博士論文

Scope Rigidity and Word Order Flexibility
（スコープの固定性と語順の自由性）

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Acknowledgments

This dissertation was in gestation for a long time. I started graduate studies at the University of Tokyo in 2005, and wrote my master's thesis on the function of dummy verbs in Chinese resultative constructions in 2007. My research interests shifted to theoretical linguistics soon after I entered the Ph.D. program at the same university, where I learned the foundations and basics of generative grammar. Meanwhile, I studied language acquisition and its methodology at the Chinese University of Hong Kong from 2009 to 2012. Some of the ideas presented in this dissertation were originally developed back in the days when I was at the Chinese University of Hong Kong, and these ideas have been repeatedly reshaped and reformulated during the second half of my graduate school days at the University of Tokyo. I owe a lot of thanks to many people for supporting me during the decade in which this dissertation gradually took shape.

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Chapter 1 Introduction

1.1 Introduction

One of the shared ideas in linguistic theory is that linguistic grammar meets the principle of economy, which is also referred to as "the principle of least effort". This principle requires a pursuit of the simplest theory where operations can be implemented with the least effort, while at the same time achieving the maximum result. In the GB era, the dominant view was that movement per se is not constrained; thus, it was assumed that movement "comes for free" by virtue of the one and only one movement rule **Move α**, which essentially means "Move any constituent anywhere." By contrast, the Minimalist Program has brought to the fore the idea that linguistic theory obeys the principle of economy, and one implementation of this idea is manifested in the view that application of movement operations is restricted to feature checking. In actual language data, however, we can find some instances of movement such as scrambling and topicalization which are arguably not motivated by feature checking. The driving forces behind these movements are not quite evident, yet we can empirically observe such movements since they change the phonological form of a sentence. In contrast, in the case of covert movement at LF, the phonological form is not changed, and empirical support for covert movement is available if a sentence has an interpretation which does not match the overt structure. In this dissertation, following Fox (2000) and Reinhart (2006), we would like to eliminate LF movement to the full extent possible, and demonstrate that minimizing covert movement provides desirable solutions to the issues on covert movements shown in 1.2.

1.2 Three Problems

1.2.1 Overview

In the field of theoretical linguistics, there has been and still is considerable discussion about scope interaction. Recently, scope-related issues have also drawn considerable attention from psycholinguists and acquisitionists, and several attempts have been made to test the validity of the proposed theoretical accounts. In this section,

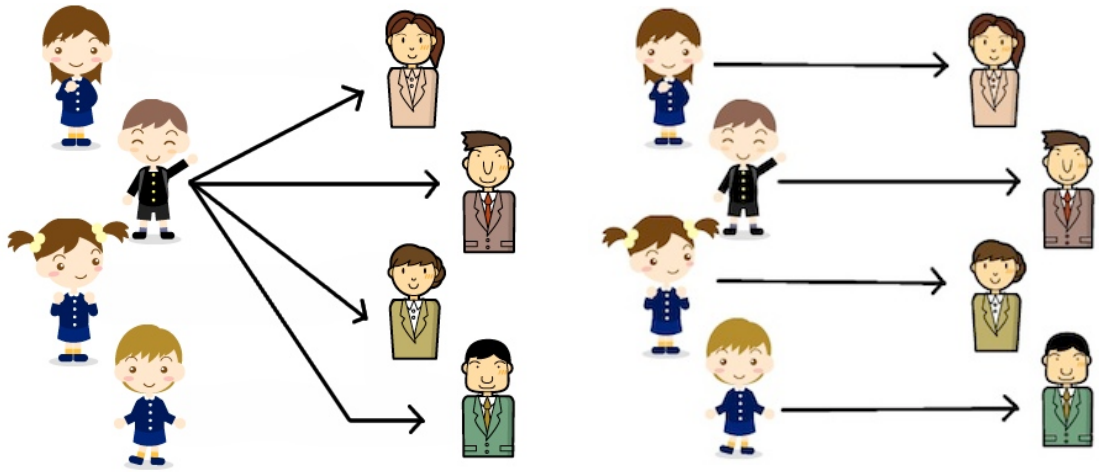
we will take a brief look at the problems facing previous theoretical analyses and acquisition studies, and outline the issues that will be addressed in this dissertation.

1.2.2 Correlation between Freedom of Word Order and Scope Rigidity

Since May (1977), it has been widely accepted that the ambiguity of a sentence with multiple quantifier phrases (QPs) is generated by the QPs' movement at LF. As is well known, the sentence in (1) is ambiguous between a reading in which *a student* takes wide scope over *every teacher* and a reading in which *every teacher* takes wide scope over *a student*. These two readings are judged true under the context of (2a) and of (2b), respectively.

(1) A student admires every teacher. ∃> ∀, ∀> ∃

(2) a. a student > every teacher b. every teacher > a student



The sentence under the reading of *a student* > *every teacher* is true if there is a student who admires all teachers, while the truth condition of the *every teacher* > *a student* interpretation is that, for every teacher, there is a student who admires him/her. May captures this ambiguity by postulating an operation called **Quantifier Raising (QR)**. According to his theory, all quantifiers adjoin to IP at LF. Since the order of adjunctions is not fixed, there are two possible LF representations generated for sentence (1). In one representation, *a student* is adjoined higher than *every professor*, whereas in the other, the relative height of the two quantifiers is reversed.

(3) a. [$_{IP}$ a student$_i$ [$_{IP}$ every teacher$_j$ [$_{IP}$ t_i admires t_j]]] ∃> ∀

b. [$_{IP}$ every teacher$_j$ [$_{IP}$ a student$_i$ [$_{IP}$ t_i admires t_j]]] ∀> ∃

The crucial assumption here is that the scope of a QP is defined in terms of the set of nodes that it c-commands at LF (cf. May 1977: 25, 1985: 5). Given the definition, the scope of *every teacher* in (1a) is contained within the scope of *a student* because the former c-commands a proper subset of the nodes that the latter does. In contrast, the representation in (1b) yields the *every teacher* > *a student* reading since *every teacher* c-commands a superset of the nodes that *a student* does. In this paper, we will refer to the former scope relation, where the c-command relation between two QPs at surface structure is isomorphic to that in LF, as **surface scope**, while the latter scope relation, where the c-command relation between two QPs in overt syntax is reversed in LF, will be referred to as **inverse scope**.

In addition to QR, there is another mechanism which yields scope ambiguity. Consider the following examples.

(4) Someone seems to love my daughter. ∃> *seem*, *seem* > ∃

In this sentence, the quantifier *someone* can be understood as taking either wide or narrow scope with respect to *seem*. Thus, under the surface scope construal, the sentence is interpreted as asserting that there is a specific person who seems to love my daughter, and under the inverse scope construal, it is interpreted as asserting that it seems that there is someone who loves my daughter. The ambiguity here is not generated by the same mechanism that is responsible for the ambiguity in (1). The mainstream syntactic theories analyze the raising construction as follows.

(5) Someone$_i$ seems t_i to love my daughter.

The surface subject in the raising construction is not base-generated at the position where it is pronounced, but has undergone movement from the embedded subject

position at overt syntax. An inverse-scope interpretation in this case is generated by the quantifier *someone* moving back to the original position at LF. This process is called **reconstruction**.

QR and reconstruction nicely account for the ambiguity of sentences with multiple QPs. However, not all languages show the same ambiguity as English. Languages such as Japanese, Korean and German generally do not allow inverse scope[1].

(6) a. *Japanese*

dareka-ga	daremo-o	semeta.	∃> ∀, *∀> ∃
someone-NOM	everyone-ACC	criticized	

'Someone criticized everyone.' (Kuno and Takami 2002: 170)

b. *Korean*

Nwukwunka-ka	nwukwuna-lul	chotayhay-ss-ta.	∃> ∀, *∀> ∃
someone-NOM	everyone-ACC	invited	

'Someone invited everyone.' (Kim and Larson 1989: 686)

c. *German*

Mindestens ein	Student	HAT	jeden	Roman	gelesen.	∃> ∀, *∀> ∃
at.least one-NOM	student	has	every-ACC	novel	read	

'At least one student read every novel.' (cf. Krifka 1998)

Interestingly, it has been observed that there is an inverse correlation between word-order rigidity and scope rigidity (Bobaljik and Wurmbrand 2012, Hoji 1985/1990, Karimi 2005, 2008, Kim 1989, Krifka 1998, Pafel 2005, Sohn 1995, Szabolcsi 1997: 111, Wurmbrand 2008). That is to say, sentences with multiple scope-taking elements in free-word-order languages like Japanese, Korean and German are restricted to surface scope, while those in rigid-word-order languages like English and French allow scope ambiguity. Given the reverse correlation, the first question that we will address in this dissertation is what it is that relates scope rigidity to freedom of word order

[1] Throughout this dissertation, the glosses are adapted for the sake of consistency.

1.2.3 Chinese as a Scope-Rigid Language

Although it is widely believed that scope rigidity is correlated with free word order, Mandarin Chinese is a potential counterexample to this generalization. Chinese is not characterized as a free-word-order language, but as exemplified below, scope shift is not allowed.

(7) *Chinese*

you	yi-ge	ren	bao-le	mei-ge	haizi.	∃> ∀, *∀> ∃
有	一-个	人	抱-了	每-个	孩子	
have	one-CL	person	hug-ASP	every-CL	child	

'Someone hugged every child.'

The sentence in (7) is restricted to the surface-scope interpretation. Thus, the sentence is true if there is one and the same person who hugged all children, but it is false in the situation where each child got hugged by a different person. Although Chinese sentences with multiple scope-taking elements do not allow inverse scope in most cases, certain types of sentences exceptionally exhibit scope ambiguity.

(8) a.

Shengdan yeye	song-le	yi-ge	haizi	mei-ge	liwu.
圣诞 爷爷	送了	一-个	孩子	每-个	礼物
Santa Clause	give- ASP	one-CL	child	every-CL	present

'Santa Clause gave a child every present.' ∃> ∀, *∀> ∃

b.

Shengdan yeye	song-le	yi-ge	liwu	gei	mei-ge	haizi.
圣诞 爷爷	送了	一-个	礼物	给	每-个	孩子
Santa Clause	give- ASP	one-CL	present	give	every-CL	child

'Santa Clause gave a present to every child.' ∃> ∀, ∀> ∃

Despite the semantic similarity between (8a) and (8b), only the latter sentence is scopally ambiguous. Under the surface scope, the sentence in (8a) is true in a situation

where there is a child to whom Santa Clause sent all presents, and the sentence in (8b) is true in a situation where there is a present such that Santa Clause sent it to all children. Under the inverse scope, the sentence in (8b) is true if each child received a different present from Santa Clause, but the inverse-scope reading is not available in (8a), where every present from Santa Clause is received by a different child. As we will see in Chapter 3, scope shift is observed in limited types of sentences in Chinese. Given these linguistic facts, the second question that we will address in this dissertation is why sentences with multiple scope-bearing operations in Chinese are restricted to surface scope even though Chinese is not a free-word-order language, and why only some types of sentences allow inverse scope.

1.2.4 Problems with Acquisition and Psycholinguistic Data

As we have seen in section 1.2.2, an inverse-scope reading of sentences like (1) is derived via the object QP's QR over the subject.

(1) A student admires every teacher. ∃> ∀, ∀> ∃

Regarding the issue of how scope rigidity is derived, there are basically two possible lines of approach. The first analytical option is, following May (1977), to take QR as a default computation for all QPs and assume other mechanisms to block the movement for scope-rigid sentences. Another option is to postulate that no QR applies by default, and assume that QPs raise to a higher position for some reason. In principle, both analyses would work if we introduce some mechanisms which block QR or which trigger QR. However, the first solution seems to fare better if we take into account child language data[2].

As we will discuss in 4.2.2, previous studies on first language acquisition report that Japanese children aged five to six, to some extent, accept inverse-scope construals of sentences like (6a) even if the scope shift is not allowed in adult grammar

[2] The idea that QR is considered to be a default computation seems to run counter to the principle of economy, which requires motivation for movement. However, as pointed out in 1.1, it is an empirical fact that optional movements such as scrambling and topicalization are widely attested in natural languages. Moreover, we will discuss in Chapter 2 that the application of QR is banned if it is not required at the level of syntax-semantics interface. See Chapter 2 for details.

(Sano 2004, Goro 2007, Yamakoshi and Sano 2007, Sano 2009). What these results indicate is that, children know QR at an early stage of language development (possibly innately), and in the course of language acquisition, they come to know the way of deriving scope rigidity. If we assume QR as a default computation, it seems natural that young children interpret a scope-rigid sentence ambiguously since they still do not know the way of excluding inverse scope. In contrast, if we pursue the second line of analysis, it is not immediately clear why scope ambiguity is observed in child language. For these reasons, it seems more reasonable to adopt the QR-by-default analysis, and assume that an independent mechanism is at work in scope-rigid sentences.

That said, there is still something mysterious in children's behavior that needs further investigation. In the past experiments employing the truth-value judgment task methodology, children's acceptance of inverse-scope readings has never been above chance, and their individual data show that their acceptance is not consistent; that is, they sometimes accept an inverse-scope reading and sometimes reject it. If children do not know how to block inverse scope, the most natural prediction is that they should consistently accept inverse-scope readings.

Furthermore, based on experimental data, psycholinguistic studies have shown that, even for English-speaking adults, an inverse scope of doubly-quantified sentences is more difficult to obtain than the surface-scope reading even if the context is biased toward the inverse-scope reading or the sentence unambiguously has an inverse-scope interpretation (Anderson 2006).

In light of these results of acquisition and psycholinguistic studies, the third question to address here is why children inconsistently accept inverse-scope readings, and what makes it more difficult to obtain inverse scope than surface scope.

1.2.5 Summary

In section 1.2, we have discussed some issues on scope (un)rigidity from various perspectives, and raised questions that we would like to address in this dissertation. To sum up, the present study aims to solve the following three questions.

(i) What is the underlying mechanism that links scope rigidity and free word order?

(ii) Why do sentences with multiple scope-bearing operators in Chinese usually receive only surface-scope interpretations? And why do only certain types of sentences allow inverse scope?

(iii) Why do children inconsistently accept inverse-scope readings, and why is it more difficult even for adults to obtain inverse-scope readings than surface-scope readings?

This dissertation is organized as follows. In 1.3, we will introduce some important concepts that are of relevance to our discussion. In Chapter 2, we will discuss the issues on LF computation from the view of economy, and answer the first question. Specifically, application of QR calls for comparison among multiple possible derivations to check whether executing the operation is the optimal option. This computation, which is called reference-set computation, blocks application of QR in scope-rigid languages. In Chapter 3, we will analyze Chinese data to answer the second question. We will demonstrate that the scope rigidity in Chinese is also derived by the same mechanism as in other scope-rigid languages like Japanese. Chapter 4 aims to answer the last question. We will reanalyze acquisition data in previous experiments conducted with Japanese children and demonstrate that Japanese-speaking children accept inverse-scope readings by chance. We further report results of our experiments with Chinese children, showing that they can reject inverse-scope readings in an adultlike way. Based on the experimental results, we will examine why Japanese children, but not Chinese children, accept inverse-scope readings in an irregular fashion. Chapter 5 makes a conclusion.

1.3 Two Important Concepts to Remember

1.3.1 Overview

In linguistic research, empirical data are often collected drawing on native speakers' intuition. In this sense, we can say that our intuition is a reliable guideline for linguistic analysis, but on the other hand, it sometimes misleads us to a wrong

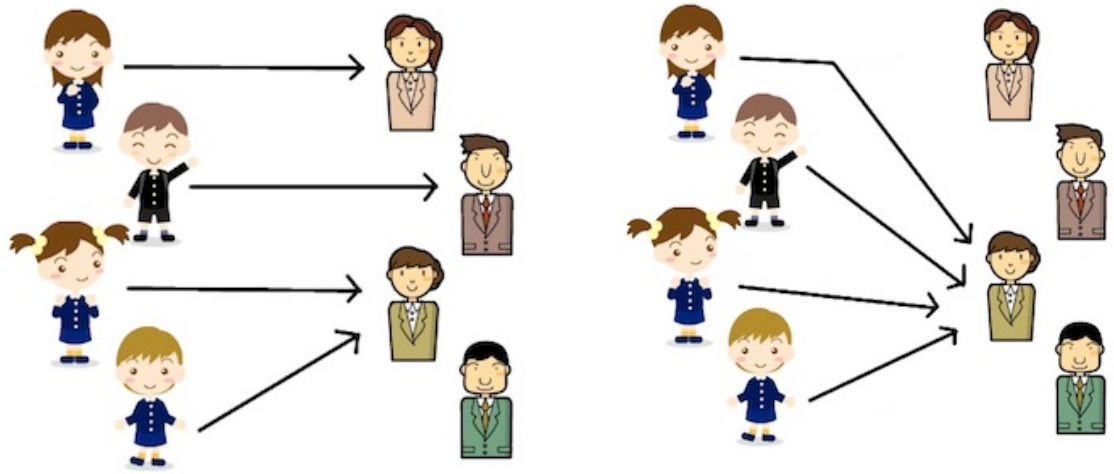
conclusion. This section will introduce two traps that one might fall into when discussing scope-shifting operations based on introspective data.

1.3.2 Entailment Problems

The first thing that we should take into account in regard to the availability of inverse scope is whether there is an entailment relation between surface-scope and inverse-scope readings. Consider the following sentence in (9).

(9) Every student admires a teacher. ∀> ∃, ∃> ∀

(10) a. every student > a teacher b. a teacher > every student

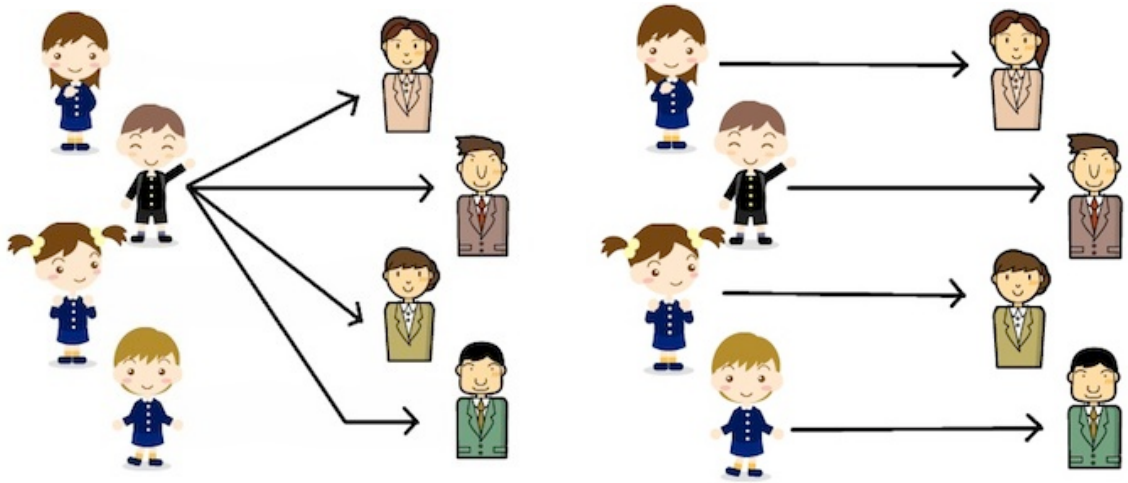


According to native speakers' intuition, the sentence in (9) is ambiguous between two readings: one where for each student there is a teacher s/he admires (as illustrated in (10a)) or one where there is a teacher who is admired by every student (as illustrated in (10b)). While these two readings are intuitively different, whether the sentence is assigned two distinct LF representations is a different question. There is no doubt that the inverse-scope reading of (9) is true in the context of (10b), but the context is compatible not only with the inverse-scope reading but also with the surface-scope reading precisely because in every situation where one specific teacher is admired by every student, it is automatically true that every student admires a teacher (regardless of whether they happen to admire one and the same teacher). Thus, in order to show that the scopal relation between the universal QP in subject position and the existential QP in object position is indeed reversed at LF, one must present a context where the

inverse-scope construal is true but the surface-scope construal is false. But this is impossible in cases like (9) since the inverse-scope construal entails the surface-scope construal. That is to say, whenever the truth condition of the inverse-scope reading is met, that of the surface-scope reading is also met. To see that an inverse scope indeed exists, we must avoid using sentences in which the inverse-scope reading entails the surface-scope reading.

(1) A student admires every teacher. ∃> ∀, ∀> ∃

(2) a. a student > every teacher b. every teacher > a student



The sentence in (1) has two possible LF representations. Under the surface-scope interpretation, the sentence is true if there is (at least) one student who admires every teacher as in (2a), and under the inverse-scope interpretation, it is true if for every teacher, there is a student who admires him/her as in (2b). In the case of sentence (1), the entailment problem does not ensure since we can find a situation like (2b) where the sentence is true under the inverse scope but is false under the surface scope.

As we saw above, when we investigate scope shift phenomena, native speakers' intuition is sometimes not useful, because an apparent inverse-scope reading possibly comes from the surface-scope representation if the inverse-scope construal entails the surface-scope construal. To make sure that an inverse-scope interpretation is generated by covet movement, one must judiciously choose examples that do not face the entailment problem.

1.3.3 Distinction between *Type* and *Token*

The second thing that we need to be aware of is the so-called type-token distinction. In philosophy, a concept of objects is distinguished from concrete objects. The former is called **type** and the latter is called **token**. For example, the *cake* in the following sentence is ambiguous in the sense that it can be interpreted either as a type or as a token.

(11) John and Mary are eating the same cake.

In the type interpretation of *cake*, the sentence is true if John and Mary are eating the same kind of cake but they are eating different pieces of cake. In the token interpretation, on the other hand, the sentence is true only if John and Mary are eating the same piece of cake. Each situation is described below.

(12) a. Type interpretation of *cake* b. Token interpretation of *cake*

What is important here is that the type-token difference may give rise to distinct truth conditions of sentences with multiple QPs. Let us consider the following example.

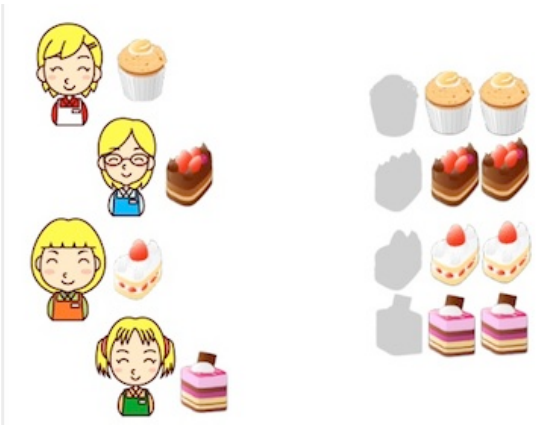
(13) A girl ate every cake. ∃> ∀, ∀> ∃

Not only is the sentence in (13) ambiguous with respect to quantifier scope, but the type-token distinction also contributes to the truth condition of the sentence. Thus, sentence (13) is four-ways ambiguous, as shown below.

(14) *Type reading*

a. Surface scope

b. Inverse scope



(15) *Token reading*

a. Surface scope

b. Inverse scope

Under the type reading, the *cake* refers to 'the kind of cake', and so the surface-scope reading is such that there is a student who ate every kind of cakes regardless of whether other girls ate cake or whether there are uneaten pieces of cake. On the other hand, in the inverse-scope reading, the interpretation is such that for every kind of cake, there is (at least) one girl who ate it. By contrast, the token reading of *cake* yields different truth conditions. As illustrated in (15a), the surface-scope construal is such that there is a girl who ate all pieces of cake, while the inverse-scope construal, as illustrated in (15b), is such that for every piece of cake, there is a girl who ate it. Since the type-token distinction may affect the possible interpretations of quantified expressions, to

circumvent irrelevant issues, we use nouns like *professor* and *child*, which do not have type-token distinctions, wherever possible.

1.4 Summary

In this chapter, we outlined three issues that will be addressed in this dissertation. We then introduced two important concepts that we need to taken into account when dealing with issues on scope interaction, namely the entailment relation and the type-token distinction. With this much background, we will explore the three issues in the chapters that follow.

Chapter 2 Economy, Word Order and Scope Rigidity

2.1. Introduction

As discussed in Section 1.2.2 of Chapter 1, it has been pointed out in previous studies that there is a reversed correlation between word-order rigidity and scope rigidity, and sentences with multiple scope-taking operators in free-word-order languages like Japanese, Korean and German receive only surface-scope readings, while those in rigid-word-order languages like English allow scope ambiguity (Bobaljik and Wurmbrand 2012, Hoji 1985/1990, Karimi 2005, 2008, Kim 1989, Krifka 1998, Pafel 2005, Sohn 1995, Szabolcsi 1997: 111, Wurmbrand 2008). This chapter aims to provide an answer to the first set of questions raised in Chapter 1, that is, the questions of why there exists an inverse correlation between the rigidity of word order and that of scope, and what rationale underlies this relation. Before tackling these issues, we would first like to review May's (1977) analysis of LF movement, with special reference to QR.

According to May, QPs are homogeneously subject to QR, so that, in cases like (1), both QPs raise at LF (as shown in (2)) to obtain the surface-scope interpretation, although the resulting scope relation is identical to the original (pre-movement) scope relation.

(1) A student admires every teacher. ∃> ∀, ∀> ∃

(2) [$_{IP}$ a student$_i$ [$_{IP}$ every teacher$_j$ [$_{IP}$ t_i admires t_j]]] ∃> ∀

This means that in the case of the surface-scope interpretation, the application of covert movement is not informative in that it ends up changing neither the phonological form nor the semantic interpretation. In terms of derivational economy, such phonologically and semantically vacuous movement is to be eschewed. In Section 2.2, we will take a close look at the theoretical problems facing any theory which maintains that every QP undergoes QR unconditionally. Then, in Section 2.3, we will consider Fox's (2000) analysis, who claims that covert movement applies only when it has semantic

contribution. On this view, semantically vacuous movement as in (2) is not allowed. Fox's theory succeeds in minimizing covert movement operations, but further discussion is required to account for some data provided by Reinhart (2006). In 2.4, we will examine Reinhart's theory, according to which reference-set computation is at work in the application of QR. Section 2.5 will compare the proposals by Fox and Reinhart, and show that Reinhart's analysis does not contradict Fox's. Section 2.6 will present our proposal explaining the mechanism that links the rigidity of scope and the flexibility of word order. Section 2.7 will introduce yet another theory, which has recently been proposed by Bobaljik and Wurmbrand (2012), who also address the same issue as this dissertation, and point out the problems of their analysis. We then show that our account does not suffer from the same problems. Section 2.8 summarizes the discussion in this chapter.

2.2. Theoretical Issues on Covert Movement

It is fair to say that May's (1977) seminal work laid the foundation for the theory of LF, and the basic idea is still accepted as the standard analysis in mainstream generative grammar. According to his analysis, all QPs adjoin to IP at LF, and thus, sentence (3) has two possible LF representations as shown in (4). This is how scope ambiguity comes about.

(3) A student admires every teacher. ∃> ∀, ∀> ∃

(4) a. [$_{IP}$ a student$_i$ [$_{IP}$ every teacher$_j$ [$_{IP}$ t_i admires t_j]]] ∃> ∀

b. [$_{IP}$ every teacher$_j$ [$_{IP}$ a student$_i$ [$_{IP}$ t_i admires t_j]]] ∀> ∃

May's analysis is based on the following three assumptions.

(5) May's assumptions

a. Representations at Logical Form are phrase markers.

b. The rules which map from Surface Structure to Logical Form are identical in form and functioning to rules mapping from Deep to Surface Structure.

c. The structures derived by these rules are subject to a set of well-formedness conditions, stated at the level of Logical Form.

(May 1977: 17)

Simply speaking, May argues that the rules that apply at LF are the same as those that apply in overt syntax. In the GB era, it was assumed that syntactic movement freely applies by virtue of the rule Move-α, which states that "move any element or constituent anywhere". However, in the Minimalist Program, where derivational economy is of central concern, derivations with fewer operations are preferred over those with more operations, and movement only applies when it must. Given that the rules that govern overt syntax computation likewise govern covert syntax computation, it is desirable if the number of covert movement operations is also reduced.

Looking closely at the data like (3), we find that the representations in (4) contain uninformative movements in that they change neither the phonological form nor the semantics of the sentence. In other words, the two readings of the sentence in (3) can obtain if only the QP in the object position, but not the one in the subject position, is optionally moved. To be more specific, the surface-scope interpretation can be derived if no QP raises, and the inverse-scope interpretation is derived if the QP in the object position alone is moved. In 2.3 and 2.4, we will review Fox (2000) and Reinhart (2006) in turn, both of which reanalyze LF computations in terms of economy and pave the way for a solution to the problem of why the inverse correlation between the rigidity of word order and scope holds.

2.3. Restricting Vacuous Movement at LF (Fox 2000)

2.3.1. Overview

As we saw in 1.2.2, there are two types of covert computation yielding scope ambiguity, namely QR and reconstruction. Fox (2000) demonstrates with convincing evidence that both scope-shifting operations occur only when they have semantic

contribution. In the following sections, we will review his discussion of QR and reconstruction, and see that vacuous movement is disallowed.

2.3.2. Scope Economy and QR

Fox (2000) questions the widely-held (yet rarely empirically tested) assumption that all QPs undergo QR, and demonstrates with convincing evidence that QR is not an obligatory computation imposed on every QP. Below are the economy conditions proposed by Fox.

(6) *Scope Economy*

Scope Shift Operations that are not forced for type considerations must have a semantic effect. (Fox 2000: 23)

(7) *Shortest Move*

QR must move a QP to the closest position in which it is interpretable. In other words, a QP must always move to the closest clause-denoting element that dominates it. (Fox 2000: 23)

These conditions work as follows. First, movement of a QP in the subject position is not theoretically well motivated. It is standardly assumed that a quantificational DP is of type <*et, t*> (given that a quantificational determiner is of type <*et*, <*et*, *t*>>). Thus, if it is the sister of a one-place predicate, there is no type mismatch. By contrast, when a QP is in other positions, it must move out of the position to circumvent a type mismatch. Let us illustrate this with the following example.

(8) A girl admires every teacher.

In sentence (8), the movement of the QP in the object position is coerced because the type of the QP conflicts with that of the two-place predicate *admire*, which is of type <*e, et*>. The Shortest Movement requires that it move to the closest clause-denoting expression, namely the type *t* node that dominates it. Thus, the LF representation of the sentence in (8) after the QR is something like (9). In this representation, the subject

originates from a VP-internal position (in accordance with the VP-internal subject hypothesis).

(9) [$_{IP}$ a girl$_i$ [$_{VP}$ every teacher$_j$ [$_{VP}$ t_i admires t_j]]].

Then, by Scope Economy, QPs can raise to IP only when the movement yields a semantic effect. Suppose that *a girl* adjoins to IP, as shown in (10). This movement is disallowed because it is semantically vacuous.

(10) [$_{IP}$ a girl$_i$ [$_{IP}$ t'_i [$_{VP}$ every teacher$_j$ [$_{VP}$ t_i admires t_j]]]].

Scope Economy, however, does not block QR of *every teacher,* since in this case, as shown in (11), the operation changes the scope relation between *every teacher* and *a girl*.

(11) [$_{IP}$ every teacher$_j$ [$_{IP}$ a girl$_i$ [$_{VP}$ t'_j [$_{VP}$ t_i admires t_j]]]].

Fox offers four pieces of supporting evidence for this analysis using ellipsis sentences. Let us consider the examples below.

(12) a. A Canadian flag is in front of every building, and an American flag is, too.

b. A Canadian flag is in front of many buildings, and an American flag is, too.

c. A Canadian flag is in front of most buildings, and an American flag is, too.

d. One guard is standing in front of every building, and one policeman is, too.

e. A boy admires every teacher. A girl does, too.

$\exists > \forall, \forall > \exists$ (Fox 2000: 30)

All these sentences are scopally ambiguous. An important interpretive property of ellipsis is that the scope relation between operators in the antecedent sentence must be

parallel to the scope relation between the corresponding operators in the ellipsis sentence. That is to say, if the antecedent sentence takes a subject-wide-scope reading, the subject in the ellipsis sentence must also take scope over the object. In the same way, in the case where the object outscopes the subject in the antecedent sentence, the object in the ellipsis sentence must also take wide scope over the subject. The scope parallelism between the antecedent sentence (β_A) and the ellipsis sentence (β_E) is generalized as follows[1].

(13) *Parallelism*

In an ellipsis/phonological reduction the scopal relationship among the element in β_A must be identical to the scopal relationship among the parallel elements in β_E.

(Fox 2000: 32)

With this in mind, consider the first piece of evidence.

(14) a. A boy admires every teacher. A girl does, too <admire every teacher>.

∃> ∀, ∀> ∃

b. A boy admires every teacher. Mary does, too <admire every teacher>.

∃> ∀, * ∀> ∃ (Fox 2000: 32-33)

The antecedent sentence in (14a) is scopally ambiguous. Interestingly, however, if the subject of the ellipsis sentence is replaced with a referential NP, the ambiguity disappears as shown in (14b). To consider the mechanism underlying this contrast, let us look into the LF representation of the ellipsis sentence in each example.

(15) a. [$_{IP}$ a girl$_i$ [$_{VP}$ every teacher$_j$ [$_{VP}$ t_i admires t_j]]].

b. [$_{IP}$ every teacher$_j$ [$_{IP}$ a girl$_i$ [$_{VP}$ t'_j [$_{VP}$ t_i admires t_j]]]].

[1] To be more precise, Fox (2000) divides Parallelism into two types, namely Direct Parallelism and Indirect Parallelism, and the definition here refers to Direct Parallelism. See Chapter 3 of Fox (2000) for relevant discussion.

(16) a. [$_{IP}$ Mary$_i$ [$_{VP}$ every teacher$_j$ [$_{VP}$ t_i admires t_j]]].

b. *[$_{IP}$ every teacher$_j$ [$_{IP}$ Mary$_i$ [$_{VP}$ t'_j [$_{VP}$ t_i admires t_j]]].

In the case of (14a), as discussed already, the object QP can raise over the subject because it has a semantic contribution. In the case of (14b), on the other hand, the movement of *every teacher* over *Mary*, which is not a scope-baring element, is banned because it is semantically uninformative. Since the ellipsis sentence can only receive a surface-scope interpretation in (14b), Parallelism blocks the antecedent sentence from receiving an inverse-scope construal. This is why there is a contrast in scope interpretation between (14a) and (14b).

