the head noun of the RC. The results showed that children tended to misinterpret the RC-internal subject (e.g., *xiaoma* “the horse” in (44)) as the head noun (i.e., make Head Errors) for Mandarin object RCs, leading to a Mandarin subject RC advantage. This suggests that children prefer the sentential subject to be the agent, and expect the agent to be relativized (Diessel & Tomasello, 2005; Kim & O’Grady, 2016; Mak et al., 2006; O’Grady, 2011; Well et al., 2009).

[Mandarin object RC]

(44) [小马　　抱]　的　小猪　　在　哪里？

[xiaoma　bao]　de　xiaozhu　zai　nali

horse　　hug　DE　pig　　is　where

"Where is the pig that the horse is hugging?"

In addition to canonicity effects that occur intra-linguistically, canonicity effects have also been observed across languages in bilingual children (e.g., Chan et al., 2017; Hu et al., 2020; Kidd et al., 2015; Tsoi et al., 2019; Yang, 2019). For example, Kidd et al. (2015) looked at Cantonese-English bilingual children's comprehension of Cantonese RCs by using a character-sentence matching task. Recall that Cantonese is similar to Mandarin in its typologically rare combination of head-final RCs and canonical SVO word order (Dryer, 2013). Kidd et al. (2015) reported that compared to vocabulary-matched monolingual children, Cantonese-English bilingual children made more Head Errors for Cantonese object RCs by misinterpreting the RC-internal subject as the head noun. Based on this, the structural overlap between English simple SVO transitives and Cantonese object RCs has been suggested to cause more comprehension difficulties for Cantonese object RCs. Using the same task, Chan et al. (2017) also found that Cantonese-English-Mandarin trilingual children made more Head Errors for Cantonese object RCs than their age-matched monolingual peers because of the negative influence from English.

The canonicity effect shown in bilingual children's comprehension of Cantonese object RCs is consistent with the cross-linguistic influence hypothesis proposed by Hulk and Müller (2000) (see Section 1.2.1). Following this hypothesis, Cantonese/Mandarin object RCs that resemble simple SVO transitives in both Cantonese/Mandarin and English are

expected to be a candidate case for cross-linguistic influence. However, both the canonicity effects and Hulk and Müller (2000)'s cross-linguistic influence hypothesis do not clarify whether cross-linguistic influence is positive or negative. In the character-sentence matching task mentioned above, a negative cross-linguistic influence was found, while in spontaneous speech, a positive influence is likely to occur. Recall that in Mandarin-speaking monolingual children's spontaneous speech, the early emergence of Mandarin object RCs has been suggested to be facilitated by structural overlap between Mandarin object RCs and simple SVO transitives (e.g., Chen & Shirai, 2015; Hsu, 2014; Liu, 2015). Following monolinguals, bilinguals may produce a higher proportion of object RCs in Mandarin due to the influence of English SVO transitives. As far as I am aware, there is no previous research focusing on RCs in Mandarin-English bilingual children's spontaneous speech. This will be one of the questions explored in this thesis (Chapter 3).

Furthermore, no previous research has investigated whether Mandarin-English bilingual children process Mandarin RCs with omitted head nouns differently compared with monolinguals. As just mentioned before, Mandarin RCs and simple SVO transitives allow head nouns and arguments to be omitted when they refer to an established discourse topic. However, English RCs and simple SVO transitives do not allow the omission of head nouns and arguments, regardless of their information status. So far, it is also unknown whether the acquisition of English would make Mandarin-English bilingual children produce fewer RCs with omitted head nouns, and comprehend RCs with omitted head nouns less accurately than monolinguals. This is also one of the questions explored in this thesis (Chapters 3 and 4).

1.4.5 Frequency Effects

Apart from canonicity effects, the usage-based approach highlights input frequency as an important factor for driving language acquisition and processing. As discussed in Section

1.1.2, the basic idea of input frequency is that language acquisition and processing are tightly linked to an individual's language experience. All things being equal, the more frequently a construction is heard, the more firmly the construction is entrenched in the mental grammar, and the more easily the construction will be activated (e.g., Bybee & Hopper 2001; Diessel & Tomasello, 2000; Lieven, 2010).

In English, although children produce more subject RCs in their early speech, they produce proportionally more object RCs with increasing age. This is consistent with studies of child-directed speech, in which they hear more object RCs than subject RCs (Diessel & Tomasello, 2000). In addition to RC structures, the input frequency of specific constraints like animacy and givenness has also been spotted in English. For example, object RCs have been found to occur overwhelmingly with inanimate head nouns and pronominal RC-internal subjects in naturalistic speech (e.g., ***the car*** *that* ***she*** *borrowed had a low tyre*) (Fox & Thompson, 1990; Reali & Christiansen, 2007; Roland et al., 2007). Several sentence processing studies have pointed out that when the object RCs used in the task match the object RCs that children and adults hear and speak in everyday life, the processing of object RCs can be facilitated (Brandt et al., 2009; Gennari & MacDonald, 2009; Kidd et al., 2007; Macdonald et al., 2020; Reali & Christiansen, 2007; Traxler et al., 2002; Wells et al., 2009).

Unlike English RCs, Mandarin RCs show a relatively complex picture of input frequency. Corpus-based studies consistently report an object RC advantage in the input (Chen & Shirai, 2015; Liu, 2015), while some child experimental evidence reveals a subject RC advantage (e.g., Hu et al., 2016a; Hu et al., 2016b; Hu & Guasti, 2017; Hsu, 2014; Tsoi et al., 2019, Yang, 2019). For the difference between corpus-based and experimental results in studies on children in Mandarin, Tsoi et al. (2019) provided a potential explanation by focusing on the frequency of subject RC-like and object RC-like structures. Subject RC-like and object RC-like patterns include subject and object RCs, as well as other utterances

following the same patterns as subject and object RCs ("V-N-DE-(N)" and "N-V-DE-(N)" patterns). Tsoi et al. (2019) reported that subject-like structures occur far more often than object-like structures in the input and suggested that this finding could partially explain the subject RC advantage found in past experimental studies. That is to say, when children are establishing constructions, they not only generalize across target constructions, but also across other constructions that share similar patterns.

However, Tsoi et al. (2019)'s explanation should also be considered with some caution. They claimed that the frequency effects occurring at different levels may have different relevance, but did not explain why certain levels of frequency played a more important role than other levels of frequency. Moreover, several studies, such as Lin (2015) found that Mandarin native speakers read passive subject RCs (i.e., an object RC turned into a subject RC through passivation) like (45) faster than active subject RCs (46) in a self-paced reading experiment. However, passive subject RCs are extremely rare in native speakers' spontaneous speech (Wu, 2009), and passive subject-like RC structures ("N V de [N]" pattern, i.e., object RC-like pattern) should also occur less frequently than active subject RC-like structures (see Hu et al. (2020) for a similar argument based on Italian examples).

[Mandarin passive subject RC]

(45) **[被 小猪 抱] 的 小马 看到 山羊。**

bei xiaozhu bao de xiaoma kandao shanyang

BEI pig hug DE horse see goat

"The horse [that was hugged by the pig] saw the goat.

[Mandarin active subject RC]

(46) **[抱 小猪] 的 小马 看到 山羊。**

bao xiaozhu de xiaoma kandao shanyang

hug pig DE horse see goat

"The horse [that hugged the pig] saw the goat.

In addition to the input frequency of RC or RC-like structures, the discourse contexts that Mandarin RCs tend to occur in have received little attention. Unlike corpus-based child studies that analyse Mandarin RCs in spontaneous speech and reveal an object RC advantage (Chen & Shirai, 2015; Hsu, 2014; Liu, 2015), the majority of corpus-based adult studies focus on RCs in written genres, especially written news, and report a subject RC advantage (Hsiao, 2003; Hsiao & Macdonald, 2013; Lin, 2011; Vasishth et al., 2013; Wu, 2009). It has been suggested that the higher use of subject RCs is mainly because of the discourse needs of written news. Specifically, Mandarin subject RCs that carry animate head nouns can be used to describe people in the news or news events that involve people (Pu, 2007; Wu, 2009). However, it is unclear whether written genres that follow the more natural flow of speech like prose will also show a similar distributional pattern. So far, there is no previous research that addresses whether genre influences the distribution of RCs in Mandarin, which is also one of the questions explored in this thesis (Chapter 5).

1.4.6 Conclusion

Unlike in English, there is no consistent subject or object RC advantage in Mandarin. This poses a challenge to the current accounts that predict either a subject RC advantage (NPAH, Keenan & Comrie, 1977; structure-based accounts, Friedmann et al. 2009; Hawkins, 2004; O'Grady, 1997; Rizzi, 1990, 2004), or an object RC advantage (linear distance-based accounts, Gibson, 1998, 2000).

On the other hand, although canonicity effects and input frequency can partially explain the mixed results in Mandarin, there are a number of aspects that deserve more

investigation. Specifically, when focusing on RCs in Mandarin monolingual children's spontaneous speech, an overwhelming object RC advantage has been reported (e.g., Chen & Shirai, 2015). It has been suggested that the high frequency of canonical SVO transitives in Mandarin supports the acquisition of Mandarin object RCs that share the same word order. However, it is unclear whether the absence of head nouns would influence this object RC advantage (Hsu, 2014; Liu, 2015). Moreover, attention has not been paid to Mandarin-English bilingual children. It is thus unknown whether the acquisition of English SVO transitives influences the acquisition of Mandarin object RCs with overt and omitted head nouns.

When focusing on the comprehension of Mandarin RCs using a character-sentence matching task, there was an overwhelming subject RC advantage (e.g., Tsoi et al., 2019). This could be because, in Mandarin object RCs, it is the patient – rather than the agent – being relativized. Children have difficulty matching the patient with the head noun for Mandarin object RCs (e.g., Tsoi et al., 2019). However, when head nouns are omitted, whether children will comprehend object RCs in the same manner and how the acquisition of English SVO transitives influence bilingual children's comprehension of Mandarin object RCs deserve further investigation.

Lastly, when looking at the distributional frequency of RCs in adult Mandarin native speakers and second language learners, a more complex picture emerged. Unlike Mandarin-speaking children who hear and produce more object RCs than subject RCs in everyday life, adult Mandarin native speakers show a subject RC preference, while L2 learners show mixed results (e.g., Pu, 2007; Wu, 2009; Chang, 2017). At the same time, adult Mandarin native speakers show a clear preference for non-centre-embedded RCs over centre-embedded RCs in corpus-based studies, while Mandarin-speaking children and Mandarin adult L2 do not (e.g., Chen & Shirai, 2015; Li & Wu, 2013; Pu, 2007; Wu, 2009; Chang, 2017). I will

propose that the distributional frequency of RC structures themselves is not sufficient to explain the mixed nature of those findings. An in-depth investigation of other factors such as the discourse context that RCs appear in, the information status that RCs encode, and the length of RC will be conducted in this thesis.

Chapter 2: Outline of the Thesis

This thesis examines the use and comprehension of Mandarin relative clauses (RCs) by Mandarin-speaking monolingual and heritage Mandarin-English bilingual children, as well as adult Mandarin native speakers (L1) and second language learners (L2).

Mandarin RCs, with a unique combination of canonical Subject-Verb-Object (SVO) word order and head-final property, have attracted increasing attention in the literature (e.g., Chan et al., 2017; Chen & Shirai, 2015; Hsiao & Gibson, 2003; Hsiao & Macdonald, 2013; Hu et al., 2020; Lin, 2011; Lin & Bever, 2006; Packard et al., 2010; Pu, 2007; Tsoi et al., 2019; Wu et al., 2010; Yang et al., 2020). However, to date, there is no clear picture of RC processing in Mandarin across different language groups (e.g., monolinguals and bilinguals), age groups (e.g., child and adult), modalities (written vs. spoken) and methods (corpus analyses vs. experimental methods). Furthermore, relatively less attention has been given to language-specific factors (e.g., omission of head noun) and other semantic, pragmatic and discourse constraints (e.g., information status, grammatical weight) that influence RC processing in Mandarin (e.g., Liu, 2015; Pu, 2007; Tao & Liang, 2010; Wu et al., 2012; Yang, 2019).

2.1 Research Questions of the Thesis

The thesis centres on three main research questions (RQs): (1) Whether there is a universal subject over object RC preference in Mandarin, and the factors influencing the subject-object asymmetry; (2) whether there is a universal non-centre-embedded over centre-embedded RC preference in Mandarin, and the factors influencing the preference; and (3) whether acquiring another language like English would influence the acquisition and processing of RCs in Mandarin. These RQs will be elaborated by the series of studies in this thesis described below:

The first study (Chapter 3) examines the use of Mandarin RCs in the spontaneous speech of Mandarin-speaking monolingual and heritage Mandarin-English bilingual children. Unlike previous studies such as Chen and Shirai (2015) which only looked at RCs in Mandarin-speaking monolingual children's spontaneous speech, this study takes a new perspective by investigating heritage Mandarin-English bilingual children, who are exposed to Mandarin as a heritage language at home, and to English as the societal majority language. It aims to test whether the current theories on RC acquisition that have been developed based on head-initial languages like English, are language-universal. The RQs of the first study are addressed as follows: (1) Whether there is a subject RC preference in monolingual and bilingual children's spontaneous speech, and whether the presence or absence of a head noun influences the subject-object asymmetry; (2) whether there is a preference for non-centre-embedded over centre-embedded RCs in monolingual and bilingual children's spontaneous speech; and (3) whether there is cross-linguistic influence from English to Mandarin, which makes bilingual children perform differently to monolingual children.

The second study (Chapter 4) investigates the comprehension of Mandarin subject and object RCs by heritage Mandarin-English bilingual children and their vocabulary-matched monolingual peers with an experimental design. Previous experimental studies such as Tsoi et al. (2019) and Hu et al. (2020) have investigated the comprehension of Mandarin RCs in heritage Mandarin-English and Mandarin-Italian bilingual children respectively. However, it is still not fully clear how word order similarities across languages (i.e., between Mandarin and English), language dominance and age would drive cross-linguistic influence shown in Mandarin RCs. Moreover, previous studies have not paid attention to the comprehension of Mandarin RCs with omitted head nouns. The RQs of the second study are as follows: (1) Whether there is a subject RC preference in bilingual and monolingual children's comprehension of Mandarin RCs; (2) whether the presence or absence of a head

noun influences the subject-object asymmetry in bilingual and monolingual children's comprehension of Mandarin RCs; (3) whether bilingual children's language dominance influences their comprehension of Mandarin RCs; and (4) whether bilingual children's age influences their comprehension of Mandarin RCs.

Due to the fact that the current theories that prefer a certain type of RCs are not able to explain the complex picture of RC processing in Mandarin, the third study (Chapter 5) aims to explore other factors affecting the distribution of Mandarin RCs such as the discourse contexts that RCs are situated in, information status and grammatical weight (i.e., the length of a constituent). Written data covering a variety of genres from adult Mandarin L1 speakers and written data from adult Mandarin L2 learners of different L1 backgrounds and proficiency levels allow taking the first step towards explaining the complexity of RC processing by adopting this multifactorial perspective. The following RQs are addressed: (1) Whether the discourse context influences the subject-object asymmetry in Mandarin; (2) whether the information status of RCs and head nouns influences the subject-object asymmetry in Mandarin; (3) whether syntactic embedding influences the choices of the matrix-clause positions RCs appear in; and (4) whether the grammatical weight of matrix subject and object noun phrases influences the choices of the matrix-clause positions RCs appear in.

2.2 Methods of the Thesis

The thesis combines corpus-based and experimental methods across three studies:

RCs in Mandarin-speaking monolingual and heritage Mandarin-English bilingual children's spontaneous speech (1;00-5;00) as well as in child-directed speech, were obtained from the Tong (Deng & Yip, 2018), Zhou2 (Li & Zhou, 2004), Zhou3 (Zhang & Zhou, 2009) corpora, and the Child Heritage Chinese Corpus (Mai & Yip, 2017) as part of the CHILDES

database (MacWhinney, 2000). The corpus data document the emergence and development of RCs in children's spontaneous speech, which enables an examination of whether children are able to produce adult-like RCs at the earliest stage, or whether they develop their RCs gradually based on the simple structures they have already acquired. At the same time, the corpus data enable an examination of whether RCs in children's spontaneous speech resemble RCs in the input. However, children only produce a small number of RCs at the young age, which might not be sufficient and reliable enough to conduct a quantitative analysis.

RC comprehension data were obtained via a character-sentence matching task. In this task, children were presented with two pictures, each containing a pair of cartoon characters performing reversible actions. Then, they were asked to point out the character that corresponds to the head noun of the RC they had just heard (e.g., *Where is the pig that the horse is hugging?*). Seventy-seven heritage Mandarin-English bilingual children aged between 4;00 and 10;11 years, and vocabulary-matched Mandarin-speaking monolingual children aged between 4;00 and 5;09 years were recruited from the UK and China. The character-sentence matching task was selected as it has been widely used in the literature (e.g., Tsoi et al., 2019, Hu et al., 2020), making it easier to compare the current study with previous studies. Moreover, the character-sentence matching task enables a clear detection of factors influencing children's RC comprehension, for example, whether canonical word order and the omission of head nouns influence children's head noun assignment. In general, experimental methods allow researchers to carefully assess the participants recruited (e.g., language dominance, vocabulary ability, age) and control the testing environment. They also enable researchers to control experimental stimuli by only focusing on specific factors (e.g., the omission of head nouns) they are interested in when all other things are equal (e.g., animacy, the length of RCs). However, unlike corpus data that record utterances that children

hear and speak in everyday life, the relatively unnatural nature of experimental stimuli could be a limitation of the experimental studies.

RCs in the writing of adult Mandarin native speakers and second language learners were obtained from The Lancaster Corpus of Mandarin Chinese (LCMC) (McEnery & Xiao 2004), and the HSK Dynamic Composition Corpus (Version 2.0) developed by Beijing Language and Culture University. The LCMC contains a variety of discourse contexts that RCs are situated in, including fiction, general prose (non-fiction), learned (academic) and press, which makes it possible to examine the discourse functions that RCs encode. The HSK Dynamic Composition Corpus comprises the HSK composition papers written by L2 Mandarin learners from different L1 backgrounds (e.g., English, Japanese) and proficiency levels, which can help to examine the role of L2 Mandarin learners' L1 (head-initial vs. head-final) and Mandarin language proficiency in their RC production. In general, comparing written texts with spontaneous speech, written texts tend to consist of more complex sentences and more (advanced) writing techniques, which provides an excellent opportunity to explore the effects of a variety of discourse contexts in influencing the frequency and distribution of RCs.

Chapter 3: The Acquisition of Mandarin Relative Clauses in Mandarin-speaking Monolingual and Heritage Mandarin-English Bilingual Children

Studies focusing on European languages, such as English, French and German, have consistently reported that subject relative clauses (RCs) are easier to acquire and process than object RCs. However, it remains unclear whether there is also a subject RC preference in East Asian languages like Mandarin. The study presented in this chapter investigated the distribution of Mandarin RCs in Mandarin-speaking monolingual and heritage Mandarin-English bilingual children's spontaneous speech between the ages of 1 and 5 years. The results revealed that both monolinguals and bilinguals produced more object RCs than subject RCs in Mandarin, and the object RC advantage was stronger in bilinguals. In addition, the study also examined whether non-centre-embedded RCs showed an advantage over centre-embedded RCs. Unlike English, there was no clear evidence to support a non-centre-embedded preference in Mandarin. Moreover, centre-embedded Mandarin RCs that were attached to the predicate nominal of a copular clause were observed to occur more often in bilinguals' than in monolinguals' speech. This could be because RCs that are attached to the predicate nominal of a copular clause are non-centre-embedded in English, and the most frequently uttered RC type in English-speaking children's speech (Diessel & Tomasello, 2000). Overall, the results suggest that language-specific properties hinging on canonical word order, syntactic embedding and input frequency are all at play in monolingual and bilingual children's acquisition of Mandarin RCs.

3.1 Introduction

The acquisition of RCs has received considerable attention in the field of psycholinguistics over the past half-century. The complexity and diversity of RCs provide a good test case to examine whether different languages are processed on the basis of a certain set of universal (i.e., cross-linguistically applicable) mechanisms. The present study investigates Mandarin RCs in Mandarin-speaking monolingual and heritage Mandarin-English bilingual children's spontaneous speech, focusing on two structural aspects: the role of the head noun within the RC and the role of the head noun within the matrix clause. The aim is to explore whether the mechanisms of RC acquisition are language-universal or language-specific, and whether there are cross-linguistic influences across two typologically different languages (i.e., Mandarin and English) in the acquisition of RCs.

This chapter is organized as follows. First, it describes Mandarin and English RCs based on the role of the head noun within the RC. It then discusses Mandarin and English RCs based on the role of the head noun within the matrix clause and the related issue of centre-embedding. Third, it provides the research questions (RQs) and hypotheses of the present study. It then illustrates the corpus-based methodology and reports the results of this study. Finally, it offers a general discussion of findings.

3.2 The Role of the Head Noun in the RC

As mentioned in Chapter 1.3, based on the role of the head noun within the RC, subject and object RCs are the two main RC structures being widely studied. As shown by examples (1) and (2), the same event can be described by either a subject or object RC, but, as I will discuss, the respective ease of processing of the two structures appears to be different.

[English subject RC]

S V O

(1) The horse [that hugged the pig]

[English object RC]

O S V

(2) The pig [that the horse hugged]

In head-initial languages like English, both corpus data and experimental evidence suggest that subject RCs are easier to acquire and to process than object RCs (e.g., Adani, 2011; Adani et al., 2010; Brandt et al., 2009; Diessel & Tomasello, 2000, 2005; Kidd et al., 2007). As mentioned in Chapter 1.4, there have been a range of theoretical perspectives that account for this subject RC advantage. For example, based on typological research, the Noun Phrase Accessibility Hierarchy (Keenan & Comrie, 1977) proposed a cross-linguistic generalization of the differential ease of relativizing different syntactic positions. Keenan and Comrie's hierarchical ranking of syntactic positions is repeated in (3):

[Noun Phrase Accessibility Hierarchy] (">" means "is more accessible than")

(3) subject > direct object > indirect object > oblique > genitive > object of comparison

In Keenan and Comrie's framework, the higher an item's position on the hierarchy, the easier (and more common) it is for it to be relativized. For instance, an indirect object is comparatively more accessible than an oblique, while in turn a subject is expected to be more accessible than a direct object. This hierarchy has been widely used to explain RC acquisition and processing (e.g., Hawkins, 2007). Most crucially, as the subject occupies the highest

position in the hierarchy, subject RCs are considered easier to acquire and process than any other RC type.

It is important to recall that the Noun Phrase Accessibility Hierarchy is assumed to be typologically universal. In contrast with that, the usage-based approach (e.g., Diessel & Tomasello, 2000, 2005) emphasizes that children's RC acquisition is a gradual process, and that usage patterns can differ across languages and affect this learning process. It is also suggested that children acquire complex constructions from simpler related constructions that they have previously acquired. In addition, the more frequently children hear a construction, the more firmly the construction is entrenched in their mental grammar, and thus the more easily the construction will be activated. In English, subject RCs follow the canonical Subject-Verb-Object (SVO) word order (see example (1)). Conversely, object RCs display a non-canonical OSV word order (see example (2)). From a usage-based perspective, English subject RCs are easier to process, as they resemble simple SVO transitive sentences that are very frequent in the input (e.g., Diessel & Tomasello, 2000; Kidd et al., 2007).

Unlike English, the findings of subject vs. object RCs in head-final languages like Mandarin are contradictory. Some studies have reported a subject advantage in RC acquisition and processing (e.g., Hu et al., 2016; Hu & Guasti, 2017, Tsoi et al., 2019), while others have revealed an object RC advantage (e.g., Chen & Shirai, 2015; Hsu, 2014; Liu, 2015). However, the use of different methods (e.g., corpus vs. experimental) and materials can explain some of the inconsistent findings (Kidd et al., 2007). When only Mandarin RCs in monolingual children's naturalistic speech is taken into account, recent studies consistently show that object RCs are acquired earlier and occur more frequently than subject RCs (e.g., Chen & Shirai, 2015; Hsu, 2014; Liu, 2015; Tsoi et al., 2019, Yang, 2019).

It is worth noting, however, that this object RC advantage in Mandarin might have some qualifications. Different from English, Mandarin allows the head nouns of RCs to be

omitted. For example, the head noun *xiaoma* “horse” and *xiaozhu* “pig” are omitted in examples (4) and (5) respectively (indicated by ø). Liu (2015) looked at subject and object RCs in the spontaneous speech of Mandarin monolingual children (3;00-6;00) and their caregivers. They found that there was an object RC advantage for both children and their caregivers regardless of the presence or absence of head nouns. Hsu (2014) also targeted this issue in the spontaneous speech of monolingual children (1;05-3;11), yet without analysing their caregivers’ speech. Hsu (2014) reported that the Mandarin object RC advantage only held when the head nouns of RCs were present. Out of a total of 36 headed RC structures, the vast majority (83.3%) were object RCs, while out of a total of 29 headless RC structures, only 48.3% were object RCs. However, Hsu (2014)’s results should be taken with some caution, as they were based on a very limited number of RCs (only 65 tokens), and the difference between headless subject RCs and headless object RCs was very marginal (15 vs. 14). Similarly, it is important to note that the age range of the monolingual children in Liu (2015) and Hsu (2014) was different.

[Mandarin headless subject RC]

(4) [抱 小猪] 的 ø 在 哪里？

[bao xiaozhu de ø zai nali

hug pig DE is where

“Where is (the horse) that is hugging the pig?”

[Mandarin headless object RC]

(5) [小马 抱] 的 ø 在 哪里？

[xiaoma bao] de ø zai nali

horse hug DE is where

"Where is (the pig) that the horse is hugging?"

In spite of the potential qualification, the object RC advantage found in Mandarin poses a challenge to the universal subject RC advantage proposed in Keenan and Comrie's Noun Phrase Accessibility Hierarchy. Instead, it has been suggested to support the usage-based account (e.g., Chen & Shirai, 2015). As shown in examples (6) and (7), due to the head-final property, Mandarin subject RCs display a non-canonical VOS word order, while object RCs follow the more canonical SVO word order. From a usage-based perspective, the word order overlap between Mandarin object RCs and simple SVO sentences is likely to facilitate Mandarin-speaking monolingual children's production of object RCs. In addition, the influence of the input could be another reason for this object RC advantage. In fact, Mandarin-speaking monolingual children's caregivers also utter more object RCs than subject RCs in child-directed naturalistic speech (e.g., Chen & Shirai, 2015; Liu, 2015; Yang, 2019).

[Mandarin subject RC]

V O S

(6) [抱 小猪] 的 小马

[bao xiaozhu] de xiaoma

hug pig DE horse

"the horse that hugged the pig"

[Mandarin object RC]

S V O

(7) [小马　抱]　的　小猪

[xiaoma bao]　de　xiaozhu

horse　hug　DE　pig

“the pig that the horse hugged”

In light of the object RC advantage in Mandarin-speaking monolingual children’s naturalistic speech, this study aims not only to revisit the monolingual acquisition of Mandarin headed and headless RCs, but also to take on a new perspective by focusing on heritage Mandarin-English bilingual children. The latter are exposed to Mandarin as a heritage language at home, and to English as the societal majority language. Naturalistic data from heritage Mandarin-English bilingual children can better aid the understanding of how the acquisition of Mandarin RCs is affected by related structures in Mandarin and how it is affected by the acquisition of related structures in English.

More specifically, Mandarin object RCs not only resemble simple SVO sentences in Mandarin, but also simple SVO sentences in English. According to both the effect of canonical word order and the cross-linguistic influence hypothesis proposed by Hulk and Müller (2000) (see Sections 1.2.1 and 1.4.4), heritage Mandarin-English bilingual children are predicted to show an increased preference for object RCs, compared to monolingual children. In addition, Mandarin overt and omitted head nouns could also be a case of cross-linguistic influence, as Mandarin allows the head nouns of RCs to be omitted, while English head nouns do not. In comparison with monolingual children, heritage Mandarin–English bilinguals may use less headless RCs than Mandarin-speaking monolinguals due to the influence of English.

3.3 The Role of the Head Noun in the Matrix Clause and Centre Embedding

RCs can also be categorized based on the role of the head noun in the matrix clause:

- NP RCs (RCs that are attached to an isolated noun phrase) such as (1) and (2).

- PN RCs (RCs that are attached to the predicate nominal of a copular clause)

(8) This is the horse [that hugged the pig].

- SUBJ RCs (RCs that are attached to the subject of the matrix clause)

(9) The horse [that hugged the pig] saw the goat.

- DOBJ RCs (RCs that are attached to the direct object of the matrix clause)

(10) The goat saw the horse [that hugged the pig].

- OBL RCs (RCs that are attached to the noun phrase of a prepositional phrase in the matrix clause)

(11) The horse is at the place [where it drinks water].