The sentences in (14) may have another option to obtain an inverse-scope reading. After the obligatory QR applies, the subject can lower to the original VP internal position. The LF representations after the operation are in (17).

(17) a. [$_{IP}$ ___ [$_{VP}$ every teacher$_j$ [$_{VP}$ a girl admires t_j]]].

b. *[$_{IP}$ ___ [$_{VP}$ every teacher$_j$ [$_{VP}$ Mary admires t_j]]].

This option is also not available for (17b), because Scope Economy bans such semantically uninformative movement. As a result, the antecedent sentence in (14b) unambiguously takes surface scope.

Note that the theory along the line of May cannot predict this contrast because under May's approach, all QPs are affected by QR, and nothing prevents *every teacher* in the antecedent sentence as well as the ellipsis sentence in (14b) from raising over the subjects. Therefore such an analysis wrongly predicts scope ambiguity, contrary to fact.

Another piece of evidence for Scope Economy comes from Weak Cross Over (WCO) effects. The sentences in (18) are marginal under the interpretation where the

variable *its* inside the subject phrase is bound by the QP in the object position, which raises across the pronoun at LF.

(18) a. ??[Its$_1$ prime minister] knows the capital of [every country]$_1$. (Fox 2000: 36)

b. ??[Its$_1$ producer] admires [every movie]$_1$. (Fox 2000: 36)

However, the WCO effect is very weak or absent in some environments.

(19) a. [The person who produced it$_1$] admires [every movie]$_1$. (Fox 2000: 37)

b. [The expert who was invited to talk about it$_1$] knows the capital of [every country]$_1$. (Fox 2000: 37)

c. [His$_1$ tutor] is admired by [every boy]$_1$. (Fox 2000: 37)

Using sentences like (19) and Parallelism in (14), Fox convincingly demonstrates that QR applies only when it has semantic contribution. Consider the sentences in (20).

(20) a. One of the film reviewers admires every movie. [The person who produced it] does, too. $\exists > \forall, \forall > \exists$ (Fox 2000: 37)

b. One of the film reviewers admires every movie. [The person who produced the film festival] does, too. $\exists > \forall, * \forall > \exists$ (Fox 2000: 37)

The sentence in (19a) is used as an ellipsis sentence in (20a), and sentence (20b) is identical to (20a) except that the pronoun *it* is replaced with a definite NP. In (20a), QR feeds pronominal binding and therefore has semantic import, whereas in (20b), application of QR is semantically uninformative. Thus, it is expected in Fox's analysis that the inverse-scope reading of the antecedent sentence is available in (20a) but not in (20b). This prediction is, in fact, borne out. As expected, the antecedent sentence in (20a) allows the inverse-scope interpretation when the pronoun *it* in the ellipsis

sentence is bound by the universal QP, while the one in (20b) has only a surface-scope reading.

The third piece of evidence comes from the relative scope between an object QP and negation. Consider the sentences in (21). Both sentences in (21) are scopally ambiguous. Under the reading where negation takes wide scope over *more than three*, sentence (21a) is true if it is not the case that there are more than three languages that I speak. Under the reading where *more than three* takes wide scope over negation, on the other hand, sentence (21a) is true if there are more than three languages I do not speak. Here we suppose that I speak fewer than three languages. Thus the sentence in (21a) is true under both readings. In contrast, Ken Hale speaks more than three languages, and in this case, the sentence in (21b) is true only in the inverse-scope construal.

(21) a. I don't speak more than three languages.

¬ > *more than 3* (*True*), *more than 3* > ¬ (*True*)

b. Ken Hale doesn't speak more than three languages.

¬ > *more than 3* (*False*), *more than 3* > ¬ (*True*)

(Fox 2000: 45)

Now, compare the sentences below.

(22) a. I don't speak more than three languages. Rob Pensalfini does. (*True*)

b. Ken Hale doesn't speak more than three languages. Rob Pensalfini does. (*False*)

c. Ken Hale doesn't speak more than three languages. Rob Pensalfini doesn't as well. (*True or False*)

(Fox 2000: 45)

The "True"/"False" symbol in parentheses indicates the truth or falsity of the antecedent sentence in the provided context. Although, in the case of (22a), the antecedent sentence

is true, it becomes false if the subject of the antecedent sentence is replaced with *Ken Hale* like (22b). If both the antecedent sentence and the ellipsis sentence are negated like (22c), the antecedent sentence can be either true or false. The contrast here again results from Scope Economy. In (22a, b), QR of *more than three languages* in ellipsis sentences is banned by Scope Economy because the computation is semantically vacuous. Consequently, due to Parallelism, the antecedent sentences are prevented from generating inverse scope. Thus, (22a) and (22b) have opposite truth values. On the other hand, the ellipsis sentence in (22c) contains negation, which makes QRing the object QP semantically informative. As a result, (22c) has both surface- and inverse-scope interpretations, which in turn ensures that the antecedent sentence can receive both surface-scope readings and inverse-scope readings.

The fourth piece of evidence comes from a coordination construction. The Coordinate Structure Constraint (CSC) prohibits extraction of an element from coordinate structures unless movement applies to all coordinates *Across-the-Board* (ATB) (Ross 1967, Williams 1978, among many others). Thus the sentence in (23a), where *wh* movement takes place only from the first conjunct, is ungrammatical, though the sentence is fine if the movement takes place from both coordinates across the board like (23b).

(23) a. *Who do you think Mary likes *t* and Bill hates Sue? (Fox 2000: 50)

b. Who do you think Mary likes *t* and Bill hates *t*? (Fox 2000: 50)

The contrast of grammaticality in the above sentences is accounted for with the following two assumptions.

(24) a. Extraction out of a coordination structure is possible only when the structure consists of two independent substructures, each composed of one of the coordinates together with material above it up to the landing site (henceforth, *component structures*). (Fox 2000: 50)

b. Grammatical constraints are checked independently in each of the component structures. (Fox 2000: 50)

The component structures of both sentences in (23) are as shown below.

(25) *Component structures of (23a)*

1. who do you think Mary likes *t*
2. who do you think Bill hates Sue (Fox 2000: 50)

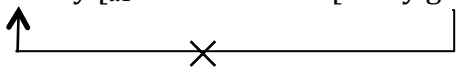
(26) *Component structures of (23b)*

1. who do you think Mary likes *t*
2. who do you think Bill hates *t* (Fox 2000: 50)

The second component of (23a) shown in (25) involves vacuous quantification, that is, the *wh* operator does not have a variable to bind. This makes the sentence ill-formed. In contrast, as shown in (26), both components are well-formed in (23b).

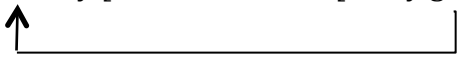
Given the contrast between the two sentences in (23), consider QRs in the sentences in (27) and (28).

(27) a. *Billy [$_{\alpha 1}$ wants to date [every girl in this class]$_1$] and



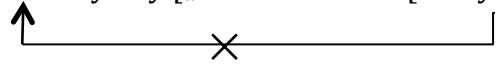
[$_{\alpha 2}$ has already asked [her]$_1$ out]. (Fox 2000: 53)

b. A boy [$_{\alpha 1}$ wants to date [every girl in this class]$_1$] and



[$_{\alpha 2}$ has already asked [her]$_1$ out]. *∃> ∀, ∀> ∃ (Fox 2000: 54)

(28) a. *Every boy [$_{\alpha 1}$ wants to date [every girl in this class]$_1$] and



[$_{S2}$ have already asked [her]$_1$ out]. (Fox 2000: 54)

b. Many boys [$_{\alpha 1}$ wants to date [every girl in this class]$_1$] and

[$_{\alpha 2}$ have already asked [her]$_1$ out]. $*\ many > \forall, \forall > many$ (Fox 2000: 55)

The contrast in grammaticality here is also attributed to Scope Economy. Specifically, QR is blocked in (27a) and (28a) because a semantically uninformative movement is involved in the first component. That is, while the universal QP's QR over the subject in (27b) and (28b) alters the relative scope between the subject QP and the object QP, the same movement would have no semantic contribution in (27a) and (28a). This is why QR is forbidden in (27a) and (28a). Note that the pronoun in the second component in this case is a bound variable bound by the object QP, and in order for the pronoun to be bound, QRing *every girl in this class* is necessary. Consequently, the sentences in (27a) and (28a) are ill-formed under the interpretation given, and the sentences in (27b) and (28b) can only give rise to inverse-scope readings.

In this section, we reviewed Fox (2000), who provides four pieces of evidence suggesting that QR is subject to Scope Economy, and claims that application of QR must have semantic contribution. The next section demonstrates that the same holds true for another type of covert movements, namely, reconstruction.

2.3.3. Scope Economy on Reconstruction

Fox provides some pieces of evidence in support of the claim that reconstruction is also subject to Scope Economy. Consider the following sentence.

(29) An American runner seems to Bill to have won a gold medal.

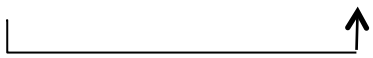
$\exists > seems,\ seems > \exists$ (Fox 2000: 46)

The sentence in (29) is ambiguous with respect to the relative scope between the existential quantifier in the subject position and the attitude verb *seem*. Under the reading of the existential quantifier taking wide scope over *seem*, the sentence is true only if Bill has some particular American runner in mind and it seems to Bill that the runner won a gold medal. If the attitude verb, on the other hand, takes wide scope over the existential quantifier, Bill is not required to have a particular American runner in

mind. The sentence is true if it seems to Bill that an American runner won a gold medal, but he does not know who the American runner is.

The two readings of this sentence differ with respect to the position where the subject is interpreted at LF. The subject of a raising verb overtly moves from an embedded subject position to the surface position where it gets pronounced. The sentence allows the derived subject to take wide scope over the raising predicate if the subject is interpreted at the position where it is pronounced as in (30a). But if the subject is moved back to the original position at LF as shown in (30b), it has narrow scope relative to the attitude verb.

(30) a. an American runner$_1$ seems to Bill [t_1 to have won a gold medal].

b. _____ seems to Bill [[an American runner] to have won a gold medal].

(Fox 2000: 47)

Now let us consider what happens when the sentence in (29) is embedded in a VP-ellipsis construction.

(31) An American runner seems to Bill to have won a gold medal and a Russian athlete does too. $\exists > seems,\ seems > \exists$ (Fox 2000: 47)

(32) An American runner seems to Bill to have won a gold medal and Sergey does too.
$\exists > seems, * seems > \exists$ (Fox 2000: 47)

The antecedent sentence in (31), where the subject of the ellipsis sentence is also a QP, is scopally ambiguous. But when the subject of the ellipsis sentence is replaced with a referential NP as in (32), the antecedent sentence is no longer ambiguous. The contrast here naturally follows from the assumption that reconstruction is also subject to Scope Economy. (33) shows well-formed/ill-formed LF representations for the sentence in (31). Again, Parallelism requires that the scope relation in the antecedent sentence be parallel to that in the ellipsis sentence, and thus, (33c, d), where only one of the QPs in the antecedent sentence or ellipsis sentence moves back to the embedded subject

position, are ruled out. In addition to surface scope, Scope Economy allows the subject to reconstruct to the original position because the movement feeds scope interpretation in both the antecedent sentence and the ellipsis sentence. Therefore, the antecedent sentence in (31) shows scope ambiguity.

(33) a. an American runner$_1$ seems to Bill [t_1 to have won a gold medal] and
a Russian athlete$_1$ seems to Bill [t_1 to have won a gold medal]

b. _____ seems to Bill [[an American runner] to have won a gold medal] and
_____ seems to Bill [[a Russian athlete] to have won a gold medal]

c. * an American runner$_1$ seems to Bill [t_1 to have won a gold medal] and
_____ seems to Bill [[a Russian athlete] to have won a gold medal]

d. *_____ seems to Bill [[an American runner] to have won a gold medal] and
a Russian athlete$_1$ seems to Bill [t_1 to have won a gold medal]

(Fox 2000: 47)

Now consider the well-formed/ill-formed LF representations for sentence (32) shown in (34). Scope Economy requires that covert movement have semantic import. Thus, when the second conjunct has a referential NP subject, the moved subject cannot be reconstructed to the pre-movement position. As a result, due to Parallelism, the subject of the antecedent sentence is banned from moving back to the original position, as shown in (34b). In the same vein, sentences (34c, d) are ruled out in violation of Parallelism. This explains why the antecedent sentence in (32) is restricted to surface scope.

(34) a. an American runner$_1$ seems to Bill [t_1 to have won a gold medal] and
Sergey$_1$ seems to Bill [t_1 to have won a gold medal]

b. *_____ seems to Bill [[an American runner] to have won a gold medal] and
_____ seems to Bill [[Sergey] to have won a gold medal]

c. * an American runner$_1$ seems to Bill [t_1 to have won a gold medal] and
_____ seems to Bill [[Sergey] to have won a gold medal]

d. *_____ seems to Bill [[an American runner] to have won a gold medal] and
Sergey$_1$ seems to Bill [t_1 to have won a gold medal]

(Fox 2000: 48)

Another piece of evidence comes from coordination structures. Consider the following example.

(35) A guard is standing in front of every church and sitting at the side of every mosque.
(Fox 2000: 59)

The sentence has an inverse-scope reading, in which the subject takes narrow scope relative to the universal QP. This reading obtains via the subject's reconstruction[2].

(36) ____ is [$_{VP}$ every church$_1$ [$_{VP}$ [a guard] standing in front of t_1]] and
[$_{VP}$ every mosque$_1$ [$_{VP}$ [a guard] sitting at the side of t_1]]
(Fox 2000: 59)

If quantifier lowering (or LF reconstruction) applies in both conjuncts, Scope Economy is not violated since the lowering operation has semantic import. The analysis here

[2] There is another plausible way to yield the inverse scope, namely by QRing both universal QPs to a position higher than the subject.

(i) every mosque$_1$ every church$_2$ [a guard is [standing in front of t_2] and
[sitting at the side of t_1]
(Fox 2000: 59)

However, this analysis does not work well. The truth condition of this LF representation is that each pair of a mosque and a church has a single guard standing in front of the church and sitting at the side of the mosque. Obviously, this is not the intended interpretation. See Fox (2000: 59) for discussion.

predicts that if the universal QP in the second conjunct is replaced with a referential NP, the inverse scope in the first conjunct is not licensed due to violation of Scope Economy. As predicted, the inverse-scope reading is not available in sentence (37). (The sentence is odd under surface scope because it is pragmatically uninterpretable.)

(37) #A guard is standing in front of every church and sitting at the side of this mosque.
(Fox 2000: 61)

These data indicate that reconstruction is also subject to Scope Economy.

2.3.4. Summary

In this section, we have reviewed Fox's (2000) argument that scope shift operations, namely QR and reconstruction, apply only if the operation brings about a semantically informative result. While Fox provides a number of compelling pieces of evidence for his claim, there are certain scope phenomena that are not amenable to his analysis. Some English data found in Reinhart (2006) cannot be accounted for in Fox's theory. The next section will review Reinhart's (2006) analysis, which is much in line with Fox's theory in that not all QPs are subject to QR, and see how the relevant English data is explained in Reinhart's theory.

2.4. Transderivational Constraints (Reinhart 2006)

2.4.1. Overview

According to Fox (2000), a semantic contribution is a necessary condition for licensing scope shift. Upon closer scrutiny, it seems that further investigation is required to explain the unambiguity of sentences like (38b).

(38) a. A flag was hanging in front of two buildings. ∃> *two*, *two* > ∃

b. Three flags were hanging in front of two buildings. *three* > *two*, **two* > *three*
(Reinhart 2006: 113)

In both sentences above, QR of *two buildings* over the subject is semantically informative, and Fox's account predicts that both sentences show scope ambiguity, contrary to fact. Reinhart (2006) proposes an analysis which captures the contrast in (38) in a way compatible with Fox's theory. In Section 2.4.2, we will first look at important notions for her analysis. Then Section 2.4.3 and 2.4.4 provides a mechanism which can explain why sentences like (38b) bear only surface-scope interpretations. Section 2.4.5 briefly shows that Reinhart's analysis can also provide an account of some questions in psychological and acquisition studies. Section 2.4.6 summarizes the discussion.

2.4.2. Choice Functions and Existential Closure

Reinhart (2006) demonstrates that some indefinite NPs can be interpreted either collectively or distributively. Following Kamp and Reyle (1993), Reinhart divided indefinite NPs into two groups: one group includes unmodified numerals such as *a, some, three, which, many*, and the other group includes all plural numerals with any kind of modifier such as *less than three, at least three, more than three, exactly three, three or more*, and *between three and five*. The two groups differ in that the collective construal is available only to the former group but not to the latter. The differences between the two groups can be observed in examples like (39) and (40). Some collective predicates like *be a good team/couple* and *weigh two pounds* can co-occur only with indefinites of the first group[3]. As exemplified in (41), strong generalized quantifiers also cannot be used with this kind of collective predicates. These examples indicate that only indefinites of the former group can be construed collectively.

(39) a. Three/many potatoes weigh two pounds together.

b. Ten/which workers in our office are a good team.

(Reinhart 2006: 93)

(40) a. *?Less than five potatoes weigh two pounds together.

[3] Not all collective predicates can distinguish the two groups of indefinites. Predicates like *meet* and *surround* can have an indefinites subject of either type. See 2.6.4 of Reinhart (2006) for discussion.

b. *?At least three potatoes weigh two pounds together.

c. *?More than ten workers in our office are a good team.

d. *?Exactly ten workers in our office are a good team.

(Reinhart 2006: 93)

(41) a. *?Most potatoes weigh ten pounds together.

b. *?All workers in our office are a good team.

(Reinhart 2006: 93)

Reinhart proposes that the collective interpretation is generated via a function called **choice function**. In addition to the standard-generalized-quantifier interpretation, which always yields a distributive reading, the first type of indefinite NPs also has a choice-function interpretation. The definition of the function is given below.

(42) *Choice function*

A function f is a choice function (CH (f)) if it applies to any nonempty set and yields a member of that set. (Reinhart 2006: 81)

A choice function always generates a collective interpretation when it applies to a QP. Let us take (39a) for example. *Three potatoes* in (39a) is not concerned with individual potatoes but rather denotes a set of potatoes which contains three members. The representation of the QP under the choice-function interpretation is given in (43a), which correctly generates a set interpretation. Following Reinhart, we will use an informal notation like (43b), which should be read as (43a).

(43) a. f ({ X | potato (X) ∧ |X|=3})

b. f (three potatoes)

Singular indefinites like *a* or *some* is also considered as a set which has only one member. Thus, the representation for *a potato* is like below.

(44) a. f ({ X | potato (X) ∧ |X|=1})

b. f (a potato)

Importantly, Reinhart assumes that indefinites as generalized quantifiers behave in the same way as other generalized quantifiers and their covert movement is restricted by syntax. On the other hand, indefinites under the choice-function interpretation can take any scope, depending on where an existential closure applies. What follows from this assumption is that indefinite NPs can scope out of a syntactic island just in case they are construed collectively. Let us consider the example shown below.

(45) If three relatives of mine die, I will inherit a house. (Reinhart 2006: 88)

Under the reading where the existential takes wide scope over *if*, *three relatives* can be construed only collectively. In other words, the sentence cannot be true in a situation where there are three relatives and I will inherit a house if one of them dies, but rather, it is true only in the case where there is a set of three relatives and I will inherit a house if all of them die. The collective reading cannot be obtained by simply postulating (ad-hoc) long-distance QR since, as shown in (46), this ad-hoc operation would merely give rise to distributive reading, which the sentence does not have.

(46) a. [three relatives of mine]$_i$ [if e_i die, I will inherit a house]

(Reinhart 2006: 88)

b. ∃ three x (relative of mine (x) & (x dies → I inherit a house))

(Reinhart 2006: 88)

However, the choice function allows us to obtain the correct reading without any ad-hoc stipulation. (47a) is the logical representation with a choice function, and (47b) is how it should be read[4].

(47) a. ∃f (CH (f) ∧ (f (three relatives of mine) die → I inherit a house))

(Reinhart 2006: 90)

b. ∃f (CH (f) ∧ ((f ({Y | relatives of mine (Y) & |Y|=3}) die) → (I inherit a house)))

The function variable is introduced to apply to *three relatives* in situ, and it can be existentially closed anywhere. If it is existentially closed outside the conditional, the collective reading is correctly obtained. (47b) is read such that there is a function f, such that if the set of three relatives of mine it chooses dies, I inherit a house.

To summarize the points here, there are two types of indefinites: one includes bare numerals and the other includes modified numerals. As summarized in (48), the former is ambiguous between a collective reading and a distributive reading, while the latter only allows a distributive reading. A collective reading is generated by a choice function, and the choice function allows indefinites to take any scope depending on where an existential closure applies. On the other hand, indefinites as generalized quantifiers, which always yield a distributive reading, are restricted by syntax, and they cannot scope out of an island.

[4] Reinhart's (2006: 90) notation is as follows.

(i) ∃f (CH (f) ∧ ((f ({Y | relatives of mine (Y) & three (Y)}) die) → (I inherit a house)))

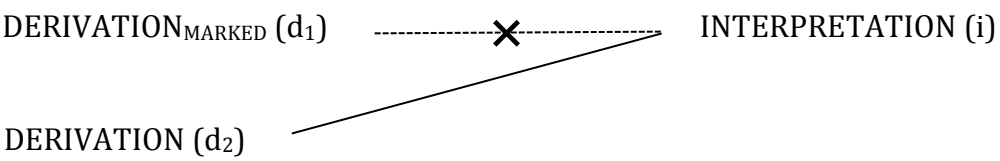
For the sake of consistency, we use the notation of |Y|=3 rather than three (Y).

(48)

Unmodified Numerals	*Modified Numerals*
generalized quantifier - distributive interpretation - restricted by syntax	
choice function - set interpretation - can have any scope	

2.4.3. Reference-Set Computation for QR

As we have seen, Fox (2000) demonstrates that QR is not freely applied, but rather, it is allowed only if it has a semantic contribution. In this section, we will review another strategy of economy called **reference-set computation**, which is proposed by Reinhart (1997, 2006). According to her theory, the well-formedness of a sentence is not always determined absolutely, but rather may be evaluated by constructing and comparing a set of possible derivations and selecting the optimal competitor out of the constructed set. This computation is called reference-set computation. Reference-set computation is called for in situations where a derivation contains a marked operation[5]. Suppose there are two different derivations d_1 and d_2, which generate the same interpretation *i*, and d_1 contains a marked operation, as in (49). In such a case, d_2 (i.e., the derivation without a marked operation) is chosen as the optimal derivation to achieve *i*, with the consequence that the association of d_1 with *i* is blocked.

(49) 

[5] Reinhart uses the term 'illicit' rather than 'marked'. But this word may give the wrong impression that the operation is grammatically disallowed. Rather it means that the operation can be executed just in case its application is justified. To avoid misunderstanding, we will use 'marked' instead of 'illicit'.

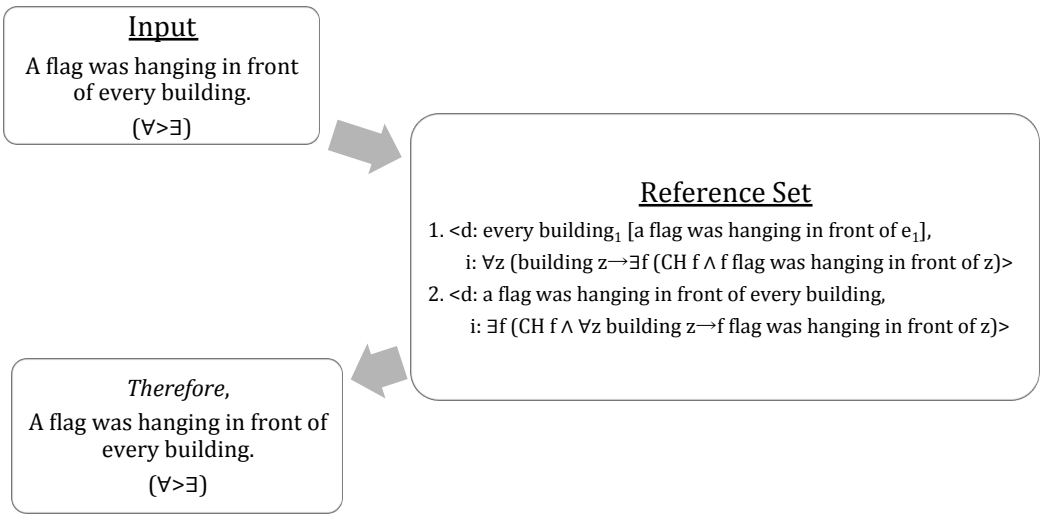
Just like Fox, Reinhart also claims that QR does not come for free. In her analysis, QR, which is executed covertly, is a marked operation since its application leads to a change in semantic interpretation without changing the phonological form of the input and increases the number of interpretations associated with a given phonological form. Therefore, the operation never applies unless it is forced by interface needs. In her framework, when QR is to be executed, it is always necessary to check whether the derivation is justified. Let us see with sentence (50) how inverse scope is licensed.

(50) A flag was hanging in front of every building. ∃> ∀, ∀> ∃

(Reinhart 2006: 116)

When QR applies to derive inverse scope, reference-set computation is executed. The figure below shows the way the relevant computation proceeds.

(51)



When sentence (50) is input in a context compatible with the inverse-scope reading, it is necessary to construct a reference set to check whether there is an alternative way to derive the same interpretation without applying a marked operation. The reference set is composed of the target set of <d, i> and sets of <d, i> which share the same

numeration[6]. Since the target set of <d, i> is (52), the reference set, in this case, contains two members as illustrated in (53).

(52) <d: every building$_1$ [a flag was hanging in front of e$_1$], i: ∀> ∃>

(53) a. <d: every building$_1$ [a flag was hanging in front of e$_1$],
i: ∀z (building (z) → ∃f (CH (f) ∧ (f (flag) was hanging in front of z))>

b. <d: a flag was hanging in front of every building,
i: ∃f (CH (f) ∧ ∀z (building (z) → f (flag) was hanging in front of z))>

(53a) is the target pair of <d, i>, the interpretation of which is derived with QR. While holding the pair in memory, one must look for such pairs of <d, i> as derived from the same numeration as (53a). The sentence in (50) also has a surface-scope interpretation, and thus the pair of <d, i> in (53b) is also included in the reference set. Then, the pairs in the set are compared to check whether there is a pair of <d, i> such that *i* is equivalent to the target interpretation and *d* involves no marked operation. If there is such a pair in the reference set, QR of the object QP is blocked. However, since no such pair is found in (53), QR is approved.

It is difficult to find direct evidence showing that such computation is indeed at work in the application of QR precisely because reference-set computation is not

[6] Reinhart (2006: 106) states that a reference set is composed of "pairs <d, i>, of a derivation and its interpretation, all with the same input (numeration) and the same interpretation". In the discussion of the detailed procedures of reference-set computation, however, Reinhart (2006: 116) states as follows.

> When the option of applying the illicit covert-movement operation is considered, we need to construct a <d, i> pair of the intended derivation. We then need to find out whether the same i(nterpretation) is not available without applying QR—in other words, whether the same interpretation cannot be associated with the overt derivation. Strictly speaking, the only way to find that out is by running through all the interpretations of the overt derivation.

The last sentence implies all interpretations of the target derivation must be examined. In other words, according to the statement here, a reference set contains pairs of <d, i>, which have the same derivation with possible different interpretations. Therefore, regarding the membership in a reference set, we assume that a reference set is composed of pairs of <d, i> which originate from the same numeration but do not necessarily have the same LF.

directly observable. However, Reinhart demonstrates with some examples that scope ambiguity is not absolutely determined by the nature of a QP itself, but rather by sets of derivations or interpretations. Consider the following examples.

(54) a. Three flags were hanging in front of two buildings. (Reinhart 2006: 113)

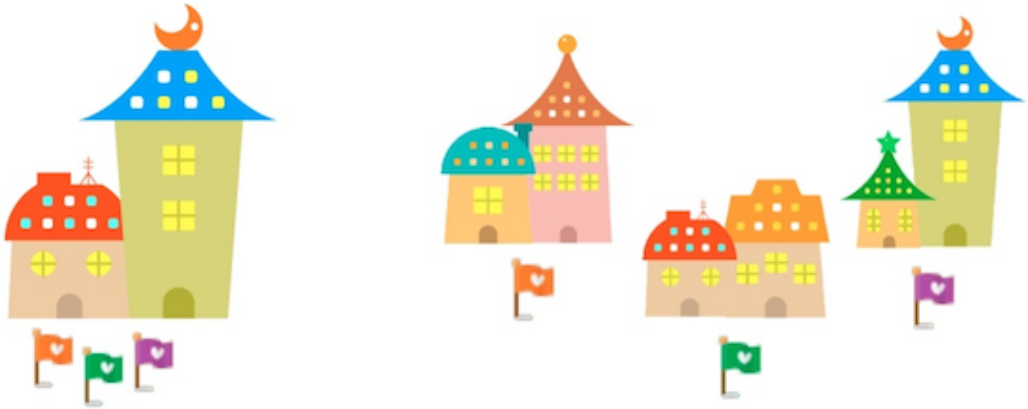
three > *two*, **two* > *three*

b. Five guards stood in front of twenty buildings. (Reinhart 2006: 113)

five > *twenty*, **twenty* > *five*

The sentences do not have inverse-scope readings. Specifically, (54a), for instance, is true in the situation where (a) there is a set x of three flags and a set y of two buildings, such that x is hanging in front of y (three flags and two buildings in total), or (b) there is a set of three flags, such that for each flag x in the set, there is a set y of two buildings (three flags and six buildings), and x is hanging in front of y, but it is not interpreted as asserting that (c) there is a set of two buildings, such that for each building y in the set, there is a set x of three flags, and x is hanging in front of y (six flags and two buildings). Each interpretation is figured below.

(55) a. Three flags and two buildings b. Three flags and six buildings



c. Six flags and two buildings

The unavailability of inverse scope indicates that the lower QP, in these cases, is not allowed to raise over the subject. However, as can be seen from the sentences in (56), the unavailability of inverse scope is not due to the numeral phrase in the object position itself. If the numeral in the subject position is replaced with an existential QP, the inverse-scope reading becomes available.

(56) a. An American flag was hanging in front of two buildings. $\exists > two, two > \exists$
(Reinhart 2006: 111)

b. A guard stood in front of twenty buildings. $\exists > twenty, twenty > \exists$

The availability of QR in (56) indicates that the numerals *two/twenty buildings* themselves can in principle undergo QR. The contrast here cannot be captured in Fox's theory. Reinhart gives another set of interesting examples. Compare the sentences in (57) with (54).

(57) a. Three identical flags were hanging in front of two buildings.

b. Two simultaneous questions confused fifteen subjects in the experiment. (The others did fine with two simultaneous questions.)

c. Ten matching answers brought two couples to the final round [in a televised couples contest].

d. Two subsequent meetings took place in three offices.

e. Four guests sleep together in two rooms.

(Reinhart 2006: 114-115)

As we saw in (54), a sentence with two numerals cannot have inverse scope. However, if the subject numeral occurs with adjectives like *identical*, *simultaneous, matching,* and *subsequent* or adverbs like *together* as in (57), inverse-scope readings become available. Sentence (57a) can be interpreted such that there are two buildings, and three flags are hanging in front of each of the two buildings. Similarly, in (57b), it is not necessarily the same pair of questions that confused the subjects. In (57c) as well, the matching answers can be different between the two couples. In (57d), there is no reason to assume that each office hosted the same two meetings. The sentence in (57e) is also acceptable in its inverse-scope reading, where each room has four guests sleeping. These observations suggest that the availability of QR is not determined solely by the properties of QP, but may be affected by some other factors. Again, Fox's theory as it stands does not offer a natural explanation for the fact that inverse-scope readings are possible in (57) but impossible in (54).

2.4.4. Adults' Inverse Scope

We have seen in the previous section that sentences with multiple unmodified numeral phrases do not display inverse scope, but if the numeral subject comes with modifiers like *identical, simultaneous,* and *matching*, otherwise unavailable inverse-scope interpretations suddenly emerge. This section will demonstrate how this contrast is captured in Reinhart's theory. The relevant examples are repeated below.

(54) a. Three flags were hanging in front of two buildings. (Reinhart 2006: 113)

three > *two*, **two* > *three*

b. Five guards stood in front of twenty buildings. (Reinhart 2006: 113)

five > *twenty*, **twenty* > *five*

(57) a. Three identical flags were hanging in front of two buildings.

b. Two simultaneous questions confused fifteen subjects in the experiment. (The others did fine with two simultaneous questions.)

c. Ten matching answers brought two couples to the final round [in a televised couples contest].

d. Two subsequent meetings took place in three offices.

e. Four guests sleep together in two rooms.

(Reinhart 2006: 114-115)

The question that naturally arises here is what kind of subject allows a lower QP to undergo QR and why sentences with a modified numeral subject, but not those with a bare numeral subject, generate inverse-scope readings. In the previous section, we argued that inverse scope is blocked via reference-set computation if there is a better alternative to derive the target interpretation. Reinhart discusses another case where inverse scope is precluded. To execute reference-set computation, it is necessary to construct a reference set, and make a comparison among the members in it. The steps involved in reference-set computation arguably impose a heavy cost on working memory, especially if the size of a reference set is big. In situations where the size of a reference set exceeds the capacity of the parser, even adults have no way to complete reference-set computation, and as a result, the target <d, i> pair is not approved. Thus, examples like (54) are taken to indicate that inverse scope is ruled out due to a processing overload.

Before examining how inverse-scope readings are excluded in (54), let us consider the sentences in (57). What is common across these sentences is that the subject QPs is biased against having a distributive interpretation due to the presence of *identical, simultaneous, matching, subsequent* and *together*. As we saw in 2.4.2, bare numerals are ambiguous between generalized quantifier and choice-function

interpretations. Based on this, we can draw the following generalization: QR can apply to a numeral object when a numeral subject is forced to receive a collective interpretation.

Now let us look at how an inverse-scope reading is generated in sentences like (57a). Consider (58), in which (58b) and (58c) represent the target derivation and interpretation of (58a).

(58) a. Three identical flags were hanging in front of two buildings.

three > *two*, *two* > *three*

b. [two buildings]$_1$ [three identical flags were hanging in front of e_1].

c. There is a set of two buildings such that for each building x in this set, there is a set y of three identical flags, and y is hanging in front of x. (six flags, two buildings)

Since the property of *identical* in subject QP disfavors a distributive interpretation, the reference set only contains the choice-function interpretations of the two numerals, as shown below.

(59) *Choice function*[7]

There is a set x of three identical flags and a set y of two buildings, such that x is hanging in front of y. (Three flags, two buildings) (cf. Reinhart 2006: 117)

[7] In fact, there are two possible representations that derive the choice-function interpretation.

(i) $\exists f_i$ (CH (f_i) ($\exists f_j$ (CH (f_j) (f_i (two flag) was hanging in front of f_j (three identical buildings)))

(ii) $\exists f_j$ (CH (f_j) ($\exists f_i$ (CH (f_i) (f_i (two flag) was hanging in front of f_j (three identical buildings)))

Note that both representations do not contain any movement. The difference is where existential closures are applied: in (i), the existential closure of *two flags* is higher than that of *three buildings* and in (ii), the order of the two closures is reversed.

The target reading in (58c) is different from the choice-function interpretation given in (59), and thus, the application of QR is approved.

In the case of sentences in (54), the reference set of each sentence contains the target pair of <d, i> and an alternative pair of <d, i>, the latter of which involves a choice function. In addition, in this case, the numerals can also be interpreted distributively. Thus, included in the reference set of the sentence in (54a) are the following members.

(60) *Target derivation and interpretation*

< d: [two buildings]$_1$ [three flags were hanging in front of e$_1$].

i: There is a set of two buildings such that for each building x in this set, there is a set y of three flags, and y is hanging in front of x. >(six flags, two buildings)

(61) *Choice function*

There is a set x of three flags and a set y of two buildings, such that x is hanging in front of y. (Three flags, two buildings) (cf. Reinhart 2006: 117)

(62) *Distributive subject*

a. There is a set of three flags, such that for each flag x in this set, there is a set y of two buildings, and x is hanging in front of y. (Three flags, six buildings)

b. There is a set of two buildings y, and a set of three flags such that each flag x in this set is hanging in front of y. (Three flags, two buildings)

(cf. Reinhart 2006: 117)

The interpretations in (61) and (62a, b) are different from the target interpretation so that QR of the lower QP should be approved. However, Reinhart claims that reference-set computation is not complete in this case. As we discussed already, reference-set computation imposes a heavy cost on working memory, and the bigger the size of a reference set is, the heavier the cost of the computation becomes. The scope shift operation is not approved in (58a) because the reference set for this sentence contains four (or five, if the derivation of choice function counts as two) candidates, which presumably overtaxes the parser. Put differently, reference-set computation

involves holding a set of competing representations in active memory, while also selecting the best competitor out of the reference set, but four (or five) pairs of <d, i> are simply too many to hold in working memory, so much so that even the adult parser cannot complete the required task. On this view, then, the unavailability of the inverse-scope interpretation is attributed to a processing failure. What is crucial here is the availability of a distributive reading, which adds two more members to the reference set and complexifies the reference-set computation.

2.4.5. A Brief Note on Psycholinguistic and Acquisitional Studies

Reinhart's account also provides an answer to some questions concerning psycholinguistics and language acquisition. First, intuitively, an inverse-scope reading is more difficult to obtain than the corresponding surface-scope reading. In fact, psycholinguistic experimental studies show that inverse scope is generally much more difficult to come by than surface scope, and the difficulty holds even when the context is biased toward an inverse-scope reading or when the quantified sentence has only an inverse-scope reading (Anderson 2006). The difference in complexity between surface scope and inverse scope cannot be explained away if we assume that every QP is affected by QR, because under such an assumption the two readings do not differ in terms of computational load (see (1) above). However, Reinhart's analysis nicely captures the difficulty of inverse scope. As we have seen, reference-set computation involves constructing and comparing possible sets of <d, i> while holding them in working memory. This computation presumably comes with a heavy processing load, thereby rendering inverse scope difficult to obtain. Note that reference-set computation is required only when a marked operation is involved, which means that the computation is not required for deriving surface scope. This is why deriving inverse scope is more costly than deriving surface scope.

Second, as we will discuss in Chapter 4, previous experimental acquisition studies employing the truth-value judgment task found that children speaking Japanese, which is a scope-rigid language, assign inverse scope to a doubly-quantified sentence more often than adults (Sano 2004, Yamakoshi and Sano 2007, Goro 2007, Sano 2009). If scope-shifting operations are grammatically restricted and children allow inverse scope in an early developmental stage, the question arises as to how they fix their

linguistic knowledge in the course of language acquisition without negative evidence. However, this is less of an issue in Reinhart's theory. She contends that children know what to do when faced with the application of QR, but the costly computation exceeds children's limited processing ability. As a result, when the truth-value judgment task is employed, they give answers by resorting to a guess. As they grow up, the size of their working memory gets bigger enough to complete the whole computation (see Chapter 4 as to the discussion on acquisition study).

2.4.6. Summary

In this section, we have seen the mechanism called reference-set computation proposed by Reinhart. Reinhart's analysis provides a natural account of why certain sentences with double numeral phrases in English do not display inverse-scope readings, a fact that is not immediately amenable to Fox's analysis. Moreover, we have seen that Reinhart's idea also provides an answer to the question of why inverse-scope readings are generally more difficult to obtain than the corresponding surface-scope readings, and why children apparently permit inverse scope more often than adults. Deriving inverse scope always requires executing reference-set computation. This costly computation is the source of the difficulty in deriving inverse scope, and it exceeds children's processing capacity, which is why children irregularly accept inverse-scope readings.

2.5. Similarities and Differences between Fox (2000) and Reinhart (2006)

In Section 2.3 and 2.4, we have seen that both Fox (2000) and Reinhart (2006) successfully minimized the application of QR. In a nutshell, Fox argues that an LF movement occurs only when the movement is semantically informative, while Reinhart claims that QR applies only when it is the most optimal way to derive the target interpretation. Their analyses might at first sight seem contradictory, but in fact they share the same spirit. First, their analyses are developed in accordance with the principles of economy. Specifically, they attempt to minimize the application of QR under the premise that movement must be as restrictive as possible. Moreover, in both

Fox and Reinhart's theory, QR is licensed by comparing a set of possible candidates. The difference between the two approaches lies in where the constraint works. In Fox's theory, it applies to a derivation, and comparison is made between a post-movement stage of derivation and a pre-movement stage of derivation[8]. In Reinhart's theory, on the other hand, the comparison is executed transderivationally (in Müller's (2011) term), and the number of competing candidates can be more than two. The latter theory crucially involves constructing an alternative representation against which to compare the input representation.

Theoretically, to the extent that both analyses have the same explanatory and descriptive power, Fox's analysis is more preferable than Reinhart's account in terms of computational complexity. Müller (2011) classifies syntactic constraints into five types, arguing that Reinhart's type of transderivational constraint is more complex than Fox's, the latter of which falls under the category of global constraint according to Müller's taxonomy (see Müller's (2011) section 2 in Chapter 1). Thus, if Fox's account could describe a full range of relevant facts, reference-set computation would not be necessary to start with.

However, as we have seen, Fox's analysis does not provide an answer to the question of why sentences like (54) do not exhibit inverse-scope construals.

(54) a. Three flags were hanging in front of two buildings. (Reinhart 2006: 113)

three > *two*, **two* > *three*

b. Five guards stood in front of twenty buildings. (Reinhart 2006: 113)

five > *twenty*, **twenty* > *five*

[8] According to Müller's (2011) taxonomy, Fox's type of principle is categorized in "global constraints", though Reinhart considers that the computation is done locally. According to Müller's definition, "*global* constraints apply neither to single steps of derivations, nor to output representations thus generated; rather, they apply to whole derivations of sentences where they correlate non-adjacent steps" (Müller 2011: 13). Given the definition, the computation in Fox's account is an instance of global constraints. Especially, in the case of reconstruction, we can see that the application of the covert movement to the original position indicates that the derivational history is maintained in the stage where reconstruction is carried out. Thus, in this dissertation, we assume that Fox's type of computations is executed globally.

At this stage, let us clarify our position. We assume with Fox that covert movement (QR and reconstruction) applies only if it is semantically informative. We also assume following Reinhart that the application of QR requires transderivational reference-set computation. In the sections that follow, we will show how the analysis here captures the correlation between the flexibility of word order and the rigidity of scope.

2.6. Word Order and Scope Rigidity

This section demonstrates how scope shift is blocked in scope-rigid languages. We assume the following economy conditions.

(63) *Economy Conditions*

A. Scope shift operations that are not forced for type considerations must have a sematic effect. (Following Fox 2000)

B. Reference-set computation is executed when QR is to apply.

(Following Reinhart 2006)

Reference set is defined as follows[9, 10].

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[9] Müller's (2011: 17) definition of reference set for transderivational constraints is as follows.

(i) Two derivations D_1 and D_2 are in the same reference set iff (a) and (b) hold:

a. D_1 and D_2 start with the same lexical array and have the same LF representation.

b. D_1 and D_2 do not violate local or global constraints.

This definition is stronger than the one in (64) in that membership in a reference set is restricted to derivations that have the same lexical array *and* the same LF representation. Theoretically, the stronger definition is preferable because it is more restrictive. However, as we discussed in 2.4.3 with English examples with double numerals, pairs of <d, i> with different LF representations can belong to the same reference set. Therefore, we will adopt the definition in (64).

[10] It has always been a matter of debate as to how the set of competitors in a reference set is chosen. Some argue that, as we define in (64), derivation$_1$ is compared to derivation$_2$ if they are convergent and start with the same lexical array (Chomsky 1993). Others argue that derivations with the same interpretation are to be compared (Fox 1995, 2000, Reinhart 2006). Reinhart (2006) basically adopts the latter idea, but as for scope shift, she seems to assume that

(64) *Reference Set*

Two pairs of <d, i>, <d, i>$_1$ and <d, i>$_2$, are in the same reference set iff

a. <d, i>$_1$ and <d, i>$_2$ start with the same lexical array.

b. <d, i>$_1$ and <d, i>$_2$ do not violate local or global constraints.

Following Müller (2011), local and global constraints are defined as follows.

(65) *Local Constraint*[11]

A local constraint applies to syntactic (Merge or Move) operations or an output representation. (cf. Müller 2011: 10)

(66) *Global Constraint*

A global constraint applies to a whole derivation; it correlates nonadjacent steps in the derivation. (Müller 2011: 10)

Now consider the following Japanese example to see how inverse scope is blocked in canonically-ordered sentences in Japanese.

(67)	Dareka-ga	subete-no	ringo-o	tabeta.	∃> ∀, * ∀> ∃
	someone-NOM	all-GEN	apple-ACC	ate	
	'Someone ate all apples.'				

To generate inverse scope, the universal quantifier in the object position needs to raise over the subject. Economy Condition A allows this operation because it changes scope relation between the subject QP and the object QP. Then Economy Condition B requires

---

derivations that have different interpretations but start from the same numeration are compared in the same reference set. Also see 4.3.2 for discussion.

[11] Müller divides local constraints into two types, namely a local derivational constraint and a local representational constraint. The local constraint here refers to both.

executing reference-set computation to see whether there is a more optimal way to derive the same interpretation. Under the definition in (64), the reference set in this case contains the following three members.

(68) *Reference set for (67)*

a. <d: Subete-no ringo$_i$-o dareka-ga t_i tabeta, i: ∀> ∃> [QR]

b. <d: Dareka-ga subete-no ringo-o tabeta, i: ∃> ∀>

c. <d: Subete-no ringo$_i$-o dareka-ga t_i tabeta, i: ∀> ∃> [overt movement]

(68a) is the target pair of <d, i>. The target sentence also has another interpretation, namely an existential-wide-scope reading, which is shown in (68b). Needless to say, (68b) is a member of the reference set since the derivation in (68b) starts from the same lexical array as the one in (68a). Moreover, free-word-order languages like Japanese have an option of scrambling, and thus, the <d, i> pair in (68c) participates in the reference set. Among these candidates, a pair in (68c) is selected as the optimal pair because it derives the same interpretation as the target one without a marked operation. As a result, canonically-ordered sentences are not associated with inverse-scope readings.

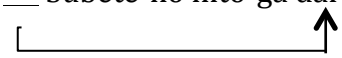
It should be noted that the same does not hold true for reconstruction. Even in scope-rigid languages like Japanese and German, inverse scope is acceptable in scrambled sentences (Bobaljik and Wurmbrand 2012).

(69) Dareka$_i$-o subete-no hito-ga t_i mita. ∃> ∀, ∀> ∃
someone-ACC all-GEN person-NOM saw
'Someone saw all the persons.'

If reconstruction calls for reference-set computation, the reference set as in (70) should be constructed.

(70) *Reference set for (69)*

a. <d: ___ Subete-no hito-ga dareka$_i$-o mita, i: ∀> ∃> [reconstruction]



b. <d: Dareka$_i$-o subete-no hito-ga t_i mita, i: ∃> ∀>

c. <d: Subete-no hito-ga dareka-o mita, i: ∀> ∃>

(70a) is the target pair of <d, i>, which is composed of the scrambled form and the inverse-scope interpretation. The reference set also has (70b), which has the same phonological form but has an interpretation distinct from the target <d, i>. What is important is the pair in (70c), which has a representation identical to the target pair, but has the canonical word order. To be more specific, the target interpretation, where the universal QP takes wide scope over the existential QP, can be derived from the surface scopal relation without applying reconstruction in (70c). Thus, if reference-set computation is required for reconstruction, the pair in (70c) would be selected as the optimal pair. But the acceptability of inverse scope in scrambled sentences indicates that reference-set computation should not work for reconstruction.

Although we currently do not have independent evidence for the view that no reference-set computation is involved in reconstruction, it seems theoretically reasonable that the computation is required only for QR. Compared to reconstruction, QR is a more marked operation in that there is a stronger possibility for it to yield multiple interpretations vis-à-vis one phonological form. Specifically, every QP can in principle undergo QR, whereas reconsntruction is available only to those phrases which have undergone overt movement. Moreover, the landing site of QR varies depending on the position the QP occupies, and it possibly applies multiple times. But in the case of reconstruction, the landing site is always fixed to the original position, and thus it applies only limited times. For these reasons, we will take the position that transderivational reference-set computation is required for QR but not for reconstruction.

In this section, we demonstrated that the Economy Conditions in (63) successfully predict scope interaction in scope-rigid languages like Japanese. Crucially, the conditions also answer our first question: What is the underlying mechanism that

links scope rigidity and flexible of word order? That is, reference-set computation blocks canonically-ordered sentence from deriving inverse scope due to the existence of scrambling, which can derive the same interpretation without a marked computation.

2.7. Bobaljik and Wurmbrand (2012)

2.7.1. Overview

This section will examine Bobaljik and Wurmbrand (2012), who deal with the inverse correlation between the rigidity of word order and the rigidity of scope. In 2.7.2, we will introduce their model and see how it links word order and scope interactions. Then 2.7.3 discusses problems of their analysis. Their main problem lies in how topic phrases should be analyzed. Since this issue is not irrelevant to our account, Section 2.7.4 will be devoted to the discussion of issues concerning topic phrases with special focus on discourse-configurational languages. Section 2.7.5 summarizes the discussion in this section.

2.7.2. Analysis

Bobaljik and Wurmbrand (2012) is a crosslinguistic study on scope (un)rigidity. The main interest of the paper is the correlation between word-order flexibility and scope rigidity. As we have discussed so far, it is a crosslinguistically robust fact that free-word-order languages like Japanese, Korean and German exhibit scope rigidity while rigid-word-order languages like English allow scope ambiguity (Bobaljik and Wurmbrand 2012, Hoji 1985/1990, Karimi 2005, 2008, Kim 1989, Krifka 1998, Pafel 2005, Sohn 1995, Szabolcsi 1997: 111, Wurmbrand 2008). Examples are given below.

(71) a. Some toddler read every book. ∃> ∀, ∀> ∃
(Bobaljik and Wurmbrand 2012: 374)

b. Dareka-ga subete-no hon-o yonda. ∃> ∀, * ∀> ∃
someone-NOM all-GEN book-ACC read
'Someone read all the books.' (Bobaljik and Wurmbrand 2012: 374)

However, the inverse correlation between word-order rigidity and scope rigidity is not perfect, and generally, scrambled sentences in scope-rigid languages show scope ambiguity.

(72) Subete-no hon-o dareka-ga yonda. ∃> ∀, ∀> ∃
all-GEN book-ACC someone-NOM read
'Someone read all the books.' (Bobaljik and Wurmbrand 2012: 374)

As is observed from these examples, among four possible logical pairs (canonical order/scrambled order × surface scope/inverse scope), three of the four combinations are often possible, and only one of them is unacceptable. Bobaljik and Wurmbrand call this the ¾ effect. Examining linguistic data in German, Japanese and English, they attempt to elucidate the mechanism underlying this effect. Of particular importance is that they proposed the following economy condition.

(73) *Scope Transparency* (ScoT)
If the order of two elements at LF is A>>B, the order at PF is A>>B
(Bobaljik and Wurmbrand 2012: 373)

Now, let us see with the examples in (71) how ScoT works in both scope-rigid languages and scope-free languages. Bobaljik and Wurmbrand assume that ScoT is a soft constraint, in the sense that it can be violated as a last resort. What the constraint does is suggest a preferable PF representation vis-à-vis a given LF. In Bobaljik and Wurmbrand's model, LF is computed first, and then a PF representation is spelled out, which is where their analysis departs from the traditional Y model. Suppose that the derived relative scope in LF is like "*every book*$_i$ > *someone* > t_i", and it is sent out to PF. PF then figures out all representations that can be derived from the target LF representation. For languages with free word order like Japanese, there are two possible PF representations, namely a canonically-ordered sentence with QR as in (71b), and a scrambled sentence as in (72) repeated below.

(71) b. Dareka-ga subete-no hon-o yonda. ∃> ∀, ∗ ∀> ∃
someone-NOM all-GEN book-ACC read
'Someone read all the books.' (Bobaljik and Wurmbrand 2012: 374)

(72) Subete-no hon-o dareka-ga yonda. ∃> ∀, ∀> ∃
all-GEN book-ACC someone-NOM read
'Someone read all the books.' (Bobaljik and Wurmbrand 2012: 374)

ScoT prefers LF and PF to be isomorphic. As a result, in this case, the scrambled sentence is preferred and an object-wide-scope reading of the canonical sentence is blocked. On the other hand, English does not allow scrambled word order. Thus, although it violates ScoT, canonically-ordered sentences are allowed to be associated with inverse-scope LF representations. The table below summarizes the predictions with respect to scope-interaction possibilities in rigid-word-order and free-word-order languages respectively. *A* and *B* in the table indicate the order of scope-bearing operations in a given sentence. To take (71) for an example, *A* corresponds to the subject *dareka*, and *B* to the object *subete-no hon*.

(74) *German, Japanese scrambling*

	LF	PF	ScoT
a. √	B»A»t_B	B»A»t_B	√
* (QR)	B»A»t_B	A»B	*
b. √	A»B	A»B	√
* (Reconstruction)	A»B	B»A»t_B	*

(Bobaljik and Wurmbrand 2012: 375)

(75) *English*

		LF	PF	ScoT
a.	* Scrambling	B»A»t_B	*B»A»t_B	√
	√ (QR)	B»A»t_B	A»B	*
b.	√	A»B	A»B	√
	* Scrambling	A»B	*B»A»t_B	*

(Bobaljik and Wurmbrand 2012: 375)

ScoT predicts that in free-word-order languages like Japanese and German, only surface-scope readings are allowed in canonically-ordered sentences and scrambled sentences alike, contrary to the facts. In German, as well as Japanese, scrambled sentences show scope ambiguity.

(72) Subete-no hon-o dareka-ga yonda. ∃> ∀, ∀> ∃
all-GEN book-ACC someone-NOM read
'Someone read all the books.' (Bobaljik and Wurmbrand 2012: 374)

(76) weil mindestens einen Roman jeder Student t_{OBJ} gelesen hat
since at.least one novel every student read has
'Since every student read at least one novel.' ∃> ∀, ∀> ∃
(Wurmbrand 2008: 90)

Before considering why scope ambiguity is observed in scrambled sentences, they pointed out that inverse scope is possible in canonically-ordered sentences in German when a special rise-fall tone is used.

(77) weil mindestens/EIN Student \JEDen Roman gelesen hat
since at.least one student every novel read has
'Since at least one student read every novel' ∃> ∀, ∀> ∃
(Bobaljik and Wurmbrand 2012: 401)

Following Büring (1997b), Bobaljik and Wurmbrand assume that the special tone assigns TOPIC and FOCUS to the subject and object respectively. The fact that changing information structure makes it possible to have scope ambiguity indicates that information structure is also one of the factors which determine scope interaction. Based on the assumption on TOPIC/FOCUS assignment, they extend the idea of ScoT to information structure, and assume a soft constraint which requires that the order of TOPIC and FOCUS in information structure must be isomorphically represented at PF. Neeleman and Koot (2008) point out that information structure orders TOPIC before FOCUS. Now consider how the derivation of sentence (77) is.

(78) a. Syntax: [*a student*]$_{\text{TOP}}$ [*every novel*]$_{\text{FOC}}$

b. QR: [*every novel*]$_{\text{FOC}}$ [*a student*]$_{\text{TOP}}$ [*every novel*]$_{\text{FOC}}$

c. LF: [*every novel*]$_{\text{FOC}}$ [*a student*]$_{\text{TOP}}$ ~~[*every novel*]$_{\text{FOC}}$~~

IS: ~~[*every novel*]$_{\text{FOC}}$~~ [*a student*]$_{\text{TOP}}$ [*every novel*]$_{\text{FOC}}$

d. PF1: [*every novel*]$_{\text{FOC}}$ [*a student*]$_{\text{TOP}}$ ~~[*every novel*]$_{\text{FOC}}$~~ *ScoT (IS)

PF2: ~~[*every novel*]$_{\text{FOC}}$~~ [*a student*]$_{\text{TOP}}$ [*every novel*]$_{\text{FOC}}$ *ScoT (LF)

(Bobaljik and Wurmbrand 2012: 401)

In order for the object to take wide scope, it must raise over the subject at LF, as shown in (78b). Since the intended LF, as shown in (78c), is *every novel* > *a student*, ScoT for LF prefers PF1 shown in (78d), where the same scopal relationship is kept at PF, while ScoT for information structure (IS), on the other hand, prefers PF2, which has the identical scope relation with LF. In total, since PF1 and PF2 equally contain one violation, both PF representations are licensed.

The ambiguity observed in scrambled sentences is also explained along the same line. Following Neeleman (1994), Bobaljik and Wurmbrand assume that a moved object is interpreted as a TOPIC. Thus, the derivation of sentence (76) proceeds as in (79).

(79) a. Syntax: [*every student*][*a novel*]$_{\text{TOP}}$

b. Scrambling: [*a novel*]$_{\text{TOP}}$ [*every student*][*a novel*]$_{\text{TOP}}$

c. LF: ~~[*a novel*]$_{\text{TOP}}$~~ [*every student*][*a novel*]$_{\text{TOP}}$

IS: [*a novel*]$_{\text{TOP}}$ [*every student*]~~[*a novel*]$_{\text{TOP}}$~~

d. PF1: ~~[*a novel*]$_{\text{TOP}}$~~ [*every student*][*a novel*]$_{\text{TOP}}$ *ScoT (IS)

PF2: [*a novel*]$_{\text{TOP}}$ [*every student*]~~[*a novel*]$_{\text{TOP}}$~~ *ScoT (LF)

The intended scopal relation in this case is *every student* taking wide scope over *a novel*. In the information structure, topic occupies a hierarchically higher position than others. Since ScoT for LF and ScoT for information structure prefer different PF representations, both a canonically-ordered sentence and a scrambled sentence allow *every student* to exhibit a wide-scope reading.

To summarize the points of Bobaljik and Wurmbrand's analysis, they assume an Optimality-Theory-like mechanism in that contsraints are violable (Prince and Smolensky 1993, 2004), and scope (un)rigidity is determined by an economy condition called ScoT. ScoT is relevant not only to quantifier scope but also to information structure: ScoT on quantifier scope requires that the scope relation in LF be identical to that in PF, and ScoT on information structure requires that a topic phrase be structurally higher than a focus phrase. A PF candidate with fewer ScoT violations is considered a better PF output.

Their mechanism here seems to succeed in capturing the correlation between word order and scope shift, but some problems remain. The next section discusses the remaining problems with their analysis.

2.7.3. Problems

Above, we have seen Bobaljik and Wurmbrand's analysis, which contends that two economy conditions, namely ScoT on scope and that on information structure, are at work in the application of scope-shifting operation. Their analysis seems to provide a convincing account of why the flexibility of word order correlates with scope rigidity, but some problems still remain to be solved.

First, there is something unclear about Bobaljik and Wurmbrand's argument. In their paradigm, free scope shift in English is established upon the impossibility of

scrambling. However, as Bobaljik and Wurmbrand themselves pointed out, there are other overt ways, say topicalization or passivization, to make the object precede the subject.

(80) a. Every detective interviewed exactly two suspects.

b. Exactly two suspects, every detective interviewed.

c. Exactly two suspects were interviewed by every detective.

In their account, passivized sentences do not compete with corresponding canonically-ordered sentences in the way that scrambled sentences do, since only sentences originated from the same numeration are qualified as competitors. Morphologically speaking, it is obvious that active sentences and passive sentences start from different numerations. As for topicalization, they claim that non-topicalized sentences do not compete with corresponding topicalized sentences since they have different LF representation.

(81) "For topicalization in English, we will need the assumption (which we make use of throughout the article) that information structure (topic, focus) is part of LF in the relevant sense and thus that topicalization structures have a different LF than counterparts without topicalization. This will ensure that [(80a)] and [(80b)] do not compete." (Bobaljik and Wurmbrand 2012: 378)

If information structure is part of LF, as stated above, scrambled sentences cannot be competing alternatives to their canonical counterparts since in their framework, scrambled phrases are considered to be equivalent to topic constituents. Thus, if we accept the statement in (81), it is predicted that scrambled sentences are excluded from the set of competing alternatives, and if we do not accept it, on the other hand, topicalized structures in English should compete with non-topicalized sentences.

Second, their account does not give a clear answer to the question of why a sentence with multiple numeral phrases repeated below does not show scope ambiguity in English, which is not a problem for Reinhart's theory, which we are endorsing.

(54) a. Three flags were hanging in front of two buildings. (Reinhart 2006: 113)

three > *two*, **two* > *three*

b. Five guards stood in front of twenty buildings. (Reinhart 2006: 113)

five > *twenty*, **twenty* > *five*

One way to solve this problem in Bobaljik and Wurmbrand's analysis is to introduce another constraint such that surface scope is preferred only when two numeral phrases are involved in a sentence wherein a subject phrase is ambiguous between a distributive reading and a collective reading. Of course, such an ad-hoc stipulation is merely a restatement of the facts rather than an explanation.

2.7.4. Sentence Topic in Discourse-Configurational Languages

The treatment of topicalizaion is not a trivial problem in Bobaljik and Wurmbrand's theory. In our account as well, this issue must be addressed since if topicalized sentences are to be compared with their canonical counterparts via reference-set computation, it would be wrongly predicted that English sentences like (82a) should not be associated with inverse-scope readings because of the existence of topicalized structure like (82b).

(82) a. Someone loves everyone.

b. Everyone$_i$, someone loves t_i.

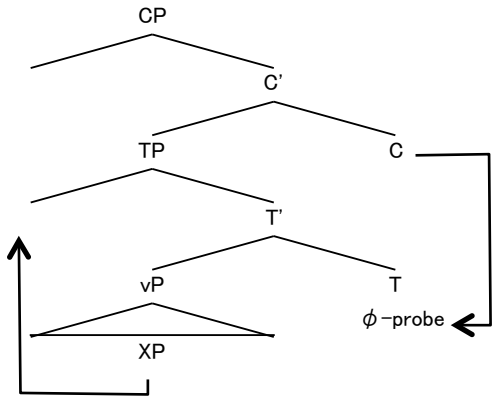
To discuss why topicalized sentences are not included in a reference set, we firstly review Miyagawa (2010).

Miyagawa (2010) clearly distinguishes the two notions of "sentence topic" and "discourse topic". While discourse topic is characterized as what is being talked about in

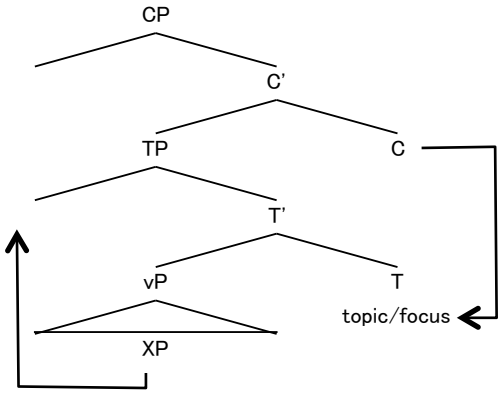
a discourse, sentence topic refers to the entity the sentence is about. Sentence topic is different from discourse topic in that it does not need to refer to an anchored item in the context. The Japanese topic marker *wa* always marks a discourse topic. Miyagawa's (2010) interests lies in sentence topic, especially in discourse-configurational languages. According to Kiss (1995), a discourse-configufational language is defined as a language where the discourse-semantic functions 'topic' and/or 'focus' are associated with a particular structural position. Miyagawa's major point is as follows. In discourse-configurational languages like Japanese and German, a topic/focus feature, which occurs on C and ultimately shows up on T, triggers movement. The mechanism is just parallel to *φ* features in non-discourse-configurational languages like English.

Let us briefly take a look at how Miyagawa's mechanism works. He claims that discourse-configurational languages and non-discourse-configurational languages exhibit movement triggered by a grammatical feature, and the mechanisms are identical in all respects except what appears on T to trigger movement. In the case of non-discourse-configurational languages, *φ* features on C are inherited by T, and trigger movement to the node between C and T. In discourse-configurational languages, on the other hand, notions of informational structure like topic/focus are grammaticalized, and they serve the same function as *φ* features. Therefore, in this type of language, a topic/focus feature, rather than *φ* features, triggers movement of XP from a *v*P-internal position to Spec TP.

(83) Non-discourse-configurational languages



(84) Discourse-configurational languages



Miyagawa argues that the default topic/focus feature is –focus topic, which simply requires its specifier to be filled (Miyagawa 2010: 86-87). Thus, the word order of a sentence is determined depending on what item fills the spec position. If it is filled with a subject DP, a canonically-ordered sentence is derived. On the other hand, if the position is satisfied with an object DP, a scrambled sentence is obtained.

If we adopt Miyagawa's analysis, two things follow. First, all sentences in discourse-configurational languages, but not those in non-discourse-configurational languages, have a topic feature in their numeration by default, and the sentences always have a sentence topic. However, in both types of language, deriving a discourse topic is required to add another feature in the numeration. Second, scrambling is a kind of topicalization, and a canonically-ordered sentence and the corresponding scrambled sentence are generated from the same numeration.

Given the discussion above, we can answer the question of why English topicalized sentences like (82b) permit deriving inverse scope from canonically-ordered sentences like (82b), whereas Japanese scramble sentences do not. In the case of English, which is a non-discourse-configurational language, topicalization always requires a topic feature in the numeration which is not contained in the numeration for canonical sentences. Since only those derivations which start from the same numeration are subject to reference-set comparison, topicalized sentences do not compete with corresponding canonical sentences. By contrast, a scrambled sentence in Japanese is derived from a canonical sentence with the same numeration, and therefore, it can successfully prevent inverse scope from being associated with canonically-ordered sentences.

2.7.5. Summary

This section reviewed Bobaljik and Wurmbrand (2012), who discuss the issue on the rigidity of word order and scope, and pointed out the problems of their account. One of the problems is concerned with the treatment of topicalization. In Section 2.7.4, we clarified our position, and explained why topicalized sentences do not obviate the inverse-scope interpretations of canonical sentences in languages like English. Based on Miyagawa's (2010) analysis, we argued that there are two types of topic, namely discourse topic and sentence topic, and the latter is derived by a grammatical feature, -focus topic feature, which "comes for free" in sentences in discourse-configurational languages. In the case of non-discourse-configurational languages like English, on the other hand, topicalization requires a topic feature, which is not present in the numeration of canonical sentences. Since the lexical arrays of a canonical sentence and a corresponding topicalized sentence are not identical, a topicalized sentence does not prevent the association of inverse scope with a canonical sentence.

2.8. Summary

In this chapter, we addressed the first question raised in Chapter 1, that is, what is the underlying mechanism whereby scope rigidity and the flexibility of word order are interconnected? To answer this question, following Fox (2000) and Reinhart (2006), we proposed the following two Economy Conditions along with a definition of a reference set.

(63) *Economy Conditions*

A. Scope shift operations that are not forced for type considerations must have a sematic effect. (Following Fox 2000)

B. Reference-set computation is executed when QR is to apply.
(Following Reinhart 2006)

(64) *Reference Set*

Two pairs of <d, i>, <d, i>$_1$ and <d, i>$_2$, are in the same reference set iff

a. <d, i>$_1$ and <d, i>$_2$ start with the same lexical array.

b. <d, i>$_1$ and <d, i>$_2$ do not violate local or global constraints.

As we have discussed, the interplay between scope and word order is attributed to the fact that scope shift requires reference-set computation. In languages with free word order, a scrambled sentence is selected as the optimal derivation to derive the same interpretation as what would be obtained by scope-shifting QR of a canonically-ordered sentence, and it is precisely for this reason that the association of inverse-scope construals with canonically-ordered sentences is obviated. Since scrambling is not an option in rigid-word-order languages, deriving inverse scope from a canonical sentence is possible. Moreover, we have demonstrated in 2.6 that reference-set computation dose not come into play when reconstruction is to apply, and thus even scope-rigid languages show scope ambiguity in scrambled sentences.

Chapter 3 Analyzing Chinese Data

3.1. Introduction

Chinese is not a free-word-order language, but shows scope rigidity in most types of sentence. This chapter aims to give an answer to the second set of questions raised in Chapter 1: that is, why do the sentences with multiple scope-taking elements in Chinese receive only surface-scope interpretations? And why do only some types of sentences allow inverse scope? We begin in Section 3.2 by introducing Chinese data and show when scope interactions are (and are not) observed. From Section 3.3 to Section 3.5, we discuss syntactic and semantic properties of Chinese sentences and demonstrate that it is not the case that scope-shift operations are blocked due to syntactic or semantic constraints per se. In Section 3.6, we show that reference-set computation is a crucial operation for generating scope (un)ambiguity in Chinese despite the fact that it is a rigid word-order language. Section 3.7 summarizes the discussion in this chapter.