In English, PN RCs are reported to occur the earliest and most frequently in children's spontaneous speech (1;09-5;02), followed by NP RCs and DOBJ RCs, while OBL RCs and SUBJ RCs are quite rare in young children's speech (Diessel & Tomasello, 2000). NP RCs are syntactically and semantically simpler than the other types, as they involve only one clause and one proposition. Similarly, although PN RCs attach to the predicate nominal of a copular clause, they also express only one proposition. In fact, the copular clause of PN RCs (e.g., *this is* in (8)) are often used in child-directed speech to focus the attention of the hearer

on a new head noun (e.g., *the horse* in (8)) rather than expressing a proposition in the surrounding situation (Diessel & Tomasello, 2000). DOBJ RCs, OBL RCs and SUBJ RCs are relatively more complex, as they attach to a matrix clause and contain more than one proposition. However, after a closer look, Diessel and Tomasello (2000) found that the majority of DOBJ RCs had an imperative matrix clause such as *Look at dat train (pause) Ursula bought*, in which *look* served as an attention getter focusing the hearer on the head noun *dat train*. This means that the majority of DOBJ RCs actually can arguably considered to contain just one proposition, making them to be acquired earlier and more frequently than OBL RCs or SUBJ RCs.

In addition to propositional complexity, syntactic embedding has also been proposed to explain the processing difficulty of RCs (e.g., Jäger et al., 2017; McElree et al., 2003; Shoji, 2017). English SUBJ RCs fall right in the centre of the matrix clause (i.e., they are centre-embedded), whereas NP RCs, PN RCs, DOBJ RCs and OBL RCs are right-branching (i.e., they are non-centre-embedded). When processing SUBJ RCs, readers and listeners need to store the matrix subject (*the horse* in (9)) in working memory and retrieve it while encountering the matrix predicate (*saw the goat* in (9)), which might require more cognitive load (e.g., Gibson, 2000). On the other hand, this store-retrieval mechanism is not necessary when processing non-centre-embedded RCs, as readers process the whole matrix sentence first (e.g., *The goat saw the horse* in (10)), and only then do they process the RC (*that hugged the pig* in (10)).

The picture of RC acquisition in Mandarin is not fully compatible with that of English, due to some language-specific characteristics (e.g., head-initial vs. head-final). Chen and Shirai (2015) found that in Mandarin-speaking children's spontaneous speech (0;11-3;05), NP RCs such as (6) and (7) are the most frequently uttered especially at early stages of development. This is because they are the least complex, as they involve only one clause and

one proposition. PN RCs such as (12) are also mono-propositional. However, they occur less frequently and later than NP RCs (Chen & Shirai, 2015). Unlike English, in Mandarin, PN RCs, DOBJ RCs and OBL RCs such as (14) and (15) are centre-embedded, which might explain their relatively later occurrence and lower frequency in contrast with English. Similarly, the left-branching property may be related with a relatively early occurrence of SUBJ RCs such as (13) in Mandarin (Chen & Shirai, 2015). This is also in contrast with English, where SUBJ RCs occur comparatively later and with lower frequencies (See Table 3.1 below for a brief summary of syntactic embedding in Mandarin and in English).

[Mandarin PN RC]

(12) 这 是 [抱 小猪] 的 小马。

zhe shi [bao xiaozhu] de xiaoma

this is hug pig DE horse

"This is the horse that hugged the pig."

[Mandarin SUBJ RC]

(13) [抱 小猪] 的 小马 看到 山羊。

[bao xiaozhu] de xiaoma kandao shanyang

hug pig DE horse see goat

"The horse that hugged the pig saw the goat."

[Mandarin DOBJ RC]

(14) 山羊 看到 [抱 小猪] 的 小马。

shanyang kandao [bao xiaozhu] de xiaoma

goat see hug pig DE horse

"The goat saw the horse that hugged the pig."

[Mandarin OBL RC]

(15) 小马 在 [喝 水] 的 地方。

xiaoma zai [he shui] de difang

horse at drink water DE place

"The horse is at the place where (it) drinks water."

Table 3.1: Syntactic embedding in Mandarin and English

RC types	**Syntactic embedding**	
	Mandarin	**English**
NP RCs	Non-centre-embedded	Non-centre-embedded
PN RCs	Centre-embedded	Non-centre-embedded
SUBJ RCs	Non-centre-embedded	Centre-embedded
DOBJ RCs	Centre-embedded	Non-centre-embedded
OBL RCs	Centre-embedded	Non-centre-embedded

To summarize, two crucial factors of propositional complexity and syntactic embedding have been reported to influence the RC acquisition in both English and Mandarin. In particular, propositionally simpler and non-centre-embedded RCs tend to occur earlier and more often than the propositionally more complex and centre-embedded ones. The typological variation (head-initial vs. head-final) between English and Mandarin involves different syntactic embedding patterns. However, the results of both languages support that non-centre-embedded RCs are easier to process than centre-embedded RCs when they have

the same number of propositions. The current study focuses on heritage Mandarin-English bilingual children and provides a good opportunity to examine whether this "non-centre-embedded over centre-embedded" assumption also holds in the bilingual context. That is, I aim to see whether there is cross-linguistic influence from English to Mandarin making bilingual children display a different RC acquisition pattern than monolingual children.

3.4 Research Questions and Hypotheses

The current study investigates the distribution of Mandarin RCs in Mandarin-speaking monolingual and heritage Mandarin-English bilingual children's spontaneous speech, aiming to address the following RQs:

RQ1: Is there a subject-object asymmetry in monolingual and bilingual children's spontaneous speech? If so, does the presence or absence of a head noun influence the subject-object asymmetry?

RQ2: Is there a "non-centre-embedded over centre-embedded" preference in monolingual and bilingual children's spontaneous speech?

RQ3: Does cross-linguistic influence from English to Mandarin make bilingual children perform differently than monolingual children?

Regarding RQ1, I hypothesize that both monolingual and bilingual children produce more object RCs than subject RCs in Mandarin due to the word order similarity between Mandarin object RCs and Mandarin simple SVO sentences. In this respect, I follow Liu (2015) in expecting monolingual and bilingual children to produce more object RCs than subject RCs no matter whether head nouns occur or not.

Regarding RQ2, both monolingual and bilingual children are expected to utter non-centre-embedded RCs earlier and more often than centre-embedded RCs, as long as they have the same number of propositions. As discussed before, both NP RCs and PN RCs

involve only one proposition. However, NP RCs are expected to be uttered more often and earlier than PN RCs. This is because NP RCs are left-branching, while PN RCs are centre-embedded. In turn, SUBJ RCs, DOBJ RCs and OBL RCs involve more than one proposition. Even in this case, centre-embedding comes into play as an additional condition to propositional complexity. In fact, I similarly expect SUBJ RCs to be produced relatively earlier and with higher frequency than DOBJ RCs and OBL RCs as SUBJ RCs are non-centre-embedded.

Turning now to RQ3, I expect that bilingual children will show cross-linguistic influence from English to Mandarin. First, as Mandarin object RCs also resemble English simple SVO sentences, bilingual children are expected to produce a higher proportion of Mandarin object RCs than monolingual children. Second, as head nouns are not allowed to be omitted in English, bilingual children are expected to utter a lower proportion of headless subject and object RCs than monolingual children. Last, I assume that bilingual children will produce a higher proportion of PN RCs, but a lower proportion of SUBJ RCs, compared to monolinguals. This is due to the fact that PN RCs are centre-embedded in Mandarin but non-centre-embedded in English. The latter have been found to be the most frequent pattern in English-speaking children's early speech (Diessel & Tomasello, 2000). In contrast, SUBJ RCs are non-centre-embedded in Mandarin but centre-embedded in English.

3.5 Method

3.5.1 Data

The present study was based on the spontaneous speech of Mandarin-speaking monolingual children from the Tong (Deng & Yip, 2018), Zhou2 (Li & Zhou, 2004) and Zhou3 (Zhang & Zhou, 2009) corpora and heritage Mandarin-English bilingual children from the Child Heritage Chinese Corpus (Mai & Yip, 2017) as part of the CHILDES database

(MacWhinney, 2000). All the corpora contained interactions between children and their caregivers. The caregivers were not only parents, but also grandparents, or occasional visitors like aunts. Children were also invited to interact with research staff in some conversations. This study analysed children's speech and child-directed speech from all the caregivers as well as research staff (i.e., input).

Tong and Zhou3 are longitudinal child corpora and each of them is based on one Mandarin-speaking monolingual child. In Tong, 22 one-hour recordings at one-month intervals from 1;07 to 3;04 were released. For Zhou3[3], most of the conversations were recorded at monthly or bi-monthly intervals from 0;08 to 4;05. The Bilingual Child Heritage Chinese Corpus is a longitudinal corpus gathering data of three American-born Chinese children — Luna, Avia and Winston. Luna was almost exclusively exposed to Mandarin at home since birth. From 2;00 to 4;01, she was video- and audio-recorded by her parents at home every week or fortnight. From 3;10 to 4;11, she was also recorded while having conversations with research staff at the Chinese University of Hong Kong via Skype at monthly intervals. Unlike Luna, Avia's mother is Chinese, and her father is American. In their interactions with her, the mother exclusively spoke Mandarin and the father spoke English. From 2;00 to 3;11, Avia was recorded while interacting with her mother in Mandarin at bi-weekly or tri-weekly intervals. As for Winston, his parents grew up in China, speaking both Cantonese (Guangzhou) and Mandarin. At home, they used Cantonese 70% of the time and Mandarin 30% of the time when interacting with Winston. Their home conversations with Winston from 1;07 to 3;07 in both Cantonese and Mandarin were recorded at weekly or bi-weekly intervals.

[3] The collection and analysis of the data in Zhou3 had been finished in March 2020. After that, Zhou3 corpus was revised and re-edited. The current release consists of 30 recordings from 1;08 to 5;04.

Table 3.1 shows total number of words in their speech across different age ranges and in their input. As bilingual data from the Bilingual Child Heritage Chinese Corpus and monolingual data from Tong and Zhou 3 were not balanced in terms of age ranges, additional monolingual data from 3;07 to 5;00 were added to balance with the bilingual dataset. They were randomly selected from the cross-sectional corpus Zhou2. Zhou2 includes videotaped conversations between mothers and their children. Mothers were instructed to use contents of four boxes (e.g., ball, paper, crayon, a picture book with stories in Chinese) to encourage children to interact with them. The Child Heritage Chinese Corpus is the only one focusing on Mandarin-English bilingual children that could be accessed at the time of the study. As a result, I could not find additional bilingual data to match the monolingual data from 0;07 to 1;11.

Table 3.2: The age range of each child and the total number of words in each child's speech across different age ranges and in their input in four corpora

Corpus		**Age**	**No. of child words**					**No. of words in input**
			0;07-1;11	2;00-3;06	3;07-4;05	4;06-5;00	Total	
Tong		1;07-3;04	4,637	26,159	\	\	30,796	98,391
Zhou3		0;08-4;05	9,767	14,541	5,639	\	29,947	68,573
Zhou2		3;05-5;00	\	\	5,842	4,191	10,033	32,798
Total (monolingual data)			**14,404**	**40,700**	**11,481**	**4,191**	**70,776**	**199,762**
Bilingual child heritage Chinese	Luna	2;00-4;11	\	17,311	8,190	4,107	29,608	96,810
	Avia	2;00-3;11	\	16,088	2,293	\	18,381	57,794
	Winston	1;07-3;07	411	8,451	1,062	\	9,924	37,259

Total (bilingual data)	**411**	**41,850**	**11,545**	**4,107**	**57,913**	**191,863**

3.5.2 Data Coding and Analysis

All the utterances that contained a RC marker DE and a RC-internal verb were manually extracted, in the form of Verb-DE-(Head Noun) such as (16). Utterances where DE appears in the form of *shi…de* construction (17) and topic-comment construction (18) are not part of this study[4].

(16) 张三　　买　的　书。

Zhangsan　mai　de　shu

Zhangsan　buy　DE　book

"The book that Zhangsan bought."

(From Cheng (2008))

(17) 这本　书　是　张三　　买　的。

zhe-ben　shu　shi　Zhangsan　mai　de

this-CL　book　is　Zhangsan　buy　DE

"This book is bought by Zhangsan."

(From Cheng (2008))

[4] *shi…de…*construction (17) is a grammaticalized construction that acquired a specific contrastive focus function (e.g., Cheng, 2008; Paul & Whitman, 2008; Zhan & Traugott, 2019) out of an original RC one. This entails that it underwent a diachronic process of differentiation (De Smet et al., 2018), as it is often distinctively used to focus on some aspect of a past event, rather than encoding a RC function. In turn, topic-comment construction (18) is a case of further chunking (Bybee 2010) and phonetic reduction of early contrastive focus forms, whereby the original *shi* is dropped.

(18) 这本　　书　　张三　　买　　的。

zhe-ben　shu　Zhangsan　mai　de

this-CL　book　Zhangsan　buy　DE

"This book Zhangsan bought."

All the utterances were coded based on the following three structural features:

a) The role of the head noun within the RC: (transitive and intransitive) subject RCs and object RCs. Other types of RCs such as oblique RCs were not included here.
b) The headedness of subject and object RCs: headed subject RCs, headless subject RCs, headed object RCs, and headless object RCs.
c) The role of the head noun within the matrix clause: NP RCs (RCs that are attached to an isolated noun phrase), PN RCs (RCs that are attached to the predicate nominal of a copular clause), SUBJ RCs (RCs that are attached to the subject of the matrix clause), DOBJ RCs (RCs that are attached to the direct object of the matrix clause), and OBL RCs (RCs that are attached to the noun phrase of a prepositional phrase in the matrix clause).

3.6 Results

3.6.1 The Role of the Head Noun in the RC

First, the proportion of subject and object RCs produced by monolingual and bilingual children was analysed. As shown in Figure 3.1, object RCs were more frequent than subject RCs in both monolingual and bilingual children's speech (monolingual children: $X^2 = 8.11$, $df = 1$, $p = 0.004$; bilingual children: $X^2 = 16.08$, $df = 1$, $p = 6.072\text{e-}05$). When comparing bilingual children with monolingual children, bilingual children produced a significantly higher proportion of object RCs ($X^2 = 5.66$, $df = 1$, $p = 0.02$). The results confirmed the

hypotheses that both monolingual and bilingual children showed an object RC advantage, with bilingual children producing more object RCs than monolingual children.

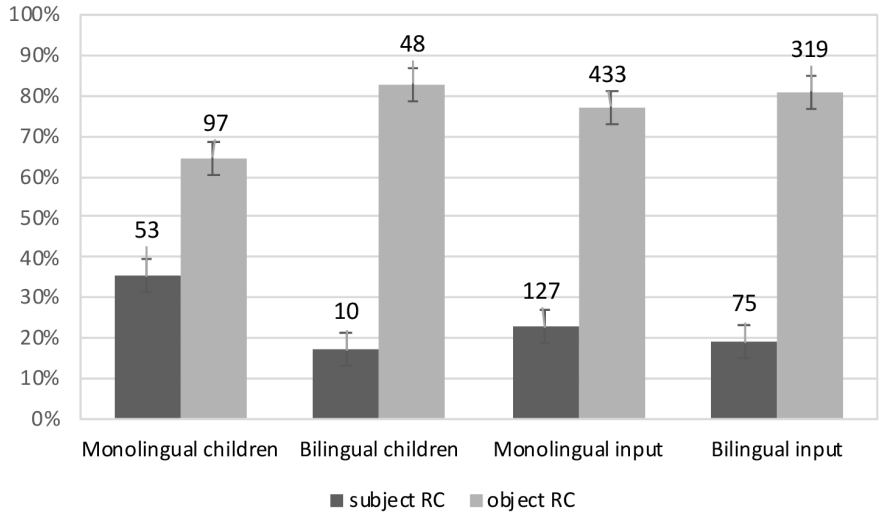


Figure 3.1: Proportion of subject and object RCs in monolingual and bilingual children's speech and in their input (The raw frequencies are provided above the bars.)

Second, the proportion of subject and object RCs in monolingual and bilingual children's input was analysed (see also Figure 3.1). Object RCs were also significantly more frequent than subject RCs in both monolingual and bilingual children's input (monolingual input: $X^2 = 114.17$, $df = 1$, $p < 2.2e\text{-}16$; bilingual input: $X^2 = 103.93$, $df = 1$, $p < 2.2e\text{-}16$), while there was no significant difference in the distribution of subject and object RCs between monolingual and bilingual children's input ($X^2 = 1.63$, $df = 1$, $p = 0.2$). When comparing children with their input, monolingual children produced a significantly higher proportion of subject RCs than their caregivers ($X^2 = 9.35$, $df = 1$, $p = 0.002$), while bilingual children were consistent with their input in the distribution of subject and object RCs ($X^2 = 0.02$, $df = 1$, $p = 0.88$).

Due to the disparity between monolingual children's speech and their input, I further calculated the distribution of monolingual children's subject and object RCs over three age

ranges: 0;07-1;11, 2;00-3;06, 3;07-5;00[5]. The aim here was to investigate whether monolingual children's RC production would increasingly match that of their caregivers with age. The results showed that monolingual children produced 21.62% subject RCs in the first age range (0;07-2;11), but the percentage of subject RCs sharply increased to 45.33% in the second age range (2;00-3;06). In the third age range (3;07-5;00), it dropped to 28.95%. As monolingual children tended to produce fewer subject RCs from the second to the third age range, it was evident that monolingual children's performance became more adult-like when they grew older. It was yet necessary to explain why monolingual children's subject RCs increased sharply from the first age range to the second age range. After a closer look it has been found that among the subject RCs produced by the child of Zhou3, six out of eight subject RCs in the first age range were from song lyrics such as (19). In the second age range, 8 out of 17 subject RCs were from song lyrics and stories such as (20). The substantial proportion of song lyrics and stories partially explains the higher number of subject RCs in younger monolingual children's speech.

(19) 我 是 [卖 报 的] 小 行家。

wo shi mai bao de xiao hangjia

I am sell newspaper de little expert

"I'm a little expert who (are good at) selling newspapers."

(From 1;04, child, Zhou3)

(20) 王后 扮成 一个 [卖 苹果 的 老太婆]。

[5]Table A.1 in the "Appendix A" provides the raw number of subject and object RCs in monolingual and bilingual children's speech across different age ranges.

wanghou bancheng yige mai pingguo de laotaipo

queen pretend-turn-into one-CL sell apple de old-woman

"The queen pretends to be an old woman who sells apples."

(From 2;08, child, Zhou3)

All in all, the results indicate that object RCs occurred more often than subject RCs in both monolingual and bilingual children's speech and their input. When comparing monolingual children with bilingual children, bilingual children produced more object RCs. After comparing monolingual and bilingual children with their input, the distribution pattern between monolingual children and input was not fully consistent. However, monolingual children's usage of RCs became more adult-like as they grew older.

3.6.2 The Headedness of Subject and Object RCs

This section further explores whether the presence or absence of a head noun would influence the object RC advantage shown in Mandarin monolingual and bilingual children's speech[6]. The results indicate that when the head noun was present, object RCs occurred significantly more often than subject RCs in both monolingual and bilingual children's speech (monolingual children: $X^2 = 4.12$, $df = 1$, $p = 0.04$; bilingual children: $X^2 = 4.7$, $df = 1$, $p = 0.03$). When the head noun was absent, object RCs were also more frequent than subject RCs, which reached marginal significance in monolingual children's speech ($X^2 = 3.54$, $df = 1$, $p = 0.06$), and statistical significance in bilingual children's speech (headless: $X^2 = 12.15$, $df = 1$, $p = 0.0005$).

[6] Table A.2 in the "Appendix A" provides the raw number of headed and headless subject and object RCs in monolingual and bilingual children's speech and in their input.

As head nouns are not allowed to be omitted in English, bilingual children were expected to utter a lower percentage of headless subject and headless object RCs than monolingual children. However, no difference was found between monolingual and bilingual children in the distribution of headed and headless subject RCs ($X^2 = 1.07$, $df = 1$, $p = 0.3$) or in the distribution of headed and headless object RCs ($X^2 = 0.9$, $df = 1$, $p = 0.34$).

The distribution of headed and headless subject and object RCs in monolingual and bilingual children's input also showed a similar pattern. Object RCs occurred significantly more often than subject RCs regardless of the presence or absence of a head noun (headed subject vs. headed object RCs: monolingual input: $X^2 = 52$, $df = 1$, $p = 5.552e\text{-}13$; bilingual input: $X^2 = 48.28$, $df = 1$, $p = 3.704e\text{-}12$; headless subject vs. headless object RCs: monolingual input: $X^2 = 64.63$, $df = 1$, $p = 9.033e\text{-}16$; bilingual input: $X^2 = 55.51$, $df = 1$, $p = 9.306e\text{-}14$). When comparing children with their input, no significant differences in the distribution of headed and headless subject RCs (monolingual: $X^2 = 0.05$, $df = 1$, $p = 0.83$; bilingual: $X^2 = 1.65$, $df = 1$, $p = 0.2$) or in the distribution of headed and headless object RCs (monolingual: $X^2 = 1.5956e\text{-}31$, $df = 1$, $p = 1$) were observed.

It can be concluded from these results that the presence or absence of a head noun did not influence the object RC advantage in either monolingual or bilingual children's speech or in their input. When comparing bilingual and monolingual children, bilingual children did not utter a lower percentage of headless subject or object RCs than monolingual children. When comparing children with their input, their distribution patterns were very similar.

3.6.3 The Role of the Head Noun in the Matrix Clause

Having examined RCs according to the role of the head noun within the RC, the section turns to the analysis of RCs according to the role of the head noun within the matrix clause. The aim here is to investigate whether monolingual and bilingual children would show a "non-

centre-embedded over centre-embedded" preference. Of note, the comparisons are between non-centre-embedded and centre-embedded RCs that have the same number of propositions (i.e., NP RCs vs. PN RCs; SUBJ RCs vs. DOBJ RCs vs. OBL RCs).

As shown in Figure 3.2, in monolingual children's speech, NP RCs occurred significantly more often than PN RCs ($X^2 = 23.04$, $df = 1$, $p = 1.585e\text{-}06$). SUBJ RCs occurred significantly more often than OBL RCs ($X^2 = 7.66$, $df = 1$, $p = 0.006$), but less often than DOBJ RCs ($X^2 = 8.8$, $df = 1$, $p = 0.003$). As for bilingual children, their NP RCs occurred significantly less often than PN RCs ($X^2 = 4.43$, $df = 1$, $p = 0.04$), while SUBJ RCs occurred similar with DOBJ RCs ($X^2 = 0.45$, $df = 1$, $p = 0.5$) and OBL RCs ($X^2 = 0.42$, $df = 1$, $p = 0.5$). The results were not fully consistent with the hypothesis that non-centre-embedded RCs (NP RCs, SUBJ RCs) showed an advantage over centre-embedded RCs (PN RCs, DOBJ RCs, OBL RCs).

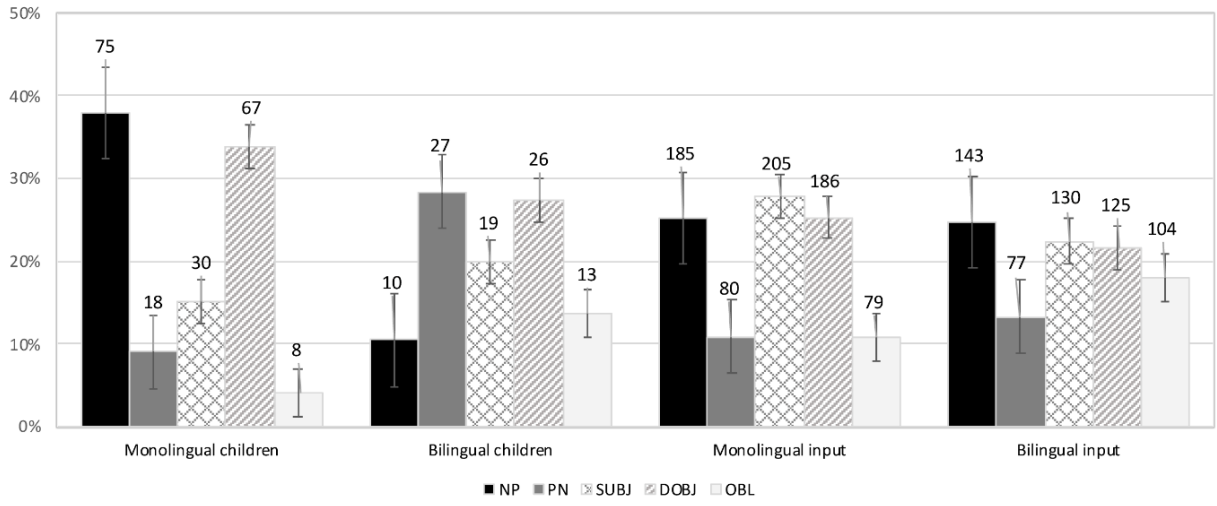


Figure 3.2: RCs by the role of the head noun in the matrix clause in monolingual and bilingual children's speech and in their input (The raw frequencies are provided above the bars.)

The RC distribution patterns across monolingual and bilingual children were also compared. Figure 3.3 is an association plot. Each bar corresponds to a Language group - RC type pair and its area is proportional to the difference in the observed and expected frequencies. The width of the bar indicates frequency, while the height of the bar represents significance. If the observed frequency is significantly higher than the expected one, the bar rises above the dashed line and is coloured blue. Conversely, if the observed frequency is significantly lower than the expected frequency, the rectangle falls below the dashed line and is coloured red. As shown in Figure 3.3, compared to monolingual children, bilingual children uttered significantly fewer NP RCs (indicated by the red bar in the leftmost column), and more PN RCs and OBL RCs (the blue bars in the second left and the rightmost columns) ($X^2 = 42.26$, $df = 4$, $p = 1.477\text{e-}08$).

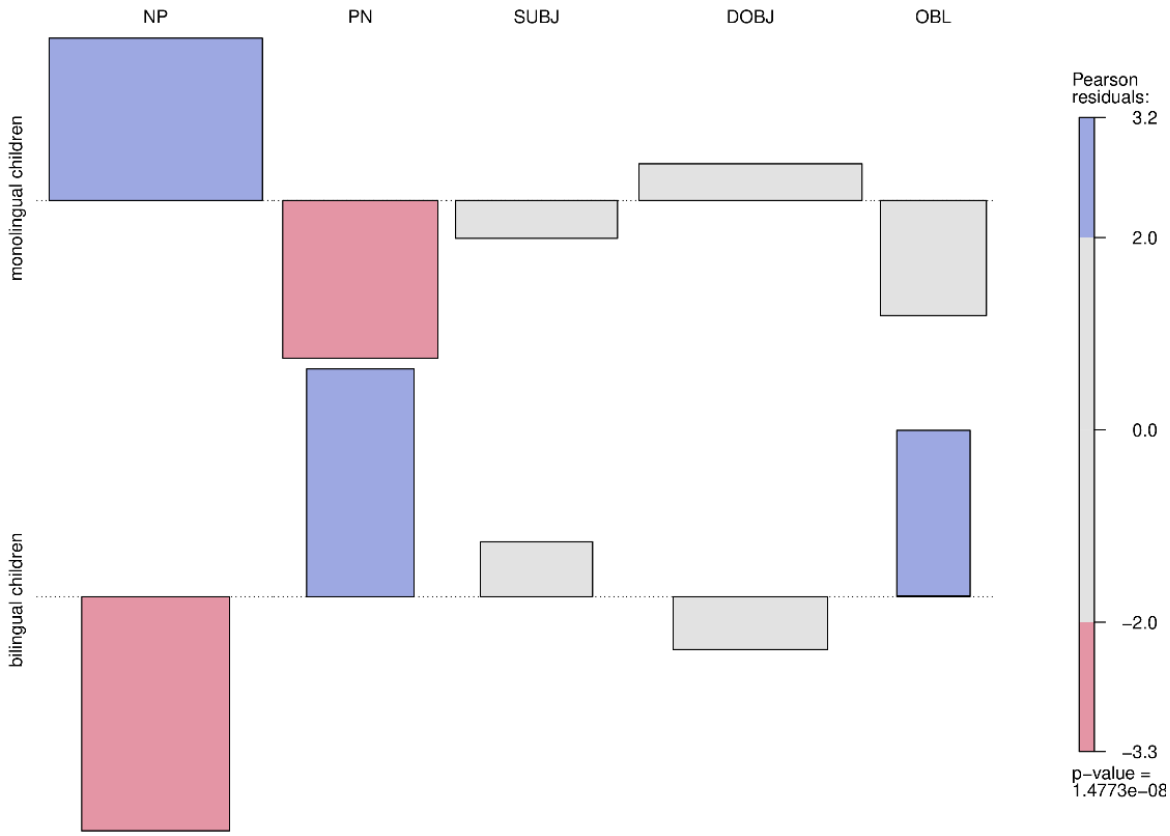


Figure 3.3: Association plot between monolingual/bilingual children and RC types in monolingual and bilingual children's speech

Next, I analysed the distribution patterns of RCs in monolingual and bilingual children's input. As can be seen in Figure 3.2, in both monolingual and bilingual children's input, NP RCs occurred significantly more often than PN RCs (monolingual input: X^2 = 27.43, df = 1, p = 1.631e-07; bilingual input: X^2 = 12.73, df = 1, p = 0.0004), whereas SUBJ RCs and DOBJ RCs were similar in frequency (monolingual input: X^2 = 0.52, df = 1, p = 0.47; bilingual input: X^2 = 0.03, df = 1, p = 0.86). The only significant difference between monolingual and bilingual children's caregivers was that the former produced significantly more SUBJ RCs than OBL RCs (X^2 = 37.2, df = 1, p = 1.067e-09), while the latter's SUBJ RCs and OBL RCs had similar frequency (X^2 = 1.71, df = 1, p = 0.19). The significantly higher frequency of OBL RCs shown in bilingual children's caregivers (X^2 =19.36, df = 4, p = 0.001) might explain the higher frequency of OBL RCs produced by bilingual children. However, neither monolingual nor bilingual children's speech was fully consistent with their input. As can be seen in Figure 3.4, monolingual children produced significantly more NP RCs (the blue bar), but fewer SUBJ RCs and OBL RCs (the red bars) than their caregivers (X^2 = 31.28, df = 4, p = 2.68e-06). While bilingual children produced significantly more PN RCs (the blue bar), but fewer NP RCs (the red bar) than their caregivers, as shown in Figure 3.5 (X^2 = 21.61, df = 4, p = 0.0002).

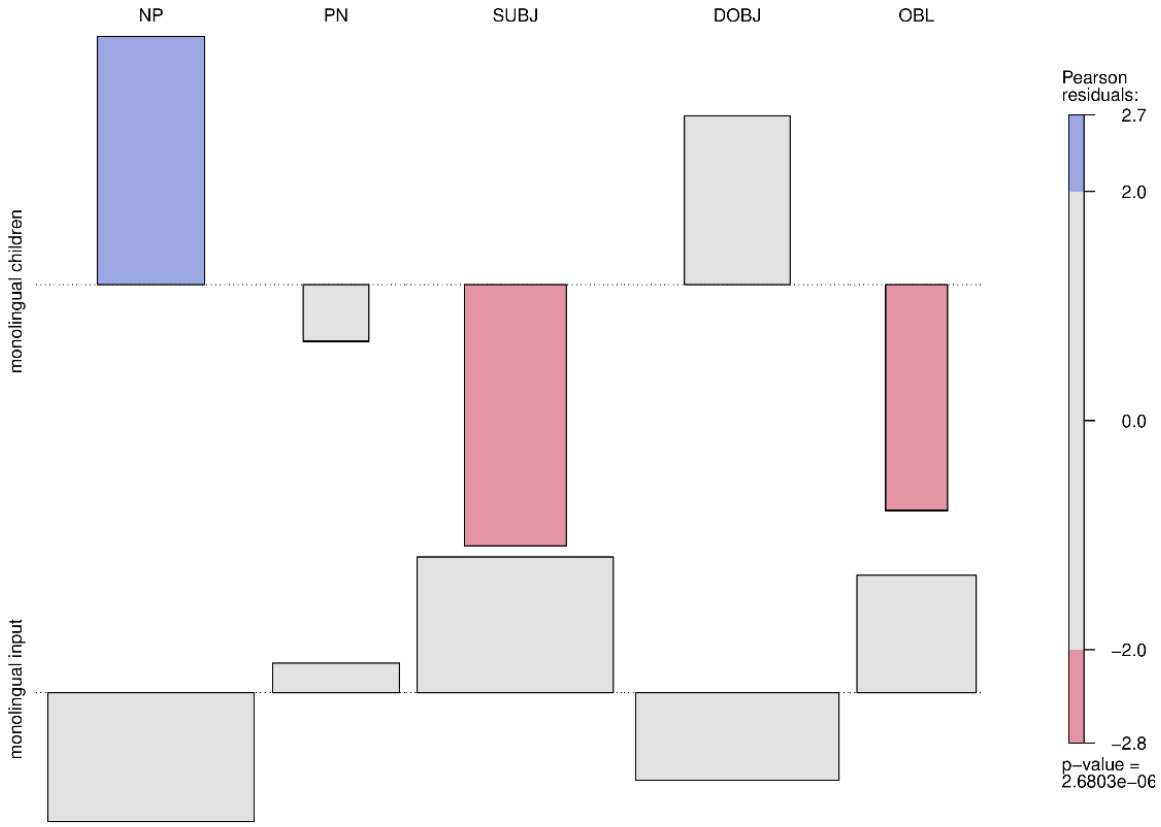


Figure 3.4: Association plot between children/input and RC types in monolingual children's speech and in their input

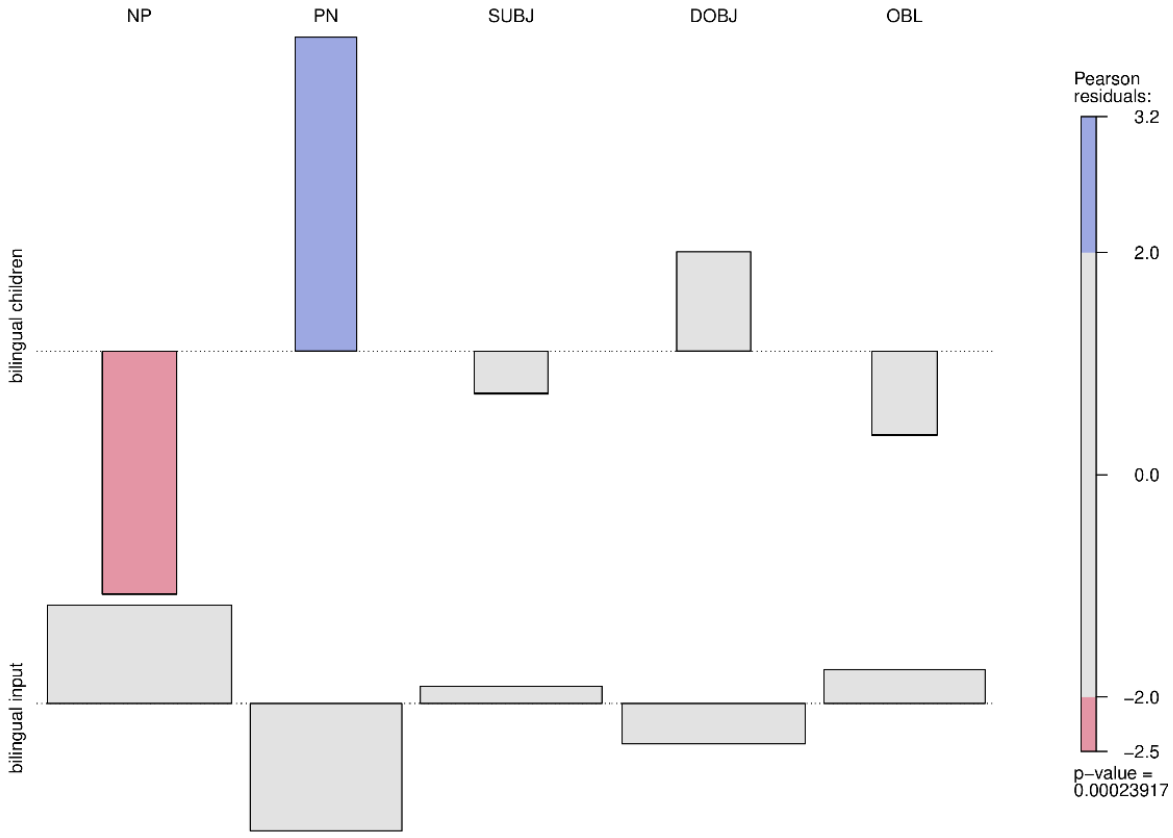


Figure 3.5: Association plot between children/input and RC types in bilingual children's speech and in their input

In order to investigate whether children's performance became more adult-like with increasing age, the developmental patterns of five types of RCs in children's speech were also analysed[7]. It can be seen from the leftmost and the second left columns in Figure 3.6 that monolingual children tended to utter more NP RCs and PN RCs in the first age range (0;07-1;11), while this tendency decreased in the second and third range (2;00-3;06; 3;07-5;00). Meanwhile, they tended to utter more DOBJ RCs and OBL RCs in the second age range (the second right and the right most columns), and more SUBJ RCs in the third age range (the middle column). Recall that monolingual children uttered more NP RCs but fewer SUBJ RCs

[7] Table A.3 in the "Appendix A" provides the raw number of five types of RCs in monolingual and bilingual children's speech across different age ranges.

and OBL RCs than their input. Hence, it could be concluded that monolingual children tended to have a more adult-like RC performance with increasing age. However, bilingual children did not show the tendency to become more adult-like with age (see Figure 3.7). They produced more PN RCs than their caregivers, and the proportion of PN RCs (the second left column) did not decrease significantly with age ($X^2 = 3$, $df = 4$, $p = 0.56$). This result suggests that the higher proportion of PN RCs in bilingual children's speech was not driven by their input.

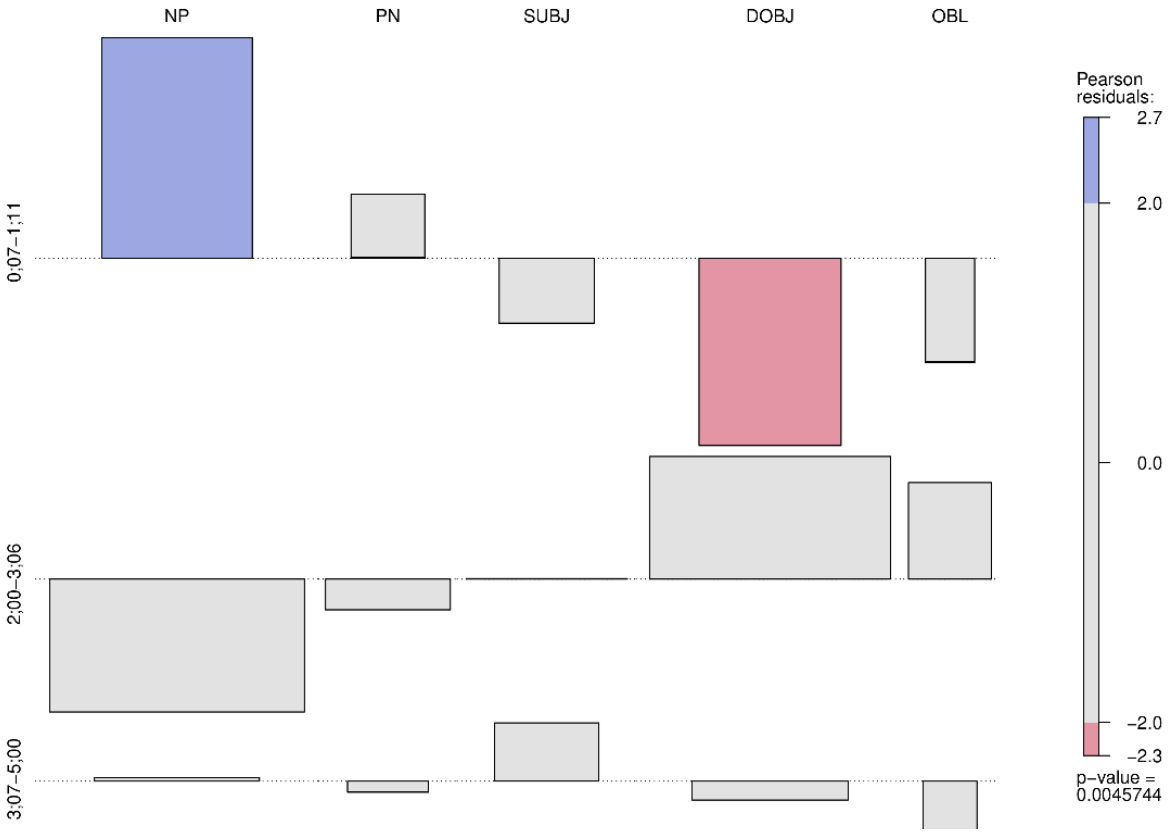


Figure 3.6: Association plot between RC types and age in monolingual children's speech

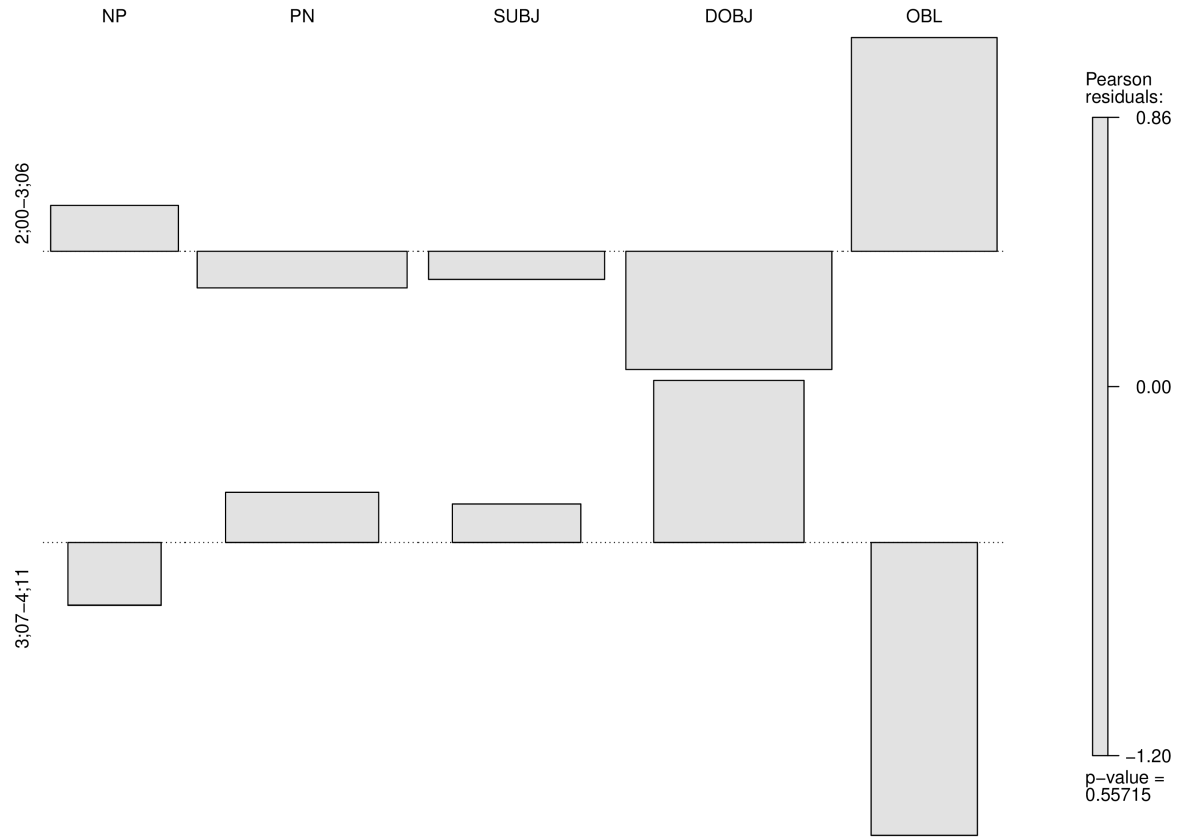


Figure 3.7: Association plot between RC types and age in bilingual children's speech

To conclude, the results did not fully support the "non-centre-embedded over centre-embedded" preference (e.g., Jäger et al., 2017; McElree et al., 2003; Shoji, 2017). Monolingual children produced more NP RCs than PN RCs, but more DOBJ RCs than SUBJ RCs. Although the distribution patterns between monolingual children and their input were not identical, they became more adult-like by producing less NP RCs but more SUBJ RCs with increasing age. In comparison with monolingual children, bilingual children produced more PN RCs and OBL RCs. The relatively higher proportion of OBL RCs in bilingual children's speech is probably driven by the input, while the high proportion of PN RCs is not, which will be discussed in detail in the General Discussion.

3.7 General Discussion

The study analysed the distribution patterns of Mandarin RCs that were divided by the role of the head noun within the RC and the role of the head noun within the matrix clause in Mandarin-speaking monolingual and English-Mandarin bilingual children's spontaneous speech. The main aims were to examine (a) whether there is a subject-object asymmetry in Mandarin, (b) whether there is a "non-centre-embedded over centre-embedded" preference in Mandarin, and (c) whether bilingual children perform differently than monolingual children due to cross-linguistic influence from English to Mandarin.

3.7.1 Subject-object Asymmetry

The results confirm the subject-object asymmetry in the spontaneous speech of Mandarin monolingual children previously reported in the literature (e.g., Chen & Shirai, 2015; Hsu, 2014; Liu, 2015; Tsoi et al., 2019, Yang, 2019). Object RCs occurred more often than subject RCs. Furthermore, the object RC advantage has also been found in heritage Mandarin-English bilingual children. These findings are in contrast with the cross-linguistic subject RC advantage proposed in Keenan and Comrie's Noun Phrase Accessibility Hierarchy (1977) and with findings in English and other European languages. Thus, the first question to be asked here is why both monolingual and bilingual children showed a strong primacy of object over subject RCs in Mandarin? I propose that the role of simple related structures and the input are decisive (e.g., Diessel & Tomasello, 2000, 2005; Chen & Shirai, 2015). Crucially, Mandarin object RCs share the same SVO word order of simple transitives, which facilitates monolingual and bilingual children's production of this kind of RC. In addition, as both the monolingual and bilingual children's input showed an object RC advantage, children's RC production was also driven by their input.

When comparing monolingual children with bilingual children, bilingual children produced a higher proportion of object RCs, which also confirmed the hypothesis. Recall that the word order of Mandarin object RCs not only overlaps with that of Mandarin simple SVO sentences, but also with English simple transitives. I suggest that these word order similarities facilitate bilingual children's production of Mandarin object RCs. In other words, both the related structures from within Mandarin and from English facilitate the acquisition of Mandarin RCs by the heritage Mandarin-English children.

In addition, the results provide evidence for the assumption that the presence or absence of the head noun does not influence the primacy of object RCs in the spontaneous speech of monolingual and bilingual children and their input. This is consistent with the results found in Liu (2015), but incompatible with that of Hsu (2014). Hsu (2014) only investigated monolingual children and found that headed object RCs occurred more often than headed subject RCs, but headless subject RCs occurred slightly more than headless object RCs. As mentioned previously, the number of RCs in Hsu (2014) was quite low, and the difference between headless subject RCs and headless object RCs was small. Therefore, their results should be considered with caution. When comparing monolingual children with bilingual children, bilingual children were expected to utter a lower proportion of headless RCs than monolingual children because of cross-linguistic influence from English to Mandarin. However, bilingual children did not show this tendency.

Why did bilingual children not produce fewer headless RCs than monolingual children? Taking a closer look, I found that when head nouns were absent, RCs were very short in both monolingual and bilingual children's speech, such as *chi de* "that can be eaten / food" in (21). Moreover, those short headless RCs are the very common ones in Mandarin oral communication. "Mandarin allows pervasive ellipsis of noun arguments (NPs) in discourse" (Lee & Naigles, 2008, p.1028). Therefore, there is a high possibility that, rather

than treating *chi de* as a headless RC meaning "that can be eaten", children see *chi de* as an unanalysed chunk (or word) meaning "food" in their early acquisition of Mandarin RCs. In this case, bilingual children would not utter fewer headless RCs than monolingual children due to the influence of English.

(21) 买　吃　的。

mai　chi　de

buy　eat　de

"Buy (the one) that can be eaten / food."

(From 2;07, Luna, Child Heritage Chinese Corpus)

3.7.2 Non-centre-embedded vs. Centre-embedded RCs

I will now turn to discuss the comparison between non-centre-embedded RCs and centre-embedded RCs. As previous studies (e.g., Brandt et al., 2008; Diessel & Tomasello, 2000) have reported that propositional complexity influences the processing difficulty of RCs, this study only compared RCs that have the same number of propositions. Both NP RCs (RCs that are attached to an isolated noun phrase) and PN RCs (RCs that are attached to the predicate nominal of a copular clause) contain a single proposition, but as PN RCs are centre-embedded, children were expected to produce more NP RCs than PN RCs. The results of monolingual children were in accordance with this hypothesis, but bilingual children showed an opposite pattern as they produced more PN RCs than NP RCs. The influence from the input cannot be used to explain the results from the bilingual children, as in both monolingual and bilingual children's Mandarin input, NP RCs occurred significantly more often than PN RCs. Then why did the bilingual children produce significantly more PN RCs than NP RCs in Mandarin? I propose that it can be attributed to cross-linguistic influence from their

dominant language English to Mandarin. In English, PN RCs, which were found to be the most frequent in English-speaking children's speech (Diessel & Tomasello, 2000), are not centre-embedded.

As for SUBJ RCs (RCs that are attached to the subject of the matrix clause), DOBJ RCs (RCs that are attached to the direct object of the matrix clause), and OBL RCs (RCs that are attached to the noun phrase of a prepositional phrase in the matrix clause), they involve more than one propositions, but as SUBJ RCs are non-centre-embedded, they were expected to outnumber DOBJ RCs and OBL RCs. However, the results did not support this assumption. Moreover, unlike Chen and Shirai (2015), the results also did not show that SUBJ RCs occurred earlier than DOBJ RCs. However, in Chen and Shirai (2015)'s study, the number of SUBJ RCs (27 tokens) and DOBJ RCs (23 tokens) was quite low, and only one out of four children produced SUBJ RCs earlier than DOBJ RCs. The other three children produced both SUBJ RCs and DOBJ RCs in the same age range. That is to say, both Chen and Shirai (2015) and this study cannot find strong evidence to support the SUBJ over DOBJ RC preference in Mandarin.

I suggest that syntactic embedding does not influence children's Mandarin RC acquisition alone. Other factors such as the length of the RC and the omission of the head noun might also play a role. For instance, as Mandarin is head-final, when head nouns of DOBJ RCs are omitted, as in (22), DOBJ RCs are not centre-embedded. I found that around one-third of the head nouns of DOBJ RCs were omitted in children's speech (monolingual children: 21/67, 31.34%; bilingual children:7/26, 26.92%), as well as in their input (monolingual input: 50/186, 26.88%; bilingual input:39/125, 31.2%). In addition, compared to adult-directed speech, child-directed and child speech might contain shorter RCs. When centre-embedded RCs are shorter, they probably cause less interruption for the processing of the matrix clause, and therefore less burden on working memory. Future research would be

needed to gauge the impact of the length of the RCs in the acquisition and processing of Mandarin RCs.

(22) 明天 妈妈 再 给 你 买 一个 [小朋友 玩] 的。

mingtian mama zai gei ni mai yige xiaopengyou wan de

tomorrow mom again for you buy one-CL child play de

"Tomorrow mom will buy (the one) for you that children can play."

(From 2;10, mother, Tong)

3.8 Conclusion

This study investigated the acquisition of Mandarin RCs by Mandarin-speaking monolingual and heritage Mandarin-English bilingual children. For the subject-object asymmetry in Mandarin, a reliable object RC preference was observed in both monolingual and bilingual children's speech. Furthermore, this object RC preference was not influenced by the presence or absence of a head noun. Supporting the usage-based account, the word order similarity between Mandarin object RCs and Mandarin SVO simple sentences and the input frequency have been suggested to explain the results. Considering RCs according to the role of the head noun within the matrix clause, the results did not fully support the "non-centre-embedded over centre-embedded" preference in either monolingual or bilingual children's speech. I suggest that apart from syntactic embedding, other factors such as the length of RC and the omission of the head noun also influence children's Mandarin RC acquisition. In comparison with monolingual children, bilingual children reflected cross-linguistic influence from their dominant language English to Mandarin by producing a higher proportion of object RCs and PN RCs. These findings suggest that the acquisition of Mandarin RCs is not only influenced by related structures from within Mandarin but also related structures from the typologically

different language English. However, there was no cross-linguistic influence in bilingual children's headless RCs. Similarly, I propose that children's Mandarin RC acquisition cannot be affected by one factor alone. Other language-specific properties and the properties involved in the child/child-directed speech also play a role.

Chapter 4: Processing of Mandarin Relative Clauses in Heritage Mandarin-English Children: Evidence for Cross-linguistic Influence

Mandarin object relative clauses (RCs) resemble simple Subject-Verb-Object (SVO) sentences in both Mandarin and in English. Chapter 3 has found that in children's spontaneous speech, the word order similarities within Mandarin and between Mandarin and English facilitate the acquisition of Mandarin object RCs, regardless of the presence or absence of head nouns. However, it is not fully clear how the word order similarities influence the comprehension of Mandarin object RCs. To address this, the study presented in this chapter investigated the comprehension of Mandarin subject and object RCs in heritage Mandarin-English bilingual children (4;00-10;11) and their vocabulary-matched monolingual peers (4;00-5;09) using a character-sentence matching task. The results showed that both bilinguals and monolinguals comprehended object RCs less accurately than subject RCs, as they misinterpreted Mandarin object RCs as Mandarin simple transitives. Moreover, their comprehension of both subject and object RCs was not influenced by the presence or absence of head nouns, indicating that both bilinguals and monolinguals were able to recover omitted head nouns from the context provided. When compared to vocabulary-matched monolinguals, bilinguals had a similar comprehension of object RCs. However, bilinguals who were more English dominant were more likely to misinterpret Mandarin object RCs as simple transitives than those less dominant in English, but this negative cross-linguistic influence diminished with increasing age.

4.1 Introduction

Cross-linguistic influence has been widely documented in bilingual children's syntactic processing (e.g., Döpke, 1998, 2000; Hulk & Müller, 2000; Müller & Hulk, 2001; Paradis & Navarro, 2003; Serratrice et al., 2004; Sorace & Filiaci, 2006; Sorace & Serratrice, 2009; Yip & Matthews, 2000). As discussed in Chapter 1.2, in the past few decades, many researchers have tried to define the conditions for cross-linguistic influence to take place. One of the most influential hypotheses is that proposed by Hulk and Müller (2000), which suggests that structural overlap is a necessary condition for cross-linguistic influence to take place. To recall, structural overlap refers to the partial overlap at surface level between Languages A and B for a certain structure. If Language A (potentially) allows Analyses 1 and 2 for the structure, but Language B allows only Analysis 1, then Language B might strengthen the use of Analysis 1 in Language A (Van Dijk et al., 2021).

Following Hulk and Müller (2000)'s hypothesis, a great number of studies have found evidence of cross-linguistic influence (e.g., Hacohen & Schaeffer, 2007; Paradis & Navarro, 2003; Schmitz et al., 2011; Serratrice & Sorace, 2003; Serratrice et al., 2004; Sorace & Filiaci, 2006; Haznedar, 2010). For example, Hacohen and Schaeffer (2007) looked at the use of overt and null subjects in the spontaneous speech of a Hebrew-English bilingual child and Hebrew-speaking monolingual children. In Hebrew, both overt and null subjects are allowed depending on the discourse context, while in English, subjects are typically not allowed to be omitted[8]. The results showed that compared to monolinguals, the Hebrew-English bilingual child uttered more pragmatically inappropriate overt subjects in Hebrew. In other words, the partial overlap between Hebrew and English led to the bilingual child's overuse of overt subjects in Hebrew, supporting Hulk and Müller (2000)'s hypothesis.

[8] In English, subjects are only allowed to be omitted in a restricted number of contexts such as in coordinated clauses and topic drop (see Serratrice et al., 2004).

Whereas the Interface Hypothesis (Sorace & Filiaci, 2006) claims that irrespective of the occurrence of partial structural overlap, cross-linguistic influence is likely to happen when a linguistic property is presented at the external interfaces such as the syntax-pragmatic interface. As mentioned in Chapter 1.2.1, Sorace et al. (2009) used an acceptability judgment task to compare the comprehension of null and overt subject pronouns by Spanish-Italian and English-Italian bilingual children and their monolingual counterparts. Unlike English, the appearance of overt subjects in Italian and Spanish is not obligatory and noun phrases (NPs) that have been mentioned in the previous discourse can be omitted in the subject position. Sorace et al. (2009) observed that like English-Italian bilingual children (i.e., partial structural overlap), Spanish-Italian bilingual children (i.e., complete structural overlap) also accepted more overt subjects in Italian in contexts where Italian monolinguals omitted subjects. It suggested that the presence of partial structural overlap is not necessary for cross-linguistic influence to take place.

Nevertheless, there is also some research observing that cross-linguistic influence occurs outside the external interfaces, as well as in the absence of structural overlap. For instance, Yip and Matthews (2000) looked at Cantonese and English RCs produced by a Cantonese–English bilingual child. Cantonese RCs are head-final, while English RCs are head-initial. The Cantonese–English bilingual child was found to transfer head-final RC structure based on Cantonese to English due to the fact that the child was dominant in Cantonese. This result indicated that cross-linguistic influence could take place in a single syntactic domain, and language dominance was an important determinant of the direction of cross-linguistic influence.

In addition, age has also been suggested to have an effect on cross-linguistic influence. For example, several studies have reported that the effect of cross-linguistic influence decreases with age (e.g., Serratrice et al., 2009; Sorace et al., 2009). The pattern of

cross-linguistic influence has also been observed to change with age corresponding to the length of language exposure to the children's two languages, which will be introduced in detail in Section 4.4 (e.g., Hu et al., 2020). However, other researchers did not find a significant relationship between cross-linguistic influence and age (e.g., Bosch & Unsworth, 2020; Nicoladis, 2002, 2003).