3.2. Linguistic Facts

S. F. Huang (1981) is the first study that found that Chinese sentences with multiple scope-taking elements show no ambiguity. He points out that scopal relations in Chinese are determined by surface order[1].

[1] S. F. Huang (1981) gives the following example rather than the example in (1a) to show that Chinese sentences with multiple quantifier phrases do not allow inverse scope.

(i)

Mei-ge	ren	dou	xuan-le	yi-men	huaxue	ke.
每-个	人	都	选-了	一-门	化学	课
every-CL	person	all	take-ASP	one-CL	chemistry	course

'Everyone takes a chemistry course.'

In this sentence, a universal QP occurs in the subject position and an existential QP occupies the object position. Lee (1986: 144-146) and Aoun and Li (1993: 14) argue that this kind of sentence does not have an inverse-scope reading because the indefinite NP cannot be referred to with a singular pronoun.

(ii) a.

Mei-ge	nanren	dou	xihuan	yi-ge	nüren.
每-个	男人	都	喜欢	一-个	女人
every-CL	man	all	like	one-CL	woman

(1) a. You yi-ge ren xuan-le mei-men huaxue ke.
有 一-个 人 选-了 每-门 化学 课
have one-CL person take-ASP every-CL chemistry course
'There is a person taking every chemistry course.'

b. You yi-men huaxue ke mei-ge ren dou xuan-le.
有 一-门 化学 课 每-个 人 都 选-了
have one-CL chemistry course every-CL person all take-ASP
'There is a chemistry course that everyone takes.' (S. F. Huang 1981: 238)

Tamen xihuan de naxie nüren dou hen you qian.
他们 喜欢 的 那些 女人 都 很 有 钱
they like DE those women all very have money
'Every man loves a woman. The women they love all are rich.'
(Aoun and Li 1993: 14)

b. *Mei-ge nanren dou xihuan yi-ge nüren.
每-个 男人 都 喜欢 一-个 女人
every-CL man all like one-CL woman

Tamen xihuan de na-ge nüren dou hen you qian.
他们 喜欢 的 那-个 女人 都 很 有 钱
they like DE that-CL women all very have money
'Every man loves a woman. The woman they love all is rich.'
(Aoun and Li 1993: 14)

However, as exemplified below, if it is in an appropriate context, an existential-wide-scope reading comes to be available.

(iii) Zhe-ci kaoshi mei-ge ren dou da-dui-le
这-次 考试 每-个 人 都 答-对-了
this-CL exam every-CL person all answer-correct-ASP

yi-dao ti, cai cai shi na yi-dao.
一-道 题 猜 猜 是 哪 一-道
one-CL problem guess guess be which one-CL
'In this examination, everyone solved a question. Guess which one.'

The sentence in (iii) shows that an existential QP at the object position can refer to a specific object. However, this example cannot be taken as evidence for availability of an inverse-scope construal due to an entailment problem. See Section 1.3.2 of Chapter 1 for the detailed discussion of entailment problems.

c. You yi-ge ren mei-yi-men huaxue ke dou xuan.
有 一-个 人 每-一-门 化学 课 都 选
have one-CL person every-one-CL chemistry course all take
'There is a person taking every chemistry course.' (S. F. Huang 1981: 238)

In Chinese, an indefinite NP is not generally allowed to occupy the subject position, and in such a case, *you* 'have' has to be added before the indefinite NP. All sentences above do not show scope ambiguity.

Since S. F. Huang (1981), Chinese has been considered to be a scope-rigid language. C.-T. J. Huang (1982) proposes the following general condition on scope interpretation, claiming that scopal relations in Chinese are determined by c-command relations at the surface structure (SS) (also see Lee 1986).

(2) *The General Condition on Scope Interpretation*
Suppose A and B are both QPs or both Q-NPs or Q-expressions, then if A c-commands B at SS, A also c-commands B at LF. (C.-T. J. Huang 1982: 220)

Further observation led Aoun and Li (1993) to claim that certain types of Chinese sentences in fact show scope ambiguity. One such instance comes from passive sentences, as exemplified below.

(3) Mei-ge ren bei yi-ge nüren zhua-zou-le.
每-个 人 被 一-个 女人 抓-走-了
every-CL person by one-CL woman arrest-away-ASP
'Everyone was arrested by a woman.' (Aoun and Li 1993: 12)

This sentence is ambiguous between two readings: a reading where everyone was arrested by a different woman and a reading where everyone was arrested by one and the same women. However, we cannot claim with this example that an inverse-scope reading is available in Chinese passive sentences. In sentence (3), the inverse-scope reading entails the surface-scope reading, so that every context where the inverse-scope

reading is true always makes the surface-scope reading true. Therefore we cannot deny the possibility that the apparent 'inverse'-scope reading is just a special case of the LF representation of the surface-scope reading. In fact, if the positions of the universal QP and the existential QP are reversed, the scope ambiguity disappears (see also Kuno and Takami 2002).

(4) You yi-ge ren bei mei-ge nüren zhua-zou-guo.
有 一-个 人 被 每-个 女人 抓-走-过
have one-CL person by every-CL woman arrest-away-EXP
'There is a person arrested by every woman.' ∃> ∀, * ∀> ∃

Given the unambiguity of the sentence in (4), it is plausible to argue that the ambiguity observed in (3) is not generated by QR, but rather, it comes from the surface-scope representation.

Yet another type of scope ambiguity is also found in sentences like (5b) and (6b). These sentences are fine under the inverse-scope interpretation (namely, where every child was given a different present and where every student was taught a different language). Despite the semantic similarities, the sentences in (5a) and (6a) do not allow inverse-scope readings. The pictures in (7) illustrate possible situations where the surface- and inverse-scope readings are true[2].

(5) a. Shengdan yeye song-le yi-ge haizi mei-jian liwu.
圣诞 爷爷 送-了 一-个 孩子 每-件 礼物
Santa Clause give-ASP one-CL child every-CL present
'Santa Clause gave a child every present.' ∃> ∀, * ∀> ∃

[2] Kairong Yang (p.c.) pointed out that the sentence is odd if a universal QP occupies the direct object position in the double-object construction as in (5a) and (6a). However, as we will see in Chapter 4, in Su's (2001) experiment, where sentences of the same type were employed, adult Chinese speakers accepted the surface-scope interpretation 97% of the time. We thus take the experimental results to suggest that sentences like (5a) and (6a) are acceptable at least for some Chinese speakers.

b. Shengdan yeye song-le yi-jian liwu gei mei-ge haizi.
圣诞 爷爷 送-了 一-件 礼物 给 每-个 孩子
Santa Clause give-ASP one-CL present give every-CL child
'Santa Clause gave a present to every child.' ∃> ∀, ∀> ∃

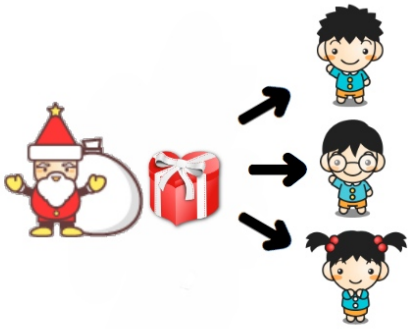
(6) a. Zhangsan jiao-le yi-ge xuesheng mei-zhong yuyan.
张三 教-了 一-个 学生 每-种 语言
Zhangsan teach-ASP one-CL student every-CL language
'Zhangsan taught a student every language.' ∃> ∀, * ∀> ∃

b. Zhangsan jiao-le yi-zhong yuyan gei mei-ge xuesheng.
张三 教-了 一-种 语言 给 每-个 学生
Zhangsan teach-ASP one-CL language give every-CL student
'Zhangsan taught a language to every student.' ∃> ∀, ∀> ∃

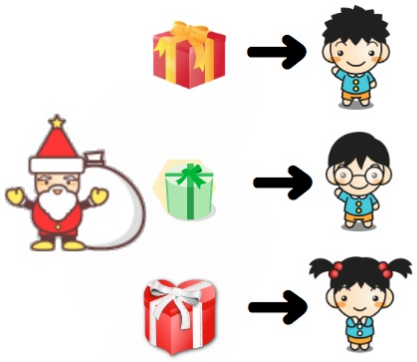
(7) a. Surface-scope reading of (5a)

b. Inverse-scope reading of (5a)

c. Surface-scope reading of (5b)



d. Inverse-scope reading of (5b)

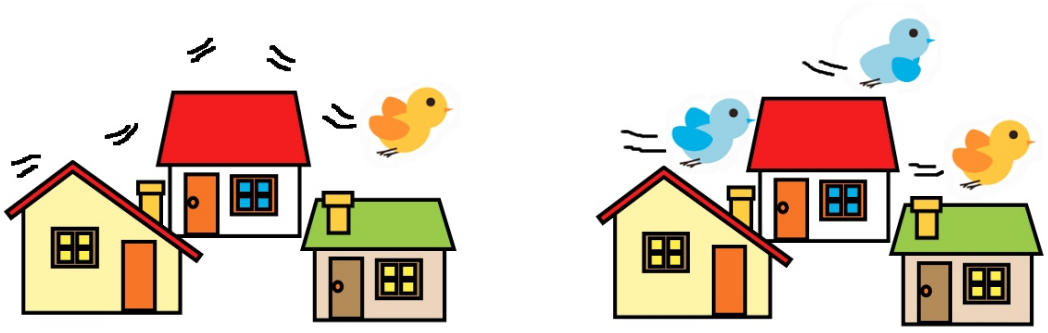


In addition, Lee (2008) pointed out that scope interaction is affected by thematic relations, and inverse-scope readings are easier to obtain if the object QP is a goal or location than if it is a theme. Some of our informants indeed accept an inverse-scope reading of sentences like (8a). However, as Lee (2008) points out, an inverse-scope reading of sentences like (8b) are marginal even for these speakers.

(8) a. You yi-zhi xiao-niao fei-guo mei-ge wuding. ∃> ∀, ?∀> ∃
有 一-只 小-鸟 飞-过 每-个 屋顶
have one-CL little-bird fly-pass every-CL rooftop
'There is a little bird flying over every rooftop.' (Lee 2008)

b. You yi-zhi xiao-niao fei-guo san-ge wuding. *one>three*, *?*three>one*
有 一-只 小-鸟 飞-过 三-个 屋顶
have one-CL little-bird fly-pass three-CL rooftop
'There is a little bird flying over three rooftops.' (Lee 2008)

(9) a. Surface-scope reading of (8a, b) b. Inverse-scope reading of (8a, b)



The question that naturally arises here is why Chinese sentences with multiple QPs generally show scope rigidity but sentences like (5b), (6b) and (8a) allow inverse-scope interpretations.

3.3. Chinese *You*-Sentences

Before addressing the issue of scope shift in Chinese, let us closely look at the characteristics of Chinese *you*-sentences. As we mentioned above, when an indefinite NP occupies a subject position, it is necessary to add *you* 'have' before the indefinite NP. In our discussion, we will dub the sentences containing *you* like (10a) ***you*-sentences**. In previous studies on scope interaction, sentences like (10a) have been treated on a par with English sentences like (10b).

(10) a.

You	yi-zhi	xiao-tuzi	chi-le	mei-gen	hongluobo.
有	一-只	小-兔子	吃-了	每-根	红萝卜
have	one-CL	little-rabbit	eat-ASP	every-CL	carrot

'There is a little rabbit eating every carrot.'

b. A little rabbit ate every carrot.

However, *you*-sentences are also known as the closest counterpart to the existential *there*-construction (Huang 1987), as the English translation in (10a) suggests.

According to McNally (2011), typical existential sentences have the following five syntactic characteristics cross-linguistically.

(11) *Syntactic Characteristics of Existential Sentences*

a. An expletive subject may be required (e.g. *<u>There</u> are bugs eating the corn.*).

b. Though existential sentences do not always contain a verb, if there is one it is often homophonous with a verb meaning 'to be' or 'to have', or with some other verb related to possession.

c. In all existential sentences, there is a 'pivot' nominal which describes the individual whose existence is under discussion (e.g. *There are <u>bugs</u> eating the corn*).

d. In most languages, a 'coda' phrase may appear, which is external to the pivot noun phrase (e.g. *There are bugs <u>eating the corn</u>*).

e. In many languages, a locative expression appears which may be obligatory and 'bleached' of content (like English *there*), though the syntactic role this expression plays in the construction may vary from one language to another.

Chinese sentences like (10a) also carry most of the characteristics that are typically associated with existential sentences. Although (11a) does not hold true for Chinese due to the lack of expletives, this construction contains *you* 'have', which conforms to (11b). Moreover, as mentioned in (11c, d), a pivot nominal (e.g. *yi-zhi xiao-tuzi* 'one little rabbit' in (10a)) and a coda phrase (e.g. *chi-le mei-gen hongluobo* 'ate every carrot' in (10a)) appear in this type of sentence. As for (11e), the following example shows that a locative expression can optionally occur before the verb *you* 'have'.

(12)	Zheli	you	yi-zhi	xiao-tuzi	chi-le	mei-gen	hongluobo.
	这里	有	一-只	小-兔子	吃-了	每-根	红萝卜
	here	have	one-CL	little-rabbit	eat-ASP	every-CL	carrot

'Here has a little rabbit eating every carrot.'

In addition to the fact that Chinese sentences like (10a) bear most of the characteristics of existential sentences pointed out in McNally (2011), these Chinese sentences are also subject to a restriction which is observed in existential sentences. It is cross-linguistically observed that a definite NP cannot be a pivot nominal, which is known as definiteness effect (DE). As shown in the following examples, Chinese is no exception[3,4] (Huang 1987, Hu and Pan 2007).

(13) a. There is a/*the man very rich.

[3] According to Huang (1987), "definites" include proper names, pronouns, NPs with a definite article or a demonstrative, bare NPs interpreted as generic or definite, universally-quantified NPs, and NPs with quantifier like *most*, while "indefinites" include NPs with existential quantifiers and bare NPs interpreted as nongeneric.

[4] Huang (1987) and Hu and Pan (2007) discuss exceptional cases where no DE is observed.

b. You	yi-ge/*nei-ge	ren	hen	you	qian.
有	一-个 / *那-个	人	很	有	钱
have	one-CL/that-CL	man	very	have	money

(14) a. There is a/*the little rabbit coming by jumping.

b. You	yi-zhi/*na-zhi	xiao-tuzi	tiao-guo-lai	le.
有	一-只 / *那-只	小-兔子	跳-过-来	了
have	one-CL/that-CL	little-rabbit	jump-pass-come	ASP

(15) a. There is a/*the little rabbit eating every carrot.

b. You	yi-zhi/*na-zhi	xiao-tuzi	chi-le	mei-gen	hongluobo.
有	一-只 / *那-只	小-兔子	吃-了	每-根	红萝卜
have	one-CL/that-CL	little-rabbit	eat-ASP	every-CL	carrot

The examples in (13) to (15) demonstrate that just like English existential sentences, indefinite subjects are congenial to *you*-sentences, while definite subjects are not. Given the characteristics of *you*-sentences, it seems reasonable to treat them on a par with existential sentences. In the following discussion, we will call pivot nominals **NP_1**, and coda phrases **XP** for convenience.

3.4. Syntactic Restrictions?

If *you*-sentences are existential sentences, a question arising here is whether the scope rigidity in Chinese can be attributed to independent syntactic restrictions on existential sentences. One classical analysis of English existential sentences proposes that the post nominal XP modifies NP_1 (Williams 1984). If Chinese *you*-sentences also have the same structure as shown in (16), it seems natural that the QP inside the predicative phrase cannot raise over the existential QP because the application of QR violates the island constraint.

(16) You [NP yi-zhi xiao-tuzi [chi-le mei-gen hongluobo]].
有 一-只 小-兔子 吃-了 每-根 红萝卜
have one-CL little-rabbit eat-ASP every-CL carrot
'There is a little rabbit eating every carrot.'

Appealing though it is, this analysis is not viable. As Huang (1987) pointed out, there is a semantic contrast between complex NPs and *you*-sentences with respect the way co-occurring adjectives are interpreted[5].

(17) a. Zhuo-shang you yi-ben hen youqu de shu. (Huang 1987: 234)
桌-上 有 一-本 很 有趣 的 书
table-on have one-CL very interesting DE book
'On the table there is a very interesting book.'

b. Zhuo-shang you yi-ben shu hen youqu. (Huang 1987: 234)
桌-上 有 一-本 书 很 有趣
table-on have one-CL book very interesting
'On the table there is a book very interesting.'

When *youqu* 'interesting' occurs inside an NP like (17a), it has a restrictive meaning, while when it functions as a coda phrase XP in *you*-sentences as in (17b), it receives a predicative interpretation. In addition to the semantic contrast, Huang (1987) offers another piece of evidence that the NP_1-XP sequence is not a complex NP. It is uncontroversial that the internal structure of Chinese NP is strictly head-final, but if we adopt the structure in (16), we need to assume that only those NPs which occur in *you*-sentences are head initial. However, such an assumption is not independently motivated

[5] The same semantic contrast is observed in English, as Huang (1987: 234) shows with the following examples.

(i) a. There is a flying plane.

b. There is a plane flying.

in this language. The semantic contrast and the structure of Chinese NP indicate that the NP_1-XP sequence is best analyzed not as involving a structure of NP, but as instantiating a predication structure (Huang 1987).

Moreover, empirical data shows that the NP_1-XP sequence in *you*-sentences does not constitute a syntactic island. In Chinese like other languages, a complex NP forms a syntactic island, and an NP cannot be topicalized out of a complex NP as exemplified in (18b).

(18) a. (Hen jiu hen jiu yiqian,)
（很 久 很 久 以前，）
very long.time very long.time before

you [$_{NP}$ yi-zhi [$_{RC}$ chi-le mei-gen hongluobo de] xiao-tuzi].
有 一-只 吃-了 每-根 红萝卜 的 小-兔子
have one-CL eat-ASP every-CL carrot DE little-rabbit
'(Long long ago,) there was a little rabbit which ate every carrot.'

b. *Mei-gen hongluobo$_i$ you [$_{NP}$ yi-zhi [$_{RC}$ chi-le t_i de] xiao-tuzi].
每-根 红萝卜 有 一-只 吃-了 的 小-兔子
every-CL carrot have one-CL eat-ASP DE little-rabbit
'For every carrot, there was a little rabbit which ate it.'

However, topicalization is allowed in *you*-sentences.

(19) a. You yi-zhi xiao-tuzi chi-le mei-gen hongluobo.
有 一-只 小-兔子 吃-了 每-根 红萝卜
have one-CL little-rabbit eat-ASP every-CL carrot
'There was a little rabbit eating every carrot.'

b. Mei-gen hongluobo$_i$ you yi-zhi xiao-tuzi chi-le t_i.
每-根 红萝卜 有 一-只 小-兔子 吃-了
every-CL carrot have one-CL little-rabbit eat-ASP
'For every carrot, there was a little rabbit which ate it.'

For these reasons, we follow Huang's idea that the NP_1-XP sequence in *you*-sentences is not a complex NP, but rather has a topic-comment structure (or a subject-predicate relation), which in turn means that the unavailability of inverse-scope readings does not reduce to independent syntactic restrictions on *you*-sentences.

3.5. Semantic Restrictions?

This section examines another potential factor that could be responsible for the absence of inverse-scope interpretations in existential sentences. To be more specific, we will investigate the possibility that an inverse-scope reading semantically conflicts with the existential construction, which results in scope rigidity. Our conclusion, however, is that, although the specificity of a numeral phrase after *you* has a bias toward surface-scope readings, it is not a crucial restriction on scope shift in Chinese.

According to Hu and Pan (2007), the basic function of Chinese existential sentences is to introduce new information into discourse. Basically, a numeral phrase after *you* should be interpreted as indefinite specific. That is, the denotation of the numeral phrase should be known to the speaker, but unknown to the hearer (cf. Huang 1987, Hsin 2002, Yao 2011). Let us consider the following examples.

(20) a. You ren zhan-zai menkou.
有 人 站-在 门口
have person stand-at gate
'There is a person standing at the gate.' (Hsin 2002: 359)

b. You yi-ge ren zhan-zai menkou,
有 一-个 人 站-在 门口
have one-CL person stand-at gate

(yizhi xiang limian zhangwang, zei-tou-zei-nao de).
(一直 向 里面 张望， 贼头贼脑 的)
'There is a person standing at the gate, (and he is gazing at the inside furtively).'
(Hsin 2002: 360)

The position immediately after *you* can be occupied either by a bare noun or a numeral phrase if a stage-level predicate is used, but the meanings are different. In (20a), the speaker of the sentence does not know the person standing at the gate, while in (20b) s/he knows who the person is (Hsin 2002). The semantic contrast between (20a) and (20b) shows us that a numeral phrase after *you* 'have', in this case, is interpreted as specific.

If the referent of the existential QPs in (1) and (4) were specific singleton entities introduced into the discourse, it would be natural that the sentences lack inverse-scope interpretations. However, as we can see from the fact that some speakers accept the inverse-scope readings of sentence (8a), the referent of NP_1 need not always be a specific entity. Thus, the semantic characteristics of *you*-sentences cannot be taken as responsible for the absence of inverse scope. Moreover, the semantics of numeral phrases in existential sentences is silent as to what makes the contrast in ditransitive sentences like (5). We thus claim that the semantic characteristics of NP_1 have a strong bias toward surface-scope readings, but it cannot be taken as a rationale behind the general ban on scope shift in Chinese.

3.6. Reference-Set Computation

3.6.1. Overview

In the previous section, we have seen that semantic properties of Chinese existential sentences show a strong preference for surface-scope interpretations, but are not the source of scope rigidity. This section demonstrates that in Chinese as well, in

spite of its word-order rigidity, reference-set computation plays a crucial role in obviating inverse-scope construals. In section 3.6.2, we will delve into the reference-set computation involved in Chinese doubly-quantified sentences. Then, 3.6.3 to 3.6.5 show how reference-set computation works in certain types of Chinese sentences. Section 3.6.6 summarizes the discussion.

3.6.2. Membership in a Reference Set in Chinese Doubly-Quantified Sentences

We have discussed in Chapter 2 that application of QR calls for reference-set computation. The definition of a reference set for QR is repeated below.

(21) *Reference Set*

Two pairs of <d, i>, <d, i>$_1$ and <d, i>$_2$, are in the same reference set iff

a. <d, i>$_1$ and <d, i>$_2$ start with the same lexical array.

b. <d, i>$_1$ and <d, i>$_2$ do not violate local or global constraints.

As we have discussed in 2.7.4, in the case of discourse-configurational languages like Japanese and German, inverse-scope interpretations of canonically-ordered sentences and surface-scope interpretations of corresponding scrambled sentences are in the same reference set, and the latter win the competition. This is how scope rigidity comes about.

According to Kiss's (1995: 5) definition, where a discourse-configurational language is defined as a language where the discourse-semantic functions of topic and/or focus are associated with particular structural positions, Chinese is also a discourse-configurational language in that topic is highly grammaticalized as syntactic constituents (Li and Thompson 1976, Xu 2002, Liu 2004)[6]. If so, like Japanese, a topic/focus feature is included in a numeration by default. Note, however, that the basic

[6] It should be noted that in Miyagawa's analysis, Chinese is a non-discourse-configurational language like English. See Miyagawa (2010) for discussion.

structure of Chinese sentences is topic-comment, and a subject is not systematically codified (Li and Thompson 1976). Then the default feature in Chinese should be a discourse-topic feature, like *wa* in Japanese, rather than a sentence topic.

Given the definition in (21), it follows that in Chinese, a reference set for deriving the inverse scope of a canonically-ordered sentence like (22a) contains a corresponding topicalized sentence, as in (22b). In some topicalized sentences, inserting a resumptive pronoun at the original position of the topicalized phrase makes the sentence more natural. In some languages like Hebrew and Northern Palestian Aabic, a resumptive pronoun shows up in a relative clause when the gap cannot be left phonologically null. (Shlonsky 1992). If the resumptive pronoun in (22b) is the phonological spell-out of the topicalized phrase, it follows that (22a) and (22b) start with the same lexical array and hence are in the same reference set.

(22) a. *Canonical Order*

You	yi-ge	laoshi	ma-le	mei-ge	xuesheng.
有	一-个	老师	骂-了	每-个	学生
have	one-CL	teacher	curse-ASP	every-CL	student

'There is a teacher cursing every student.'

b. *Topicalization*

Mei-ge	xuesheng	you	yi-ge	laoshi	ma-le	(ta).
每-个	学生	有	一-个	老师	骂-了	(他)
every-CL	student	have	one-CL	teacher	curse-ASP	him

'Every student, there is a teacher cursing.'

Note that although object NPs can be preposed in the constructions as exemplified in (23), (23a, b) and canonically-ordered sentences do not vie for inverse scope[7].

[7] In the literature, the BA construction has often been discussed in connection with the notion of "affectedness" or "disposal". This successfully captures the contrast in acceptability between the following sentences.

(23) a. BA *Construction*

Wo	ba	bingqilin	mai-le.
我	把	冰淇淋	买-了
I	BA	ice.cream	buy-ASP

'I bought the ice cream.'

b. *Object preposing*

Wo	bingqilin	mai-le.
我	冰淇淋	买-了
I	ice.cream	buy-ASP

'I bought the ice cream.'

Obviously, the lexical array for the BA construction contains *ba* which canonically-ordered sentences do not have. For the case of object preposing, the status of the preposed object is a matter of considerable debate. Some past studies claim that the object preposing is a sort of topicalization (Xu and Langendoen 1985, Paul 2002, Xu and Liu 2007 among others), while others claim that it is a type of focalization (Ernst and Wang 1995, Shyu 1995 among others). Of particular interest to our discussion,

---

(i) a.

Wo	nian	Zhongwen	nian-le	san-xiaoshi	le.
我	念	中文	念-了	三-小时	了
I	read	Chinese	read-ASP	three-hour	ASP

'I read Chinese for three hours.' (Hu and Pan 2007)

b.

*Wo	ba	Zhongwen	nian-le	san-xiaoshi	le.
我	把	中文	念-了	三-小时	了
I	BA	Chinese	read-ASP	three-hour	ASP

'I read Chinese for three hours.' (Li 2007: 424)

c.

Wo	ba	zhe	juzi	nian-le	san-xiaoshi	le.
我	把	这	句子	念-了	三-小时	了
I	BA	this	sentence	read-ASP	three-hour	ASP

'I read this sentence for three hours.' (Li 2007: 424)

Sentence (ib) is ungrammatical because a language, in contrast to a sentence, cannot be manipulated or dealt with by a reading event.

though, is that whichever analysis may turn out to be correct, a feature like +focus or +topic other than the default feature should be contained in the numeration. Therefore, the BA construction and object-preposing sentences won't be in competition with canonically-ordered sentences.

3.6.3. Blocking QR

Now let us see how reference-set computation prevents inverse scope from being generated from Chinese *you*-sentences like (1a).

(1) a. You yi-ge ren xuan-le mei-men huaxue ke.
有 一-个 人 选-了 每-门 化学 课
have one-CL person take-ASP every-CL chemistry course
'Someone takes every chemistry course.' ∃> ∀, * ∀> ∃

The target interpretation in this case is the reading of the universal QP taking wide scope, which is derived via QR, as shown in (24a). This derivation also has a surface-scope interpretation, and thus the <d, i> pair in (24b) is included in the reference set. Yet another competitor is the syntactic derivation where a default topic/focus feature moves object DP. So the <d, i> pair in (24c) is also added in the reference set.

(24) *Reference Set of (1a)*

a. QR, inverse scope

⟨ mei-men huaxue ke$_i$ you yi-ge ren xuan-le t_i
d: 每-门 化学 课$_i$ 有 一-个 人 选-了 t_i, i: ∀> ∃
every-CL chemistry course have one-CL person take-ASP ⟩

b. Canonical order, surface scope

⟨ you yi-ge ren xuan-le mei-men huaxue ke
d: 有 一-个 人 选-了 每-门 化学 课, i: ∃> ∀
have one-CL person take-ASP every-CL chemistry course ⟩

c. Overt movement, surface scope

	mei-men	huaxue	ke_i	you	yi-ge	ren	xuan-le	t_i	
d:	每-门	化学	课 $_i$	有	一-个	人	选-了	t_i,	i: ∀> ∃
	every-CL	chemistry	course	have	one-CL	person	take-ASP		

With these pairs in a reference set, the next step is to single out the optimal candidate from the narrowly constructed set of options. In the reference set, the pair in (24c) generates the target interpretation without a marked operation, and consequently, the inverse scope of (1a) is blocked. The unavailability of inverse scope for sentences (1b, c) is also explained in the same way. Since these sentences have alternative derivations for the target interpretation which do not involve a marked operation (as in (25) and (26)), applying QR to the universal QPs is not justified.

(1) b. You yi-men huaxue ke mei-ge ren dou xuan-le.
有 一-门 化学 课 每-个 人 都 选-了
have one-CL chemistry course every-CL person all take-ASP
'There is a chemistry course that everyone took.' (S. F. Huang 1981: 238)

(25) a. Mei-ge ren dou you yi-men huaxue ke xuan-le.
每-个 人 都 有 一-门 化学 课 选-了
every-CL person all have one-CL chemistry course take-ASP
'Everyone, there is a chemistry course that s/he took.'

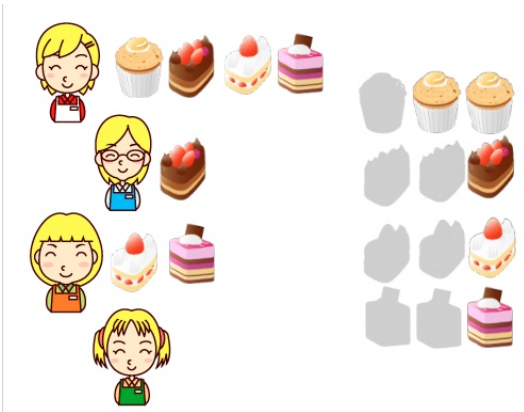
(1) c. You yi-ge ren mei-yi-men huaxue ke dou xuan.
有 一-个 人 每-一-门 化学 课 都 选
have one-CL person every-one-CL chemistry course all take
'There is a person taking every chemistry course.' (S. F. Huang 1981: 238)

(26) Mei-yi-men huaxue ke dou you yi-ge ren xuan.
每-一-门 化学 课 都 有 一-个 人 选
every-one-CL chemistry course all have one-CL person take
'For every chemistry courses, there is a person who takes it.'

In our analysis, as we discussed in chapter 2, reference-set computation is not executed in the case of reconstruction. It is predicted, then, that topicalized sentences in Chinese show scope ambiguity. In fact, sentences like (25) and (26) have an inverse-scope reading so that sentence (25) is true if there is a specific chemical course which everyone takes, and sentence (26) likewise is true if there is a specific person who takes every chemical course. However, here also arises an entailment problem; whenever an inverse-scope reading is true, the surface-scope interpretation is true. To avoid this problem, let us take a look at the topicalized sentence in (27) against the context illustrated in (28).

(27) Mei-zhong dangao zhenghao you yi-ge nühai chi-le.
每-种 蛋糕 正好 有 一-个 女孩 吃-了
every-kind cake exactly have one-CL girl eat-ASP
'Every kind of cake, exactly one girl ate.'

(28)



In this sentence, the numeral phrase is forced to have an exactly-one reading. Additionally, the classifier *zhong* 'kind' in the topicalized phrase requires a noun phrase *dangao* 'cake' to have a type reading. Thus, under the inverse-scope interpretation, the

sentence is true if there is exactly one girl who ate every kind of cake, regardless of whether there are other girls who ate some, but not all, kinds of cakes, as depicted in (28). Note that this situation is not true under the surface-scope reading, because chocolate cakes, shortcakes and blueberry cakes are eaten by two girls. If sentence (27) in this situation were true, it would mean that the topicalized phrase was reconstructed to the original position. However, the sentence is not accepted under such a circumstance. We conjecture that the absence of an inverse-scope reading here is due to the fact that a topic in Chinese is a discourse topic in Miyagawa's (2010) sence, which is like Japanese *wa*. Topic NPs in general have a definite referent, and in fact, like Japanese *wa*-marked topic, indefinite NP cannot be topicalized in Chinese.

(29) A. XiaoZhang mai-le yi-jian yifu.
小张 买-了 一-件 衣服
XiaoZhang buy-ASP one-CL cloth
'Xiao Zhang bought a dress.'

B. *Yi-jian yifu, wo ye mai-le.
一-件 衣服 我 也 买-了
one-CL cloth I also buy-ASP
'A dress, I bought too.' (Xu and Liu 2007)

Definite NPs generally do not take scope, so the topicalized sentences lack inverse-scope readings.

If scope rigidity in Chinese is obtained due to reference-set computation as we have discussed, it is predicted that sentences with an object QP which cannot be topicalized show scope ambiguity. As exemplified in (29), Chinese indefinite numeral phrases cannot be topicalized. Our analysis predicts, then, that, due to the impossibility of topicalization of the object phrase, sentences like (30) show scope ambiguity.

(30) Mei-ge xiaohai dou da-dui-le yi-dao ti.
每-个 小孩 都 答-对-了 一-道 题
every-CL child all answer-correct-ASP one-CL question
'Every child answered a question correctly.'

However, since there is an entailment relation between the truth condition of the surface-scope reading and that of the inverse-scope reading, the jury is still out as to whether the inverse-scope reading is indeed available in (30). Let us therefore consider the following sentences. (31a) is a sentence where another scope-taking element *mei* 'not' is added to the sentence in (30). (31b) forms a minimal pair with (31a), where the quantifiers modifying the subject and the object are reversed.

(31) a. Mei-ge xiaohai dou mei da-dui yi-dao ti.
每-个 小孩 都 没 答-对 一-道 题
every-CL child all not answer-correct one-CL question
'Every child did not answer a question correctly.' *not* > *one, one* > *not*

b. You yi-ge xiaohai mei da-dui mei-dao ti.
有 一-个 小孩 没 答-对 每-道 题
have one-CL child not answer-correct every-CL question
'There is a child who did not answer every question correctly.'
not > *every, *every* > *not*

If *yi-dao ti* 'one question' in (31a) could raise at LF, the sentence should have a reading of the numeral phrase taking wide scope over *mei* 'not'. The sentence indeed has at least two readings: on the *not* > *one* reading, the sentence is true if every child answered all questions incorrectly, and on the *one* > *not* reading, it is true if there is a specific question to which every child did not give a correct answer. Interestingly, in spite of the ambiguity observed in (31a), sentence (31b) only has a *not* > *every* reading, where there is a child who answered some questions correctly and some incorrectly, but it does not have an *every* > *not* reading, where all questions are answered incorrectly. The contrast

here supports our analysis. A universal QP in (31b) can be topicalized as shown in (32b). Since this phonological form can yield the *every* > *not* reading without recourse to QR, the inverse scope of (31b) is blocked. The sentence in (31a), on the other hand, does not have an alternative like (32a) because indefinite NPs have no option of topicalization. As a result, (31a) shows scope ambiguity.