The current study aims to test whether and to what extent structural overlap, language dominance and age predict cross-linguistic influence in heritage Mandarin-English bilingual children's comprehension of Mandarin RCs. Mandarin RCs are typologically different from English RCs in head direction (i.e., head-final vs. head-initial) and the discourse-based omission of head nouns, which provides an ideal case to test the role of structural overlap and discourse-pragmatic constraints in cross-linguistic influence. Heritage Mandarin-English bilingual children are early bilinguals who grow up exposed to their heritage language Mandarin in the home environment and to the dominant societal language English outside the home (Montrul, 2015). This group of bilingual children enables an examination of whether language dominance and age affect cross-linguistic influence.

This chapter is organized as follows. First, it briefly reviews the typological differences between Mandarin and English RCs, and previous studies focusing on the comprehension of Mandarin and English RCs. Then, it discusses potential cross-linguistic influence in heritage Mandarin-English bilingual children's Mandarin RC comprehension, and provides a brief review of previous studies on bilingual children. It then illustrates the methodology of the current experimental study and reports the results. Finally, it offers a general discussion of the findings.

4.2 RCs in Mandarin and English

As mentioned in Chapter 1.3, both Mandarin and English have the same SVO canonical word order (e.g., Givón, 1979; Li, 1990; Sun & Givón, 1985). However, Mandarin RCs are head-final, while English RCs are head-initial. As shown in examples (1) and (2), Mandarin subject RCs exhibit a non-canonical VOS word order, but object RCs display the canonical SVO word order. In contrast, English subject RCs are canonically SVO, while object RCs are non-canonical OSV (examples (3) and (4)). Moreover, Mandarin head nouns can be omitted when they are known to both speakers and hearers (Lin & Bever, 2010; Huang & Phillips, 2021). For example, the head noun *xiaozhu* "the pig" in (5b) is omitted (indicated by ø), as it has just been mentioned in (5a). Conversely, for English RCs, head nouns are not grammatically allowed to be omitted regardless of discourse status.

[Mandarin subject RC]

V O S

(1) **[抱 小猪] 的 小马 在 哪里？**

[bao xiaozhu] de xiaoma zai nali

hug pig DE horse is where

"Where is the horse that is hugging the pig?"

[Mandarin object RC]

S V O

(2) **[小马 抱] 的 小猪 在 哪里？**

[xiaoma bao] de xiaozhu zai nali

horse hug DE pig is where

"Where is the pig that the horse is hugging?"

[English subject RC]

S V O

(3) Where is the horse [that is hugging the pig]?

[English object RC]

O S V

(4) Where is the pig [that the horse is hugging]?

(An experimenter is talking with a child)

(5) a. 你 看！ 小马 在 抱 小猪。

ni kan xiaoma zai bao xiaozhu

you look horse is hug pig

"Look! The horse is hugging the pig."

b. 你 指 一下 [小马 抱] 的 ø 在 哪里？

ni zhi yixia xiaoma bao de ø zai nali

you point once horse hu DE is where

"Can you point out where is (the pig) that the horse is hugging?"

In English, experimental evidence and corpus data consistently suggest that the similarity between English subject RCs and simple SVO transitive sentences facilitates the production and comprehension of subject RCs (e.g., Diessel & Tomasello, 2000; Kidd et al., 2007). However, in Mandarin, only child corpus-based studies have found that the similarity

between Mandarin object RCs and simple SVO transitives supports the production of object RCs (see Chapter 3). In contrast, a number of child experimental studies have revealed that this word order similarity tends to hinder the comprehension of Mandarin object RCs in the character-sentence matching task (e.g., Tsoi et al., 2019).

In the task, two pictures, each containing a pair of cartoon characters performing reversible actions (e.g., horse hugging pig, pig hugging horse) are provided (see Figure 4.1). Children are asked to point out one of the characters according to their interpretation of RCs like *Xiaoma bao de xiaozhu zai nali?* "Where is the pig that the horse is hugging?". The correct answer corresponds to the head noun of the RC *xiaozhu* "the pig". Tsoi et al. (2019) reported that Mandarin-speaking monolingual children tended to misinterpret the RC-internal subject *xiaoma* "the horse" as the head noun for Mandarin object RCs. That is to say, they pointed out the correct picture (e.g., "horse hugging pig" in the left part of Figure 4.1), but the incorrect character (e.g., the horse). This type of error is called a Head Error.

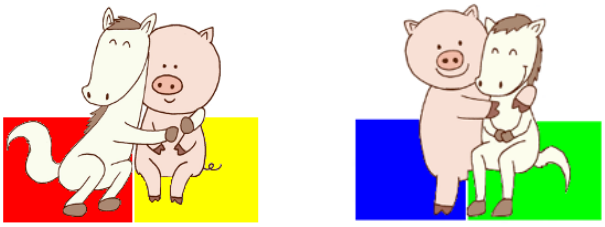


Figure 4.1: Example of the visual stimulus for the character-sentence matching task

The question here is why the similarity between English subject RCs and simple transitives leads to a positive effect, while the similarity between Mandarin object RCs and simple transitives shows both positive and negative effects. I suggest that this mainly relates to the head direction. In English subject RCs (e.g., *Where is the horse [that is hugging the pig]?)*, the head noun *the horse* is the subject and agent of the RC verb *hug.* It has been suggested that children prefer the sentential subject to be the agent, and expect the agent to be

relativized (e.g., Diessel & Tomasello, 2005). However, in Mandarin object RCs (e.g., *Xiaoma bao de xiaozhu zai nali?* "Where is the pig that the horse is hugging?"), the sentential subject or agent *xiaoma* "horse" is not the one being relativized, while the object or the patient *xiaozhu* "the pig" is. The match between the object/patient and the head noun could partially explain the comprehension difficulty of Mandarin object RCs. Furthermore, Mandarin object RCs used in comprehension experiments usually have animate head nouns and RC-internal subjects (Hu et al. 2016; Hu & Guasti, 2017; Tsoi et al., 2019; Yang, 2019), while the RCs children hear and produce in everyday speech usually contain inanimate head nouns and animate RC-internal subjects (e.g., Yang, 2019). Without semantic cues, the difficulty of pointing out the correct head nouns for Mandarin object RCs may increase.

Another question is whether children's comprehension of Mandarin RCs is affected by the presence or absence of head nouns. As just discussed, when head nouns are present, children are likely to misinterpret RC-internal subjects as head nouns (i.e., make Head Errors) for Mandarin object RCs (Tsoi et al., 2019). When head nouns are absent, they may make more Head Errors for Mandarin object RCs by taking the only (RC-internal) NP as the head noun. However, the discourse-based omission of subject or object arguments is very frequent in Mandarin simple transitives, and Mandarin-speaking children have been found to produce sentences with omitted arguments around the age of two (Wang et al., 1992). In other words, there is a higher possibility that children are familiar with the discourse-based omission of arguments and therefore the omission of head nouns will not influence their Mandarin RC comprehension. To my knowledge, no previous experimental study has investigated this issue using the character-sentence matching task.

4.3 Cross-linguistic Influence

Following Hulk and Müller (2000)'s hypothesis, Mandarin object RCs (see example (2), rewritten as (6)) are a candidate case for cross-linguistic influence as they not only resemble simple SVO transitives in Mandarin, but also simple SVO transitives in English. Due to the influence of English simple SVO transitives, bilingual children are more likely to take the RC-internal subject *xiaoma* "horse" as the head noun, that is, make more Head Errors for Mandarin object RCs than monolinguals.

[Mandarin object RC]

(6) **[小马 抱] 的 小猪 在 哪里？**

[xiaoma bao] de xiaozhu zai nali

horse hug DE pig is where

"Where is the pig that the horse is hugging?"

Tsoi et al. (2019) looked at the comprehension of Mandarin subject and object RCs by Mandarin-English bilinguals (4;05-10;10) and their vocabulary-matched Mandarin-speaking monolingual peers using the character-sentence matching task. However, they did not observe that the structural overlap alone led to differences between mono- and bilinguals. Specifically, Mandarin-English bilinguals did not comprehend either subject or object RCs differently from monolinguals (at the group level). Instead, they found that Mandarin-English bilinguals who were more English dominant made more Head Errors for Mandarin object RCs. That is to say, the interaction between structural overlap and individual differences in language dominance contribute to cross-linguistic influence. Inconsistent with Tsoi et al. (2019), Kidd et al. (2015) used the same task and found that heritage Cantonese–English bilingual children made more Head Errors for Cantonese object RCs than their vocabulary-

matched Cantonese-speaking monolingual peers (at the group level). Similarly, Chan et al. (2017) found that Cantonese-English-Mandarin trilingual children made more Head Errors for Cantonese object RCs than their age-matched Cantonese-speaking monolingual peers using the same task. Chan et al. (2017) further suggested that not only the structural overlap between Cantonese object RCs and English SVO transitives, but also the structural overlap between Cantonese object RCs and English subject RCs (also SVO) could motivate the incorrect head noun assignment. Recall that Cantonese and Mandarin are similar in their combination of head-final RCs and SVO word order. Thus, a question here is whether the structural overlap between Mandarin object RCs and English SVO transitives and subject RCs alone can also predict cross-linguistic influence.

Another question is to what extent cross-linguistic influence will vary with increasing age. Tsoi et al. (2019) observed that Mandarin-English bilinguals made fewer Head Errors for Mandarin object RCs with increasing age. That is to say, the cross-linguistic influence shown in Mandarin object RCs diminished with age. Using the same task, Hu et al. (2020) also found that Mandarin-Italian bilingual children made fewer Head Errors with increasing age. Similar to English, Italian has canonical SVO word order and head-initial RCs. However, Hu et al. (2020) also observed that the number of another type of error increased with age. This type of error is called the Reversal Error, indicating that children misinterpret the head nouns of object RCs as RC-internal subjects and therefore reverse the thematic roles. For example, when hearing *Xiaoma bao de xiaozhu zai nali?* "Where is the pig that the horse is hugging?", children choose the correct head noun *xiaozhu* "the pig", but the incorrect picture, that containing "pig hugging the horse". To remind, Head Error means that children misinterpret the RC-internal subject RC *xiaoma* "the horse" as the head noun *xiaozhu* "the pig". Hu et al. (2020) suggested that the higher number of Reversal Errors than Head Errors in older bilinguals was due to the fact that the older bilinguals had been exposed to Italian for two

more years than the younger ones. With longer exposure to Italian subject RCs in the form of "S that VO", children tended to impose a subject RC analysis on Mandarin object RCs "S V DE O" by reversing the thematic roles.

In addition, whether there is a difference between cross-linguistic influence shown in Mandarin object RCs with overt and omitted head nouns is unknown. The previous studies I summarized above only focus on bilingual children's comprehension of Mandarin RCs with overt head nouns (Tsoi et al., 2019; Kidd et al., 2015; Hu et al., 2020). In Mandarin, RCs and simple SVO transitives allow the discourse-based omission of head nouns and arguments, while English RCs and simple SVO transitives do not. Based on this, I assume that in the character-sentence matching task, Mandarin-English bilinguals may make more Head Errors for Mandarin object RCs with omitted head nouns (headless object RCs) by taking the RC-internal subject NP as the head noun, compared to those with overt head nouns (headed object RCs). In other words, the cross-linguistic influence shown in headless object RCs may be stronger than that for headed object RCs. However, Mandarin subject RCs with overt and omitted head nouns may not be comprehended differently. When hearing subject RCs like *Bao xiaozhu de (xiaoma) zai nali?* "Where is (the horse) that is hugging the pig?", children are likely to interpret the subject of the verb *bao* "hug" as the head noun even if it is omitted.

In sum, cross-linguistic influence has been observed in Mandarin-English bilingual children's comprehension of Mandarin object RCs with overt head nouns. This cross-linguistic influence has been suggested to be caused by the structural overlap between Mandarin object RCs and English simple SVO transitives. However, it remains unclear whether structural overlap alone is sufficient to cause cross-linguistic influence. In other words, whether other factors such as language dominance and age also play a role is unknown. What also deserves investigation is whether the absence of a head noun would influence cross-linguistic influence shown in Mandarin.

4.4 Research Questions and Hypotheses

Following Tsoi et al. (2019), the current study examines heritage Mandarin-English bilinguals and their vocabulary-matched monolingual children's comprehension of Mandarin subject and object RCs in the character-sentence matching task. The study addresses the following research questions (RQs):

RQ1: Is there a subject-object asymmetry in bilingual and monolingual children's comprehension of Mandarin RCs at the group level?

RQ2: Does the absence of a head noun influence the subject-object asymmetry in monolingual and bilingual children's comprehension of Mandarin RCs at the group level?

RQ3: With greater English dominance, do bilingual children comprehend Mandarin headed and headless object RCs less accurately at the individual level?

RQ4: With increasing age, do bilingual children comprehend Mandarin headed and headless object RCs more accurately at the individual level?

Regarding RQ1, I hypothesize that, in the character-sentence matching task, children will comprehend subject RCs better than object RCs. The word order similarity between Mandarin object RCs and Mandarin simple SVO transitives is expected to make Mandarin object RCs more difficult to comprehend. Specifically, children are likely to misinterpret RC-internal subjects as the head nouns of Mandarin object RCs (i.e., make Head Errors) (Tsoi et al., 2019). Following Tsoi et al. (2019), I expect that the heritage Mandarin-English bilingual children will roughly match their vocabulary-matched monolinguals in the comprehension of both subject and object RCs at the group level. That is to say, the structural overlap alone is not expected to lead to cross-linguistic influence.

For RQ2, I hypothesize that the absence of a head noun will not influence the subject-object asymmetry at the group level. In Mandarin RCs, head nouns that are known to both

speakers and hearers can be omitted (Lin & Bever, 2010; Huang & Phillips, 2021). Similarly, Mandarin simple SVO transitives allow discourse-based omission of object arguments. Therefore, due to the influence of Mandarin simple SVO transitives, both bilingual and monolingual children are expected to recover the omitted head nouns based on the context, that is, the omission of head nouns will not influence their Mandarin RC comprehension at the group level.

For RQ3, following Tsoi et al. (2019), I expect that at the individual level, the more bilingual children are dominant in English, the more likely they are to make Head Errors for Mandarin object RCs, due to the influence of English SVO transitives and subject RCs. That is, the interaction between language dominance and structural overlap is expected to cause cross-linguistic difference. Moreover, due to the fact that the omission of arguments and head nouns is not grammatically acceptable in English, I expect that at the individual level, heritage Mandarin-English bilinguals who are more dominant in English will make more Head Errors for headless object RCs than headed object RCs in Mandarin.

Regarding RQ4, following Tsoi et al. (2019), I expect that at the individual level, bilingual children will make fewer Head Errors for Mandarin headed and headless object RCs with increasing age. However, I do not expect that bilingual children will make more Reversal Errors than Head Errors for Mandarin objects with increasing age, as the total number of Reversal Errors was quite small in several previous studies (e.g., Kidd et al., 2015; Tsoi et al., 2019).

4.5 Method

The current study has a 2 (Language group: monolingual vs. bilingual) x 2 (Type: subject RC vs. object RC) x 2 (Head: headed RC vs. headless RC) design. Children's age, Mandarin

vocabulary knowledge and language dominance are also considered as factors that might affect their Mandarin RC comprehension.

4.5.1 Participants

Seventy-seven children participated in total. The bilingual group consisted of 38 (17 males, 21 females) UK-based Mandarin-English bilingual children between the ages of 4;00 and 10;11, who were recruited online via social media. The selection criteria for the bilingual children were the following: At least one parent is a native speaker of Mandarin; from birth the child has been regularly exposed to their heritage language Mandarin at home; the child has been exposed to their dominant language English later when receiving mainstream formal education; the child does not have any language impairment or hearing loss. Following Tsoi et al. (2019), the bilingual children were divided via a median split into two age groups because of their large age range: a younger group (4;00–7;06, M = 69.26 (months); SD = 13.07) and an older group (7;07–10;11, M = 108.37 (months); SD = 14.44). Data from an additional bilingual child was collected but excluded because the child could not understand the Mandarin instructions.

Thirty-nine (20 males, 19 females) Mandarin-speaking monolingual children between the ages of 4;00 and 5;09 were also recruited online via social media as a comparison group. They were all born in Mainland China and grew up being exposed to Mandarin at home and in school. None of them had a language impairment or hearing loss. In order to compare with the two bilingual age groups, the monolingual children were also divided via a median split into two age groups: a younger group (4;00–4;08, M = 51.89 (months); SD = 3.09) and an older group (4;09–5;09, M = 63.1 (months); SD = 4.61). Data from an additional monolingual child was also collected but excluded because the child refused to finish the tasks.

The parents of the bilingual children were asked to complete a questionnaire soliciting details of language use and exposure, which was established by Kidd et al. (2015) and Tsoi et al. (2019). The questionnaire addressed the following four questions: (a) If the child was born or had lived in Mandarin-speaking countries or regions like Mainland China, Taiwan and Singapore, (b) how many hours on average per week the child spends in Mandarin- and English-speaking environments, (c) how frequently the child speaks Mandarin and English at home, as rated by the parent (measured with a 5-point Likert scale from 1 = *never* to 5 = *all the time*), and (d) how well the child understands spoken Mandarin and English, as rated by the parent (measured with a 7-point Likert scale from 1 = *poor* to 7 = *excellent*).

Table 4.1 displays the length of time (in months) that the bilingual children had lived in Mandarin-speaking countries or regions (i.e., Mainland China) and the average number of hours they spent in English- and Mandarin-speaking environments per week. Around half of the younger children (10/19) and 36.84% of the older children (7/19) had spent time living in Mainland China (younger: 2–28 months; older: 2–23 months). While the older children had lived in Mainland China longer than the younger children on average, the difference did not reach statistical significance, t (34.35) = 0.4, p = 0.69, d = 0.09. It also can be seen from Table 4.1 that both younger and older children spent more time in English-speaking environments than in Mandarin-speaking environments. However, the differences between the time they spent in each language environment also did not reach statistical significance (younger: t (34.5) = 0.96, p = 0.34, d = 0.2; older: t (28.26) = 0.77, p = 0.45, d = 0.17).

Table 4.1: Length of time that the bilingual children lived in Mainland China and the average number of hours they spent in English- and Mandarin-speaking environments per week

	Months lived in Mainland China	Hours per week spent in each language environment	
		Mandarin	English

Age group	*M*	*SD*	*M*	*SD*	*M*	*SD*
Younger	3.42	6.45	38.05	14.85	42.29	12.01
Older	4.36	8.07	32.95	15.43	36.05	8.63

Table 4.2 lists the bilingual children's frequency of speaking Mandarin and English at home, and their abilities to understand each language. Based on their parents' rating, there was no significant difference between the younger and older children's frequency of speaking Mandarin, t (34.62) = 1.26, p = 0.22, d = *0.3,* and English, t (27.54) = -1.48, p = 0.15, d = -0.32. Similarly, the difference between the younger and older children's ability to understand English was not statistically significant, t (33.6) = -0.5, p = 0.62, d = -0.12. However, the younger children's ability to understand Mandarin was rated to be marginally better than that of the older children, t (30.92) = 2.03, p = 0.05, d = 0.51.

Table 4.2: Bilingual children's parent-rated frequency of speaking Mandarin and English at home, and their parent-rated abilities to understand spoken Mandarin and English

	Parent-rated frequency of speaking each language at home				Parent-rated abilities to understand each spoken language			
	Mandarin		English		Mandarin		English	
Age group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Younger	4.11	0.81	3.47	0.51	6.32	1.29	5.58	1.12
Older	3.74	0.99	3.84	0.96	5.21	1.99	5.79	1.47

Concluding from the questionnaire, the length of time that both the younger and older bilingual children had lived in Mainland China was similar, and the average number of hours per week they spent in the Mandarin- and English-speaking environments was equal. Based

on the parents' rating, both younger and older bilingual children showed similar a frequency of speaking Mandarin and English at home and a similar ability to understand English. The only difference is that the younger children's parent-rated ability to understand Mandarin was slightly better than that of the older children.

4.5.2 Materials

4.5.2.1 Mandarin Vocabulary Test. A version of the British Picture Vocabulary Scale III (Dunn et al., 2009) translated into Mandarin was used to assess the children's Mandarin receptive vocabulary. The British Picture Vocabulary Scale III consists of 168 items grouped into 14 sets, each set containing 12 items. Each successive set is harder than the preceding one (Set 1 is the easiest set). Each item includes four simple pictures on a page. In order to move this paper-based assessment online, the test materials were scanned.

4.5.2.2 Character-sentence Matching Task. The character-sentence matching task was conducted to examine children's comprehension of subject and object RCs. The test sentences were manipulated for (a) Type: subject RC and object RC, and (b) Head: headed RC and headless RC. Thus, there were four conditions: headed subject RC, headed object RC, headless subject RC, headless object RC (see examples (1), (2), (7) and (8)). For counterbalancing, four parallel forms of the task were constructed. Each form contained 26 sentences, including 16 test sentences (four in each condition), eight filler sentences and two practice sentences (for a full list of test sentences see Appendix B). Filler sentences and practice sentences were simple non-RC sentences like example (9). The order of the test sentences was pseudo-randomized. There were no more than two consecutive test sentences from the same condition occurring together. Filler sentences were randomly interspersed

between the RC test sentences. All sentences were pre-recorded by a female native speaker of Mandarin.

[Mandarin headless subject RC]

(7) 现在 [抱 小猪] 的 ø 在 哪里?

xianzai [bao xiaozhu] de ø zai nali

now hug pig DE is where

"Where is (the horse) that is hugging the pig now?"

[Mandarin headless object RC]

(8) 现在 [小马 抱] 的 ø 在 哪里?

xianzai [xiaoma bao] de ø zai nali

now horse hug DE is where

"Where is (the pig) that the horse is hugging now?"

[Simple non-RC sentence]

(9) 大 大 的 猴子 在 哪里?

da da de houzi zai zaili

big big DE monkey is where

"Where is the big monkey?"

The test materials followed those established in Tsoi et al. (2019). The test sentences contained cartoon animals who perform reversible actions (e.g., horse hugging pig, pig hugging horse). Four transitive and reversable verbs were used: *wei* "feed", *bao* "hug", *qin*

"kiss", *tui* "push". Each verb occurred once in each condition. The animacy of head nouns and RC-internal NPs was neutralized. 16 cartoon animals were used: horse, pig, lion, bear, monkey, dog, chicken, mouse, duck, rabbit, elephant, tiger, cow, giraffe, cat and sheep. In total, 16 picture pairs were constructed (e.g., horse and pig, tiger and bear). In order to control for the length of each test sentence (each test sentence contained nine to ten characters), the adverb *xianzai* "now" was placed at the beginning of headless RCs such as (7) and (8).

Each auditory stimulus was associated with three visual stimuli. First, a picture of two animals performing an action was shown (Figure 4.2A) and accompanied by a verbal description (10a), followed by another picture depicting the same two animals performing the reversed action (Figure 4.2B) with the verbal description (10b). These two pictures provided an appropriate context for the use of the test sentence. For the third visual stimulus (Figure 4.2C), both pictures (Figure 4.2A and 4.2B) were presented, along with the test sentence (10c). If a child failed to respond to the test sentence, the third picture and the verbal description were repeated one more time before moving on to the next item. Note that four animals in each set of pictures had four background colours (red, yellow, blue, green). The order of the four background colours was the same for each test sentence (from left to right: red, yellow, blue, green). The two animals always performed the action from left to right. The location of the target animal was counterbalanced, occurring equally often in the left- and right-hand picture. The number of times the target animal appeared in the first or second visual stimulus (e.g., Figures 4.2A and 4.2B) was also counterbalanced.

(10) a. 你　看！　小马　　在　　抱　　小猪。

ni　kan　xiaoma　zai　bao　xiaozhu

A

you look horse is hug pig

“Look! The horse is hugging the pig.”

B

b. 咦！小猪 在 抱 小马。

yi xiaozhu zai bao xiaoma

ooh pig is hug horse

“Ooh! The pig is hugging the horse.”

C

c. 小马 抱 的 小猪 在 哪里？

xiaoma bao de xiaozhu zai nali

horse hug DE pig is where

“Where is the pig that the horse is hugging?”

Figure 4.2: Examples of visual stimuli

4.5.3 Procedure

Due to Covid-19, this experimental study was conducted online using the video chat platforms Zoom and DingTalk for the UK and Mainland China participants respectively. A private meeting invite link was sent to the caregiver via email before the study. By clicking on the link, the caregiver and their child were able to join the meeting. Before the study began, the experimenter double checked with the caregiver and their child if the internet connection was stable, the webcam, microphone and speaker were working, and the test environment was quiet enough. If the caregiver wanted to sit beside the child during the test, the experimenter reminded them that they should not provide any visual or verbal clues to the answers.

The Mandarin vocabulary test was conducted first via screen share. Before beginning the actual testing, children completed four trials to understand the vocabulary test procedure. The procedure and martials used for the trials were the same as those for the test items. Children were asked to select one out of four pictures on a page that represented the word spoken by the experimenter. Each child started from Set 1. If a child answered eight or more items wrongly in a set of 12 items, the testing would be discontinued after completing the set.

Then, the character-sentence matching task was also presented via screen share. The nature of the task was introduced to the children by using two simple non-RC practice sentences. For example, children were presented with a small and a big monkey on the screen, and were asked to say what the background colour behind the monkey was after hearing a pre-recorded sentence like *Da da de houzi zai nali?* "Where is the big monkey?". During the test, the children were required to say the background colour of one out of the four animals on the screen according to their interpretation of the test sentences as they were asked to do in the test sentences. In both the Mandarin vocabulary test and the character-sentence matching task, the experimenter only provided positive feedback such as "well tried" or "good effort" after each response irrespective of the child's performance.

4.5.4 Scoring

In the Mandarin vocabulary test, each child's raw score was computed by subtracting the number of incorrect answers from the total number of answers before the Ceiling item. The total number of answers was 168. The Ceiling item was the last item in the set in which eight or more errors were made. This means that correct answers made by the child above the lowest ceiling were ignored.

In the character-sentence matching task, when participants identified the correct character (i.e., head noun) in the correct picture, they got a score of 1. If not, they got a score

of 0 and the errors they made were coded into the following categories: (a) Head Error: the correct picture but the wrong character were selected (i.e., in order to answer "*Where is the pig that the horse is hugging?*", the child selected the horse with the red background colour of Figure 4.2C); (b) Reversal Error: the wrong picture but the correct character were selected (i.e., the pig with the blue background colour of Figure 4.2C); (c) Other Error: the wrong picture and the wrong character were selected (i.e., the horse with the green background colour of Figure 4.2C).

4.6 Results

4.6.1 Mandarin Vocabulary Test

Table 4.3 lists the bilingual and monolingual children's Mandarin vocabulary test scores. For both language groups, older children were significantly better than younger children in their Mandarin vocabulary knowledge (bilinguals: t (35.58) = 2.22, p = 0.03, d = 0.49; monolinguals: t (36.92) = 2.31, p = 0.03, d = 0.57). When comparing the two language groups, even though the monolinguals received higher scores than the bilinguals, the differences between them were not significant (younger: t (30.46) = -1.54, p = 0.13, d = -0.34; older: t (32.4) = - 0.81, p = 0.42, d = -0.15).

Table 4.3: Bilingual and monolingual children's Mandarin vocabulary test scores

	Bilinguals			Monolinguals		
Age group	*M*	*SD*	Range	*M*	*SD*	Range
Younger	85.11	36.29	35-131	100.26	23.02	57-130
Older	109.95	32.54	41-153	117.35	23.18	62-146
Total	97.53	36.26	35-153	109.03	24.38	57-146

4.6.2 Character-sentence Matching Task

The data analyses were carried out using Generalized Linear Mixed-effects Models with the *lme4* package (Bates et al., 2015) in R (R Core Team, 2020), version 3.6.3. Null models including random effects for participants and items, and random slopes for all the random effects were constructed. Subsequently, random slopes for the random effects were removed when they lacked model convergence or did not help improve the model fit (Barr et al., 2013). Type (subject RC vs. object RC), Language group (bilingual vs. monolingual), Age group (younger vs. older) and Head (headed RC vs. headless RC) were categorical variables, while Age (in months) and Language dominance were continuous variables. Based on the purpose of each analysis, certain variables were selected and entered into the model one at a time. Then the ANOVA function was used to compare the new models with the null model to assess their contribution (Baayen, 2008). Fixed effects that did not improve the fit of a model were dropped.

4.6.2.1 Mandarin RC Accuracy. The first analysis addressed RQ1 and RQ2: (1) Whether there was a subject-object asymmetry in bilingual and monolingual children's comprehension of Mandarin RCs at the group level, and (2) whether the presence or absence of a head noun influenced the subject-object asymmetry at the group level. The null model included random effects of participants and items. Type, Language group, the interaction of Type and Language group, and Head were successively entered into the model one at a time. At last, Age group was also added to the model to test whether younger and older children performed differently. The final model indicates that the main effect of Type significantly added to the model, $\chi 2 = 10.39$, $df = 1$, $p = 0.001$, but the main effect of Head did not. It indicates that children were more accurate on Mandarin subject RCs, and this Mandarin subject RC advantage was not influenced by the presence or absence of a head noun. A

significant interaction between Language group and Type, $\chi 2 = 13.88$, $df = 1$, $p = 0.0002$ also significantly added to the model, while the main effects of Language group and Age group did not. As shown in Figure 4.3, the interaction was driven by the fact that bilingual children were more accurate than monolingual children in the comprehension of Mandarin subject RCs, and the difference between subject and object RCs was bigger in the bilingual group than in the monolingual group. The details of the final model are shown in Table 4.4.

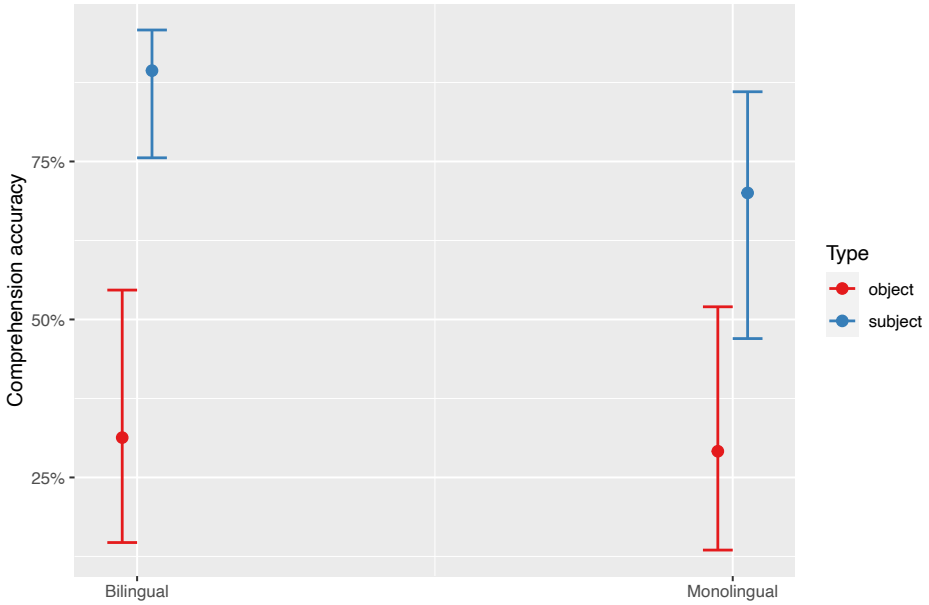


Figure 4.3: The comprehension accuracy of Mandarin subject and object RCs in bilingual and monolingual children

Table 4.4: Significant main effects and interactions in the final model of bilingual and monolingual children's comprehension of Mandarin subject and object RCs

	β	*SE(β)*	*z*	*p*
(Intercept)	-0.79	0.5	-1.58	0.11
Type	2.91	0.64	4.57	4.92e-06***
Type x Language Group	-1.18	0.31	-3.75	0.0002***

Note. Type = subject RCs vs. object RCs (reference level). Language Group = children monolingual vs. bilingual children (reference level). LogLik = −619.8. Number of observations = 1232. ***$p < 0.001$*

4.6.2.2 Error Analysis. Then three types of errors (i.e., Head, Reversal and Other Errors) children made when they failed to comprehend Mandarin RCs[9] were analysed. I predicted that, due to the word order similarity between object RCs and simple SVO transitives in Mandarin, both bilingual and monolingual children would be likely to misinterpret the RC-internal subject as the head noun, that is, make more Head Errors for Mandarin object RCs than for Mandarin subject RCs.

Each type of error was analysed separately using the same analytical strategy as for the accuracy data. The null models included random effects of participants and items, and by-participants random slope for Type. Type, Language group, and their interactions were successively entered one at a time as fixed effects. Age group was also added to the model to test whether the type of errors would vary with age.

For Head Errors, only the main effect of Type significantly added to the model, $\chi 2$ = 30.69, df = 1, p = 3.023e-08, confirming that both mono- and bilingual children made significantly more Head Errors for object RCs than for subject RCs (see Table 4.5). For Reversal Errors, no main effects added significantly to the model. Lastly, for Other Errors, the main effects of Type, $\chi 2$ = 15.59, df = 1, p = 7.883e-05, and Language Group, $\chi 2$ = 8.78, df = 1, p = 0.003, added significantly to the model (see Table 4.6). The results indicate that both mono- and bilingual children made significantly more Other Errors for subject RCs than for object RCs, and monolingual children made more Other Errors than bilingual children.

[9] Table B.1 in the "Appendix B" provides the raw number of the three types of Errors.

Table 4.5: The significant main effect in the final model of bilingual and monolingual children's Head Errors

	β	*SE(β)*	*z*	*p*
(Intercept)	0.45	0.33	1.35	0.18
Type	-3.66	0.59	-6.21	5.27e-10***

Note. Type = subject RCs vs. object RCs (reference level). LogLik = −534.9. Number of observations = 1232. ****p <0.001*

Table 4.6: Significant main effects in the final model of bilingual and monolingual children's Other Errors

	β	*SE(β)*	*z*	*p*
(Intercept)	-13.37	1.94	-6.89	5.47e-12
Type	7.64	1.97	3.89	0.0001***
Language Group	2.13	0.79	2.7	0.007**

Note. Type = subject RCs vs. object RCs (reference level). Language Group = children monolingual vs. bilingual children (reference level). LogLik = −210.3. Number of observations = 1232. ***p < 0.01. ****p <0.001*

To conclude, in line with the hypothesis, both bilingual and monolingual children made significantly more Head Errors for object RCs than for subject RCs, which led to the subject RC advantage in Mandarin. At the same time, both language groups made more Other Errors for subject RCs than object RCs. In comparison with monolingual children, bilingual children overall made fewer Other Errors, while they did not differ in Head and Reversal Errors. In addition, the results did not find that the type of errors changed with age groups.

4.6.2.3 Individual Differences. Several individual analyses were further run to address RQ3 and RQ4: (1) Whether bilingual children who were more English dominant comprehended Mandarin headed and headless object RCs less accurately, and (2) whether bilingual children comprehended Mandarin headed and headless object RCs better with increasing age.

Language dominance was analysed first. It has been expected that bilingual children whose English was the more dominant were more likely to make Head Errors for Mandarin object RCs, and they made even more Head Errors for Mandarin object RCs when head nouns were omitted. The bilingual children's language dominance was rated by the children's caregivers in the questionnaire, including English exposure time, frequency of speaking English at home, and ability to understand English. However, English exposure time was excluded from the analyses, as parents had trouble accurately and reliably counting the language exposure time of each of their children's languages. For example, some caregivers counted home time exclusively as Mandarin exposure time. However, some children actually watched English TV and spoke English with siblings at home. In addition, Covid-19 had an extreme effect on children's exposure times for both languages. Frequency of speaking English at home and ability to understand English were analysed separately. If not, the models would fail to converge, which is probably due to the correlation between those two factors (r_s = 0.21, p = 1.237e-07).

For the relationship between bilingual children's Frequency of speaking English with Head Errors, the null models included random effects of participants and items. Frequency of speaking English, Type, Head and their interactions were successively entered one at a time as fixed effects. The results show that the main effect of Frequency of speaking English did not significantly add to the model, while the interaction between Frequency of speaking

English and Type did, $\chi 2 = 7.57$, $df = 1$, $p = 0.006$ (see Table 4.7). The interaction was driven by the fact that the impact of Frequency of speaking English was only found for object RCs. It confirms that bilingual children who spoke more English at home produced more Head Errors for Mandarin object RCs. However, there was no significant main effect of Head, meaning that bilinguals did not make more Head Errors for headless object RCs than headed object RCs. When replacing Frequency of speaking English with Ability to understand English, there were no significant main effects of Ability to understand English and Head, and no significant interactions.

Table 4.7: Significant main effects and interactions in the final model of bilingual children's Head Errors with Frequency of speaking English

	β	*SE(β)*	*z*	*p*
(Intercept)	-2.31	1.19	-1.94	0.05.
Frequency of speaking English	0.71	0.32	0.35	0.02*
Frequency of speaking English x Type	-0.96	0.34	-2.81	0.005**

Note. Type = subject RCs vs. object RCs (reference level). LogLik = −274.6. Number of observations = 608. *. p =0.05. *p <0.05. **p <0.01*

Then, turning to analyse the relationship between Head Errors with Age (in months)[10], the null model included random effects of participants and items. Age (in months), Head, Type and their interactions were successively entered into the model one at a time as fixed effects. The interaction between Age (in months) and Type, $\chi 2 = 11.66$, $df = 1$, $p = 0.0006$ significantly added to the model (see Table 4.8), while the main effect of Head did

[10] Reversal and Other Errors were not included in the individual analyses as their numbers were very small (see Table B.1 in the "Appendix B").

not. As shown in Figure 4.4, object RCs have a negative slope, while subject RCs have a nearly flat line, indicating that bilingual children made fewer Head Errors for both headed and headless object RCs with increasing age.

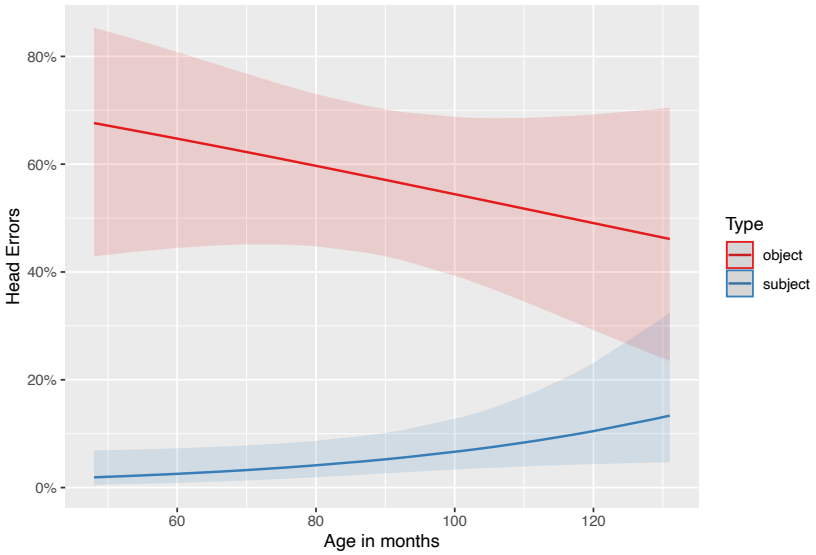


Figure 4.4: The relationship between bilingual children's Head Errors with Age (in months)

Table 4.8: Significant main effects and interactions in the final model of bilingual children's Head Errors with Age (in months)

	β	*SE(β)*	*z*	*p*
(Intercept)	1.25	0.98	1.28	0.2
Type	-6.39	1.12	-5.73	9.88e-09***
Age x Type	0.04	0.01	3.31	0.0009***

Note. Type = subject RCs vs. object RCs (reference level). LogLik = −274. Number of observations = 608. ****p <0.001*

To summarize, it has been observed that bilingual children's object RC accuracy was affected by their language dominance and age (in months). The more bilingual children spoke English at home, the more likely they were to make Head Errors for Mandarin object RCs.

On the other hand, with increasing age, they made fewer Head Errors for Mandarin object RCs. However, the results did not show any differences between headed and headless object RCs. As for bilingual children's subject RC accuracy, it was not affected by language dominance or age, which could be because the number of Head Errors on subject RCs was very small in general.

4.7. General Discussion

Using the character-sentence matching task, the comprehension of Mandarin subject and object RCs by heritage Mandarin-English bilingual children and their vocabulary-matched monolingual peers has been investigated. The results indicated that (1) Both bilinguals and monolinguals comprehended subject RCs more accurately than object RCs in Mandarin, and the absence of a head noun did not influence this subject RC advantage at the group level; (2) Compared to monolinguals, bilinguals showed similar accuracy in their comprehension of object RCs, but were more accurate in their subject RCs at the group level; (3) Individual analyses revealed that the comprehension accuracy of Mandarin object RCs decreased with bilinguals' increasing English dominance, but increased with their age. However, there was no significant difference between bilinguals' comprehension of headed and headless object RCs.

4.7.1 Subject-object Asymmetry

The results confirm the subject RC advantage previously reported for Mandarin using the character-sentence matching task (e.g., Hu & Guasti, 2017; Hu et al., 2016; Tsoi et al., 2019). By conducting error analyses, the results also confirm that the subject RC advantage was caused by the fact that both bilingual and their vocabulary-matched monolingual children made significantly more Head Errors for object RCs than for subject RCs in Mandarin. To be

specific, children tended to misinterpret the RC-internal subject, which comes first in the sentence, as the head noun for object RCs. Therefore, similar to Tsoi et al. (2019), I suggest that in the character-sentence matching task, the similarity between Mandarin object RCs and Mandarin SVO transitives is likely to hinder children's comprehension of Mandarin object RCs.

Moreover, the study extends the subject RC advantage in Mandarin to subject and object RCs with omitted head nouns. It has been observed that bilinguals and their vocabulary-matched monolinguals comprehended headless subject and object RCs similarly to headed ones. It means that once the context is provided, children as young as four are able to recover omitted head nouns from the context and therefore the omission of head nouns does not influence their Mandarin RC comprehension. I suggest that this could be because of the influence from Mandarin simple SVO transitives, in which discourse-old subject and object arguments are also allowed to be omitted (Wang et al., 1992).

4.7.2 Cross-linguistic Influence

Following Hulk and Müller (2000)'s hypothesis, Mandarin object RCs that structurally overlap with simple SVO transitives in both Mandarin and English are expected to be a candidate case for cross-linguistic influence. However, previous studies such as in Tsoi et al. (2019) showed that this structural overlap alone did not lead to cross-linguistic influence, while the interaction between structural overlap and language dominance did. Specifically, bilingual children performed similarly with their vocabulary-matched monolingual peers in the comprehension of Mandarin object RCs at the group level, while bilingual children who were more English dominant comprehended Mandarin object RCs worse (i.e., individual level).

In the current study, heritage Mandarin-English bilingual children were also on par with their vocabulary-matched monolinguals in their comprehension of object RCs. However, bilingual children were more accurate in their comprehension of Mandarin subject RCs than their monolingual peers, which is inconsistent with the results found in Tsoi et al. (2019). I suggest that the participant recruitment could partially explain the inconsistent results. Instead of collecting data in one Chinese school like Tsoi et al. (2019), the heritage bilingual children in this study were recruited online across the UK. Parents who wanted their children to be involved might focus more on their children's Mandarin language development, and therefore their children were more likely to acquire and maintain Mandarin better (e.g., Daller & Ongun, 2017; Zhang & Slaughter-Defoe, 2009). However, as heritage bilingual children only performed better in their comprehension of subject RCs rather than object RCs, it indirectly provides evidence that bilingual children may have some difficulty in comprehending Mandarin object RCs accurately.

On the other hand, the results clearly indicate that the interaction between structural overlap and language dominance caused cross-linguistic influence. Bilingual children who were more English dominant made more Head Errors for Mandarin object RCs. However, it has not been observed that bilinguals made more Head Errors for Mandarin headless object RCs than headed object RCs. Mandarin object RCs allow the omission of head nouns, while English simple SVO transitives do not. I expected that bilingual children who were more English dominant would have more difficulty recovering omitted head nouns for Mandarin object RCs, and therefore would make more Head Errors by taking the RC-internal subject (the only NP in the RC) as the head noun. However, the results suggest that bilingual children were able to recover head nouns from the previous context regardless of their language dominance. In other words, bilingual children may be as sensitive as monolinguals in their comprehension of discourse-pragmatic cues. However, in order to support this assumption,

further studies would need to be conducted to test whether the absence of context or different types of contexts (e.g., only provide visual context) would lead to the same result.

In addition, the current study also suggests that cross-linguistic influence is a developmental rather than a stable phenomenon. With increasing age, bilingual children made fewer Head Errors for object RCs, that is, the effect of cross-linguistic influence diminished. However, the pattern of cross-linguistic influence did not change as Hu et al. (2020) report. Recall that in Hu et al. (2020), Mandarin-Italian bilinguals tended to make more Head Errors for Mandarin object RCs, while older bilinguals who were exposed to Italian for two more years than the younger ones, made more Reversal Errors than Head Errors for Mandarin object RCs. They suggested that due to the longer exposure to Italian subject RCs, children tended to use a subject analysis for Mandarin object RCs by reversing the thematic roles. However, in both the current study and Tsoi et al. (2019), the number of Reversal Errors was very small.

I suggest that the different experimental materials used could be the reason for the difference between the results from the current study and Tsoi et al. (2019) as opposed to Hu et al. (2020). The current study and Tsoi et al. (2019) used the testing picture shown in Figure 4.2C, in which children need to identify one out of four characters, and the correct answer could be any of them. However, there were only three options in the testing pictures used by Hu et al. (2020), and the correct option was always on the periphery of each picture (see Figure 4.5). As children make fewer Head Errors with increasing age, older children are likely to know that the head noun is *ma* "horse" when hearing sentence (11). This means that older children will tend to focus on the horses on the periphery of the picture. Hence, if they choose the horse on the right-hand side of Figure 4.5, they make a correct decision. If they choose the horse on the left-hand side of Figure 4.5, then they make Reversal Errors. Thus, there is a possibility that the higher frequency of Reversal Errors than Head Errors made by

older Italian-English bilingual children in Hu et al. (2020) was actually due to the limitations of the testing materials.

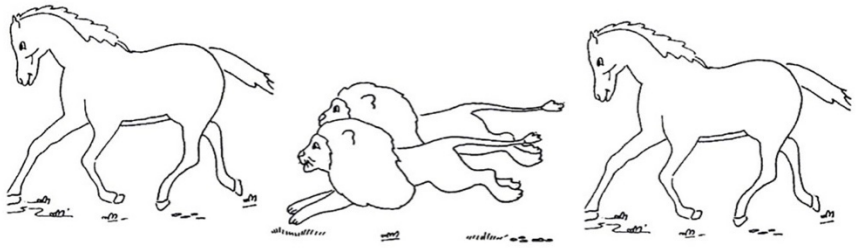


Figure 4.5: The testing picture used in the character-sentence matching task in Hu et al. (2020)

(11) 指出　狮子 追　的　马。

zhichu shizi zhui de ma

point-to lion chase DE horse

"Point to the horse that the lions are chasing."

(From Hu et al. (2020))

Lastly, there is a limitation with this study that is worth mentioning. Unlike typical classroom second language learners, heritage bilingual acquisition takes place early in the home setting. Heritage bilingual children can vary a lot in their heritage language proficiency due to factors such as input quantity and quality (e.g., De Houwer, 2007; Jia & Fuse, 2007; Sun et al., 2020). When recruiting heritage bilingual participants, a more fine-grained assessment should be adopted to categorize or filter them (De Bruin, 2019). For example, the presence of older siblings should be recorded, as older siblings might have more exposure to the majority language and tend to use the majority language to talk with their younger siblings at home (e.g., Rojas et al., 2016; Shin, 2002).

4.8 Conclusion

Using the character-sentence matching task, this study investigated the comprehension of Mandarin subject and object RCs in heritage Mandarin-English bilingual children and their vocabulary-matched monolingual counterparts. In line with previous studies (e.g., Tsoi et al., 2019; Hu et al. 2020), both bilingual and monolingual children showed a subject RC advantage, as they had difficulty distinguishing RC-internal subjects and head nouns for Mandarin object RCs. Similar to previous research, I suggest that the word order similarity between Mandarin object RCs and Mandarin simple SVO transitives hindered the comprehension of Mandarin object RCs. Moreover, extending previous research, the study found that the absence of a head noun did not influence bilinguals and monolinguals' RC comprehension, indicating that both groups of children were able to recover omitted head nouns from the context provided at an early age.

As for cross-linguistic influence, there is no direct evidence to support the hypothesis that the structural overlap between English simple SVO transitives and subject RCs and Mandarin object RCs alone could cause cross-linguistic influence on Mandarin object RCs. Instead, the interaction between the structural overlap and language dominance, as well as that between the structural overlap and age, made a difference. That is, the comprehension accuracy of Mandarin object RCs decreased with English dominance but increased with age.

Chapter 5: Rethinking Relative Clause Asymmetries in Mandarin: A Multifactorial Perspective

Previous research has produced conflicting results on the distribution of relative clauses (RCs) in Mandarin. In order to disentangle this issue, this study used conditional inference trees (Hothorn et al., 2006; Tagliamonte & Baayen, 2012) and random forest (Breiman, 2001) to scrutinise factors affecting the use of RCs in the writing of adult Mandarin native speakers (L1) and second language learners (L2). The results revealed that both groups of L1 and L2 speakers tended to use subject RCs that carried new information to describe people, but use object RCs that encoded given information to define objects or things. In addition, both L1 and L2 speakers showed a preference for placing RCs at the beginning of a sentence to avoid centre-embedding. Compared to the L1 Mandarin speakers, fewer factors influenced the L2 Mandarin speakers' choices of RCs, probably due to their relatively limited Mandarin writing ability. Overall, the study adopted a multifactorial perspective to provide a broader picture of RC processing in Mandarin and suggests that, in addition to the distribution of RC structures themselves, the discourse contexts that RCs are situated in and the information status and length of RCs and head nouns all play a crucial role in the distribution of RCs in Mandarin.

5.1 Introduction

One of the most intriguing topics within the field of cognitive linguistics and psycholinguistics is RC processing. Its complexity and diversity give a great insight into the mechanisms underlying language processing across languages. As mentioned in Chapter 1.3, past research has mainly concentrated on RCs that are classified based on two structural features: (i) the role of the head noun within the RC: subject and object RCs; and (ii) the role of the head noun within the matrix clause: RCs in the matrix subject position (SUBJ RCs)

and in the matrix direct-object position (DOBJ RCs). As shown in examples (1)-(4), different types of RCs can be used to describe similar events, but the effort involved in processing them appears to be different (e.g., Diessel & Tomasello, 2000, 2005; Reali & Christiansen, 2007; Villiers et al., 1979).

[subject RC, SUBJ RC]

(1) The horse [that hugged the pig] saw the goat.

[subject RC, DOBJ RC]

(2) The goat saw the horse [that hugged the pig].

[object RC, SUBJ RC]

(3) The pig [that the horse hugged] saw the goat.

[object RC, DOBJ RC]

(4) The goat saw the pig [that the horse hugged].

The present corpus-based study explores the asymmetries of processing difficulties between subject and object RCs, and between SUBJ and DOBJ RCs in Mandarin. It focuses on two language groups: adult Mandarin L1 speakers and L2 learners. Mandarin has the typologically unique combination of canonical SVO word order and head-final RCs (Dryer, 2013), which enables an examination of crucial factors that influence RC processing such as information status and grammatical weight, and of whether those factors are language-universal or language-specific.

This chapter is organized as follows. First, it describes subject and object RCs in Mandarin and factors affecting subject-object asymmetry. Then, it reports factors that influence the choices of the matrix-clause positions that RCs tend to appear in (i.e., SUBJ vs. DOBJ RCs). Third, it provides a brief review of previous work on the processing of Mandarin RCs by adult Mandarin L2 learners. Fourth, it presents the research questions (RQs) and hypotheses of the current study. It then illustrates the current corpus-based study methodology and reports the results of the study. Finally, it offers a general discussion of the findings.

5.2 Subject RCs vs. Object RCs

In head-initial languages such as English, German and Italian, it has been well established that subject RCs are easier to acquire and to process than object RCs (e.g., Adani, 2011; Adani et al., 2010; Brandt et al., 2009; Diessel & Tomasello, 2000, 2005; Kidd et al., 2007). As discussed in detail in Chapter 1.4, a range of theoretical perspectives has been proposed to account for this subject RC advantage, including the Noun Phrase Accessibility Hierarchy (Keenan & Comrie, 1977), structure-based accounts (Friedmann et al., 2009; Hawkins, 2004; O'Grady, 1997; Rizzi,1990, 2004), linear distance-based accounts (Gibson, 1998, 2000), canonicity effects (e.g., Bever, 1970; MacDonald & Christiansen, 2002), as well as frequency effects (e.g., Ambridge et al., 2015; Roland et al., 2017).

Unlike the consistent subject RC advantage suggested and reported in English, theoretical predictions and findings for Mandarin are contradictory. The Noun Phrase Accessibility Hierarchy and the structure-based accounts predict a universal preference for subject RCs, while the linear distance-based and canonicity effects accounts suggest an object RC advantage in Mandarin. Specifically, due to the head-final property, Mandarin object RCs (6) have a shorter linear distance between a head noun and its gap than subject RCs (5). At

the same time, Mandarin object RCs follow the more canonical SVO word order, while Mandarin subject RCs follow a non-canonical VOS word order. In support of the linear-distance and canonical effects accounts, it has been shown that Mandarin-speaking caregivers produce more object RCs than subject RCs, and that Mandarin-speaking children produce object RCs earlier and more often than subject RCs (Chen & Shirai, 2015).

[Mandarin subject RC]

V O S

(5) **[_ 抱 小猪] 的 小马**

[bao xiaozhu] de xiaoma

hug pig DE horse

"the horse that hugged the pig"

[Mandarin object RC]

S V O

(6) **[小马 抱 _] 的 小猪**

[xiaoma bao] de xiaozhu

horse hug DE pig

"the pig that the horse hugged"

However, in contrast to child and child-directed speech, adult L1 Mandarin speakers consistently produce more subject RCs than object RCs (e.g., Hsiao, 2003; Lin, 2011; Pu, 2007; Vasishth et al., 2013; Wu, 2009; Hsiao & Macdonald, 2013). It seems that the theoretical accounts mentioned above and the frequency effect of RC structures themselves

are not sufficient to explain the mixed results found in Mandarin. Are there any other factors that can affect the distribution of Mandarin RCs? I propose that, among other things, the situated context in which RCs are uttered should be taken into account (see Roland et al. (2007) pp. 356- 359 for a discussion of the impact of genre in the distribution of subject and object RCs in English). All child corpus-based studies analyse RCs in spontaneous speech (Chen & Shirai, 2015; Hsu, 2014; Liu, 2015). However, the majority of adult corpus-based studies focus either on RCs in written news (Hsiao, 2003; Wu, 2009; Hsiao & Macdonald, 2013) or on RCs in a combination of different types of written genres (Lin, 2011; Vasishth et al., 2013)[11]. It has been suggested that the high frequency of subject RCs in written news is because Mandarin subject RCs tend to carry animate head nouns, which can be used to describe people in the news or news events that involve people (Pu, 2007; Wu, 2009). So far, it is unclear whether RCs in different types of written genres would show the same distribution pattern.

Moreover, as RCs are not processed as isolated dependent clauses but used in discourse contexts, the information status of RCs and head nouns may also play a role. Based on Chafe (1980, 1987, 1994), the information status of referential entities can be divided into two categories: (a) New: a referent is newly introduced into the discourse and does not have an anaphoric relation with any previous referent; (b) Given: a referent is not newly introduced into the discourse and has an anaphoric relation with a previous mention. Pu (2007) found that when both subject and object RCs were in the matrix subject position, subject RCs tended to provide distinguishing and characterizing information to help readers identify a new head noun (e.g., *zhongnianren* "middle-aged person" in (7)), while object RCs were likely to give repetitive or redundant information to remind readers of a given head noun. In example (8) provided by Pu (2007), the RC-internal noun phrase (NP) *dajia*

[11] Only Pu (2007) collected adult data from oral narratives, but the total number of RCs collected was very low.

"everybody" has been introduced into the discourse at an earlier point and the head noun *Xiao Ma* (name) also refers to a known woman identified in the previous context.

(7) 一个 [手提 公文包] 的 中年人 回到 家。

yi-ge [shouti gongwenbao] de zhongnianren huidao jia

one-CL hand.carry portfolio DE middle.aged.person return home

"A middle-aged person who carried a portfolio returned home."

(8) [大家 推崇] 的 小马 就是 一个 典型。

[dajia tuichong] de Xiao-Ma jiushi yi-ge dianxing

everybody admire DE Xiao-Ma just-is one-CL typical.example

"Xiao Ma whom we all admire was a typical example."

(Examples (7) and (8) from Pu (2007))

However, Pu (2007)'s results should be considered with some caution because the number of object RCs in the matrix subject position was quite low. Instead of serving as a reminder of given head nouns, object RCs are also likely to function to ground new head nouns by relating them to given RC-internal NPs. In effective communication, referents that are not clear from prior mention or situation need to be made relevant. Grounding is the primary way in which speakers make an NP relevant (Fox & Thompson, 1990). As indicated by example (9), the object RC makes the new head noun *ershouyan* "second-hand smoke" relevant by relating it to the given RC-internal NP *tamen* "they".

(9) [他们 呼出 的] 二手烟 污染了 整个 区域 的 空气。

[tamen huchu de] ershouyan wuranle zhenge quyu de kongqi

they exhale DE secondhand-smoke pollute-PAR whole area POSS air

"The second-hand smoke that they exhale pollutes the air of the whole area."