(32) a. *Yi-dao ti mei-ge xiaohai dou mei da-dui.
一-道 题 每-个 小孩 都 没 答-对
one-CL question every-CL child all not answer-correct
'(lit.) A question, every child did not answer correctly.' *not* > *one, one* > *not*

b. Mei-dao ti you yi-ge xiaohai mei da-dui.
每-道 题 有 一-个 小孩 没 答-对
every-CL question have one-CL child not answer-correct
'Every question, there is a child who did not answer it correctly.'

3.6.4. Ditransitive Puzzle

As we have seen in 3.2, some Chinese ditransitive verbs such as *song* 'give', *huan* 'return', *jiao* 'teach' and *jie* 'lend' allow alternations between the double-object construction and the so-called dative construction (Xu and Liu 2007: 159). The former construction does not allow inverse scope while the latter shows scope ambiguity. Examples are given in (5a) and (5b).

(5) a. Shengdan yeye song-le yi-ge haizi mei-jian liwu.
圣诞 爷爷 送-了 一-个 孩子 每-件 礼物
Santa Clause give- ASP one-CL child every-CL present
'Santa Clause gave a child every present.' ∃> ∀, ∗ ∀> ∃

b. Shengdan yeye song-le yi-jian liwu gei mei-ge haizi.
圣诞 爷爷 送-了 一-件 礼物 给 每-个 孩子
Santa Clause give-ASP one-CL present give every-CL child
'Santa Clause gave a present to every child.' ∃> ∀, ∀> ∃

In previous studies, sentences like (5a) are considered analogous to English double-object constructions and sentences like (5b) are treated on a par with English *to*-dative constructions (Soh 1998, Su 2001, Yang 1991among others). The question here is why scope ambiguity is observed in (5b) but not in (5a). In addition to the two constructions in (5), the *gei* phrase in the Chinese ditransitive construction can also occur preverbally as shown in (33). In this case, an inverse-scope reading is not available.

(33) Shengdan yeye gei yi-ge haizi song-le mei-jian liwu.
圣诞 爷爷 给 一-个 孩子 送-了 每-件 礼物
Santa Clause give one-CL child give- ASP every-CL present
'Santa Clause gave every present to a child.' ∃> ∀, * ∀> ∃

If reference-set computation were at work among sentences like (5a), (5b) and (33), the inverse-scope interpretation in sentence (5b) would be blocked by sentences like below.

(34) Shengdan yeye song-le mei-ge haizi yi-jian liwu
圣诞 爷爷 送-了 每-个 孩子 一-件 礼物
Santa Clause give- ASP every-CL child one-CL present
'Santa Clause gave every child a present.'

(35) Shengdan yeye gei mei-ge haizi song-le yi-jian liwu.
圣诞 爷爷 给 每-个 孩子 送-了 一-件 礼物
Santa Clause give every-CL child give- ASP one-CL present
'Santa Clause gave a present to every child.' ∃> ∀, * ∀> ∃

In the following discussion, we will firstly demonstrate why scope ambiguity is observed in (5b). Specifically, we will show that comparison does not occur between (5b) and (34), and (5b) and (35) because they do not originate from the same numeration. In our discussion, sentences like (5a) are referred to as **double-object sentences**, the sentence like (5b) as **postverbal-*gei* sentences**, and sentences like (33) as a **preverbal-*gei* sentences**.

As we can see from the sentences in (5b) and (35), the *gei* phrase can occupy either a preverbal position or a postverbal position. We claim that the two instances of *gei* are two different lexical items: that is, the postverbal *gei* is a verb while the preverbal one is a preposition.

Chinese prepositions historically derived from verbs (Aoun and Li 1993: 14), and even in modern Chinese, some words such as *gei* and *zai* are ambiguous between a preposition and a verb, as exemplified below.

(36) a. Zhangsan gei wo da dianhua. (prepositional *gei*)
张三 给 我 打 电话
Zhangsan for I do telephone
'Zhangsan made a phone call to me.'

b. Zhangsan gei wo yi-ben shu. (verbal *gei*)
张三 给 我 一-本 书
Zhangsan give I one-CL book
'Zhangsan gave me a book.'

(37) a. Zhou Jielun zai Zhongguo hen shou huanying. (prepositional *zai*)
周 杰伦 在 中国 很 受 欢迎
Zhou Jielun at China very receive welcome
'Zhou Jielun is popular in China.'

b. Zhou Jielun zai Zhongguo. (verbal *zai*)
周 杰伦 在 中国
Zhou Jielun be.at China
'Zhou Jielun is in China.'

Although, as we saw in (5b) and (33), the *gei* phrase can occupy either a postverbal position or a preverbal position, PPs with a preposition which does not function as a verb cannot appear postverbally. As in (38a), *cong* 'from' in modern Chinese cannot be used as a verb. This type of preposition cannot occur postverbally.

(38) a. *Wo cong Zhongguo.
我 从 中国
I from China

b. Wo gang cong Zhongguo hui-lai.
我 刚 从 中国 回-来
I just from China return-come
'I just came back from China.'

c. *Wo gang hui-lai cong Zhongguo.
我 刚 回-来 从 中国
I just return-come from China
'I just came back from China.'

Given this characteristic, it is reasonable to assume that the *gei* phrase in postverbal position is not a prepositional phrase.

There is another piece of evidence that *gei* in preverbal position is a preposition while *gei* in postverbal position is a verb. In some sentences, a preverbal *gei* phrase and a postverbal *gei* phrase are semantically distinct. In the context of (39a), a *gei* phrase means 'on behalf of him', and in the context of (39b), it can also indicate a direction. However, if a *gei* phrase occurs postverbally like (40), the former meaning is

not available. As a result, the *gei*-phrase semantically conflicts with the latter part of the sentence in (40a). (The # symbol indicates infelicitous use in the given context.)

(39) a. Ni gei ta$_i$ da ge dianhua,
你 给 他 打 个 电话
you for 3sg do CL telephone

shuo ta$_i$ zai wo zher you shi.
说 他 在 我 这儿 有 事
say 3sg at I here have thing
'You made a phone call on behalf of him, and said to somebody that he is with me and has something to do.' (Li and Thompson 1981: 360)

b. Ni gei ta da ge dianhua,
你 给 他 打 个 电话
you for 3sg do CL telephone

jiao ta mashang dao zher lai.
叫 他 马上 到 这儿 来
let 3sg soon till here come
'You made a phone call to him and let him come up here soon.' (Lü 1999: 227)

(40) a. #Ni da ge dianhua gei ta$_i$ shuo ta$_i$
你 打 个 电话 给 他 说 他
you do CL telephone give 3sg say 3sg

zai wo zher you shi.
在 我 这儿 有 事
at I here have thing
'You made a phone call on behalf of him, and said to him that he is with me and has something to do.'

b. Ni da ge dianhua gei ta
你 打 个 电话 给 他
you do CL telephone give 3sg

jiao ta mashang dao zher lai.
叫 他 马上 到 这儿 来
let 3sg soon till here come
'You made a phone call to him and let him come up here soon.'

Moreover, a preverbal *zai* phrase and a postverbal *zai* phrase likewise display a sharp contrast in meaning. In (41a), the preverbal *zai* phrase denotes a place where the action of jumping was happening, while in (41b), the postverbal *zai* acts as the directional complement of the verb.

(41) a. Xiao-houzi zai mabei-shang tiao.
小-猴子 在 马背-上 跳
little-monkey be.at horse's.back-on jump
'The little monkey was jumping on the horse's back.' (Tai 1985: 58)

b. Xiao-houzi tiao zai mabei-shang.
小-猴子 跳 在 马背-上
little-monkey jump at house's.back-on
'The little monkey jumped on the horse. ' (Tai 1985: 58)

Given the fact that prepositions with no verbal function cannot occur postverbally and the semantic contrast between the preverbal and postverbal phrases, we conclude that *gei* in preverbal position is a preposition while *gei* in postverbal position is a verb.

Now, let us go back to the discussion of why the sentences in (34) and (35) cannot be in competition with (5b). Recall that all members in a reference set should share the same numeration. Obviously, (5b) has the lexical item *gei* in its numeration

which (34) does not have. Similarly, (5b) and (35) do not belong to the same reference set because, as we have discussed, the postverbal *gei* in (5b) is a verb while the preverbal *gei* in (35) is a preposition. Since the two instances of *gei* are different lexical items, the <d, i> pair for (35) and <d, i> pair for (5b) do not vie for wellformedness. According to our analysis, if (5b) allowed the universal QP to overtly move across the existential QP, it is predicted that the inverse scope of (5b) would be blocked. But, no such movement option is available, as demonstrated by the following example[8].

(42)	*Mei-ge	haizi$_i$	Shengdan yeye	song-le	yi-jian	liwu	gei	t_i.
	每-个	孩子 $_i$	圣诞 爷爷	送-了	一件	礼物	给	t_i
	every-CL	child	Santa Clause	give- ASP	one-CL	present	give	

Since there is no other alternative way to derive the reading of the universal QP taking wider scope, QR of the universal-quantifier phrase in (5b) is allowed.

The fact that (5a) can only have a surface-scope construal follows naturally from the existence of a corresponding topicalized sentence[9].

(43)	?Mei-jian	liwu$_i$	Shengdan yeye	song-le	yi-ge	haizi	t_i.
	每-件	礼物 $_i$	圣诞 爷爷	送-了	一-个	孩子	t_i
	every-CL	present	Santa Clause	give- ASP	one-CL	child	
	'Every present, Santa Clause gave a child.'						

This sentence is in the same reference set as (5a), and is selected as a more optimal derivation than (5a) to derive the interpretation of the universal QP taking wide scope

[8] We do not explore the question of why the sentence in (42) is ruled out. However, what is important here is that there is no way to have another phonological form which is derived from the same numeration as that of (5b), and which has the same interpretation as the inverse-scope reading of (5b).

[9] For some informants, the sentence in (43) is marginally acceptable without *dou* 'all'.

(i)	ok Mei-jian	liwu$_i$	Shengdan yeye	dou	song-le	yi-ge	haizi	t_i.
	每–件	礼物 $_i$	圣诞 爷爷	都	送–了	一–个	孩子	t_i
	every-CL	present	Santa Clause	all	give- ASP	one-CL	child	
	'Every present, Santa Clause gave a child.'							

over the existential QP. Thus, the inverse-scope reading is not associated with sentence (5a).

3.6.5. Locative QPs' Puzzle

As we have seen in 3.2, an inverse-scope reading is available for some speakers when a postverbal QP is a locative universal QP, but is marginal when the universal QP is replaced with a numeral QP. The relevant examples are repeated below.

(8) a. You yi-zhi xiao-niao fei-guo mei-ge wuding. ∃> ∀, ?∀> ∃
有 一-只 小-鸟 飞-过 每-个 屋顶
have one-CL little-bird fly-pass every-CL rooftop
'There is a little bird flying over every rooftop.' (Lee 2008)

b. You yi-zhi xiao-niao fei-guo san-ge wuding. *one>three*, *?*three>one*
有 一-只 小-鸟 飞-过 三-个 屋顶
have one-CL little-bird fly-pass three-CL rooftop
'There is a little bird flying over three rooftops.' (Lee 2008)

In Chinese, postverbal locative phrases are introduced with *guo* 'pass', *dao* 'arrive', and *zai* 'be at', which independently function as a verb.

(44) Guo-le zhe-tiao lu jiu dao.
过-了 这-条 路 就 到
pass-ASP this-CL road soon arrive.
'We will get there after passing this road.'

(45) Wo yijing dao jia le.
我 已经 到 家 了
I already arrive house ASP
'I already got home.'

(37) b. Zhou Jielun zai Zhongguo.
周杰伦 在 中国
Zhou Jielun be.at China
'Zhou Jielun is in China.'

In the sentences that show scope ambiguity, the verbs introducing a locative forms a compound verb with another verb, say *fei-guo* 'fly and pass', *pao-dao* 'run and arrive' and *zhu-zai* 'live and be at', and behave like a verb. The account here predicts that the inverse-scope reading is allowed if the lower QP cannot be topicalized. However, as exemplified below, topicalization of the universal QP in (8a) is allowed contrary to the prediction.

(46) Mei-ge wuding you yi-zhi xiaoniao fei-guo.
每-个 屋顶 有 一-只 小鸟 飞-过
every-CL roof have one-CL little-bird fly-pass
'Every roof, a little bird flies over.'

The reason why some Chinese speakers accept the inverse-scope reading of sentences like (8a) might be that for these speakers, the verbal compounds are treated as two separate verbs. That is, the structure of (8a) may be analyzed in the same way as a postverbal *gei/zai/dao* phrase as in (47) as discussed in Section 3.6.4.

(47) You yi-zhi xiao-niao fei [guo mei-ge wuding].
有 一-只 小-鸟 飞 过 每-个 屋顶
have one-CL little-bird fly pass every-CL rooftop
'There is a little bird flying over every rooftop.'

If the postverbal *guo* 'pass' in sentence (8a) is analyzed as an independent verb, no <d, i> pair prevents inverse scope since the QP after the verb *guo* cannot be topicalized, as we saw earlier.

(5) b. Shengdan yeye song-le yi-jian liwu gei mei-ge haizi.
圣诞 爷爷 送-了 一-件 礼物 给 每-个 孩子
Santa Clause give-ASP one-CL present give every-CL child
'Santa Clause gave a present to every child.' ∃> ∀, ∀> ∃

(42) *Mei-ge haizi Shengdan yeye song-le yi-jian liwu gei *t*.
每-个 孩子 圣诞 爷爷 送-了 一件 礼物 给
every-CL child Santa Clause give- ASP one-CL present give

If so, it makes sense that only some native speakers interpret this kind of sentence as ambiguous.

In our analysis, the contrast between (8a) and (8b) is attributed to the difference in the size of the reference sets. Let us consider the reference set for (8a) first. As we discussed in 2.4.2 of Chapter 2, unmodified numerals have either generalized quantifier or choice-function interpretations. This means that the sentence in (8a) has three possible construals shown in (48). To simplify the discussion, we use English for representing the derivations and interpretations.[10]

(48) *Reference set for (8a)*

a. <d: [every rooftop]$_i$ [there is a little bird flying over t_i],
i: ∀x [rooftop (x) → ∃f [CH (f) ∧ fly over (f({Y|little bird(Y) ∧ |Y| = 1}), x)]]> [QR]
(plural number of birds, every rooftop)

b. <d: [there is a little bird flying over every rooftop],
i: ∃f [CH (f) ∧ ∀x [rooftop (x) → fly over (f({Y|little bird(Y) ∧ |Y| = 1}), x)]]>
(one bird, every rooftop)

[10] For the sentence *A flag was hanging in front of every building*, Reinhart (2006: 116) does not take into account a competitor like (48c), where the numeral is interpreted as generalized quantifier. However, given her claim that unmodified numerals are ambiguous, it should also be included in the reference set.

c. <d: [there is a little bird flying over every rooftop],

i: ∃(y)[bird (y) ∧ ∀x [rooftop (x) → fly over (y, x)]]>

(one bird, every rooftop)

(48a) is a target <d, i> pair, where *every rooftop* is QRed over the existential QP. In this reading, the sentence is true if every rooftop has a different little bird flying over it. The reference set for this <d, i> pair includes those pairs of <d, i> which start from the same numeration. Without QR, the derivation has two more possible interpretations shown in (48b, c). Under the choice-function reading of the numeral subject shown in (48b), the sentence is true if there is a set Y of little birds, which is composed of one member, such that for every x, if x is a rooftop, Y flies over x. Under the generalized-quantifier reading of the numeral subject as in (48c), on the other hand, the sentence is true if there is a bird y such that for every x, if x is a rooftop, y flies over x. Among the three competitors, there is no pair of <d, i> that has the same interpretation as the target pair. As a consequence, the inverse-scope reading of the target sentence is allowed.

Now consider the reference set for (8b).

(49) *Reference set for (8b)*

a. <d: [three rooftops]$_i$ [there is a little bird flying over t_i],

i: ∃ three x [rooftop (x) ∧ ∃f [CH (f) ∧ fly over (f ({Y|little bird(Y) ∧ |Y| = 1}), x)]] > (three birds, three rooftops)

b. <d: [there is a little bird flying over three rooftops],

i: ∃f ∃g [CH (f) ∧ CH (g) ∧ fly over (f ({Y|little bird(Y) ∧ |Y| = 1}), g ({X| rooftop(X) ∧ |X| = 3}))]> (one birds, three rooftops)

c. <d: [there is a little bird flying over three rooftops],

i: ∃g ∃f [CH (g) ∧ CH (f) ∧ fly over (f ({Y|little bird(Y) ∧ |Y| = 1}), g ({X| rooftop(X) ∧ |X| = 3}))]> (one bird, three rooftops)

d. <d: [there is a little bird flying over three rooftops],

i: $\exists y \left[\text{bird}(y) \wedge \exists g\, [\text{CH}(g) \wedge \text{fly over}(y, g(\{X \mid \text{rooftop}(X) \wedge |X| = 3\}))]\right]$>

(one bird, three rooftops)

e. <d: [there is a little bird flying over three rooftops],

i: $\exists g\, [\text{CH}(g) \wedge \exists y\, [\text{bird}(y) \wedge \text{fly over}(y, g(\{X \mid \text{rooftop}(X) \wedge |X| = 3\}))]]$>

(one bird, three rooftops)

The target pair of <d, i> in this case is the one shown in (49a), where *three rooftops* has undergone QR. The truth condition of this sentence is that there are three x, which is a rooftop, and for each x there is a little bird y flying over x. The sentence in (8b) is associated with four more potential interpretations. (49b) and (49c) include the application of choice function to both existential QPs. The only difference between the two pairs lies in where the choice functions are existentially closed; in (49b), the existential closure for *a little bird* is at a position higher than that of *three rooftops*, while in (49c), *three rooftops* is existentially closed at a position higher than *a little bird*. Therefore, the truth conditions for these interpretations are equivalent. Under these interpretations, the sentence is true if there are a singleton set of a little bird Y and a set of three rooftops X such that Y flies over X. In addition to the choice-function interpretation, *a little bird* also has a generalized-quantifier interpretation. In both (49d) and (49e), *a little bird* is interpreted as a generalized quantifier and *three rooftops* is interpreted as a choice function, but there is a difference between the two with respect to where existential closure applies. In the former, it applies at a position lower than the generalized quantifier *a little bird*, and in the latter, it applies at a position higher than the generalized quantifier. Note that both representations involve no QR. The representation of (49d) is read in the way that there are a little bird y and a set of three rooftops X such that y flies over X, and the representation of (49e) means that there are a set of three rooftops X and a little bird y such that y flies over X. Given the members of the reference set, there is no other possible derivation that can derive the same interpretation as the inverse-scope reading of (8b). This means that deriving inverse scope should be allowed in this sentence, contrary to fact. As we discussed in 2.4.3, according to Reinhart (2006), the disallowance of inverse scope in this case is attributed

to the processing complexity that arises due to the size of the reference set. Specifically, a reference set with five members is too big in size to hold in working memory, so much so that the processing cost of reference-set computation exceeds the human processing capacity. As a result, the derivation of inverse scope fails in (8b).

To wrap up, the difference in the acceptability of inverse-scope readings in (8a) and (8b) stems from the difference in the size of the reference sets: there are three members in the former case and five in the latter. The load of reference-set computation with five competitors exceeds the human processing capacity, and as a result, the inverse-scope reading of the latter sentence fails to be accepted.

3.6.6. Summary

This section demonstrated how reference-set computation blocks inverse-scope readings in Chinese. Chinese is a discourse–configurational language just like Japanese, and therefore a topic/focus feature is in a numeration by default. But unlike Japanese, the basic sentence structure in Chinese is a topic-comment structure. It follows from this that canonically-ordered sentences and corresponding topicalized sentences are included in the same reference set. Since topicalized sentences contain no marked operation, they are chosen as the optimal <d, i> for inverse scope, which in turn means that deriving inverse scope from canonically-ordered sentences is blocked. We also discussed why postverbal *gei* sentences with a ditransitive verb and sentences with a locative QP show scope ambiguity. These sentences have no topicalized counterpart, and as such, they are optimally associated with inverse-scope interpretataions.

3.7. Summary

In this chapter, we provided an answer to the second set of questions raised in Chapter 1: why do the sentences with multiple scope-taking elements in Chinese display only surface-scope interpretations? And why do only some types of sentences allow inverse scope? Although Chinese does not allow scrambling, topicalized sentences block inverse scope in most types of sentences. There are also sentences which do not have topicalized counterparts, in which case scope ambiguity may arise.

Chapter 4 Acquisition of Scope Interaction

4.1. Introduction

In the previous chapters, we demonstrated that reference-set computation is executed when QR is to apply. In this chapter, we will review past acquisition studies on scope interaction and reference-set computation, and answer the last question raised in Chapter 1, that is, the question of why children inconsistently accept inverse-scope readings, and why it is more difficult even for adults to obtain inverse-scope readings than surface-scope readings.

In Section 4.2, we will review acquisition studies on scope interaction in Japanese and Chinese, and reanalyze the data reported in previous studies. It has been observed in the literature that when a truth-value judgment task is conducted, Japanese children accept inverse-scope readings in a non-adultlike way. But our statistic reanalysis reveals that Japanese children's acceptance rates of inverse-scope readings are not significantly different from chance level. We will also present results of a novel experiment with Chinese-speaking children which was designed to investigate whether they accept non-adultlike inverse-scope interpretations just like Japanese children. The results show, however, that Chinese children systematically succeed in rejecting inverse-scope construals. To examine the differences between Japanese and Chinese acquisition data, we will see in Section 4.3 how children respond in a truth-value judgment task when other types of sentences which require reference-set computation are used. In Section 4.4, we will demonstrate that Japanese children inconsistently accept inverse-scope readings due to the difficulty in handling reference-set computation. In Section 4.5, the results of our follow-up experiment will be reported, and we will discuss why Chinese children show adultlike responses. Section 4.6 will be devoted to the discussion of the cost of reference-set computation for QR. Section 4.7 summarizes this chapter.

4.2. Scope Interaction in Child Language

4.2.1. Overview

This section examines whether children speaking a scope-rigid language (in particular Japanese and Chinese) can reject inverse-scope readings in an adultlike manner. In Section 4.2.2, we will review previous experimental studies which employed a truth-value judgment task, and reanalyze the obtained experimental data. One of the interesting results reported in these studies is that Japanese-speaking children allow inverse-scope readings of doubly-quantified sentences unlike adults. However, detailed statistic analyses reveal that children's acceptance rates of inverse-scope readings are not significantly different from chance. Section 4.2.3 is primarily concerned with the scope interaction in child Chinese. The results of past experimental studies, together with our own experimental results, show that Chinese-speaking children can successfully reject unattested inverse-scope interpretations. It should be mentioned that we restrict our attention to those experimental studies which employed truth-value judgment tasks and used test sentences containing two quantifiers. Scope interaction between other scope-bearing elements such as negation and modals will not be discussed.

4.2.2. Scope Interaction in Child Japanese

4.2.2.1. Overview

This section reviews four previous studies on scope interaction in child Japanese. Most of these studies claim without conducting a detailed statistical analysis that Japanese children accept inverse-scope readings unlike adults. Although Goro (2007) offers a statistic-based analysis, his argument calls for closer scrutiny. In what follows, we will closely examine the data obtained in previous studies, demonstrating that Japanese children's acceptance rates are not different from chance.

4.2.2.2. Sano (2004)

To our knowledge, Sano (2004) is the first experimental study on scope interaction in child Japanese. He investigates Japanese children's scope interpretations in canonically-ordered sentences and scrambled sentences. In his experiment, 20

monolingual Japanese-speaking children aged 4;1 to 6;5, and 10 adult controls were tested using a truth-value judgment task. Below are the test sentences used in his experiment.

(1) a. Dareka-ga dono neko-mo tukamaeta. ∃> ∀, *∀> ∃
someone-NOM every cat-also caught
'Someone caught every cat.' (Sano 2004)

b. [Dono neko-mo]$_i$ dareka-ga t_i tukamaeta. ∀> ∃, ∃> ∀
every cat-also someone-NOM caught
'Someone caught every cat.' (Sano 2004)

The two sentences in (1) have an existential QP subject and a universal QP object, the difference being that while sentence (1a) is in canonical word order, (1b) contains a scrambled object preceding the subject. In adult Japanese, the existential QP in sentence (1a) unambiguously takes wide scope, but scope ambiguity is observed in sentence (1b). In Sano's experiment, these test sentences were presented in two different scenarios: in one scenario, there was a boy who caught all cats, and in the other scenario, each cat was caught by a different child. In adult's grammar, the former story makes both test sentences true, while the latter scenario makes only (1b) true. The table in (2) summarizes the results obtained in his experiment. Sano (2004) only reported the children and adults' acceptance rates in each condition, but in the table below, we added p-values of binomial tests to see whether his claim is statistically supported.

(2) Correct Response Rates

		∃> ∀		∀> ∃	
Canonical sentence	Children (4;1-6;5)	18/20 (90%)	$p < .001$	14/20 (70%)	$p = .12$
	Adult Control	10/10 (100%)	$p < .001$	2/10 (20%)	$p = .11$
Scrambled sentence	Children (4;1-6;5)	15/20 (75%)	$p < .05$	14/20 (70%)	$p = .12$
	Adult Control	10/10 (100%)	$p < .001$	10/10 (100%)	$p < .001$

It can be seen that children consistently accepted the surface-scope reading of the canonical sentence much the same way as adults (binomial test, $p < .001$). However, they failed to reject the inverse-scope reading about 70% of the time. Sano argues that the 70% acceptance rate indicates their failure of rejecting the test sentence, but our statistic analysis shows that this acceptance rate is not different from chance (binomial test, $p = .12$). Adults, on the other hand, accepted the inverse-scope reading of the canonically-ordered sentence only 20% of the time, but their acceptance rate is also not significantly different from chance (binomial test, $p = .11$). However, the Chi-square test reveals that the children's acceptance rate is significantly different from that of adults' (Chi-square test, $p < .01$). The results for the scrambled sentence show that children's acceptance rate of the surface-scope reading is not significantly different from chance (binomial test, $p = .12$), while that of the inverse-scope reading is above chance (binomial test, $p < .05$).

Although Sano's experimental results are new and interesting, a follow-up study is called for. Goro (2007) pointed out three flaws of Sano's experiment. First, the data set was quite limited, and it contained only one item per condition. Secondly, there is an entailment problem with the scrambled sentence; namely, the surface-scope interpretation entails the inverse-scope reading. Thus, in this experiment, accepting the inverse-scope reading does not necessarily warrant the conclusion that inverse scope is indeed grammatically available. Lastly, the Japanese indefinite existential QP *dareka* 'someone' was used in an infelicitous context. In the scenario where an existential QP takes wide scope, it refers to a person who is known to the speaker. The context provided in this experiment, however, is apparently not one where an indefinite *dareka* 'someone' is felicitously used. To use the indefinite *dareka* felicitously, the context must be set up in such a way that the speaker of the test sentences is not sure who caught every cat in the scenario. Goro (2007) modified Sano's experimental design, and conducted experiments designed to investigate whether children apply scope-shifting operations in the same way as adults do. Before embarking on the discussion of Goro (2007), we will examine Yamakoshi and Sano (2007) in the next section.

4.2.2.3. Yamakoshi and Sano (2007)

Yamakoshi and Sano (2007) investigate children's understanding of the scope interaction between an existential quantifier and a universal quantifier in mono-clausal and bi-clausal structures. The test sentences used in this experiment came in two types, as shown in (3). These sentences differ in that while the two quantifiers are in the same clause in sentence (3a), they are in the subject positions of different clauses in the case of sentence (3b).

(3) a. *Mono-clausal structure*

Dareka-ga	dono	neko-mo	tukamaetayo.
someone-NOM	every	cat-also	caught

'Someone caught every cat.' (Yamakoshi and Sano 2007: 478)

b. *Bi-clausal structure*

Dareka-ga	dono	ringo-mo	oisii-to	ittayo.
someone-NOM	every	apple-also	delicious-that	said

'Someone said that every apple was delicious.' (Yamakoshi and Sano 2007: 478)

In both sentences, the existential QP *dareka* 'someone' unambiguously takes wide scope over the universal QP *dono neko/ringo* 'every cat/apple'. Recall at this point that according to our analysis, the scope rigidity of (3a) and that of (3b) stem from different mechanisms. Inverse-scope readings for mono-clausal sentences like (3a) are blocked on the grounds that canonically-ordered sentences compete with corresponding scrambled sentences like (4) through the process called reference-set computation.

(4)

Dono	neko$_i$-mo	dareka-ga	t_i	tukamaetayo.
every	cat-also	someone-NOM		caught

'Someone caught every cat.'

On the other hand, bi-clausal sentences like (3b) do not allow inverse-scope readings because, as is well known, QR is clause-bounded, and hence non-clausemate QPs do not scopally interact.

Yamakoshi and Sano, employing a truth-value judgment task with 28 monolingual Japanese-speaking children aged 4;3 to 6;9 (7 four-year-olds, 9 five-year-olds and 12 six-year-olds), investigated whether children could correctly reject inverse-scope readings of the test sentences. Eleven native Japanese adults also participated in this experiment as a control group. Tables (5) and (6) summarize the results of the experiments. We ran a binomial test on the data from each subject group in each condition, and included the obtained p-values in the tables.

(5) Acceptance rates for mono-clausal structures and *p*-values obtained from the binomial test

	∃> ∀		∀> ∃	
Children	92.9% (52/56)	$p < .001$	32.1% (18/56)	$p = .01$
Adults	100% (22/22)	$p < .001$	0% (0/22)	$p < .001$

(6) Acceptance rates for bi-clausal structures and *p*-values obtained from the binomial test

	∃> ∀		∀> ∃	
Children	94.6% (53/56)	$p < .001$	48.2% (27/56)	$p = .89$
Adults	95.5% (21/22)	$p < .001$	4.5% (1/22)	$p < .001$

Let us consider mono-clausal structures first. As shown in (5), the children correctly accepted surface-scope readings 92.9% of the time. The binomial test reveals that the acceptance rate is statistically significant (binomial test, $p < .001$). They also incorrectly accepted inverse-scope readings only 32.1% of the time, which is significantly below chance (binomial test, $p = .01$). Although children performed in an adultlike way, the Chi-square test reveals that children's acceptance rate of inverse-scope readings is significantly higher than adults' (Chi-square, $p < .005$). Note that the results on the inverse-scope reading here are not similar to those reported in Sano (2004). As we have seen, in Sano's (2004) experiment, both children' acceptance rates and adults'

acceptance rates of inverse-scope reading were within the range of chance performance. It is not clear why the two studies did not obtain convergent results, but it should be noted that both experiments showed that children accepted inverse-scope readings more often than adults.

The results for bi-clausal structures show children's high performance on surface-scope readings (94.6%; binomial test, $p < .001$). However, they failed to reject inverse-scope interpretations 48.2% of the time, which is not significantly different from chance (binomial test, $p = .89$).

In addition, by analyzing individual results, Yamakoshi and Sano also found that children's acceptance of inverse-scope interpretations in mono-clausal structures correlated with their acceptance of inverse-scope interpretations in bi-clausal structures. In their experiments, as the table in (7) shows, 11 children could not reject at least one out of two inverse-scope readings in the mono-clausal condition. Among them, 10 children also failed to reject at least one inverse-scope reading in the bi-clausal condition.

(7)

	Children	Adults
Number of subjects accepting at least one inverse-scope reading in mono-clausal structures	11	0
Number of subjects accepting at least one inverse-scope reading in bi-clausal structures among the subjects who accepted them in mono-clausal structures	10	0

The fact that some children consistently accepted unattested inverse-scope readings irrespective of clause type is not directly predicted since the unavailability of inverse-scope readings in the two trials supposedly stems from different mechanisms. That said, it is not evident whether the stimuli used in the bi-clausal condition actually tested participants' comprehension of bi-clausal sentences. Specifically, what Yamakoshi and Sano analyze as the embedded subject as in (3b) can possibly be sitting in the matrix object position. To be more precise, sentences like (3b) are structurally ambiguous.

Indeed, the thematic subject of the embedded predicate can be marked with either accusative case or nominative case, as demonstrated below, but this is masked by the particle *mo* in the case of (3b).

(8)	Dareka-ga	subete-no	ringo-o/-ga	oisii-to	ittayo.
	someone-NOM	all-GEN	apple-ACC/-NOM	delicious-that	said
	'Someone said that all apples were delicious.'				

Crucial to our discussion is the fact that there is a fair amount of evidence that the accusative-marked QP as in (8) sits in the matrix clause. While no consensus has yet been reached as to whether the accusative QP is base-generated or has moved from the embedded subject position (Kuno 1976, Saito 1983 among others), it is generally agreed that it occupies the matrix object position. Then, if the *mo*-marked QP in (3b) is analyzed as sitting in the matrix object position, it is natural that participants show consistent behavior in the mono-clausal condition and the bi-clausal condition alike because both conditions contain two QPs in the same clause.

In sum, the experimental results reported by Yamakoshi and Sano (2007) suggest that some children consistently rejected inverse-scope readings in mono-clausal structures, but they do not allow us to draw any conclusion regarding children's knowledge of scope interpretation in bi-clausal structures.

4.2.2.4. Goro (2007)

Goro (2007) is a follow-up study on Sano (2004). Revising Sano's experimental design, he conducted an experiment using the sentences like (9)[11].

[11] Goro also conducted a truth-value judgment task with 16 Japanese children aged 4;11 to 5;10 (mean age: 5;6) and 16 Japanese adults to see children's interpretation of scrambled sentences as in (i) in a context which matches the inverse-scope construal.

(i)	Aoi hako-mo kuroi hako-mo	Pikachu-dake-ga	aketa.	both $>$ only, $*$ only $>$ both
	blue box-also black box-also	Pikachu-only-NOM	opened	
	'Both the blue box and the black box, only Pikachu opened.'			

We will not discuss this experiment because it is orthogonal to our interest.

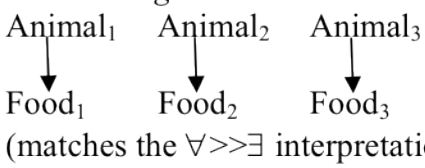
(9) Dareka-ga dono tabemono-mo tabeta. ∃> ∀, ∗ ∀> ∃
someone-NOM every food-also ate
'Someone ate every food.'

Goro modifed Sano's experimental design in the following ways. First, he employed a larger number of items (four test sentences per condition). Moreover, greater care was given to the contexts where indefinite QPs were used. As we saw, when indefinite *dareka* is used, the speaker generally does not know who the referent is. In Goro's experiment, the experimental setting was such that the speaker of the test sentences did not remember who ate the food.

The participants of the experiment were 16 Japanese children aged 4;10 to 5;9 (mean age: 5;4) and 16 Japanese adults. The experiment was composed of two phases. In the first phase, 12 groups of animals, each of which had three animals of the same kind, were introduced. Each group participated in an "eating game", and they were instructed to eat three pieces of food (e.g., a cream puff, banana, and a pepper). There were two rules in the game. The first rule is that every food must be eaten, and another rule is that each member of a group must eat one piece of food. If each member of a group is generous enough to share the food and each animal eats something, the group gets a gold medal. By contrast, if a group fails to share the food because one member in the group is greedy and eats all food by himself, the group gets a black cross. If a group successfully shares the food but one member refuses to eat the assigned food because he does not like it, the group also loses the game and gets a black cross. The three scenarios are illustrated as follows:

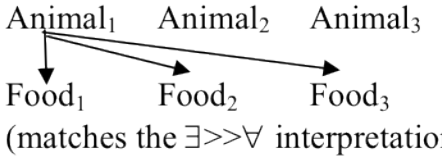
(10)

a. *Success: a gold medal*



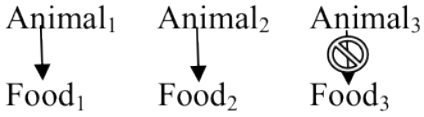
(matches the ∀>>∃ interpretation)

b. *Failure type I: a black cross*



(matches the ∃>>∀ interpretation)

c. *Failure type II: a black cross*



(Goro 2007: 49)

Note that the successful pattern matches the inverse-scope interpretation of the test sentences as in (9), and the first unsuccessful pattern matches the surface-scope interpretation. After all groups were introduced, participants proceeded with the second phase of the experiment, namely a truth-value judgment task. A puppet manipulated by an experimenter said that he did not remember what happened in the game, and started to guess how well each group did in the game based on the reward they got. There were four critical trials testing children's inverse-scope readings, which were interspersed with eight fillers. In addition to the main experiment, a control experiment was conducted with 16 Japanese-speaking children (age: 4;9-5;9, mean age: 5;3) to test their surface-scope readings.

The acceptance rates of the surface-scope and inverse-scope readings are shown below.

(11) a. Acceptance rates of the surface-scope readings

	Surface-scope readings
Japanese children (N=16)	90.6% (58/64)
Japanese adults (N=16)	–

b. Acceptance rates of the inverse-scope readings

	Inverse-scope readings
Japanese children (N=16)	42.2% (27/64)
Japanese adults (N=16)	0% (0/64)

In the control experiment, children consistently accepted surface-scope readings 90.6% of the time. In the main experiment, while Japanese adults never accepted inverse-scope readings in the canonical sentences, children failed to reject them 42.2% of the time. The 42.2% acceptance rate is too high to conclude that children do not allow inverse-scope readings, but at the same time it is too low to conclude that they accepted inverse-scope readings. Goro offers his own interpretation of this acceptance rate by conducting the same experiment with 29 adult English speakers, and comparing the results with Japanese children's results[12]. The test sentences for English speakers were like (12).

(12) Someone ate every food. ∃> ∀, ∀> ∃

Given that this type of sentence is scopally ambiguous in English, it is expected that English-speaking adults accept inverse-scope readings just as they accept surface-scope readings. However, the results were that adult English speakers accepted them only 33.6% of the time (39/116), which is nearly the same acceptance rate as the Japanese children's. Moreover, Goro reports that both Japanese-speaking children and English-speaking adults exhibited inconsistent acceptance patterns. The table in (13) shows the distribution of individual acceptance rates of these two groups. In these experiments, there were four critical trials, and thus each of the individual acceptance rates of inverse scope should be 0%, 25%, 50%, 75% or 100%.

[12] Goro also did the same experiment with English-speaking children, but we do not consider the data from this group since they are not crucial to our discussion.

(13)

% acceptance of inverse scope	0%	25%	50%	75%	100%	Total N
Japanese children (n)	5	3	3	2	3	16
English adults (n)	14	3	3	6	3	29

(cf. Goro 2007: 56)

A Chi-square test was conducted to compare the difference in the distributional pattern of acceptance between the two groups, and no significant difference was found (χ^2 = 2.74, p = 0.603). Based on the fact that the two groups showed similar response patterns, Goro concluded that Japanese children do in fact accept inverse-scope readings in canonically-ordered sentences.

Goro's argument hinges on his interpretation of the English-speaking adults' performance in his experiment. The crucial point is that although English-speaking adults showed rather poor performance on sentences with inverse-scope construals, he took the results as expected "successful" performance, leaving aside the question of why adults apparently failed to endorse inverse-scope readings in the experiment. The tacit assumption here is that since inverse-scope readings in English doubly-quantified sentences are independently attested or reported to be available, adults' performance should be taken as a baseline of success however poor it may turn out to be. To be fair, however, the 33.6% acceptance rate cannot normally be considered to be successful. Moreover, we conducted a binomial test and found that their total acceptance rate is significantly lower than chance (binomial test, p < .001). The statistic analysis indicates that English adults in Goro's experiment consistently rejected the inverse-scope interpretations of the test sentences, and to that extent, it is not reasonable to conclude, based on the English-speaking adults' performance, that Japanese children's grammar permits inverse-scope readings.

We also conducted binomial tests on Japanese children's data and Japanese adults' data, and the results show that Japanese children's acceptance rate is not significantly different from chance (binomial test, p = .26) unlike Japanese adults' performance.

(14) Results of a binomial test

	Acceptance rate	*p*-value
Japanese children (N=16)	42.2% (27/64)	$p = .26$
Japanese adults (N=16)	0% (0/64)	$p < .001$

To sum up, based on the results of a series of experiments with Japanese and English speakers, Goro (2007) concluded that Japanese children accept inverse-scope readings of canonically-ordered sentences with multiple QPs. However, according to our detailed statistic analyses, there is no strong reason to believe that Japanese children's acceptance of inverse-scope readings differ from chance.

4.2.2.5. Sano (2009)

Sano (2009) examines whether children accept inverse-scope readings of a doubly-quantified sentence with a numeral and a universal quantifier like (15).

(15) Ni-hiki no buta san-ga dono koppu-mo kosutta. two>every, *every>two
two-CL of Mr.Pig-NOM every cup-also brushed
'Two pigs brushed every cup.'

A truth-value judgment task was employed with 20 Japanese-speaking children aged 5;0 to 6;10 (10 five-year-olds and 10 six-year-olds). Nine adults also participated in this experiment as a control group. The test sentences were presented after a story which made inverse-scope readings true. The results are summarized in (16). Based on these results, Sano argues that both 5-year-olds and 6-year-olds accepted inverse-scope readings more than adults (5-year-olds: 55%, 6-year-olds: 30%, adults: 11.1%). However, the binominal tests we conducted indicate that the children's acceptance rates are not significantly different from chance.

(16) The acceptance of the inverse scope readings

	5-year-olds	6-year-olds	Adults
Acceptance Rate	11/20	6/20	2/18
Percentage	55%	30%	11.1%
Binomial test	$p = .82$	$p = .12$	$p < .005$

4.2.2.6. Summary

In this section, we reviewed previous studies on scope interaction in the Japanese child language. Sano (2004), based upon his experimental results, claims that children accept inverse-scope readings of canonically-ordered sentences. However, our statistic analysis revealed that children in his experiment accepted them only by chance. Moreover, Goro (2007) pointed out some flaws with Sano's experiment. We also reviewed Yamakoshi and Sano (2007), who report that children who fail to reject inverse-scope readings in mono-clausal structures also fail to reject those in bi-clausal structures; that is, children's rejection of inverse-scope readings in mono-clausal structures correlates with their rejection of inverse-scope readings in bi-clausal structures. Although this correlation itself is not directly predicted by our analysis, we pointed out that a potentially interfering factor was not controlled for in their experiment, and to that extent, the conclusion drawn from the data is moot. Goro (2007) refined Sano's (2004) experimental design and conducted follow-up experiments. The results show that children accepted inverse-scope readings 42.2% of the time. Goro also conducted the same experiment with adult English speakers, and found that Japanese children's response patterns were not significantly different from adult English speakers. Based on these findings, he concludes that inverse-cope readings are allowed in Japanese children's grammar. However, as we pointed out, the data does not actually warrant his conclusion since our statistic analysis reveals that Japanese children might well have accepted inverse-scope readings only by chance. A similar remark can be made for Sano's (2009) experimental results.

4.2.3. Scope Interaction in Child Chinese

4.2.3.1. Overview

In the last section, we reviewed previous studies investigating scope interaction in child Japanese, and saw that children accept inverse-scope interpretations by chance. This section reviews previous acquisition studies conducted with Mandarin-speaking children, and examines to what extent they accept inverse-scope readings of sentences with multiple QPs. There has been a growing body of experimental research on children's interpretation of scope interaction, but the experimental methods employed differ across studies (see Lee 1986, 1991b for experiments employing picture-identification tasks, and Lee 1986, 1991a, 1991b and Chien and Wexler 1989 for act-out tasks, Lee 2008 for picture-verification tasks, and Lee 1997 and Su 2001 for truth-value judgment tasks). Here, we exclude from our discussion the studies carrying out a picture-identification task and an act-out task. These tasks allow us to identify what interpretations subjects have but there is no way to know what interpretations they do not have, and even if they allow multiple readings for a given sentence, we cannot see to what extent the dispreferred reading of the sentence is accepted. We also exclude Lee (2008) because he investigates children's sensitivity to clause boundedness, which is orthogonal to our interest here. Thus, in the following section, we will review Lee (1997) and Su (2001) to consider whether Mandarin-speaking children accept inverse-scope readings.

4.2.3.2. Lee (1997)

In Lee's (1997) study, an experiment employing a truth-value judgment task was conducted to test how children interpret sentences with multiple scope-taking elements. The participants of this study were 13 Mandarin-speaking children aged four and 14 children aged five. As a control group, 14 Mandarin-speaking adults also participated in this experiment. The test sentences came in five different types, two of which are relevant to our discussion.

(17) a. Universal-quantifier subject; numeral object

suoyoude	shushu	dou	tiao-zhe	liang-tong	shui.
所有的	叔叔	都	挑-着	两-桶	水
all	uncle	each	carry.on.shoulder-ASP	two-CL	water

'All the men are carrying (on their shoulder) two buckets of water.'

b. Numeral subject; numeral object

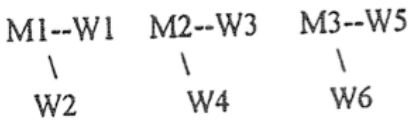
you	san-ge	shushu	tiao-zhe	liang-tong	shui.
有	三-个	叔叔	挑-着	两-桶	水
have	three-CL	uncle	carry.on.shoulder-ASP	two-bucket	water

'Three men are carrying (on their shoulder) two water-buckets.'

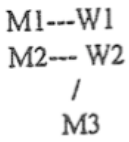
The sentences in (17a) and (17b) were provided in six contexts illustrated in (18).

(18) Contexts for (17a) and (17b) (M=person, W=water bucket, S=stone)

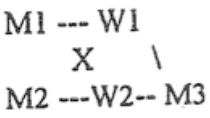
a. distributive



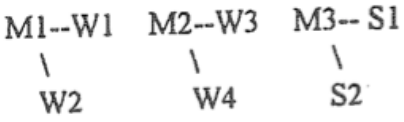
b. cumulative



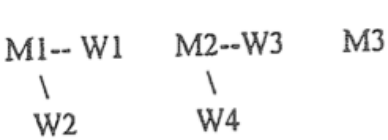
c. each-all



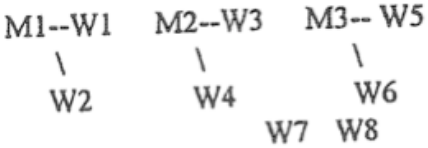
d. unrelated-theme



e. non-exhausted agent



f. extra-theme

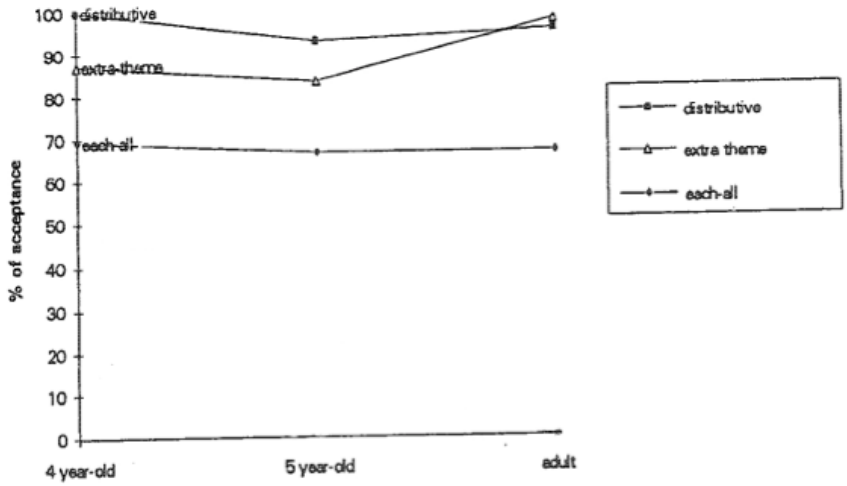


Our current interest is to know whether children accept inverse-scope readings and surface-scope readings. Thus, among these conditions, we would like to focus on the

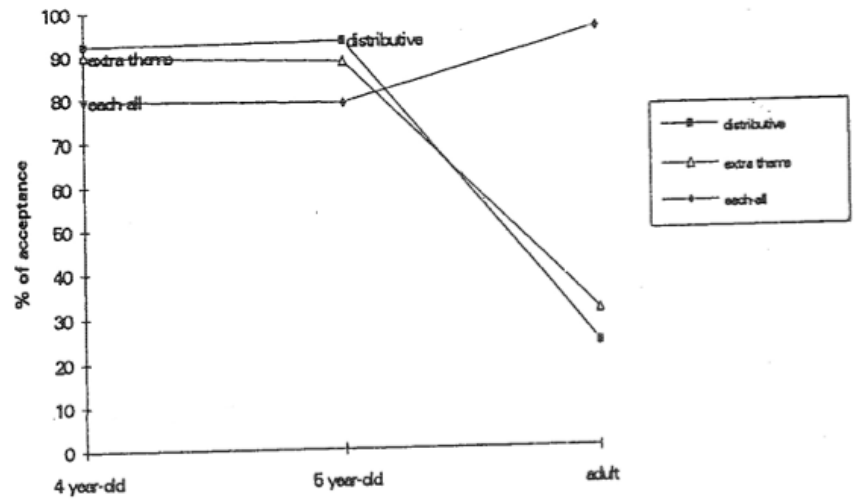
sentences in (17) provided in the context of (18a, c, f). Under the inverse-scope interpretations, the sentences in (17) are true if there are two buckets of water such that all men are carrying them, a context that is illustrated in (18c). Under the surface-scope readings, on the other hand, the sentences would be true if there are men and each of them is carrying two buckets of water, as depicted in (18a, f).

The figures in (19) and (20) plot the results of this experiment. (The figures are taken from Lee 1997, but to highlight the results of the conditions that are of relevance to our discussion, irrelevant details are omitted.).

(19) Universal quantifier subject; numeral object: (17a)



(20) Numeral subject; numeral object: (17b)



As observed in (19) and (20), children highly accepted the test sentences in (17) in all three conditions. Specifically, both sentences were accepted approximately 85% in the distributive and extra theme contexts, which make the surface-scope readings true. This indicates that children successfully accept the surface-scope readings of the sentences in (17). Children also accepted them in the each-all context approximately 70%. However, these results do not necessarily indicate that children indeed accepted inverse-scope construals because there is an entailment problem. That is to say, the situation in (18c), where each man is holding two buckets (though the buckets that all men are holding are the same ones), makes both the surface-scope construal and the inverse-scope construal true. Thus, we cannot exclude the possibility that children accepted the test sentence in the context of (18c) as a special case of the surface-scope representation.

From the experiment conducted in Lee (1997), we can conclude that Mandarin-speaking children sufficiently understand surface-scope readings of sentences with multiple scope-taking elements, but the results are not informative as to whether children accept inverse-scope readings.

4.2.3.3. Su (2001)

As discussed in 3.6.4, postverbal *gei* sentences with multiple QPs, but not double-object constructions, show scope ambiguity.

(21) a. Shengdan yeye song-le yi-ge haizi mei-jian liwu.
圣诞 爷爷 送了 一-个 孩子 每-件 礼物
Santa Clause give- ASP one-CL child every-CL present
'Santa Clause gave a child every present.' ∃> ∀, * ∀> ∃

b. Shengdan yeye song-le yi-jian liwu gei mei-ge haizi.
圣诞 爷爷 送了 一-件 礼物 给 每-个 孩子
Santa Clause give- ASP one-CL present give every-CL child
'Santa Clause gave a present to every child.' ∃> ∀, ∀> ∃

In the double-object constructions in (21a), the universal quantifier cannot take wide scope over the existential quantifier, whereas the postverbal-*gei* sentences in (21b) allows both surface-scope and inverse-scope interpretations. Su (2001) investigated whether children interpret these sentences in an adultlike way. On a typical trial, children were presented with test sentences like the following.

(22) a. *Double-object construction*

Baixuegongzhu	gei	yi-ge	xiaojie	mei-duo	hua.
白雪公主	给	一-个	小姐	每-朵	花
Snow White	give	one-CL	lady	every-CL	flower

'Snow White gave a lady every flower.' ∃> ∀, * ∀> ∃

b. *Postverbal*-gei *sentences*

Xiao-airen	mai-le	mei-ge	jiezhi	gei	yi-ge	nühai.
小矮人	卖-了	每-个	戒指	给	一-个	女孩
dwarf	sell-ASP	every-CL	ring	give	one-CL	lady

'The dwarf sold every ring to a girl.' ∀> ∃, ∃> ∀

Each test sentence was presented after a story which matched either the surface-scope reading or the inverse-scope reading of the sentence. Children were asked to judge whether each test sentence described the story correctly. The participants were 27 Mandarin-speaking children aged 4;9 to 6;10 (mean age: 5;9) and 22 adult Mandarin speakers. The results of the experiments were summarized in (23). Since Su only reports the raw numbers and rates of acceptance, we ran binomial tests to examine whether children's acceptance rates differ from chance, and included the results in the table.

(23)

		Double object		Postverbal *gei*	
		∃> ∀	∀> ∃	∃> ∀	∀> ∃
Children	Number of acceptance	95/104	12/54	52/53	15/53
	Acceptance rate	91%	22%	98%	28%
	p-value of binomial test	$p < .001$	$p < .001$	$p < .001$	$p < .005$
Adults	Number of acceptance	85/88	3/44	37/39	8/39
	Acceptance rate	97%	7%	95%	21%
	p-value of binomial test	$p < .001$	$p < .001$	$p < .001$	$p < .005$

In this experiment, children successfully rejected the reading of *every* taking wide scope and accepted the *one*-wide-scope readings just as adults did. In the postverbal-*gei* condition, children also showed almost the same acceptance rates as adults[13]. Note, however, that the results for the postverbal-*gei* sentences cannot lead us to the conclusion that children's grammar permits the inverse-scope interpretation because here as well there is an entailment problem. That is, in every situation where the inverse-scope reading is true, the surface-scope reading is also true. The results are therefore silent about children's ability of deriving inverse scope. However, the double-object condition does not face the same problem. Thus, the conclusion we can draw from Su's experiment is that Mandarin-speaking children successfully rejected inverse-scope interpretations in the double-object construction.

Compared to Japanese children's high acceptance rates of inverse-scope readings, Su's experimental results are very interesting in that Chinese children show consistent adultlike responses despite the fact that Chinese is a scope-rigid language like Japanese. To our knowledge, however, no study has yet examined children's responses in the simplest constructions like SVO. Thus we conducted an experiment to investigate

[13] As we have seen, the test sentences in the postverbal-*gei* condition are scopally ambiguous. Then it is expected, contrary to the actual results, that adults should accept both surface-scope and inverse-scope readings, but it is not clear what makes it difficult even for adults to accept surface-scope interpretations.

whether unlike Japanese-speaking children, Mandarin-speaking children also successfully reject inverse-scope readings in simple sentences.

4.2.3.4. Experiment 1

4.2.3.4.1. Children's Interpretations of Numerals

The aim of Experiment 1 is to see whether Chinese children can successfully reject inverse-scope interpretations in simple sentences in canonical word order like (24) below.

(24)	You	yi-zhi	xiao-mifeng	chi-le	mei-zhong	shuiguo.	
	有	一-只	小-蜜蜂	吃-了	每-种	水果	
	have	one-CL	little-honeybee	eat-ASP	every-kind	fruit	
	'A little honeybee ate every kind of fruit.'						∃> ∀, * ∀> ∃

Running the experiment, we must set a felicitous context for a noun phrase existentially quantified by a numeral. Some experimental results in past studies reported that children might prefer interpreting a numeral phrase as specific. Su (2001) conducted a series of experiments with Mandarin-speaking children to investigate their scope interaction in passive sentences and negative sentences, and claims that young children tend to interpret numeral QPs as specific. Interestingly, she observed that Chinese children accepted inverse-scope readings but rejected surface-scope readings of sentences like (25) below.

(25)	Milaoshu	mei	you	qi	yi-zhi	gou.	¬ > ∃, ∃ > ¬
	米老鼠	没	有	骑	一-只	狗	
	Mickey.Mouse	not	have	ride	one-CL	dog	
	'Mickey Mouse did not ride a dog.'						

This type of Chinese sentence is ambiguous between two readings: one in which negation takes wide scope over the existential QP and one in which the existential QP takes wide scope over negation. Under the surface-scope reading, the sentence is true if

Mickey Mouse did not ride any dog, and under the inverse-scope reading, it is true if Mickey Mouse rode all but one dog. In Su's experiments, Chinese-speaking adults accepted surface-scope readings 89% of the time and inverse-scope readings 64% of the time. We ran binomial tests on the obtained results and found that their acceptance is statistically significant (surface-scope readings: $p < .001$, and inverse-scope readings: $p = .007$). In contrast, Chinese children accepted surface-scope readings only 26% of the time while they accepted inverse-scope readings 77% of the time. We also conducted binomial tests on the children's data and found that they reliably rejected surface-scope readings and accepted inverse-scope readings (surface-scope readings: $p < .005$, and inverse-scope readings: $p = .001$). Given children's consistent rejection of surface-scope readings and consistent acceptance of inverse-scope readings, Su concluded that Chinese children interpret *yi-zhi* 'one-CL' as specific, and this is why they always prefer wide-scope interpretations of existential QPs.

We can also find an experimental study with Japanese children whose results support the claim that children tend to take numerals as specific. Using a truth-value judgment task, Sano (2009) presented Japanese children with the following sentence in a context where the surface-scope interpretation was true; that is, each cup was brushed by different pairs of pigs.

(26) Dono koppu-mo ni-hiki no buta san-ga kosutta.
Every cup-also two-CL of Mr. Pig-NOM brushed
'Two pigs brushed every cup,.'

Twenty Japanese-speaking children and 16 Japanese-speaking adults participated in this experiment. Sano also investigated whether they accepted inverse-scope readings of canonically-ordered sentences like (15), repeated below.

(15) Ni-hiki no buta san-ga dono koppu-mo kosutta. two>every, *every>two
two-CL of Mr.Pig-NOM every cup-also brushed
'Two pigs brushed every cup.'

Interestingly, the results show that 10 out of 20 Japanese-speaking children successfully rejected the inverse-scope reading of sentence (15), and among them, only two children successfully accepted the surface-scope reading of sentence (26). In light of the fact that surface scope is generally easier to obtain than inverse scope, it is worthwhile to consider why these children successfully rejected the inverse-scope interpretation of sentence (15) but failed to accept the surface-scope reading. Although Sano does not take up this issue, one possibility is that children prefer numeral phrases like *ni-hiki no buta san* 'two pigs' to be specific. In fact, in certain contexts like (27), Japanese non-split QPs like *futatu no ringo-o* 'two of apple-ACC' are said to trigger an exhaustive presupposition. On the other hand, split QRs like *ringo-o futatu* 'apple-ACC two' has no such presupposition (cf. Nishiguchi 2009).[14]

(27) a. ??Onaka-ga suita node futatu no ringo-o kudasai.
stomach-NOM empty because two of apple-ACC give
'I got hungry, and so please give me two apples.'

b. Onaka-ga suita node ringo-o futatu kudasai.
stomach-NOM empty because apple-ACC two give
'I got hungry, and so please give me two apples.'

[14] Nishiguchi (2009) claims with some examples like (i) that a non-split QR, but not a split QR, presupposes a unique set of entities. According to her discussion, the sentence in (ia) is semantically deviant because the presupposition conflicts with the mention to other elephants.

(i) a. #2-to no zo-ga hashit-te, hoka no zo-wa suwat-teiru.
2-CL of elephant-NOM run-and other of elephant-TOP sit-PROG
'The two elephants are running and other elephants are sitting.'

b. Zo-ga 2-to hashit-te, hoka no zo-wa suwat-teiru.
elephant-NOM 2-CL run-and other of elephant-TOP sit-PROG
'Two elephants are running and other elephants are sitting.'

However, the contrast is not so sharp for many speakers, and the sentence in (ia) is totally natural. What is more, in Sano's (2009) experiment, all of 16 Japanese adults accepted the distributive reading of the sentence in (26). These results show that numeral phrases can be interpreted distributively.

If children are sensitive to this distinction or they tend to interpret numerals as specific, it is not surprising that they rejected surface-scope readings, but accepted inverse-scope readings when faced with sentences containing numerals. These things were taken into account in our experiment, where the experimental context was set up in such a way that numeral phrases should be interpreted quantificationally.

4.2.3.4.2. Experimental Design

We employed a truth-value judgment task with Mandarin-speaking children. On a typical trial, children heard the sentence shown in (24). This type of sentences in Mandarin Chinese does not show scope ambiguity.

(24)	You	yi-zhi	xiao-mifeng	chi-le	mei-zhong	shuiguo.
	有	一-只	小-蜜蜂	吃-了	每-种	水果
	have	one-CL	little-honeybee	eat-ASP	every-kind	fruit
	'There is a little honeybee eating every kind of fruit.'					∃> ∀, ∗ ∀> ∃

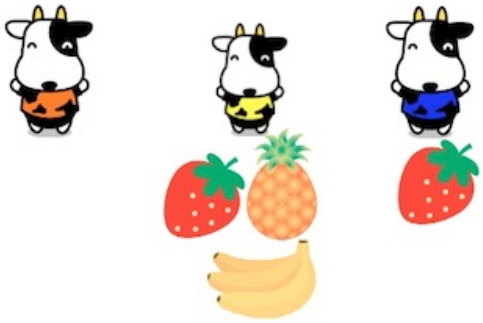
As we saw in 4.2.3.4.1, children may have tendency to interpret numeral phrases as specific. If children assign a specific interpretation to the subject numeral phrase *yi-zhi xiao-mifeng* 'a little honeybee' in (24), it is not clear how children handle scope interaction since specific NPs do not take scope. To avoid this problem, we told them prior to the experiment that the puppet was learning counting numbers, and tried to force quantificational interpretations. First of all, we introduced to the child a little monkey who did not know how to count numbers, and asked the child to teach him numbers. Then five cards with a picture of a giraffe were shown with a prompt asking her to show the monkey how to count them. This task was intended to make sure that she had no problem with counting numbers as well as understanding the classifier *zhi*, which is used for counting animals. After confirming that the child can count 1 to 5 without difficulty and understand the classifier *zhi*, we also checked whether she also correctly understood the classifier *zhong,* which is used for counting types. Then a banana, a pineapple and two apples were shown to the child, and an experimenter asked her how many kinds of fruit (*ji-zhong shuiguo* 'how.many-CL fruit') there were. The

correct answer is three, but if the child does not distinguish *zhong* from *ge,* which is a classifier for counting individuals, she should answer "four". Children who passed these pretests went on to the experimental part.

In the experimental part, children were asked to watch games named "sharing-fruit game" with a monkey puppet. The experiment was composed of two parts: a training part and a test part. The training part was intended to make them familiar with the procedures of this experiment. After each game, the monkey described what happened in the game. The task of the children was to judge whether the monkey described the game correctly. The design of the "sharing-fruit game" was essentially modeled after Goro (2007). The first game, which is a training part, contained three trials with three pictures. Each picture depicted a group composed of three members of the same animal shown in (28). In this game, each group was given three kinds of fruit: strawberries, bananas and pineapples. The important rule of this game was that each member of a group must eat only one kind of fruit, and every kind of the fruits had to be eaten. If each member of a group successfully eats one kind of fruit and the group jointly eats all kinds, the group would get a gold medal. But if some member is not generous enough to share the fruits and ate all kinds alone, the group will get a black cross. After the rule was explained, children were asked to judge which group should be awarded a gold medal. In the case of (28), children were expected to give a gold medal to the chick group, and a black cross to the horse group and the cow group.

(28) a. b.

c.



When the child gave a correct judgment, the experimenter asked the monkey whether he remembered what happened in the game, and the monkey answered, "I am not sure what happened in this game". Then the experimenter said, "Let's check whether the monkey remembers what happened to each group", and pictures were shown to the child one by one. The experimenter asked her how many kinds of fruit there were, and how many animals ate strawberries/pineapples/bananas. These questions were meant to ensure that she understood what the picture represented. After she answered these questions correctly, the monkey started to describe for each group what happened, and the child made a judgment as to whether the monkey's description was right. If she judged that it was wrong, she was asked why she thought so.

(29) is the test sentences used in the training part. Sentence (29b) was provided, pointing to an arbitrarily-selected chick. Sentence (29a) and (29c) were uttered with pointing either to an animal who ate every type of fruits or to an animal who ate some fruit. Children were expected to accept the test sentences in the former situation, but reject them in the latter situation. If children did not know that *mei zhong* means "every type" rather than "every individual unit", they should reject the test sentences in the former situation. Those children who did not understand the meaning of *mei-zhong* 'every-CL' or accepted all test sentences were excluded from the analysis.

(29)	a. Zhe-zhi	xiao-ma	chi-le	mei-zhong	shuiguo.
	这-只	小-马	吃-了	每-种	水果
	this-CL	little-horse	eat-ASP	every-kind	fruit

'This little horse ate every kind of fruit.'

b. Zhe-zhi xiao-ji chi-le liang-zhong shuiguo.
这-只 小-鸡 吃-了 两-种 水果
this-CL little-hen eat-ASP two-kind fruit
'This chick ate two kinds of fruits.'

c. Zhe-zhi xiao-niu chi-le mei-zhong shuiguo.
这-只 小-牛 吃-了 每-种 水果
this-CL little-cow eat-ASP every-kind fruit
'This little cow ate every kind of fruit.'

The test part was conducted in the same way as the practice part. In the test part, however, six groups participated in the game. Among the six pictures, two make the surface-scope interpretations true and the other four match the inverse-scope readings, as exemplified in (30) and (31) respectively[15].

(30) a. *Surface-scope reading*
You yi-zhi xiao-xiongmao chi-le mei-zhong shuiguo.
有 一-只 小-熊猫 吃-了 每-种 水果
have one-CL little-panda eat-ASP every-kind fruit
'There is a little panda eating every kind of fruit.'

b. Context

[15] Since previous studies (cf. Lee 1997, Sano 2004, Yamakoshi and Sano 2007, Goro 2007) report that children have no problem deriving surface-scope readings, we included only two items for testing surface-scope readings.

(31) a. *Inverse-scope reading*

You	yi-zhi	xiao-mao	chi-le	mei-zhong	shuiguo.
有	一-只	小-猫	吃-了	每-种	水果
have	one-CL	little-cat	eat-ASP	every-kind	fruit

'There is a little cat eating every kind of fruit.'

b. Context

In addition to these sentences, two fillers were also included in the stimuli.

(32) *Filler*

You	yi-zhi	xiao-xiongmao	chi-le	caomei
有	一-只	小-熊猫	吃-了	草莓。
have	one-CL	little-panda	eat-ASP	strawberry

'There is a little panda eating a strawberry'

The pictures as in (30b) were also provided with filler sentences, and thus two pictures were used twice.

4.2.3.4.3. Participants

Mandarin-speaking children were recruited at three kindergartens in Shenzhen: Shenzhen kindergarten, Cuizhu kindergarten and Meidiying kindergarten. Twenty children who had passed the pretest participated in our experiment. Among these children, three were excluded from the analysis because one accepted all the test sentences, and two did not give justifications for their responses, or rejected test

sentences for irrelevant reasons. The remaining 17 children were aged 4;8 to 6;3 (mean age: 5;3). Nine Mandarin-speaking adults also participated as adult controls.

4.2.3.4.4. Results and Discussion

(33) Acceptance rates and *p*-values obtained by a binomial test

		Surface reading	Inverse reading	Filler
Children	Number of acceptance	26/34	13/68	3/34
	Acceptance rate	76.5%	19.1%	8.8%
	p-value of binomial test	$p < .005$	$p < .001$	$p < .001$
Adults	Number of acceptance	18/18	0/0	10/18
	Acceptance rate	100%	0%	55.6%
	p-value of binomial test	$p < .001$	$p < .001$	$p = .81$

The table in (33) summarizes the results of this experiment. Adult participants accepted all surface-scope interpretations and rejected all inverse-scope interpretations. Similarly, children also overwhelmingly accepted surface-scope readings (binomial test, $p < .005$) and rejected the inverse-scope readings (binomial test, $p < .001$). A Cochran's Q test revealed that no difference was found between items in each condition (surface-scope readings: $p = .157$, inverse-scope readings: $p = .80$). In this respect, we can say that children showed adultlike responses in both conditions. It is also found from the distribution of individual acceptance rates shown in the table below that children showed consistent responses in the condition that tests comprehension of inverse scope.