(From the HSK dynamic Composition Corpus)

In brief, unlike English, there is no consistent preference for subject RCs in Mandarin in general. The canonicity effect hypothesis and other theoretical accounts that favour either a subject or an object RC cannot fully explain the results in Mandarin. I suggest that in addition to the frequency effect of RC structures themselves, the discourse contexts that RCs are situated in (e.g., different types of written genres), and the information status of RCs and head nouns may have an impact on the distribution of subject and object RCs in Mandarin.

5.3 RCs in the Matrix Subject Position vs. RCs in the Matrix Direct-object Position

Previous studies on English show a clear tendency for DOBJ RCs (RCs in the matrix direct-object position) to be easier to acquire and to process than SUBJ RCs (RCs in the matrix subject position) (e.g., Diessel & Tomasello, 2000; Kidd & Bavin, 2002; McElree et al., 2003; Santi et al., 2018). Among the factors thought to contribute to this tendency, syntactic embedding has been suggested to play an important role. Consider examples (1) and (2), rewritten as (10) and (11).

[English SUBJ RC]

(10) The horse [that hugged the pig] saw the goat.

[English DOBJ RC]

(11) The goat saw the horse [that hugged the pig].

As mentioned in Chapter 1.4.3, in English, SUBJ RCs (10) fall right in the centre of the matrix clause (i.e., they are centre-embedded), while DOBJ RCs (11) branch to the right of the matrix clause (i.e., they are non-centre-embedded). More cognitive load is required to process SUBJ RCs, as readers need to keep the matrix subject *the horse* in working memory, until the matrix predicate *saw the goat* can be accessed (e.g., Gibson, 1998, 2000; Prideaux & Baker, 1986). However, when processing DOBJ RCs, readers can process the whole matrix clause *the goat saw the horse* first, and then process the RC.

Another explanation for the DOBJ RC advantage in English is related to grammatical weight. Grammatical weight is measured by the length of a constituent in terms of the number of words in relation to other constituents of a sentence. It has been attested that in head-initial languages with canonical SVO word order such as English, speakers prefer processing long constituents after short constituents (e.g., Arnold et al., 2000; Wasow, 1997). Placing long constituents later in English also facilitates the efficiency of parsing. As illustrated by examples (10) and (11), English DOBJ RCs place the longer (and more complex) matrix direct-object NP *the horse that hugged the pig* after the shorter matrix subject *the goat*, and therefore they have a shorter dependency length between the matrix subject and the matrix verb than English SUBJ RCs. The shorter the dependency length, the less the memory cost (Gibson, 1998, 2000; Hawkins 1994, 2004). In English, the "short-before-long" preference is in line with the "non-centre-embedded over centre-embedded" preference.

However, in head-final languages with canonical SOV word order such as Japanese and Korean, speakers seem to show the opposite pattern of placing longer constituents before short constituents (e.g., Choi, 2007; Hawkins 1994, 2004; Yamashita & Chang, 2001). This "long-before-short" preference is also in line with a "non-centre-embedded over centre-

embedded" preference. Example (12), from Japanese, is preferred over (13), as in (12) the matrix subject *Ken-ga kiratteiru onna-ga* "the woman who Ken hated" that is longer than the matrix direct-object *giin-o* "the senator" is placed earlier, and the RC in (12) is not centre-embedded.

[Japanese SUBJ RC]

(12) [Ken-ga kiratteiru] onna-ga giin-o hometa.
Ken-NOM hate woman-NOM senator-ACC praised
"The woman who Ken hated praised the senator."

[Japanese DOBJ RC]

(13) Onna-ga [Ken-ga kiratteiru] giin-o hometa.
woman-NOM Ken-NOM hate senator-ACC praised
"The woman praised the senator who Ken hated."

(Examples (12) and (13) from Shoji (2017))

Different from both English (a head-initial language with canonical SVO word order) and Japanese (a head-final language with canonical SOV word order), Mandarin uniquely combines head-final RCs with canonical SVO word order (Dryer, 2013). It thus provides an excellent opportunity to disentangle the effects of structural embedding and grammatical weight. In Mandarin, SUBJ RCs (14) are non-centre-embedded, while DOBJ RCs (15) are centre-embedded. If Mandarin also supports "non-centre-embedded over centre-embedded" assumption, Mandarin SUBJ RCs should be predicted to be processed more easily than DOBJ RCs. However, the evidence from Mandarin does not fully support this idea. Only adult L1 Mandarin speakers consistently produce more SUBJ RCs than DOBJ RCs in their

writing (e.g., Hsiao & Macdonald, 2013; Li et al., 2010; Lin & Bever, 2006; Pu, 2007; Wu, 2009). A DOBJ RC advantage and no preference for SUBJ or DOBJ RCs has been found in L2 Mandarin learners' writing (e.g., Li & Wu, 2013; Chang, 2017), which will be discussed in detail in the following section.

[Mandarin SUBJ RC]

(14) [抱 小猪] 的 小马 看到 山羊。

bao xiaozhu de xiaoma kandao shanyang

hug pig DE horse see goat

"The horse [that hugged the pig] saw the goat."

[Mandarin DOBJ RC]

(15) 山羊 看到 [抱 小猪] 的 小马。

shanyang kandao bao xiaozhu de xiaoma

goat see hug pig DE horse

"The goat saw the horse that hugged the pig."

Similarly, there does not seem to be a clear "long-before-short" or "short-before-long" preference in Mandarin. For example, Yao (2018) looked at the alternation between Mandarin SVO and the *ba* constructions in L1 Mandarin speakers' spontaneous speech and in their writing. In the *ba* construction like (16), an object NP *na ben shu* "that book" is preposed in a preverbal position, and the grammatical marker *BA* comes just before the preposed object NP. Yao (2018) reported that both very short and very long object NPs tended to be preposed compared to medium-length ones. Inconsistent with Yao (2018), Chen

et al. (2021) found that long object NPs tended to be preposed more than short ones, supporting a "long-before-short" preference. Chen et al. (2021) suggested the difference between their study and Yao (2018)'s may have resulted from the different definitions of short versus long NPs. NPs that were categorised as long in Chen et al. (2021) included three or more characters, while the cut-off for long NPs in Yao (2018) was five characters. To my knowledge, no previous research has investigated the effect of grammatical weight in the processing of Mandarin RCs.

[Mandarin *ba* construction]

(16) 他 把 那 本 书 放 下 了。

ta ba na ben shu fang xia le

he BA that CL book put down ASP.

"He put down that book."

(From Yao (2018))

In addition to structural embedding and grammatical weight, the information status of RCs and head nouns also needs to be taken into consideration here. In language production and comprehension, it has been suggested that given information tends to occur in earlier syntactic positions than new information, which allows readers or listeners to retrieve the topic under discussion (e.g., Clark & Haviland, 1977; Ferreira & Yoshita, 2003; Haviland & Clark, 1974; Levelt, 1989). Supporting the "given-before-new" assumption, Fox and Thompson (1990) found that English SUBJ RCs tended to refer to given information, while English DOBJ RCs tended to encode new information. To be specific, when English RCs are in the matrix subject position as in (17), they are usually used to ground the head noun (here, *the problem*) by relating the head noun to the given RC-internal NP (here, *I*). However, when

English RCs are in the matrix direct-object position, as in (18), hearers have already heard the matrix subject and are likely to have already related the head noun to a given referent in the matrix clause or prior discourse (Fox & Thompson, 1990). There is no need for DOBJ RCs to serve a grounding function anymore.

(17) Well see what the problem [I have] is my skin is oily and that lint just flies into my face.

(18) There's a woman in my class [who's a nurse].

(Examples (17) and (18) from Fox & Thompson (1990))

Arnold et al. (2000)'s corpus data of English also support this "given-before-new" assumption. Furthermore, they revealed a relationship between information status and grammatical weight. Arnold et al. (2000) looked at two English constructions: heavy NP shift (nonshifted vs. shifted) and the dative alternation (prepositional vs. double object). They found that in both cases, speakers tended to postpone new and long constituents, and new constituents tended to be postponed even when the referents were relatively equal in length. Specifically, for heavy NP shifts such as (19) and (20), shifting increased when the direct object NP (underlined) was newer and longer than the prepositional phrase (italicized). For the dative alternation such as (21) and (22), the use of double object datives was higher when the direct object NP (underlined) was newer and longer than the indirect object NP (italicized).

[Nonshifted NP]

(19) The waiter brought <u>the wine we had ordered</u> *to the table*.

[Shifted NP]

(20) The waiter brought *to the table* the wine we had ordered.

[Prepositional dative]

(21) Chris gave a bowl of Mom's traditional cranberry sauce to *Terry*.

[Double object dative]

(22) Chris gave *Terry* a bowl of Mom's traditional cranberry sauce.

(Examples (19) - (22) from Arnold et al. (2000))

Different from the results found in English, the "given-before-new" assumption does not always hold in Mandarin. As mentioned previously, Pu (2007) found that when both subject and object RCs were in the matrix subject position, there was a tendency for subject RCs to express new information, while for object RCs to carry given information. In other words, unlike in English, the matrix-clause positions that RCs are located in do not interact with the information status of RCs in Mandarin. Moreover, Liu (2007) investigated the SVO-SOV alternation in Mandarin and reported that the trend of preposing given object NPs only held for short and medium-length constituents. When the object NPs were long, the effect of information status was reversed. That is, long and given object NPs were more likely to be postposed, while long and new object NPs tended to be preposed.

To conclude, for head-initial languages with canonical SVO word order like English, studies have found clear "non-centre-embedded over centre-embedded", "short-before-long" and "given-before-new" preferences, all of which support the assumption that DOBJ RCs should be easier to process than SUBJ RCs. There is also a close relationship between

grammatical weight and information status, that is, new and long constituents tend to be placed at the end of the sentence. For head-final languages with canonical SVO word order like Mandarin, only adult L1 speakers tend to show a clear tendency to support a "non-centre-embedded over centre-embedded" preference. That is, SUBJ RCs are produced more often than DOBJ RCs. The role of grammatical weight and information status in Mandarin RC processing is not entirely clear and deserves more attention. The next section will review the mixed results of corpus-based studies on the production of Mandarin RCs by L2 Mandarin learners.

5.4 The Distribution of Mandarin RCs in L2 Mandarin Learners' Writing

For the distribution of subject and object RCs, unlike for adult L1 Mandarin speakers, there is no clear subject RC advantage in L2 Mandarin learners' writing. It has been suggested that both L2 Mandarin learners' L1 and L2 proficiency levels affect their performance. Chang (2017) reported that intermediate level L1 English- and L1 Japanese-L2 Mandarin speakers showed a preference for object RCs over subject RCs. However, with improvement in Mandarin proficiency, the proportion of L2 Mandarin speakers' subject RCs increased. Specifically, upper-intermediate level L1 English-L2 Mandarin speakers showed a subject RC preference, while upper-intermediate level L1 Japanese-L2 Mandarin speakers had no preference for subject or object RCs. For the difference between upper-intermediate level L1 English- and L1 Japanese- L2 Mandarin speakers, Chang (2017) suggested that it could be related to cross-linguistic influence from Japanese to Mandarin. RCs in both Mandarin and Japanese are head-final, and Mandarin object RCs and Japanese object RCs have the same SVO word order. These word order similarities are likely to lead L1 Japanese-L2 Mandarin speakers to produce more object RCs in Mandarin. Of note, object RCs occur slightly more often than subject RCs in written Japanese (Sato et al., 2012).

Inconsistent with Chang (2017), Yang (2021) did not find any impact of L2 Mandarin learners' L1 on their production of Mandarin RCs. Instead, there was a clear subject RC preference in the writing of both upper-intermediate level L1 Japanese- and L1 Thai- L2 Mandarin learners. Thai is similar to English, which has the canonical SVO word order and head-initial RCs. The difference between Chang (2017) and Yang (2021) could partially result from the different corpora used. Chang (2017) used the TOCFL learner corpus (Lee et al., 2018), while Yang (2021) used the HSK Dynamic Composition Corpus (Version 1.1). Although both TOCFL and HSK tests are standardized Mandarin language proficiency tests for non-native speakers, they are not fully equivalent in terms of their difficulty, as well as writing topics.

On the other hand, I suggest that the investigation of factors like information status might help to better understand whether, and if so how, L2 Mandarin learners' L1s influence their production of Mandarin subject and object RCs. For example, as Mandarin and Japanese RCs precede head nouns, the information status of RCs may significantly influence their relationship with head nouns (i.e., distribution of subject and object RCs). However, as English RCs are head-initial, whether RCs carry new or given information may depend on the matrix-clause positions that they appear in (Fox & Thompson, 1990). If head nouns have been grounded by a given referent in the matrix clause or prior discourse, there is no need for RCs to serve a grounding function anymore (Fox & Thompson, 1990).

Turning to compare SUBJ and DOBJ RCs in L2 Mandarin learners' writing. Similarly, L2 Mandarin learners, unlike adult L1 Mandarin speakers, do not show a preference for SUBJ RCs. However, there seems to be a tendency for them to produce more SUBJ RCs with increasing proficiency. In Chang (2017), both intermediate- and upper-intermediate level L1 English- and L1 Japanese-L2 Mandarin speakers produced significantly more DOBJ RCs than SUBJ RCs. Though both groups made more errors when producing

DOBJ RCs than SUBJ RCs, the number of errors was very limited. With improvement in Mandarin proficiency, upper-intermediate and advanced level L1 Japanese-L2 Mandarin speakers and advanced-level L1 English-L2 Mandarin speakers in Yang (2020) and Li and Wu (2013) produced similar numbers of SUBJ and DOBJ RCs.

Regarding why Mandarin L2 learners did not show a SUBJ preference like L1 Mandarin speakers, Li and Wu (2013) suggests that it could be related to the length of their RCs. Compared to L1 Mandarin speakers, L2 learners especially those with a lower level of proficiency tend to use short RCs such as *chouyan de ren* "people who smoke" in (23). When centre-embedded RCs (i.e., DOBJ RCs) are shorter, they do not really separate the matrix clause, and therefore do not cost more working memory (e.g., Gibson, 2000).

(23) 这 项 新 措施 可以 减少 [抽烟] 的 人。

zhe xiang xin cuoshi keyi jianshao chouyan de ren

this CL new measure can reduce smoke DE people

"This new measure can reduce (the number of) people who smoke."

(From Li & Wu (2013))

To conclude, unlike adult L1 Mandarin speakers, L2 Mandarin learners do not show a consistent preference for subject RCs (the head noun is coreferential with the RC-internal subject) and SUBJ RCs (the head noun of the RC is in the matrix subject position). However, there is a tendency for them to become more native-like by producing more subject RCs and SUBJ RCs with increasing levels of proficiency. So far, it is not clear whether L2 Mandarin speakers' L1 (head-initial vs. head-final) also influence their production of Mandarin RCs. I suggest that the investigation of factors such as information status might help to understand the role of L2 Mandarin speakers' L1 better.

5.5 Research Questions and Hypotheses

The present corpus-based study investigates the use of Mandarin RCs in the writing of L1 Mandarin speakers and L2 Mandarin learners from English and Japanese backgrounds. The aim is to explore the factors that drive the distribution patterns of RCs in Mandarin. The RQs are as follows:

RQ1: Does the discourse context influence L1 and L2 Mandarin speakers' preference for subject vs. object RCs?

RQ2: Does the information status of RCs and head nouns influence L1 and L2 Mandarin speakers' preference for subject vs. object RCs?

RQ3: Do L1 and L2 Mandarin speakers show a "non-centre-embedded over centre-embedded" preference in Mandarin by producing more RCs in the matrix subject position (SUBJ RCs) than RCs in the matrix direct-object position (DOBJ RCs)?

RQ4: Does the grammatical weight of matrix subject and object NPs influence L1 and L2 Mandarin speakers' preference for SUBJ vs DOBJ RCs?

Regarding RQ1, based on previous corpus-based studies (e.g., Chen & Shirai, 2015; Lin, 2011; Pu, 2007; Vasishth et. al, 2013; Wu, 2009; Hsiao & Macdonald, 2013), I hypothesise that context will influence the choice of subject and object RCs in the writing of L1 Mandarin and advanced L1 English- and L1 Japanese-L2 Mandarin speakers. Written genres that are closer to spontaneous speech are expected to show an object RC advantage, while others such as written news may have a subject RC advantage. However, lower level L1 English- and L1 Japanese-L2 Mandarin speakers may prefer object RCs in general (Chang, 2017). The word order similarity between Mandarin object RCs and simple SVO transitives is expected to make Mandarin object RCs easier to process in L2 Mandarin

learners' early production. Moreover, lower level L2 Mandarin speakers' writing might be more similar to spontaneous speech, which is expected to show an object RC advantage.

Regarding RQ2, I expect that the information status of RCs and head nouns will also influence L1 Mandarin and advanced L1 English- and L1 Japanese-L2 Mandarin speakers' choices of subject and object RCs. It is likely that subject RCs tend to provide new distinguishing or characterizing information for new head nouns (see example (7)), while object RCs prefer to provide given information to ground new head nouns or remind readers of given head nouns (see examples (8) and (9)). Compared to advanced L2 Mandarin speakers, lower level L2 Mandarin speakers might be influenced more by their L1. Due to the English head-initial property, lower level L1 English-L2 Mandarin speakers may be more sensitive to the information status of matrix clauses rather than RCs. That is, when RCs are in the matrix subject position, both subject and object RCs may encode given information to ground the head noun. However, when RCs are in the matrix direct-object position, head nouns may have been grounded by matrix subjects, and therefore both subject and object RCs may tend to carry new information (see examples (17) and (18)) (Fox & Thompson, 1990). However, lower level L1 Japanese- L2 Mandarin speakers are expected to show a similar information status pattern as advanced L2 Mandarin speakers.

Regarding RQ3, I expect that L1 Mandarin and advanced L1 English- and L1 Japanese-L2 Mandarin speakers will show a "non-centre-embedded over centre-embedded" preference by producing more SUBJ RCs than DOBJ RCs. However, when L1 English- and L1 Japanese-L2 Mandarin speakers are at lower proficiency levels, they are not expected to show a SUBJ RC preference as they might tend to use shorter RCs (Li & Wu, 2013). When RCs are shorter, it is likely that they do not separate the matrix clause and do not cost more working memory (e.g., Gibson, 2000). In this case, DOBJ RCs, which are centre-embedded, are not harder to process than SUBJ RCs.

Turning to RQ4, I expect that the grammatical weight of matrix subject and object NPs will also influence the preference for SUBJ vs. DOBJ RCs in Mandarin. As mentioned previously, English displays both "non-centre-embedded over centre-embedded" and "short-before-long" preferences (Diessel & Tomasello, 2000; Arnold et al., 2000), while Japanese displays "non-centre-embedded over centre-embedded" but "long-before-short" preferences (Shoji, 2017). Although the effect of grammatical weight in Mandarin is more complex, I expect that the grammatical weight preference will be compatible with the "non-centre-embedded over centre-embedded" preference in the writing of L1 Mandarin and advanced L1 English- and L1 Japanese-L2 Mandarin speakers. Regarding lower level L1 English- and L1 Japanese-L2 Mandarin speakers, as RCs might be shorter in their writing, it is unlikely that they will have a clear "short-before-long" or "long-before-short" preference.

5.6 Method

5.6.1 Data

The current corpus-based study is based on the written data of L1 Mandarin speakers from The Lancaster Corpus of Mandarin Chinese (LCMC) (McEnery et al. 2003; McEnery & Xiao 2004), and of L1 English- and L1 Japanese-L2 Mandarin learners from the HSK Dynamic Composition Corpus (Version 2.0) developed by Beijing Language and Culture University.

LCMC is a one-million-word balanced corpus of written Mandarin Chinese, which is built with reference to the Freiburg-LOB Corpus of British English (Hundt et al. 1998) and the Freiburg-Brown Corpus of American English (Hundt et al. 1999). It sampled five hundred written Chinese texts published in Mainland China in the 1990's, with each text containing 2,000 words. Four broad genres were covered: fiction, general prose (non-fiction), learned (academic) and press. The HSK Dynamic Composition Corpus comprises the HSK composition papers written by advanced L2 Mandarin learners from a large variety of

countries. 11,569 compositions based on given topics were sampled, with 4.24 million characters. The current study focuses on those with English (USA, UK, Australia, Canada) and Japanese L1 backgrounds in three certificate bands (Band A, B, C; Band A is the highest band), in order to examine the impact of L2 Mandarin learners' L1 (head-initial vs. head-final) and Mandarin language proficiency on their RC production.

5.6.2 Data Coding

All subject and object RCs in the matrix subject and object positions from the LCMC and the HSK Dynamic Composition Corpus were manually extracted. RCs without overt head nouns were filtered out, as the length and information status of head nouns needed to be measured. Topicalized RCs, such as in (24), were also not part of this study, as they involve a specific contrastive focus function and their information status might be different from canonical structures (Shyu, 2016). In the HSK Dynamic Composition Corpus, L1 English- L2 Mandarin speakers only produced 190 targeted RCs in total. In order to match them, the same number of targeted RCs were randomly selected from L1 Japanese- L2 Mandarin speakers' writing, while controlling for certificate bands and composition topics. Similarly, in order to match with L2 Mandarin learners from both English and Japanese backgrounds, 100 targeted RCs in each genre from L1 Mandarin speakers' writing were randomly selected, with 400 targeted RCs in total.

[Mandarin topicalized RCs]

(24) **[我 要] 的 东西，没有 人 可以 不 给 我。**

Wo yao de dongxi meiyou ren keyi bu gei wo

I want DE thing not people can not give me

"Nobody can (choose) not to give me the thing I want."

(From the HSK dynamic Composition Corpus)

All selected RCs from the LCMC and the HSK Dynamic Composition Corpus were coded based on the following 10 properties:

1. Language background: L1 Mandarin, L1 English, L1 Japanese
2. Certificate band (Level of proficiency): A, B, C (only applied to L2 Mandarin learners)
3. Genre: Fiction, general prose (non-fiction), learned (academic), press (only applied to L1 Mandarin speakers)
4. The role of the head noun within the RC: subject RC (25), object RC (26).

[subject RC, DOBJ RC]

(25) 他 也 给了 [上 大学 的] 妹妹。

ta ye geile shang daxue de meimei

he also give-PAR go-to university DE little-sister

"He also gave (it) to his little sister who goes to university."

(From the LCMC)

[object RC, SUBJ RC]

(26) [父亲 所 做 的] 事 也 就 算是 在 "备课"。

[fuqin suo zuo de shi ye jiu suanshi zai beike

father PAR do DE thing also then count-as DUR lesson-preparation

"The thing that the father did can also be counted as "lesson preparation".

(From the HSK dynamic Composition Corpus)

5. The role of the head noun in the matrix clause: RCs in the matrix subject position (SUBJ RCs) (26), RCs in the matrix direct-object position (DOBJ RCs) (25).
6. Information status of the head noun:
    a. Given: In this study, a head noun that is mentioned in the previous ten sentences is identified as "given". In (26), its head noun *shi* "thing" carries given information, as it has been mentioned in the previous context that "a child will hear stories about what kind of person the father is (i.e., the things that the father was doing)".
    b. New: In this study, a head noun that is not mentioned or referred to in the previous ten sentences is identified as "new".
7. Information status of the RC-internal NP: This is also divided into "new" and "given" categories, depending on whether it is mentioned in the previous ten sentences. If an RC-internal NPs is omitted, it is marked as "absent". In (26), the RC-internal noun *fuqin* "father" expresses given information as it refers to the hero of the whole text.
8. Length of the matrix subject NP: This is measured by the number of characters in the matrix subject NP. In (26), the matrix subject *fuqin suo zuo de shi* "the thing that the father did" contains the RC. The length of the matrix subject is six characters.
9. Length of the matrix direct-object NP: This is measured by the number of characters in the matrix direct-object NP. In (25), the matrix object *shang daxue de meimei* "little sister who goes to the university" contains the RC. The length of the matrix object is six, while length of the matrix subject *ta* "he" is one.

10. Length of the matrix verbal construction: As the length of the matrix verbal construction may interact with the length of the matrix subject and direct-object NPs, I also take this factor into account. It is measured by the number of characters in the matrix verbal construction. Verbal constructions include resultative verb compounds (see Li & Thompson, 1989, pp. 54-68), parallel verb compounds (see Li & Thompson, 1989, pp. 68-70), and verb+ particle (*zhe*, *le*, *guo*). In (25), the length of the matrix verbal construction *geile* "gave" is two.

Twenty percent of the data were coded by a second coder to check the intercoder reliability of the information status of the head noun and the RC-internal NP. The other eight properties were not included as their coding schemes were relatively unambiguous. Intercoder reliability was 91% (Cohen's Kappa = 0.82) for information status of the head noun and 90% (Cohen's Kappa = 0.85) for information status of the RC-internal NP. Disagreements in the coding were resolved by the first coder based on the coding scheme.

5.6.3 Data Analysis

The present study used conditional inference tree (Hothorn et al., 2006; Tagliamonte & Baayen, 2012) and random forest (Breiman, 2001) models to analyse factors driving the distribution of RCs. In recent years, these models have gained more and more popularity in corpus linguistics (Levshina, 2020), as they are more robust to violations of some of the common assumptions of linear models such as multicollinearity. Previous studies have used them to find out the motivators of clause positioning (e.g., Rezaee & Golparvar, 2016, 2017), and factors that impact the syntactic alternations (e.g., Szmrecsanyi et al., 2016) and priming in interaction (e.g., Tantucci & Wang, 2021).

The conditional inference tree is a kind of decision tree showing statistically significant predictor variables intersecting hierarchically with one another. It divides the dataset into two subsets based on the most salient predictor. Then it splits each subset until there are no statistically significant relationships between any of the predictors (i.e., the higher the node in the hierarchy, the more significant the "conditional decision"). To run this analysis, the "ctree" function of the R package "party" was used (Levshina, 2015).

However, the conditional inference tree is itself a single-tree model and may be unreliable as minor changes in the input variables could lead to significant changes in the output. To support the findings, a random forest of such trees was built, which is more robust for selecting variables (Brieman, 2001). A random forest measures how salient each predictor variable is in the model averaged over many conditional trees. The "cforest" function of the R package "party" was used (Levshina, 2015). It has been noted that conditional inference trees may require additional inspection of potential interactions between variables in certain datasets (Gries, 2020). Thus, the "find.interaction" function of the R package "randomForestSRC" (Ishwaran & Kogalur, 2019) was further used to detect interactions between variables. However, I did not observe any further additional interactions being identified by randomForestSRC.

5.7 Results

5.7.1 Subject vs. Object RCs

A conditional inference tree model was fitted to explore the factors affecting the distribution of subject or object RCs in L1 and L2 Mandarin speakers' writing respectively. All annotated properties were included in the models: Genre (for L1)/proficiency (for L2), the role of the head noun in the matrix clause, information status of the head noun, information status of the

RC-internal NP, length of the matrix subject and object NPs, and length of the matrix verbal construction.

Figure 5.1 illustrates the conditional inference tree for the distribution of subject and object RCs in L1 Mandarin speakers' writing. In the ovals of Figure 5.1, the names of the predictors and the corresponding *p*-values are reported. The categories of the nominal predictors or the values of the numerical predictors are specified on the "branches". The boxes at the bottom display the proportions of subject and object RCs in each end node.

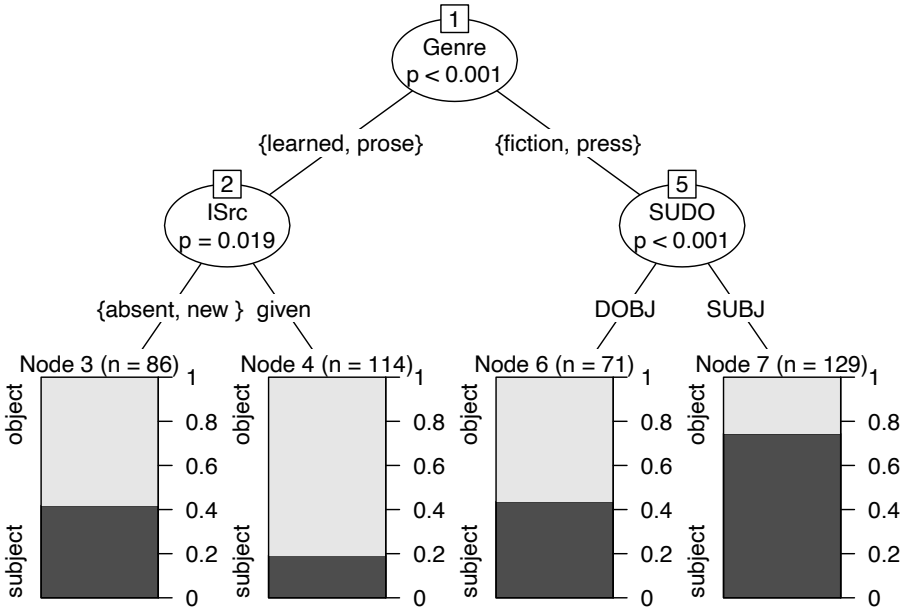


Figure 5.1: Conditional inference tree for the distribution of subject and object RCs in L1 Mandarin speakers' writing

Note. ISrc = Information status of the RC-internal noun phrase; SUDO = The role of the head noun in the matrix clause

I interpret the conditional inference tree from top to bottom. The first split at the top is based on Genre (Node 1, $p < 0.001$). That is, genre was the best predictor of the choices of subject or object RCs in L1 Mandarin speakers' writing. Then, the left branch with learned and prose genres is split based on ISrc (information status of the RC-internal NP) (Node 2, $p = 0.019$). The end nodes show that in learned and prose genres, there was an object RC

preference (Nodes 3 and 4), and this preference was stronger when the RC-internal NP carried given information (Node 4). On the other hand, the right branch with fiction and press genres is split based on SUDO (the role of the head noun in the matrix clause) (Note 5, $p < 0.001$). In fiction and press genres, subject RCs tended to occur only when RCs were in the matrix subject position (Node 7).