(34) Individual acceptance rates of inverse-scope readings

0%	25%	50%	75%	100%	Total N
12	2	0	1	2	17

We also examined individual acceptance patterns of surface-scope readings and inverse-scope readings. (35) is a cross tabulation which plots the number of

subjects for each acceptance pattern. As we can see from the table, most of the children (11 children out of 17) showed adultlike responses for both readings.

(35) Number of subjects for each acceptance pattern

		Surface reading		
		0%	50%	100%
Inverse reading	0%	1	-	11
	25%	1	1	-
	50%	-	1	-
	75%	-	-	-
	100%	1	-	1

From the results obtained here, we conclude that Chinese children consistently reject inverse-scope readings and accept surface-scope readings just as adults do.

As we discussed in 4.2.2, Japanese children accepted inverse-scope readings of doubly-quantified sentences by chance. If Chinese-speaking children assigned a quantificational meaning to the numerals, the question arises as to why Chinese children, but not Japanese children, showed consistent adultlike performance.

One might wonder whether the context we set up failed to force numerals to be interpreted quantificationally, and children still assigned specific readings to numerals. However, this does not seem to be the case; children systematically rejected filler sentences like (32) in contexts like (30b), where there were two pandas who ate a strawberry. If the numeral *yi-zhi* 'one-CL' had had a specific referent in children's interpretation, they would have accepted the filler sentences. The systematic rejection of the filler sentences indicates that, at least in sentences without scope interaction, the numeral phrases were not interpreted referentially. However, numerals are not necessarily interpreted in the same way as in non-scope-interacting contexts. It is worth investigating whether children also assign non-specific readings to numerals in scope-interacting contexts. We will come back to this issue in Section 4.5.

4.2.3.5. Summary

In Section 4.2.3, we investigated whether Chinese children accept inverse-scope readings of doubly-quantified sentences unlike adults. In previous studies, Su (2001) reported that Chinese children successfully rejected inverse-scope readings of double-object sentences. Their adultlike interpretation is clearly different from Japanese children's. However, no studies have investigated to what extent Chinese children accept inverse-scope readings in simple structures like SVO sentences. We thus conducted a truth-value judgment task and found that Chinese children succeed in rejecting inverse-scope reading in an adultlike way. In Section 4.5 we will come back to the discussion of why Chinese-speaking children and Japanese-speaking children differ with respect to the way they interpret doubly-quantified sentences.

4.2.4. Summary and Questions

In Section 4.2, we examined scope interaction in child Japanese and child Chinese. Reanalyzing the data reported in past studies, we found that Japanese children inconsistently accept inverse-scope readings of canonically-ordered sentences in a non-adultlike way. However, our experimental results showed that Chinese children, who also speak a scope-rigid language like Japanese, successfully reject unattested inverse-scope readings just like adults. Given the experimental results, two questions arise. The first question is why Japanese children inconsistently accept inverse-scope interpretations. If they had simply lacked relevant linguistic knowledge to block inverse scope, they would have shown consistent acceptance. Thus the questions that must be answered are what their inconsistent responses reflect, and what makes it difficult for them to reject inverse-scope readings. The second question is why Chinese children successfully rejected inverse-scope readings. As we discussed in Chapter 3, in adults' grammar, deriving inverse scope is blocked in Chinese via reference-set computation, just as in Japanese. If the same mechanism underlies scope rigidity in both languages, the question arises as to why Chinese children, but not Japanese children, respond like adults. To address these questions, we will discuss how children carry out reference-set computation in other environments.

4.3. Child Reference-Set Computation

4.3.1. Overview

This section reviews acquisition studies on reference-set computation. According to previous studies, reference-set computation is at work at least in the following five environments: coreference in Principle B environments, computation of the Avoid Pronoun Principle, stress shift for focus identification, scalar implicatures and QR. There have been acquisition studies on the first four issues, and it has been argued that young children have difficulty in handling reference-set computation (Chierchia et al. 2001, Grodzinsky and Reinhart 1993, Reinhart 2006). Specifically, to complete the computation, it is necessary to construct a reference set and choose an optimal competitor out of the constructed reference set. This computation supposedly comes with a processing cost that exceeds children's processing capacity, and when faced with a task that requires reference-set computation, children resort to bypassing strategies to circumvent a processing overload. According to Reinhart (2006), this is why children's performance on tasks involving reference-set computation falls within the range of chance performance. In the following sections, we review acquisition studies on coreference in Principle B environments, pronoun interpretation in Avoid Pronoun contexts, stress shift for focus identification and scalar implicatures. A definition of a reference set for QR was given in Section 2.6. But in Section 4.3.2, we claim that another definition is required for a reference set for the four environments. Then, Section 4.3.3 reviews acquisition studies on coreference in Principle B environments and pronoun interpretation in Avoid Pronoun contexts. Reinhart (2006) states that when children are faced with the need to execute reference-set computation, there are two distinct bypassing strategies to avoid processing overload: a simple guessing strategy and an arbitrary default strategy. Coreference in Principle B environments and pronoun interpretation in Avoid Pronoun contexts are those areas in which children use a simple guessing strategy. In Section 4.3.4 we will review acquisition studies on stress shift for focus identification and scalar implicatures, where children tend to employ an arbitrary default strategy. Section 4.3.5 summarizes the discussion.

4.3.2. Two Definitions of a Reference Set

How the selection of competitors in a reference set is made has been a matter of debate. Recall that in Section 2.6, we gave the following definition for a reference set for QR.

(36) *Reference Set*

Two pairs of <d, i>, <d, i>$_1$ and <d, i>$_2$, are in the same reference set iff

a. <d, i>$_1$ and <d, i>$_2$ start with the same lexical array.

b. <d, i>$_1$ and <d, i>$_2$ do not violate local or global constraints.

However, in this section, we will claim that another definition is needed for reference-set computation in other environments such as coreference in Principle B environments, computation of the Avoid pronoun principle, stress shift for focus identification and scalar implicatures, which we review in the following sections. To avoid circularity, we will also explain why the selection of competitors in a reference set is made differently than in other areas of reference-set computation.

Previous studies offer two different slants on how a reference set is constructed: one is to assume that relevant derivations compete strictly within narrow syntax, and the other is that comparison occurs at the interfaces, based on the LF equivalence of relevant derivations. Specifically, in the former idea, two derivations are in the same reference set if both of them are convergent and start with the same lexical array (Chomsky 1993), while in the latter position, two derivations are compared if they have the same interpretation (Fox 1995, 2000, Reinhart 2006). According to Müller (2011), there are two types of constraints that require reference-set computation. One type is characterizes as "transderivational" constraints, which include, among others, Fewer Steps, Shortest Paths and Merge over Move, and the other is called "translocal" constraints, which include, among others, the Avoid Pronoun Principle. The difference between the two types of constraints is that, in the case of transderivational constraints, the optimal competitor is chosen on the basis of whether or not a marked operation is involved in the derivational steps, so that computing these constraints requires that a

set of full derivations with their derivational histories be held. In the case of translocal constraints, on the other hand, comparison is done on the basis of output representations, and in this sense how these representations are generated is not relevant. What is crucial here is that while QR is classified as a transderivational constraint in Müllar's taxonomy, other four constraints, namely coreference in Principle B environments, pronoun interpretation in Avoid Pronoun contexts, stress shift for focus identification and scalar implicatures, are instances of translocal constraints. We thus need different definitions of a reference set, depending on the type of constraint. As for transderivational constraints like QR, <d, i>$_1$ and <d, i>$_2$ are in the same reference set if they start with the same lexical array, and for translocal constraints, two derivations are compared if they have the same LF representation[16]. Below is the summery of the how reference sets are determined.

(37)

Environments	**Members of a reference set**
Coreference in Principle B environments	have the same LF representation
Avoid Pronoun Principle	
Stress shift for focus identification	
Scalar implicatures	
QR	start with the same lexical array

[16] In Müller (2011), too, the definition of a reference set depends on the type of constraint that applies.

(i) Reference Set for Transderivational Constraints:
Two derivations D_1 and D_2 are in the same reference set iff (a) and (b) hold:
a. D_1 and D_2 start with the same lexical array and have the same LF representation.
b. D_1 and D_2 do not violate local or global constraints.

(ii) Reference Set for Translocal Constraints:
Two representations R_1 and R_2 are in the same reference set iff:
a. R_1 and R_2 have the same lexical categories and the same LF representation.
b. R_1 and R_2 do not violate local constraints.

Details aside, these definitions are in line with the ones adopted in this dissertation in that members in a reference set for transderivational constraints are restricted to those which start with the same lexical array, but there is no such restriction for translocal constraints.

4.3.3. Simple Guessing Strategy

4.3.3.1. Overview

According to Reinhart (2006), when children are faced with the need to execute reference-set computation, they resort to either of the following two bypassing strategies: a simple guessing strategy or an arbitrary default strategy. In the following subsections, we will first look at the cases in which children adopt a simple guessing strategy, namely the cases of coreference in Principle B environments and computation of the Avoid Pronoun Principle.

4.3.3.2. Coreference in Principle B Environments

The interpretative properties of pronominal system are one of the most intensively studied areas of language acquisition. This is also the earliest area of acquisition research where reference-set computation is believed to be relevant.

It is generally agreed among generative grammarians that the distribution of pronouns is governed by Binding Principle B.

(38) Binding Principle B:
A pronominal is free [(not bound)] in its governing category
(Chomsky 1981: 220)

Binding and governing category are defined as follows.

(39) Binding
α is X-bound by β if and only if α and β are coindexed, β c-commands α, and β is in an X-position. (Chomsky 1981: 184)

(40) Governing Category
β is a governing category for α if and only if β is the minimal category containing and a SUBJECT accessible to α. (Chomsky 1981: 220)

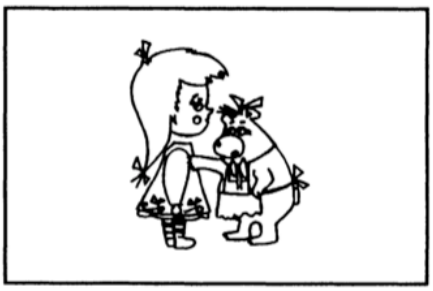
Chomsky's Principle B correctly accounts for the fact that *her* and *Mama Bear* cannot have the same referent in the following sentence.

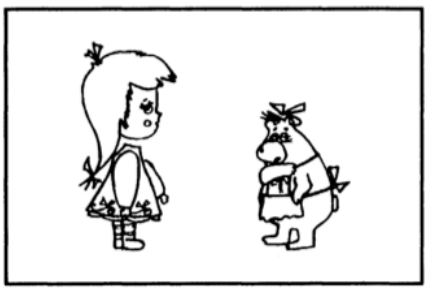
(41) Mama Bear$_i$ touched her$_{*i/j}$.

Soon after the binding theory was formulated, a number of studies reported that young English-speaking children apparently fail to show knowledge of Principle B, a finding that is not expected under the assumption that Binding Principles are principles of UG and hence need not be learned. In Chien and Wexler's (1990) seminal experiment, 44 children aged five to six were asked the question in (42) with the picture shown in (43a), and they correctly answered positively 99.2% of the time. However, when the same question was asked with the picture in (43b), they successfully gave a rejection only 49.2% of the time.

(42) Is Mama Bear touching her? (Chien and Wexler 1990: 262)

(43) a. b.



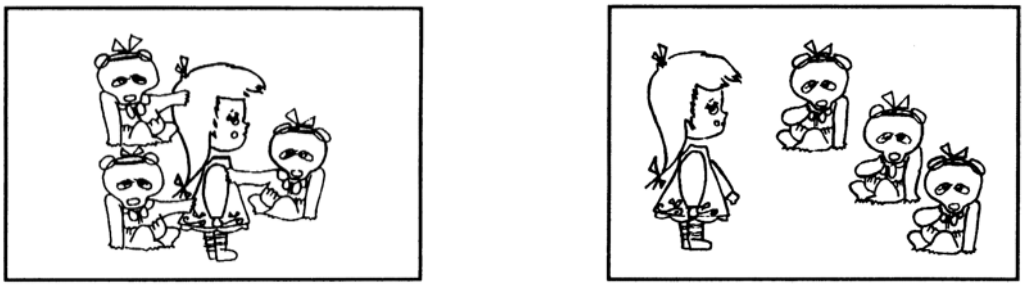


(Chien and Wexler 1990: 262)

Children's failure in the latter context cannot simply be attributed to their late acquisition of Principle B, because the same children gave correct responses to sentences with a quantificational antecedent like (44) in the context of (45a) and the context (45b) alike (accuracy rate: 97.9% and 83.7% respectively). These results seem to indicate that children indeed have knowledge of Principle B.

(44) Is every bear touching her? (Chien and Wexler 1990: 263)

(45) a. b.



(Chien and Wexler 1990: 263)

Grodzinsky and Reinhart (1993) argue that these seemingly contradictory observations receive a principled account under Reinhart's (1983) version of Binding Theory, and that the apparent delay of acquiring Principle B results from children's limited processing capacity[17].

Under Reinhart's theory, pronouns can establish anaphoric relations with their antecedents in two different ways: namely, by binding or covaluation (coreference). To illustrate the difference between the two mechanisms, consider the following sentence in (46a).

(46) a. Only Alfred$_i$ thinks that he$_i$ is a great cook. (Grodzinsky and Reinhart 1993: 74)

b. *Binding*

Only Alfred (λx (x thinks that x is a great cook))

c. *Covaluation*

Only Alfred (λx (x thinks that he is a great cook) & *he* = *Alfred*)

Sentence (46a) has two ways wherein the interpretation of the pronoun *he* is dependent on *Alfred*. In the case of binding, the pronoun is interpreted as a variable bound by a lambda operator (as represented in (46b)). In the case of covaluation, the pronoun picks

[17] Chien and Wexler (1990) do not attribute the children's incorrect interpretations of sentences like (42) to their processing limitations, but rather to their lack of relevant pragmatic principles. See Chien and Wexler (1990) for detailed discussion.

up the same value (reference) as *Alfred* (as represented in (46c)). The fact that these two readings are empirically distinct can be seen in the contrast in possible entailments for the sentence. The reading in (46b) entails that the other people do not consider themselves to be great cooks, while the reading in (46c) entails that the other people do not think that Alfred is a great cook. Crucially, on Reinhart's account, Principle B restricts only binding, and covaluation does not fall under Binding Theory. In the case of (42), the pronoun *her* can actually refer to *Mama Bear* via covaluation, although local binding of the pronoun is prohibited by Principle B. The theoretical prediction here obviously conflicts with native speakers' intuitions because (42) is normally unacceptable if *her* is coreferential with *Mama Bear*. According to Grodzinsky and Reinhart (1993) and Reinhart (2004, 2006), in those structural configurations where binding is in principle possible, coreference is prohibited if the intended coreference interpretation is equivalent to what would be obtained by binding. This is a well-known economy condition on accidental coreference called **Rule I** (Grodzinsky and Reinhart 1993: 79), originally proposed by Reinhart (1983). In (42), intrasentential coreference is blocked precisely because the same interpretation would be obtained by variable binding. The core idea behind Rule I is that binding is a more economical (and hence optimal) way of expressing anaphora than coreference, and therefore, the former is chosen over the latter. This means that assessing the availability of coreference (in certain restricted environments) calls for reference-set computation.

Let us elaborate more on how intrasentential coreference is blocked in (42). When the sentence in (42) is uttered in the context where Mama Bear touched herself like (43b), reference-set computation is carried out. To examine whether the pronoun can be covaluated with *Mama Bear*, it is necessary to construct a reference set. The reference set in this case is composed of two members: the <d, i> of (42), where *her* covalues with *Mama Bear*, and the <d, i> pair which involves binding and is truth-conditionally equivalent to the interpretation obtained by covaluation. Then the two members are compared and the <d, i> with binding is chosen as the most optimal derivation to generate the target interpretation. Since this process requires constructing a reference set with multiple derivations and making a global comparison of competitors held in working memory, it comes with a high processing cost, which presumably exceeds children's processing ability. As a result, they avoid processing

overload by using simple guessing as a bypassing strategy. This is the reason why their performance on coreference in Principle B environments falls within the range of chance level. Thornton and Wexler (1999) further conducted statistical analyses on their experimental outcomes to see whether children's individual accuracy rates were not significantly different from the binomial model of results expected by pure chance. The results of the analysis indicate that children participated in the experiments responded simply by guessing.

Note that children do well on those sentences which contain a quantified subject like (44). Grodzinsky and Reinhart's analysis nicely accounts for the contrast between children's performance on sentences with a referential subject and sentences with a quantificational subject. The point is that the quantified NP *every bear* has no reference, and therefore the pronoun cannot be referentially dependent on *every bear* via covaluation. So the interpretation can be excluded if children know Principle B. In other words, in the case of (44), reference-set computation is not called for because covaluation is not an option to start with. Therefore children succeed in responding in an adultlike way.

To sum up, children aged five to six do exhibit adultlike knowledge of Principle B but fail to show mastery of covaluation. This makes sense if we suppose that they have (innate) knowledge of Binding Principles but they have difficulty computing Rule I, which comes into play when covaluation possibilities are evaluated. The computation of Rule I, by its very nature, requires reference-set computation, and presumably children's limited working memory cannot withstand the cost of this computation. As a result, when faced with the need to calculate covaluation in Principle B environments, children give an answer by guess, and hence their performance consistently falls within the range of chance performance.

4.3.3.3. Avoid Pronoun

The second instance of reference-set computation where children use a simple guessing strategy is concerned with the Avoid Pronoun Principle. Chomsky's (1981: 65, 1982: 25) definition of the Avoid Pronoun Principle states that in a context where there is a choice between PRO and an overt pronoun (to express intrasentential anaphora),

PRO is chosen over an overt pronoun. This principle has the following consequence: if an overt pronoun is used in a context where PRO can occur, a disjoint interpretation is forced[18]. Most importantly for our discussion, computing the Avoid Pronoun Principle calls for reference-set computation because it involves comparison between a sentence with a pronoun and the corresponding sentence with PRO (see Müller 2011 for extended discussion); that is, it requires constructing a comparison set of <d, i> and selecting an optimal candidate within the constructed set.

Shibata and Yashima (2014) conducted an experiment designed to examine whether Mandarin-speaking children can successfully compute the Avoid Pronoun Principle in an adultlike manner. Mandarin Chinese provides an excellent opportunity to investigate children's knowledge of the Avoid Pronoun Principle. In the so-called V-*de* resultative construction, an overt pronoun in the embedded subject position must be interpreted as disjoint in reference from the matrix subject, as exemplified in (47a). By contrast, when the embedded subject is phonetically null, its reference is obligatorily dependent on the matrix subject, as exemplified in (47b).

(47) a. Dahuilang$_1$ chou-de ta$_{*1/2}$ yizhi kesou.
Big Wolf smoke-DE he continuously cough
'Big Wolf$_1$ smoked, and as a result he$_{*1/2}$ coughed again and again.'
(Shibata and Yashima 2014)

b. Dahuilang$_1$ chou-de PRO$_{1/*2/*arb}$ yizhi kesou.
Big Wolf smoke-DE PRO continuously cough
'Big Wolf$_1$ smoked, and as a result he$_{1/*2/*arb}$ coughed again and again.'
(Shibata and Yashima 2014)

Since there is no violation of syntactic principles (more specifically, Binding Principles), it is not immediately obvious why the pronoun in (47a) should be interpreted as disjoint in reference from the matrix subject. The illicitness of the conjoint reference construal is

[18] Several alternative analyses have been proposed to derive this principle from more general properties of language use (see Horn 1984, Levinson 1987, Huang 1994 among others), but the basic idea underlying all these proposals is that an optimal competitor is selected from a narrowly constructed set of alternative options.

most naturally viewed as a consequence of the comparison of two possible representations: one involving an overt pronoun and the other involving PRO (for a neo-Gricean account of this construction, see Huang 1994: 174). That is to say, although the conjoint interpretation of the pronoun is allowed by the computational system, it is ruled out on the grounds that an alternative well-formed derivation with PRO is available to express the same interpretation. This is how the obligatory disjoint interpretation comes about. Thus, to determine whether a pronoun in such an environment can establish anaphoric relations with an intrasentential antecedent, one must check whether the same interpretation can be obtained by an alternative well-formed derivation with PRO.

Using this construction, Shibata and Yashima examined Mandarin-speaking children's interpretation of pronouns in Avoid Pronoun contexts. The experiment employed a truth-value judgment task, and on a typical trial, children heard test sentences like those below.

(48) a. *PRO Condition*

Daxiang$_1$	chang-de	PRO$_{1/*2/*arb}$	ku-qi-lai	le.
Big Elephant	sing-DE	PRO	cry-up-come	ASP

'Big Elephant$_1$ sang, and as a result he$_{1*2/*arb}$ began to cry.'

b. *Pronoun Condition*

Daxiang$_1$	chang-de	ta$_{*1/2}$	ku-qi-lai	le.
Big Elephant	sing-DE	he	cry-up-come	ASP

'Big Elephant$_1$ sang, and as a result he$_{*1/2}$ began to cry.'

c. *Full DP Condition*

Daxiang	chang-de	Xiaohouzi	ku-qi-lai	le.
Big Elephant	sing-DE	Little Monkey	cry-up-come	ASP

'Big Elephant sang, and as a result Little Monkey began to cry.'

Each test sentence was provided by a puppet after the experimenter told a story. Each story had two versions.

(49) *Scenario A*

Big Elephant sang a sad song for Little Monkey. Big Elephant got excited while singing, but Little Monkey gradually became sad while listening and eventually started crying.

(50) *Scenario B*

Big Elephant sang a sad song for Little Monkey. Little Monkey was delighted to listen to the song, but Big Elephant gradually became sad while singing and eventually started crying.

The two scenarios differ in terms of whether or not the participant of the initial causing event is identical to that of the resulting event. In adults' grammar, the test sentence of the PRO condition must be rejected in scenario A, but accepted in scenario B. By contrast, the test sentence of the full NP condition must be accepted in scenario A, but rejected in scenario B. The main interest of this experiment lies in how children interpret the test sentences of the pronoun condition, where reference-set computation is required. For adult Chinese speakers, scenario A makes the test sentence of the pronoun condition true, and scenario B makes it false. If children have difficulty in handling reference-set computation, they are expected to give non-adultlike responses in the pronoun condition. In this experiment, the full NP condition is included to make sure that children know that the resultative predicate (e.g., *ku-qi-lai* 'cry-up-come' in (48c)) is predicated of the NP after V-*de*.

Eighteen Mandarin-speaking children aged 4;7 to 5;10 (mean age = 5;3) participated in this study, and the results show that they can give correct answers in the PRO condition 83.3% of the time and in the full DP condition 85.4% of the time, but their correct response in the pronoun condition dropped to 37.5%, which is not significantly different from chance (binominal test, p = .15). Their good performance in the PRO condition and the full DP condition reveals that they have no problem understanding the *de*-resultative construction. But they showed difficulty in identifying the referents of pronoun in Avoid Pronoun environments, a finding that comports well with Reinhart's theory.

4.3.4. Arbitrarily Default Strategy

4.3.4.1. Overview

In this section, we will review other experimental studies that suggest how children behave when they adopt an arbitrarily default strategy. We will examine stress shift for focus identification in 4.3.4.2 and scalar implicatures in 4.3.4.3.

4.3.4.2. Stress Shift

The first area where children reportedly adopt an arbitrarily default strategy is the stress-shift operation. Cinque (1993) proposes an influential analysis of stress determination. He distinguishes neutral stress from marked stress, which is also known as contrastive stress, and demonstrated that neutral stress is determined independently of focus consideration. Details aside, his theory, which is based on the Metrical Grid theory of Halle and Vergnaud (1987), argues that the neutral main stress always falls on the most deeply embedded constituent[19]. On this view, whether it is a VO language as English or an OV language as German, the most deeply embedded constituent *book* in (51) receives the main stress as schematized below. (Using bold indicates the place of the main sentence stress)

(51) a. I read the **book.**

b. dat ik het **boek** las.
that I the book read. (Reinhart 2004: 125)

Reinhart (2004, 2006) further claims that determination of the main sentence stress is deeply associated with a set of possible foci. (52) is the definition of a focus set. The focus set for (51) is schematized in (53).

(52) The focus set of IP consists of the constituents containing the main stress of IP.
(Reinhart 2004: 126)

[19] For detailed discussions of stress determination, see Cinque (1993) and Reinhart (2006).

(53) a. [$_{IP}$ Subject [$_{VP}$ V **Object**]]
b. [$_{IP}$ Subject [$_{VP}$ **Object** V]]
c. Focus set: {IP,VP, Object} (Reinhart 2004: 126)

A focus set is determined when both the syntactic tree and stress are visible. According to the definition in (52), in the case of (53a, b), IP, VP and Object are members of the focus set because these constituents contain the object, which receives the main stress. In actual use, all members in the set can in principle serve as a focus, as exemplified in (54b-d). By contrast, Speaker B's responses in (55a, b) are not felicitous because the focused constituents do not belong to the focus set.

(54) a. My neighbor is building a **desk**.

b. Speaker A: What's this noise?
Speaker B: [$_{F}$ <u>My neighbor is building a **desk**</u>]

c. Speaker A: What's your neighbor doing these days?
Speaker B: My neighbor [$_{F}$ <u>is building a **desk**</u>]

d. Speaker A: What's your neighbor building?
Speaker B: My neighbor is building [$_{F}$ <u>a **desk**</u>] (Reinhart 2004: 126)

(55) a. Speaker A: Has your neighbor bought a desk already?
Speaker B: #No, my neighbor is [$_{F}$ <u>building</u>] a **desk**.

b. Speaker A: Who is building a desk?
Speaker B: #[$_{F}$ <u>My neighbor</u>] is building a **desk**. (Reinhart 2004: 126)

In cases like (55), since the intended focus is not a member of the focus set with neutral stress, a stress-shift operation must apply. The operation is defined as follows. (We use star to mark stress.)

(56) *Main Stress Shift*

Add two stars. (Reinhart 2004: 127)

In the case of (55b), where the focus is put upon the subject, the main stress shift rule works in the following way.

```
                    *
    *       *       *
```

(57) My neighbor is building **a desk**. → **My neighbor** is building a *desk.*

(Reinhart 2004: 127)

In this case, the rule of main stress shift adds two stars on *my neighbor* and the main stress falls on the constituent. According to the definition in (52), the focus set of the obtained sentence contains *my neighbor*, and the sentence becomes totally felicitous in the context of (55b).

According to Reinhart, stress shift is a marked operation in that it violates the neutral main stress rule. Applying this operation requires executing reference-set computation to check whether it is indeed the only possible way to reach the target interpretation. A well-known characteristic of the focus obtained by the stress shift rule is that a projection cannot bear a focus. In other words, it always takes the narrowest focus, and in a stress-shifted sentence, the focus cannot fall on IP or VP as shown in (58) and (59).

(58) Speaker A: What's this noise?

Speaker B: #[$_F$ **My neighbor** is building a desk]

#[$_F$ My neighbor is **building** a desk] (Reinhart 2004: 129)

(59) Speaker A: What's neighbor doing these days?

Speaker B: #My neighbor [$_F$ is **building** a desk] (Reinhart 2004: 129)

Since the focus sets of subject-stressed sentences contains IP and the focus set of verb-stressed sentences contains IP and VP, as shown in (60b) and (61b), it is theoretically

possible for the stressed subject to project its focus to IP and the stressed verb to IP and VP, contrary to fact.

(60) a. **My neighbor** is building a desk.

b. Focus set: {IP, Subject} (Reinhart 2004: 130)

(61) a. My neighbor is **building** a desk.

b. Focus set: {IP, VP, V} (Reinhart 2004: 130)

According to Reinhart's (2004, 2006) claim, the projection of a focus in stress-shifted sentences is blocked via reference-set computation. Once the stress-shifting operation is applied, a reference set is constructed. By way of illustration, let us consider whether IP can be focused in the verb-stressed sentence in (61a). In this case, the reference set at least contains the following two members, which share the same IP-focused interpretation.

(62) a. <d: My neighbor is building a **desk**. → My neighbor is **building** a desk.
i: Focus: IP>

b. <d: My neighbor is building a **desk.**
i: Focus: IP> (Reinhart 2004: 130)

The <d, i> pairs in (62a) and (62b) are compared, and (62b) is chosen as the optimal derivation to derive the IP-focused interpretation since the interpretation is obtained without recourse to main stress shift, and as a result, (62a) is blocked. The stress shift like (62a) is, however, perfectly natural when the verb serves as a focus. In this case as well, reference-set computation is carried out in order to check whether the application of stress shift is justified. Since there is no other way to obtain the V-focused interpretation, stress shift is permitted.

(63) <d: My neighbor is building a **desk**. → My neighbor is **building** a desk.
i: Focus: V> (Reinhart 2004: 130)

Previous language acquisition studies that investigate whether children can handle stress-shift operations report that children understand sentences with neutral stress in an adultlike way, but they show adultlike interpretation only around 50% of the time when it comes to stress-sifted sentences.

Gennari et al. (2001) conducted a truth-value judgment task with 20 children aged from 4;1 to 5;8 (mean age: 4;8) to examine whether young children can handle sentences with neutral and non-neutral stress just as adults do. The stimuli used are exemplified in (64). Each test sentence was provided with a story. The story and the test sentence matched in the shifted-stress condition, but not in the neutral-stress condition. In the case of (64), for example, the story made it clear that the referent of the subject (the Troll in (64a) and the Storm Trooper in (64b)) threw an object (a Frisbee in (64a) and a chair in (64b)) to some characters and did not threw anything else available in the discourse situation. If children behave like adults, they are expected to reject (64a), and accept (64b).

(64) a. The Troll only threw a Frisbee to **Mickey Mouse**. [neutral stress]
(adultlike answer: no)

b. The Storm Trooper only threw **a chair** to Winnie the Pooh. [shifted stress]
(adultlike answer: yes)

The results of the experiment showed that young children successfully rejected the test sentences in the neutral stress condition 97.5% of the time, but they wrongly rejected the ones with shifted stress 63.5% of the time. Other studies such as Gualmini et al. (2003) and Szendrői (2004) replicated similar results. Given that children prefer to give a positive response when they are not sure about the answer (i.e. "yes bias" in the sense of Crain and Thornton 2000: 211), their rejection indicates that they had good reason to deny the test sentences in the stress-shifted condition. In Gennari et al.'s (2001) experiment, the experimenter asked children the reason for their rejection, and

interestingly, they consistently said that the sentence was wrong because Storm Trooper also threw a chair to another character in the story. This indicates that in those children's interpretations, the focus was assigned to the VP including the unstressed last NP.

What is worth noting here is that chance-level performance was observed at the group level, meaning that children consistently gave either adultlike answers or non-adultlike answers. In Szendrői's (2004) experiment, seven out of twenty-three children consistently gave adultlike yes answers on stress-shifted sentences like (64b), nine children consistently rejected the sentences, and the remaining seven children offered somewhat inconsistent answers. The fact that many children showed consistent performance is not quite amenable to the claim that children used simple guessing as a bypassing strategy to avoid processing overload.

According to Reinhart (2006), as we have already mentioned in Section 4.3, when children have trouble handling reference-set computation, they adopt either of the following strategies; the simple guessing strategy or the arbitrary default strategy. In the former case, children randomly give an answer in each trial by guess. In the latter case, on the other hand, they arbitrarily select an answer as the default and stick to their initial choice in subsequent trials. The latter strategy is claimed to be available in those tasks which involve semantic disambiguation. In the case of focus resolution, multiple interpretations are associated with one derivation, and the optimal focus is selected out of the focus set. This allows the arbitrary default strategy, and children choose one option as the default and adhere to it. As a result, they consistently produce either adultlike or non-adultlike answers. This is why chance performance was not observed at the individual level. Note that chance level performance was still observed at the group level because children's selection of the default is arbitrary[20].

To summarize the findings in previous studies on stress shift, young children have difficulty in handling the reference-set computation required for stress shift, which is directly confirmed by the fact that children display chance performance on truth-value judgment tasks involving stress shift. However, since children may take what is

[20] It might at first sight seem that the observed group-level chance performance can be explained if we assume that children have no difficulty in executing reference-set computation, but half of the subjects happened to lack knowledge of the stress shift rule. However, as Reinhart claims, in such a case, the same results will not be replicated across different experiments.

called the arbitrary default strategy, chance performance is expected to be observed only at the group level, but not necessarily at the individual level.

4.3.4.3. Scalar Implicatures

Another area where the arbitrary default strategy is reported to be employed by children is scalar implicatures. It is known that logical words like *or* and *and* constitute a scale (Horn 1972). Although the sentence in (65a) is normally interpreted as meaning (65b) and not (65c), (65c) is a logically possible interpretation.

(65) a. John brought pizza or pasta to the party. (Chierchia et al. 2001: 158)

b. John brought either pizza or pasta to the party.

c. John brought both pizza and pasta to the party.

The inclusive-*or* interpretation is witnessed in downward entailing contexts such as the restrictor of a universal quantifier, as exemplified in (66) (Chierchia et al. 2001).

(66) Every student who takes phonology or syntax must take psycholinguistics.

The reason why (65a) does not have an inclusive-*or* interpretation does not come from any grammatical constraint, but rather it is excluded due to scalar implicatures. Scalar implicatures arise when a weak expression is used while a stronger alternative holds true. In the case of (65a), circumstances that verify *A and B* are a subset of circumstances that verify *A or B.* Upon encountering the logical word *or*, we surmise that the speaker uses *or* rather than *and* since she has no evidence that the latter holds. In other words, the exclusive interpretation of (65c) comes from the comparison between the forms *A and B* and *A or B*. As discussed already, reference-set computation imposes a heavy cost on the language processing system, and young children with early working memory and processing capacity cannot execute it in an adultlike way. This is why children show non-adultlike performance.

Chierchia et al. (2001) conducted a series of experiments showing that children's difficulty in interpreting scalar implicatures comes from the difficulty of constructing a reference set. In their first experiment, children were asked to judge whether a sentence like (67) matched the context provided.

(67) Every dwarf who chose a banana or a strawberry received a jewel.
(Chierchia et al. 2001: 164)

The provided story was about Snow White and four dwarves at a picnic shown below.