The results above indicate that there was no overwhelming subject or object RC advantage in L1 Mandarin speakers' writing in general. L1 Mandarin speakers' choices of subject and object RCs highly depended on the context of use. Specifically, learned and prose genres tended to use object RCs that encoded given information (*women* "we" in (27)) to define objects or things (*ceshi zhuangzhi* "the test equipment" in (27)), while fiction and press genres used subject RCs to describe people (*fumu* "parents" in (28)), and people were usually placed at the beginning of the sentence (i.e., matrix subject position).

(27) [我们 首先 研制] 的 测试 装置 采用了 刨削 破 煤

[women shouxian yanzhi] de ceshi zhuangzhi caiyongle paoxiao po mei

we first develop DE test equipment use-PAR plow break coal

方法。

fangfa

method

"The test equipment that we developed first used a plowing method to break the coal."

(From the learned genre, LCMC)

(28) [当 教师] 的 父母 做梦 也 想不到 儿子 会 关押

dang jiaoshi de fumu zuomeng ye xiangbudao erzi hui guanya
work-as teacher DE parents dream also never-expect son will put-in-prison
在 大 墙 之内。

zai da qiang zhinei
in big wall inside

“The parents who work as a teacher never expected that (their) son would be sent to prison.”

(From the press genre, LCMC)

For L2 Mandarin learners (see Figure 5.2), the results also did not show that either subject or object RCs were dominant. The distribution of subject or object RCs was driven by ISrc (information status of the RC-internal NP) (Node 1, $p < 0.001$). When RC-internal NPs involved given information, object RCs, especially object RCs with new head nouns, were far more common than subject RCs (Nodes 3 and 4). On the contrary, when RC-internal NPs carried new information or when RC-internal NPs were absent, L2 Mandarin learners were more likely to produce subject RCs (Node 5). That is to say, similar to L1 Mandarin speakers, L2 Mandarin learners tended to use object RCs that encoded given information to ground new things, and to use subject RCs that carried new information to distinguish or characterize people.

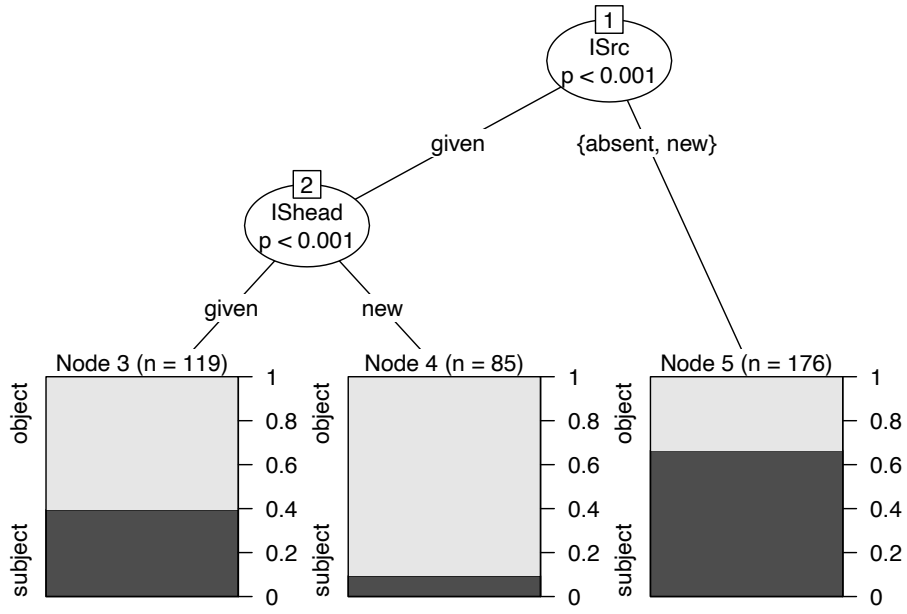


Figure 5.2: Conditional inference tree for the distribution of subject and object RCs in L2 Mandarin speakers' writing

Note. ISrc= Information status of the RC-internal noun phrase; IShead = Information status of the head noun

When comparing Figures 5.1 and 5.2 for L1 and L2 Mandarin speakers respectively, it can be observed that Figure 5.2 is slightly simpler. There are seven nodes in Figure 5.1, but five nodes in Figure 5.2. This suggests that fewer factors influenced the choices of subject and object RCs in the writing of L2 Mandarin speakers than that of L1 Mandarin speakers. To confirm this, I further fitted random forest models after computing 500 conditional trees. Figure 5.3 depicts the variable importance scores in L1 Mandarin speakers' writing. Genre was the outstanding predictor for the distribution of subject and object RCs (0.032), followed by ISrc (information status of the RC-internal NP) (0.007). However, in L2 Mandarin speakers' writing (see Figure 5.4), ISrc (information status of the RC-internal NP) (0.04) was more important than other predictors. This indicates that compared to L1 Mandarin speakers, L2 Mandarin speakers may adopt a simpler strategy (i.e., information status of RCs) to decide their choices of subject and object RCs, which could because of their limited writing skills in Mandarin.

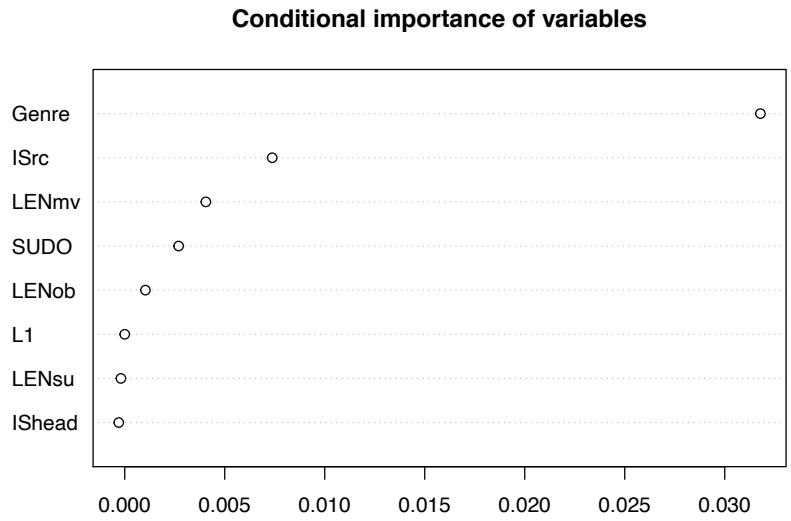


Figure 5.3: Conditional importance of factors affecting the distribution of subject-object RCs in L1 Mandarin speakers' writing

Note. ISrc = Information status of the RC-internal noun phrase; SUDO = The role of the head noun in the matrix clause; LENmv = Length of the matrix verbal construction; LENob = Length of the matrix direct-object noun phrase; LENsu = Length of the matrix subject noun phrase; IShead = Information status of head noun; L1 = First language

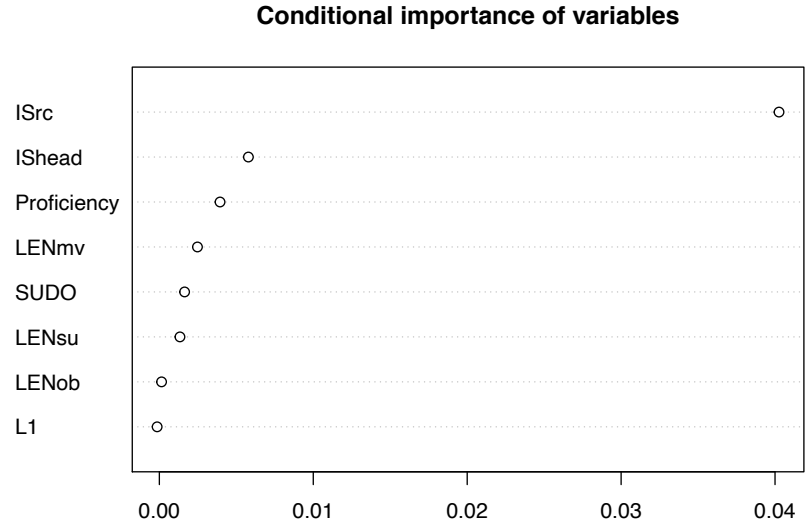


Figure 5.4: Conditional importance of factors affecting the distribution of subject and object RCs in L2 Mandarin speakers' writing

Note. ISrc = Information status of the RC-internal noun phrase; LENmv = Length of the matrix verbal construction; IShead = Information status of the head noun; LENsu = Length of the matrix subject noun phrase;

SUDO = The role of the head noun in the matrix clause; LENob = Length of the matrix direct-object noun phrase; L1 = First language

5.7.2 RCs in the Matrix Subject Position vs. RCs in the Matrix Direct-object Position

Turning to analyse the factors that affect the distribution of SUBJ and DOBJ RCs in L1 and L2 Mandarin speakers' writing, conditional inference tree models were also fitted and all annotated properties were included in the models: Genre (for L1)/proficiency (for L2), the role of the head noun within the RC, information status of the head noun, information status of the RC-internal NP, length of the matrix subject and object NPs, and length of the matrix verbal construction.

As shown in Figures 5.5 and 5.6, in both L1 and L2 Mandarin speakers' writing, LENsu (length of the matrix subject NP) was the best predictor of the distribution of SUBJ and DOBJ RCs (Node 1, p <0.001). When the matrix subject NP was shorter than or equal to 4 characters, DOBJ RCs occurred much more often than SUBJ RCs. Conversely, when the matrix subject NP was longer than 4 characters, SUBJ RCs were dominant. In general, more SUBJ RCs occurred than DOBJ RCs in both L1 and L2 Mandarin speakers' writing, supporting a "non-centre-embedded over centre-embedded" preference. That is to say, L1 and L2 Mandarin speakers tended to put longer and more complex matrix subject NPs (i.e., RCs) at the beginning of the sentence in order to avoid centre-embedding.

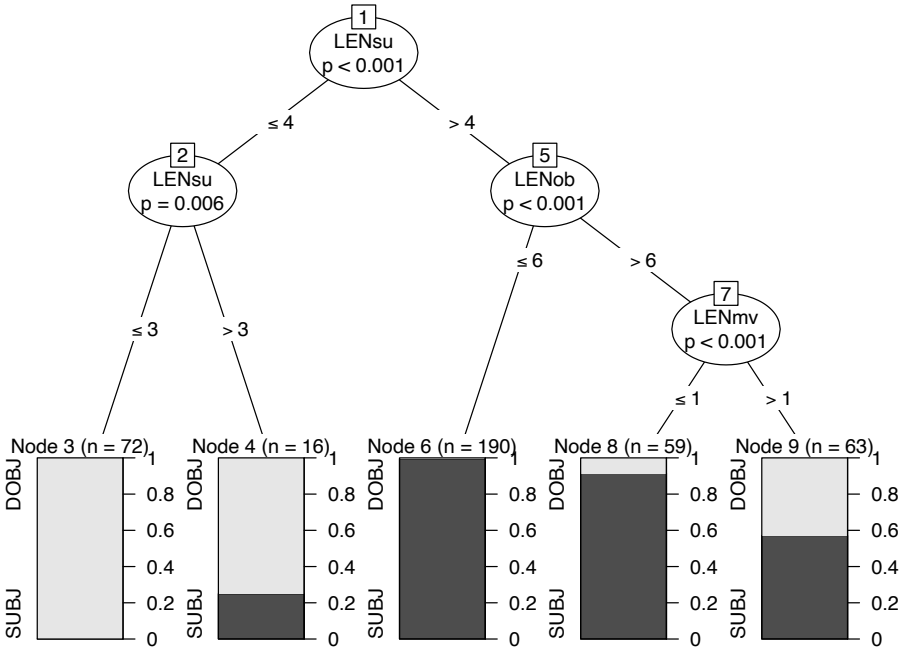


Figure 5.5: Conditional inference tree for the distribution of SUBJ and DOBJ RCs in L1 Mandarin speakers' writing

Note. LENsu = Length of the matrix subject noun phrase; LENob = Length of the matrix direct-object noun phrase; LENmv = Length of the matrix verbal construction

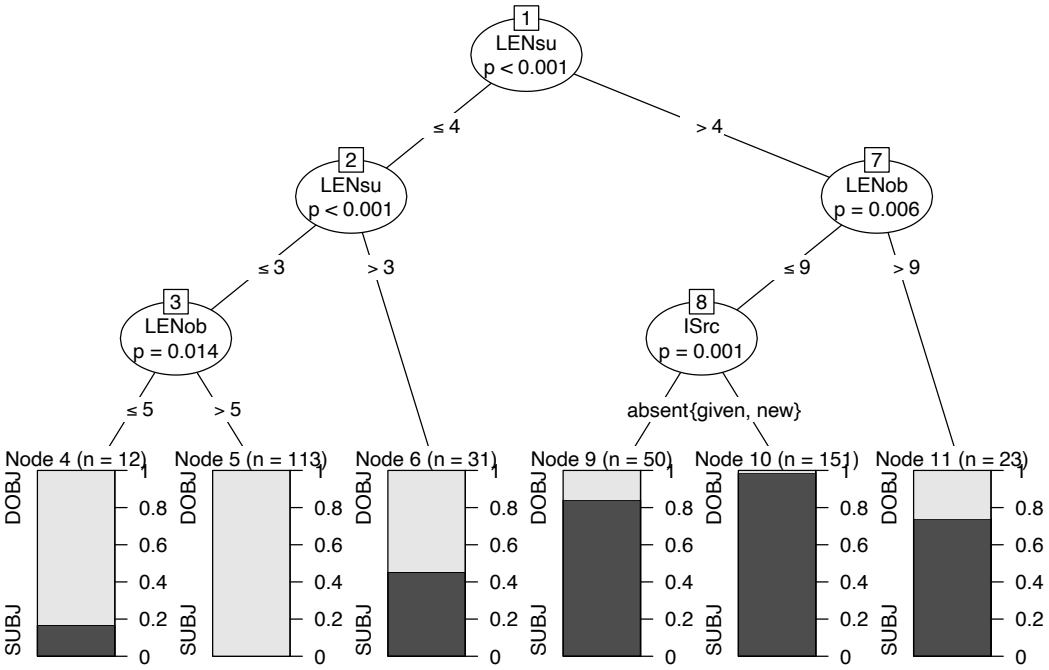


Figure 5.6: Conditional inference tree for the distribution of SUBJ and DOBJ RCs in L2 Mandarin speakers' writing

Note. LENsu = Length of the matrix subject noun phrase; LENob = Length of the matrix direct-object noun phrase; ISrc = Information status of the RC-internal noun phrase

However, in both L1 and L2 Mandarin speakers' writing (see also Figures 5.5 and 5.6), the results did not show that when the matrix subject NP was longer than 4 characters, the matrix object NP tended to be shorter than 4 characters. In other words, there was no clear "long-before-short" preference. At the same time, the results also did not show that the length of matrix verbal NPs interacted significantly with the length of the matrix subject and direct-object NPs, which could be because the majority of matrix verb NPs in both groups' writing were very short (i.e., 1-2 characters).

Random forest models confirmed the decisive impact of length of the matrix subject NP in the distribution of SUBJ and DOBJ RCs, and further found that fewer factors influenced L2 speakers' distribution of SUBJ and DOBJ RCs than that of L1 Mandarin speakers. In L1 Mandarin speakers' writing (see Figure 5.7), LENsu (length of the matrix subject NP) (0.065) turned out to be the most important predictor of the distribution of SUBJ and DOBJ RCs, followed by LENob (the length of the matrix object NP) (0.017). However, in L2 Mandarin speakers' writing (see Figure 5.8), LENsu (the length of the matrix subject NP) (0.127) was far more important than other predictors.

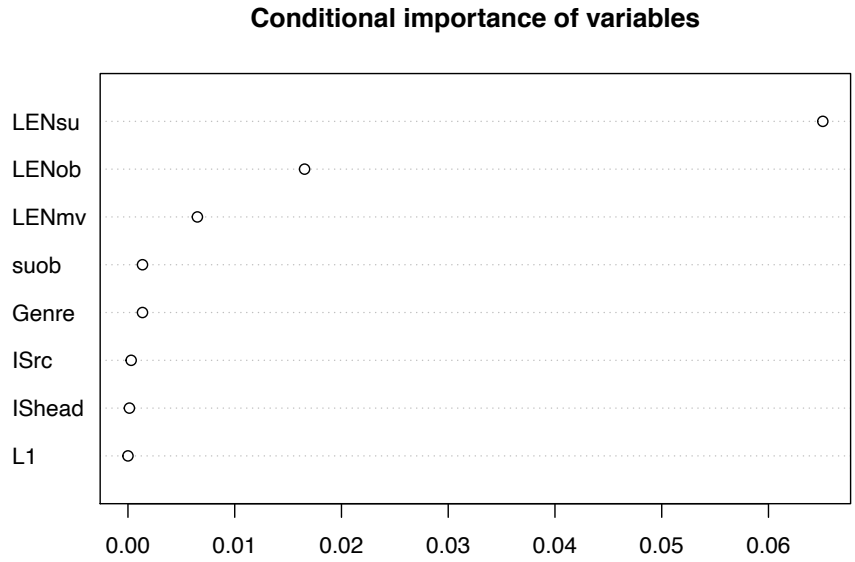


Figure 5.7: Conditional importance of factors affecting the distribution of SUBJ and DOBJ RCs in L1 Mandarin speakers' writing

Note. LENsu = Length of the matrix subject noun phrase; LENob = Length of the matrix direct-object noun phrase; LENmv = Length of the matrix verbal construction; suob = The role of the head noun within the RC; ISrc = Information status of the RC-internal noun phrase; IShead = Information status of the head noun; L1= First language

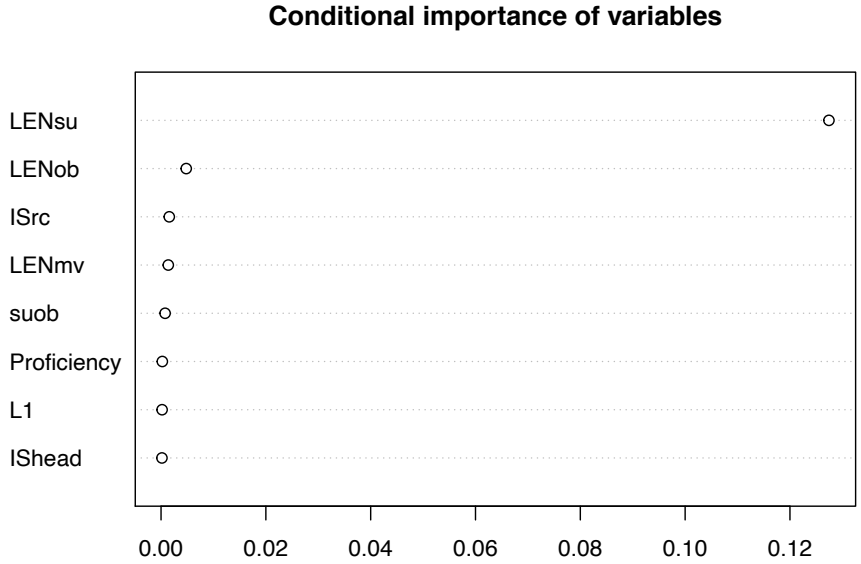


Figure 5.8: Conditional importance of factors affecting the distribution of SUBJ and DOBJ RCs in L2 Mandarin speakers' writing

Note. LENsu = Length of the matrix subject noun phrase; LENob = Length of the matrix direct-object noun phrase; ISrc = Information status of the RC-internal noun phrase; LENmv = Length of the matrix verbal construction; suob = The role of the head noun within the RC; L1 = First language; IShead = Information status of the head noun

5.8 General Discussion

The present corpus-based study adopted a novel multifactorial approach to analyse the distribution of Mandarin RCs in the writing of L1 and L2 Mandarin speakers. Instead of showing a general preference for certain types of RCs, the study scrutinised how factors like genre, information status, and grammatical weight affected the distribution of RCs in Mandarin, and how these factors distinguished RCs in the writing of L1 and L2 Mandarin speakers.

5.8.1 Factors Influencing the Distribution of Subject and Object RCs

Using conditional inference trees and random forests, it has been observed that genre was the strongest predictor of the distribution of subject and object RCs in L1 Mandarin speakers' writing. This entails that the asymmetry between subject and object RCs is not only related to RC structures themselves. Instead, the discourse context guides the selection of RCs that are associated with different discourse functions.

In learned (academic) and prose genres, L1 Mandarin speakers preferred to use object RCs than subject RCs. This result is similar to the distribution pattern found in the everyday speech of Mandarin-speaking children and their caregivers (e.g., Chen & Shirai, 2015; Hsu, 2014; Liu, 2015). Moreover, there was a stronger tendency for object RCs to occur when RC-internal NPs carried given information (*women* "we" in (27), rewritten as (29)) than new information. I suggest that like everyday speech, learned and prose genres are generally more straightforward. By using object RCs that put given information at the beginning of the

sentence, Mandarin listeners or readers can follow the discussion topic more easily (Haviland & Clark, 1974). In addition, as suggested by previous studies, subject RCs tend to be associated with animate head nouns, while object RCs tend to refer to inanimate head nouns (Hsiao & MacDonald, 2013; Pu, 2007; Wu, 2009). Learned and proses genres include many official documents and scientific reports[12], which may involve more inanimate head nouns like *ceshi zhuangzhi* "the test equipment" in example (27), rewritten as (29).

(29) [我们 首先 研制] 的 测试 装置 采用了 刨削 破 煤

[women shouxian yanzhi] de ceshi zhuangzhi caiyongle paoxiao po mei

we first develop DE test equipment use-PAR plow break coal

方法。

fangfa

method

"The test equipment that we developed first used a plowing method to break the coal."

(From the learned genre, LCMC)

In contrast to learned and prose genres, L1 Mandarin speakers preferred to use subject RCs than object RCs in fiction and press genres. This is in line with results found in previous adult corpus-based studies, the majority of which focus on RCs in written news (Hsiao, 2003; Wu, 2009; Hsiao & Macdonald, 2013; Lin, 2011; Vasishth et al., 2013). Unlike learned and proses genres, fiction and press genres focus more on people. Mandarin subject RCs that

[12] "Learned genre" includes four subcategories: religion, skills, trades and hobbies, popular lore, biographies and essays. "Prose genre" includes two subcategories: report and official documents, and academic prose (McEnery et al., 2003; McEnery & Xiao, 2004).

carry animate head nouns (Pu, 2007; Wu, 2009) can be frequently used to describe people in the news, and to portray characters in fiction.

Another explanation of the subject RC advantage in fiction and press genres may be related to the writing techniques they used. As discussed previously, Mandarin object RCs are likely to carry given information, while Mandarin subject RCs tend to encode new information (Pu, 2007). Instead of telling stories in the most straightforward manner by mentioning given information at the beginning of the sentence, fiction and press genres may keep readers captivated by creating and sustaining suspense in the stories and therefore used more subject RCs.

However, it should be noticed that the subject RC preference in fiction and press genres only occurred when RCs were in the matrix subject position (see example (14), rewritten as (30)). When RCs were in the matrix direct-object position, the subject-object asymmetry disappeared (see example (15), rewritten as (31), and example (32)). This could be because when RCs are in the matrix direct-object position, matrix subjects that occur earlier may have already described the main characters. Therefore, it is not necessary to use subject RCs to serve this function anymore. Another possibility is that subject RCs that occur in the matrix direct-object position are relatively harder to process, as their head nouns have different functions in RCs and matrix clauses (Sheldon, 1974; MacWhinney,1977, 1982). In example (31), the head noun *xiaoma* “the horse” is coreferential with the RC-internal subject, but occupies the matrix direct-object position, which may take more cognitive effort to process. However, object RCs that occur in the matrix direct-object position (32) have the same function in both RCs and matrix clauses.

[Mandarin subject RCs in the matrix subject position]

(30) **[抱　小猪]　的　小马　　看到　　山羊。**

bao xiaozhu de xiaoma kandao shanyang

hug pig DE horse see goat

"The horse [that hugged the pig] saw the goat."

[Mandarin subject RCs in the matrix direct-object position]

(31) 山羊 看到 [抱 小猪] 的 小马。

shanyang kandao bao xiaozhu de xiaoma

goat see hug pig DE horse

"The goat saw the horse that hugged the pig."

[Mandarin object RCs in the matrix direct-object position]

(32) 山羊 看到 [小马 抱] 的 小猪。

shanyang kandao xiaoma bao de xiaozhu

goat see horse hug DE pig

"The goat saw the pig that the horse hugged."

Similar to L1 Mandarin speakers' writing, subject and object RCs in L2 Mandarin speakers' writing were also associated with different discourse functions. Specifically, L2 Mandarin speakers frequently used subject RCs to provide distinguishing and characterizing new information to define animate head nouns such as *chouyan de ren* "people who smoke", *xihuan yundong de fumu* "parents who like doing sports", *shengzhang zai nanjiazhou de wo* "*I who grew up in South California*". On the other hand, they used object RCs that encoded given information to bring out new inanimate head nouns like *wo zui xihuan de jijie* "the

season that I like the most", or to remind readers about things that have been mentioned previously like *fuqin suo zuo de shi* "the thing that the father did".

5.8.2 Factors Influencing the Distribution of the Matrix-clause Positions That RCs Appear in

For the distribution of SUBJ vs. DOBJ RCs, the length of the matrix subject NP has been found to play a decisive role in both L1 and L2 Mandarin speakers' writing. Both groups preferred putting longer matrix subject NPs at the beginning of sentences than the shorter ones (cut-off for short and long NPs: 4 characters). The longer the matrix subject NP, the higher the possibility a SUBJ RC would occur. As SUBJ RCs are non-centre-embedded and DOBJ RCs are centre-embedded in Mandarin, it can be concluded that the results support the "non-centre-embedded over centre-embedded" assumption. However, there was no clear relationship between the length of matrix subject and matrix object NPs. That is, the results could not provide evidence to support a "long-before-short" or "short-before-long" preference in Mandarin RC processing.

The current results are partially in line with those found in other head-final languages such as Japanese and Korean (e.g., Choi 2007; Hawkins 1994, 2004; Yamashita & Chang 2001), in which longer constituents tend to occur earlier. In contrast, in head-initial languages such as English, the opposite pattern of preferring the earlier occurrence of short constituents has been reported (Hawkins, 1994; Arnold et al., 2000). As discussed previously, mirror-image preferences for grammatical weight in head-initial and head-final languages are likely to result from the efficiency of parsing (e.g., Gibson, 1998, 2000; Hawkins 2004; Nakatani & Gibson, 2008). Specifically, the shorter the linear distance between two syntactic dependencies (matrix subject/object NP and verb), the less the memory cost (Gibson, 1998, 2000). Take Mandarin as an example. When Mandarin RCs (30) place the longer and more

complex matrix subject NP *bao xiaozhu de xiaoma* "the horse that hugged the pig" at the beginning of the sentence, the dependency length between the matrix subject/object NP and the matrix verb *kandao* "saw" is very short, and therefore less cognitive effort is required.

However, it should be noticed that based on this explanation, it cannot be concluded that there is a "long-before-short" preference in Mandarin RC processing. For example, when replacing the short matrix object NP *shanyang* "goat" in (30) with the longer *shanyang, nainiu he henduo xiaoniao* "*goats, cows and lot of birds*", the dependency length between the matrix verb and the matrix object NP is still the same. In this case, there is no "long-before-short" preference. Although a "long-before-short" preference was reported in Japanese (Shoji, 2017), it was found in a sentence comprehension study and it is unclear whether this result holds for spontaneous production.

In addition to syntactic embedding and grammatical weight, the information status of RCs and head nouns has also been mentioned as influencing the distribution of SUBJ and DOBJ RCs. In English, SUBJ RCs tend to provide given information, while DOBJ RCs tend to carry new information (Fox & Thompson, 1990). However, similar to Pu (2007), the current results did not find that the information status of RCs had an impact on the matrix-clause position that they tend to occur in in Mandarin. I suggest that the difference may be due to head direction. For example, when English RCs are in the matrix direct-object position (e.g., *There's a woman in my class [who's a nurse]* (Fox & Thompson, 1990)), the head noun that occurs before the RC may have already been grounded by a given referent in the matrix clause or prior discourse. Therefore, English DOBJ RCs tend to add new information. However, Mandarin RCs are head-final. In addition to adding new information, Mandarin DOBJ RCs that occur just before head nouns are also likely to provide given information to ground the head nouns. In other words, the information status of Mandarin RCs is not associated with the matrix positions that they are located in.

Lastly, when comparing L1 with L2 Mandarin speakers, it has been observed that fewer factors influenced L2 Mandarin speakers' choices of subject and objects RCs, and of SUBJ and DOBJ RCs in general. I suggest that L2 Mandarin speakers may not be able to use as many writing skills as L1 Mandarin speakers as their skills are inevitably more limited. Therefore, they only relied on certain factors (e.g., information status of RCs and head nouns, length of matrix subject NPs) to determine their choices of RCs. On the other hand, it could also be due to the limitations of the L2 data. Compared to the four genres covered by the L1 data, the writing topics in the HSK test are relatively limited. Due to the same reason, the results did not show any significant effects of the L2 Mandarin speakers' L1 or level of Mandarin proficiency on their distribution of RCs. Although L2 Mandarin speakers in the HSK Dynamic Composition Corpus were in different certificate bands (A, B, and C), they were all advanced L2 Mandarin speakers.

5.9 Conclusion

Using conditional inference trees and random forests, this study examined whether and how genre, information status, syntactic embedding and grammatical weight influenced the use of Mandarin RCs in the writing of L1 and L2 Mandarin speakers. The findings demonstrated that there was no overwhelming subject or object RC advantage in Mandarin. Both L1 and L2 Mandarin speakers used subject and object RCs that were associated with the different discourse functions based on the contexts they were in. Specifically, subject RCs that carried new information were frequently used to describe people, while object RCs that encoded given information tended to define things. At the same time, object RCs by which given information occurred at the beginning of the sentence were used to express meaning straightforwardly, while subject RCs were likely to be used rhetorically to create suspense. Furthermore, the results showed a clear tendency for both L1 and L2 Mandarin speakers to

place RCs at the beginning of sentences, which could be attributed to processing efficiency. Compared to L1 Mandarin speakers, the strategies L2 Mandarin speakers used to determine their choices of subject and object RCs, and of SUBJ and DOBJ RCs were less complex.

Chapter 6: Conclusion

The goal of this thesis has been to gain an in-depth understanding of the processing of relative clauses (RCs) in Mandarin across different language groups (monolinguals and bilinguals), age groups (children and adults), modalities (written vs. spoken) and methods (corpus analyses vs. experimental methods). It has been observed in the literature that the word order similarity between Mandarin simple SVO transitives and Mandarin object RCs has a significant impact on Mandarin-speaking monolingual children's Mandarin RC acquisition and comprehension (e.g., Chen & Shirai, 2015; Kidd et al., 2019). Yet, it has been unclear whether and how the word order similarity across languages (i.e., English simple SVO transitives and Mandarin object RCs) and language-specific factors like the omission of head nouns influence (bilingual) children's Mandarin RC processing. Furthermore, despite compelling evidence that the distributional frequency of RCs matters (e.g., Diessel & Tomasello, 2000, 2005; Chen & Shirai, 2015), little has been known about how factors like discourse context, information structure, syntactic embedding and grammatical weight influence the distribution of Mandarin RCs. The three studies (Chapters 3-5) in the thesis were designed to address these gaps in the literature. This chapter will first summarise the major findings of the three studies. Then, a general discussion of the major contributions of this research will be presented, followed by directions for future research.

6.1 Summary of the Major Findings

6.1.1 Monolingual and Bilingual Children's Acquisition of Mandarin RCs

The first study (Chapter 3) investigated the use of Mandarin RCs in the spontaneous speech of Mandarin-speaking monolingual and heritage Mandarin-English bilingual children between the ages of 1 and 5 years. The results indicated that both the monolingual and bilingual children had an overwhelming preference for object RCs over subject RCs, and the

object RC preference was not influenced by the absence of a head noun. This could be because object RCs share the same canonical SVO word order with simple transitives (in Mandarin and English) and occur more often than subject RCs in the input. When looking at the matrix-clause positions in which RCs occurred, there was no clear evidence to suggest that the monolingual or bilingual children preferred placing RCs in a non-centre-embedded position over a centre-embedded position. This indicates that syntactic embedding did not influence children's Mandarin RC acquisition alone, and that other factors like the length of the RC and the omission of the head noun may also play a role.

In comparison with the monolingual children, the heritage Mandarin-English bilingual children produced a higher proportion of object RCs, suggesting that the acquisition of Mandarin RCs is not only influenced by simple SVO transitives in Mandarin, but also simple SVO transitives in English. However, although head nouns are not allowed to be omitted in English, the bilingual children did not produce fewer headless subject or object RCs than the monolinguals. This might be because children treat those headless RCs as unanalysed chunks (or words) in their early acquisition of Mandarin RCs. Furthermore, bilingual children have been found to use more RCs to modify the predicate nominal of a copular clause than monolinguals. This could be because this type of RCs is centre-embedded in Mandarin but non-centre-embedded in English, and is the most frequent type in English-speaking children's early speech (Diessel & Tomasello, 2000).

Overall, the results can be explained by the usage-based account, that is, that children acquire RCs through their language experience. Specifically, they do not acquire all types of RCs at the same time. Instead, they acquire RCs that resemble the earlier acquired constructions and that occur frequently in the input earlier and produce them more often than those that are less frequent and less similar to other constructions. Moreover, rather than

relying on a certain set of universal mechanisms, children's acquisition of RCs is affected by properties involved in the specific language and child/child-directed speech.

6.1.2 Monolingual and Bilingual Children's Comprehension of Mandarin RCs

The second study (Chapter 4) investigated the comprehension of Mandarin subject and object RCs in heritage Mandarin-English bilingual (4;00-10;11) and vocabulary-matched Mandarin-speaking monolingual children (4;00-5;09). The results showed that both the bilingual and monolingual children found object RCs more difficult to comprehend than subject RCs. The error analysis suggested that the comprehension difficulty of Mandarin object RCs was related to the word order similarity between Mandarin object RCs and Mandarin simple SVO transitives. Moreover, the absence of a head noun did not influence either the bilinguals or monolinguals' RC comprehension, suggesting that both groups of children were able to recover the omitted head nouns from the context provided.

In comparison with the monolingual children, the heritage Mandarin-English bilingual children showed a similar accuracy in their comprehension of Mandarin object RCs. That is to say, there was no direct evidence to suggest that the structural overlap between Mandarin object RCs and English simple SVO transitives and subject RCs alone could cause cross-linguistic influence on Mandarin object RCs. On the other hand, the results clearly indicated that the interaction between structural overlap and language dominance, and between structural overlap and age caused cross-linguistic influence. That is, bilingual children's comprehension accuracy of Mandarin object RCs decreased with English dominance but increased with age.

Overall, the results provide support for the usage-based account, indicating that children rely on the canonical simple transitives they have already acquired to guide their comprehension of RCs. However, this reliance causes more errors in children's

comprehension of RCs, while it leads to a higher frequency of production of RCs (see Chapter 3), which could be partially attributed to fact that comprehension studies including this one do not use the RCs that children encounter in everyday speech to test children. Moreover, in addition to RC structures themselves, children's comprehension of RCs is affected by their age and experience with the language(s) (e.g., the quantity and quality of the input).

6.1.3 The Use of Mandarin RCs in Adults' Writing

The third study (Chapter 5) investigated the use of Mandarin RCs in the writing of Mandarin adult native speakers (L1) and advanced second language learners (L2) by taking several semantic, pragmatic and discourse factors into account. In general, there was no overwhelming subject or object RC advantage in either the L1 or advanced L2 speakers' writing. The results indicated that subject and object RCs were associated with different discourse functions, and the discourse contexts determined adults' choices of RCs. Specifically, adult Mandarin L1 and advanced L2 speakers frequently used subject RCs that encoded new information to describe people, while they used object RCs that carried given information to define objects or things. Object RCs were also used to express more accessible content as they tended to place given information at the beginning of the sentence, while subject RCs tended to be used to create suspense in the stories.

In terms of the matrix-clause positions in which RCs tended to occur, both the L1 and advanced L2 Mandarin speakers preferred matrix subject position over matrix direct-object position. Moreover, the longer the matrix subject NP, the higher the possibility the RC would occur in the matrix subject position. As RCs in the matrix subject position are non-centre-embedded, while RCs in the matrix direct-object position are, the results support the "non-centre-embedded over centre-embedded" assumption.

Compared to L1 Mandarin speakers, fewer factors have been found to influence advanced L2 Mandarin speakers' choices of subject and object RCs in the subject and direct-object positions. It could be because although the L2 Mandarin speakers were at an advanced level, their skills were inevitably more limited, which may not have enabled them to use as many writing skills as the L1 Mandarin speakers.

Overall, the findings can also be explained by the usage-based account, indicating that adults' preference for one construction over another does not purely depend on its syntactic complexity, but more on the discourse contexts, in which certain meaning and discourse function are required.

6.2 Summary of the Major Contributions

6.2.1 Is There a Universal Subject RC Preference?

The three studies of the thesis (Chapters 3-5) demonstrated mixed findings regarding Mandarin RC processing, which poses an important challenge to the Noun Phrase Accessibility Hierarchy (Keenan & Comrie, 1977) and structure-based accounts (e.g., Friedmann et al. 2009; O'Grady, 1997; Rizzi, 1990, 2004) that propose a universal subject RC preference. Instead, canonicity effects (e.g., Bever, 1970; MacDonald & Christiansen, 2002) have been found to play a crucial role in monolingual and bilingual children's RC processing, although they had different effects on production and comprehension (Chapters 3 and 4). Specifically, the canonical SVO word order facilitated children's production of Mandarin object RCs, but misled children to interpret RC-internal subjects as head nouns for Mandarin object RCs in comprehension. The results are consistent with a hypothesis in Chan et al. (2021), which states that the surface identity between Cantonese object RCs and SVO transitives could lead to facilitation in formulating object RCs in production but errors in interpreting object RCs in comprehension.

However, canonicity effects seem insufficient to explain the results in adults' Mandarin RC production (Chapter 5). Adults did not show an overwhelming preference for either subject or object RCs in general. This suggests that unlike children, adults who have already mastered RC structures may not rely on the simple SVO transitives that they have previously acquired to process RCs (Lau, 2016). Instead, the discourse context has been found to guide their selection of RCs that are associated with different discourse functions. This usage-based result contributes significantly to the current theories of RC processing, suggesting that other than RC structures themselves, semantic, pragmatic and discourse factors have a significant effect on the subject-object asymmetry in Mandarin.

6.2.2 Does the Absence of a Head Noun Influence the Subject-object Asymmetry?

In addition to studying Mandarin RCs with overt head nouns, this research is novel in also taking Mandarin RCs with omitted head nouns into account. In spontaneous speech (Chapter 3), the results showed that monolingual and bilingual children as young as two were already producing Mandarin RCs with omitted head nouns, and the omission of head nouns did not interact with the RC type. In other words, the presence or absence of a head noun does not seem to influence the subject-object asymmetry in Mandarin RC production.

Similarly, the absence of a head noun does not appear to influence the comprehension of Mandarin RCs (Chapter 4). Both monolingual and bilingual children comprehended Mandarin RCs with omitted head nouns as accurately as those with overt head nouns. As the omission of head nouns in Mandarin greatly depends on the discourse context, the results constitute an important contribution to the literature, showing that bilinguals and monolinguals as young as four years are able to recover omitted head nouns from previous mentions. These results are consistent with those reported in previous studies (e.g., Huang, 2011; Yuan, 2017), in which both Mandarin-speaking monolinguals and Mandarin-English

bilinguals between the ages of 2 and 3 years were able to use overt and omitted subject and object arguments pragmatically appropriately in their spontaneous speech.

6.2.3 Is There a Universal "Non-centre-embedded over Centre-embedded" Preference?

Based on the linear distance-based accounts (e.g., Gibson, 2000; Prideaux & Baker, 1986), centre-embedded RCs are expected to be harder to process than non-centre-embedded ones, as they place a greater burden on working memory. Supporting this hypothesis, in their writing adult Mandarin L1 and advanced L2 speakers (Chapter 5) tended to avoid centre-embedding through their placing RCs at the matrix subject position rather than the matrix direct-object position. Moreover, this "non-centre-embedded over centre-embedded" preference was compatible with the pattern of grammatical weight. That is, RCs were more likely to occur in the matrix subject position when the matrix subject NPs were longer. These results are similar to those reported in other head-final languages such as Japanese and Korean, in which longer constituents also tend to be placed earlier to avoid centre-embedding (e.g., Choi 2007; Hawkins 1994, 2004; Yamashita & Chang 2001).

However, unlike in adults' writing, there was no clear "non-centre-embedded over centre-embedded" preference in children's spontaneous speech (Chapter 3). Again, the length of RCs may play a role. RCs may be shorter (and less complex) in child/child-directed speech than in adults' writing. When RCs are shorter, whether they are centre-embedded or not may not make a big difference. Moreover, short RCs, especially short headless RCs are pervasive in Mandarin oral communication. In children's early acquisition, they may treat high-frequency short headless RCs like *chi de* "that can be eaten" as an unanalysed chunk (or word) meaning "food". In this case, syntactic embedding does not seem to play any role in children's early acquisition of Mandarin RCs. This study is novel in addressing the possibility that syntactic embedding is unlikely to be the sole determinant of children's

Mandarin RC acquisition, and that the grammatical weight and input frequency of RCs should also be considered.

6.2.4 Cross-linguistic Influence

The structural overlap between English simple SVO sentences and Mandarin object RCs has been found to trigger cross-linguistic influence in heritage Mandarin-English bilingual children's RC processing. In bilingual children's RC acquisition (Chapter 3), this structural overlap made them produce more Mandarin object RCs than their age-matched monolingual peers in spontaneous speech. However, this structural overlap seemed to cause more difficulty in bilingual children's comprehension of Mandarin object RCs (Chapter 4). The more dominant bilinguals were in English, the less accurately they comprehended Mandarin object RCs. The results are novel in emphasising that the structural overlap across languages can lead to different effects in production and comprehension.

6.3 Limitations and Suggestions for Future Research

6.3.1 An In-depth Analysis of the Nature of RCs

The first study of the thesis (Chapter 3) investigated the distribution of Mandarin RCs in both monolingual and bilingual children's spontaneous speech, and took the omission of head nouns into account. However, it did not take into account the discourse context that Mandarin RCs tend to appear in. In Mandarin, only head nouns that are known to both speakers and hearers can be omitted (Lin & Bever, 2010; Huang & Phillips, 2021). So far, it is unclear whether both monolingual and bilingual children omit head nouns based on their discourse-pragmatic status, or whether they just omit head nouns randomly. Moreover, while the first study claimed that the headless RCs in both monolingual and bilingual children's spontaneous speech are the very common ones in Mandarin oral communication, it did not

provide corpus evidence to support this assumption. Further studies could consider measuring the frequency of headless RCs in Mandarin child/child-directed speech and analysing the discourse context that headless RCs tended to appear in.

Second, in children's spontaneous speech, bilingual children have been found to use more Mandarin RCs attached to a copular clause, but fewer Mandarin RCs attached to an isolated NP, than monolinguals (see examples (1) and (2) below). I suggested that this difference can be attributed to cross-linguistic influence from English to Mandarin. To strengthen this claim, further study could investigate whether there is supportive evidence that these bilinguals are also manifesting this phenomenon (i.e., producing more PN RCs than NP RCs) in their English spontaneous speech. Moreover, further studies could analyse the communicative functions that are associated with each type of RC. In English, RCs that are attached to a copular clause are often used to focus the hearer's attention on a new referent, while RCs that are attached to an isolated NP are commonly used to answer a previous question (Diessel, 2009; Diessel & Tomasello, 2000). It is unknown whether RCs in Mandarin also relate to the same communicative functions as in English, and whether that is causing the difference between bilinguals and monolinguals.

[Mandarin RC that is attached to the predicate nominal of a copular clause]

(1) 这 是 [抱 小猪] 的 小马。

zhe shi [bao xiaozhu] de xiaoma

this is hug pig DE horse

"This is the horse that hugged the pig."

[Mandarin RC that is attached to an isolated NP]

(2) [_ 抱 小猪] 的 小马

bao xiaozhu de xiaoma

hug pig DE horse

"the horse that hugged the pig"

On the other hand, the differences between RCs produced by different age groups (child vs. adult) in various modalities (written vs. spoken) should also be noticed. For example, in contrast to the object RC preference found in both child and child-directed speech, a subject RC advantage has been found in written news (e.g., Hsiao, 2003; Wu, 2009; Hsiao & Macdonald, 2013). By taking modalities, the information status of RCs and head nouns, and grammatical weight into account, the third study of the thesis (Chapter 5) indeed observed that those factors played an important role in influencing adult Mandarin L1 and advanced L2's choices of RCs. Further studies could consider comparing RCs in child/child-directed speech with those in adult-directed speech, and comparing RCs in older children's writing with those in adults' writing. For instance, RCs may be shorter and less complex in child/child-directed speech than in adult-directed speech, leading to no clear "non-centre-embedded over centre-embedded" preference in child/child-directed speech.

6.3.2 Testing Children Using RCs They Hear and Speak

The subject-object asymmetries shown in both monolingual and bilingual children's spontaneous speech and comprehension are different. I and others have been suggested (see Section 4.2) that this could be because the object RCs used in comprehension experiments are not consistent with the RCs encountered in children's everyday life. Recall that the latter often contain inanimate head nouns and animate RC-internal subjects (e.g., Yang, 2019), while the former usually have both animate head nouns and RC-internal subjects (Hu et al. 2016; Hu & Guasti, 2017; Tsoi et al., 2019; Yang, 2019). Several sentence processing studies

on English and German have pointed out that when the object RCs used in the task match the object RCs that children and adults hear and produce in everyday life, the processing of object RCs can be facilitated (e.g., Kidd et al., 2007; Macdonald et al., 2020). Further studies in Mandarin could also look at whether animacy manipulation is responsible for the different subject-object asymmetries in comprehension experiments and corpus-based studies.

Moreover, as mentioned in the previous section (Section 6.3.1), discourse context, grammatical weight, and the information status of RCs and head nouns could all influence the distribution of RCs. Comprehension experiments could also test whether those factors influence children's RC comprehension. For example, the second study (Chapter 4) found that bilingual children were as accurate as monolingual children in their comprehending of headless RCs, suggesting that both groups of children were able to recover the head nouns from previous mentions. However, in order to understand whether bilingual children really are as sensitive as monolingual children to discourse-pragmatic cues, further studies need to be conducted to test whether the absence of context or different types of contexts (e.g., where only visual context is provided) would lead to the same results.

6.3.3 Testing Children Using Different Experimental Designs

The second study of the thesis (Chapter 4) found that like Mandarin-speaking monolingual children, heritage Mandarin-English bilingual children tended to make Head Errors by misinterpreting RC-internal subjects as head nouns for Mandarin object RCs, and this type of error decreased with increasing age. While in Hu et al. (2020), Mandarin-Italian bilingual children also showed similar results, they made more Reversal Errors by misinterpreting head nouns as RC-internal subjects (i.e., reversing the thematic roles) with increasing age. Importantly, this was neither observed in the second study of the thesis nor in Tsoi et al. (2019). Rather than attributing the higher proportion of Reversal Errors to longer exposure to

Italian, as suggested by Hu et al. (2020), different stimuli used could partially explain their result. While the correct answer in the task for the second study of the thesis and Tsoi et al. (2019) was randomized, for Hu et al (2020), the correct option was always on the edges of each picture. Therefore, the higher frequency of Reversal Errors as opposed to Head Errors made by older Italian-English bilingual children in Hu et al (2020) may be because of the influence of testing materials. Further studies could test whether testing stimuli play a role in influencing the comprehension result.

6.3.4 A More Fine-grained Assessment of Bilinguals

Following Tsoi et al. (2019), the second study of the thesis (Chapter 4) used vocabulary scores to match heritage Mandarin-English bilingual children and Mandarin-speaking monolingual children. There are several potential problems with this approach. First, heritage bilingual and monolingual children share different cultural backgrounds, and heritage bilingual acquisition mostly takes place in the home setting. It seems unfair to use the same vocabulary assessment materials to test both monolingual and bilinguals' vocabulary ability. For example, in the Mandarin-translated version of the British Picture Vocabulary Scale III (Dunn et al., 2009), pictures referring to *shuiluobo* "radish" and *yangji* "artichoke" are easier for UK-based heritage bilingual children to recognize, while very hard for young Mandarin-speaking children, as they are not common vegetables in China. As suggested by Tsoi et al. (2019), further studies could consider using a grammar test to match monolinguals and bilinguals (Tsoi et al., 2019).

Second, unlike typical second language learners, heritage bilingual children can vary a lot in their heritage language proficiency due to factors such as input quantity and quality (e.g., De Houwer, 2007; Jia & Fuse, 2007; Sun et al., 2020). For example, first-born bilinguals and later-born siblings might be different in their heritage language proficiency

(e.g., Rojas et al., 2016; Shin, 2002). Bilingual children who are only encouraged to speak their heritage language at home and bilingual children who often switch languages at home are also different (e.g., Schwartz, 2010). When recruiting heritage bilingual participants, further studies could consider using a more fine-grained assessment to categorize or filter them (De Bruin, 2019).

In addition to heritage Mandarin-English bilingual children, this thesis (Chapter 5) also looked at adult Mandarin L2 learners. When comparing L1 with L2 Mandarin speakers, it was observed that fewer factors influenced L2 Mandarin speakers' choices of RCs. It could be because L2 Mandarin speakers may not be able to use as many writing skills as L1 Mandarin speakers due to their limited Mandarin writing skills. On the other hand, limitation of the L2 data could also play a role. Specifically, compared to the four very different genres covered by the L1 data, the writing topics covered by the L2 data (in the HSK test) are relatively limited. Furthermore, there was no significant effect of L2 Mandarin speakers' L1 or Mandarin proficiency on their distribution of RCs. This could be because the L2 Mandarin speakers were all at an advanced level. Further studies should consider looking at RCs produced by lower-level L2 Mandarin speakers.

6.4 Conclusion

This thesis contributes to the understanding of the production and comprehension of RCs in Mandarin. With its typologically unusual head-final RC structures, Mandarin presents a unique picture of RC processing. For children's Mandarin RC production and comprehension, the thesis emphasizes that children acquire RC structures on the basis of related structures that they have previously acquired. In addition to the related structures within Mandarin, the related structures across languages also influence children's Mandarin RC processing. The results support usage-based accounts (e.g., Diessel & Tomasello, 2000,

2005). Moreover, this study adds to the growing literature that language-specific properties such as the omission of head nouns and the properties involved in child/child-directed speech, such as the length of RCs, also need to be taken into account in children's RC processing. Regarding adults' Mandarin RC processing, neither the canonicity effects nor other theoretical accounts that only focus on RC syntactic structures are able to provide a satisfactory explanation. Instead, this thesis has demonstrated how semantic, pragmatic and discourse factors contribute to adults' Mandarin RC processing, which outlines a clear direction for future research.

Appendix A (Chapter 3)

Table A.1: The raw number of subject and object RCs in monolingual and bilingual children's speech across different age ranges

Age range	Language group	Subject RCs	Object RCs
0;07-1;11	Monolingual children	8 (21.62%)	29 (78.38%)
	Bilingual children	0	0
2;00-3;06	Monolingual children	34 (45.33%)	41 (54.67%)
	Bilingual children	6 (16.22%)	31 (83.78%)
3;07-5;00/4;11	Monolingual children	11 (28.95%)	27 (71.05%)
	Bilingual children	4 (19.05%)	17 (80.95%)

Table A.2: The raw number of headed and headless subject and object RCs in monolingual and bilingual children's speech and in their input

Language group	Headed		Headless	
	Subject RCs	Object RCs	Subject RCs	Object RCs
Monolingual children	36 (36.73%)	62 (63.27%)	17 (32.69%)	35 (67.31%)
Monolingual input	90 (26.24%)	253 (73.76%)	37 (17.05%)	180 (82.95%)
Bilingual children	9 (25.71%)	26 (74.29%)	1 (4.35%)	22 (95.65%)
Bilingual input	48 (21.62%)	174 (78.38%)	27 (15.70%)	145 (84.30%)

Table A.3: The raw number of five types of RCs in monolingual and bilingual children's speech across different age ranges

Age range	Language group	NP	PN	SUBJ	DOBJ	OBL
0;07-1;11	Monolingual children	25 (64.10%)	5 (12.82%)	4 (10.26%)	5 (12.82%)	0
	Bilingual children	0	0	0	0	0
2;00-3;06	Monolingual children	32 (28.57%)	9 (8.04%)	17 (15.17%)	47 (41.96%)	7 (6.25%)
	Bilingual children	7 (11.29%)	17 (27.42%)	12 (19.35%)	15 (24.19%)	11 (17.74%)
3;07-5;00/4;11	Monolingual children	18 (38.30%)	4 (8.51%)	9 (19.14%)	15 (31.91%)	1 (2.13%)
	Bilingual children	3 (9.09%)	10 (30.30%)	7 (21.21%)	11 (33.33%)	2 (6.06%)

Appendix B (Chapter 4)

Test Sentences for the Character-sentence Matching Task:

1. 抱　小猪　　的 小马　　在　哪里？

bao xiaozhu de xiaoma zai zaili

hug pig DE horse is where

"Where is the horse that is hugging the pig?"

2. 现在　推　狮子 的　ø　在　哪里？

xianzai tui shizi de ø zai zaili

now push lion DE is where

"Where is (the bear) that is pushing the lion now?"

3. 猴子　喂　的　小狗　　在　哪里？

houzi wei de xiaogou zai zaili

monkey feed DE dog is where

"Where is the dog that the monkey is feeding?"

4. 现在　公鸡　亲　的 ø　在　哪里？

xianzai gongji qin de ø zai zaili

now chicken kiss DE is where

"Where is (the mouse) that the chicken is kissing now?"

5. 亲　老虎　的　小象　　在　哪里？

qin laohu de xiaoxiang zai zaili

kiss tiger DE elephant is where

"Where is the elephant that is kissing the tiger?"

6. 老鼠 推 的 鸭子 在 哪里？

laoshu tui de yazi zai zaili

mouse push DE duck is where

"Where is the duck that the mouse is pushing?"

7. 现在 兔子 喂 的 ø 在 哪里？

xianzai tuzi wei de ø zai zaili

now rabbit feed DE is where

"Where is (the chicken) that the rabbit is feeding now?"

8. 现在 抱 奶牛 的 ø 在 哪里？

xianzai bao nainiu de ø zai zaili

now hug cow DE is where

"Where is (the giraffe) that is hugging the cow now?"

9. 喂 小熊 的 小象 在 哪里？

wei xiaoxiong de xiaoxiang zai zaili

feed bear DE elephant is where

"Where is the elephant that is feeding the bear?"

10. 小猫 抱 的 小羊 在 哪里？

xiaomao bao de xiaoyang zai zaili

cat hug DE sheep is where

"Where is the sheep that the cat is hugging?"

11. 现在 亲 猴子 的 ø 在 哪里？

xianzai qin houzi de ø zai zaili

now kiss monkey DE is where

"Where is (the cow) that is kissing the monkey now?"

12. 现在 老虎 推 的 ø 在 哪里？

xianzai laohu tui de ø zai zaili

now tiger push DE is where

"Where is (the horse) that the tiger is pushing now?"

13. 推 兔子 的 小羊 在 哪里？

tui tuzi de xiaoyang zai zaili

push rabbit DE sheep is where

"Where is the sheep that is pushing the rabbit?"

14. 小猪 亲 的 小狗 在 哪里？

xiaozhu qin de xiaogou zai zaili

pig kiss DE dog is where

"Where is the dog that the pig is kissing?"

15. 现在 狮子 抱 的 ø 在 哪里？

xianzai shizi bao de ø zai zaili

now lion hug DE is where

"Where is (the giraffe) that the lion is hugging now?"

16. 现在 喂 小猫 的 ø 在 哪里？

xianzai wei xiaomao de ø zai zaili

now feed cat DE is where

"Where is (the duck) that is feeding the cat now?"

Table B.1: The proportion of Head, Reverse and Other Errors made by monolingual and bilingual children for Mandarin subject and object RCs

Age and language groups	Subject RCs			Object RCs		
	Head	Reverse	Other	Head	Reverse	Other
Younger bilinguals	8 (26.67%)	7 (23.33%)	15 (50%)	87 (87.88%)	9 (9.09%)	3 (3.03%)
Older bilinguals	22 (66.67%)	3 (9.09%)	8 (24.24%)	83 (90.22%)	9 (9.78%)	0
Younger monolinguals	23 (36.51%)	9 (14.29%)	31 (49.21%)	104 (92.04%)	4 (3.54%)	5 (4.42%)
Older monolinguals	23 (41.07%)	7 (12.5%)	26 (46.43%)	78 (86.67%)	8 (8.89%)	4 (4.44%)

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