(68) *Context*
When the dwarves are ready to choose some food, Snow White invites them to choose healthy food, and she promises a jewel to all the dwarves who will choose healthy food. She reminds them that bananas and strawberries are healthy food. Three of the dwarves want to receive a jewel, so they choose fruit, but they are very hungry, so they choose both a banana and a strawberry. One of the dwarves says he doesn't care about jewels, and he chooses potato chips. Snow White only gives a jewel to the dwarves who have chosen a banana and a strawberry. (Chierchia et al. 2001: 164)

What is crucial here is that computation of scalar implicatures is not required in sentence (67) because the scalar item appears in a downward entailing environment, and the sentence is true under the inclusive-*or* interpretation. In this experiment, 15 children aged from 3;7 to 6;3 (mean age: 4;11) participated, and they correctly accepted the target sentences with an accuracy of 91.6% (55 out of 60 trials in total). However, they showed non-adultlike interpretations on sentences like (69), where the logical word *or* is in an upward entailing environment.

(69) Every boy chose a skate-board or a bike. (Chierchia et al. 2001: 165)

This sentence was presented after a story in which four boys at a summer camp are choosing toys they are going to play with.

(70) *Context*

There are a lot of toys they can choose: some skate-boards, some bikes, a boat and a truck. After considering the possible choices, the four boys take both a skate-board and a bike. (Chierchia et al. 2001: 165)

In (69), a scalar implicature does arise and the sentence is judged as false in the context in (70) in adults' interpretation, since every boy chose both a skate-board and a bike. Fifteen children aged from 3;5 to 6;2 (mean age: 5;2) who did not participated in the first experiment were tested, and they correctly rejected the target sentence only 50% of the time (30 out of 60 trials in total). Chierchia et al. conducted another experiment and found that children's difficulty in computing scalar implicatures lies in the construction of a reference set, and once they succeed in constructing a reference set, they can complete the whole computation (also see Gualmini et al. 2001). In this experiment, two test sentences like (71) and (72) were presented by two puppets after a story, and children were asked to reward the puppet who described the story better. On a typical trial, they heard about some farmers who were cleaning their animals. In this story, each farmer cleaned both a horse and a rabbit.

(71) Every farmer cleaned a horse or a rabbit. (Chierchia et al. 2001: 167)

(72) Every farmer cleaned a horse and a rabbit. (Chierchia et al. 2001: 167)

Fifteen different children aged from 3;2 to 6;0 (mean age 4;8) participated in this experiment, and they correctly chose 93.3% of the time (56 out of 60 trials), when given a choice between (71) and (72). These results suggest that although children have difficulty in handling reference-set computation required to process sentences like (71), their performance improves if members of the reference set are presented. In other words, children have no difficulty in comparing competitors, and what they cannot do is to construct a reference set. These results are compatible with the claim that children already have knowledge of scalar implicatures, but show non-adultlike interpretations due to the heavy processing cost involved in scalar implicatures.

In these experiments, like the case of stress shift, chance performance is observed only at the group level, and individuals consistently accepted or failed to accept the test sentences. This is due to the semantic properties of scalar implicatures. In the case of (71), there are two semantic representations associated with the derivation, as shown in (73).

(71) Every farmer cleaned a horse or a rabbit.

(73) a. Every farmer (λx (x cleaned a horse or a rabbit)

b. Every farmer (λx (x cleaned a horse or a rabbit and ¬x cleaned a horse and a rabbit))

As we have seen in Section 4.3.4.2, this type of semantic property allows children to adopt the arbitrary default strategy, which results in group-level (but not individual) chance performance.

To wrap up, previous experimental studies on scalar implicatures show that it is hard for children to complete the computation of scalar implicatures, and when a truth-value judgment task is conducted, their accuracy rate falls into chance. However, since in the case of scalar implcatures, an arbitrary default strategy is available, individual children give consistent responses. Moreover, Chierchia et al. (2001) show that the difficulty young children have in carrying out reference-set computation lies in the construction of competitors. If the set of competitors is explicitly provided, they can complete reference-set computation like adults.

4.3.5. Summary

We have seen past acquisition studies on reference-set computation. The experimental results obtained by truth-value judgment tasks show that young children give non-adultlike responses to test sentences where reference-set computation is required. Specifically, our statistic analyses show that the acceptance rates obtained in past experimental studies are not different from chance, which cannot be explained

away if we assume that the source of their non-adultlike performance is the lack of relevant pragmatic rules. According to Reinhart, children's chance-level performance is due to their yet-to-be-developed working memory. That is, their limited processing capacity cannot withstand the cost of reference-set computation, and as a result, they respond by guess. On the basis of experimental results, Reinhart also argues that there are two types of bypassing strategies to resolve the costly computation: the simple guessing strategy and the arbitrary default strategy. In the case of simple guessing, the yes/no judgment on each sentence is done by guess, and thus chance performance is expected at the group level as well as at the individual level. In the case of the arbitrary default strategy, on the other hand, children make an arbitrary choice of one answer, and stick to the option. Thus, in dual-choice tasks, chance performance is still observed at the group level, but not at the individual level. The arbitrary default strategy is reported to be available only in tasks which involve semantic disambiguation.

4.4. Analysis of Japanese Children's Interpretation of Inverse Scope

In this section, we would like to consider the discussion on why Japanese children inconsistently accept inverse-scope interpretations. As we discussed in 4.2.2, reanalyzing the experimental data of Goro (2007) and Sano (2009), we found that Japanese children accept inverse-scope interpretations of canonically-ordered sentences by chance. As we demonstrated in Chapter 2, deriving inverse scope via QR calls for reference-set computation. When a doubly-quantified sentence is encountered in a context which makes an inverse-scope interpretation true, reference-set computation is carried out to examine whether the application of QR is the optimal way to derive the intended interpretation. According to the previous studies on children's reference-set computation, however, the heavy cost of this computation exceeds children's processing capacity, and as a result, they end up responding by guess. Then the reason that children showed chance-level performance in previous experiments on scope interaction may well be attributed to processing reasons. It should be noted that not only group performance but also individual performance reported in those experiments was compatible with chance. This is because the arbitrary default strategy, which is commonly adopted in tasks involving semantic disambiguation, is not available in the case of QR. Let us consider the following example.

(9) Dareka-ga dono tabemono-mo tabeta. ∃> ∀, ∗ ∀> ∃
someone-NOM every food-also ate
'Someone ate every food.'

This sentence is ambiguous between one reading where the existential QP takes wide scope over the universal QP and one reading where the universal QP takes wide scope over the existential QP. However, this is not an instance of semantic ambiguity since the two interpretations are generated from different syntactic derivations. In such a case, the arbitrary default strategy is not an available option, and the simple guessing strategy is adopted as a bypassing strategy.

In the past studies, children have difficulty on handling inverse scope, but show adultlike responses on surface-scope interpretations. Psycholinguistic studies have reported that, even for English-speaking adults, an inverse-scope reading of doubly-quantified sentences is more difficult to obtain than the surface-scope reading even in the case where the context is biased toward the inverse-scope reading or the sentence unambiguously has an inverse-scope reading (Anderson 2006). These results also follow if deriving inverse scope, but not surface scope, requires reference-set computation.

4.5. Numeral Interpretation in Scope-Interacting Environments in Child Chinese

4.5.1. Overview

We have so far argued that Japanese children accept inverse-scope interpretations by chance due to the fact that their immature processing capacity cannot withstand the cost of reference-set computation. The prediction of this analysis is that Chinese children also show non-adultlike chance performance when the same experiment is conducted. As we saw in 4.2.3.4, however, the Chinese-speaking children in our experiment consistently rejected inverse-scope interpretations in an adultlike way. In this section, we will examine the issue of why Chinese children provided successful adultlike responses. Specifically, we examine the possibility that Chinese

children's interpretation of numerals is different from adults', which results in successful responses to scopal interpretations. That is, children possibly assign specific interpretations to numeral phrases in scope-interacting environments and thus successfully rejected inverse-scope readings in Experiment 1. In what follows, we will first discuss related issues on children's interpretations of numerals. Then in 4.5.3, we will report results of our experiment designed to test this analytical possibility.

4.5.2. Exact Readings of Numerals

We have discussed in 4.2.3.4.4 that one possible interpretation of Chinese-speaking children's successful performance on sentences involving inverse-scope readings is that they assign specific interpretations to numerals. This hypothesis is worth testing since as discussed in 3.5, a numeral phrase after *you* 'have' tends to receive a specific indefinite reading. Before elaborating on our experiment, we would like to discuss some issues related to children's interpretation of numerals.

We have seen in 4.3.4.3 that the logical word *or* constitutes a scale with another logical word *and*. Numerals are also one of the classic examples of scalar terms. In addition to exact readings, numerals implicitly have "at-least" readings as well, which can be observed if a numeral appears in a downward entailing context. For instance, in contexts like (74), cardinal numbers are normally taken to express an exact number, so that the sentence in (74) is understood as asserting that John has exactly two apples.

(74) John has two apples.

In some environments, however, cardinal numbers can be interpreted as expressing the lower boundary. For example, sentence (75) does not mean that students who write exactly two papers receive a good grade, but rather means that the students who write two or more papers can receive a good grade.

(75) Students who write two papers receive a good grade.

The reason why cardinal numbers generally receive exact readings is that according to the neo-Gricean account, the "at least" readings would violate the maxim of

quantity, which requires speakers to make his contribution as informative as required and not to make his contribution than is required. Thus, if the speaker utters (74) in a situation where John has more than two apples, the sentence is not maximally informative in describing the situation. This is why an "exact" implicature is generated.

Previous studies on children's understanding of scalar terms have reported that children are often insensitive to similar types of scalar implicatures (Chierchia et al. 2001, Musolino and Lidz 2002, Noveck 2000). As we discussed in 4.3.4.3, children in previous experiments failed to calculate the scalar implicature of the logical term *or*. In contrast, Chinese children in our experiments rejected filler sentences like (32) in a context like (30b), where at least one panda ate a strawberry.

(32) *Filler*

You	yi-zhi	xiao-xiongmao	chi-le	caomei
有	一-只	小-熊猫	吃-了	草莓。
have	one-CL	little-panda	eat-ASP	strawberry

'There is a little panda eating a strawberry'

(30) b. Context

If children had had difficulty in computing scalar implicatures, participants in our experiment would have failed to reject the filler sentences in this context.

It has been pointed out that numerals trigger inferences that are essentially different from scalar inferences triggered by other scalar terms. For one thing, numerals display certain properties that are not observed for other scalar terms (Carston 1995, 1998, Horn 1992). Specifically, numerals can receive an "at most" reading (e.g. *She can have 2000 calories a day without putting on weight*), but other scalar terms do not

implicate the maximum border. The scalar term *some*, for instance, which constitutes a scale with *all*, can mean "some or all" but does not mean "none or some" (e.g. *Every student who take some language classes is required to take phonology.*). Based on the differences between numerals and other scalar terms, it has been argued that scalar inferences associated with numerals do not come from conversational implicatures, but rather are so underspecified that the "at least", "exact" and "at most" readings are all allowed for. This arguably results in the possibility of having an "at most" reading (for further disucssion, see Carston 1998, Levinson 2000, Sadock 1984 among others). In addition, it is reported that those children who have problem calculating scalar implicatures have no trouble assigning exact readings to numerals. Papafragou and Musolino (2003) conducted two experiments with Greek-speaking children employing a truth-value judgment task to investigate whether children aged five treat all types of scalar terms in the same way. The tested pairs of scalar terms are *some/all, two/three* and *start/finish.* Test sentences in (76a-c) are provided in those contexts describing situations in (77a-c) respectively. All test sentences in these situations are logically true. If children can compute scalar inferences like adults, they are expected to reject the sentences.

(76) a. Merika apo ta aloga pidiksan pano apo to fraxti.
some of the horses jumped over of the fence
'Some of the horses jumped over the fence.'

b. Dio apo ta aloga pidiksan pano apo to fraxti.
two of the horses jumped over of the fence
'Two of the horses jumped over the fence.'

c. To koritsi arxise na ftiaxni to pazl.
the girl started to make the puzzle
'The girl started making the puzzle.'

(77) a. All of the horses jumped over the fence.

b. Three of the horses jumped over the fence.

c. The girl finished making the puzzle.

The results of the experiments indicate that children failed to endorse scalar implicatures with *some/all* and *start/finish*, but successfully assigned adultlike "exact" interpretations to *two/three*[21].

To sum up, there are three possible interpretations for Chinese indefinites: the specific interpretation, the "at-least" interpretation and the exact interpretation. It is therefore important to investigate what readings children assign to numerals in scope-interacting environments.

4.5.3. Experiment 2

4.5.3.1. Experimental Design and Predictions

We suggested in 4.2.3.4.4 and 4.5.2 that Mandarin-speaking children possibly assign non-adultlike readings to numerals. It is possible that they succeed in rejecting inverse-scope interpretations in Experiment 1 by assigning specific readings to numerals in scope-interacting environments. For this reason, Experiment 2 was designed to test how children interpret numerals in scope-interacting environments. The design of this experiment is identical to that of Experiment 1 except for the sentences used. Experiment 2 used topicalized versions of the test sentences used in Experiment 1, as exemplified below.

[21] According to Barner and Bachrach's (2010) analysis, the reason that young children succeeded in computing scalar implicatures for numerals is that children explicitly learn cardinal numbers in sequence. In other words, unlike other scalar items, numbers are learnt together with other items on the same scale. Thus, even for young children, it is presumably easy to access competing alternatives in the case of numbers, which accounts for their successful performance.

(78) Mei-zhong shuiguo$_i$ you yi-zhi xiao-xiongmao chi-le t_i.
每-种 水果 有 一-只 小-熊猫 吃-了
every-kind fruit have one-CL little-panda ate-ASP
'For every kind of fruit, there is a little panda eating it.' ∀>∃, ∃>∀

The truth condition of the surface-scope reading of sentence (78) is that for each type of fruit there is a (possibly different) panda which ate it as shown in (79a), and the truth condition of the inverse-scope reading is that there is a panda who ate every type of fruit as in (79b).

(79) a. b.

Note however that as we mentioned in 1.4.1, in the case where a universal quantifier overtly takes wide scope over an existential quantifier, an entailment problem arises: the truth of the inverse-scope reading may be just a special case of the surface-scope construal. Given that the surface scope is generally easier to obtain, if children interpret the numeral phrase *yi-zhi* as meaning "at least one", it comes as no surprise that children accept the test sentence in both contexts in (79) (the truth condition: for every kind of fruit, there is at least one little panda eating it). However, if they endorse a specific reading, it is expected that they accept the test sentences in the context in (79b), but reject them in the context in (79a), because only in the context in (79b) is there a panda who ate all the three types of fruit. On the other hand, if children adopt an "exact" reading, the prediction is that children accept test sentences in the context of (79a) since each fruit has exactly one panda who ate it but they reject test sentences in the context of (79b) because strawberries and pineapples are eaten by two pandas. (80) summarizes the predictions.

(80) Predictions

	(79a)	(79b)
At-least reading	Accept	Accept
Specific reading	Reject	Accept
Exact reading	Accept	Reject

In the experiment, two test sentences were provided in a context like (79a) and four were given in a context like (79b). In addition to the test sentences, two fillers like (81) were also included in the stimuli. The fillers were provided in contexts like (79b).

(81) Caomei$_i$ you yi-zhi xiao-xiongmao chi-le t_i.
草莓 有 一-只 小-熊猫 吃-了
strawberry have one-CL little-panda ate-ASP
'For strawberries, there is a little panda eating them.'

The fillers were designed to see whether children prefer exact readings of numerals in environments with no scope interaction involved. If children assign exact readings to numerals, the filler sentences should be rejected.

4.5.3.2. Participants

Twenty-four Mandarin-speaking children aged from 4;9 to 6;8 (mean: 5;7) as well as 9 control adults participated in this experiment. All of the children were also recruited at the same kindergartens as in Experiment 1, but no subject participated in both experiments. All children passed the same pre-tests as used in Experiment 1.

4.5.3.3. Results and Discussion

The results of the experiment are summarized in (82). Children showed the same acceptance pattern as adults. They significantly accepted the test sentences in contexts like (79a) (binomial test, children: $p < .001$, adults: $p < .001$) and rejected the filler sentences (binomial test, children: $p < .001$, adults: $p < .01$). However, the acceptance rates of the test sentences in contexts like (79b) are not statistically

significant (binomial test, children: p = .61, adults: p = 1). A Cochran's Q test found that in both adult and child data there was no difference among items in each condition (children's readings in context (79a): p = .56, adults' readings in context (79a): p = .32, children's readings in context (79b): p = .24, adults' readings in context (79b): p = .11). These results suggest that the overall acceptance rates of both adults and children in the context in (79b) were not different from chance.

(82) Acceptance rates in Experiment 2

		(79a)	(79b)	Filler
Children	Number of acceptance	37/48	45/96	12/48
	Acceptance rate	77.1%	46.9%	25%
	p-value of binomial test	$p < .001$	$p = .61$	$p < .001$
Adults	Number of acceptance	17/18	18/36	3/18
	Acceptance rate	94.4%	50.0%	16.7%
	p-value of binomial test	$p < .001$	$p = 1$	$p < .01$

The table in (83) shows the distribution of individual acceptance rates in each condition. Most of the children as well as adults systematically accepted the test sentences in contexts like (79a) and rejected the filler sentences. The systematic rejection of the filler sentences indicates that participants assign exact interpretations to numeral phrases in those environments where no scope interaction is involved. What is important here is the response pattern observed in contexts like (79b). As we can see from the table in (83), only one child accepted the test sentences 50% of the time, and others showed consistent acceptance or rejection.

(83) Individual acceptance rates

		0%	25%	50%	75%	100%	Total N
Children	Contexts like (79a)	4	-	3	-	17	24
	Contexts like (79b)	9	3	1	4	7	24
	Filler sentences	16	-	4	-	4	24
Adults	Contexts like (79a)	0	-	1	-	8	9
	Contexts like (79b)	3	2	0	0	4	9
	Filler sentences	6	-	3	-	0	9

Now consider the individual acceptance pattern in the contexts depicted in (79a) and (79b). (84) and (85) are the cross tabulations which plot the number of subjects vis-à-vis the acceptance rate in each context. The results are divided into "accepted", "50%" and "rejected" based on the acceptance rates shown in (83). The participants who never accepted the test sentences or accepted them only 25% of the time count as "rejected", and those who accepted them 75% or 100% of the time are classified as "accepted".

(84) Children

		Contexts like (79b)		
		Accepted	50%	Rejected
Contexts like (79a)	0%	3 (12.5%)	0 (0%)	1 (4.2%)
	50%	2 (8.5%)	0 (0%)	1 (4.2%)
	100%	6 (25%)	1 (4.2%)	10 (42%)

(85) Adults

		Contexts like (79b)		
		Accepted	50%	Rejected
Contexts like (79a)	0%	0 (0%)	0 (0%)	0 (0%)
	50%	1 (11.1%)	0 (0%)	0 (0%)
	100%	3 (33.3%)	0 (0%)	5 (55.6%)

Of particular importance are the numbers boxed. As we predicted, the subjects who displayed "at-least" readings accepted test sentences in both contexts (79a) and (79b). If they took the numeral as having a specific referent, they accepted the test sentences in (79a) but not in (79b). If the numeral was assigned an "exactly-one" reading, on the other hand, they accepted the test sentences in (79a), but not in (79b). Given these predictions, let us see again the tableaus in (84) and (85). Three adults and six children accepted the test sentences in both contexts. It indicates that these subjects assigned "at-least" interpretations to numeral phrases[22]. An interesting difference that we found between children and adults is that three children accepted test sentences only in the context in (79b), while no adults did so. This means that some children assign specific interpretations to numeral phrases in a non-adultlike way. We also found that 10 children and 5 adults rejected the test sentences in (79b) but accepted them in (79a). The results indicate that most children in our experiment prefer exact readings for numeral phrases just as adults do.

The table in (80) summarizes the results.

[22] Among these children, two accepted the filler sentences as well. Since they have never rejected stimuli, we cannot distinguish between those who had "at-least" readings and those who had a yes bias. Actually, if the numeral phrases were interpreted as "at least one", the filler sentences would have been accepted irrespective of scope interpretation. However, only two children and no adults showed such responses: three children and two adults always rejected the filler sentences, and one child and two adults accepted half of them. These results indicate that Mandarin speakers exhibit distinct interpretations for numerals in scope-interacting and non-scope-interacting environments.

(80) Summary of the results

	(79a)	(79b)	Children	Adults
At-least reading	Accept	Accept	6 (25%)	3 (33.3%)
Specific reading	Reject	Accept	3 (12.5%)	0 (0%)
Exact reading	Accept	Reject	10 (42%)	5 (55.6%)

In this experiment, we found that in addition to the "at-least" interpretation and the exact interpretation, children also give specific interpretations to numeral phrases unlike adults.

Note however that if only 12.5% of the children assigned specific interpretations to numerals, it does not warrant the conclusion that the children in Experiment 1 successfully rejected inverse-scope interpretations at over 80% of the time due to the fact that they assigned specific readings to numerals. Let us see again the test sentence used in Experiment 1.

(24) You yi-zhi xiao-mifeng chi-le mei-zhong shuiguo.
有 一-只 小-蜜蜂 吃-了 每-种 水果
have one-CL little-honeybee eat-ASP every-kind fruit
'There is a little honeybee eating every kind of fruit.' ∃> ∀, * ∀> ∃

In Section 3.4, we discussed that *you*-sentences are existential sentences and the NP_1 and the XP after *you* construct a topic-comment structure (or a subject-predicate relation). However, this sentence has a temporarily ambiguous structure. At the stage of processing where *yi-zhi xiao-mifeng* is reached, children expect that the QP is an object of the verb *you*. Thus, at this stage, children assign a SVO structure to the input and the sentence fragment is interpreted as "there is a little honeybee". Generally, it is hard for children to cancel their initial processing decision and recover from the incorrect processing (cf. Trueswell et al. 1999). So children who initially analyze the first part of the input as having SVO structure might well analyze the second part *chi-le mei-zhong shuiguo* as having a structure shown in (86), where *pro* is interpreted as referring to the little honeybee.

(86) [$_{IP}$ pro [$_{VP}$ chi-le [$_{DP}$ mei-zhong shuiguo]]]

In other words, sentences like (24) might be misinterpreted as consisting of two clauses, each of which contains a QP. If so, the sentence in (24) might well be interpreted as "there is a little honeybee and it ate every kind of fruit". Note that there is no scope interaction between *yi-zhi xiao-mifeng* 'a little honeybee' and *mei-zhong shuiguo* 'every kind of fruit' in this structure since the two QPs reside in different clauses, and thus, there is no option to derive inverse scope. But the meaning resulting from this incorrect structure is identical to the surface-scope interpretation obtained from the correct structural analysis of *you*-sentences. This is possibly the reason why Chinese-speaking children could successfully accept inverse-scope interpretations and reject inverse-scope interpretations of doubly-quantified sentences.

We mentioned in Section 4.2.3.4 that the aim of Experiment 1 was to examine whether Chinese children could successfully reject inverse-scope readings in simple SVO sentences. However, if the analysis here is on the right track, it is fair to say that we failed to examine Chinese children's interpretation of inverse scope since the wrong structure they possibly assigned to the input should thwart scope interaction. One might argue that a simple way to modify the stimuli to ensure scope interaction is to avoid the use of *you* 'have,' which can lead children to an incorrect structural interpretation. However, this is not a viable option. In Chinese, an indefinite NP cannot occur in sentence-initial position. Thus the sentence below is ungrammatical.

(87)	*Yi-zhi	xiao-mifeng	chi-le	mei-zhong	shuiguo.
	一-只	小-蜜蜂	吃-了	每-种	水果
	one-CL	little-honeybee	eat-ASP	every-kind	fruit

'A little honeybee ate every kind of fruit.'

Another possible way to examine their scope interaction in SVO sentences is to change the position of the numeral QP and the universal QP as shown in (88)

(88) Mei-zhi xiao-mifeng chi-le yi-zhong shuiguo.
每-只 小-蜜蜂 吃-了 一-种 水果
every-CL little-honeybee eat-ASP one-kind fruit
'Every little honeybee ate a kind of fruits.'

However, an entailment problem arises in this sentence, and as such, this is not an appropriate sentence, either.

All things considered, it may be impossible to examine Chinese-speaking children's inverse-scope readings in simple SVO structures. Although we could not observe inverse-scope readings in child Chinese, the experimental results we obtained from Experiment 1 and 2 are meaningful in that they provided evidence showing that the reason for Chinese children's successful rejection of inverse-scope readings in simple SVO structures is not that they assigned specific readings to numerals.

4.5.4. Summary

In Experiment 2, we tested the possibility that Chinese children in Experiment 1 rejected inverse-scope readings due to their assignment of specific readings to numerals. In the results obtained in Experiment 2, we observed three types of children: those who have specific interpretations, those who have exact interpretations, and those who have "at-least" interpretations. Considering that the first type accounts for only 12.5% of the subjects, we conclude that the reason the children in Experiment 1 successfully rejected inverse-scope interpretations is not that they assigned specific interpretations to numerals. We suggested a possibility that children may have assigned incorrect syntactic structures to Chinese *you*-sentences due to processing reasons. Specifically, due to the structural properties of *you*-sentences, children might misinterpret these sentences as having two distinct clauses, each of which contains a QP. As such, for those children, the two QPs do not interact in terms of scope.

4.6. Are All Types of Reference-Set Computations Equally Hard?

We have seen in Section 4.3 that reference-set computation is at work in at least five areas, namely coreference in Principle B environments, computation of the

Avoid Pronoun Principle, stress shift for focus identification, scalar implicatures and QR, and reference-set computation in all these environments contains the following three steps: (a) constructing a reference set, (b) comparing the competitors in the reference set and (c) choose the most optimal competitor out of the comparison set. While all of the above-mentioned areas share the same three steps, it seems that their processing costs are not equal. In fact, grammatical judgment on multiply-quantified sentences is much more difficult than on other types of sentences even for adults, and off-line judgments provided by adult speakers are not always uniform. The issue that we should consider is what accounts for the difference between QR and other instances of reference-set computation with respect to processing costs.

As we discussed in Section 4.3.2, QR is a transderivational constraint while others such as coreference in Principle B environments, the Avoid Pronoun Principle, stress shift for focus identification and scalar implicatures are transclocal constraints under Müller's (2011) taxonomy. He pointed out that transderivational constraints have higher complexity than translocal constraints in that the candidates in the reference set are full derivations in the former case, but are only output representations in the latter. Given this idea, we can reasonably speculate that the supposed differences in processing complexity may reduce to the differences in the type of constraint computed. That is, the reference-set computation required for QR is more difficult than the reference-set computation for other constraints because the former, unlike the latter, requires that full derivations of the candidates be held in the constructed reference set.

4.7. Summary

In the first part of this chapter, we have reviewed previous acquisition studies on Japanese-speaking and Chinese-speaking children's interpretation of scope. In Section 4.2.2, we reanalyzed experimental data from Japanese children. On the basis of the statistic analyses which show that the Japanese children's acceptance rates of inverse-scope readings are significantly different from Japanese adults', but are not significantly different from English adults', previous studies concluded that Japanese children permit inverse-scope readings for canonically-ordered sentences. However, our closer inspection has shown that Japanese children's acceptance rates of inverse-scope interpretations are not significantly different from chance. In Section 4.2.3, we reported

results of our experiment with Mandarin-speaking children. The results show that unlike Japanese children, Chinese-speaking children successfully reject inverse-scope readings.

To explain the contrast between Japanese and Chinese children's behavior, we reviewed previous acquisition studies on reference-set computation, and saw that if a truth-value judgment task is conducted with children around five, their acceptance rates fall within the range of chance. According to Reinhart's analysis, this is because reference-set computation comes with a heavy processing load, which exceeds children's limited processing capacity. As a result, they respond by guess, and the accuracy rates do not go beyond chance. Building on Reinhart's analysis, we answered the last question raised in Chapter 1: the question of why children inconsistently accept inverse-scope readings and what makes it more difficult to derive inverse scope than surface scope. Japanese children inconsistently accepted inverse-scope readings due to the difficulty in handling reference-set computation. While the fact that deriving inverse scope is difficult directly comes from the heavy cost of reference-set computation, the question still remains as to why the same does not hold true for Chinese children. To understand the reason behind their apparently adultlike performance, we conducted another experiment to examine the possibility that Chinese children prefer to assign specific readings to numeral phrases. Based on the results obtained in Experiment 2, we concluded that Mandarin-speaking children's semantic preference is not responsible for their good performance. We suggested instead that they possibly assigned incorrect structures to *you*-sentences due to processing reasons, which would prevent the interaction between the two QP in the sentence.

From the experimental results, we can see that the factors responsible for children's behavior are not homogeneous across languages. Although reference-set computation is required in both Japanese and Chinese to block inverse-scope interpretations, language-specific factors affect children's construals more strongly in Chinese.

In Section 4.6, we compared various types of reference-set computation and argued that the processing costs are not equal across all types of reference-set computation. Specifically, in the case of QR, full derivations of the candidates in the

reference set must be held during the computation, and hence comes a large processing cost compared to other instances of reference-set computation.

Chapter 5 Conclusion

In this dissertation, we extensively investigated the mechanisms of scope ambiguity on the basis of linguistic data as well as experimental acquisition data, and gave answers to the following three questions raised in Chapter 1.

(i) What is the underlying mechanism that links scope rigidity and free word order?

(ii) Why do sentences with multiple scope-bearing operators in Chinese usually receive only surface-scope interpretations? And why do only certain types of sentences allow inverse scope?

(iii) Why do children inconsistently accept inverse-scope readings, and why is it more difficult even for adults to obtain inverse-scope readings than surface-scope readings?

In Chapter 2, we reviewed previous studies that investigate LF computations from the viewpoint of derivational economy, and demonstrated that Fox and Reinhart's accounts can capture the link between scope rigidity and free word order. Specifically, we argued that Fox's type of local comparison works for both reconstruction and QR, and the type of reference-set computation as proposed by Reinhart is at work in QR only. Thus deriving inverse scope via QR is blocked if there is an alternative optimal derivation to derive the same interpretation. In those languages which allow scrambling, scrambled sentences yield an interpretation that is equivalent to inverse-scope readings of canonically-ordered sentences. We argued that canonically-ordered sentences and scrambled sentences compete in terms of scope economy, and that scrambling is a more economical option to obtain inverse scope. This accounts for why the application of QR is disallowed in canonically-ordered sentences in these languages. By contrast, languages with rigid word order show scope ambiguity precisely because they have no option of scrambling. This is the answer to question (i).

The answer to question (ii) was provided in Chapter 3. Chinese is exceptional in that it does not have scrambling operations, but show scope rigidity. In Chapter 3, we demonstrated that scope rigidity in Chinese is governed by the same mechanism as

observed in other scope-rigid languages. Specifically, in Chinese, which is a topic-prominent and discourse-configurational language, canonically-ordered sentences compete with corresponding topicalized sentences in terms of scope economy. We claimed that topicalized sentences are chosen over canonically-ordered sentences to obtain inverse-scope construals, which accounts for the fact that canonically-ordered sentences fail to exhibit inverse-scope readings. We also observed that certain types of Chinese sentences such as postverbal-*gei* sentences and sentences with a locative QP show scope ambiguity. We argue that since these sentences do not have an alternative way to derive the same interpretation without recourse to a marked operation, deriving inverse scope via QR is justified.

Chapter 4 discussed issues on reference-set computation in child languages and answered the questions in (iii). Previous experimental studies reported that in a truth-value judgment task, young children assign non-adultlike interpretations to sentences involving reference-set computation about 50% of the time. According to Reinhart, reference-set computation comes with a heavy processing cost, and children cannot complete the whole computation due to their limited processing resources. Thus, they response by guess, and as a result, their acceptance rates fall within the range of chance performance. This is why children inconsistently accept inverse-scope readings. The analysis here can also provide a natural answer to the second question in (iii): inverse-scope interpretations are generally more difficult to obtain than corresponding surface-scope readings because only the former, but not the latter, require reference-set computation.

If this analysis is on the right track, children who speak a scope-rigid language are expected to allow inverse-scope interpretations by chance. We started by conducting detailed statistical analyses of previously reported experimental results, and found that Japanese children's acceptance rates of inverse-scope readings for canonically-ordered sentences are not significantly different from chance. These results are compatible with other previous experimental studies on reference-set computation. However, results from Experiment 1 show that Chinese-speaking children successfully reject inverse-scope readings for canonically-ordered sentences. We thus conducted an additional experiment to locate the source of Chinese-speaking children's apparently adultlike behavior. Experiment 2 was designed to test the hypothesis that Chinese-speaking

children assign specific construals to QPs involving *yi-ge* 'one-CL.' We found that although there were a few children who preferred specific interpretations, the tendency was not robust enough to support the idea that the preference for specific interpretations is responsible for their good performance. We thus suggested another analytical possibility; that is, children might possibly analyze *you*-sentences as having a coordinated structure, which presumably precludes scope interaction.

The implications of this dissertation are two-fold. First, although the questions that we addressed here, at first sight, are unrelated separate issues, adopting a reference-set-computation-based analysis provides a principled solution to all these issues. The analysis developed here is theoretically desirable in that multiple issues can be solved with fewer operations, much in line with the spirit of pursuing the simplest theory. This in turn means that our theory is congenial to the basic tenet of the Minimalist Program, which lays emphasis on the view that language meets the requirement of economy (or efficiency). As we discussed in Section 2.2, in theories where every QP is assumed to undergo QR, phonologically and semantically vacuous movement must be required to obtain surface-scope readings in doubly-quantified sentences. Our theory successfully eliminated such phonologically and semantically uninformative movements precisely because QR applies only when it is forced by interface needs. Furthermore, our analysis does not face any learnability problems. That children accept inverse-scope readings in scope-rigid languages like Japanese is due to their processing limitations; that is, their limited processing resources cannot withstand the cost of executing reference-set computation. Thus, it is expected under this scenario that children get to show adultlike interpretations once they have developed sufficient processing capacity.

One remaining issue is that, as we discussed in 4.2.2.4, English-speaking adults in Goro's (2007) experiments successfully accepted inverse-scope readings only 33.6% of the time while Japanese adults successfully rejected them 100% of the time. Since adults have no problem executing reference-set computation, adult English speaker's low acceptance rate cannot be chalked up to the processing difficulty of reference-set computation. Further investigation is called for in order to identify the factors responsible for their apparently unsuccessful performance on sentences with inverse-scope readings.

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